Electra Report Annex 2:

ENERGY EFFICIENCY AND CO_2 REDUCTION

AS DRIVERS OF INNOVATION

1. Executive summary

Limiting global warming by reducing green house gas emissions is a global target set at the Earth Summit in Kyoto in 1997; within this context, the European Commission has set its own target to cut CO_2 emissions by 20% by the year 2020; this target should be achieved thanks, among others, to a 20% increase in energy efficiency and the introduction of 20% renewables in overall EU energy consumption.

The electrical and electronic engineering industry has a major contribution to play to achieve these targets as technologies and offering developed and supported by Electra manufacturers are playing a major role in the control and optimisation of the use of all energies.

The present paper aims to propose solutions which will allow the European Union to achieve the targets it has set up itself whilst taking into consideration both the economic and political contexts in the European Union.

The present findings are based on the knowledge and understanding of the participants, the studies and reports which propose a global mapping of greenhouse gas abatement opportunities, introducing the notion of marginal abatement cost curves demonstrating how profitable energy efficiency investments are in relation to the cost of ton of CO_2 and the results of the High Level Group on "Competitiveness, Energy and Environment".

Technologies and solutions to address the European Union energy efficiency targets across all market segments are available today and well known. New technologies leading to a significant shift in the approach to energy consumption, such as changing fuel mixes, developing clean fuels technologies or to carbon sequestration or storage solutions require further development and will provide most of the gains after 2020. Furthermore, implications associated to some of these new technologies, such as bio-fuels or carbon capture and storage (CCS technology) still need to be evaluated.

Technologies such as renewable energy sources are in most cases, currently not available at commercially viable conditions. They are complementary to energy efficiency solutions, first in the case of the penetration of energy efficiency measures is not fast enough, and secondly, in order to play a major role in the future CO_2 reduction gains Europe will need to achieve in the mid term.

Therefore the most economic and simplest way to reach the European Union's 2020 goal is to target massively energy efficiency, focusing on the inefficient use of energy across all market segments and taking up and diffusing technologies which are available today. This is technically and, in general, also economically feasible.

The diffusion of energy efficient technologies will lead to energy savings and as a consequence to the projected 2020 CO_2 emissions reduction target.

The ability to meet targets by simply persuading people to act differently or to deploy new energy efficient technology is unlikely to succeed. Likewise, just targeting new installations or constructions, less than 2% of the existing stock in all segments, will not achieve the energy efficiency target. Approximately 80% of the stock in 2020 is already in place therefore policies must foster early renovation or retrofitting as well. Time is critical because of the size of the required change and the effort required to work through the installed base. This is a matter of urgency.

A simple macroeconomic simulation, based, on the one hand, on the energy saving (cutting the annual energy bill) which is accessible to stakeholders (utilities, industry, home owners, consumers) and on the other hand on what can be considered as an acceptable payback for them illustrates just how much growth and overall economic activity energy efficiency may generate. This is why energy efficiency deserves to be taken very seriously by all actors and to become a driver of the European economy.

The accessible energy savings generally range between 10% and 20%, based on addressing the active part of the installations and using existing technologies, which directly or indirectly allow the control of most energy usage.

The stakeholders' expected payback time of course varies depending on the type of business they are in; the time ranges from 5 to 10 years for households, public buildings or major infrastructures to under 5 years for industry and private tertiary actors.

On the basis of these hypotheses, this would lead to potential investments in energy efficiency, which should translate into an additional two digits average annual growth for Europe's electrical and electronics industry. The power generation, transport and distribution of electricity and buildings (commercial and industrial) segments should see 15% to 20% growth while the industry, infrastructure and residential sectors should see a growth of between 10% and 15%. Durable consumer goods, will find it difficult to reach this level, which only further reinforces the importance that mobilisation and incentives will play in the drive to achieve greater energy efficiency.

The additional manufacturing output generated in Europe (€ 20 to 30 billion a year) will of course be amplified by the impact that this "growth engine" will have on the whole business chain and particularly on contractors, integrators and installers.

The choice of measures which will be decided upon and implemented are of fundamental importance and, besides, the stakeholders' capacity and willingness to invest in the area of energy efficiency will have to be generated.

Recommendations are made for each key market segment for which Electra manufacturers offer energy efficient products and solutions, for example, most of the energy chain, from the supply side (Electricity supply chain) to the demand side (Buildings, Housings, Industrial and Infrastructure processes, transport).

Highly efficient power generation, transmission & distribution systems, positive energy buildings, building management systems, high performance electric motors, variable speed drives or energy efficient lighting systems or appliances are as many examples which will contribute largely to the savings, provided that we will be able to enforce the implementation of these "best in class" solutions in each and every new installation as well as on a significant part of the installed base.

Education, general awareness, competencies, but also incentives and regulation are the main areas to focus on to overcome the barriers to adoption of the available Energy Efficient technologies.

Energy efficiency is the key driver to achieve environmental and economical goals but it requires investment(s) to be decided upon by owners, particularly for their installed base.

This will be facilitated if as stable, predictable and appropriate a regulatory framework as possible is established that mobilises market forces and increases competition, thereby driving innovation and investment. The deepening and completion of the internal market in order to create a larger accessible market and increased competition are indeed a prerequisite.

Engaging business actors is critical for both environmental and economic success. We stress the importance of ensuring that integrated policies create opportunities to mitigate the cost of tackling climate change for all: it is essential that solutions enabling the shift towards a global low carbon and prosperous economy do not damage economic development, including in energy-intensive sectors. The benefits and challenges of a sectorial approach suggest that, building policies around carbon or performance benchmarks and/or indicators may provide an equitable way to engage other regions.

The development of the 10 proposed measures will require, in most cases, the contribution of all concerned stakeholders (EU institutions, Member States, industry) but lead initiators are suggested, as specified hereafter:

EU institutions

- Refocus its policy more on developing growth and jobs through its programme for CO_2 reduction, including developing incentive schemes and policies other than the ETS to mobilise the economically attractive potential in the buildings, industry and other sectors. To achieve the 2020 targets this should get more emphasis than in the past.

- Foster R&D programmes, technology roadmaps and an innovation policy to support early demonstration and maintain or create lead customer markets:
  - According to the lighthouse projects and learning curve effect model (for instance Green buildings, smart grids, a high voltage direct current-grid (HVDC)
  - Allowing the development of energy efficiency metrics and metrics for the economics of CO_2 reduction.
  - Supporting the development of dynamic energy storage on a large scale to promote the deployment of renewable sources (small scale generation plants and decentralised installations for residential, commercial and industrial buildings).
  - Helping to remove barriers from regional planning and simplifying planning permission processes (transportation, grids, Renewable).

- Set overall energy efficiency targets for each Member State and enforce national binding roadmaps or action plans (for example the National Energy Efficiency Action Plans – NEEAPs under the Energy Services Directive) independently of the given Member States' energy mix, based on an exhaustive inventory of the current local environment and stimulating smart metering and intelligent power management.

- Foster the adaptation of the architecture of the transmission and distribution grids to improve their overall efficiency:
  - With interconnections and management according to a European energy supply scenario.
  - Coordinating the Union for the Coordination of Transmission of Electricity (UCTE) with a cross border and real time dynamic view.
  - Increasing the transmission and distribution voltage where possible and enhancing transformers' installed base to reduce overall network losses
  - Setting new rules to increase power factor correction so as to optimise overall network efficiency
  - Developing an incentive regulation rewarding investments - as an example -improving the efficiency quality of the grid.

- Develop benchmarking and good practices sharing with harmonised performance criteria or metrics:
  - Creating and launching a management scheme associated to energy efficiency and CO_2 reduction expanding on the Energy Performance of Buildings Directive (EPBD) in the spirit of the ISO14001 standard and the Capability Maturity model (CMM) scheme used in the field of software development.
  - Making mandatory and funding of audits and diagnostics of the installed base.
  - Providing energy passports or labels.

Member States

- Launch a massive information and education campaign aiming at raising the general awareness of all actors:
  - Fostering investment in new power engineering competences to face the resulting growth.
  - Educating the business community and particularly the installers, schools and, more generally, the general public (obligatory energy efficiency courses as part of the curriculum or apprenticeship).
  - Enforcing the use of the life cycle cost approach for installations and equipment.
- Ensure leadership of public authorities, showing the example with ambitious and visible investment plans:
  - Stimulating public-private partnerships (PPP's) in the areas of, for example, energy performance contracting and energy services.
  - Delivering leading edge (lighthouse) demonstration projects.
  - Creating national bodies to develop sharing of best practices.
- Launch long term fiscal policies and financial incentives plans adapted to each sector:
  - Encouraging investment and renovation in energy efficient products and systems and discouraging old inefficient technologies.
  - Encouraging the closure and replacement of the least efficient installations.
  - Fostering proper maintenance and renovation of the installed base.
  - Providing adequate attractive feed-in-tariffs for decentralised power generation installations.
  - Fostering financing tools, such as green funds, soft loans for investors or tax credits, purchase rebates, cash-back schemes granted directly to the consumer.
  - Overcoming the investor-user-dilemma by studying the use of "internalising" charges to investors for energy efficiency gains not utilised.

Industry and the EU institutions

- Extend technical regulation for homes and buildings to include the active energy part:
  - Transforming current regulations and codes into global ones encompassing all applications.
  - Setting minimum energy efficiency criteria for loads and installation.
  - Making these applicable to new and to existing installations.
  - Fostering transparency of energy consumption through audits, labelling or passes.

- Set appropriate minimum energy efficiency or environmentally friendly legal requirements for products and systems:
  - With, where appropriate, dynamic labelling schemes facilitating the commercialisation of the most efficient products and evolving over time according to business impact assessments.
  - Fostering, where appropriate, voluntary global European lead standards
  - Fostering an European Top Runner approach (see Orgalime proposals on www.orgalime.org).
  - Complement the Eco Design requirements of Energy using Products (EuP) Directive with new EU-wide measures tackling the efficiency of installations or systems, so as to also foster systems related approaches (SrA).

2. Introduction

2.1 General context

Limiting global warming by reducing green house gas emissions is a global target set at the Earth Summit in Kyoto in 1997 and finally ratified by 169 countries in December 2006. Under this Kyoto Protocol, countries have agreed to reduce their collective emissions of greenhouse gases. Europe's commitment was 8% reduction by 2012. Since then, European Union has set its own target to cut CO_2 emissions by 20% by the year 2020; this target will be achieved thanks to:

- 20% increase in energy efficiency
- 20% renewables in overall EU energy consumption
- 10% Bio-fuel component in vehicle fuel

The electrical and electronic engineering Industry has a major contribution as technologies and offering developed and supported by Electra manufacturers are playing a major role in the control and optimisation of the use of all energies.

We aim to propose solutions which will allow the European Union to achieve the targets it has set up itself while taking into consideration both its economic and political contexts.

We therefore aim at:

- Focusing on measures which will allow the European Union to attain the CO_2 reduction targets it has set by most economic approaches. Energy efficiency is today's most economic way for achieving CO_2 reduction.
- Laying the foundations for the introduction of 20% of renewable energy over time.
- Reconciling the three pillars which underpin the High Level Group on Competitiveness, Energy and the Environment.
- Taking into account the European Union jobs and growth agenda.

In other words, this report proposes measures which will reduce CO_2 by a maximum, while at the same time taking into account the economic factors, notably where there can be a reduction in CO_2 which either provides a positive return on investment or which has as limited a cost as possible.

We have based this report on our knowledge and understanding as well as the numerous studies and reports (such as the "Vattenfall" report dated June 2007 & "BDI Initiative – business for climate protection" developed with the support of Mc Kinsey) which demonstrate the potentials, propose a global mapping of greenhouse gas abatement opportunities and introduce the notion of marginal abatement cost curves, demonstrating the profitability of energy efficiency investments in relation to the cost per ton of CO_2 and on the results of the High Level Group on "Competitiveness, Energy and Environment". Such an approach can be deployed by member states to adapt priorities at their local situation (see German, UK and US studies on cost of CO_2 abatement).

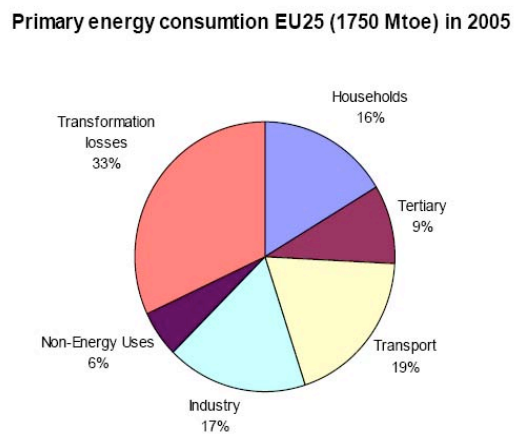
The new technologies to realise the ambitious targets proposed by the EU are no doubt on their way; these include approaches leading to a significant shift in the approach to energy consumption, such as changing fuel mixes, developing clean fuels technologies and/or carbon sequestration or storage solutions. However, these technologies will only provide real benefits after 2020 and as long as the political and economic contexts are right. Furthermore, the implications associated with some of these new technologies, such as bio fuels or Carbon Capture and Storage (commonly called CCS technology), still need to be considered.

All aspects, from the supply side to the demand side have been analysed and is clear that there are both countless challenges and opportunities.

So, how are we going to reach the targets set by the EU for 2020? The cheapest and simplest way to do so is to target massively energy efficiency, focusing on the inefficient use of energy across the market segments and taking up and diffusing technologies which are available today. This is technically and, generally, also economically feasible.

By making the necessary adjustment, we will also be able to improve the security of energy supply, foster competitiveness and stimulate the development of lead customer markets in the field of energy efficient technologies. The support of the diffusion of energy efficient solutions, their future development, effective communication and ambitious national energy efficiency plans (NEAPPs) will lead to energy savings and, as a consequence, to the achievement of the projected 2020 CO_2 emission reduction target.

Technologies such as renewable energy sources are, in most cases, currently not commercially viable, but they are complementary to energy efficiency solutions: first in case the penetration of energy efficiency is not fast enough and secondly to play a major role in the future CO_2 reduction gains Europe will need to achieve its objectives in the midterm. With the strong interest and focus of most politicians on new technologies, policies and roadmaps have been already developed (European directive, Member States' roadmaps…etc.). Electra members are supportive of these which should allow EU to achieve its second goal (20% renewables in overall EU energy consumption). Cutting edge research, pilot projects and appropriate supporting schemes are however necessary to make these technologies more competitive and above all predictable from an economic perspective.



The ability to meet targets by simply persuading people to act differently or to deploy new energy efficient technology is unlikely to succeed and just targeting new installations or construction which represent less than 2% of the existing stock in all sectors, will not achieve the energy efficiency targets Europe has set itself.

Time is critical because of the size of the required change and the effort required to work through the installed base. This is a matter of urgency.

Europe's short term energy dilemma requires simultaneous action along the whole energy chain, from the supply side to the demand side.

In this annex, we therefore deal with:

- The energy demand side which we have subdivided into four main areas :
    - Buildings, industrial and commercial
    - Housing or the residential segment
    - Industrial and infrastructures processes
    - Transport, from an electrical-electronic application perspective.
- The electricity supply chain, which includes power generation, power transmission and power distribution.

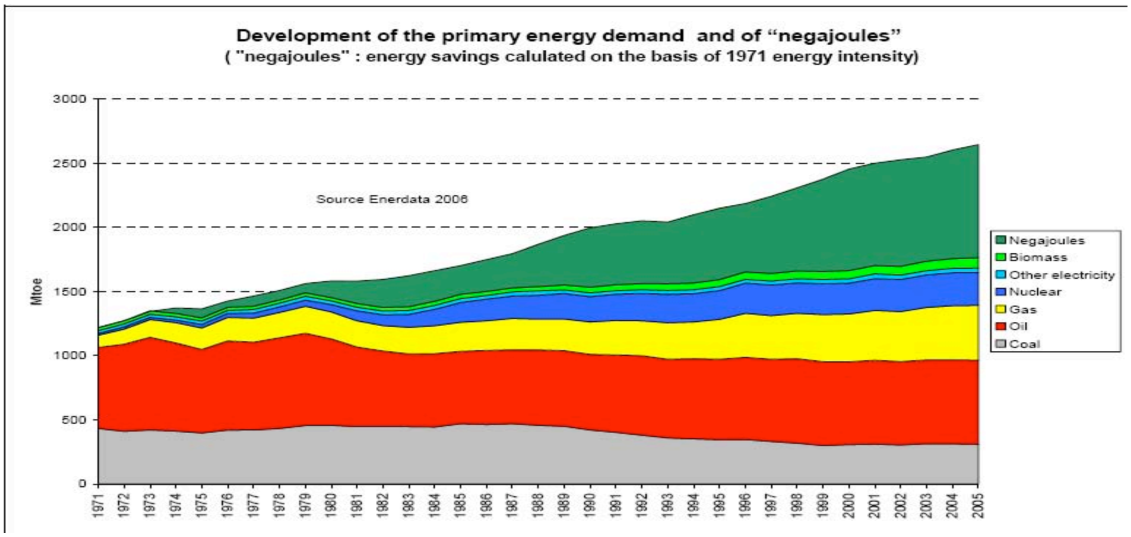
All sectors where

- Technologies and offering developed and supported by Electra manufacturers are playing a major role in the control and optimisation of the use of all energies

- We can act today.

2.2 Key stakes

Even though energy efficiency has already improved considerably *(see the graph – source European Commission 19.10.2006),* it is still technically and economically feasible, in most cases, to save at least 20% of primary energy by 2020. Most of these savings will result from an optimised energy usage across the energy chain thanks to more efficient installations.



Electricity plays a major role in this potential savings in most segments, first due to its relative weight in the different segments' energy end use and also because of its potential contribution to the management of all energy usage. Electricity overall consumption (20% of the end use energy demand) corresponds to about 50% of the primary energy consumption.

The ability to meet targets by simply persuading people to act differently or to deploy new energy efficient technology is unlikely to succeed. Recent experiences with, for example, motors and drives, lighting systems or appliances show that the adoption of the most energy efficient products or technologies despite their economic attractiveness is not as easy as we may have anticipated.

Overall, the biggest challenge relates to the installed base. Approximately 80% of the installed base that will be there in 2020 exists already; the EU 2020 goal will only be reached if a very large part of the installed base is improved or renovated significantly and as long as any new investment is designed and realised using the best technologies from an energy efficiency perspective. Therefore policies must foster early renovation or retrofitting as well. For example, annual replacement rate of street lighting is 3% only. This means that it will take more than 30 years for the full financial and environmental benefits to be realised. This is simply too slow. Every year passing reduces our chances to reach the EU's target; this is therefore a matter of urgency.

The necessary energy efficiency investments required are not easy to be quantified because most of this "additional growth" will come from the accelerated renovation or improvement of the installed base, which represents a market paradigm shift for each sector and makes any extrapolation of current trends impossible.

However, a simple macroeconomic simulation, based, on the one hand, on the energy saving (cutting the annual energy bill) which is accessible to stakeholders (utilities, industry, home owners, consumers) and on the other hand on what can be considered as an acceptable payback time for the concerned stakeholders illustrates how much growth and overall economic activity energy efficiency may create. This is why energy efficiency must be taken very seriously by all actors and should become a driver for change and for growth in Europe.

The accessible energy savings generally range between 10% and 20%, based on addressing the active part of the installations and using existing technologies, which directly or indirectly allow the control of most energy usage.

The stakeholders' expected payback time of course varies, depending on who they are: the time ranges from 5 to 10 years for households, public buildings or major infrastructure and under 5 years for industry and private tertiary actors.

On the basis of these hypotheses, this would lead to potential investments in energy efficiency, which should translate into an additional two digits average annual growth for Europe's electrical and electronics industry. The power generation, transport and distribution of electricity and buildings (commercial and industrial) segments should see 15% to 20% growth while the industry, infrastructure and residential sectors should see a growth of between 10% and 15%. Durable consumer goods, will find it difficult to reach this level, which only further reinforces the importance that mobilisation and incentives will play in the drive to achieve greater energy efficiency.

The additional manufacturing output generated in Europe ranges between € 20 and 30 billion a year; it will be of course amplified by the impact that this "growth engine" will have on the whole business chain and particularly on contractors and installers.

Some simulation exercises have been done, for example, on power capacitors by ZVEI (the German Electrical and Electronic Manufacturers' Association) or drives by the manufacturers; they both conclude that their specific market size should more than double. The greatest effect should be felt in the areas of capacitors, drives, transformers, lighting systems, buildings and home automation and control, performance contracting services, top energy performing appliances, power generation, transport and distribution technologies and traffic control systems.

The measures which will be decided and implemented are of fundamental importance as in any case the stakeholders' capacity and willingness to invest in this field will have to be generated.

2.3 Estimate of Energy savings potential

The energy savings potential across all segments has been largely quantified by a number of studies. These results are, in most cases, backed up by references to recent installations which confirm the gains and /or the newly achieved level of efficiency.

The overall end use accessible energy savings are listed in the enclosed table (Source: European Commission); these include all solutions and technologies. Amongst these, the potential contribution of the electrical and electronic engineering industry, which directly or indirectly allow the control of most energy usage, ranges generally from 10% to 20%, based on addressing the active part of the installations and using existing technologies.

Sector	Energy consumption (Mtoe) 2005	Energy Consumption (Mtoe) 2020 (Business as usual)	Energy Saving Potential 2020 (Mtoe)	Full Energy Saving Potential 2020 (%)
Households (residential)	280	338	91	27%
Commercial buildings (Tertiary)	157	211	63	30%
Transport	332	405	105	26%
Manufacturing Industry	297	382	95	25%

Figure 2: Estimates for full energy saving potential in end-use sectors[12]

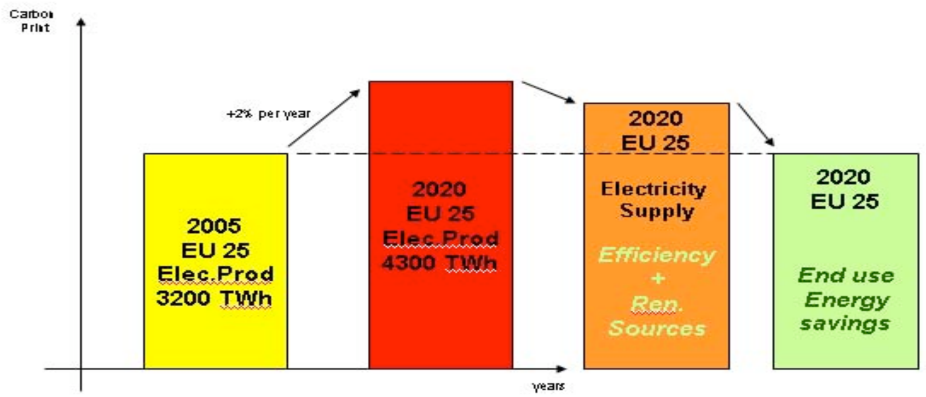
Highly efficient power generation, transmission and distribution systems, positive energy buildings, building management systems, high performance electric motors or energy efficient lighting systems or energy efficient appliances are many examples which will contribute largely to the savings, providing that we will be able to enforce the implementation of these "best in class" solutions in each and every new installation, as well as on a significant part of the installed base through appropriate renovation or retrofit. Overall, the target can be achieved according to the following:

On the demand side, the efficiency improvement comes from

- A large deployment of high efficiency loads
- An optimal energy usage thanks to better control systems
- A proper monitoring and maintenance of the installations

This last point is an essential condition to avoid the progressive deterioration of energy performance of an installation during its life cycle.

Gains will come from the optimisation of the efficiency from generation to consumption of electricity, as well as the non electric fossil energy consumption used in buildings, households and industry. According to the above data, the resulting total savings in term of carbon footprint should reach some 25%. If no action is taken we would expect total energy production to need to rise by some 2% per year leading to an increase in electricity production from 3200 TWh in 2005 to 4300 TWh in 2020 as shown in the graph hereunder.



2.4 Issues and barriers to adoption

Each of the 5 sectors we deal with in this annex has its own major issues or barriers but there are some common ones which apply to most segments:

- The lack of awareness that although energy efficient technologies cost more initially, they have reasonably fast paybacks and save a large amount of energy and money during their lifetime.
- The lack of understanding and references for performances in terms of energy efficiency
- The lack of availability of young scientists/engineers with a background in energy technologies sciences
- The lack of implementation resources (contractors) to face the coming market growth
- The lack of incentives to foster energy efficient investments
- The long replacement cycles traditionally accepted in all relevant sectors.
- The investor-user dilemma, where investors do not benefit or insufficiently benefit from energy efficiency gains
- The lack of appropriate regulation and enforcement to bring about change.

3. Building segment

3.1 General Context

Tertiary buildings with their related services represent some 20% of the overall final energy demand of which more than 50% is in the form of electricity.

The buildings segment covers a large scope of applications such as office buildings, hospitals, commercial malls, train stations etc. Some of them contain heavy processes like data centres and will have to be concerned by the present buildings and industry segment proposals.

The contribution to CO_2 emissions reduction of buildings will arise from:

- The use of low consumption – high efficiency loads (lighting systems, motors, power capacitors, transformers, cables….).
- The optimisation of the use of these loads through automation and control.
- The implementation of procedures and tools to monitor and maintain the systems.

Energy management systems are a fundamental part of the overall solution by allowing

- A significantly more optimised use of energy in areas where human behaviour is less precise and furthermore much less reliable.
- An improvement of the general reliability (quality, continuity of service) of the installation.
- The sustainability of performance through monitoring and diagnostic tools which are generally part of the system (information is key to sustaining the energy savings).
- The development of energy efficiency performance contracting services.

The bulk of the challenge is to define solutions to address the installed base which is far from being optimised.

3.2 Key stakes

The investment cycle and replacement rates in buildings are very low (Factories, Commercial buildings, public administration, train stations, hospitals…).

The challenge is to ensure that:

- The current installed base is addressed massively with appropriate solutions, as it will represent 80% of the buildings used by 2020.
- Any new buildings are from now on, designed and built according to voluntary lead standards (towards “positive energy” buildings).

Solutions exist and are already deployed in some areas, but return on investment will be a key point for building owners and their tenants.

The investor is often not the user of the building (investor-user dilemma) which means that investment rather than energy efficiency considerations may be more important to him.

The main challenges relate to overcoming this dilemma, facilitating management of the building or services contracting.

Education, incentives and probably regulation or codes will be the keys of the success.

3.3 Expected technology trend

Here after are listed the key solutions which must be largely deployed.

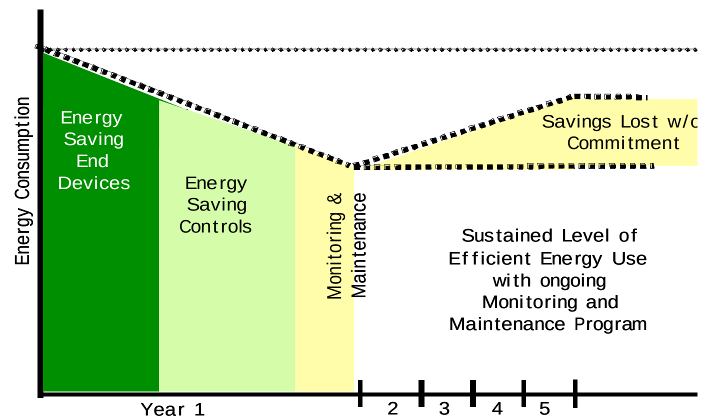
Examples of solutions include:

- Optimisation of the load of transformers thanks to an optimised power factor.
- Optimal consumption thanks to the use of variable speed drives, control and presence detection for pumps and ventilators in shopping centres / commercial malls.
- Automation and Control for central heating and air conditioning in office buildings.
- Automated lighting control.
- Improved quality and continuity of service thanks to UPS, electronic power supplies….
- Renewable sources for heating, for example heat pumps.
- Energy services and performance contracting.

3.4 Estimate of Energy savings potential

More than 50% only of the energy used in buildings is electricity. Solutions are available to contribute to the overall energy performance of these. 30% savings are possible with today's technologies provided that the measures listed above are applied in all installations (existing and of course new ones)

Performance contracting experience, today already demonstrates the validity of such potential savings, without even touching the construction of the existing buildings.



3.5 Issues and barriers to adoption

Major issues or barriers relate to change management and profitability of the investments.

As stated above, technologies exist and are largely available on the market. Solutions exist already in recent applications but the implementation is never so simple. An assessment is necessary and solutions are often customised.

Reaching energy efficiency objectives requires massive change in the complex and long business chain including:

- Better information of investors and end users; this is a prerequisite to raising the awareness and changing the working habits of installers.
- The education of the whole business chain: this will be necessary to deploy and install solutions which are often made of products coming from different suppliers.

The economic constraint is important as the return of investment is mid to long term only and it will impact the overall investment capability of all actors.

Existing installations require renovation or products/systems early replacement. National measures do not address this aspect yet.

A strong push by the authorities and major incentives should allow converting this challenge into a major market growth initiative, with the associated local jobs creation which will result of it (installers and integrators are mainly local actors).

3.6 Policy options to facilitate adoption and investment

The main recommendations are proposed to be allocated as follows:

EU institutions

- Create and launch a management scheme associated to energy efficiency and CO_2 reduction expanding on the Energy Performance Buildings Directive (EPBD), in the spirit of ISO14001 standard and the Capability Maturity Model (CMM) scheme used in the field of Software development
- Develop benchmarking tools / metrics by type of buildings / purpose (Offices, Hospital, Town hall, Post office , etc) to help building owners in their decisions
- Foster transparency of energy consumption, through audits and labelling or passes

Member States

- Ensure leadership of public authorities, showing the example
  - With an ambitious investment plan in all Member States
  - Communicated widely to the general public
- Launch fiscal and financial incentives plans encouraging investment and renovation in energy efficient product and systems, and discouraging old inefficient technologies
  - With the necessary information
  - With a long term perspective.
  - Through, for example, green funds, soft loans, amortisation rules etc.
- Launch an education initiative
  - For the business community and particularly for installers
  - For schools and universities
  - For the general public with simple messages about generic typical solutions.
- Foster energy performance contracting and support energy service companies (ESCOs).
- Overcome the investor-user dilemma by studying the use of “internalising” charges to investor for energy efficiency gains not utilised.

Industry and the EU institutions

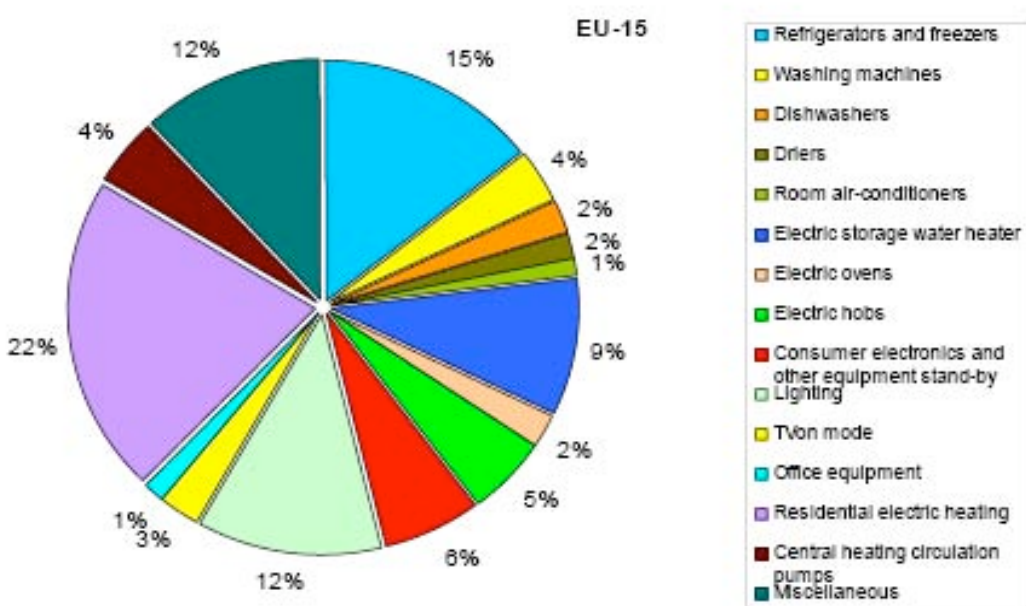
- Enlarge current technical regulations
    - To transform current buildings technical regulation and codes which address only the passive structure of the construction, into a global one encompassing all applications and setting minimum energy efficiency criteria.
    - Making this new technical Regulation oriented towards energy efficiency also progressively mandatory for existing buildings.
    - Making mandatory energy efficiency audit, including both assets and operational ratings.

4. Residential segment

4.1 General Context

Homes represent some 20% of the overall final energy demand of which up to 40 % is in the form of electricity (there are differences between countries due to the historic electricity policy for heating). The residential segment represents some 29% of the electricity consumption. It is growing particularly fast due to the increasing penetration of electrical equipments and appliances.

Electrical appliances represent 40 to 50% of the electricity consumption of the segment. The mix varies depending on countries; the following charts show the gaps between the first 15 member states and the 12 more recent ones.



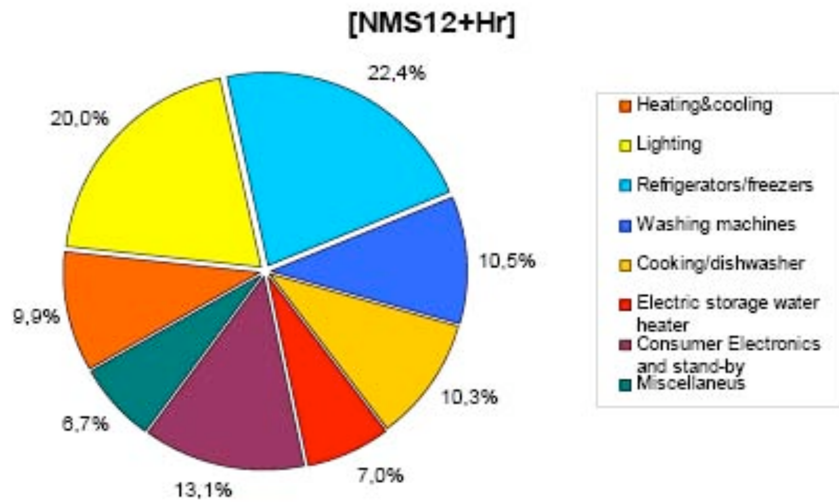


Fig 3.: Breakdown of electricity consumption among residential end-use equipment in NMS12+Hr, yr. 2004 (source JRC and [Ata2004])

Better efficiency can be achieved thanks to:

- The use of high efficiency products and systems (lighting and household appliances including heat pumps and water heaters….).
- The optimisation of the use of these products through minimum automation and load control.
- Appropriate monitoring and maintenance to keep the efficiency optimal.

The overall cost of top class energy efficient products and systems is, however, still too high to promote their diffusion on a wide scale without incentives. Moreover, the lack of market surveillance to enforce existing EU regulation is jeopardising the investment of industry in efficient new technologies and hampers the diffusion of efficient products and systems on the market.

Major potential innovation in the field of decentralised energy sources and production are emerging; they will complement the above, but their practical impact on CO_2 reduction will occur only in the mid to long term, as such technologies will mainly be used for new construction.

4.2 Key stakes

The challenge is to ensure that:

- First, any new homes are from now on designed and built according to voluntary lead standards.
- The current installed base is addressed massively with appropriate solutions and incentives as it will represent more than 80% of the homes used in 2020.

Solutions exist and are already deployed in some areas, but the efficiency of the installed base, notably in terms of electrical appliances and lighting systems, is poor compared to the state of the art products. This is largely due to the weakness of incentives for further diffusion. The diffusion of efficient home control systems, for example, is still very much a marginal factor.

The necessary incentives and willingness of consumers to uptake the most efficient products will be decisive for this segment. At the same time major savings can arise from changing people's behaviour at home (temperature settings, presence detection etc.)

Better information of end users is therefore a prerequisite to mobilise households and to put pressure on the contractors, installers and distributors. The training along the whole supply chain of energy usage will then be necessary, so as to deploy and install solutions which are often made up of a range of products coming from different suppliers.

The estimated average investment in Electra technologies to be made by a consumer, before 2020, is in the range of an equivalent of one year's full energy bill. This is against energy savings of between 10% and 20% per year. Nevertheless it will require that the consumer should provide the initial investment outlay, which may present a challenge.

4.3 Expected technology trend

Energy efficiency plays an increasing role in residential buildings and on the potential to reduce carbon emissions.

There are many examples of potential energy use reductions:

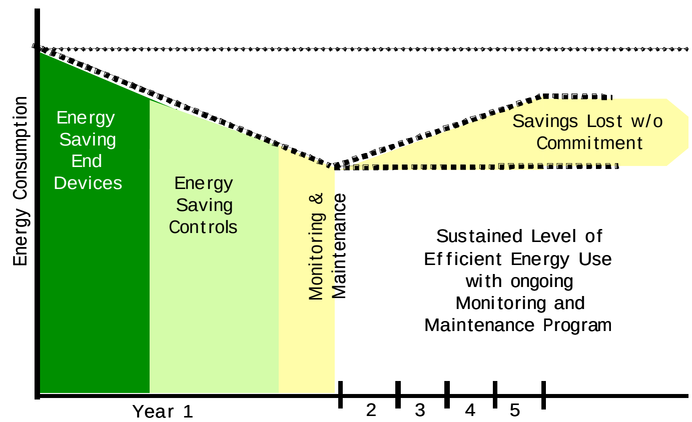
- Improved efficiency of appliances: most electrical appliances technologies have already achieved outstanding energy efficiency improvements over the last decade. Further improvement is still possible; however it will come at higher cost, for example, on refrigerators a further 20% improvement on energy consumption is considered possible, but the current highest efficiency technology is still too expensive to enter the market easily.
- The use of new lighting technologies in replacement of old incandescent lamps.
- The increased use of new heating technologies (heat pumps and solar water heating) in combination of traditional heating and hot water technologies can bring significant efficiency benefits; their diffusion in existing installations is limited due to high installation costs.
- The increased use of intelligent home control systems which allow networking of households appliances and better load management of electrical loads as well as better temperature control for heating and cooling. Such studies are not investigated enough and current results shows that the overall costs are still too high to implement it on a wider scale.
- The integration of household renewables within the domestic electrical networks and with the operation of appliances.
- The use of smart metering systems to allow demand response mechanisms to smooth peaks loads.

The overall cost of top class energy efficient products and systems is still too high to promote their diffusion on a wide scale without incentives.

Major potential innovation in the field of decentralised energy sources and production are emerging; they will complement what is listed before; however their practical effect on CO_2 reduction will occur only in the mid to long term as they will mainly be used for new constructions.

4.4 Estimate of Energy savings potential

40% only of the energy used in homes is electricity; solutions that are available contribute to the overall energy performance of the segment. 25% savings in homes are possible, with today's technologies, provided that the fundamental measures mentioned earlier and visualised in the picture are applied in all installations (existing and of course new ones)



The first gain (*Energy saving in end devices*) will mainly arise from an accelerated replacement of the energy inefficient appliances, lighting systems and the least efficient water heaters.

Secondly, (*Energy saving controls*), changes should be implemented in automatic controls for example, reduction of temperatures, adaptation to the level of presence, switching to sleep modes (stand by) etc. thanks to intelligent living solutions.

Finally, (*Monitoring & maintenance*), in order to guarantee that gains will not be lost, a minimum of controlling & monitoring capability will be needed.

4.5 Issues and barriers to adoption

Major issues or barriers relate to change management and return on investment.

The overall cost of top class energy efficient products and systems is still too high to promoting their diffusion on a wide scale without incentives.

Improving energy efficiency significantly requires change within the complex and long business chain.

- Better information of end users is a prerequisite to raise the awareness and changing the working habits of installers and the whole supply chain.
- The training along the whole energy usage supply chain will then be necessary to deploy and install solutions which are often made up of products coming from different suppliers.
- Labelling schemes in home appliances have proved to be successful in driving the buying decision, but the purchasing cost is fundamental for any consumer and in particular when the return on investment is very long. The lack of additional incentives to replace less efficient products is a limitation.
- Existing installations require renovation or products/systems early replacement; national measures do not address this aspect yet.
- The state-of-the-art products are not always easily accessible for the consumers because of the purchase price and their availability on the market.
- Enforcement of market surveillance is a critical success factor.

A strong push by the authorities and major incentives should allow the EU to make this challenge a major growth initiative with local jobs creation all along the business chain.

The full upgrading of an existing house is recognised as requiring some about 15000 to 20000€ investment (passive and active energy efficiency solutions). Most consumers cannot afford this and moreover the payback is very long or, at times even not achievable.

4.6 Policy options to facilitate adoption and investment

The main recommendations as well the party which should take the lead that we propose are::

EU institutions

- Improve the legislative framework to ensure effective market surveillance of regulatory compliance so as to secure that products put on the market are complying with the existing and coming legislation.

- The Commission and the Member States should make a more dynamic and effective labelling system for energy using products. This should be done in consultation with stakeholders; where appropriate classifying their performance with reference to minimum and lead standards and implementing effective market surveillance measures, and should go hand in hand with targeted consumer awareness campaigns

Member States

- Make the new national standards also progressively mandatory for existing houses

- Make mandatory an energy efficiency audit including both assets and operational rating.

- Launch fiscal and financial incentives schemes encouraging the investment in energy efficient product and systems and discouraging old inefficient technologies
    - With the necessary information, for example labelling.
    - With a long term perspective.
    - Tax credits, soft loans, green funds, purchase rebate, cash-back schemes granted directly to the consumer or use of white certificates are potential solutions.
- Overcome the investor-user dilemma by studying the use of "internalising" charges to investor for energy efficiency gains not utilised.

- Launch a massive education initiative.

Industry and the EU institutions

- Reinforce current construction standards
    - To transform current houses technical regulation, which addresses only the passive structure of the construction, into a global regulation encompassing all applications.
    - To set minimum energy efficiency criteria.

- Set appropriate minimum energy efficiency requirements for products and systems
  - With an appropriate and dynamic labelling scheme.
  - Ensuring a proper commercialisation of the most efficient products.
  - Evolving over time according to business impact assessments.
  - Fostering, where possible, international standards.
- Create an innovation consultation forum among relevant industry sectors to explore energy services opportunities and relationship between supply tariffs, load management and intelligent devices.

5. Industry segment

5.1 General Context

Industry represents some 30% of Europe's primary energy consumption. The overall potential final energy gain is estimated at 10% but there are significant discrepancies between industries and processes. Industries can be segmented into 2 main categories

- The energy intensive industry such as, oil and gas, pulp and paper, steel or cement which have been investing for 20 years in this area due to the impact of energy costs on their P&L.
- The lighter industries where the use of the products often uses more energy than the process, such as the Pharmaceutical, Food and Beverage, Automotive industries which present the largest potential.

An energy saving potential of between 30% and 65%, at least in many processes, can reasonably be expected. Industry is able therefore to contribute meaningfully to the achievement of European energy efficiency objectives and to the EU's 20% in 2020 EU CO_2 emission reduction target providing that:

- The use of low consumption- high efficiency loads (lighting systems, motors, power capacitors, transformers, cables….) is enforced.
- The use of these loads is optimised by installing appropriate automation & controls.
- Procedures and tools to monitor the performance and maintain the systems are implemented.

Electricity plays a major role in this environment first because of its relative increasing weight in the overall energy usage, but also because of the possibilities it offers to control, thanks to automation, measuring and monitoring, most energy usage.

Technologies to increase energy efficiency are readily available. Motors are everywhere and represent some 68 to 70% of the electricity used in industry ; 88% of the motor drives are not electronically controlled so far and 50% of these motors can be equipped with variable speed drives to achieve energy savings during partial load of up to 50%.

In addition emphasis should be given to the efficiency of the motors itself. Together with retrofitting to highly Efficient Energy Function (EEF1) standard motors (rather than the least efficient EEF3 class) there will be huge saving potentials.

Waste heat recovery too has an important part to play in fostering energy efficiency. Approximately one third of the energy used in the industry sector is heat. Industrial waste heat is generated in many processes and usually discharged into the atmosphere. Whenever surplus process heat can no longer be used in downstream process steps, operators should consider transforming it in electrical power. With relatively little investment waste heat recovery can deliver cost-effective power at temperatures of 100°C upwards. The heat is extracted from the available waste heat and steam is generated within an evaporator and drives a turbine.

Lighting systems, optimisation of the load of transformers thanks to an optimised power factor and improved quality and service thanks to uninterrupted power supply (UPS) or electronic power supplies are some of the additional technologies to achieve energy efficiency targets.

5.2 Key stakes

The challenge is to ensure that any new investment is designed based on voluntary lead standards and installed base is renewed or retrofit everywhere where it is economically feasible.

Better information of all end users is a prerequisite, with the training of the whole business chain. The economic constraint is important as return on investment is fundamental for industrial actors, who try to ensure that payback times are as short as possible.

Investment decisions in energy efficiency measures need to become a strategic management decision. This is usually not the case like for improving product quality or productivity which comes generally first, bearing in mind that energy price increases should continue.

The business environment and regulation will therefore need to make the energy efficiency issue as important an issue as quality models like ISO9000 and 14000 standards or the Capability Maturity Model scheme (CMM) in the field of software development. An ISO energy efficiency model, focusing on energy efficiency management, needs to be developed and deployed as soon as possible.

It will facilitate benchmarking by type of industry and application will become potentially available thanks to the consolidation of diagnostics and action plans; such elements would help CEOs to make decisions and to develop their plans.

5.3 Expected technology trend

The general approach for improving energy efficiency in industry is based on an equipment inventory, an assessment of the energy savings potential for each piece or group of equipment, and an action plan with monitoring and reporting.

This can be developed through a professional audit of the main processes.

For each system that uses energy (motors, compressed air system, boilers, fans, etc.), cost-effective energy efficiency measures can be implemented, either during design, maintenance or operation. The many benefits of improving efficiency justify manufacturing industries giving it an important focus.

Technologies and tools to achieve these potentials are largely available on the market. The solutions consist in the implementation of best in class process architectures and products, for example, through:

- The optimisation of the load of transformers thanks to an optimised power factor
- The use of high performance electric motors.
- Optimising consumption of motors thanks to the use of variable speed drives, regulation and presence detection for pumps and ventilators.
- An improved quality and continuity of service thanks to UPS or electronic power supplies.

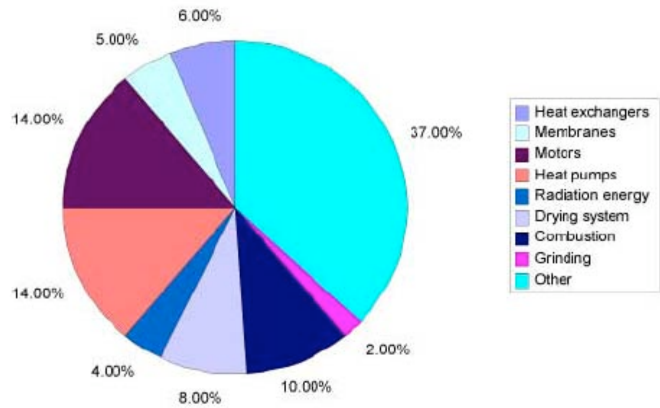
5.4 Estimate of Energy savings potential

We suggest that it is important to look mainly at the final energy consumption or demand as the basis for developing plans to reduce the usage of these energies.

Depending on the industry sector, the energy savings potential varies from 30% to 65% of which 30% of the Electricity used in its processes. The estimated long term technical energy savings potential per sector are (Source: ADEME French study)

- 50-60% for the food and beverage industry.
- 30-65% for the textile industry.
- 60% for the pulp and paper industry.
- 30% for the petrochemical and inorganic chemical industry.
- 50% for the building materials industry.
- 50% for the iron and steel industry.
- 35% for the non-ferrous metal industry.

5.5 Issues and barriers to adoption



Major issues or barriers relate to value chain management and to the profitability of investments. As stated above, technologies exist and are largely available on the market. Solutions already exist in recent applications, but their implementation is never so simple. A diagnostic is necessary and solutions are customised.

The main issues and barriers to adoption are:

- The lack of management awareness in regard to scattered small opportunities: usually a large number of small interventions are required and there is a lack of knowledge and awareness, particularly at higher management level.
- The lack of investment.
- The lack of information and experience in the use of methods (for example, how to analyse the life cycle cost).
- The lack of knowledge about factors in the electricity consumption.
- Investment decisions based on investment costs only, but not on the total life cycle costs.
- The lack of push-pull action towards system integrators or machine builders by comprehensive information of potential end users.

5.6 Policy options to facilitate adoption and investment

Better information of all end users is a prerequisite, with the training of the whole business chain. The economic constraint is important, as return on investment is fundamental for industrial actors.

Therefore the recommendations and proposed lead party for applying these are the following:

EU institutions

- Enforce the use of *Life Cycle Cost Analysis* tools.
- Pay due attention to motors, frequency converters for drives and waste heat recovery.

Member States

- Push for information campaigns and training of all the actors of the business community and introduce mandatory energy efficiency education academic studies and apprenticeship.
- Make mandatory and fund the audits and user training, foster industrial consulting.
- Propose incentives or fiscal schemes which will allow industries to bring the payback of energy efficiency investment to between to 2 or 3 years maximum.
- Foster financing tools, such as soft loans or green funds.
- Create national bodies to favour the launch of pilot projects in the major energy consumer industries and foster best practice sharing.

Industry and EU institutions

- Foster minimum performance standards and standardisation with the development and deployment of energy efficiency Quality Model; this will provide the necessary push, for those sites already registered under ISO9000 and even more under ISO14001.

6. Transport segment

6.1 General Context

The transport sector represents approximately some19 % of the overall energy consumption in the EU. Even though the share of electricity is rather small, technologies provided by Electra industry have a decisive role to play on the use of fossil fuels.

The transport and logistics sectors are vital for the competitiveness of all industries, for example because of the costs implied for consumers and for the complete goods supply chain.

Technology, Training, optimisation of transport and traffic management and the completion of the internal market can contribute to major energy efficiency gains.

6.2 Key stakes

The key challenges are:

- To ensure the competitiveness of industry and sustainable transport.
- To overcome political barriers, in particular in cross-border transport or infrastructures.
- To foster the diffusion of technologies.

Technical solutions vary widely depending on the mode of transport, whether it is road, rail, ship or air transport.

Road infrastructures, in particular, are usually a public good; therefore all users benefit from investments made, but, on the other hand, public budgetary constraints and “return on investment” hamper the deployment of technologies.

In rail transport, in particular for freight transport, no efficient cross-border system has been established to date.

In air transport, a large number of local air traffic management organisations hamper the creation of a single European sky, thereby leading to wasted time and energy.

6.3 Expected technology trend

Technical solutions vary widely depending on the mode of transport, whether it is road, rail, ship or air transport and whether public or private investments are needed. A limited number of examples of technical solutions are hereafter proposed:

- *On road transport:*
    - Piezo direct injection for cars.
    - LED traffic lights.
    - Road Telematics with floating car data, dynamic navigation, infrastructure to car and car to car communication.
    - Efficient street and road lighting systems.
    - Traffic congestion avoidance by traffic control systems.
- *On rail transport:*
    - Rail energy storage.
    - Automatic Train Supervision.
- *On ship transport:*
    - Eco-friendly port-berthed power.
    - Waste heat recovery systems or Thermo-Efficient Systems.

6.4 Estimate of energy savings potential

Much of the effort needs to be made on creating a true internal market in the area of transport: there are areas where existing technologies can bring better efficiency:

- *Piezo direct injection*: The piezo injector can reduce fuel consumption by up to 30%, compared with current gasoline or diesel engines. This technology integrates a high pressure pump and an injector in one component. The precise spraying of fuel results in higher thermodynamic efficiency and more torque per litre. When combined with modern engine control electronics, the system provides quieter engines that consume less fuel and emit fewer gases.

- *LED traffic lights*: LED’s consume up to 80% less of electricity and have a longer life time. Utilised in road traffic lighting, they can be of particular interest due to their continued usage.

- *Road Telematics*: Individual road transport can effectively be directed through road telematics, combined, for example, with congestion charging schemes.. Lower energy consumption is achieved through avoiding traffic jams, thereby decreasing traffic delays. In combination with congestion charges, a shift to public transport, more car sharing and a rise in car occupancy can be observed.

- *Rail energy storage and Automatic: Train Supervision:* Recovering the braking energy in a static electricity storage system allows the energy to be reused when needed. Automatic Train Supervision brings about a reduction of energy consumption due to less accelerating and braking.

- *Ships, eco-friendly port-berthed power and waste heat recovery or thermo-efficient systems:* Eco-friendly port berthing and power offers various anti-harbour smog-solutions (cold iron system). Using the converter system enables port-berthed ships to be connected to the medium voltage network of the local power supply – reducing energy consumption and reducing emissions in the port at the same time. Waste heat recovery solutions or thermo-efficient systems recycle the thermal losses from the 2-stroke engine back into the ship's energy supply network; the reduction of energy costs of up to 12% therefore provides a relatively short payback time.

6.5 Issues and barriers to adoption

Piezo direct injection: Buying decisions of cars are based on various factors, but only relatively rarely on the degree on energy efficiency alone. The extra price to be paid, compared to the payback time for the investment, (depending on the fuel price), do not today foster the widespread adoption of this solution.

LED traffic lights and street lighting: Replacement of traffic lights is hampered by the management systems of municipalities and in particular by the requirement for one-off capital investments, which are budgeted separately from current expenditure on energy or maintenance, even though these investments do have a positive payback over time.

Road Telematics: As mentioned above, road infrastructures are usually a public good and require government or local authority investment. Budgetary constraints hamper the deployment of these, mainly because of the infrastructures installed; on the other hand, car units, which incorporate the technologies, are also needed.

Rail energy storage and Automatic Train Supervision: Technology is already available and usually used in new fleet. Due to return on investment factors, retrofitting of the existing fleet is weak.

Ships, eco-friendly port-berthed power: investments need to be made in the harbours, when benefits are for the owner of the ship (investor-user dilemma).

6.6 Policy options to facilitate adoption and investment

The following key measures and lead party for initiating them are proposed:

EU institutions

- Deepen and complete the internal market, foster cross-border transport and national legislation, and spur innovation by a larger accessible market and more competition, with the objective of a European single market.

- Develop congestion charging schemes in road transport to contribute to direct transport and to generate the budgets, required for investments and overcome the investor-user-dilemma by studying to "internalisation" of public benefits not utilised by the investor.

- Put mandatory public procurements rules in place to spur energy efficiency.

- Push global sector agreements to drive developing countries to faster achieve sector benchmark in CO_2 efficiency.

Member States

- Unleash the potentials of public-private partnerships ("PPP") to upgrade infrastructures by combining governmental obligations and private finance, for example by setting up of best-practice-sharing.
- Give performance contracting services to the private sector to fulfil the tasks required and upgrade the system to gain cost effectiveness.
- Develop stronger incentives notably through more competitive end-user markets and stimulate public-private partnerships (PPPs), inter alia through Structural Funds to deliver leading edge (lighthouse) demonstration projects.

Industry and EU institutions

- Forster European Standards to create a common market and to spur innovation.
- Establish European Technology Platforms to create common technological road maps.

7. Power Generation, Transmission & Distribution

7.1 General Context

Today much of the conversion systems from primary energy to useful forms of energy are highly inefficient. But already today high efficient technologies are available to substantially decrease the losses of such systems.

The electrical energy system contributes to CO_2 emission (33% of the primary energy consumption) as long as electricity is generated through non-renewable energy sources such as coal, oil and natural gas fired plants. The total world generation of electricity was 19'000 TWh in 2006, the EU25 accounted for 3'300 TWh. Renewable sources globally provide some 7% of the electricity generated. Worldwide 70% of the electricity is generated from fossil fuels, while in Europe the figure is 60%.

A drastic change in the portfolio of power generation in Europe is unlikely to be feasible at present for both economic and political reasons:

- Public opinion does not accept a substantial increase in nuclear energy in some countries.
- The availability of extra hydro power is limited.
- Renewable energy sources, such as wind and solar energy, are not expected to cover more than 8 - 10% of the energy supply in the short and medium term and are not yet, in most cases, economically competitive.

Even though the nuclear option should not be abandoned for the long term, the short term focus of the electrical industry must be to increase the energy efficiency and security of supply all along the value chain.

Given the fact that a very important part of today's existing power generation efficiency is as low as 33% but, that it could be higher than 50% with existing technologies, and that, in the EU, approximately 7% of the generated electricity is lost in the power transmission and distribution, a huge reduction of CO_2 emissions is possible in the short term without even decreasing end-use consumption.

At the same time, this sector faces a number of other challenges:

- The reliability of the electricity supply and the stability of voltage and frequency are becoming more and more critical.
- The optimisation of the power transmission and distribution grid, with regard both to energy efficiency and to accepting decentralised micro power generation plants or systems. “Super Grid” projects mixing long distance high voltage direct current (HVDC) and /or smart grid technologies are urgently needed. There is a need for a fundamental restructuring of the grids.
- The availability of scientists and engineers with an educational background in energy technology sciences.

7.2 Key stakes

The first challenge is to create a legal and economical environment which will motivate and support the electrical utilities industry to apply the available technologies on the installed base and favour the introduction of renewable sources solutions like wind, solar, thermal and photovoltaic, bio fuel, geothermal and in particular energy storage of the floating load.

As soon as primary energy is transformed to electrical energy through a thermo-dynamic process, between 40 and 55% of the primary energy is lost. In older power generation plants the efficiency may be below 30%, while new coal fired plants can reach an efficiency of up to 50% and new gas fired plants, in combined cycle operations, can even reach up to 60% efficiency. The rest is unused heat released to the atmosphere. Modern combined heat and power plants (CHP) can even achieve an overall energy efficiency of up to 85%!

The second important factor relates to the power transmission and distribution grid and its optimisation and reliability in regard to energy efficiency and to be able to foster decentralised micro power generation plants or systems.

A third important factor relates to the availability of scientists and engineers with an educational background in energy technology sciences. The EU’s power engineering industry can provide the leading technologies today, but is at risk of losing this leadership due to a lack of competent human resources.

The fourth issue is the play of market forces which is very limited in the energy sector; Energy prices are largely determined by political charges and competition is limited.

7.3 Expected technology trends

7.3.1 Power Generation

Coal fired plants should adopt CO_2 capture and storage technologies when available under competitive conditions and a European roadmap would help to support this technology. However, CO_2 sequestration may reduce plant efficiency by 7 - 12% depending on the technology used.

Higher burning temperatures will help increase the efficiency of turbines in the near future. The upgrade of old power stations and a replacement of the worst performing plants will be inevitable.

Small scale generation plants will develop, using a range of new technologies which have been already commercialised. However the overall benefits and possible drawbacks of the different technologies need to be investigated and well understood before boosting their deployment (Solar, wind, geothermal, heat pumps, bio fuel…)

7.3.2 The Transmission and Distribution Grids

The power grid plays a key role in gaining energy efficiency and the reduction of CO_2, thanks to the operational optimisation they offer, but their architecture must be adapted to achieve such optimisation.

Long distance transmission technology, namely HV-DC (High Voltage Direct Current), is available since many years. The electricity can be transported underground and under the sea without environmental impact. It is possible to transport the energy over several thousand kilometres with low losses. Today this technology is mainly used for hydropower. However, these technologies are also be available for the bulk production of energy and to transport it safely to customers wherever needed. The feasibility studies and long term planning of such a “super grid” should start now. Pilot installations could be developed quickly. Political and economic partnerships, including multilateral agreements with relevant countries in and outside Europe, would be needed.

7.3.3 Grid Flexibility and Reliability

The reliability of the supply of electricity is vital for a modern society. The reliability of the electricity supply and the stability of voltage and frequency are becoming ever more critical.

The present architecture of the grid in Europe has been laid out at a time where power generation was built close to customer centres. It is no longer able to cope with long distance bulk power transmission and fast changing generation and load profiles. There is therefore a need for a fundamental restructuring of the grid.

The distribution system is primarily built for the distribution of electrical power in one direction. In the future, it will have to be ready to collect power from millions of decentralised renewable sources spread over the countries.

Today technologies, namely smart grid solutions (“super grids”), are available to increase the flexibility and the capacity of the transmission and the distribution grid without necessarily increasing the number of transmission lines. Where new lines are needed, they could possibly be laid underground

7.3.4 Transmission and Distribution losses

Overall, the losses in transmission and distribution systems account for 6 to 7.5% of the total electric energy produced. Typical losses are up to 3.5 % in the transmission system and 4.5% in the distribution system. Losses can be reduced by increasing voltages and by reducing and optimising the reactive power transmitted over the grid. Changes in the power line designs can improve the loss situation substantially.

For transformers, the efficiency level shall be increased. For example distribution transformers have an average efficiency level between 98% and 99% depending on the power rating. The efficiency level could be increased by 0.5% to 1% over time by specifying a higher efficiency level standard and replacing old distribution transformers. Therefore the present fleet of transformers should be gradually replaced.

7.3.5 Substations

Modern substation can be built on a much smaller footprint than before and with Gas Insulated Technology these substations can be built invisibly to the public. Smaller substations reduce losses due to smaller footprints. But small gas insulated switchgear enable one to enter cities with much higher voltage connections and thus considerably reduce transmission and distribution losses.

7.4 Estimate of Energy savings potential

In the area of power generation, we can assume that the present fossil fuel power generation plant installed base has an average efficiency of 35 to 40 %. It represents 60% of 3300 TWh generated in EU 25. Thanks to the available technologies, the efficiency can be reasonably increased by 15% through:

- Better maintenance (3 to 4%)
- Renovation and upgrade of the production plant chain (3 to 5%).
- Revamping and accelerated substitution of the oldest part of the park (5 to 9%).
- Each action acting pro quota, thus the objective of reaching 15% increased efficiency looks achievable which gives 3300 TWh * 0.60 * 0.15 ~ 300 TWh saved.

In the area of transmission and distribution (T & D), we can assume the following potentials:

- Increase the voltage levels and improve the conductors where feasible in T&D (0.5 - 1%)
- Reduce the transmission of reactive power (0.5%)
- Upgrade transformers (0.5%)
- The resulting total loss reduction in a EU grid ranges therefore 1.5 to 2%

The primary energy needed to generate 3300 TWh is around 2.6 * 3300 TWh ~ 8500 TWh, assuming the overall conversion efficiency in the EU and a 1.5% loss in T&D.

If the T&D losses are reduced by 1.5 to 2%, then we reduce by 1.5 to 2% the need to burn primary energy. 1.5 to 2% of 8500 TWh corresponds to about 150 TWh.

With the efficiency of generation being improved by 15%, then the impact on the improvement in T&D on the primary energy usage is decreased as well by 15% which provides some 130 TWh additional savings.

The total equation would then be: 300 (PG) + 130(T&D) = 430 TWh which represents an energy savings of approximately 14 %.

The savings will depend to a large extent on the technologies in place and therefore the potential varies significantly between countries, but the order of magnitude should be the same. These savings will be complemented by the impact of renewable energy sources which, from the forecasts presented in the introduction document, will contribute at a level of 4% reduction of the carbon footprint of Europe.

Plans and simulations need to be developed with the electrical utilities industry to confirm these broad assumptions. The efficiency gains that can be derived merit a more in depth collaboration between the institutions, European and national, the electricity utilities industry (Eurelectric) and the technology providers in Electra.

7.5 Issues and barriers to adoption

There are a wide range of barriers to adoption of these recommendations, including:

- High investment, long planning periods and approvals.
- Lack of competition.
- Regulatory flaws.
- Volatile prices and the lack of a stable and predictable legal framework, for example post-Kyoto, unbundling, CCS, hamper investments
- The focus on low procurement costs hinders higher the introduction of greater energy efficiency.
- Current financial or fiscal rules which do not foster early replacement, renovation or retrofitting.

7.6 Policy options to facilitate adoption and investment

The proposed measures will require contribution of all concerned actors including the electrical utilities industry (Eurelectric) which is one of the main stakeholder; we propose as measures and lead initiator the following:

EU institutions

- Foster R&D programmes, technology roadmaps and an innovation policy supporting early demonstration to maintain and create lead customer markets, in particular support the development of dynamic energy storage on a large scale so as to increase the share of renewable energy.

- Provide a stable, predictable and appropriate legislative framework that mobilises market forces and competition to drive innovation.

- Set overall energy efficiency targets for each member state, independent on the given energy mix.

- Enforce the development of a binding roadmap in terms of power plants, power transmission and distribution (new and retrofits) based on an exhaustive inventory of the current environment and a clear target for each Member State. Proper incentives for utilities to invest in efficient technologies should be developed to encourage the closure and replacement of the least efficient power plants and foster the proper maintenance and renovation of the installed base.

- Stimulate smart metering and intelligent power management.

- Encourage the adaptation of the architecture of the Transport & Distribution grids, their interconnections and their management according to a European energy supply scenario (the control of the Union for the Coordination of Transmission of Electricity (UCTE) must be coordinated with a cross border and real time dynamic view). Reduce network losses by increasing the voltage and set rules for power correction factor on transmission and distribution lines.

- Promote and support the deployment of renewable sources and small scale generation plants. Support decentralised renewable installations for houses and buildings with adequate feed-in-tariffs.

- Remove barriers from regional planning and simplify permission processes.

- Develop an incentive regulation rewarding investments, for example improving the quality of the grid, etc...

Member States

- Develop awareness and foster investment in new power engineering competencies to face the forecast growth of the segment.

- Develop stronger incentives notably through more competitive end-user markets and stimulate public-private partnerships (PPPs), inter alia through Structural Funds to deliver leading edge (lighthouse) demonstration projects.

Industry and EU institutions

- Harmonise equipments standard, develop technical references & codes and consider binding procurement rules or implementation measures. Encourage bench-marking and good practices sharing, facilitated by the EU Commission.