

Financial Incentives for Dispersed Investment in Sustainable Energy

Hans Nilsson, FourFact

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Summary

Financial Incentives is the most popular measure suggested in policies to promote a change in the marketplace. The idea is that when actors are presented a sufficient profit for a change, they will act since they are expected to act rationally in their own economical interest. If necessary, governments have to provide additional incentives to facilitate the action. Governments have to buy down the difference in cost.

The biggest financial incentive is however dormant in the energy use in all sectors today. There are huge economical potentials reported in all sectors, potentials that are also continuously growing, but still not realised for a variety of reasons. For governments to further add financial resources to buy these already “free lunches” would be economically impossible. The barriers may be insurmountable even if reduced or eliminated, since they are the barriers of minds and behaviour rather than barriers of economics and awareness. But we are not doomed to be inefficient.

To release the dormant incentives there is a case for “aggressive and persistent assistance” to enable actors to make the change.

- Governments need to organise themselves for delivery of energy efficiency and not only indicate possibilities and leave the rest to wishful thinking.
- Households need much more hands-on aid to find products and put them in place,
- Industry and commercial sector business need to put the energy efficiency options in a relevant perspective in a business strategy that affects their business development and survival. Opposed to being just single projects to fix a problem.
- Public sector needs to form alliances and organise support for their own purposes, and for others to make use of. These will strengthen supply of better goods and develop routines and organisation for management
- Utilities and manufacturers need to issue “detain orders” for obsolete equipment to be scrapped and replaced.
- Supply side of energy efficiency industry that is scattered in many sectors today need to form trade ally groups as “energy efficiency business associations”
- New allies, such as insurance companies and the financial sector has to recruited since sustainable energy solutions has an impact on their risk management

To underpin and further found this release of dormant incentives there is still a need for government actions to incentivise (and sweeten) options. GHG-abatement should not be an end-of-pipe issue as it is today when the emitters are give permissions to emit. It should rather be an up-stream issue since it is the demand that motivates the supply that causes the emissions. This could be made with privatising the Carbon-accounts, establishing Offset funds and bundling CDM-efficiency projects and funding the benefits from Carbon Trading. The basic rule should be that payment for carbon-emissions should be accumulated in such a way that it funds a reduction in future emissions .

Finally there is a case to foster new technologies, to enable their entry to the market and to fuel the industrial learning-process. Such technology might be more expensive in the beginning and the learning investments need to be paid. They will result in future profit.

Introduction

Financial Incentives is the most popular measure suggested in policies with the function to promote a change in the marketplace. The incentives can be applied both positively, as subsidies (carrots) to encourage use of better applications and negatively as taxes/levies (sticks) to discourage use of inferior technologies. In a few cases both are applied within a system to redistribute resources between actors through so called “feebates”.¹ There is however also a strong financial self-incentive within most activities where energy efficient opportunities are underutilised, these incentives are dormant assets in households, administration and companies.

The underlying assumption for financial incentives is that people act economically rational, as an “homo economicus”² – an economic man, and will include the financial incentive in their calculation and then chose the alternative that is most favourable to them, i.e. normally has the lowest cost. Even with alternatives to this basic model, e.g. considering bounded rationality or behavioural economics, the financial incentives are assumed to make a difference in the market, though not as direct and quickly, and not necessarily when applied generally. There is however surprisingly little literature on how financial incentives should be constructed to achieve their assumed impacts. The financial incentives are mostly dealt with as one homogenous category that is different from and in opposition to other categories of incentives such as information (e.g. labelling, assistance) and legal instruments (e.g. codes, practices).

There is therefore a case to ensure that the financial incentives are designed and used in an optimal way, i.e. really promote the alternative that gives the best effect and do not result in a waste of money on actions that would have happened anyway or that will not have a lasting effect. This study intends to investigate:

- What sort of actions and technologies that are most useful to give support and that may deliver a substantial effect reasonably fast.
- How actors respond to financial incentives of different types
- How programmes could be designed, with the financial instrument, to deliver results.

The study begins with a short look on the **actor roles in the energy systems**, section 1 supported by appendix I, to discuss and find the point of leverage where differences are made. This is followed by looking at potentials and some cases, **Technologies and users**, where the “inefficiency” seems especially blatant, section 2 supported by appendix II. In sections 3 and 4 the focus is on different incentives. How people react to them, and how success of the incentives can be measured and communicated - **Design of financial incentives** to make an impact in the **everyday reality** that people face when they are confronted with an opportunity to “be more efficient”. A short section 5 tries to wrap up the aspects and launch the idea to

¹ An example is Sweden's Nitrogen Tax. The tax revenue collected from power generators is refunded to participants based on the amount of nitrogen oxide produced per unit of energy. In the first year alone, NOx emissions fell by 35%, and investment in abatement technology increased. This system creates a dynamic where heavier polluters transfer resources to lighter polluters. This revenue neutral feebate offers a method of attaining a domestic environmental objective while minimizing adverse competitiveness impacts and still creating incentives for ongoing technological innovation.

<http://www.smartregulation.gc.ca/en/06/01/su-11c.asp#ftn5>

The system has also been suggested by the Rocky Mountain Institute, RMI, to be used in the transport sector as a revenue neutral instrument to reward fuel efficiency and punish guzzlers [Lovins et al.]

² http://en.wikipedia.org/wiki/Homo_economicus

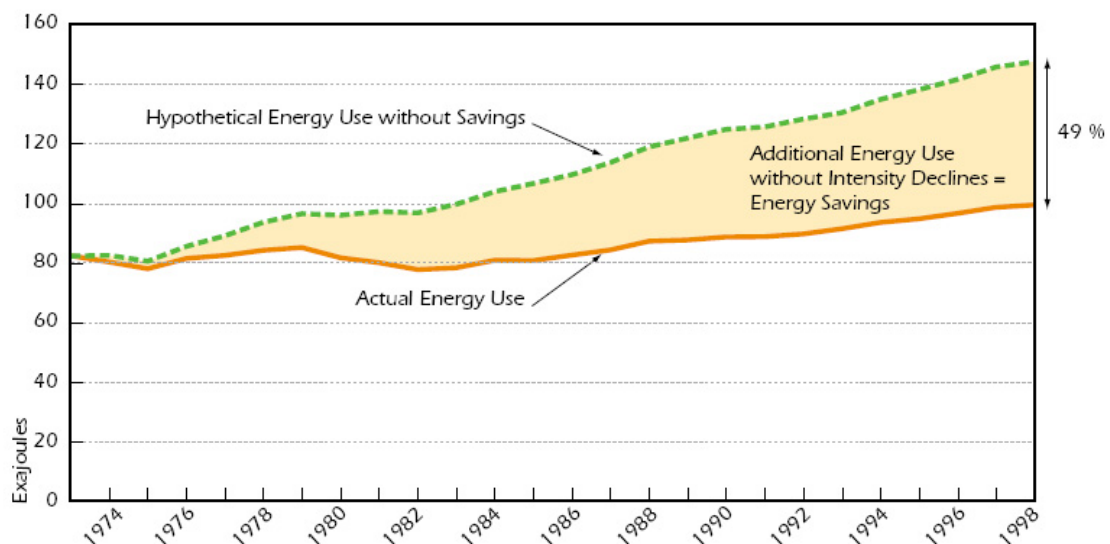
rather look at **incentives in a delivery context**, e.g. to combine incentives into packages. Finally section 6 suggests how **financial incentives can be better targeted and tailored**.

1. Finding the point of leverage in the energy systems.

The most significant characteristics of energy efficiency, when seen as an alternative to investments in energy supply, is that the energy efficiency investments are dispersed. There have to be many small decisions to invest made by many people if the aggregated effect should counter the investments in a few energy generation and transmission.

Still these investments are made everyday and the effect is huge, though the result thereof has rather been used to raise the welfare of people than used to reduce the impact from the energy systems. The IEA has shown that since its start in the early 70's the energy use in the major member countries has grown by 20%, but if energy use has remained with the same intensity as 1973, these countries would have had to use some 50% more energy than they actually do.

Figure 1: Actual Energy Use and Hypothetical Energy Use Without Intensity Reductions, IEA 11. [OECD/IEA, 2004] Figure 3-16.



1.1 The peculiarities of the energy systems

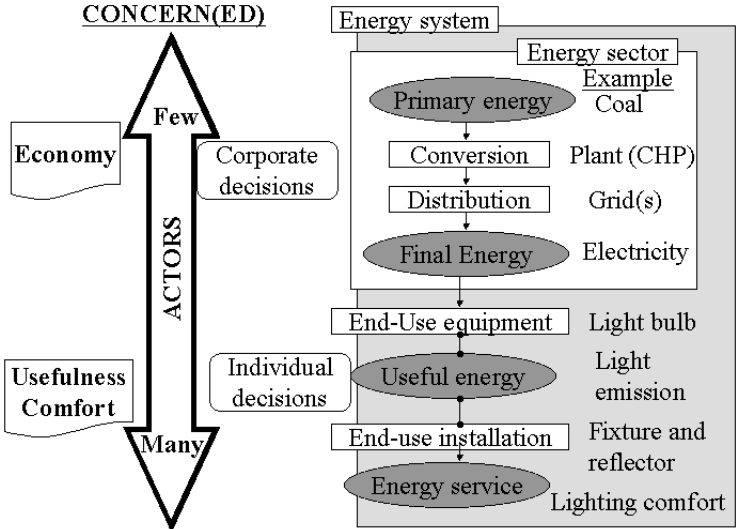
Energy systems have some features that distinguish them from most other types of production and consumption. One is the need for simultaneous generation and demand. There are some limited possibilities to stock for future demand e.g. in dams, and in thermal storages but they are limited in size and time-restricted. Production is mostly centrally located with a need for long transmission and distribution in which there are losses of the product itself before reaching the consumer (end-user).

Another feature is that the consumer's demand is not for energy itself, but for the service it provides in terms of light, motive power and room climate compensation (heating and cooling). Therefore, there is a tight connection in the system, the simultaneous supply to demand, and one loose, the demand for the service of the energy. The latter has in principle great flexibility since there is both the possibility to suppress a certain need for light, motive power or climate compensation in a given moment (**use less**) and the possibility to transfer

this need to a later time when the conditions are more suitable (**use later**). Furthermore there is the possibility to modify the equipment that provides the service. Lamps, motors, heating equipment and air-conditioning come in varieties that either use much energy or less, but still provide the needed amount of service (**use other**). In all cases we may have to invest in either control equipment or in other equipment.

Therefore we have the opportunity to balance the energy systems either by generating more energy or by using less, both in the short term and in the long. To make the economic choice between the two approaches is simple in principle– it should be the less costly - but a bit more complicated in reality. Since the decisions to generate more (or build new power) is in the hands of companies for whom energy supply is their core business and the decisions to use less is in the hands of companies and individuals who use energy as a means for their ends in which energy is hardly ever observed. It is an issue of ownership and comparability (c.f. figure below). And even when decisions are made by the same actor to either supply or to reduce consumption, the alternatives may be difficult to compare for other reasons such as e.g. life-time of the equipment and knowledge about performance.

Figure 2: Actors have different perspectives and act on different levels in the system.



This difference between the actor-perspective on the supply-side and on the demand-side has been captured in the concept called the “pay-back gap” (see Appendix I), which describes that there is a systematic under-investment on the demand side, i.e. in energy efficiency and a relative over-investment on the supply side. The suppliers with their core-business perspectives, invest with a lower interest-rate than the demand side, which has high demands for returns (so called perceived interest-rate) to invest in their part of the energy system. Therefore the need for more energy services is met more likely to be met with investment in new supply rather than investments in reduced demand, even if the latter is the less costly opportunity.

This pay-back gap is more significant in systems where the supply is monopolised since the customers do not have a choice to find another supplier. Liberalisation has somewhat reduced this difference since suppliers, in markets where there is sufficient competition, can no longer assume to retain their customers if prices and contract-conditions are not experienced by them as reasonable.

1.2 Comparing the incomparable

A true comparison should take all relevant circumstances into account, i.e. not only the cost for equipment and energy but also for maintenance and operations, and it should be made for an equal time-frame. To enable a true comparison between alternatives also external effects (externalities)³, such as emissions harmful to other actors, should be calculated and put into the calculation. This further reduces the likelihood that correct comparisons should be made at all time to balance the system, e.g. how do we foresee the development of a system's performance over a longer time period, what will happen to fuel-prices and inflation and how do we estimate the value of the externalities?

1.2.1 The local perspective- The company view.

In too many cases, when industry purchases energy using equipment, the calculation is restricted to checking the pay-back time of the investment with the criteria, set in a general policy to be short. Typically pay-back time should be less than 2-3 years. Such calculations underestimate equipment with longer life-time [OECD/IEA, 2003].

Table 1: Increases in Yields on an Investment for Years of Useful Life longer than the Payback Time Required [OECD/IEA, 2003].

		Useful Life of Equipment (Years)							
		3	4	5	6	7	10	12	15
Payback time required (years)	2	37%	79%	120%	159%	196%	300%	361%	444%
	3	-	14%	40%	65%	88%	154%	194%	247%
	4		-	0%	18%	35%	82%	111%	149%
	5			-	-	3%	40%	61%	91%
	6					-	12%	29%	53%
	8				Unprofitable			-	7%

Calculated under the assumption that the purchaser requires 15% return of capital and that inflation is 2%.

It, however, makes sense to go further and recommend Life-Cycle Cost (LCC)⁴ calculation for energy efficiency projects since that will provide a more correct comparison of costs and benefits. Even quick estimations may reveal that the benefits are huge and that huge profits from cost-reduction are foregone.

$$\text{LCC} = \text{Investment} + \text{Energy use} + \text{Operations/Maintenance} + \text{Auxilliary cost/benefits}$$

For most energy-using equipment energy is 70-90% of the LCC and grossly outweighs the extra investments that might be necessary. For some sorts of installations the maintenance and operations is reduced because of the longer life-time. A typical case is energy-efficient lighting and particularly important on commercial premises or for traffic-control lighting where frequent changes are sharply reduced. For some equipment there are auxiliary benefits in e.g. productivity and/or noise levels and/or reduced heat dissipation which reduce the need for air-conditioning. For some companies there are auxiliary benefits in their costs for

³ <http://en.wikipedia.org/wiki/Externality>

⁴ http://en.wikipedia.org/wiki/Life_cycle_cost_analysis

emission right or emission taxes, which are reduced. All these should be factored into the calculation which considers all things that are relevant⁵. The reasons such calculations are seldom made are many, e.g.:

- It requires a different routine and more data
- Organisation does not allow staff to take such decisions since it may go beyond their control and influence (depend on) decisions made by others
- Many companies are insecure about their future in a competitive environment and hesitate to calculate over a longer period
- Most calculations are considered “ceteris paribus” (all other things equal) and disregard the more important parameters.

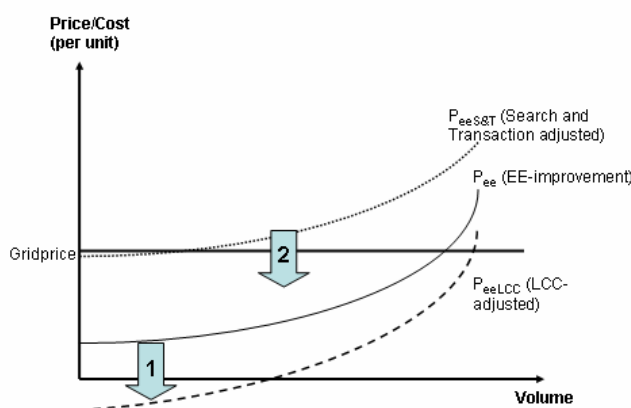
The face-value price of the energy efficiency (P_{ee}) may then have to be corrected to a value that takes the LCC into account (P_{eeLCC}) when compared to the price of energy from the grid. The result is that the favourable energy efficiency alternative may be even more favourable and shifts the cost curve even in the negative, see figure below.

But there are also other costs, not all of them fully accountable, which work in the other direction. These are the transaction costs associated with finding the efficiency alternative and get in place.⁶ Many of the efficiency solutions are not fully known to the buyer/user and even when they are they may not exist in the size of fitting needed and/or the installation requires a skill that the local craftsmen have not yet required. The perception of risk may have to be added into these. These “search and transaction costs” may have to be added to the costs and the alternative may then be less interesting, the price to be compared being ($P_{eeS\&T}$), see figure below.

The rational approach would be to enable users to realise their opportunities as captured in the P_{ee} - and P_{eeLCC} –curves in the figure, which could require (numbers corresponding to curve shifts):

1. That such actors for which operations/maintenance and auxiliary costs are substantial these should be made part of the calculation (LCC).
2. That Search and Transaction costs are lowered or eliminated

Figure 4: Supply-curves for energy efficiency improvements compared to the “grid-price” for energy.



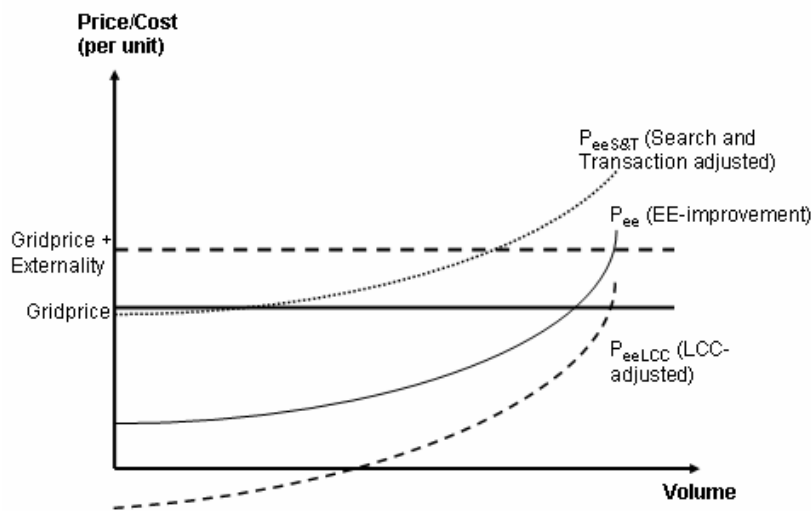
⁵ Referred to as “mutatis mutandis”, i.e. all things that counts are considered.

⁶ http://en.wikipedia.org/wiki/Transaction_cost

1.2.2. The societal perspective- Supply Side externalities

The most common problem as regards externalities concerns the supply side, subsidies, emissions and land-use. It often shows that the supply side (grid-price) needs an adjustment for the comparison of alternatives to be correct. The society tries to handle most of these by pricing (taxes) and regulation (permits), but there could still be such that should at least be taken conceptually into account. One of them is that some fuels are subsidised and the correct price should have been higher.

Figure 5: Supply-curves for energy efficiency improvements compared to the “grid-price” for energy when externalities are added.



This effect normally speaks only in the favour energy efficient solutions. Negative externalities from energy efficiency are few and mostly have to do with the choice of materials. These are mostly handled with regulation and scrapping (fees).

1.3 Responsibility for the system

The situation in the energy system is clearly characterised by the roles we have inherited in the old system when energy supply was monopolised and regarded more a “Public Good” than a commodity.⁷ Liberalisation and technology development has changed these conditions, but the organisational concept remains and will continue to do so for a long time since habits and behaviour are hard to change.

There are signs of new approaches in which the customer is more active, has greater opportunities for price response and short-term actions to balance the systems and avoid risks for black-outs. There are also signs that some energy supply will be more local and decentralised, making use of micro-CHP, Photovoltaics, windpower etc. The development of IT may also provide “smart-grids” with more complex and suitable services. But it seems as if most of the energy-using equipment will continue to be bought by users who continue to disregard the energy-perspective of their choices unless institutional innovations are developed to assist them in their choices.

⁷ http://en.wikipedia.org/wiki/Public_good

INTERLUDE – A TRUE STORY⁸

A medium-sized manufacturing company in mid-Sweden decided to change their energy-supplier to one that was more oriented to customer concerns about energy efficiency. The new one checked the benchmarks and found that the company was doing well in their use of energy. In fact they were doing so well that they got a diploma for being energy efficient. The company was indeed proud and relieved that they now had a certificate showing that they were in good shape.

Some time later they were offered a survey by a university that wanted to check what possibilities that had to improve their energy efficiency. The company happily accepted. They were in good shape and it would be a good thing to show the students. But to their surprise the students came out claiming that they could improve their use of electricity further and reduce it by 62% !! Were they and the students living in the same world or....??

This had to be checked and they hired a consultant. To their relief they found that the students were wrong. The potential for reduced use of electricity was not 62%. It was only 50%!

So the company started a programme to make better use of the energy but also to shift to renewable fuels in their heating. They engaged the entire staff, made energy improvements a strategic issue for the management and subject to continuous change.

The moral is not about whom you should trust. The moral is that if you really check up the potentials you will be positively surprised. And that when you have done, you have to make the improvements a strategic issue and the company will be in a much more favourable position to meet the future with all that it may bring you.

The lions' share of financial incentives to improve energy efficiency largely exists already with the customer, but there is a case to find much more "aggressive" and innovative ways to release them.

2. Technologies and users

Even if the nature of the incentives, as described above, indicate that the private financial incentive is big, it is still hampered by being so dispersed, which requires well conducted programmes for aggregation. Yet there are some areas that are more blatantly under-utilised than others. Areas where the actors could be more easily motivated because the technologies and the users fit well together and may deliver results faster. Such results are a product of technological potential and user acceptance:

IMPACT =Potential * Acceptance

There is a general tendency to focus more on the technologies and the potentials and forget about the actors' willingness and opportunities to make use of the thereof. It may however in some cases be more useful to aim at a match where the acceptance is high even if the potential is lower.

⁸ Told in a hearing March 22, 2006, for the Swedish Commission on Oil Independence, <http://www.sweden.gov.se/sb/d/2058/a/57732>

2.1 Overview of potentials

It is well-known and documented that several technologies are not fully utilised and have a “potential” that would result in greater value for its user if applied. Most such knowledge is derived from calculations which only regard the direct cost for the technologies and not the Life-Cycle Costs, LCC. There are few recent studies of potentials and those made were calculated at lower prices for primary energy than the present. It is therefore reasonable to believe that published potentials are higher.

Further most of them do not take the “learning-effects” into account, i.e. that many technologies that are in its infancy will be cheaper when used in bigger volumes, see section 2.3 below. Yet another factor that makes the stated potentials rather on the low side and we could assume them to be higher in reality.

If the withholding factors could be eliminated or reduced we would be able to create a higher welfare for the society as a whole since the total cost for the energy services will be less than they are today.⁹

The estimates of percentage gains that are made do not show great differences between the regions in the world. The potential assessed by various institutions may differ somewhat, but studies of potential for energy efficiency improvements present the same magnitude. Efficiency and sustainability steps may be taken both on the demand side (end use), the supply side (to switch fuels toward low carbon sources) and to improve existing energy systems taking advantage of e.g. Combined Heat and Power, CHP. There is no significant difference when looking at sectors/actors or technologies. One astonishing factor, however, is that losses in transmission and distribution seldom occurs in the studies but seem to be taken for inevitable results in the energy system, while in practice, T&D losses are substantial, but also vary substantially between countries, [Roman Targosz, 2005]

The EC states in their work related to the green book “Doing more with less” that there is approximately a 20% overall improvement in energy use. The IPCC shows 20-30% to be released over 2-3 decades. The World Energy Assessment [WEA, 2000] made a huge inventory of potential studies the year 2000, see table below, which still shows that the potentials are not realised naturally or automatically under present conditions. The business (profit) motive alone does not seem to have led to a full exploitation of the resources anywhere.

⁹ These opportunities are sometimes referred to as “Pareto-sanctioned”, meaning that at least one actor is better off, and none worse, after the change. To reach this state there may have to be a redistribution of the gains from the change, e.g. a monopolist could claim to be compensated for a loss. The important issue is however that such compensation would be possible. How it is actually made is subject to negotiations. http://en.wikipedia.org/wiki/Pareto_efficiency

Table 2: Estimates of “Economic Energy Efficiency Potential” [WEA, 2000], chapter 6.¹⁰

Sector		Region		
		Western Europe	US and Canada	Eastern Europe (except Russia and Ukraine)
Industry	Low	5% Refineries, Chemical	2-4 % Aluminium, Refineries, Chemical Pulp and Paper	3-5% Pig Iron, Metal, Leather, Wood
	High	25% Glass prod., Investment & Consumer goods	20-30% Light manufacturing, Iron and steel	30-50% Chemical ind., Hot rolled prod., Building material
Residential	Low	8% Existing building envelopes	15% Space cooling	25% Existing buildings
	High	30-45% New buildings, Appliances	30-50% Water heating, Lighting	30% New buildings
Commercial and public	Low	10% Electricity and heat in commercial buildings	10% Water heating	20% Office equipment
	High	30-50% Decentralised Cogeneration, Office equipment	50% Space heating and cooling	40% Lighting

A reflection is that there are “cultural differences” in these markets that explain why not the same technologies and objects are mentioned in all of them. There may also be underlying long-range economic development that explains why some countries and regions have (had) comparative advantages in certain sectors. But the estimates have one thing in common and that is that the potentials are big.

2.2 Strategies for improved technology performance

To obtain a lasting market transformation we may need to work with a broad approach. A typical case to illustrate this is in the buildings sector. We know how to build new, very energy efficient, buildings today. The real challenge, however, is the existing building stock with a very slow turn-over and often very traditional and conservative attitudes from owners when they are refurbished. To make the building sector more energy efficiency requires focus on the existing stock more than on the new buildings. Therefore a sustainable change of the performance of a system requires that product performance have to be observed from three aspects. One would need a strategy that handles a transition to get:

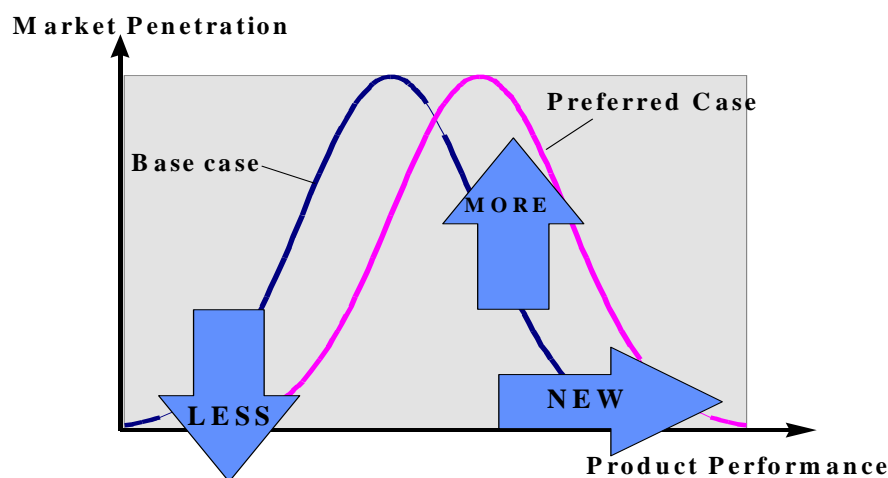
- LESS use of bad performing products. Standards of minimum energy performance (MEPS) are often used to restrict what is supplied to the market, but there is a case to find ways to have the bad ones removed and taken out from the system even if they

¹⁰ NOTE these estimates are made from different sources and regards different time perspectives.
<http://fourfact.com/images/uploads/WEATOT.pdf>

happen to function. *Financial incentives may be used to reward a scrapping of bad products when they are replaced with better ones.*¹¹

- MORE use of good products supplied to the market and as replacements for bad ones. The most common approach for this is the labelling that signals to customers the performance by use of both facts (energy use, cost for use, etc) and symbols (colours, bars, arrows, stars etc.) *Financial incentives may be used to reward the choice of the good products and also to keep them in stock for replacement of existing material when worn out.*
- NEW products that boosts performance beyond the best today, technology procurement. *Financial incentives may be used for this process both for development of products and to compensate those users who take the risks of being first in using something that is not yet fully developed.*

Figure 6: Effect of market transformation on product performance, [Nilsson, 1996].



2.3 The newest technologies are never competitive!¹²

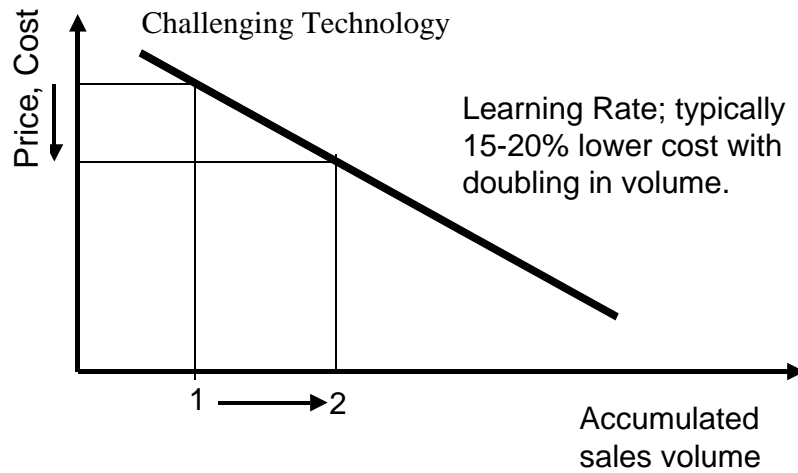
The newest, challenging, technologies are never able to compete themselves into the market based on their cost and seldom based on their performance characteristics either. Most users may find it too risky to try something that is not well documented and proven yet. Nevertheless these technologies may very quickly come in a position where they at least are worth to consider also from an economic perspective. The reason is that costs normally drop very quickly in the beginning. A phenomenon captured in the concept of the learning curve. The learning curve shows the rate of cost-reduction by volume growth (Learning Rate) that is normally in the area of 15-20% by each doubling of the accumulated volume of a technology [OECD/IEA 2000].¹³

¹¹ There was such a programme in Denmark when old (still functioning) refrigerators were turned in and awarded some 5€ per year of age (!) when exchanged for a new one and in order to take them out of circulation. The state of Maine (U.S.) has used a similar scheme for cars.

¹² This is based on the paper presented to ECEEE 2003 "Creating Markets for Efficient Technologies by establishment of Strategic Niche Markets." By Hans Nilsson and Clas-Otto Wene.

¹³ This curve is regressive in a linear scale but is often used in a double logarithmic which makes the curve look linear.

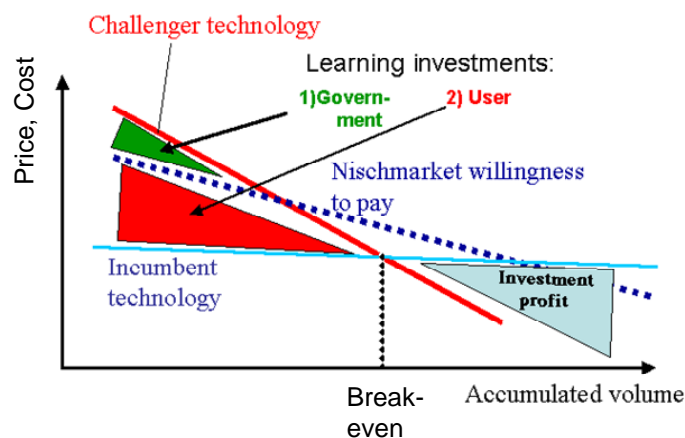
Figure 7: The Learning Curve, explained



Eventually many technologies will follow a learning-trajectory and reach a “break-even” level where they can compete on their own merits against the incumbent technology . But before they can do, someone will have to put in the “learning investments” for the process. These investments can have the form of financial incentives to a certain group of users that are more likely to adopt the new technology. Preferably these users (niche markets) would be able to pay a great deal themselves when triggered by some incentive. In the political debate such incentives are often subject to diverging opinions. It is therefore important to notice the cases where these so called subsidies in reality are “learning investments” that will yield future profits, [OECD/IEA 2003].

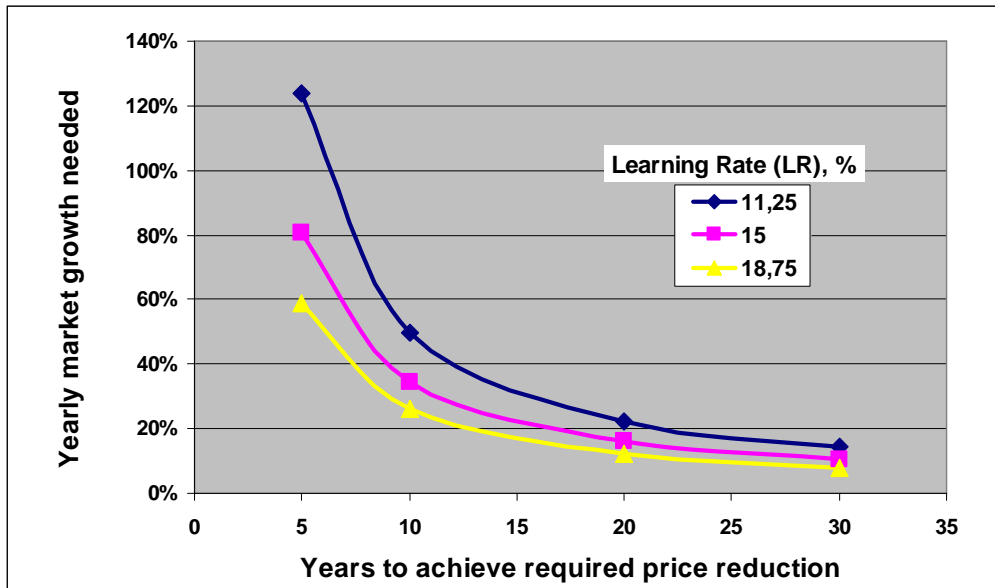
These niche market actors may have a higher willingness to pay depending on that the alternatives they face are more costly to them, but could also be more willing to pay for novelties. We need to know who are those that will make the “investments in learning”. And find out to which incentives that they respond, [ECEEE 2003].

Figure 8: Learning investments and investors.



Supporting learning investments can be a very powerful instrument to introduce new technology. A technology on a 15% learning curve requires an almost 20-fold increase in output for a 50% reduction in cost. Creating and exploiting niche markets is an efficient strategy for a deployment programme, both to provide learning investments from private sources and to stimulate organisational learning among market actors. Learning investments are most powerful in the beginning when growth is exponential and volumes that need support are relatively small.

Figure 9: Market growth and time needed to achieve a 50% cost reduction with a learning rate of 15%.



2.4 Some Energy Efficiency technologies – A cases brief.

Three areas will be used for illustration of the size and actor structure for the potentials and to investigate how they may react to different incentives

- Distribution transformers where energy itself is core business for profit-motivated industry;
- Motor Systems where industry is profit-motivated but energy is only one of several inputs;
- Lighting where the output is central for users in the commercial sector, for which lighting is an instrument to create comfort, and for users in the household sector for whom lighting is essential for primarily for domestic activities but also for decoration

2.4.1 Distribution Transformers

One huge opportunity for energy-saving is the distribution transformers, which could save more than 200 TWh/a worldwide, thus reducing carbon-dioxide emissions by 130 Mtonnes/a [Roman Targosz, 2005]. This opportunity is however a typical potential that should not be there or gradually diminishing since distribution transformers are selected by companies (mainly utilities) that are subject to business incentives of maximising their profit, i.e. reduce their costs for losses when this is economically justified.

There is a good case for saving electricity in distribution transformers according to the Leonardo report since they, in comparison to transmission transformers have 5 times higher losses and are far to easier to change than the lines.

Table 3: The average distribution of losses between components is approximately, [Roman Targosz, 2005].

	Transformers		Lines	
	Transmission	Distribution	Transmission	Distribution
% of total	6	31	19	42
TWh	80	400	240	540

The savings in distribution transformers can be estimated to some 55% if they were to be designed optimally according to LCC-criteria. The total value of the savings projected on this material is in the area of 15-30 Billion € annually including the carbon credit.¹⁴ The savings would be economically justified with a pay-back time of 1.4-8.6 years for transformers in the size interval 100-1600 kVA. The shorter times for the bigger units. The life time for such transformers are normally well beyond 25 years and, different to many other types of industry equipment, they are seldom scrapped when conditions change but just moved to another place.

Utilities who are responsible for selection of most of the distribution transformers select more often on simple investment criteria, such as first cost, than on life-cycle costs. Liberalisation of the markets and the regulations applied have not improved the situation but rather added to the problem since companies incentives (to make profit) from a switch, may be offset by regulatory demands for sharing this profit with the customers. Transformers for the industry are often delivered by a contractor without responsibility for the operations. He therefore has less interest in delivering a more advanced product.

The utilities have to focus on removing obsolete equipment and ensure that it does not come back in service and that both internal routines for design of the networks and the regulation practice start to take energy efficiency into account.

2.4.2 Motor systems

Motor systems, both in industry and in buildings, is another group where huge savings can be made and where there is a clear business case to do so, though not realised. The Motor Challenge Programme estimates that the European savings from a switch to efficient systems is in the size of 200 TWh/a, [ECI, 2004]. Such systems are estimated to use more than 70% of global manufacturing electricity and have a savings potential of at least 20%, [Ghislain and McKane, 2006].

The motor system consists of several parts in which energy efficiency can be improved:

- The electrical motor drive
- (sometimes) A variable speed drive

¹⁴ The price for electricity for households on the European market 2004-2005 was 120 €/MWh and industry 70 €/MWh. The average Saving of Carbon-dioxide is roughly 0.6 tonne/MWh which represents a value of some 10 €/MWh at present price-level (15 €/per EAU) on the European Market, which makes the GHG-premium of saving electricity roughly 10%. [IEA, 2006]

- Application (the system driven by the motor)
 - Compressed air (compressor and distribution)
 - Pump system (pump and piping)
 - Fan system (fan and ducts)
 - mixers; conveyor belts; machines; etc.

Table 4: Estimated savings in the different parts of the systems in Europe [ECI, 2004]

Part of system	Savings TWh/annum	
	EU-15	EU-25
High efficiency motor drives	24	27
Variable speed drives	45	50
Application	112	125

There is a, not altogether obvious, systems aspect in this approach. Control of the systems is often made by throttling of valves and with gearboxes in the application itself rather than with e.g. speed drives. In the application part small units are added, switched and removed with little (if any) consideration on what the systems consequences will be. Those responsible for operations have not been entrusted with responsibilities and with instruments to see the bigger system and are therefore forced to sub-optimize the company performance.

The companies need to improve routines and take both systems considerations and include the full costs in their calculations and finally arrive into a complete exchange routine

2.4.3 Lighting

Lighting might be the most well-known object for energy savings, though quite a part of the savings potential is also spent on a change to more intense lighting. Such happens in the commercial sector e.g. for more intense display, or in the households where lighting hours are longer e.g. for safety reasons or for decoration. Such spending of the savings is often referred to as the “rebound effect”.¹⁵

According to the IEA lighting is dominant in the use of electricity but also in fuel-use in developing countries, [OECD/IEA, 2006]. Lighting accounts for:

- Almost 20% (2550 TWh) of global electricity use
- Equivalent to production of all gas-fired power generation (or 1265 power plants), 650 Mtoe of primary energy consumption
- Total cost of non-mobile electric lighting is US\$356 billion/a
- Fuel for domestic fuel-based lighting costs US\$38 billion/a
- Emission of some 1900 MtCO₂ (All lighting)

Compact Fluorescent lighting (CFL) has been subject to several campaigns in which financial incentives have been used and the market has certainly changed. Products are now better, cheaper and more available than before. Global average electric lighting system efficacy was

¹⁵ The rebound effect occurs in two forms, the direct rebound when efficiency in a product leads to more use of that specific product or up-sizing of it. This effect is mostly not very dominant. The Budget-effect is the more problematic. Efficient use results in a surplus in the budget, which often is used for new consumption that also is using energy, e.g. household savings are used for more travelling.

according to the IEA 18 lm/W in 1965 and 48 lm/W in 2005. And there is yet another “revolution” in lighting around the corner e.g. in the LED-lighting. It is estimated that 30-50% of the energy for lighting can be saved in a cost-effective way, [Eurelectric, 2004].

The use of more intense lighting in shopping for display and for security also has systems effects. It leads to heating of the premises where the abundant lighting is used, which in most cases also result in a need for further cooling that requires yet more energy.

Lighting may be further improved but the market needs stimuli (directions, incentives and programmes) to improve light sources and systems. There is a challenge to combine interests of developing and industrialised countries in this process.

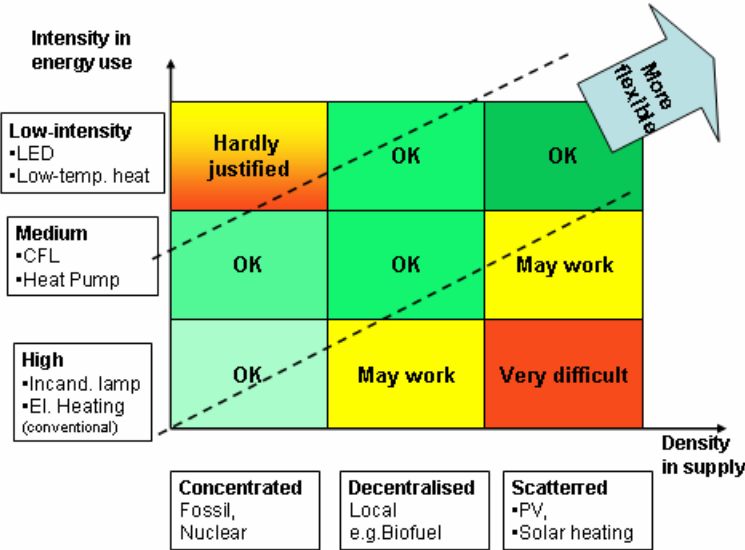
2.5 Renewable fuels and/or energy efficiency

When it comes to programmes to promote alternative energy solutions there seems to be an opposition between energy efficiency and renewable fuels. There are numerous programmes to support renewable fuels because of its higher costs, e.g. feed-in tariffs, or to ensure a certain proportion to be supplied, e.g. green certificate schemes, whereas energy efficiency often is (correctly) regarded as being able to compete on its own merits from a cost-perspective.

Does this mean that there is a genuine opposition between these two categories or is it, as is argued in a discussion paper for the conference “Renewables 2004”, that they are complements in a system, [Wuppertal, NRW, GTZ, 2004]?

From a logical standpoint there ought to be a “harmony” between energy use (intensity) and supply (density), see figure below. Very high intensive energy use, such as aluminium smelting requires power that can be delivered from fuels with high density, such as fossils, large hydro or nuclear. Very low intensive energy use, such as LED-lighting, may be fuelled by low-density sources, such as PV. The higher the intensity in energy-use the fewer options there are for supply and vice versa. Low-intensive (energy-efficient) use combined with high-density supply (concentrated generation) would however be hard to justify economically.

Figure 10: System combinations of energy intensity in use and energy density in supply.



So energy-efficiency in use gives a higher flexibility in the configuration of the systems, which reasonably would also lead to a more secure system that is less dependent on imported fuels. The ongoing research in the European Union, with focus on decentralised power generation and on so called smart-grids, opens up for creation of such “balanced systems” in the future.

2.6 Technologies and actors, do they fit?

It seems as if studies and recommendations for policies and measures mostly lack a systems approach to the issues, and even when they have, they end up with single measures assuming that “homo economicus” is in charge and that business is purely and always pursuing their profit-motives. But in reality we still end up with the potentials for improvements that are not realised.

The **systems aspect** should be stressed more. Both in the technology per se, (c.f. the motor systems), in energy systems, (c.f. matching energy-use and supply), and in the aspect of performance, (c.f. the market transformation from bad to good to super-good technologies).

In this context the budget-rebound will continue to constitute a problem to be solved or just to be acknowledged as a means for people to improve their living in terms of higher consumption.

More attention should be paid to ways to how **under-performing technologies could be phased out from industry**. There seems to be many industry routines that could be changed to up-grade the system(-components) rather than just managed in a business-as-usual way.

- a) **Scrapping** low-performing technologies should be considered as a target per se. Low-performing transformers should not, as reported, be moved but rather get a scrapping-premium.
- b) A **stock-shift** activity could be considered. Replacement of worn-out components like motors and lighting seems to be made on like-for-like basis taking a new component from stock as replacement.
- c) **LCC-routines in purchasing** may sound easy but is much harder to do in reality. There might be a case to create easier routines to be used in industry and to remunerate individuals who find new solutions with a reward.

Targeted campaigns seem to have grown out of fashion and may have to be reconsidered as ways to enable users to test equipment that is not familiar to them. Such campaigns could also be local and connected to the energy declaration of buildings where the local installers could act together with offers to up-grade buildings.

Niche markets and campaigns should be reconsidered. Once CFL-campaigns were popular but there is more to lighting than CFL. The role of utilities is different today but within the framework of so called White Certificates and Efficiency Commitments there could be ways to involve a wide variety of business actors that deliver products, installations and systems.

3. Incentives (and what they do to people)

The most used explanation to shortcomings in energy efficiency policies is that there are “barriers” that prevent actions. This metaphor suggests that if these barriers are removed or at least lowered the marketplace will automatically disseminate the more efficient products in

the optimal amount. A catalogue of these barriers has been provided by the IEA in several publications, the one below from “Creating Markets for Energy Technologies”, [OECD/IEA, 2003].

Table 5: Types of market barriers and measures that can alleviate them

Barrier	Key Characteristics	Typical Measures
Uncompetitive market price	Scale economies and learning benefits have not yet been realised	<input type="checkbox"/> Learning investments <input type="checkbox"/> Additional technical development
Price distortion	Costs associated with incumbent technologies may not be included in their prices; incumbent technologies may be subsidised	<input type="checkbox"/> Regulation to internalise ‘externalities’ or remove subsidies <input type="checkbox"/> Special offsetting taxes or levies <input type="checkbox"/> Removal of subsidies
Information	Availability and nature of a product must be understood at the time of investment	<input type="checkbox"/> Standardisation <input type="checkbox"/> Labelling <input type="checkbox"/> Reliable independent information sources
Transactions costs	Costs of administering a decision to purchase and use equipment (overlaps with ‘Information’ above)	<input type="checkbox"/> Convenient & transparent calculation methods for decision making
Buyer’s risk	<input type="checkbox"/> Perception of risk may differ from actual risk (e.g., ‘pay-back gap’) <input type="checkbox"/> Difficulty in forecasting over an appropriate time period	<input type="checkbox"/> Demonstration <input type="checkbox"/> Routines to make life-cycle cost calculations easy
Finance	<input type="checkbox"/> Initial cost may be high threshold <input type="checkbox"/> Imperfections in market access to funds	<input type="checkbox"/> Third party financing options <input type="checkbox"/> Special funding <input type="checkbox"/> Adjust financial structure
Inefficient market organisation in relation to new technologies	<input type="checkbox"/> Incentives inappropriately split – owner/designer/user not the same. <input type="checkbox"/> Traditional business boundaries may be inappropriate <input type="checkbox"/> Established companies may have market power to guard their positions	<input type="checkbox"/> Restructure markets <input type="checkbox"/> Market liberalisation could force market participants to find new solutions
Excessive/inefficient regulation	Regulation based on industry tradition laid down in standards and codes not in pace with development	<input type="checkbox"/> Regulatory reform <input type="checkbox"/> Performance based regulation
Capital Stock Turnover Rates	Sunk costs, tax rules that require long depreciation & inertia	<input type="checkbox"/> Adjust tax rules <input type="checkbox"/> Capital subsidies
Technology-specific barriers	Often related to existing infrastructures in regard to hardware and the institutional skill to handle it	<input type="checkbox"/> Focus on system aspects in use of technology <input type="checkbox"/> Connect measures to other important business issues (productivity, environment)

However common these explanations are and exhaustive the catalogues of remedies they only stop at advising the category of incentives to be used and do not go down to the level of how the incentive may be:

- Designed
- Combined with each other to make an impact.¹⁶

3.1 Designing financial incentives¹⁷

The financial incentives are basically supposed to be a leverage for a change and not an instrument for buying down the extra cost for an entire market. Even for actors who are not qualified for the incentive the incentive carries a signal that the subsidised technology has a certain extra value. Allocation of a budget for the incentives also carry a political signal that politicians care about the change and shows that they are prepared to act.

The financial incentives however have different “formats” depending on their purpose and target. A typology could be outlined as follows:

They have a **value**, which could be direct and precise or indirect and depending on the receiver’s situation. They have a defined **justification** and aims at a certain **action**. And they have a **source**, which may not always be the government budget.

3.1.1. Value

The value could be more or less “obvious” depending on how the amount is presented to the actor in their budget

- **Face value subsidies:**
 - **Cash and/or checks;** Eligible actors are presented direct money-value, often in the form of a check that can be used to buy a specific product or to make a renovation of a building, etc. Example the U.S. Commuter Choice Leadership Initiative¹⁸
 - **Tax Deduction;** An activity allows the actor to reduce their taxes.
- **Indirect value subsidies:** Conditions for the financing may be adapted and have a money value that is more indicative for the final result in the actor’s budget.
 - **Interest rate;** Activities that require substantial investments and/or a specific product may get preferential rates from their financing institute. The rate is often guaranteed by a government intervention. May also be applied on regional levels, example Manitoba Hydro Power smart loans¹⁹
 - **Leasing;** that provides a financing with precise and transparent conditions for certain product or action after a specific procedure, e.g. prescriptive energy management.
 - **Depreciation;** a specific product may get a preferential depreciation scheme, e.g. in France some such schemes are equivalent to a subsidy of 2 to 5%, depending on the useful life of the installation. Favoured for utilities and supply side, e.g. CHP
 - **Joint procurement;** may have substantial value if conditions for the delivery could be improved in terms of price and/or reliability of the products. Example, Swedish and Finnish Technology Procurement to establish new products and Danish buyer Clubs to promote good products
 - **“Feebate”;**²⁰ which means that you may have to pay a fee or receive a subsidy depending on how well you are performing in relation to a benchmark or an

¹⁶ In “Creating Markets for Energy Technologies”, OECD/IEA, Paris 2002, there is an attempt to show how policy packages can be constructed. http://www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1100

¹⁷ This is based on an analysis of the IEA database on energy efficiency, <http://www.iea.org/textbase/pamsdb/search.aspx?mode=ee> . Neither this nor any other source has paid much attention to how financial incentives are designed.

¹⁸ <http://www.commuterchoice.gov/>

¹⁹ <http://www.gov.mb.ca/chc/press/top/2003/09/2003-09-16-01.html>

²⁰ A blend of *fee* and *rebate*

average.²¹ Actors that are under-performing will have to pay the fee and the instrument is designed to be revenue-neutral.

3.1.2 Justification

The subsidy is given for a purpose that is related to a product or an action that has to verify a result or is assumed to have a certain impact.

- **Performance based**; Rewarding performance improvement in technical terms, e.g. reducing energy use by X % or intensity to Y kWh/unit.
- **Product targeted**; Tied to a certain group of products e.g. heat pumps, CFLs or refrigerators.
- **Risk reducing**; Explicitly designed to reduce a (perceived) risk that users connect with a, for them, new product.
- **Business cycle**; Connected to business cycles e.g. when there is a recession in the building sector to stimulate more activity or stimulate a quality improvement
- **Poverty**; Targeted to a certain group that is assumed to demand less than they should of since products require investment (high first costs), e.g. “fuel poverty schemes”.

3.1.3. Action

Naturally the financial incentives aims at an increase in sales and use but may reach this goal in various ways with the following activities

- **Purchasing (to test)**; For change of future purchasing preferences, e.g. Lighting Programmes with rebates for CFL
- **Demonstration**; Often for larger scale products e.g. power generation with new technologies and the subsidy aims at demonstration of the product. Sometimes within a scheme for subsequent evaluation and development
- **To change and build stock**; For industrial equipment subsidies has been used for building stock of equipment with better performance characteristics to be used in replacements e.g. energy-efficient motors
- **Scrap**; In some cases subsidies have been given to scrap old equipment when buying new to ensure that the performance improvements are secured and inferior products are taken out of circulation, e.g. refrigerators, cars

3.1.4. Source

The financial incentives are mostly a national/federal government affair, though regional and local governments may also be involved. Sometimes other actors could be involved either as a result from a legislation that forces their participation, but business motives could occur.

- **Government budget**; The normal case with allocations over the national budget to be handled by assigned administrations
- **Utility**, May be obliged to set aside resources in an orchestrated programmes, sometimes referred to as DSM-programmes. The new innovation with White Certificates (Commitments) is a variation where utilities may chose a cost-efficient delivery.
- **“Product distributor”**; Companies distributing energy efficient products may be involved and find that their participation also financially might be good from a marketing perspective, e.g. rebates on lighting products.
- **“Users”**; Redistribution of resources through levies on energy prices, collected in a fund to finance a sustainable energy policy

²¹ <http://en.wikipedia.org/wiki/Feebate>

- **Service receiver**; Insurance companies could give better premiums to customers that reduces their risks and thereby provides a service for the company.

The financial incentive need to be designed but also needs to be put in a perspective. What happens after this incentive, how do we judge success or failure, what actions are needed to support the incentive (especially if it fails).

3.2 Reading the market changes.²²

Decision-makers who institute deployment programs want to see significant results as rapidly as possible. Although this focus is understandable, it is important to understand what is possible within a given time frame and, most important, to measure program impacts accurately. Impact can be measured in volume of devices manufactured/sold, market penetration of devices, lowering of cost and improving performance, or combinations of these criteria. Some examples are given here:

a) Volume growth, Establishment of a market for “new” products takes considerable time. Example: Compact Fluorescent Lamps (CFLs) have been a target product of many energy-efficient technology programs during the past decade. The accumulated output of CFLs doubled almost six times between 1988 and 1999. Yearly sales in 1999 were on the order of 500 million units worldwide, which represents a tenfold increase in sales over 1988 figures.

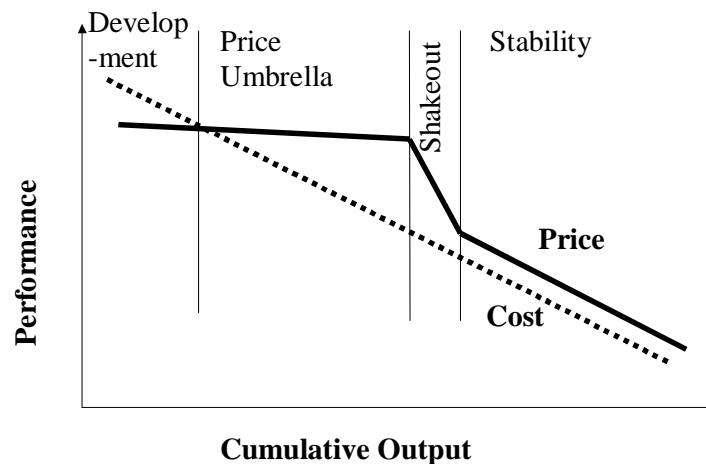
b) Volume and Market Penetration. In spite of the impressive volume growth for CFLs as seen above, market penetration of CFLs is generally low. The total volume for light bulbs is estimated to be 10 -15 Billion units per year, which means that CFLs only have a market share of between 0.5 and 3 percent. If we apply a standard product dissemination curve to the current level of market penetration, we find that full dissemination in Europe will occur only after approximately 30 years.²³

c) Volume growth and price/cost, Building up new markets release a learning procedure which can be captured and visualised in the “Learning Curves”. Depending on the market organization it might be difficult to observe the result of decreasing costs for some time since such data are generally not available. Normally only the price can be recorded and before the market has totally accepted the product and attracted the necessary competition the market leader and inventor may want to recover their costs for development in such a way that price reductions are not to the immediate benefit, (see figure).

²² From “Best Practices In Technology Deployment Policies” Hans Nilsson and Clas-Otto Wene, ACEEE 2002.

²³ Diffusion of innovations to the market follows the "Bass curve," in which the penetration N_t at a given time t is calculated as: $N_t = N_{t-1} + p \cdot (m - N_{t-1}) + q \cdot (N_{t-1} / m) \cdot (m - N_{t-1})$, where m is the market potential, p is a factor for external influence (the likelihood that a consumer will start to use the product because of, for example, media influence), and q is a factor for internal influence (the likelihood that a consumer will start to use the product because of word of mouth). In this case $q=0.015$ and $p=0.23$

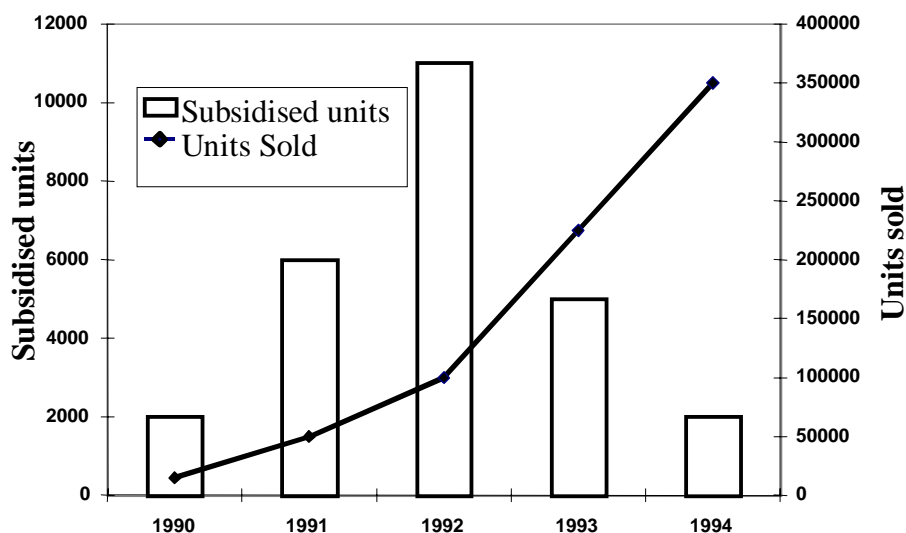
Figure 11. Phases in market actor actions for technology introductions



d) Performance. Performance improvements are to some extent a "natural" part of the market but also depend on program activities. In Europe, labelling of household appliances and associated recording of sales show a drift from prevalence of poorly performing technologies to more efficient ones over the years.

e) Attribution of impacts to measures. Market changes and the measures to which these changes can be attributed are a main focus of interest. Statistics that characterize both must be gathered in a fashion that allows comparisons. The period after a program has ended should also be evaluated. The following example of program impact assessment is from the Swedish Procurement Quality Program and related subsidies to High Frequency-ballasts in office luminaries. The subsidies seem to have initiated a market response.

Figure 12. Market response to program including subsidies



It is extremely important that a proper measure or set of measures are selected to evaluate the incentives used.

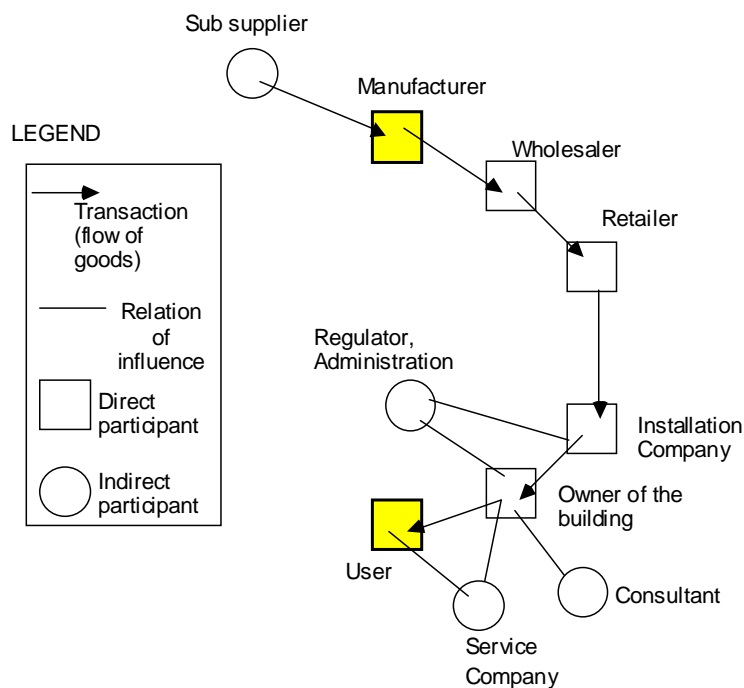
3.3. Who is in charge here?

The strongest force to move the market is the demand from the customers. Aggregated demand from customers gives suppliers of goods the necessary confidence to introduce their new products and also incentives to develop them further. Such confidence is needed not only for manufacturers but even more for the intermediaries, sub-suppliers and service providers on the market, many of them acting in Small and Medium-sized Enterprises (SME), and many of them acting in a wide spread infrastructure throughout the territory, see figure below, [Nilsson, 1996].

Most models based on the “homo economicus” concept also assume that products flow more or less without friction from the manufacturer to the customer/user. The intermediaries are however those who really (and literally) moves the goods on the market. They may like a change or they may not and they all have good honest reasons for their choice. It is therefore extremely important to find out who the trade ally could be for a change in the market place.

This is also why there is a need to consider “policy packages”. Even if the customer/user get a financial incentive it may be so that the intermediaries also need one or need something else to support and maintain the change. It could be simple information but also training. Most of them see an opportunity when it comes but they may want to be convinced before they move.

Figure 13: Developing networks for market transformation



4. Actors are only human

The issue is not so much if it would be advantageous to release the potentials but how it can be done since most evidence show that it will not come about in an atmosphere of "Business as Usual". The acceptance of the proposed measure by the individual (person, company, and organisation) is crucial for achieving the full impact and the exploitation of the analytically calculated potential.

The acceptance is certainly guided by the individuals feeling that they should be rewarded by the action they undertake. The reward may no doubt be financial but may also have other characteristics. Behavioural economics studies and put emphasis on these and how people arrive to make decisions. The New Economics Foundation, nef, has listed seven principles that are of importance:²⁴

- **Other people’s behaviour matters;** people observe and copy
- **Habits are important;** and hard to break
- **People are motivated to “do the right thing”;** money could even de-motivate them!
- **People’s self-expectations influence how they behave;** values and commitments are important for them
- **People are loss-averse;** they hang on to what they consider “theirs”
- **People are bad at computation;** very dependent on how the problem is framed
- **People need to feel involved and effective to make a change;** incentives and information is not necessarily enough

This has to be translated into how people deal with the basically invisible good “energy efficiency”. Most of the potential for improvement in energy efficiency is hidden in units of energy use that are so small that consumers do not observe the energy costs that could be saved. Moreover, many of the technologies disseminated by deployment program are used in a variety of different circumstances in which saving energy is often not a key objective, [ACEEE, 2002]

Table 6: Consciousness about Energy Depends on how the Consumer perceives it.

Decision Characteristics				Corresponding Characteristics for technology	
Frequency of Change	Basis for choice of replacement	Energy and savings as objective	Decision strategy	Unit size	End-Use Activity Type
Often	Habit	Never	Mainly along Heuristic rules (if not purely by habit and tradition) Rational within delegated responsibilities Rational in context of the purpose	Very small (20-100 W)	Household lamps
Regular	Routine	Occurs		Small (100-1000 W)	Small appliances
Normal	Planned	Important		Small (1-10 kW)	Commercial maintenance
Not often	Calculated	Important		Big by unit size or aggregation (10-5000 kW)	Industrial & Commercial. Retrofit (e.g. lighting)
Seldom	Investment	Depends		Huge (> 2 MW)	Production and process technology (e.g. casting)

²⁴ www.neweconomics.org/gen/uploads/tfi0yvpnl141p45zoi0mrrgf222092005201739.pdf

People need incentives that are in tune with their way of thinking and probably that they will need more explicit support to puzzle the proposed change into their reality. Financial support alone is sometimes not enough and sometimes not even needed.

5. Financial incentives applied.

Financial incentives are useful but should be used with care. There is a tendency to use them to sweeten deals that are already sweet. The reason for this is that a general assumption that people only act, or act faster, if they get money compensation whereas in reality the motives for an investment in energy efficiency and in renewable fuel has a variety of complex reasons. There is also a political motive in the sense that decision-makers often have to motivate and show their ability in terms of budget allocations. Money set aside and spent is a measure in itself of willingness to take political responsibility.

Financial incentives may have a significant role as part of policy packages, which are carefully thought through in terms of how impact can be reached when potential and acceptance is put together. From an overall (societal) point of view there are three things to take into account to be able to address financial incentives to get a maximum (optimal?) impact.

- The technology (section 2)
- The actor role (section 3)
- The actor psychology (section 4)

There is on the demand side a lot of technologies to be applied but that have not yet penetrated the markets sufficiently according to their potentials. These need not be sweetened by financial incentives for reasons of cost but may have to be so for other reasons. The design need to explicitly address the actor concerns and/or the distribution bottlenecks, e.g. rebates to enable users to test a product that is not known to them or that they fear create a risk (for malfunction) in their use, or rebates for changing stock of products (e.g. small efficient motors) for replacement on industrial sites

On the supply side there are several technologies that are still too expensive to be motivated from a cost-perspective except for a few niche-market cases. Those niches have to be carefully identified and may be the horse before the carriage to make these technologies “ride down the learning curve” after which they will be affordable for greater market segments. Finding and motivating the niches and the near-niches may need financial incentives that however should be accordingly managed, e.g. feed-in tariffs that are reduced as the technology improves and gets cheaper.

As regards the actor role the degree of professionalism is the most obvious divider, but even for professional partners with business motives many of the decisions are delegated way down the hierarchy where the concern for making well-founded strategic decisions for sustainability is not the issue. This may have to reflect also in the financial incentive where its format (cash, tax deduction, leasing scheme, energy service, LCC-routined purchasing, etc.) may be of great importance.

Actor psychology is less tangible for policy-making but probably the most important difference between success and failure. The financial incentive must address the issue(s) that the actor find (most) important and has with-held their action. The general assumption is that

people act from a profit motive, which may be generally true, but could mean that it is the risk (to lose money) that prevents the better deal. Old technology is known and (for the actor) new technology may be looked upon as a risky element.

Still from the risk perspective new technologies, especially energy efficiency, may be regarded as a means to reduce risk-exposure from rising energy prices. For the profit perspective there is not only the profit from operations but also the asset-value that counts.

With these perspectives it would be advantageous to see financial incentives rather as a part of a delivery mechanism for market transformation than a stand-alone object for policy making that in the worst case does not deliver but only cost.

6. Conclusion and suggestions

Acting to create sustainable energy systems requires that the quality of the action is taken into account. It matters where the actions is undertaken, before the pipe, in the pipe, at the end of the pipe or even beyond the pipe. The earlier in the system the action is the less is the risk that something goes wrong, the less the regrets if it does.

- Demand Side, energy efficiency actions are **before the pipe**
- Improving efficiency factor in generation and using renewable fuels are **in the pipe**
- Cleaning gases and emissions is **end of the pipe**
- “Repairing” harm done is **beyond the pipe**

The earlier in this stream the action is the more premium it has in respect to avoiding hazards.

The biggest financial incentive is already in place and remains with the users who can make great savings by application of energy efficient solutions that uses less energy. These incentives are however to a great extent dormant and needs to be awakened.

Another incentive with financial implications is the harm (and costs) that follow from energy generation, transmission and distribution, which results in emissions and land-use. These may need an agent to be released, aggregated and advanced. Regulations and trading of emissions are useful but also implies that a certain damage is accepted where it could still be avoided.

Finally there is a financial incentive in making investments for future profits from new high-performing technologies. Reaching these requires that niche markets and first-movers take the risks associated with the development and exploitation.

6.1 Release the dormant incentives with “aggressive assistance”

The first priority for energy policy would naturally be to release the dormant incentives that are clearly shown in all the potentials. These will however not be realised just because they are there, but continue to be hampered by stakeholders transaction costs and framing of the problem. Measures have to be developed taking behavioural economics into account and not only relying on the self-interest. People may need much more advanced assistance to be able to make things happen. If it would happen that the more “aggressive assistance” is not developed by authorities other instances, such as NGOs in co-operation, may be able to take up the services.

a) Financing in the context of delivery. Countries should consider to “institutionalise” ways to give more dedicated and aggressive assistance by forming delivery mechanisms. National

administrations may need a co-ordination of some or their actions. The main issue is to replace inferior technology with good and to identify niche markets to pave the way for more advanced future technologies. This may have to require special funding that could be based on so called “feebates” that are revenue neutral and put into revolving funds.

Countries should have an overview of the Least-Cost Opportunities which enables them to put priorities right and give preference to energy efficiency over supply side measures including financing such measures when needed to avoid emissions, extensive land-use, lengthy and costly supply side siting procedures etc. and avoid the hassle and the hazards. Such overviews could form part and be a basis for the Energy Efficiency Action Plans that will required in Europe, [Directive 2006/32/EC].

b) Households.

For the majority of households energy will continue to be invisible and probably also, when identified as a component to make the daily life work, remain of secondary order in decisions to buy and to operate equipment and installations.

- ***Labelling*** has shown to be powerful but has to be strengthened both in terms that it could be applied to many more products and to follow technological development. A labelling system should be revised (and up-graded) with a timeframe of 3-5 years.
- ***Buildings declarations*** with suggestions for improvement may be a powerful tool since it allows the building owner to have a “shopping-list” when the house is in need of refurbishment and it will allow local companies to supply better equipment/installations with reference to the “shopping-list”.

c) Business (Industry and commercial) sector

Industry knows that they have dormant assets but still have difficulties to get their act together for a variety of reasons, many of them has to do with organisation and internal management.

- ***Form business strategies*** that include sustainable energy issues. The U.S. Alliance to Save Energy has published a comparison of traditional and new approaches to make assessments in a company, [ASE, 2006]. This underlines the need to make the energy issue part of a company commitment that addresses the company strategy and commits several participants also beyond those who have energy as their specific task. The improvements should not be a project but a continuous task. This may be easier to do in a time when companies face steadily rising energy prices.
- ***Risk management*** is closely related to the above. The opportunities for energy efficiency improvements should be presented and address the risk profile of the company, who then may find it attractive to use improvements to hedge against risk, [Mills et al., 2006].
- ***Life Cycle Costing (LCC) procedure.*** LCC is well known as a concept but less applied, partly because it is not made routine and partly because there is not a standard acknowledged procedure. Neither to calculate nor to make use of in purchasing, [Fuller, 2005].²⁵ There should be developed standards and training to use LCC in purchasing and companies that sign in to different sustainability networks should also make establishment of LCC within their company mandatory.
- ***Phasing out and removal of bad equipment*** should be made much more standard practice. It may require some additional financial incentives to build a replacement stock for e.g. motors, lighting equipment etc. Tax credits should be used to promote such changes that are profound and really reduces future energy use.

²⁵ In the U.S. there was a guidance for LCC issued 2005 though there have been an executive order to apply LCC since 1999.

d) Public sector - Administration

Some of what is said about business above may also apply to the public sector and vice versa. The energy service directive in Europe assigns special tasks to the public sector as a forerunner in application of energy efficiency. The same thinking has been applied in the U.S. Federal Energy Management Programme, FEMP, since long.

- **Forming of Buyer Clubs** that commits themselves to buying only equipment from a better segment of the market could both facilitate for undertaking changes and for manufacturers to motivate development.²⁶
- **LCC should be made mandatory** within this group and to fulfil the energy service directive.
- **Aggregated purchasing** with co-operation between public sector administrations to bring up the volume, secure performance and get favourable prices for products and services required according to the Energy Services Directive, [Borg, 2003] .

e) Utilities (specifically)

The responsibility of the utilities for energy transmission and distribution within a business framework is obviously not sufficient to make them as efficient as they could be. The transformers are an especially obvious object to target.

- **Scrapping rewards** could be considered as a means not primarily for the utilities accounting but for individuals in the company to track the units that should be taken out of circulation and not shifted to another location.
- **Feebates could be made a measure in the regulatory regimes** for the same purpose. It would have the advantage that it would also engage the regulators who normally concentrate on macro-issues in regulation rather than technology details

f) Recruit and motivate trade allies

For many sectors the distribution chain for energy efficient product should be mapped for two reasons. Firstly to find if there are bottlenecks in terms of knowledge, training, business-interest or other that stops the process of energy efficiency improvement, secondly to detect if there could be formed trade-ally associations that enables a forming of an energy-efficiency branch similar to that of renewable fuels (wind, biofuel, solar etc.)

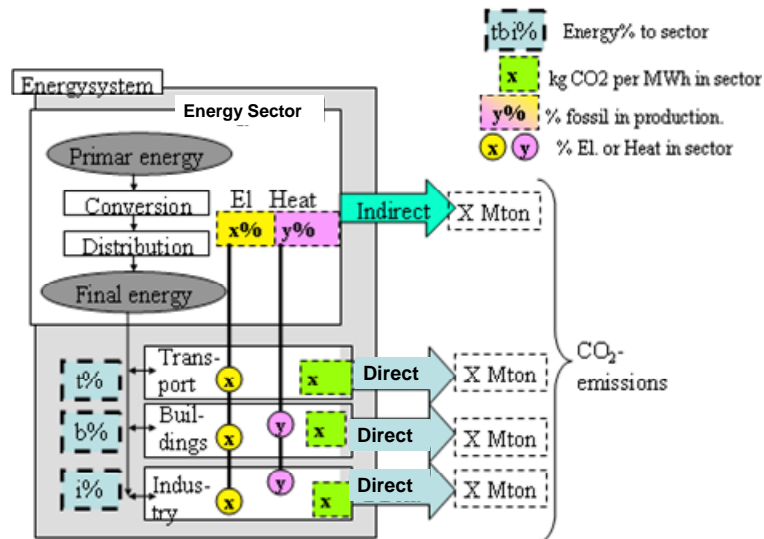
- **Forming business associations** of companies (primarily SMEs) that deliver energy efficiency and that needs to recognise each others competence and capacity to deliver the Energy Service to customers and not only their individual products. The Renewable Supply has since long been organised based on their specific fuels.
- **Insurance companies** should consider how customer energy efficiency has an impact on the risk both on a narrow sense (fire-hazards etc) and in a bigger (climate) and how this could be rewarded in premiums, [Mills and Lecomte, 2006].
- **Financial institutions** could make the same considerations as regards how their clients are exposed to risks from volatile energy prices and have hedged themselves by efficiency measures, [Mills et al., 2006].

6.2. Make GHG-reduction and end-use issue

The formation of a European trading system for GHG-emissions is certainly a step forward, which however has shown distinct drawback in that it engages only the end-of pipe (suppliers-emitters) and not the party that motivates the supply, the end-user.

²⁶ In Denmark such a club, A-klubben, exist to serve primarily the municipalities <http://www.a-klubben.dk/>

Figure 14: The Cause and the effects to GHG-emissions



One of the consequences has been that the energy companies have managed to charge their customers a great part of the price for emission-rights which have been allocated to them free of charge because of the alternative-pricing principle! This would have been reasonable if the companies had used the revenue from this pricing-operation exclusively to invest in GHG-free supply, which however does not seem to be the case.

So if the end-user will have to pay for the GHG-emissions anyway it would make more sense if he was also given the choice to pay or to invest himself in reduced energy use or in his own fossil-free supply. Presently the end-user does not see this except that it shows up in a higher energy-price. A first measure ought to be to show the individual how much he is surcharged and given information on how he can avoid this by using another supplier or by improving his energy use.

- Accumulate (keep track off) Carbon-emissions payments

The trading system today works only as an allocation of distributed allowances. Once they are given there is no guarantee whatsoever that any action will be undertaken to reduce GHG-emissions further or for that matter even to restrain them on the present level. The energy-users may have to pay for reducing their energy use and pay again for the emission right that the energy supplier charge him! A funding system should be built up to secure and continue the reductions

- Private accounts

There are suggestions to make carbon allocation to private accounts so every citizen could have their own carbon-budget. It is an interesting proposal but probably far away.

- Offsets

It is increasingly popular to buy offsets of carbon emission rights, but this will then only be up to the conscience of the individual. It would be interesting if this system could also be extended to generate resources to increase investments in sustainable energy²⁷

- CDM bundling of energy efficiency projects

²⁷ Offset programmes offer tremendous scope for corporate initiatives, but their environmental integrity should be preserved, for example through a watchdog agency with a government-mandate.

There are still only few CDM-projects that are based on energy efficiency improvement. This may be changed if there could be developed systems that bundles efficiency projects with receivers that can be responsible to deliver the savings.

6.3 Frontrunners to push the future

Most suggestions deal with the issue of how good existing technology can replace bad, but it is imperative to keep the pressure for new further improved technology.

- **Top-runner standards**, the Japanese concept for benchmark on a high level for products and declare that today's best is tomorrow's standard is commendable. This may meet resistance from some and might therefore be tough to enforce but could be the subject for buyers clubs as mentioned above.
- **Identification of niches** should be standard practice in the R&D procedure for supporting new technologies and in development of EU-projects
- **Feebates** applied more frequently could also be a way to reward those who dare the step to develop and use new technologies.
- **Public Private Partnership (PPP)**²⁸ should be investigated as a means to share risks of development and to ensure the necessary volumes for new production, [Department of Environment, 2004].
- **Technology Procurements** should be undertaken in wider scale (also European, Global and as co-operation issue with developing countries), [Borg, 2003]. Such Procurements will also have an impact on Research motivation. [DG Research, 2005].

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²⁸ http://en.wikipedia.org/wiki/Public-private_partnership

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APPENDIX I: The pay-back gap

It is often said that the price, set on a competitive market, is the necessary instrument to strike the balance between supply and demand. The correct price is important and a necessary, but not sufficient, condition. The reason is that actors on the two sides (supply and demand) do not value their opportunities equally. The demand side systematically gives the lower value.

The supplying companies have greater opportunities to obtain and treat information and to spread their risks. Supply of energy is their core business. In their calculation they know that their installations will be used for a long time and have a high degree of flexibility to meet different demand patterns. In some cases they even have a dominating position on the market or a monopoly. They are prepared for big investments in new supply.

The user has less good information and opportunities to treat it. Energy use is just a part of his activities and when he calculates he does not know if the equipment will be used for its full life time. He invests only smaller amounts if the purpose is only to lower the energy bill. The difference between the two perspectives and modes of operation is called “the pay-back gap”.

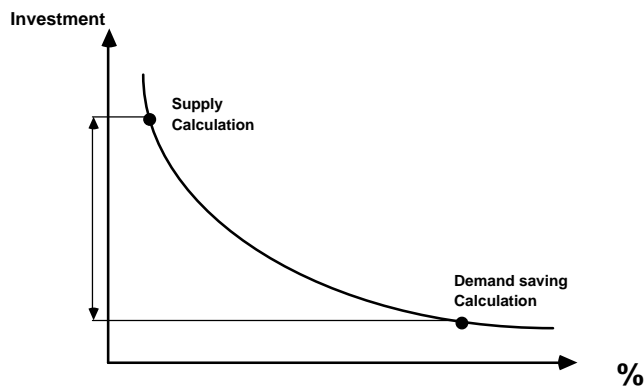


Figure A: The pay-back gap between supply and demand savings

The user's “implicit discount rates”, i.e. the rates which should have been used if the choice have been made using a formal calculation, has been thoroughly documented in research²⁹. It is noted that the level of the (implicit) discount rates greatly exceeds the “Social Discount Rate”. The levels depend on types of products but ranges from 20 to 300%. Industry applies rules of thumbs for investments. Commonly pay-back is required in the interval of 2-5 years. Households are reluctant to invest in improved efficiency due to general scepticism to new technology, high first costs, etc.³⁰.

The discount rates for supply side calculations are generally in the range of 4-8% (real value).

²⁹Implicit discount rates in residential customer choices. Volume 1. Investments in conservation measures. EPRI EM-5587, Volume 1, Project 2547, February 1988. Prepared by Cambridge Sytematics Inc.

³⁰Efficiency. A hard sell. EPRI Journal, october-november 1994.

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APPENDIX II: Lead users requires better products³¹

For the following categories of products there are known improvements in technologies that given a proper raise in market volume could be manufactured in a larger scale, with better performance and at lower costs. Many of these products are used within the public sector. Procurement groups could be formed for Technology Procurement and advancement.

For calculations the following figures could be used for final energy use in Europe³²:

Industrial energy use: 3500 TWh per annum

Transport sector energy use: 3500 TWh per annum

Other sectors energy use: 4400 TWh per annum

Of which Electricity use: 2300 TWh per annum

Purpose	Market volume	Product	Procurement possibilities	Impact assessment
Heating	150 million dwellings in EU-15 ³³ Turnover rate 1-2% per year	Heat Pumps	<ul style="list-style-type: none"> Pumps + techn. for installation and monitoring (especially in electrically heated homes) 	Reduces electricity use by 50-65%.
		Solar water heating	Roof applications Ongoing procurement in the IEA Solar heating and cooling Implementing Agreement Annex 24.	Reduces use of fuel 10-30%
		Heat distribution	<ul style="list-style-type: none"> Radiator size and place (related to high insulating windows) Valves (especially for Eastern Europe refurbishments) Small-scale circulation pumps 	Small pumps with nominal power of 20-100 W can be improved by a factor 4 by new design. Such pumps are installed in all single family houses
Cooling	Office space XX m ²	Absorption cooling applications	Performance and installation	
Refrigeration	Shops, kitchens, restaurants	See above + Conventional refrigeration	Schools, hospitals, large distributors of food	

³¹ This list was first presented by ECEEE to the European Climate Change Programme (ECCP) 2001.

³² IEA statistics 1997

³³ Distribution of fuel usage for heating in EU-15 dwellings

Gas	Electricity	Solid fuels	Oil	District heating
44%	20%	8%	23%	5%

Power	70 million domestic boilers gas fired	CHP	<ul style="list-style-type: none"> • Micro • Mini for distributed generation • Trigen applications 	40 million domestic boilers could be replaced with micro-CHP
		Photovoltaic	(see calculation in appendix)	
Lighting	10-15% of electricity use is for lighting (i.e. 230-350 TWh)	Sensors Daylighting Lightsources and luminaires	Commercial and public buildings plus residential buildings	
Street-lighting, traffic control		LED for traffic control		Saves 90% and improves road safety
Building envelope		Windows PV and solar applications for facades and roofs Transparent insulation and Transparent facades		(30-)50 % energy reduction
Ventilation		On-demand ventilation High Performance Ventilation Systems	New residential buildings Industrial buildings (refurbishment)	10-50 % energy reduction
Appliances		A+ cold equipment, dishwashers, washing machines and dryers		
Motors and applications (pumps) for industry		Flowcontrolled systems Speed control systems		
Leisure equipment (TV etc)	Stand-by power 1,5% of electricity use	Stand-by power reduction or alternative charging (PV)	Zero Stand-by electricity products (PV-battery charging etc)	
Transport sector		Fuel, Vehicles Transport planning and operation with telecommunication Logistics development (E-trade + transport planning)	Alternative transport systems and development of the infrastructure to support it, (ethanol, biogas, electricity, rape-seed oil etc)	
Water		Tap water levers in residential, public and commercial buildings		25-40 % energy reduction, 40 % fresh water reduction
		Small-scale circulation pumps		Se above under Heating