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Industrial Energy Efficiency Policy
International practice and experience analyzed for application in Egypt

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Preface

This report presents the written deliveries of Ea Energy Analyses and Aura Energi in the UNIDO technical assistance on *Development of an industrial energy efficiency policy and strategy in Egypt*[1] and the amendments outlined in the Inception Report, dated 1st March 2014.

The technical assistance project is just one of several sub-projects under the UNIDO funded industrial energy efficiency (IEE) project which started in January 2013 and is expected to run for 5 years[2]. This larger project consists of 5 components. A team of Egyptian consultants were been assigned to carry out Task 1.6 "IEE policy", namely Logic Energy Consulting and Environics SAE. The core of the assignment given to Ea Energy Analyses A/S and Aura Energi has been to develop the methodology and framework for strategy and policy development and to provide support to the Egyptian team.

UNIDO project
1: National program to define energy benchmarks and EE policy
– 1.1 Support in the adoption and dissemination of EMS
– 1.2 Structure in place for M&V of compliance with EMS
– 1.3 Industrial energy database and energy consumption benchmarks developed.
– 1.4 EMS practical guide development
– 1.5 Post-project action plan
– *1.6 IEE policy*
2: Awareness raising on industrial energy efficiency and management in industry
3: technical capacity building on energy efficiency services
4: Access to finance for EE improvement projects
5: Implementation of energy management systems and system optimisation

Figure 1: Work components of the industrial energy efficiency project. This deliverable is part of 1.6..

The present report contains the first of three deliveries foreseen in the contract, namely: "International practice and experience". In following deliverables "Strategy methodology and framework" and "Policy methodology and framework" will be covered.

The assignment was carried out in the period February 2014 – July 2015 and is based on review of a broad selection of relevant literature. A special effort has been made to include recent literature (2012-2014). The majority of the literature has an European or perspective, however also many with a global cover-

[1] SAP# 100349, described in the RFP 700000439, dated 25th November 2013,
[2] Project no. GF/EGY/12/001

age, and examples from Latin America (Assumpção, et al., 2013) (Fossa, et al., 2013), Japan (Kimura, et al., 2014) (Shibata, 2013) and China (Levine, et al., 2011) (Shi, et al., 2014) (Zhao, et al., 2013) and New Zealand (New Zealand Ministry of Economic Development, 2011) has been used. Arab countries are represented by (Elrefaei, et al., 2014) (GEF-UNDP, 2009) (Logic Energy and Environics, 2014) (Secretariat of the Arab Ministerial Council for Electricity, November 2010).

Mikael Togeby

Contents

1 Executive summary

Industry matters

From 1998 to 2009, Egypt's electricity consumption increased with 7% p.a. This growth corresponds to a doubling of demand every ten years. Such a growth is a challenge for any system, and exploiting profitable energy efficiency projects can help alleviate the burden on the system. About 45% of total final energy is consumed by industry (Blanc, 2012) and 33% of the electricity is consumed by industry. It is therefore highly relevant to aim to realise the profitable savings opportunities within the industrial sector.

Energy efficiency does not happen automatically

It is generally recognised, that even well run companies do not necessarily realise energy efficiency (EE) opportunities even if these have a very short payback time. The focus of the companies is – as it should be – on their core business. This can be described as bounded rationality, where limited time is used for finding solutions and simplified rules are based on former experiences (in contrast to an ideal search for optimal solutions)[1].

If EE can become an integrated element in the management of the business it is more likely that opportunities will be exploited, e.g. in form of a systematic energy management system (EMS). If professional assistance can be provided from outside – such as mandatory energy audits – then awareness of the energy efficiency improvement potential is raised and can bring the companies one step closer to realising the benefits.

In many countries the industrial sector represents a challenge for policy makers. It may be politically difficult to subject the industrial sector to energy efficiency requirements, since the fear is that this might influence the competiveness of the industry negatively. However, a well-planned and balanced IEE policy can reduce total costs[2] and can improve quality and productivity.

Context defines effectiveness

There is no ideal strategy or policies – they will always be political compromises made in a given context at a given point in time. Nor is there a one-fits-all policy that is effective in all contexts. The conceptual idea of an approach may be transferable while the design details have to be modified in order to achieve a satisfactory impact at a reasonable cost. The formulation of new strategies and policies should be sensitive to national traditions and current possibilities. Furthermore, an industrial energy efficiency (IEE) strategy and

[1] See: (Nehler, et al.)
[2] Here total costs refers to the cost of the IEE instruments and the end-users costs (investments and energy costs).

the accompanying policy portfolio are just one element of a larger collection of strategies and policies aimed to guide the development of a given society.

This report presents examples of international IEE policy practice and experience and suggests a methodology and framework suited for development of an Egyptian IEE strategy and affiliated policies. When searching for best practise, the starting point of this report is to look for:

- Significant impact (net impact)
- Total costs test is positive (Total cost is below total benefits)

However, evaluation of IEE are few and not always consistent in methodology. Therefore, in many cases the relevant information is not available and a more qualitative assessment have been made.

Emphasis has in the collection of examples been on illustrating key elements and not necessarily to describe all possible instruments and variations of these.

Understanding IEE

A summary of the recommendations for the elaboration of an IEE policy portfolio for Egypt are presented below. Some of the recommendations relate to good governance in general while others relate to how to address EE in industry.

The starting point for the analysis of which policy instruments to recommend to Egypt is an understanding of the understanding of IEE:

- Many IEE solutions are well proven technology and **not technically difficult**. The challenges are more an issue of awareness, capacity, and financing. E.g. with the right support from management, qualified engineers can come a long way in daily operation and when purchasing new equipment.
- **Energy prices** reflecting true market costs (and environmental impact) are critical to creating EE interest. True market prices is understood as marginal (opportunity) costs.
- Even in countries with high energy costs and high environmental concern the full potential for **EE is not realised on its own accord**. It is necessary to use policy instruments to drive forward an interest in and uptake of IEE.
- All serious IEE instruments must be **financed**. If no commitment exist for operating, maintaining and evaluation the activity it is not likely to succeed.
- **The mind-set matters** – Change management’s perception of IEE from “necessary evil” (aim for minimum required) to “opportunity” (aim:

maximum benefits) i.e. combine IEE with other development objectives such as security of supply, reducing strain on water resources, upgrading skills of labour force and increased productivity.

- Stability – **Consistent high level political attention** to IEE is key to EE capacity building and signalling to industry that EE is and will be a serious matter. This should be matched by actions in form of relevant legislation and financing.

How to develop a portfolio?

In developing an IEE policy portfolio the following observation scan be done:

- A combination of several policy instruments – a **policy portfolio** – is typically more successful than an alone standing policy instrument.
- **Stakeholder consultation** already in the early phases of strategy and policy formulation can be critical to success.
- Dynamic policies – **Monitoring and evaluation** at regular intervals are necessary for developing and adjusting policies dynamically to the latest needs and challenges. Energy audits and EMS can for example provide valuable individual information not only to company management but for future policy-making, e.g. about IEE potential.
- EE can be a cost-effective solution – It is imperative that it is communicated to industry that EE **does not require subsidies** – it makes economic sense in its own right seen from an industrial company perspective as well as a societal perspective. Subsidies tends to attract free-riders: Companies getting subsidies to activities they would have done also without the subsidy. Also, with Egypt's history of low energy prices – subsidies should be avoided.
- **Get started now**! – Political negotiations and organisational capacity building takes time. But there is no reason to wait until everything is in place. It is possible to harvest good progress by starting small and immediately by addressing energy intensive industries.
- **Market segmentation** of the industrial sector is important. Industrial companies with large energy costs are likely to be more sensitive to EE. Large energy cost can be related to high energy intensity or large scale of operation. Companies with high energy costs should have first priority, when developing IEE activities. It can be a challenge to design economically efficient activities for industrial companies with a modest energy bill, e.g. below 100,000 USD/year.
- The industrial sector is very heterogeneous in its energy use and a **balanced approach** offering both energy audits (external consultants) and energy management systems (company internal activity). And in particular EMS should be combined with an incentive to perform well, e.g. through certification and if relevant also linking tax rewards to ambition level for EE implementation.
- Certain types of policy instruments require significant **regulatory capacity** to verify compliance and uphold a reasonable level of compli-

ance and achieve real impact. Examples include minimum efficiency standards, market transformation, white certificates and voluntary agreements. ESCO can be relevant is special cases. However, in many situations the risk associated to IEE is limited and an ESCO solution may only add cost and complexity. Such activities can be very relevant in the long term but are probably not best suited as first steps to IEE in Egypt.

Candidates for IEE instruments

Based on the overview of international practise with IEE policy instruments, we point at five candidates for instruments that should be considered relevant for Egypt as first steps to increase IEE. The instruments must be adapted to the local context to be effective. The five instruments are:

- **General information and campaigns**. Using information to promote IEE is relevant and can support a growing concern for the topic and can help other instruments like energy audits and Energy management systems (EMS) to be effective.
- **Energy audit** can help with concrete and detailed information about profitable project at the individual facility. Energy audits can be made mandatory for the largest energy users. Universities can offer audits to all types of companies.
- **EMS** is a systematically approach to dealing with energy and IEE in all aspects for the production. The responsibility for effective EMS is on the industrial management. Tax reduction can be used to incentivise large energy users to use certified EMS.
- **Energy efficiency obligations** on energy companies is a way to invent an actor that can finance and run activities to promote IEE. EU consider this as a recommended instrument, and Egypt could design obligations to fit their conditions. In Europe subsidies are often used by the obligated party, but that may not be relevant in Egypt.
- Activities can also be developed around a specific technology, e.g. **motor systems**. Motor systems is the motor and the equipment that it is driving. A significant share of industrial electricity use (often more than half) is use in motors. The actual instruments to promote higher efficiency in motor systems may for a start include campaigns, labelling and can be relevant in energy audits and EMS.

Other IEE policy instruments is also possible for Egypt. However, these five are all good candidates and international practise can guide the design of instruments.

Part I: Framework for industrial energy efficiency policy

2 Introduction to Part I

The aim of “Part I: Framework for industrial energy efficiency policy” is to present international practice of developing IEE policies presenting the pros and cons and lesson learned that may be of relevance to the Egyptian context. The purpose is develop a perspective to be used when analysing the many possible IEE instruments.

- The Egyptian context: A short introduction to IEE in Egypt.
- Energy efficiency in industry: EE in industry has other challenges and characteristics than, e.g. households. This chapter highlights the special nature of IEE.
- Key consideration in EE policy development. What is the success criteria? How can industry be divided into segments? Why is evaluation important?

The chapter Key consideration will in a following deliverable be further developed into a report about strategy and policy methodology and framework.

Definitions

In the report, we distinguish between policy instrument *type* and the *design* features of a given policy instrument. For example, an audit program is an instrument type and it can be designed in a variety of different ways.

The term "industry" is used for private and public production entities, excluding energy companies. Agriculture, fishery, and forestry are in principle included but are not the primary targets. The term "industry" does not include any private or public tertiary sector entities.

3 Egyptian context

This chapter describes the main challenges of Egypt's energy policy framework and give a short introduction to current energy efficiency policies and industrial energy efficiency instruments. The chapter is based on the baseline report prepared by Egyptian experts, assigned to develop an IEE policy for Egypt (Logic Energy and Environics, 2014) where no other reference is mentioned.

3.1 Egypt's challenge

Aspirations

The Government of Egypt intends to continue the transition to market based energy prices. In 2014 the supply of local natural gas have not been able to follow the demand and the marginal natural gas demand are now paid at international import prices.

Alleviate strain

This transition to international market prices is a politically difficult task and measures to alleviate the strain placed on end-users are required. The Egyptian situation is worsened by the prospects of expected increases in global fuel prices, as for example illustrated in the scenario analyses presented in IEA World Energy Outlook where fuel prices continues to increase in the period up to 2040 (IEA, 2013). Energy efficiency (EE) can, if tailored carefully, lead to greater consumer acceptance of and protection against price increases (see Figure 2). EE can provide solutions faster than supply-side options. IEE can contribute to making Egypt and the individual industrial companies more robust against the expected global increases in fuel prices and at the same time contribute to more sustainable energy exploitation (i.e. limit energy demand and exploit fossil fuels more efficiently).

Opportunities

Looking at the situation from the opposite perspective one may claim that the foreseen price increases can be used as leverage for kick-starting an interest in energy efficiency which also has other benefits to society and the industrial companies involved (Cambell, et al., 2012). IEE can for example go hand in hand with a development in direction of modernisation of industry and industrial management, e.g. in the form of energy management systems. Increased productivity and competitiveness can be positive side effects of IEE activities (IEA, 2014).

Furthermore, countries such as Egypt with growing economy have an opportunity to pursue energy efficiency at only moderate additional cost, e.g. in relation to developing new production lines.

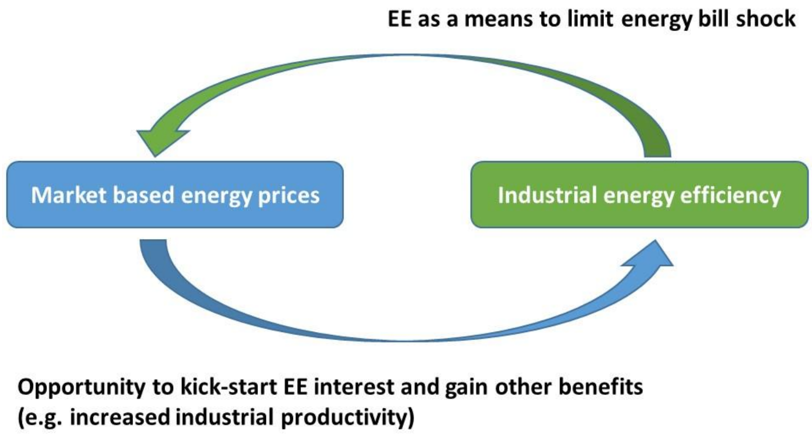

Figure 2: Perspectives on EE.

EE practice

Far from all profitable EE improvements are realised on their own accord – not in Egypt nor elsewhere – and it is widely recognised that public intervention is necessary if a larger share is to be realised. When industrial companies do not realise profitable investment it is often because they have other priorities, like product quality and production volume. Many companies do not have capability (staff and management focus) needed to *also* focus on IEE.

Years of energy prices below marginal opportunity costs means that the Egyptian industry has only had little incentive to optimise their energy consumption. Industry focus has been on acquiring sufficient energy. There is therefore little tradition for management to consider EE and most likely few industrial companies have assigned persons with the responsibility for EE.

Energy consumption

The total final energy consumption was 50 Mtoe (2008), and 42% of this was used in industry. Industrial consumption have experience a growth of 4.1% p.a. (2000/2001 to 2011/12). The three sub sectors steel, cement and fertilizers accounts for 55% of the industrial energy consumption.

Energy prices

Energy prices are controlled by the government and were fixed for long time (e.g. 1992-2004). In recent years price increases has taken place and for energy intensive industry prices has reach production costs, but still not reached opportunity costs (export price or cost for reduced import).

The current supply crises for natural gas in Egypt highlight that “all demand is marginal demand” (any reduction en natural gas consumption would reduce the last, most costly provision of gas). Electricity is primarily produced on natural gas (more than 70% is based on natural gas). Natural gas is also used e.g. for cement production – internationally, cement factories use coal and waste.

Figure 3 shows the electricity price for industry in Egypt (2012). These prices are very low compared to international market prices.

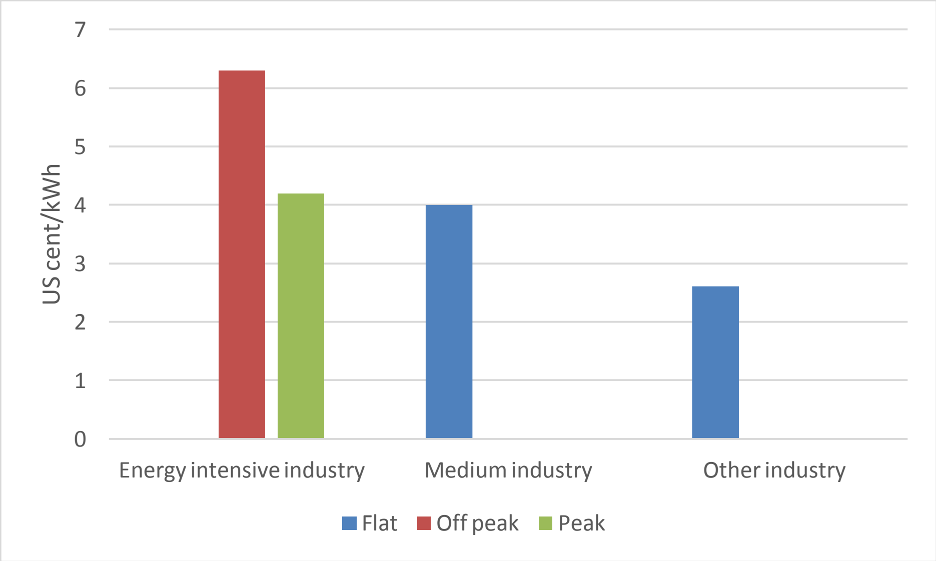

Figure 3. Electricity prices for high voltage consumers. 2012.

International comparison indicate that Egyptian industry has a lower energy efficiency than what can be found in comparable countries. A study (Missaoui, et al., 2012) indicated that the Egyptian industrial electricity price was only 25% of the price in Palestine, which in this study was used as a benchmark for an international market price.

Energy pricing policies are not addressed in this report; it is treated as integral to the supply-side. Never-the-less a sound price signal is critical to a well-functioning, modern energy system. It includes market based pricing (marginal cost including environmental costs)[1].

3.2 EE policy

The Council of Arab Electricity Ministers of the League of Arab States has adapted the Arab EE Guideline in 2010. The guideline is inspired by the EU

[1] Furthermore, policies aimed at load shifting or energy/fuel switching are not included, although also relevant to Egypt. Correct dynamic pricing, especially for electricity, can be important due to the current supply constraints. Advanced tariffs may include time-of-use tariffs (fixed schedule), real-time pricing (e.g. hourly spot prices), or critical peak-pricing (fixed schedule combined with high or low prices that can be dispatched e.g. with a day's notice).

directive 2006/32/EC on energy end-use efficiency and energy service. The guideline states that the "RE/EE Expert committee set up in accordance with the decision of the Council of Arab Ministerial Council for Electricity No. 127, and the committee's work groups shall be responsible for monitoring the implementation of this guideline in coordination with regional and international institutions and specialized research centers."[1]

The National Energy Efficiency Plan 2012-2015, prepared by the Energy Efficiency Unit for the Council of Ministers, approved by the Cabinet 11 August 2012, sets a target for 2025 of 5% cumulative electricity saving relative to the annual average of the period 2008-2012 (Energy Efficiency Unit, 2012). However, IEE is limited to building energy audit capacity. The fact that the responsibility for the energy sector development is split between two ministries – Ministry of Electricity and Energy and Ministry of Petroleum – can present a challenge in terms of formulating plans for primary and final energy. (Elrefaei, et al., 2014)

"Taking action through industrial consumers can generate results with a relatively small number of participants if the appropriate ones are targeted. For instance in Egypt, where more than 40% of total energy is consumed by the industrial sector, the energy intensive industries represent 1% of the number of factories and consume 65% of the industry energy share. Clearly these few consumers can significantly contribute to EE efforts. The most widespread potential exists in co-generation, waste heat recovery, fuel switching and improved process control." (RCREEE, 2013) However, there is likely to be EE potentials that are more easily realised.

3.3 Industrial energy efficiency instruments

Reform of the pricing system is underway. Apart from this only little public activity is currently targeted to promote IEE. In the last decades several large demonstration projects has focused on energy audits. These have been donor based arrangements and have not been transposed to permanent activities. Probably, low energy prices have hindered the success of these activities.

There is no designated EE agency "responsible for formulating, promoting, and implementing EE policies. There is an EE unit at the Council of Ministers

[1] Agree during their 26th Executive Bearue meeting that took place in Cairo on 23 November 2010 (decision no. 95 /26/2010). See also: (Secretariat of the Arab Ministerial Council for Electricity, November 2010)

secretariat that is identified as the mandated entity for development and implementing a" national EE action plan. (RCREEE, 2012)

4 Energy efficiency in industry

Seen from a policy-maker perspective the industrial sector is distinctly different from other energy consuming sector of the economy, such as the residential sector or the tertiary sector.

4.1 Characteristics of the industrial sector

Heterogeneous sector

The industrial production set-up is frequently highly individual (e.g. operational control) although certain technical components appear in many production systems (e.g. motors, pumps, compressed air, ventilation, cooling, and boilers). Policies can be composed to target such standard components but many EE decisions are best made locally because of the importance of system perspective, control systems and maintenance, i.e. within the individual industrial company or branch organisation. This limits the possibilities for generic minimum EE requirements per produced unit since many of the really significant EE improvement opportunities a specific to the individual company. Policies aiming at helping the individual industrial companies identify EE opportunities are thus of high value.

Taxation possibility

Industrial companies are typically exposed to competition. In most cases the primary competition factors of their products are price and quality. Many companies are highly sensitive to changes in production cost: It can therefore be difficult to introduce taxes on energy with the aim to stimulate EE interest although taxes in general are considered to be a cost-effective policy instrument. Especially companies that are both energy intensive and exposed to competition from other countries are typically considered particularly vulnerable to taxation regimes.

Differentiated policies

If, for example, 20% of the industrial companies represent 80% of the industrial energy consumption then it is important that these are addressed adequately in the IEE strategy. The same holds true for industry subsectors that are experiencing growth: making sure their utilisation of energy is efficient avoids unnecessary "lock-in" of future energy consumption[1].

When designing EE policies it should be kept in mind that there is a great span between small artisan companies to highly industrialised and automated companies in terms of local employment, technology complexity, required

[1] It is considered as lock-in, if e.g. a company invest in a new production line without considering the EE options. For the life time of the production line it may be difficult to improve the efficiency.

skills, innovation, and management. In addition, some companies are part of a larger conglomeration of companies – sometimes international – and therefore best addressed together.

Awareness

IEE is not necessarily technically difficult. Although the individual technological component may be high tech (e.g. a variable frequency inverter), installation and operation is a standard job for an engineer. The overall challenges are more an issue of awareness and capacity.

Examples of IEE

Tanaka (Review of policies and measures for energy efficiency in industry sector, 2011) gives the following list of types of IEE projects:

- Maintaining, refurbishing and retuning equipment to counter natural efficiency degradation and to reflect shift in process parameters
- Retrofitting, replacing and retiring obsolete equipment, process lines and facilities to new and state of the art technologies
- Using heat management to decrease heat loss and waste energy, e.g. by prober use of insulation or utilization of exhausted heat and materials from one to another process
- Improving process control, for better energy and materials efficiency and general process productivity
- Streamlining process – eliminating processing steps and using new production concepts
- Re-using and recycling products and materials
- Increasing process productivity – decreasing product reject rates and increasing material yields

This description highlight the link to productivity. New production methods or new production lines may improve EE significantly.

Creating an EE demand

The following is required for an EE demand from the industrial sector and a well-functioning IEE market[1]:

- **Awareness** among the industry of the EE possibilities and of how to realise these.

[1] Many taxonomies have been used over time. Another and more detailed taxonomy, developed recently can be found in "A novel approach for barriers to industrial energy efficiency"; Andrea Trianni, Enrico Cagno, Ernst Worrell, and Giacomo Pugliese; Renewable and Sustainable Energy Reviews 19 (2013); Elsevier Publisher; December 2012. Here emphasis is placed on segregating barriers internal and external to the company. The types of barriers include 6 internal with 27 subcategories and 6 external with 17 subcategories.

- **Information** on the current state of energy consumption and the EE potentials in typical industries or dominant technologies (motors, fans, pressurised air etc.)
- Availability and access to EE **expertise and skills** (industrial companies, key institutions, external experts and service providers including e.g. an understanding among investors and financiers of potential financial returns of EE).
- Availability and access to EE **technologies and solutions**.
- Perhaps a **driver** (in addition to the energy price signal) to create an interest among industries to take action well prior to the energy price increases.

Company culture

In addition, there are barriers to IEE that can also be very important to address, namely corporate and management cultures directly or indirectly related to energy efficiency. Examples include:

- Focus on investment costs rather than considering the recurrent energy costs arriving at life-cycle costs,
- Focus on large investment opportunities rather than more modest investments in improved day-to-day operation or systemic optimisation, and
- The general skills and mandates of the work force and the training regime for updating and upgrading these.

Ideally, an industrial company should consider EE possibilities in

- the day-to-day operation & maintenance (O&M),
- when replacing existing equipment, and
- when making a purchase decision regarding new production equipment or major product line modifications.

The key persons that influence these three activities will be the primary target groups for policies aiming to promote EE and the policies must be designed to target the time of decision-making (see Table 1**Error! Reference source not found.**).

Company activity	Time of occurrence	Primary target group
Operation & maintenance	Steadily	Staff
Retrofit (EE improvement of existing equipment)	Occasionally	Staff, External consultants or suppliers
Replacement of existing equipment	Natural (at end-of-life / breakdown)	Staff, Management
	Forced	Management
Purchase of new production equipment or major product line modifications	Production expansion or alteration	Management, Cooperate management

Table 1: Time of occurrence of company activities that influence EE levels and the primary groups making decisions regarding the company activities.

Experience from the Japanese energy management scheme underlines the fact that the ability of a company to benefit from a policy promoting for example establishment of an energy management system depends among other things on the energy intensity of the company and the organisational capacity.

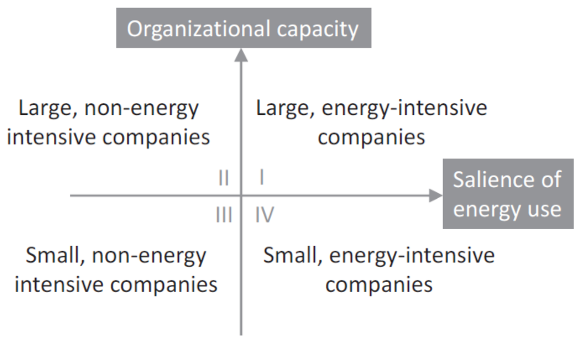

Figure 4: Categorisation of companies by salience of energy use (here: energy cost share of total costs) and organisational capacity (Kimura, et al., 2014).

4.2 Financing an EE project

An industrial company perspective

Industrial companies have limited capital for investment and typically require repeated loans for investment in their production. Since EE is not their core business they are often hesitant to take up loans for investment in EE projects. The reason is that any loan/debt and any asset including those of the EE project will figure in their balance sheet and will be scrutinised by a potential investor. Taking a loan for an EE project might mean that the company cannot take a loan for a core production investment.

It should be noted that experience shows that about 80% industrial companies only consider the payback period when deciding on investment in EE and not profitability indicators such as internal rate of return (Jochem, 2014). Their focus is in other words on the upfront investment cost instead of the full cost and benefit – including life time of investments.

An investor perspective

Many IEE investments can be considered as part of daily operation, e.g. when replacing a broken component (e.g. a motor). However, in some cases specific financing is required. There are three core types of investors available to industrial companies to acquire financing for EE projects: Bank loans, green loans, and equity loans. An industrial company is not likely to be able to obtain the main share of the investment from a bank for EE projects relying on new technologies or unproven concepts unless their balance sheet is large and robust. In these cases green funds and equity funds are more likely to be interested.

	Mainstream	**Non-mainstream**	**Invention**
EE technology	Proven technologies	New technologies	Unproven concepts
Risk perceived by investors	Low risk => low return	Known risks	High risk = potentially high return
Type of investor most likely to finance the main share of the investment	Bank	Green loan	Equity
Typical maximum share that a normal bank will provide of the total required investment	60-90%	50-80%	None or minor

Table 2: Financing options by type of EE project. (Dorine Putman-Devilee, 2014)

An IEE strategy therefore frequently contains elements to alleviate barriers to financing of EE projects. However, Egypt may focus on promoting well-proven mainstream technologies. This reduces the need for special financing mechanisms.

5 Key consideration in policy development

The aim of any energy strategy is to provide sufficient energy to facilitate the intended economic activity – in other words to ensure sufficient, reliable, robust, cost-effective, and clean energy.

There is no ideal strategy nor policies. They will always be political compromises made in a given context at a given point in time. A policy that may be effective in one context is not necessarily effective in another, nor the most cost-effective. The conceptual idea of an approach may be transferable while the design details have to be modified in order to achieve a satisfactory impact at a reasonable cost.

The formulation of new strategies and policies should be sensitive to national traditions and current possibilities. Furthermore, the industrial energy efficiency (IEE) strategy and policy portfolio are just one element of a larger collection of strategies and policies aimed to guide the development of Egypt (see Figure 5**Error! Reference source not found.**).

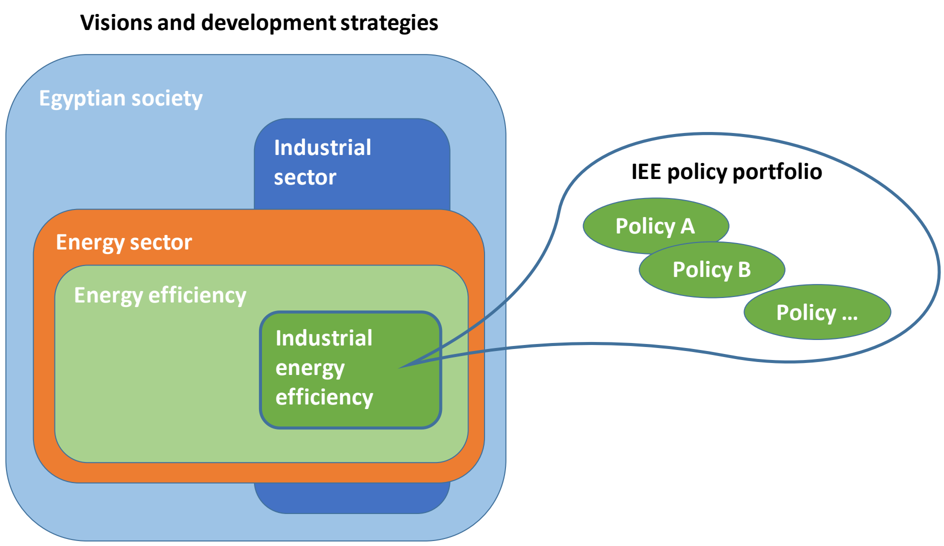

Figure 5: The IEE strategy and policy portfolio is just one of several other.

In this chapter a methodology and framework for designing and implementing efficient EE policies are discussed.

5.1 Policy instrument type

Types of policies

Seen from the end-user perspective there are three classic types of policies, namely *informative*, *economic*, and *normative*[1].

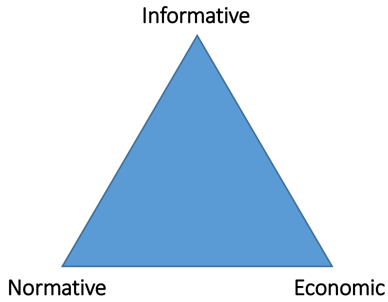

Figure 6: The three classic policy instrument types.

Examples and pros and cons are shown in Table 3**Error! Reference source not found.**. Please note that although the energy price itself is not counted as part of the economic instruments it is key to achieving EE.

[1] Many classification systems exist for EE instruments. E.g. (Review of policies and measures for energy efficiency in industry sector, 2011) uses 1) Prescriptive policies (e.g. regulation, voluntary agreements), 2) Economic policies and 3) Supportive policies (e.g. energy audits, capacity building and technical information. Institute for Industrial Productivity (Reinaud, et al., 2011) uses a pyramid of: 1) Effort-defining policies (in the top of the pyramid with mandatory targets, negotiated agreements and minimum energy norms), 2 Supporting measures (in the middle with financial incentives/disincentives, energy management and audits and equipment standards) and 3) Implementation Toolbox (in the base, with Energy management protocols, technology lists, networking, workshops).

Instrument type	Example	Pros	Cons
Economic	Taxes	Generally considered efficient: All decisions taken by end-users. Revenue to state. Do not have to be renegotiated very often.	Often difficult to get accepted, e.g. by industry.
	Subsidies to EE investments	Good attention.	Only temporary funding? High level of free riders? Too high cost for documentation? Cost for state
Informative	General information and campaigns (brochures, internet tools)	Low costs. Easy to implement. Can support other instruments	Often little impact. Often slow impact.
	Labelling (buildings, equipment, appliances, vehicles)	Can be a forerunner for minimum efficiency standards	Often little impact.
	Tailored information (audits, energy management systems, EE networks)	Takes into account the special needs and situation of the end-users. Enables the end-users to make EE decisions.	Relatively costly. Does not automatically lead to EE implementation
Normative	Minimal efficiency standard (building codes, appliance standards)	Creates a push. Suited for standardised use of appliances. Can be very cost-effictive.	Difficult in industry. Compliance verification.
Hybrid	Voluntary agreements	End-user commitment to reaching agreed targets.	Not suited for smaller entities.
Hybrid with RD&D	Technology procurement	Creates a market push and a pull at the same time. Can be very cost-effective.	Requires strong coordinated by neutral entity.

Table 3: Strengths and weaknesses of different types of policy instruments.

The *informative* policies leave a high degree of freedom and the underlying assumption is that if the end-user has the right and sufficient information they will make an energy efficient choice. The dilemma is that even if end-users respond as intended the uptake may not happen as quickly as needed.

Economic and normative instrument can on the other hand create such as push. *Economic* policies assume that the end-user is motivated by economic signals and implement measures that are cost-effective from the end-user's perspective. However, in fact the price responsiveness (i.e. price elasticity) of the different end-users varies and other non-economic factors may be more important the end-users.

The challenge of *normative* policies is to ensure compliance. If the norms i.e. the requirements, are perceived a too strict by the end-users, then compliance is likely to fall. In some contexts normative instruments are acceptable (i.e. crime) while in others they are less popular. For IEE normative instruments can have a limited scope because of the varied use of equipment. One pump may be used for a few hours per year (and a high efficiency pump may not be economical), while another pump may run all year. Important when considering normative instruments is to assess the possibilities for checking compliance and issuing penalties in case of non-compliance. If compliance cannot be verified at a reasonable cost or at all, then a normative instrument is not suited. Penalties must be high enough to be deterring – otherwise you will end up with end-users just paying the penalties and no EE improvements will take place.

Voluntary agreements can said to be a hybrid of the three classic policies since it typically entails that the end-users voluntarily commit to carry out certain EE activities or reach a certain EE improvement level in return for economic rewards and information. The inferred threat is that if the companies do not enter an agreement voluntarily then the government will use other and harsher policy instruments to achieve its goals.

Technology procurement is a hybrid between RD&D policies and the other four policies and, for example, the Swedish Energy Authority has used technology procurement with success. The technology procurement programme is a bidding process to stimulate and accelerate the development of new technologies. Technology procurement aims to develop new products, systems or processes and initiate a market shift towards new energy efficient technologies. The programme defines new buyer requirements, which are established by a group of purchasers (see below) who are more demanding than products currently on the market. These new buyer requirements then help to accelerate the introduction, adoption and use of new technologies into the wider marketplace (Reinaud, et al., 2011).

Policy choice

The choice of policy instruments depends on:

- The *urgency* for achieving results – How large a share of the target group needs to react as intended and how soon?
- The *readiness* of the entire system for the policy – Do all the market elements exist and is the political system ready to launch, monitor, and enforce the policy?
- The environment of *political acceptance* – What is politically possible within the current political context and traditions?

Policy portfolios

A combination of several policy instruments – a *policy portfolio* – is typically more successful than an alone standing policy instrument. And the design of the individual policy will of course have to consider the portfolio it will be part of. Typically, a policy portfolio would consist of a few core policy instrument that are supplemented by other policy instruments. For example in Denmark the core instruments are energy taxes (economic), minimum efficiency standards (normative), and an energy efficiency obligation scheme (economical or informative[1]). In Netherlands the core instrument targeting industry is voluntary agreements. In Finland audits is the main instrument.

A study of Swedish manufacturing industries also points to electrification and investment in clean technologies contribute to lowering energy intensity significantly (Silveira, et al., 2012).

While most agree that energy intensive companies and non-energy intensive companies have different needs and challenges relating to EE, small and medium sized companies are frequently lumped together. However, studies show that their EE needs and challenges also differ depending on size and industry branch (Trianni, et al., 2011). Misalignment between what the companies perceive to be a barrier and what is really a barrier causes them to marginalise EE (Trianni, et al.).

Broadly speaking the potential for improving EE of widely used industrial technologies such as compressed air, pumps, refrigeration, and electric motor systems is huge and optimisation of process heat systems and use of heat recovery adds to this potential[2]. An IEE strategy should therefore as minimum include some elements targeting these possibilities.

5.2 Policy development process

Key considerations

An IEA survey of 11 case studies including 22 policy instruments targeting motors provides a set of recommendations regarding some of the key elements of the organisation and management of successful energy efficiency policy (EMSA, 2011). These are liberally quoted in the following supplemented with our expert observations.

[1] The three types of instruments are defined from the end-user perspective. An energy efficiency obligation scheme is considered an economic or informative instrument, because the end-user receives information or maybe a subsidy. It is not the end-users that are given the obligation to find savings but instead the energy companies.

[2] The potential ranges from 5-50% and in most cases the pay-back time is less than 2 years, according to the study "Energy efficiency in buildings, industry and transportation"; Dobrica Milovanovic; University of Kragujevac; Paper at the 6th Global Conference on Power Control and Optimization; 2012.

Gap assessment

In order to design IEE relevant instruments the gap between the current situation and the vision and development goal for the future situation must be understood. What does the gap consist of? What changes are required? What are the potential barriers? How can these barriers be overcome or reduced? What are the critical elements that must go well to ensure significant impact and success? These elements must be given special attention.

It is important to remember to distinguish gap seen from a societal perspective and the gap as perceived by the industrial companies – individually and as economic sector.

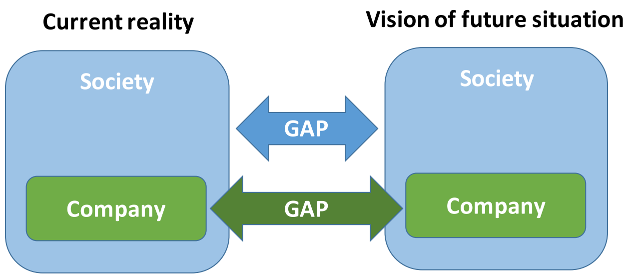

Figure 7: The gap between the current situation and the vision for the future situation differs depending on whether seen from a societal perspective or the perspective of the individual industrial company.

The gap analysis can be carried out loosely without too much data detail.

Level of ambition

The level of ambition for the policies has to be defined. How high will should the aim be to start with? Is a soft start followed by gradual increases in the level of ambition preferable to a "full-on" start? This is sought illustrated in Figure 8**Error! Reference source not found.**.

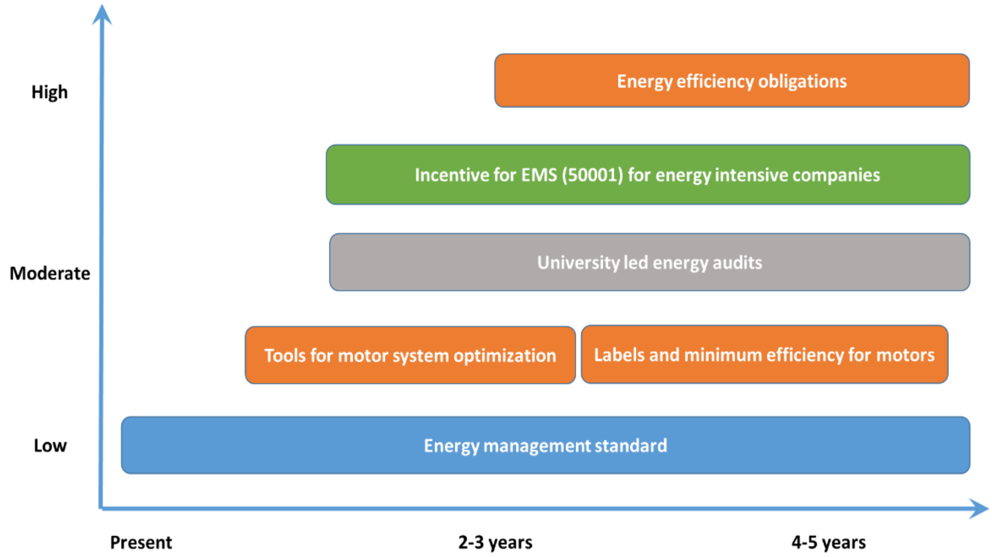

Figure 8: The choice of ambition level.

If a country, for example, is considering introducing an energy management policy, a minimum option could be to establish the ISO 50001 (see chapter 9 for definition). At a more moderate ambition level, the standard could be supplemented with a subsidy scheme for the 200 most energy intensive companies. At the high ambition level, use of energy management system could be made mandatory in the most energy intensive companies. This variation is shown on the vertical axis. The ambition level can also be varied with time (horizontal axis) – for example starting with the establishment of a standard and then moving on to a voluntary agreement with key industries which then after a number of years is replaced with an energy management system obligation for a major part of the largest industries.

EU energy efficiency target

EU has a target for energy efficiency for 2020, namely a 20% reduction in the primary energy consumption relative to a 2007 model forecast for 2020. According to the new energy efficiency directive, that was agreed upon in June 2012, the target is that primary energy consumption must be no more than 1,474 Mtoe or that final energy consumption must be no more than 1,078 Mtoe by 2020. This is an absolute target for EU as a whole. There are no binding targets for EU Member States. (Ea Energy Analyses and the Swedish Energy Authority, 2013)

Interesting is that:

- The EU EE goal in reality is an absolute goal. This is easy to meet with low economic growth and similarly difficult to meet if the economic growth is high.
- It is only an EU wide goal. When it became clear that the goal would not be met EU decided to require new EE instruments in all Member States, mainly the energy efficiency obligation scheme (Article 7 of the EU Energy Efficiency Directive).

What characterises a success?

A successful policy can be characterised by the following:

- A cost/benefit ratio below one –from a socio-economic perspective (in form of the total economy test)
- There has been a match between targets, resources, and impact.
- Has a significant impact
- Has a good reputation and can thus pave the way for new policies.

Policy planning

Key issues to be addressed during policy planning are:

- What are the aims of the policy and the intended duration;
- What can be learnt from other policies with similar objectives;
- How the policy will be managed;
- Who is the main target group(s);
- How the success of the policy will be evaluated;
- How the achievements of the policy will be measured;
- What financial and human resources will be required to deliver the program;
- Are there any capacity constraints that will limit the effectiveness of the program, e.g. skilled staff, laboratory expertise, etc.;
- What other resources will be needed, e.g. information, promotion, materials, guidelines, etc.;
- Which external organisations need to be involved in planning or delivering the program and what role will they have;
- How will a communications strategy be developed and implemented;
- Is coordination or alignment with other policies considered (link/synergy/interference).

The communication should not only focus on the time of launch of the policy but also successive communication throughout the policy period.

Tailoring

The industrial sector is very heterogeneous and therefore some of policies targeting industry must to a certain extent be tailored to the individual company in order to be successful. It may be relevant to segment the target group in to smaller segment and tailor certain components of the policy to fit each.

The policy design should also address the fact that within the individual company there are different types of decision-makers and cultures within the company. For example management commitment is crucial to capital investments in EE.

The industrial companies can be split into three segments depending on their readiness, willingness, and ability to partake in the EE market:

- Frontrunners: Companies with special profiles or competences that can kick-start the market;
- Followers: The bulk of the companies;
- Laggers: Companies that for various reasons is to be expected to lag behind in the EE market.

The core of the IEE policies should target the bulk of the companies but special policy variations can be tailored to each of the other two segments as well as those companies that are especially exposed or vulnerable:

- Frontrunners can be created by offering rewarding conditions for early action. This could for example be time-limited advantageous financial support, exemption from certain taxes, special promotion of their products, etc.
- Those lagging behind could be penalised but often a certain segment of the target group is more or less formally exempted from forced action – this could for example be the case with artisans.
- Leniency towards those companies that are especially exposed or vulnerable or extra support to these companies.

The appropriate focus of the IEE policies will depend on which company activities are being targeted. Table 4**Error! Reference source not found.** illustrate the link between the company activities and appropriate policy focus and lists a few examples.

Company activity	Focus of policies	Examples
Operation & maintenance	• Awareness • Information • Expertise/skills	• Success stories • Upgrading skills • Exchange of experience e.g. through prof networks
Retrofit (EE improvement of existing equipment)	• Technical and economical possibilities	• Audits
Natural replacement of existing equipment	• As above + • EE technologies and solutions • Capital	• EMS • Energy management standards • Availability of EE solutions • Subsidy
New purchases		
Forced replacement of existing equipment	• As above + • Driver	• EMS • Fiscal rewards/penalties

Table 4: The appropriate focus of the IEE policies depends on which company activities are being targeted.

Policy duration

Policies addressing industrial energy efficiency should run for several years in order to maximize impact. This is due to slow turn-over of motor systems technologies, and the time necessary to develop relationships, reach all relevant stakeholders, and gain recognition. Brand recognition is an important part of raising awareness and promotional activities, but this takes time to establish.

Policy management and recognition

Policy management should be neutral and independently financed to be recognised as an unbiased source of information.

Information provided by the policy needs to be considered credible and authoritative to maximise the probability that it will be acted upon.

Public recognition whereby the government clearly and repeatedly signals it commitment to EE can greatly influence the impact of the EE policies.

Partnerships

It is of great importance to integrate market actors to achieve the greatest possible policy impact and encourage further developments. Establishing relationships with and between government agencies, producers of motor systems and sales companies, experts, installers, service companies and energy consultants is central to most successful programs. Trade associations, chambers of commerce and industry organisations can also be useful partners. For direct contact to motor system users it is often helpful to work with regional contacts or local energy utilities.

Monitoring and evaluation

The identification of clear and measurable target outcomes from the outset, and supporting these with an evaluation strategy is a vital part of program design and management.

A policy needs to be continuously managed and not only designed and implemented. Regular monitoring provides feedback on progress with implementation and enables the early detection of any problems or issues that require addressing. Publicly reporting policy results is also important to increase policy recognition among the target group, policy makers and funders.

The monitoring and preliminary data collection for the final evaluation should be designed streamlined to minimize transaction costs (e.g. through online reporting) and aligned with other reporting requirements that the target group might be subject to (e.g. environmental impact, production, or income).

Policy evaluation is more extensive than the day-to-day monitoring and typically takes place near the end of the program period or after the policy period with the objective to assess whether the policy has been successful. Evaluation results can provide the basis for decisions regarding extension or expansion the policy. The evaluation is given greater credibility when performed by an independent party.

The key policy evaluation questions are:

- To which extent are the policy objectives justified in relation to the needs and problems identified?
- To which extent have the policy objectives been achieved?
- What has been the cost of achieving the objectives and have the objectives been achieved at lowest/reasonable cost?

Compliance and enforcement

Any mandatory requirements (e.g. agreements and labelling) require monitoring and verification of compliance. If compliance cannot be monitored at reasonable cost and effort then mandatory requirements are better replaced by voluntary or promotional measures. Furthermore, programs with mandatory requirements should include activities to educate stakeholders of their responsibilities and ensure that there is a sound technical basis underpinning the requirements.

The enforcement actions and penalties should be scaled in proportion to the severity of the offence of lack of compliance. The entity charged with supervision of compliance must be given appropriate powers of authority.

Communicating urgency

In some instances it is necessary to mobilise energy savings quickly for example to avoid black-outs.

The California 20/20 rebate program first introduced during the power crisis in 2001 is an example of a market driven policy intended to achieve immediate impact. The aim was to avoid brown-outs[1]. The concept consisted the electric utilities rewarding consumers that could reduce their monthly consumption during the period of the four summer months by 20% compared to the previous year with a 20% reduction in unit electricity price. Care should be taken to assure that the design of the program encourages reductions that would not otherwise have taken place and that the size of the economic reward does not undermine the program cost-effectiveness (i.e. cost per net energy impact achieved).

Recommendations regarding urgent policy measures (Pasquier, 2011) include:

- Assign a neutral, non-political group to lead the effort to avoid political disputes and finger-pointing.
- Keep the end-users informed about the impact of their response and that the end is in sight – if possible using quantitative indicators.
- Beware that multiple crisis can lead to crisis fatigue and lack of end-user response.
- Use the crisis as an opportunity to prepare the ground for long-term EE, to set-up data collection, and to implement elements that facilitate better interaction between supply and demand.

Compromises

The current political debate as well as other factors internally or externally (e.g. upcoming elections or sudden changes in the global energy market) will influence what policies are finally politically approved. Furthermore, proposed policies are often adjusted in the political negotiation process where compromises are frequently necessary. The resulting changes can be in the choice of policy types but also the more detailed design of the individual policy instrument.

[1] The term *black-out* refers to the total loss of power to an area and is the most severe form of power outage that can occur and may last from a few minutes to weeks. The term *rolling black-outs* is used to describe a deliberate outage of certain areas. A *brown-out* is the term used for a drop in voltage in an electrical power supply. The term brown-out comes from the dimming experienced by lighting when the voltage sags.

It can therefore be a useful exercise to reflect on what the critical policies in the portfolio are if a significant impact is to be achieved and where compromises can be permitted.

Broad political settlements on the overall IEE strategy will make the strategy more robust to changes in government and political power.

It should also be noted that the importance of the government signalling its ambition to pursue an EE development path is critical to the success of any EE strategy and policies.

Part II: Selected energy efficiency instruments

6 Introduction to part II

The ambition of "Part II: Selected energy efficiency instruments" is to present limited but relevant examples of approaches and instruments that can be implemented in Egypt in the next few years. It is important that the Egyptian IEE strategy and the associated policy portfolio to be developed are robust and realistic while achieving a noticeable impact.

The international examples and the suggestions presented are based on the assumption that industrial energy efficiency improvement will be considered as a tool for alleviating the difficult transition to market based energy prices but also as buffer against the expected global increases in fuel prices. Naturally, also other development objectives such as for example job creation, security of supply, and environmental protection will influence the appropriate choice of policy portfolio. These are however not discussed. Load shifting and fuel switching examples are also not included although these are highly relevant topics for Egypt. The basic policy design principles are nevertheless the same.

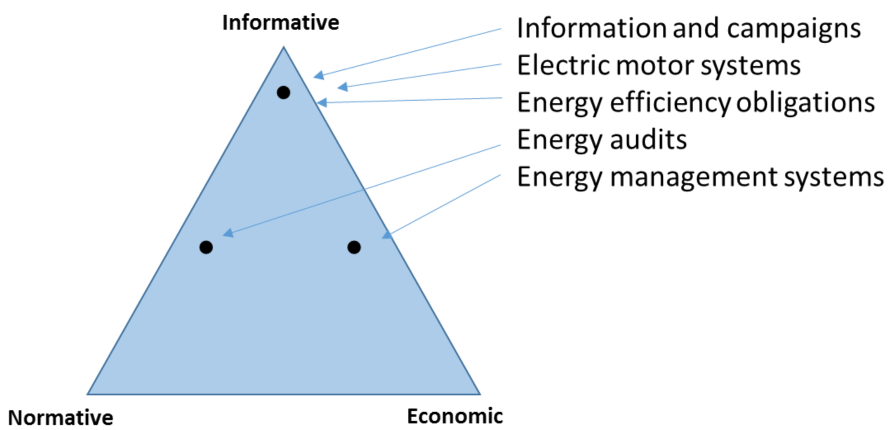

Figure 9. The selected five IEE policy instruments. The location of the instruments in the triangle is decided from the perspective of the end-user companies.

Five IEE instruments

I part II, chapter 7-11 present the key characteristics of five selected policy types followed by concrete examples. The idea is to add more details for these instruments.

- General information and campaigns (chapter 7): Information is often used as policy instrument in combination with other activities. Information and campaigns are typically uncontroversial and rather soft instruments. Impact are often moderate, but information can support other activities and prepare the ground for new activities (including new policy instruments).

- Energy audits (chapter 8): Energy audits can be described as high quality information that is targeted and adapted to the individual industrial company.
- Energy management systems (chapter 9): While energy audits are delivered by external experts, energy management systems are mainly driven by company staff. This can improve the timing of the activities and broaden the scope. EE can be pursued where most relevant for the company.
- Energy efficiency obligation (chapter 10): This chapter focuses on how to create an actor to promote energy efficiency. The obligated party, e.g. an energy company, may use information, energy audits or subsidies to fulfil the obligation.
- Electric motor systems (chapter 11): This chapter illustrates how technology can be used as focus for a policy intervention. The actual policy instrument related to motor system could be a combination of information, minimum efficiency standard – and tools to highlight the system perspective in analyses of motor systems.

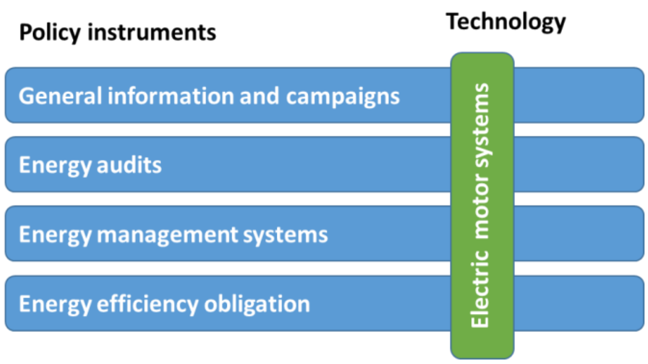

Figure 10: Policy angles applied in this report.

In **Error! Reference source not found.** a qualitative rating of the five policy instrument is indicated.

	Information	Audits	EMS	EEO	Motors
Relevant as a first generation policy instrument in Egypt	XXX	XX	XXX	XX	XX
Expected impact in Egypt	X	XX	XX	XXX	X
Expected result of total economy test	X	XXX	XXX	XX	XX
Low need for financing of policy instrument, e.g. by the state	XXX	X	X	X	X

Table 5. Qualitative rating of the five selected policy instruments

What is not covered?

Many other instruments could have been selected. However, seen in an Egyptian perspective we find that more complex instruments, like voluntary agreements and Energy Service Companies, ESCO, can be relevant, but not from the start. After years with active IEE policy and where institutions have matured, such instruments can also be relevant.

An ESCO may finance, implement and guarantee an EE project. Many variation exists. See (JRC, 2014) for a status in 27 EU countries and 15 non EU countries. ESCO can be relevant in specific situations – also in Egypt. However, if an EE project is simple and require only little risk, then the extra cost of contracting and the sharing of the benefits with the ESCO may not be needed (WEC, 2008).

"Voluntary agreement" (also referred to as "negotiated agreements" or "Target setting agreements") covers a variety of designs. On one end of the scale we find agreements without sanctions and on the other end of the scale agreements that include an element of sanctioning or penalty if performance is below the agreed target. In many cases a financial incentive exist for entering a voluntary agreement, e.g. a tax reduction (as in the case of Denmark and Sweden). See (UNIDO, 2008), (JRC, 2010), (Persson, et al., 2005), (Dalkmann, et al., 2005) and (Goldberg, et al., 2014) for more information and voluntary agreements.

7 General information and campaigns

Informative policy instruments includes

- general information and campaign;
- labelling (could be part of 11: Electric motor systems)
- Information tailored to the individual industrial company (see chapters 8: Energy audits, 9: Energy management systems, 10: Energy efficiency obligation).

In this chapter we address the first category.

7.1 Characteristics

Aim

The aims of general information and campaign measures are to create awareness of the need for energy efficiency and the possibilities for achieving energy efficiency and to provide access to related information and know-how.

Ranges

General information spans from printed leaflets and online information (e.g. webinars) to professional network sessions and tools for self-assessment. Campaigns may range from advertisements in professional media, promotion campaigns to competitions and awards.

	Low involvement	High involvement
General information	Leaflets Success stories Guidebooks Online information	Tools Network Help lines
Campaigns	Broad media campaigns	Competitions Awards

Table 6: The degree of involvement of the target group varies for the different types of initiatives.

Target groups and impact assessment

What characterises general information and campaigns is that they are aimed at more or less defined target groups rather than the individual end-user or company. Assessment of impact can therefore only with great difficulty if at all be linked to changes in energy consumption. Evaluator must therefore be content with assessment of indicators such as number of leaflets distributed, number of calls, number of participants, opinions of user or participants regarding usefulness etc. Surveys and focus groups can be used to collect opinions of users.

Combinations

As a consequence, general information and campaign measures are rarely used alone but are used to underpin other policy measures. An the reverse – Success stories from for example implementation of an energy management system in a specific company can be used in connection with general information and campaigns to bring the core messages to life.

7.2 Examples

General information

The range of general information spans from broad generic information to targeted activities about certain topics.

Irish Large Industry Energy Network

An example of targeted information activity about certain topics is the Irish Large Industry Energy Network (LIEN). LIEN relies on the mutual exchange of experiences among industrial company staff supplemented with topical talks or studies on technological solutions and practises. The underlying understanding is that staff frequently consult peers when looking for information and place a greater deal of trust in their experience than a random technology supplier. LIEN is an initiative by the Sustainable Energy Authority of Ireland and is part of a package of initiatives targeting the larger industries (+1 million EUR[1]) that also includes a voluntary agreement program with an energy management standard (see Figure 11). Participants in LIEN or the voluntary agreement program may participate in so-called Special Working Groups (SWGs). Those participating may decide which areas of expertise the groups will focus on thus ensuring that it is of particular interest and relevance to the participants.

A Danish variation of information and experience sharing in amore ad-hoc form is the so-called “ERFA-træf” (an abbreviation of “experience gathering”). The objective of these meetings is to gather professionals to discuss a common professional interest with the aim to develop through sharing experiences and knowledge. In relation to EE they have been taken the form of after-work meetings with e.g. talks on motor efficiency.

Other current examples include the German Local Energy efficiency Networks (www.leen-systeme.de) launched by the German Federal Ministry for the Environment and the Industrial Energy efficiency Network Forum, Southeast

[1] 9.7 million EGP, assuming 9.7 EGP/EUR.

America (www.industrialee.org) launched by the American Council for an Energy Efficient Economy (ACEEE).

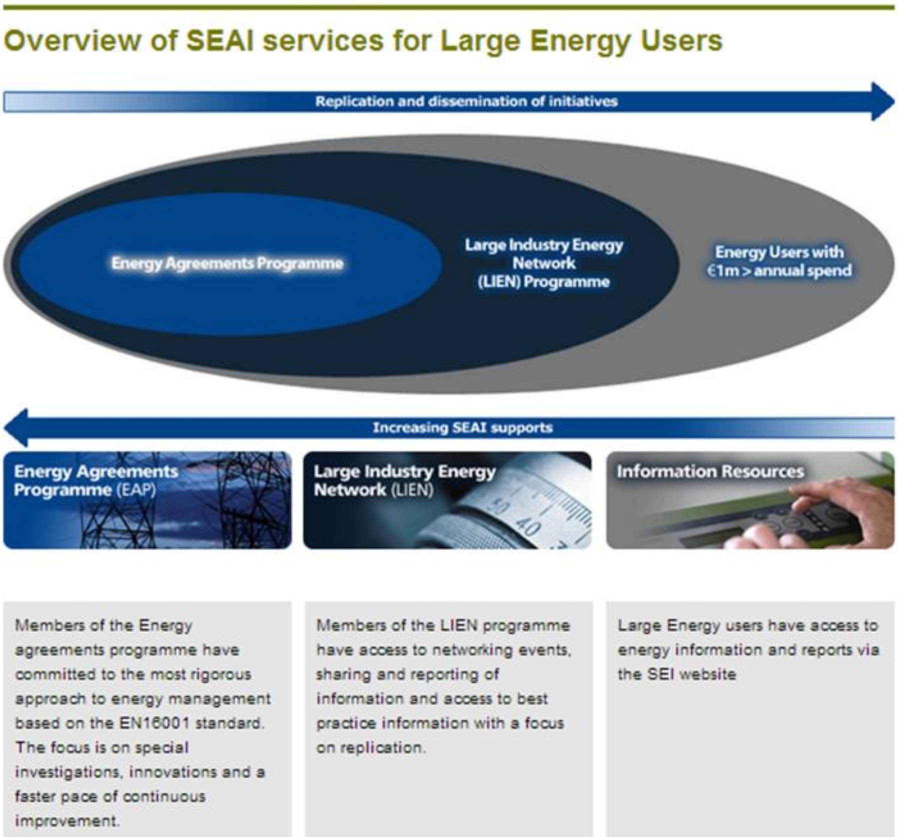

Figure 11: The Irish LIEN is one of three initiatives tailored to the larger industries (http://www.seai.ie/Your_Business/Large_Energy_Users/LIEN/).

Special Working Groups (SWGs) are run each year as part of the Special Initiatives under the Energy Agreements Programme (EAP).

Focus: SWGs are focused on specific technologies, initiatives and areas of particular interest to members (see list in table below).

Membership: Members are drawn from the EAP and LIEN, and are supported by SEAI-appointed experts.

Phases and Spins: Each SWG initiative goes through the phases of Piloting, Implementation, Replication and Standardisation. The projects are divided into Spins, to cater for project phases and new members.

Benefits: SWGs offer a wide range of benefits to members, including by:

> Focusing on areas that particularly interest members
> Enabling members to share knowledge and experiences and learn from energy experts
> Identifying energy-saving projects, grouped special investigations, and benchmarking
> Providing shared studies, self-assessments, methodologies and guidelines
> Continuing to add value for members after the initial EnMS implementation phase

Activities: SWG activities include site assessments, audits, demonstration projects, special investigations, desktop research, design of experiments, methodology development, new tools and new solutions development.

Reports: Published SWG reports include international input and details of energy-saving opportunities.

Figure 12: The Irish Special Working Group initiative (http://www.seai.ie/Your_Business/Large_Energy_Users/LIEN/).

Partnerships can help

Partnerships can help programs by providing technical expertise, program design and implementation guidance, and expanding program outreach and implementation channels. In USA, For example state energy offices can also complement and support ratepayer-funded programs through training, energy assessments, certification, and recognition awards. State energy offices use their established partnerships with other relevant stakeholders such as the Manufacturing Extension Partnership (MEP), DoE's Industrial Assessment Center (IAC) Database and resources provided by the EPA's ENERGY STAR for Industry program to inform thousands of investments in state and utility IEE programs. (Hedman, et al., 2014)

Campaigns

Campaigns range from advertisements in professional media and promotion campaigns to competitions and awards. They may be used more or less intensive depending on the need for attention among the target group.

Japanese Cool Biz

The Japanese Ministry of Environment began the Cool Biz campaign in summer 2005 as a means to help reduce electric consumption by limiting use of air conditioning in certain months. Central government ministries were to set air conditioner temperatures at 28°C March-September. Inspired by japan, the South Korean Ministry of Environment, the British Trades Union Congress, and the UN to name a few were inspired to promote their own Cool Biz campaigns. Such campaigns can in addition to the immediate impact also result in structural impacts of a more lasting character.

Cool Biz

"… Since the United Nations must lead by example, we took the challenge seriously. This past 1 August, at our headquarters in New York, we began the "Cool UN" initiative, in which we turned up the thermostats five degrees Fahrenheit. During the weekends, the air conditioning systems were switched off completely. To cope with the anticipated warmth, we encouraged staff and delegations to wear lighter clothing, including national dress for those coming from warmer climates.

This practical step to reduce emissions and increase staff awareness of climate change was the ultimate win-win-win. We achieved a reduction in emissions equivalent to 3,000 tonnes of carbon dioxide. We saved money. And thanks to the lighter side of "Cool UN", the relaxed dress code, we generated quite a bit of conversation – about climate change and about the customs and cultures underpinning our staff members' various forms of national dress. In short, the initiative was an all-round winner, and we plan to conduct a similar exercise in winter, this time in reverse, by turning down the thermostats by five degrees Fahrenheit. …"

Source: UN Secretary-General's message on receiving the "Cool Biz" Award, delivered by Konrad Osterwalder, Rector, United Nations University, 7 October 2008.

Assessment tools

ABB has developed calculation tools for estimating the energy savings that become available when applying speed control to certain flow machines. Using PumpSave and FanSave tools, AC drive control in pumps and fans can be compared against traditional flow control methods in terms of energy usage[1].

Isover has calculation tool for insulation of industrial processes and general heating, ventilation and air conditioning[2].

The European Industrial Insulation Foundation offers a standardised approach to inspection of insulation improvement possibilities in the form of training and certification of insulation-auditors in combination with a calculation tool aimed at detecting insulation possibilities[3].

According to a survey carried out for the foundation even energy-intensive industries overlook the benefits from industrial insulation. One of the reasons for this is according to the foundation that split incentives (see Figure 13). "The additional investment needed for good insulation (in comparison with current insulation levels) tends to be controlled by the maintenance manager. The savings that are realised by this create decreased costs in the energy budget, which tends to be controlled by a different department. To bring

[1] See: www.abb.com/product/ap/seitp322/24b03100d005c31ac1256e040043f4c1.aspx?country=US
[2] See: www.isover-technical-insulation.com/Calculation-softwares/TechCalc-Presentation
[3] See: www.eiif.org/?TIPCHECK%20information/30.

these two together requires a decision on a higher management level, where unfortunately even less awareness of the technology and potential benefits of insulation exists.” (Gürtler, et al., 2014)

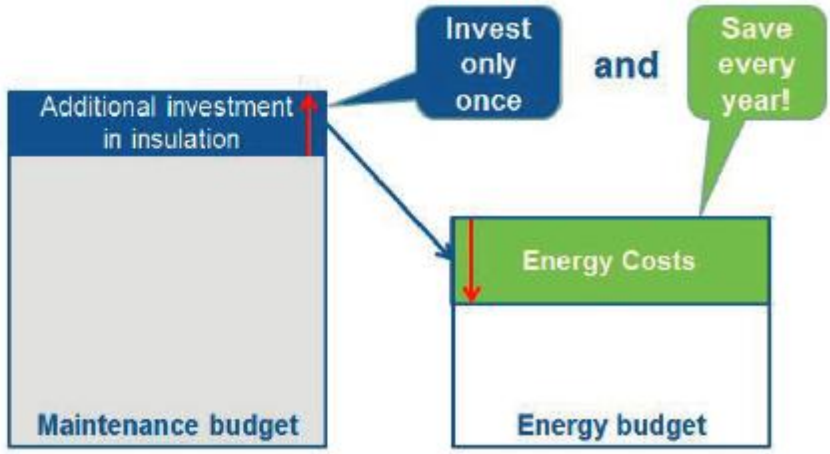

Figure 13: Split responsibilities (Gürtler, et al., 2014).

8 Energy audits

Energy audits are an informative policy instrument tailored to the individual industrial company. An energy audit is an examination of the energy consumption at a facility. The outcome is a formal report that shows the main areas where energy efficiency can be improved, suggests energy efficiency improvement measures, and estimates the likely costs and savings. The audit may be of the entire facility or specific systems or processes. The audit is typically carried out by experts external to the company (as opposed to energy management systems which are more integrated in the company).

8.1 Characteristics

Aim

Energy audits bring external expertise to the individual company and carries out an assessment of the company's current energy situation and options for improving energy efficiency. The aim is thus to "lend" know-how and tools to the individual company for the time necessary to make an assessment thereby answering the first question of concern of the company: Can we save energy and at what effort and cost?

Energy audits are can be a stand-alone policy that for example precedes other policies. Frequently, audits are a key supporting component of industrial energy efficiency policies such as voluntary agreements.

Ranges

The actual audit and the experts offering audits may vary. The audit may be a simple "walk-through" requiring 1-2 hours or it may be a detailed assessment that can take days and include detailed measurements, e.g. of the electricity consumption of individual compressors. This can document the actual loading and can highlight in-adequate control. The more detailed the choice of audit type, the more important it becomes that the auditor is familiar with the unique characteristics and requirements of the production systems of the particular branch. On the other end of the scale, very simple audits can be carried out by less specialised auditor whose main expertise is familiarity with more generic areas where energy is typically wasted (e.g. leaking pipes for compressed air, lighting and ventilation).

Irrespective of the degree of detail, it is important that the quality of the work is high. Once a poor reputation is gained it is close to impossible to remedy.

A 2011 survey of 8 audit policies without supporting policies used 8 parameters to describe their characteristics (Price, et al., 2011):

- Audit costs – The customer may carry the entire cost or financial support may be offered to varying degree – full coverage, upper limit in terms of fixed value or fixed percentage or both. Financial support may also be provided under certain conditions for example upon realisation of those measures that have a payback time of less than one year. And the support may vary depending on type of company (turnover, employees, branch, location, etc.).
- Standardised guidebooks, templates and tools for auditors – To minimise work load per audit but also in order to standardise the approach and thereby improve the quality. Furthermore, a coherent and consistent approach permits aggregation of audit data for impact assessment and learning insights. Tools may also be produced in cooperation with producers of energy efficiency solutions.
- Auditor training – To build capacity and thus support the development of audit businesses. Training can be voluntary, recommended or mandatory.
- Auditor certification – To ensure a certain level of quality in the audit services offered. Can be combined with public listing of approved auditors and branding of these. Certification can be issued to individuals as well as companies.
- Database of energy audit results – To allow easy access for auditors and perhaps also industrial companies and other interested parties in the improvement possibilities. It can also help ensure learning insights and assessment of aggregated impact.
- Availability of case studies – To show realistic success stories (what-is-in-it-for-me) that can inspire others to follow
- Post-audit follow up – To assess impact of the audit but also as a reminder for those that have not implemented any of the recommended improvements and to hear if additional assistance is needed. The best timing may vary depending on the type of companies in question but could for example be half a year after the audit or individually agreed with each company.

An overview of the findings can be seen in Table 7.

<table>
<tr><th>Programs</th><th>Audit Costs</th><th>Standardized Manuals</th><th>Auditor Training</th><th>Auditor Certification</th><th>Database of Energy Audit Results</th><th>Post-Audit Follow-ups</th><th>Standardized Tools</th><th>Availability of Case Studies</th></tr>
<tr><td>US Industrial Assessment Centers (IACs)</td><td rowspan="4">Free</td><td>Y</td><td>Y</td><td rowspan="5">N</td><td>Y</td><td rowspan="5">Y</td><td>Y</td><td rowspan="6">Y</td></tr>
<tr><td>UK Carbon Surveys (Carbon Trust)</td><td rowspan="2">N/A</td><td>N[1]</td><td rowspan="5">N</td><td rowspan="2">N</td></tr>
<tr><td>Japan (Energy Conservation Center of Japan)</td><td>Y</td></tr>
<tr><td>Ireland (Energy Advice to SMEs)</td><td rowspan="3">Y</td><td>N</td><td>Y</td></tr>
<tr><td>Sweden (Energy Audits for Companies)</td><td rowspan="2">Cost-shared</td><td>N[2]</td><td>N</td></tr>
<tr><td>France (Energy Auditing for SMEs)</td><td>Y</td><td>Y</td><td>N</td><td>Y</td></tr>
</table>

Y: available; N: not available; N/A: not applicable

Notes:

1. Although no specific energy auditing training is provided, each Carbon Survey is conducted by an independent accredited consultant. Online training on creating a customized "energy saving action plan" is available on the website of Carbon Trust.
2. Swedish Energy Agency provides a list of energy experts and professionals to provide advices to companies.

Table 7: Availability of key components in the selected stand-alone energy auditing programs. (Price, et al., 2011)

It is possible to increase the interest in EE project by recognising and quantifying non-energy benefits of already implemented EE projects. Non-energy benefits, such as improved productivity or quality gains, can be as high as or even higher than the energy cost saving benefits achieve. Some co-benefits, such as water savings, are relatively easy to quantify, while others, such as safety improvements are more complex to assess. (Hedman, et al., 2014)

Demand for audits

Audits can be promoted more or less aggressively. It can be left to the discretion of the industrial companies to ask for an audit but the likelihood of a great interest is very low. If audits are offered on a commercial basis, the audit companies have an incentive to contact potential clients. If audits are provided by a non-profit entity, then a target for how many audits must be carried out might be necessary to ensure sufficient progress. An option could also be to form an outreaching team that seek up the industrial clients.

Target groups and impact assessment

The walk-through audits or stand-alone audits (i.e. without any additional supporting policies) are typically directed at small and medium sized companies while the more extensive audits and audits coupled with requirements are typically aimed at large and energy-intensive companies (Price, et al., 2011).

Small and medium sized companies typically show limited interest in energy audits or do not have the financial resources to afford a professional energy audit due to limited management capacity and a pressure for economic survival. An audit policy combined with some kind of financial support can help alleviate these barriers.

In the case of audits the target group and individual company is known and the audits establish the energy profile and potential for savings. Evaluators of audits as a policy instrument can therefore rely on this information for impact assessments. However, the fact that a given company now knows what the possibilities are does not necessarily mean that they will act upon this information. Perhaps the company will actually use the audit information but not until they have time to do so which could be several years after the audit.

The timing of the audit does rarely coincide the time when investment decisions are being made, and is not integrated in day-to-day operation and management of the company. It is possible to reduce this problem to some extent, for example, by requiring an audit to be carried out prior to approval of an application for an investment loan.

Energy audits should not be regarded as a once only event. Production processes change over time and with it the energy consumption pattern. Furthermore, new more energy efficient technologies and processes continue to appear on the market and provide new opportunities for optimisation.

In order to use the audit as leverage for actual implementation of some of the identified cost-effective energy efficiency improvements the cost of the audit that the company has to pay is frequently reimbursed if certain improvements are actually implemented within a given timeframe.

Added benefit

In addition to providing the audited company with data on its energy situation the audits can also provide valuable data on a national scale if certain data are compiled for use in formulation of future Egyptian policies.

8.2 Examples

Finnish audits

Finland has had audits schemes since 1993 and consider them to be very successful. MOTIVA[1], the Finnish Energy Agency, has facilitated training of auditors and provided a format for performing audits. MOTIVA approves audits upon which usually 30-40% of the audit cost is paid by government. Target groups are industry and tertiary sector.

[1] Motiva operates as an affiliated Government agency (an in-house unit), and its functions will be developed as such. The company's entire share stock is in Finnish state ownership. http://www.motiva.fi/en

Industrial Assessment Centres

Since 1976 Industrial Assessment Centres, IAC, has been active in the USA. These centres are located at universities across the US, and are funded by the United States Department of Energy to spread ideas relating to industrial energy conservation. The centres conduct research into energy conservation techniques for industrial applications and perform energy audits or assessments at manufacturers near the particular centre. Today, there are 24 active Industrial Assessment Centres in the United States[1]. The IAC program has achieved of over 4.5 billion USD of implemented energy cost savings via 14,000 audits.

The unique feature of IAC is that they combine support to industry in form of free energy audit – and at the same time increase the EE skills for student and candidates. Compared to other audit schemes the cost of IAC is moderate.

In relation to the IAC activities a database of the results of more than 16,000 audit has been compiled. The database is publicly available[2] and permits search by type of facility assessed (size, industry, energy usage, products, location), resulting recommendations (description, energy savings, implementation costs, and payback), and the IAC that carried out the audit.

New Danish audit requirements

As part of implementing the 2012 EU energy efficiency directive, Denmark is currently setting up new requirements about energy audits in all companies with more 250 employees. Companies within trade and services with an energy consumption below 100 MWh are exempted. The companies must from 2015 have executed a detailed energy audit and this must be updated every four years.

If the companies have an EMS (like ISO 50001) that already includes an energy audit, they do not need additional activity.

French capacity building

The French energy auditing program ("Aide à la Décision") tours around France with 3-day training sessions for auditors. The content changes depending on which sector the auditors to be trained will focus on in their work but the basic structure of the training includes (Despretz, 2002):

- Presentation of ADEME scheme and the auditing program;
- Introductions to energy auditing model specifications;

[1] http://energy.gov/eere/amo/industrial-assessment-centers-iacs and http://iac.rutgers.edu/case_studies/
[2] http://iac.rutgers.edu/database/

- Description of the most encountered errors and omissions;
- Presentation and training of auditing software and tools;
- Demonstration of two real case studies by trainees.

Start simple

A survey, carried out by Institute for Resource efficiency and Energy Strategies and Fraunhofer Institute, of 366 German companies (energy-intensive, less energy-intensive, and service sector) analysed 7,984 implemented EE measures. The survey distinguished between organisational level EE measures and technical level EE measures. The organisational measures included (Roser, et al., 2014):

- Low-investment measures are measures that can directly increase energy efficiency through little investment:
  - “Insulation: the insulation of pipes, fittings and devices. These types of measures have a high energy saving potential.
  - Free cooling: the difference between outdoor and indoor temperature can be used to cool rooms with almost no energy consumption. Sometimes existing equipment can be used, sometimes a little investment is necessary to automate this process.
  - Leakage detection: a regular control detects and quantifies leaks so they can be eliminated. This is particularly relevant to the efficient running of technical equipment but it is often overlooked.”
- Setting adjustment is another measure to optimise control systems with almost no investment. Examples include:
  - “Automatic and manual switch-off of unused equipment: in many companies, electrical devices and appliances are not switched off when not in use; they remain in an active or passive standby mode. This might be office equipment, technical equipment, lighting, or heating etc. In some cases, there is even a consumption of energy when the device has been switched off (off-mode electricity) and they have to be disconnected from the grid before electricity consumption ceases.
  - Pressure reduction: the adjustment of the operating pressure for compressed air and vacuum systems can improve efficiency. Compressed air is the most expensive energy carrier and is used in nearly every field of production.
  - Temperature adjustment: In many cases the temperature is higher in heated areas or lower in air-conditioned areas than necessary (e.g. in server rooms) and an adjustment can significantly contribute to energy efficiency.”

- Management measure examples:
  - “Energy control/energy management: exact consumption recording and billing of energy consumption can raise awareness of the responsibility of employees and is therefore an essential prerequisite for achieving energy efficiency goals in a company. Major electricity consumers can be detected and improvements made to increase energy efficiency.
  - Procurement guidelines of energy-related equipment: new machines and systems should be assessed according to their energy consumption.
  - Staff training: the every-day actions of employees might have an energy saving potential that should be considered. Employees should be trained in careful handling of equipment and general awareness of energy issues and specific demonstrations may lead to more energy efficient behaviour.”

Of the 7,984 implemented EE measures 1,584 were organisational level measures and the rest cross-cutting technologies (i.e. not process specific). Analysis showed that each of the three categories of organisational measures contributed significantly to EE (see Figure 14) and the payback time was less than three years in average.

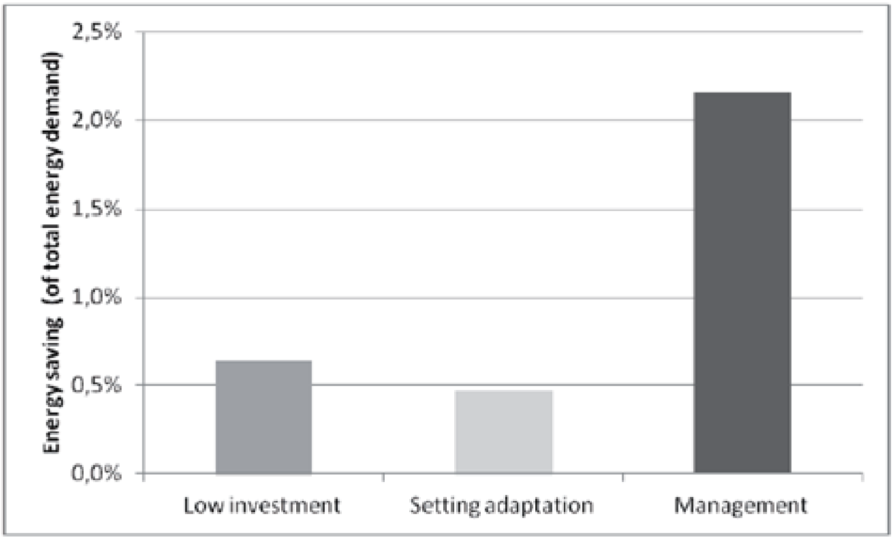

Figure 14: Energy saving potential relative to the total energy demand of each company (N=872) (Roser, et al., 2014)

Non-energy benefits

Energy efficiency improvement measures may also bring other benefits in addition to the energy savings. Such “non-energy benefits” can have higher value than the energy savings and can function as important leverage for company interest.

The IEA Energy Efficiency Unit began mapping the range of non-energy benefits in 2012 (Cambell, et al., 2012) and is expecting publish a handbook for policy makers and evaluators on capturing the multiple benefits of energy efficiency. Benefits may be counted at different levels of the economy – from end-user level and economic sector level (such as transport, residential, industrial sectors) to national (including macro-economic benefits, and benefits to national budgets) and international level.

With regard to industrial companies the non-energy benefits that are likely to be most valuable are those leading to improvement in productivity and competitiveness but also better compliance with safety, waste, and environmental protection regulations.

A Danish research project is currently working to establish a database[1] on non-energy benefits as perceived by the companies that carried out energy efficiency improvements. The intention is that once the database is sufficiently large average values may be derived for the non-energy benefit resulting from different types of energy efficiency improvement measures.

A survey of industrial companies found that the main barriers for inclusion of non-energy benefits investment calculations are imperfect information, hidden costs and bounded rationality. Bounded rationality means that organisations and individuals do not act based on complete information, instead they act more by "rule of thumb" where only few solutions are considered and previous solutions to similar problems are often chosen. (Nehler, et al.)

[1] http://neb.teknologisk.dk/ - In Danish only at the moment, but will soon be in English also.

9 Energy management systems

Energy management systems are just like energy audits an informative policy instrument tailored to the individual industrial company. The energy management system is however not carried out by experts external to the company but are fully integrated in the company operation.

9.1 Characteristics

Aim

Energy management systems (EMS) – like ISO 50001 – have been developed to be the companies' own tool for running the production, like similar systems for quality management (ISO 9001), environmental management (14001), or social responsibility (ISO 26000). The core function of these systems is to define a systematically way of setting goals and implementing the activity.

Energy management is thus a continuous focus on optimising energy consumption (see Figure 15). It is likely that significant savings can be achieved in any company to start with without investment in EE equipment.

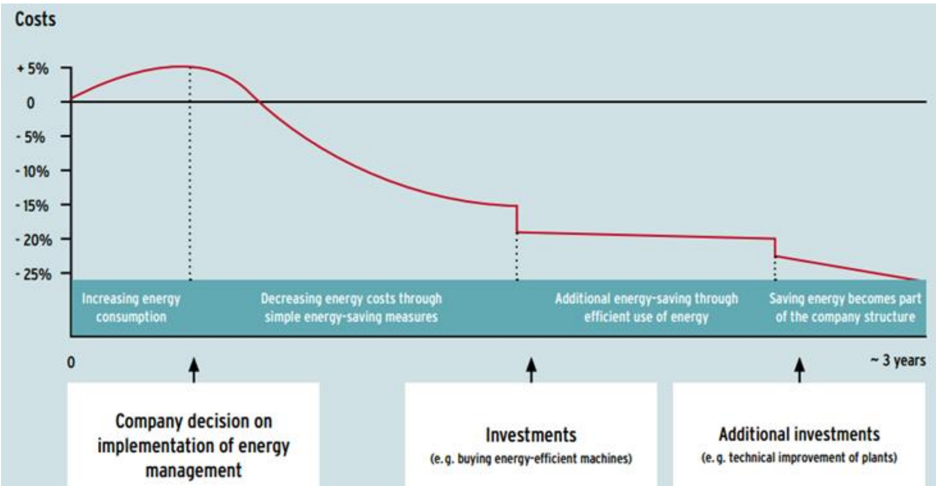

Figure 15: Gradual energy cost reduction through energy management. (Kahlenborn, 2012)

Companies may adopt energy management systems at their own free will simply as a way to achieve the goals. They may also choose such a system so they can document the activity and the results to customers (e.g. quality) or interest groups (e.g. environment).

The different systems may be combined. ISO 50001 is data driven and focuses on energy performance, while ISO 14001 provides a more qualitative looks at all significant environmental impacts of an organisation. Both standards can be implemented individually or they can be integrated with each other, or with any other ISO management system standards, such as ISO 9001.

If energy is an organisation's most significant environmental impact, ISO 50001 might be more appropriate than ISO 14001. Many organisations will manage energy successfully via ISO 14001, but especially in organisations where energy is a significant cost, ISO 50001 provides a more specific framework that enables organisations to apply a sharper focus to energy efficiency[1].

EMS as policy instrument

There is a crucial difference between EMS and many other policy instruments. The EMS is an internal system managed by the company, while e.g. a free energy audit in many cases will be run by external consultants. The difference may be very important. With an effective EMS all opportunities can be captured. E.g. it the EE opportunities are often significant in relation to investment in new equipment, while external systems like energy audit often come at a random time and not necessarily timed in relation to such opportunities.

A systematic approach to energy management can be applied by any industrial company. However, using a commonly agreed approach such as the ISO 50001 permits certification and setting standards for what is systematically carried out and which EE improvements implemented.

EMS is not only promoted by public authorities. There are also other potential drivers for large scale EMS adoption. The most frequent is energy utilities. But industrial associations may also take the initiative in order to support peer-to-peer cooperation. Another perhaps growing trend is for large corporation such as Ford, 3M, IKEA, and Walmart to try to influence the companies in their supply chains e.g. through preferential purchasing strategies placing requirements on their supply chain. And finally, financial institutions may encourage EMS in relation to provision of funds.

[1] Quoted from Wikipedia. See the following links for ISO 50001 guide books:
www.umweltbundesamt.de/publikationen/energy-management-systems-in-practice
www.gut-cert.de/info-energiemanagement0.html?&L=1&lang=enhttp://ul-dqsusa.com/wp-content/docs/ISO%2050001PractitionersGuideandScorecard2011Sample.pdf
www.hkeia.org/iso50001/eguidebook/ISO50001%20guide_ENG%2019Aug%28Final%29.pdf
ecenter.ee.doe.gov/EM/SPM/Pages/Home.aspx
www.nsai.ie/NSAI/files/bd/bd0f95ec-74d0-4c04-a990-76f3343a6f7d.pdf
www.bsr.org/reports/bsr-energy-management-handbook.pdf

Delivery models	Examples of drivers for players to develop EMS programs	Drivers for EMS adoption by companies
Supply chains (large coop-erations)	Enhance company's reputation; EMS can be used by all industrial play-ers, large and small; Government support allowing compa-nies to meet their EE obligations by engaging their value chain.	Buying-power of the large company; Cost savings; Possible implementation support.
Utilities and energy ser-vice provid-ers	Improve the utility's relations; Strategy to improve reliability and availability of energy supply at lower cost than supply resources; Regulatory requirements for EE.	Sustainable source of financing; Technical assistance.
Financial institutions	Increase number of deals and project finance; Help assess the risks and returns of EE projects; Reduce investment risks; Improve and enhance customer rela-tions.	Lower loan transaction costs; Blending technical assis-tance with financial products.
Industry associations	Provide valuable service to member companies.	Sharing information; Implementation support.
Government agencies	Strengthen economic development while reducing strain on resources; Strengthen international competitive-ness.	

Table 8: Delivery models for EMS implementation (inspired by (Reinaud, et al., 2014))

For example, in the United States Pacific Northwest, the largest industry trade organisation, the Northwest Food Processing Association (NWFPA), introduced a voluntary collaborative EMS framework to its the 100+ members (Reinaud, et al., 2014). Partnering with an energy service provider, the Northwest Energy Efficiency Alliance (NEEA), this collaborative framework convenes company leadership and action around common energy reduction goals. Aggregating energy saving efforts through NWFPA allows an entire industry – as opposed to individual enterprises – to apply resources toward a unified energy reduction goal – sharing in the risk, efficiency and energy savings potential and adoption of EMS as an ongoing business practice. In 2009, NWFPA member enterprises set an industry wide energy intensity reduction goal of 25% in 10 years, and 50% in 20 years. NWFPA was the first U.S. industry wide association to commit to this goal, and signed a pledge with the U.S. Department of Energy.

Ranges	Companies can decide to use their own energy management system. Companies with a limited energy consumption may use an informal system with little paper work and informal procedures. A certified version of ISO 50001 or a similar system has the advantage that it is well defined and can have elements that document the activities – also for stakeholders outside the company.
Target groups and impact assessment	The ISO 50001 can be implemented at many levels of details. However, the nature of a formal management system can be attractive for larger companies and companies with large energy consumption.
Combination	EMS can be combined with other instruments. E.g. a subsidy or a tax rebate may require that a formal EMS is used.

9.2 Examples

Several cases exist where EMS has been part of a public IEE policy. This has been the case in e.g. Sweden (Martínez, et al., 2013), Ireland and Denmark (Goldberg, et al., 2012).

In Sweden, the program for improving energy efficiency in energy intensive industries was introduced in 2005 as part of a voluntary agreement between industry and government. The program aims to increase energy efficiency in energy intensive industries with a focus on electricity consumption. Energy-intensive companies in the manufacturing industry can be granted tax exemption on their electricity consumption (0.55 €/MWh) if they take action to improve their energy efficiency, including using a certified EMS, e.g. ISO 50001.

Table 9 shows examples of how energy management policies have been structured in selected countries.

Country	Program name	EnMS type	Voluntary Mandatory	Certification	Drivers
Australia	Energy Efficiency (EE) Opportunities	EEO Assessment Framework	M	No	Public reporting of EE opportunities
China	Top 10,000 Enterprise Program	GB 23331	M	Voluntary	Mandatory
Denmark	Agreement on Industrial Energy Efficiency (DAIEE)	ISO 50001	V	Yes	Tax rebate
Ireland	Energy Agreements Program	ISO 50001	V	Yes	Extensive technical support
South Korea	GHG and Energy Target Management scheme	ISO 50001	M	Yes	Mandatory
USA (Federal)	Superior Energy Performance	ISO 50001	V	Voluntary	Awards, technical resources, possible tax rebate

Table 9: Examples of energy management policies and how they are structured. (Reinaud, et al., 2014)

Paper work or actual EE improvements

As with all mandatory requirements it is important to consider the risk of compliance without EE impact, as experience from Japan shows. Japan has a mandatory energy management systems for industrial companies with an energy consumption of more than 1.5 million litres of crude oil equivalents per year (approximately 12,000 companies) that includes a target of 1% improvement in energy intensity per year. Other requirements include appointment of energy managers, compliance with qualitative and quantitative standards of "judgement for rational use of energy in factories", annual reporting on consumption plus annual submission of a medium- and long-term plan for investment. The latter does not include EE improvements that do not necessitate investment.

However, the requirements focus on reporting rather than implementation, with the result that in spite of more than 90% compliance with documentation requirements the number of companies actually implementing EE improvements as a direct consequence of the energy management system is much lower. The formulation of the requirements are such that they do not encourage actual integration of energy management in the company operation. As a consequence the scheme is of no or little extra value to large energy-intensive companies while smaller companies lack the organisational capacity to incorporate energy management into the overall management and operation of the company. (Kimura, et al., 2014)

Inspection of documents are warned several months ahead of inspection visit leaving the companies ample time to get the paper work done. There has been examples, of smaller companies hiring a consultant to prepare the paperwork without energy management becoming part of the day-to-day operation because they found the regulation and preparation of manuals too complicated.

Target setting

Several of the surveyed companies indicated that having a formal target resulted in higher attention among management towards EE potentials. Since the target was a joint target for a company with several location or franchises it was necessary to compile information on the energy consumption from each location – something which helped create an awareness at management level of energy costs. However, another lesson learned from Japan is that a target formulated as percent reduction of energy intensity is of limited use, since it is only partially within the control of the companies. For example, in times of low economic activity and declining sales production volumes will reduce and the energy intensity increase. A change in energy intensity is in other words not clearly indicative of the implemented EE efforts. (Kimura, et al., 2014)

Figure 16: The four steps – Plan-Do-Check-Act – of energy management (Natural Resources Canada[1]).

Swiss EMS education

In 2011, Université de Genève, Switzerland, launched an accredited education course in energy management[2] with the aim to increase the capacity for energy management and harmonise skills. The course comprises six modules (170 hours of teaching, 260 hours of homework):

1. Energy and management: basic notions and issues at stake.

[1] http://www.nrcan.gc.ca/energy/efficiency/industry/iso/5385
[2] More information can be found at http://www.albasim.ch/en/solutions/managenergy/overview-managenergy.

2. Managing projects and driving change.
3. Assessing energy performance and defining an action plan.
4. Strategic and financial approaches of energy efficiency projects.
5. “Learning by doing”.
6. End of studies work.

The target group is working adults with at least 3 years of professional experience, a university degree, or a high school degree. Energy/technology academics or professionals are responsible for the teaching related to energy/technology aspects while business school professors teach management aspects. Completing the course the participants will receive a Certificate of Advanced Studies corresponding to 15 ECTS[1] points (Cooremans, 2014).

[1] An ECTS credit point represents a certain amount of work. At Université de Genève one credit corresponds to 25-30 hours of academic work for a student. Typically, one full-time year corresponds to 60 ECTS-credits.

10 Energy efficiency obligation

A voluntary agreement system sets, as we saw in chapter **Error! Reference source not found.**, a target for EE that has to be achieved within a certain time limit. The target is set together with and for the agreement companies (typical industrial companies). An alternative way to creating a push for the uptake of EE is to place an obligation on the energy providers to find EE improvement opportunities among end-users. This is referred to as an energy efficiency obligation system (EEO). In US the term Energy efficiency resource acquisition is also used.

The energy savings target and how to recover the cost of the effort are determined by the regulator while it is left open for the obligated party to decide where to find the savings. The characteristics of an EEO system is described in the following together with illustrative examples.

EU has in the Energy Efficiency Directive (EED)[1] of December 2012 pointed out EEO as a central policy instrument for the member countries to meet the common 2020 EE target. Member countries are encouraged to implement EEO, but alternative instruments are also allowed, but must accepted by the commission.

10.1 Characteristics

Aim is to create a driving force

Energy efficiency is not the core business of industrial companies. Therefore it is far from all cost-effective improvements that are realised even if the companies are aware of the importance and benefits of energy efficiency. An external force driving implementation forward can therefore be useful to society. An EEO system can create exactly such a driving force.

The idea is simply that an obligation is put on an actor, typically an energy company, and that the obligated party is allowed to recover their cost of the activity. The obligated party may do energy audits or pay subsidies, or may interact with other executive parties, e.g. suppliers or engineering companies.

In a guide to the EU Member States (European Commission, 2013) the EU Commission gives this instruction regarding the design of an EEO:

[1] EU Energy efficiency directive. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. Inter-institutional File: 2011/0172 (COD)

1. Establish the total quantity of energy savings that has to be achieved and its spread over the obligation period;
2. Establish which sectors and individual actions are to be targeted so that the required amount of energy savings is achieved;
3. Decide whether to use EEOs or alternative policy measures, and, while designing the schemes or measures, ensure that certain criteria are met;
4. Establish how energy savings from individual actions are to be calculated;
5. Ensure control, verification, monitoring and transparency of the scheme or alternative policy measures; and
6. Report and publish the results.

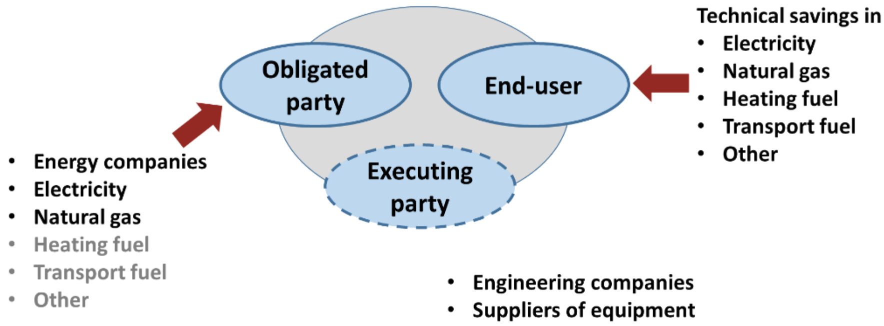

Figure 17: Key actors in an energy efficiency obligation scheme.

Ranges

EEO's can cover all or some sectors energy vectors. In some cases transport is excluded. Even if EE from all sectors are allowed rules about reporting and documentation may hinder industry to be main area.

In some cases the obligated parties may trade realised savings. This can take place bilaterally or with an exchange where bids and prices are published.

Financing is typically done by allowing the energy company to collect costs though tariffs. Tariffs can be based on the full cost used for EEO, or a fixed cost may be collected.

It can be specified if only technical projects or if behaviour savings also can be included.

Impact assessment

It can be relevant to do evaluation of EEO, e.g. to document the level of net savings. This can be done by surveys (e.g. interviews) or with statistical analyses. The level of free riders cannot accurately be defined for the individual project, because it include an evaluation of what would have happed without the intervention. This can for an analyses with many observations.

10.2 Examples

EEOs and the related tradable white certificates have been used for years in Denmark, France, Italy and United Kingdom. From 2013, an EEO have been in place in Poland. Luxembourg and other EU member states are preparing EEOs from 2015. The existing EEOs illustrate the diversity of possible designs. E.g. among the four examples the Danish EEO is the strongest in relation to energy efficiency in industry. This is in contrast to the examples from France, Italy, and UK where households and the public sector dominate.

Danish EEO

Energy distribution companies have been involved in energy savings at the end-user level since the early 1990s. Traditionally, their savings effort was limited to advice their own customers. This work was formalised with the first EEO operating from 2006 onwards. The EEO was based on a voluntary agreement within a legislative framework with the distributors of electricity, natural gas, district heating. The private heating oil companies committed to the obligation voluntarily. With the introduction of the EEO the savings effort was significantly restructured and the energy distribution companies were able to realise energy savings across the country and within all forms of energy. The change meant increased competition in providing competent advice to the attractive industrial customers.

From 2011 onwards first-year savings are weighted with a simple priority factor (with values 0.5, 1 or 1.5), which to some extend reflects the lifetime of savings, gross energy consumption associated with the realised savings cost, and expected CO_2 impact of savings – especially in regards to whether the savings are realised inside or outside the EU ETS area. Negotiation for the upcoming period (2013-2020) of the Danish EEO is still ongoing.

The target development of the Danish EEO can be seen in Table 10 while the design parameters of the current Danish EEO can be found in Figure 18.

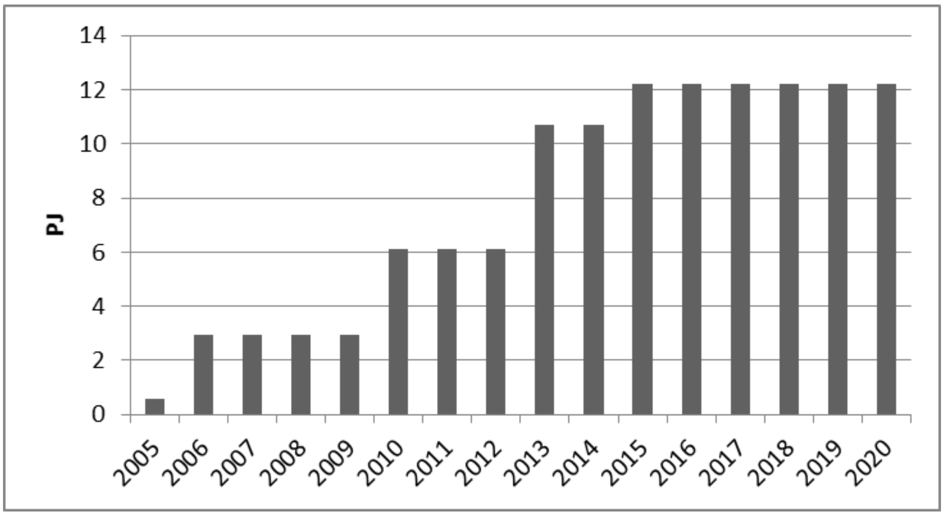

Figure 18: Development in the Danish EEO target. First years saving. The value for 2005 (0.6 PJ) shows savings from the previous system and is estimated based on reporting from utilities.

According to the EU EED the energy savings achieved by each obligated party, or each sub-category of obligated party, shall be published once a year. The EU EED emphasises that a measurement, control and verification system must be put into place to ensure that at least a statistically significant proportion and representative sample of the energy efficiency improvement measures put in place by the obligated parties is verified. Furthermore, this verification must be conducted independently of the obligated parties.

The Danish EEO fulfils the EU EED requirements within the area of control, verification and documentation. Independent random sampling tests are conducted each year and independent evaluations of the EEO are carried out routinely. With regards to penalties applicable in case of non-compliance the Danish design is insufficient. The only consequence of deliberate or involuntary faults or omissions discovered in the annual random sampling control is that the overall energy sector must provide extra savings the following year equivalent of the savings that was deemed faulty. As the risk of being caught is small, this system gives incentives for over reporting of savings.

Design parameter	Denmark
Policy Objectives	To decrease total primary energy consumption by 7.6 % in 2020 compared to 2010.
Legal Authority	Voluntary agreements by obligated parties and the Danish Energy Agency within a legislative framework.
Fuel Coverage	Electricity, natural gas, district heating, and heating oil. The transport is not included.
Sector and Facility Coverage	Residential, public & private business and industry end-users.
Energy Saving Target	2.95 PJ/year for 2006-2009 (0.7% of total final consumption); 6.1 PJ/year for 2010-2012 (1.2% of total final consumption) 10.7 PJ/year for 2013-2014 and 12.2 PJ/year for 2015-2020. The target is in first year savings.
Sub-targets and Portfolio Requirements	None.
Obligated Parties	Distributors of electricity, natural gas, district heating (regulated monopolies), and heating oil.
Measurement, Verification, and Reporting	Distributors verify and report savings; can be calculated or deemed savings. Yearly random sample control.
Compliance Regime	Energy savings must be well documented and they must be verifiable by an independent party if chosen for control
Penalty	None
Performance Incentives	Yearly benchmark of savings and costs for obligated parties
Eligible Energy Savings	Distributors must engage third parties to achieve energy savings outside own distribution area or energy type except for transport
Eligible Energy Efficiency Measures	Many types, including energy audits, subsidies for efficient appliances, equipment and retrofitting; also small scale renewables
Trading of Energy Savings	Energy savings, when realised, may only be traded among obligated energy distributors
Funding	Cost recovery through tariffs

Table 10: Design parameters of the Danish EEO scheme.

The obligated parties in Denmark have monopoly status and the cost incurred as a result of their EEO activity is financed over the energy bill. Only the total costs are reported by the obligated parties and in essence the Danish Energy Agency and the Danish Energy Regulatory Authority do not know what the money is spent on. Nor are the energy consumer informed of how much they contribute to energy savings financed over the energy bill. The system is designed in this way in order to minimise administration cost.

Within the Danish system there is probably a certain amount of self-discipline and potential shaming effect if caught. It can, however, be argued that the system does not sufficiently encourage cost-minimisation and that credibility currently rests on the generally low corruption level in the country; that the obligated party have experience in providing energy savings for end-users and therefore have highly skilled employees; and that the obligated parties supports and agrees with the target. If these circumstances are not in place the credibility of a cost recovery system with a minimum of control might not be appropriate.

More information on EEO can be found in (Regulatory Assistance Project, 2012), (Staniaszek, et al., 2012), (Bertoldi, 2010), (Betz, et al., 2013), (Bundgaard, 2013), (DECC, 2012), (Di Santo, et al., 2011), (Giraudet, et al., 2012), (Greaume, et al., 2011), (IEA, 2013), (JRC, 2010), (Lees, 2012), (OFGEM, 2013), (Regulatory Assistance Project, 2012), (Rosenow, 2012), (Rosenow, 2013), (Scheuer, 2013), (Swanson, 2012), (Togeby, et al., 2007) and (Togeby, et al., 2012).

10.3 Recommendations for Egypt

If Egypt choses to use EEO as a policy instrument, it could be focused only on industry or other sectors could be included. For industry the obligated parties may not be allowed to use subsidies, but only energy audits and individual advice. The use of subsidies could be relevant in a later stage, when international market prices for energy has been reached.

11 Electric motor systems

In this chapter we apply a different angle of perspective on policy-making. We take our starting point in the *technology* that represents by far the largest share of energy consumption within industry, namely electric driven motor systems. What is needed to increase the energy efficiency of the use of motors? Again examples have been selected with the aim to illustrate varies initiatives to address this end-use.

11.1 Why motors systems?

Motors are ubiquitous – they are used in all industries – and they hold a great potential for energy efficiency improvement in terms of design, system context, and operation.

A huge potential

According to IEA, electric motor systems account for 64% of manufacturing electricity use in industrial facilities worldwide and they are the largest single electricity end-use accounting for more than 40% of global electricity consumption. Around 25% of their electricity consumption could be saved cost-effectively, "reducing total global electricity demand by about 10%." (IEA, 2011 and Rao, 2013)

It is for example estimated that in Ecuador 73% of all electricity consumed in industry is consumed by motor systems (Fossa, et al., 2013) and in Brazil industrial motor systems alone represent 62% of electricity consumption and 28% of all electricity consumption in Brazil (Assumpção, et al., 2013).

Production processes and equipment change over time and inefficiencies compound and reoccur (Rao, et al., 2013). Therefore, even countries that have pursued industrial energy efficiency for many years can continue to harvest cost-effective savings in motor systems. Two such countries are the Netherlands and Denmark. Research and pilot projects in the Netherlands show that system optimisation and best-available-technologies can deliver 20-30% electricity reduction within motor system for industrial heating, cooling, and ventilation systems and industrial production (van Werkhoven, et al., 2013). In Denmark, about 70% of the electricity consumed in Danish factories is for motor-driven systems and several studies estimate potential saving levels to 5-30%. (Hvenegaard, 2009)

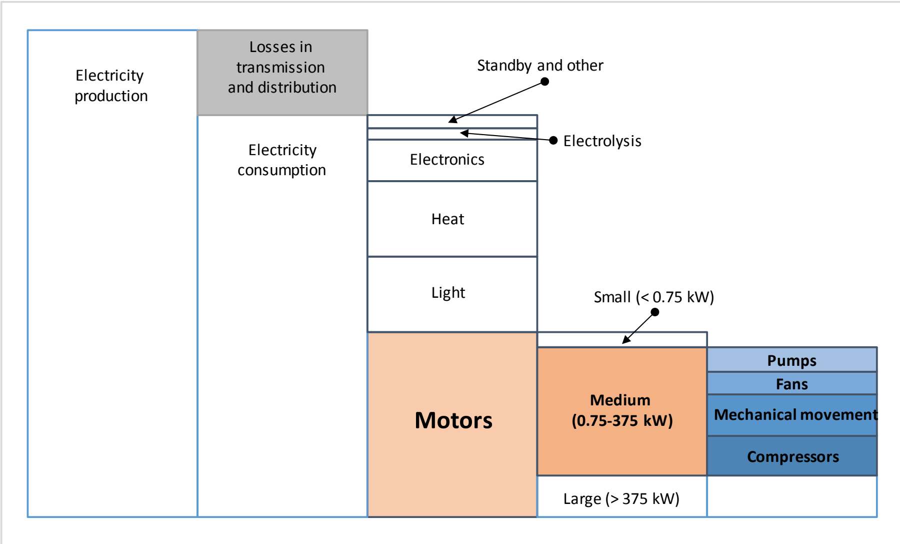

Figure 19: Estimated global electricity consumption by motors (based on (Waide, et al., 2011), page 40).

Motor systems

Motor systems can be complex systems and its efficiency depends on various factors which include: motor efficiency; motor controls (such as soft-starters and variable speed drives); the distribution network that feeds the motor (attention to power factor and distribution losses); system oversizing (proper equipment sizing); the transmission and mechanical components (optimized transmission systems); maintenance practices (careful maintenance of the entire drive power system) and the match between the load and the motor (good load management practice). (Fossa, et al., 2013)

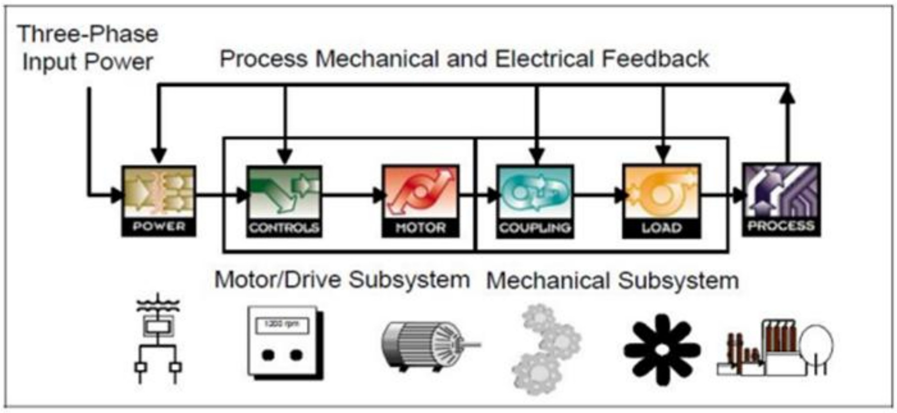

Figure 20: General configuration of a motor system showing the component that influence system efficiency (Fossa, et al., 2013).

Definition

The term "electric motor systems" may include:

- The motor itself,

- The equipment driven by the motor (pumps, fans, compressors, etc.) including interconnections and variable speed drives, and
- The "eventual application of power (a water heating piping system, an air ventilation ducting system, a cooling system with its cold water network and the cooling tower, a compressed air pipe system and the storage tank, a conveyor belt installation, an elevator for people and goods, etc.) as well as electric equipment between the grid and the motor (such as uninterruptible power supply, transformers, power factor compensation etc.)". (Waide, et al., 2011)

Furthermore, motors may be a separate piece of equipment or fully embedded in other equipment. Table 11 provides an overview of the main types of motors and their typical characteristics.

	Small	Medium	Large
Range	> 0.75 kW	0.75-375 kW	>375 kW
Stock	2,000 million (90%)	230 million (10%)	0.6 million (0.03%)
Electricity consumption	9%	68%	23%
Typical application	Fully integrated in appliances, small pumps, small fans	Pumps, fans, compressors, conveyors, and industrial handling and processing applications	Industrial and infrastructural applications
Operation voltage	Often operate at mains voltage or less (> 240 Volt)	Low voltage i.e. 200-1,000 Volt	High voltage i.e. 1,000-20,000 Volt
Phase etc.	Often single phase induction, shaded pole, or shunt-wound motors,	Polyphase, typically asynchronous AC induction motors, 2,4,6 or 8 poles,	Polyphase, synchronous,
Production	Custom made to fit another product	Large series, standard dimensions	Custom-designed, assembled on site

Table 11: Main types of motors and their typical characteristics (inspired by (Waide, et al., 2011)).

As a consequence, the EE measures related to motors systems span from simple to more advanced, and some improvements can be achieved without capital investment.

EU MEPS

Minimum energy performance requirements can help remove the least energy efficient products on the market. One of the important instruments targeting among other motors is thus the EU minimum energy performance standards (MEPS)[1] which ensure a certain minimum efficiency of the new products sold in the EU and motors are since June 2011 also encompassed. The MEPS for motors are in Europe and Asia described by use of IEC/EN standards set by the International Electrotechnical Commission (IEC)[2]. USA, Canada, and other countries related to the US have a similar system named NEMA.

The EU MEPS for new motor purchases is as follows:

- From 16 June 2011: IE2 for motors with an output of 0.75-375 kW.
- From 1 January 2015: IE3, or IE2 fitted with variable speed drive for motors with an output of 7.5-375 kW (i.e. 0.75-7.4 remains IE2).
- From 1 January 2017 = IE3, or IE2 fitted with variable speed drive for motors with an output of 0.75-375 kW.

A 3-pole, 50 Hz motor with an output of for example 0.75 kW must have an efficiency of 79.6% in class IE2 and 82.5% in class IE3.

What is the challenge?

A tendency among management to focus on up-front investment rather than life-cycle-cost (figure) overlooks the fact that the initial investment is only a very small part of the total life-cycle-cost.

Other barriers to efficiency include a tendency to focus on individual components rather than systems and a disconnect/split incentive between management staff and technical operators.

There are two simple indicators of inefficient motor systems (Brunner, et al., 2013):

1. The age of the motor system stock – If the motor system stock is old it shows lack of renewal and technical enhancements; and
2. How well the motor system size fits the task – If the motor systems are oversized it results in low efficiencies due to only partial loads.

An inspection of 17 industrial parks and 4,142 electric motor systems in Switzerland showed that more than 56% are older than the 10-20 year operating life expectancy and on average about double the expected age. The analysis

[1] COMMISSION REGULATION (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors.

[2] IEC 60034 standards contain recommended electrical practices developed by the participating IEC countries. Mechanical dimensions and tolerances of motors are specified by the IEC 600 72 and EN50347 standards. Metric units (SI units) apply.

found that the oldest motor had been running for 64 years! (Brunner, et al., 2014)

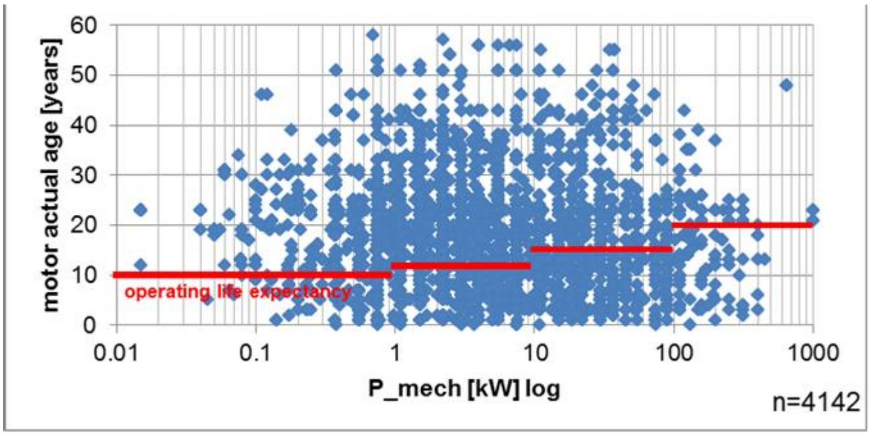

Figure 21: Actual motor age surveyed in Swiss industrial companies compared to expected life-time. The red line shows the expected lifetime of motors according to Anibal de Almeida et al, EUP Lot 11 Motors, ISR- University of Coimbra, 2008. (Brunner, et al., 2014)

In growing industries, there is an opportunity to secure energy efficiency at little extra cost and hassle provided that decisions are influenced at the right moment. However, it is a challenge that motor retailers have an economic incentive to promote larger motors thus leading to a risk of oversizing relative to the actual needs of a given company.

11.2 Illustrative examples

A strategy comprising energy audits and energy management supplemented with a focus on motor systems would target a large portion of the industrial energy consumption and would, if successful, have a significant impact. This fact is recognised worldwide and is reflected in the national industrial energy efficiency strategies of several countries as well as several international cooperation for a including UNIDO. Some example of international cooperation are provided below followed by examples of national strategies/policies.

International cooperation

EMSA

The Electric Motor Systems Annex (EMSA[1]) is an annex under the IEA Implementing Agreement for a cooperation program on energy efficient end-use equipment[2] (4E). The aim of EMSA is to raise worldwide awareness of the efficiency potential of motor systems and provide guidance and tools to ex-

[1] http://www.motorsystems.org/.
[2] http://www.iea-4e.org/about-4e.

ploit this. More specifically EMSA work addresses international standards, policies, testing, and capacity building. EMSA was created in 2009, renewed in 2012, and will run until 2014. The current participants are Australia, Austria, Denmark, Netherlands, Switzerland, and USA.

EMSA works for globally harmonized and robust technical standards for the classification and testing of motors and variable frequency drives through representation in standards working groups, and for implementing motor system management as part of the energy management system standard ISO 50001.

The Danish Technology Institute has developed a motor system assessment tool[1] for EMSA. This tool is unique in how it is applying a system approach to energy efficiency. Not only is the motor performance calculated, but also the transmission, drive and load itself are calculated and optimised.

Best practices and factsheets will be produced that are suitable to inform both a technical and non-technical public. (van Werkhoven, et al., 2013)

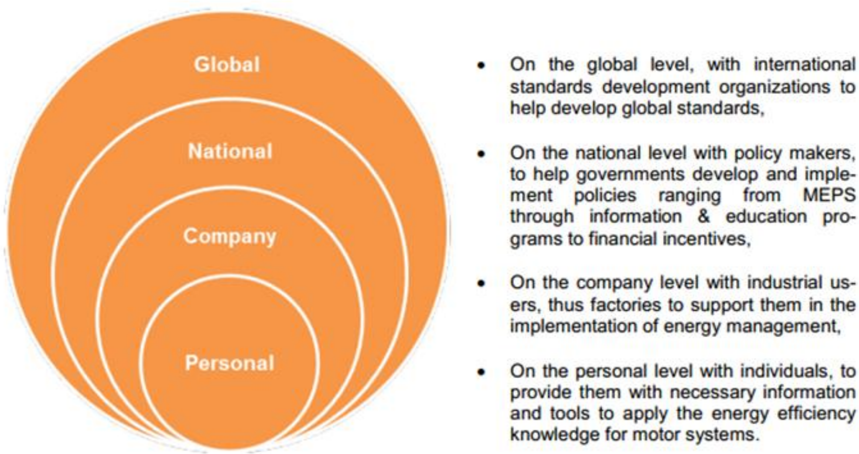

Figure 22: EMSA works on different levels (Brunner, et al., 2013).

Motor challenge

The European Motor Challenge program[2] is promoted by the European Commission and offers assistance to companies in improving their electric motor driven systems through national contact points in each EU Member State. It was launched in 2003, inspired by an earlier program in USA.

[1] Can be downloaded at http://www.motorsystems.org/motor-systems-tool.

[2] Main page: http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/index.htm; Evaluation: http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/pdf/The%20European%20Motor%20Challenge%20Programme_Evaluation%202003-2009.pdf

Companies that use motor driven systems can request “Partner” status while companies that supply motor driven systems and services can become “Endorsers”. Endorsers get public acknowledgement for their efforts to support the Motor Challenge program.

As a partner, a company commits to the following:

- Carry out an inventory of company’s motor driven systems.
- Assess possible energy efficiency improvements.
- Formulate an action plan that defines the scope and nature of the company’s commitment to energy efficiency. (After which the Commission approves the action plan and grants Partner status to the company.)
- Execute the action plan and submit annual progress reports to the European Commission.

The partner company commits to undertaking specific measures to reduce energy consumption but the partner company decides which production sites, and which types of systems are covered by the commitment. In return, the company receives advice and technical assistance. Guides and materials are accessible via the Motor Challenge website. An example is the database for motor systems, EuroDEEM[1], which contains data on high efficiency electric motors.

The partner company is also rewarded by recognition by the European Commission in the form of:

- Plaques on the company building or production plant;
- Press releases;
- Exclusive use of the Motor Challenge logo;
- Inclusion in the partnership catalogue;
- Participation in the Motor Challenge awards.

Overall the Motor Challenge is a relatively “soft” instrument aimed at creating awareness and visibility.

[1] http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/index.htm

National policies

China

China became the largest energy user in the world in 2009 and the largest energy related CO_2 emitter in 2007. Industry accounts for about 70% of these (Shi, et al., 2014). The Top 1,000 program and its successor the Top 10,000 program are the key policies aimed at reducing the energy intensity of the Chinese industrial sector. The Top 10,000 presented in the 12th Five-Year-Plan (2011-2015) covers more than 15,000 industries and 2,000 buildings and 160 transport entities – in total representing about 2/3 of China's total energy consumption. The target is 7,327 PJ reduction in energy consumption.

The program components are benchmarking, audits, technical retrofit projects and incentives/penalties. The financial incentives for implementation of EE projects under the 12th Five-Year-Plan were increased from 200 RMB to 240 RMB (27 EUR) per ton carbon saved per year for East China and from 250 RMB to 300 RMB (33 EUR) for Central and west China and the minimum project size to qualify was reduced from 10,000 ton standard coal equivalent (293 TJ) to 5,000 (147 TJ). The projects must be within coal-fired industrial boiler retrofits, district cogeneration, waste heat and pressure utilisation, oil conservation and substitution, or energy efficiency improvement of motor systems. (Shi, et al., 2014), while energy audits, training and capacity building for auditors, energy management do not receive financial support.

China's 10 Key Projects for EE[1], launched in connection with the 11th Five-Year-Plan, include a motor system program since the sales of small and medium sized three-phase asynchronous motor grew more than 14% in 2011. The program continues in 12th and 13th Five-Year-Plan (Zhao, et al., 2013).

China has about 3,000 motor manufacturers and motor manufacturers are small and sporadically dispersed with weak product development capability and low overall EE. High efficiency motors only make up 3% of the Chinese market and most are exported.(China motor efficiency upgrading program 2013-2015; Ministry of Industry and Information Technology of the People's Republic of China, EEMODS October 2013).

[1] The "10 Key Projects" for EE improvement focus on 1) coal-fired industrial boiler (kiln) retrofits, 2) district cogeneration, 3) waste heat and pressure utilisation, 4) oil conservation and substitution, 5) motors energy efficiency, 6) energy system optimisation, 7) building energy conservation, 8) green lighting, 9) government agency energy conservation, and 10) energy saving monitoring and testing and technology service system building. (Levine, et al., 2011)

Minimum energy performance standards are in China combined with recommended efficiencies, which will become mandatory within a short time horizon e.g. 4-5 years. (Zhao, et al., 2013)

The Netherlands

The Dutch motor strategy consists of three core initiatives – Voluntary agreement program for energy management systems, participation in IEA 4E Electric Motor Systems Annex (EMSA) and electric motor systems knowledge network (van Werkhoven, et al., 2013) – supplemented by the "Green Deal" program.

The first generation of voluntary agreements were signed in 1992 with the Ministry of Economic Affairs and the agreement was to reduce annual energy use per unit produced by 2%. The current and third generation of voluntary agreements (VA3) were signed in 2008 and will run until end 2014. The ambition is to achieve 30% EE improvement over the period 2005-2020. The Dutch Ministry of Economic Affairs has similar agreements with industrial companies subject to the EU ETS. VA3 signatories must implement three activities: Make an EE plan every four years, monitor production levels and energy use annually, and implement an energy management system. Activities are organised for the VA3 signatories such as thematic workshops, pilot projects, energy audits, and technology road maps.

In the past years, special attention is given to motor system efficiencies. Motor measures have been added to the list of technologies subject to a tax relief program which rewards companies that invest in EE and sustainable energy – the net profit on their investment in EE equipment can amount up to 11%. The VA3 signatories can also apply for an "Energy Investment Allowance" support to cover the costs of an action plan for electric motors provided, that these are implemented.

A random sample check of the VA3 companies is carried out annually to assess compliance but also the level of activity. The 2012 sample check showed that a weak point is a weak or non-existent management review of operation leading to low involvement and lack of monitoring of the actual effectiveness of the implementation EE measures.

The Netherlands also participate in several cooperation such as the EMSA work for globally harmonised and robust technical standards for the classification and testing of motors and variable frequency drives through representation in standards working groups, and for implementing motor systems management as part of the energy management systems standard ISO 50001[1]. (van Werkhoven, et al., 2013)

In addition to these three core policies the Dutch government has also launched a project – “The Green Deal Efficient Motor Systems” to achieve tangible energy savings and CO_2 reduction through the use of efficient motor systems in industrial companies (van Werkhoven, 2014). The “Green Deal Efficient Electric Motor Systems” is one of more than 100 projects within the Dutch Green Deal program, aimed at sustainable development. Green Deal projects are initiated by market actors, non-governmental organisations, whilst the Ministry of Economic Affairs delivers facilitating services and helps in removing existing barriers in regulation, market circumstances and such.

The “Green Deal Efficient Electric Motor Systems” was formulated by the Federation of Suppliers of Electric Motors, Drives, and Automation (FEDA) and Uneto-VNI, the trade association of installation and electromechanical maintenance companies, and the Dutch National Office of Entrepreneurs. It runs from 2012 to 2015 and there are currently additional 28 producers & retailers of motor systems, producers and retailers of pump systems, and installers and maintenance companies have signed on as partners[2].

The goal is to establish a standardised, systematic, step-by-step audit method for retrofitting motor systems applying best available technologies and life cycle costing principles which shall be proven through real-life application at 35 industrial users. By doing so it also creates case examples that can inspire other companies to follow. The activities also include exploration of financing options and knowledge transfer and training.

An important feature of the program is the involvement of motor suppliers and service companies. Furthermore, they learn to apply a new business model based on efficient systems while the industrial case companies save energy and familiarize themselves with the benefits of efficient motor systems. (Brunner, et al., 2014)

[1] ISO 50001 Energy Management was launched in 2011 and seeks to establish routines for continual consideration of energy issues in the management (investment) and operation & maintenance (O&M) culture of the individual company. It provides a framework of requirements for organisations to: Develop a policy for more efficient use of energy, fix targets and objectives to meet the policy, use data to better understand and make decisions about energy use, measure the results, review how well the policy works, and continually improve energy management. http://www.iso.org/iso/home/standards/management-standards/iso50001.htm.

[2] http://greendealaandrijfsystemen.nl/

Switzerland

Swiss Agency for Efficient Energy Use launched a financial incentive program on 1 November 2010 that will run until 31 October 2014. It is called the Efficiency for Electric Motor Systems (EASY[1]) and the goal of the program is to retrofit existing motor systems in mid-size industrial and infrastructure plants as well as large buildings with 10-50 GWh/year electricity consumption. The program budget is 1.22 million EUR (1 million CHF) from public funding.

EASY operates with four levels of subsidy depending on the steps in the implementation process (see Figure 23). Step 1 is an assessment of the EE potential and the subsidy covers 100% of the assessment cost. Step 2 consists of compiling an overview of the motors in the company. For each motor 6 criteria are used to assess whether the motor should be tested i.e. proceed to step 3. This work is subsidized with 25-75%. The subsidy for step 2 is paid in three instalments – 25% in step 2 25% after completion of step 3 and 25% after completion of step 4. Thus if only step 2 is completed the subsidy is 25%. Step 3 is on-site testing of selected or all motor systems in place and 50% subsidy is possible. The fourth and final step is the actual implementation of EE improvements. Here a 10% subsidy is offered. (Werle, et al., 2013)

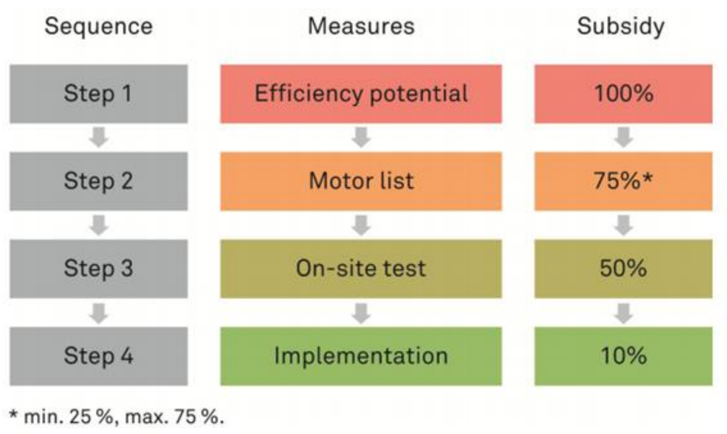

Figure 23: The four steps of the EASY program and the respective subsidy levels (Werle, et al., 2013).

However, the Swiss government is aware of the fact that although subsidies might help to open doors it does not remove all barriers to EE. Another initiative to further EE includes an education program for energy management at University of Geneva, available as of January 2013. Furthermore, the Swiss government plans to introduce a voluntary agreement program for energy intensive companies i.e. companies whose electricity costs constitute more

[1] www.topmotors.ch/easy.

than 5% of total costs. Companies that sign on will in return get their feed-in tariff payment refunded.

Typical EE measures, which have been implemented at participating companies, are (Werle, et al., 2013):

- Higher-level control system for compressed air and cooling systems,
- Reduction of volume, nominal pressure and speed in air ducts and water pipes,
- Downsizing of motors based on actual measured requirements,
- Improve starting conditions to reduce maximum required torque,
- Replacement of old motors with new (down-sized) IE3 motors,
- Installation of variable speed drives in motors with variable load conditions,
- New, smaller components (e.g. pumps, fans, compressors) for an optimised system,
- Better transmission (synchronous belts) or direct drive,
- Optimization of operating hours depending on production requirements (e.g. necessary operation during the night, weekend, etc.).

Japan

The Japanese Top Runner program[1] was launched in 1999 with the ambition to push product development and sales towards more EE products. The Top Runner program operates with two types of standards (Shibata, 2013):

- Minimum energy performance standard (MEPS) which requires product manufacturers to achieve prescribed minimum efficiencies in each product. Sale of products not meeting the standard is prohibited.
- Class-average standards (CAS) which are the average efficiency of a manufactured product, allowing each manufacturer to select the level of efficiency for each model so that the overall average is achieved. CAS allows manufactures to meet the standard by the sales-weighted average energy efficiency, which brings the benefit that manufacturers can provide a variety of product line-up to meet the consumers' needs (both low and high efficiency), while guaranteeing the total energy efficiency of the market.

The standard is set at the level of the most efficient product that exists in the market at the time of standard setting.

[1] http://www.eccj.or.jp/top_runner/

Energy performance standards for three-phase motors were agreed in December 2011 and the “requirements regarding product coverage, standard, and target year were specified in 2013”. The standard was set at the level equal to IE3 standard[1]. Manufacturers and importers are required that sales-weighted average efficiency of their products in each category should exceed the standard by the target fiscal year 2015. By implementing the standards, the sales weighted average efficiency is expected improve from 81.1% in 2010 to 87.1% in 2015. (Shibata, 2013)

One of the reasons for the success of the Top Runner program is a high enforcement/compliance. The Japanese business culture (and social culture) places great emphasis on being the best and not losing face e.g. in case of non-compliance. The fact that it is at all possible to agree on standards can be attributed the cooperation among stakeholders in setting standards and that the maturity of the technologies in question allows competition on EE improvements. On the other hand, lessons learned are that excess focus on EE can result in other product features being counterproductive (e.g. growth in size of room air conditioner, reduced lifetime of gas boilers due to corrosion from condensation caused by the lowering of exhaust gas temperature) (Shibata, 2013).

11.3 Recommendations for Egypt

An Egyptian motor policy for industry should aim to:

- Speeding up elimination of inefficient motor systems,
- Promoting uptake of energy efficiency motor systems, and
- Strengthening motor system management.

Mapping the motor situation

Many of the barriers to motor system efficiency will be common to those of other countries but the most effective way to overcome these barriers could differ due to differences in industrial practices and the special features of Egyptian society. A sound first step to formulating a motor policy for Egypt could therefore be to describe the current motor situation in Egypt. This “mapping” could for example be conducted as a focus group discussion with representatives of industries, branch organisations, universities, suppli-

[1] Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to eco-design requirements for electric motors, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0026:0034:EN:PDF

ers/importers, Egyptian motor/equipment producers. A focus group discussion is a small-group discussion guided by a facilitator[1].

Topics for discussion could include:

- What is the current state of motor stock and system operation and maintenance practices including the logics behind the practices?
- What characterises the Egyptian motor market including available product ranges, efficiency levels, prices, services, and preferences for second-hand equipment?
- What are the prevalent company management practices in particular regarding responsibility, investment decisions, and upgrading of staff qualifications?
- What are the major concerns of industrial companies by segment?
- What role do the branch organisations have?
- What mandatory requirements are currently placed on the industrial companies (e.g. environmental requirements regarding reporting of waste, financial information for tax purposes, reporting statistical data)?
- What is the awareness of company energy consumption levels and degree energy efficiency among various levels of management and staff?

As time progresses and audits are carried out and energy management systems are implemented in some companies as a consequence of the current UNIDO initiative these can feed back to the understanding of the motor situation in Egypt and related topics. A deliberate and structured collection of experiences gained through the audits and energy management systems would be highly beneficial to any future EE initiatives and adjustment of existing initiatives.

A motor policy could contain elements for all company sizes but be tailored to the size specific needs.

Success inspires success

[1] Focus group discussions are often used to learn more about opinions on a designated topic, and then to guide future action. A focus group is different from regular group in three ways: 1) The group has a specific discussion topic (a focus). The group's task is to stay on it, and not wander all over the place. 2) The group has a facilitator whose task it is to keep the group on course. 3) The group's composition and the group discussion are carefully planned to create a non-threatening environment, in which people are free to talk openly. The participants are actively encouraged to express their own opinions and respond to other members, as well as to questions posed by the leader. Because focus groups are structured and directed, but also expressive, they can yield a lot of information in a relatively short time

It will be important to build success stories from the beginning to help leverage interest. These should not be limited to written materials. A higher impact can be expected if successful companies are given the opportunity to present their own experiences to their peers ("show-and-tell").

Start small

There are here-and-now possibilities for improving energy efficiency with no capital investment. Targeting these could open the door for more substantial alterations. And they could ensure some progress towards energy efficiency while more laborious initiatives such as mandatory requirements are developed, politically approved, and launched.

Alliances

Experience from other countries show that alliances with branch associations are an effective way forward. These associations may help blue stamp the policy initiatives but also function well as a gate for access to member companies. Working together has mutual benefits and provides branding opportunities. The association would be seen to be doing something for its members, and the policy initiatives could be tailored to the specific needs of the branch in question and be combined with other business concerns such as environmental requirements.

Voluntary agreements

Voluntary agreements is a more flexible alternative to mandatory motor requirements although the voluntary agreements also contain commitments and possible penalties. If voluntary agreements are to be used it might be relevant to operate with 2-3 types of agreements – one for branch associations, one for energy intensive industries, and one for state-owned companies.

Mobile diagnostic team

Experiences from all over the world show that there is a long way from the best of intentions to action no matter how cost-effective a solution is. A "Mobile motor diagnostic team" that proactively seeks up industrial companies and offers their diagnostic services/assistance could stimulate company interest and actual implementation of motor related EE improvements.

Manuals and tools necessary for assessing the current situation and potential improvements have already been prepared by others and presumably only minor adaptations to Egyptian context if any are necessary.

Financial incentives

Financial incentives of some kind will most likely be needed at least initially to spark an interest. Such incentives can take many forms and care should be taken to develop incentives well suited for Egypt. Examples include:

- Income tax based incentives such as preferential income tax (e.g. 10% of investment value can be deducted and exempted from tax payable in the year of investment and can be carried over the next five years if income tax amount is lower[1]);
- Reduction of energy taxes or environmental taxes;
- Special loans – For example interest free loans for EE equipment investment or low interest loans with the interest rate depending on the equipment efficiency levels or comprehensiveness of alterations;
- Subsidies – That vary depending on investments, equipment efficiency levels and/or achieved energy efficiency improvements. The need for A time limit can help improve impact per spent EUR and spur on a rapid response;

In addition to tax measures, public financing, and international funds the traditional funding sources for companies include commercial banks, lending institutions, venture capital firms, equity funds, strategic partnerships (e.g. utilities and engineering firms), leasing companies; and equipment manufacturers.

Target all key actors

Finally, a motor policy should contain elements so that all key actors are targeted – policy makers, research & education institutions, producers, importers, retailers, service companies (including audit experts), and industrial companies (managers, facility engineers).

[1] Zhao (2013)

Part III: References

12 Additional information

12.1 Keeping updated

Today several international fora for collaboration and sharing experiences on energy efficiency related matters exist. Some of the most relevant for Egypt are listed below.

Energy efficiency

RDCREEE

The Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) is an independent non-profit regional organisation, established in 2010, which aims to enable and increase the adoption of renewable energy and energy efficiency practices in the Arab region. Current member states are: Algeria, Bahrain, Djibouti, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, Palestine, Sudan, Syria, Tunisia, and Yemen. RCREEE is financed through its member state contributions, government grants provided by Germany through the German Development Cooperation (GIZ), Denmark through the Danish International Development Agency (DANIDA), and Egypt through the New and Renewable Energy Authority (NREA). RCREEE is also financed through selected fee-for-service contracts. Work areas included research and analysis, capacity development, and technical assistance. http://www.rcreee.org/

ACEEE

American Council for an Energy-Efficient Economy (ACEEE), founded in 1980, is a non-profit, organisation that acts as a catalyst to advance energy efficiency policies, programs, technologies, investments, and behaviours. ACEEE focuses on energy policy (federal, state, and local), research (including programs on buildings and equipment, utilities, industry, agriculture, transportation, behaviour, and economic analysis), and outreach (including conferences, publications, and the Ally Program). http://aceee.org/

ECEEE

European Council for an Energy Efficient Economy (ECEEE), founded in 1993, is a membership-based non-profit association, that generates and provides evidence-based knowledge and analysis of policies, and we facilitate co-operation and networking through our Summer Studies, workshops, and social media. http://www.eceee.org/

ECEEE also organises biannual conference on matter relating to industrial energy efficiency, http://www.eceee.org/industry

IIP

The Institute for Industrial Productivity (IIP), established in 2010, is an independent non-profit organisation whose aim is to accelerate the uptake of industrial energy efficiency practices by partnering with both industry and governments. IIP work focuses on the countries and sectors that drive industrial demand and offer major opportunities for improvement – such as in the cement, iron and steel, and chemicals sectors in China, India, and USA. IIP has created an industrial efficiency policy database (IEPD) that provides information on industrial energy efficiency and greenhouse gas mitigation policies, currently containing policies from 14 countries: Australia, Canada, Germany, Russia, South Africa, Thailand, Sweden, Finland, the United Kingdom, Japan, India, the Netherlands, the United States and China. http://iepd.iipnetwork.org/

Energy efficient motor systems

EEMODS

Energy Efficiency in Motor Driven Systems (EEMODS) conference, first organised in 1996, is an annual conference. In relation to each conference a magazine is published. http://www.eemods2013.org/Default.asp

EMSA

Electric Motor Systems Annex (EMSA) is an annex under the IEA Implementing Agreement for a cooperation program on energy efficient end-use equipment[1] (4E). EMSA was created in 2009 and addresses international standards, policies, testing, and capacity building, http://www.motorsystems.org/

Standards and labelling

CLASP

CLASP, founded in 1999, develops and shares practical and transforming policy and market solutions in collaboration with global experts and local stakeholders. CLASP is a leading international resource and voice for energy efficiency standards and labels for appliances, lighting, and equipment. CLASP has worked in over 50 countries on 6 continents pursuing every aspect of appliance energy efficiency, from helping structure new policies to evaluating existing programs. http://www.clasponline.org/

ISO

The International Organisation for Standardisation (ISO), was created in 1947, and develops and publishes international voluntary standards. ISO has published more than 19,500 International Standards covering almost all aspects of technology and business from food safety to computers, and agriculture to healthcare. ISO member count 162 countries including Egypt (represented by

[1] http://www.iea-4e.org/about-4e.

Egyptian Organisation for Standardisation and Quality Control). http://www.iso.org/iso/home.html

Energy efficiency policy development

RedLacEE

The Latin American and the Caribbean Network for Energy Efficiency (RedLacEE), created in 2011, is a public/private non-profit organisation that contributes to develop energy efficiency in the region, facilitating exchange and dissemination of technical, legal, and regulatory information among institutions and interested professionals in the region. http://red-lac-ee.org/

RedLacEE is based in the offices of the Permanent Secretariat of the Latin American Energy Association (OLADE) in Ecuador.

OLADE was created in 1973 to protect the natural resources in the region and further technical cooperation on policies for sustainable development. OLADE is the political and technical support organisation by means of which its Member States undertake common efforts to achieve regional and sub-regional energy integration.

UNIDO

United Nations Industrial Development Organisation (UNIDO), created in 1966, is an autonomous body under United Nations. UNIDO aims to promote and accelerate inclusive and sustainable industrial development in developing countries and economies in transition. UNDIO work focuses on poverty reduction through productive activities, trade capacity-building, and energy and environment, including assistance to resource-efficient and low-carbon industrial production. http://www.unido.org/ Publication themes include industrial energy efficiency http://www.unido.org/en/resources/publications/energy-and-environment/industrial-energy-efficiency.html

Evaluation of energy efficiency policies and programs

IEPEC / IEPPEC

North American International Energy Program Evaluation Conference (IEPEC) is a conference first held in 1984 and again in 1985. Since then conferences are held biannually and as of 2010 a European conference has been added in alternate years. Due to the broader scope of evaluation and especially the focus on policies, the name has recently changed to International Energy Policies & Programmes Evaluation Conference (IEPPEC). The purpose of the conferences is to provide a forum for the presentation, critique, and discussion of objective evaluations of energy policies and programs. http://www.iepec.org/

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12.3 Useful links

- *IEA policies and measures database* (http://www.iea.org/policiesandmeasures/energyefficiency/)
- *IEA Policy Pathways series*; IEA and the Institute for industrial productivity; http://www.iea.org/publications/policypathwaysseries/

- *World Energy Council*; Energy Efficiency Policies Database; http://www.wec-policies.enerdata.eu/
- Global, Super-efficient equipment and appliance deployment (SEAD) http://www.superefficient.org/
- *US Office of EE and RE* http://energy.gov/eere/efficiency/advanced-manufacturing
- *US Department of Energy, Office of EE and RE*; http://energy.gov/eere/efficiency/advanced-manufacturing
- *EU-MURE database on energy efficiency policies*; http://www.measures-odyssee-mure.eu/
- *EU national energy efficiency action plans* submitted by the EU Member States, no. 1 and 2.; http://ec.europa.eu/energy/efficiency/end-use_en.htm
- European Motor challenge www.motor-challenge.eu
- European Industrial Insulation Foundation http://www.eiif.org/
- European GreenLight program www.eu-greenlight.org
- Chinese top ten program http://iepd.iipnetwork.org/policy/ten-key-projects-programme
- French http://www.guide-topten.com/ = http://www.guidetopten.fr/
- UK http://www.top10energyefficiency.org.uk/

12.4 Abbreviations

CAS – Class average standards

EE – Energy efficiency

EEO – Energy efficiency obligation

EMS and EnMS – Energy management system

EU EED – EU Energy Efficiency Directive

IEE – Industrial energy efficiency

RD&D – Research, development, and demonstration

VA – Voluntary agreements

MEPS – Minimum energy performance standard

12.5 Acronyms

ACEEE – American Council for an Energy Efficient Economy

ECEEE – European Council for an Energy Efficient Economy

EEMODS – Energy Efficiency in Motor Driven Systems

EMSA – Electric Motor Systems Annex

GoE – Government of Egypt

IEA – International Energy Agency

RCREEE – Regional Center for Renewable Energy and Energy efficiency

UN – United Nations

Appendix: Historical development of the Danish IEE policy

Countries are different. The importance of industry is different and the political priorities are different. The Netherlands has been especially successful in using voluntary agreements, Finland are strong in energy audits and Denmark has been a forerunner in energy efficiency obligations. The differences is also based on the trajectory in each country. Positive results can encourage further development along the same lines.

In the following is presented the subjective history on the long development of Danish IEE policy – based on the authors' active participation in the process.

From the first oil crisis and forward there has been a broad support about the energy policy in the Parliament. There has been lots of discussion, but most policy decisions has been made with a broad majority with parties from left to right.

An important focus of energy efficiency in Denmark has been on the residential sector, e.g. with high taxes (in the order of 100%) of energy. In the table below is summarised important milestones in relation to IEE.

1973: First oil crisis 1979:L Second oil crisis	Denmark was heavily dependent of oil for transport, heating and electricity generation. This was the start of creating a Department of Energy (in 1976) and the Ministry of Energy (in 1979), first Energy action plan (1976) and the decision about the Danish Natural gas project (in 1979). The action plan from 1976 covered a broad set of measures, including energy efficiency in industry and homes. Measures in relation to industry included information campaigns and investment subsidies. A law about heat planning from 1979 also had focus on the utilisation of surplus heat from industry as district heating.
1986 – 1993	Electric utilities developed extensive energy audit programme and training for consultants based on a voluntary agreement with the national energy agency. Research project about electricity efficiency, including test of extensive energy audit in energy intensive companies. Result documented significant savings and a positive total economy.
1993 –	CO_2 tax on all energy users. Introduced over three years. Possible reduction in tax for energy intensive companies if that undertook an extensive energy audit (including requirement to implement profitable projects and to perform special investigations of more complicated issues and to implement energy management)
1986 – 2006	DSM activity in energy companies. First in electricity companies and later in all sectors such as natural gas and district heating companies. Now the activities went from extensive energy audits, to more focused audits on selected part, covering the needs from the customer
1995 – 2001	Project Toolbox: Information dissemination of energy saving possibilities and tools and industrial networking groups.
1993 – 2001	Subsidies to energy efficiency investments, up to 30% of the investment. Subsidies was introduced as part of the CO_2 tax. Was stopped by a new liberal Government. In the start, this Government wanted less state interventions and lower taxes. Later it turned green, e.g. up to the COP 15 in Copenhagen.
1999 –	Mandatory labelling of buildings bigger than 1500 m^2 was established, with the aim to reduce energy consumption. Mainly developed in relation to the service sector.
2001 –	The research found Elforsk was established with the purpose to support research within energy efficiency. Yearly

	calls for new projects.
2005 –	EU Emissions Trading System (EU ETS) for CO_2 introduced. New phases started in 2008 and 2013. It is a Cap & trade system, effectively functioning as a European wide CO_2 tax for users with boilers over 20 MW. Short periods with high CO_2 price – long periods with low price and minimum impacts.
2006 –	Transformation of energy companies EE activities. Increased focus on realise projects (instead, of recommended projects): Energy efficiency obligation (EEO). The obligation increased in 2010, 2013 and 2015. Competition across energy types and geography. Extensive energy audits are now rare. However, subsidies are used commonly. Large portion of saving is in industry as they are the cheapest seen from the utility and society side.
2012	EU recommend EEO to all Member states in the energy efficiency directive
2014	Several taxes on energy is reduced for industry due to the economic crisis.

The interest for energy policy and EE in Denmark has been more or less constant since the first oil crisis. The motivation has been driven by security of supply (e.g. oil crisis, Russian/Ukrainian natural gas crisis), environment (e.g. greenhouses effect) and economy (e.g. trade balance).

Figure 24 illustrate the overall development for energy intensity for Danish industry. A development in direction of less energy intensive industrial sectors have been part of the development.

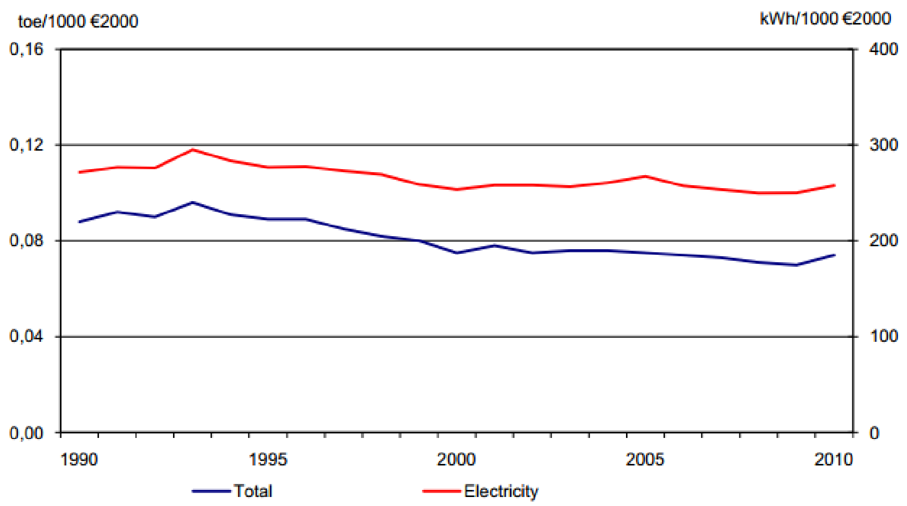

Figure 24. Energy and electricity intensities in Danish industry. (Danish Energy Agency, 2012)