Unlocking Energy Efficiency

Management and control is the key

White paper

Schneider Electric™

Summary

Executive Summary

While there are a number of factors influencing the attitudes and opinions towards energy efficiency – most notably the increasing cost of energy and a rising social conscience – it is likely to be legislative drivers that have the greatest impact on changing behaviours and practices. Respective governments internationally are introducing energy-saving targets and effecting regulations to ensure they are met.

Reducing greenhouse gas emissions is a global target set at the Earth Summit in Kyoto in 1997 and finally ratified by 169 countries in December 2006 enabling the Agreement's enactment in February 2005.

Under the Kyoto Protocol, industrialized countries have agreed to reduce their collective emissions of greenhouse gases by 5.2% by 2008-2012 compared to the year 1990 (however, compared to the emissions levels expected by 2012 prior to the Protocol, this limitation represents a 29% cut). The target in Europe is an 8% reduction overall with a target for CO_2 emissions to fall by 20% by 2020.

Of the six greenhouse gases listed by Kyoto, one of the most significant by volume of emissions is carbon dioxide (CO_2) and it is gas that is mainly emitted as a result of electricity generation and use, as well as direct thermal losses in, for example, heating.

Up to 50% of CO_2 emissions attributable to residential and commercial buildings is from electricity consumption. Moreover, as domestic appliances, computers, and entertainment systems proliferate, and other equipment such as air conditioning and ventilation systems increase in use, electricity consumption is rising at a higher rate than other energy usage.

The ability to meet targets by simply persuading people to act differently or deploy new energy-saving or energy-efficient technology is unlikely to succeed. Just considering construction and the built environment, new construction is far less than 2% of existing stock. If newly constructed buildings perform exactly as existing stock, the result by 2020 will be an increase in electricity consumption of 22%. On the other hand, if all new construction has energy consumption of 50% less than existing stock, the result is still an increase of 18%.

In order to reach a fall in consumption of 20% by 2020 the folllowing has to happen:

- All new buildings constructed to consume 50% less energy
- 1 in 10 existing buildings reduce consumption by 30% each year

Significantly, by 2020 in most countries 80% of all buildings will have already been built. The refurbishment of existing building stock and improving energy management is vital in meeting emission-reduction targets. Given that in the west, most buildings have already undergone thermal insulation upgrades such as cavity wall insulation, loft insulation, and glazing, the only potential for further savings is by reducing the amount of energy consumed.

Action on existing built environment will almost certainly become compulsory to meet targets fixed for the coming years.

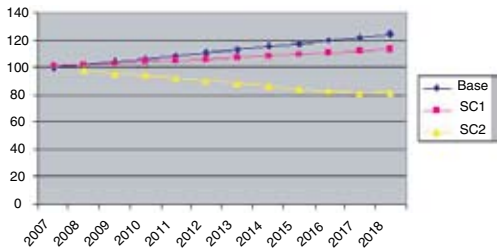
As a result, governments are applying pressure to meet the ambitious targets. It is almost certain that ever more demanding regulations will be enforced to address all energy uses, including existing buildings and, naturally, industry. At the same time, energy prices are rising as natural resources become exhausted and the electrical infrastructure in some countries struggles to cope with increasing demand.

Technology exists to help tackle energy efficiency on many levels from reducing electrical consumption to controlling other energy sources more efficiently. Strong regulatory measures may be required to ensure these technologies are adopted quickly enough to impact on the 2020 targets.

The most important ingredient however, is the ability of those in control of industry, business, and government to concentrate their hearts and minds on making energy efficiency a critical target. Otherwise, it might not be just the Kyoto targets on which the lights go out.

The message to heed is that if those empowered to save energy don't do so willingly now, they will be compelled under legal threat to do so in the future.

Companies such as Schneider Electric have the expertise and experience to provide the very best advice, backed by the latest technology to make savings inexpensively, quickly, and simply. Visit: www.schneider-electric.com



A minimum **renovation of 10% per year** of existing stock is compulsory to reach less 20%

Renovation = **70%** of the savings
New = **30%** of the savings

Purpose

This white paper demonstrates that energy consumption can be lowered by effective control and that such measures can significantly reduce carbon emissions and make a major contribution towards meeting Kyoto targets.

Energy first came into sharp focus during the oil crisis in the 1970s, following which some countries adopted energy policies. However, at that time most measures aimed at addressing building materials, insulation, glazing, and heating efficiency.

Even today, most people think only of lighting control when electrical energy is considered. It also remains true that with a few recent notable exceptions (such as Building Regulations Part L in the UK, and the move towards the European Buildings Directive to rate buildings' CO_2 emissions) most regulations address thermal and insulation issues.

Electricity and energy efficiency delivers a further benefit for industry, business, and government in being perceived by their respective publics as being socially and environmentally responsible. They will achieve lower energy costs too.

Introduction

This white paper explores every aspect of the use of electricity and its impact on the environment. With greenhouse gas emissions in sharp focus around the world, the time has come for everyone to take action to economize on energy use by the intelligent application of technology to bring about energy efficiency.

Economies are readily possible in electricity generation and distribution, in its use and in the way electricity can be used wisely to make efficiencies in the use of other energy. Indeed, the management and control of other primary thermal energy from coal, oil, and gas is also a key to reducing both consumption and emissions.

The technology is available to maximize the effectiveness of electricity and the way in which it is distributed.

The technology is there to control buildings' energy use in lighting, heating, HVAC, building controls, and distribution. Lighting alone can account for 40% of a typical commercial enterprise's electricity consumption. It is also important to consider that passive energy reduction measures, such as installing insulation, can create problems if adequate ventilation is not considered at the same time.

In industry there are proven systems to reduce the power consumed by electric motor systems and to better control the application of electrical power throughout a plant. Two thirds of electrical energy used by industry is used powering motors. In most countries, less than 10% of those motors have any kind of control and therefore cannot be slowed down or switched off automatically.

In the home, new products enable lighting and heating controls that enhance living standards yet save electricity. In most countries, every single domestic dwelling (including individual apartments) contributes about 6.5 tonnes of CO_2 each year - or, to put it another way, enough gas to fill six hot-air balloons!

Yet just switching off lights in unoccupied rooms could save 2.2 tonnes per household.

In short, there is no reason not to be able to save electricity and other energy, provided there is the understanding of what is at stake, together with the desire to do something about it.

Electrical energy usage

World energy consumption is projected to rise 30% by 2020 according to Enerdata's latest predictions from May 2007. Electricity consumed in 2005 was estimated at 18 140 TWh with 67% of that capacity produced by coal, oil, and gas power stations.

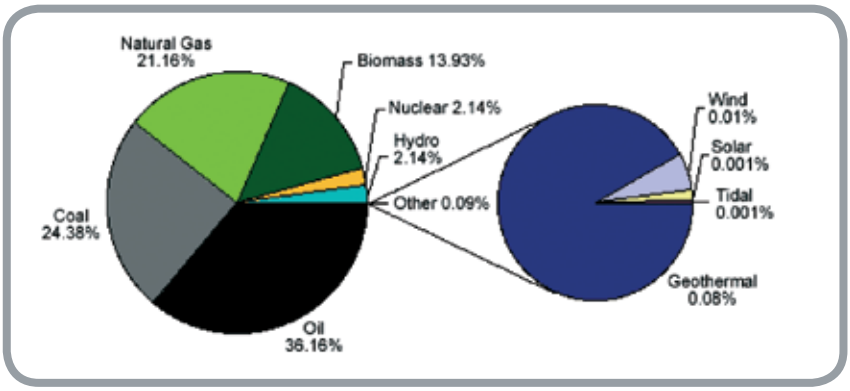
It is clear that electrical energy consumption will rise over the coming decades if no action is taken to economize. This is particularly true in third-world and emerging economies where not only is the use of new electrical equipment growing, but much of the populations of certain regions currently without electricity supplies will subsequently get them.

In offices, the explosion of information technology has seen huge increases in electrical consumption, as has the preference for air conditioning systems. The prolific growth of data centres and new industries has also contributed to a dramatic rise in electrical power usage.

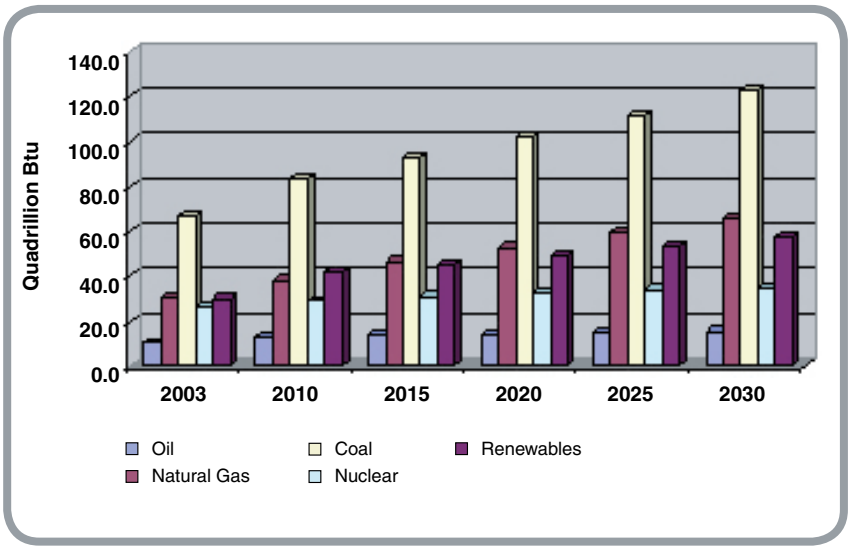
In industry, automation and the use of electrical power as well as inefficient hydraulic and pneumatic systems have grown.

In the home, computers, multiple televisions sets, modern electrical appliances, air conditioning, and even outside lighting and powered equipment have seen an exponential growth in consumption. Indeed, in many western economies, domestic electricity consumption outstrips even industrial use.

It would be hard for most people to imagine a life without electricity, but that does not mean consumption cannot be controlled.



World energy consumption figures demonstrate global reliance on primary fossil fuels



Electricity's Role in Energy

Electricity generation and distribution

The debate about how electricity is generated continues to rage and there are strong arguments for all the technologies that can be deployed. The greatest impact on carbon reduction would be to see an end to the use of fossil fuels in electricity generation. However, in developing countries, coal, oil, and gas powered stations remain the most economical. Nuclear power still attracts negative lobbies, but has been shown to be a clean, reliable source of power. Of the renewable energy technologies, hydroelectric generation is a significant contributor where such opportunities exist, while in Europe wind-powered electricity generation is accelerating.

From a consumption perspective, one of the areas in which utility companies can make a contribution is in the efficiency of both their generating systems and their distribution infrastructure. Higher voltage transmission helps - for example, the UK retains an 11kV supply whereas most developed countries have adopted a 22kV network - but low-loss transformer technology also needs to be deployed more extensively.

In power generation, better monitoring and control can lead to leaner burning stations. Equipment powered by electric motors can have speed controls fitted to reduce energy consumption. Equipment maintenance and upgrading can also improve efficiency.

2002 GWh	BE	CZ	DK	DE	EE	GR	ES	FR	IE	IT	CY	LV	LT
TOTAL	**83190**	**75699**	**39269**	**576385**	**8526**	**55271**	**249429**	**565463**	**25547**	**292144**	**3785**	**3975**	**18148**
Nuclear	47360	18738		164842			63016	436760		0			14142
Conventional Thermal	31500	54265	31858	355395	8490	50494	145001	53144	23461	228702	3785	1491	2794
Pumped Storage	1130	353		4740		663	3350	5320	352	7743			427
Renewables	3200	2343	7411	51408	36	4114	38062	70239	1734	55699	0	2484	785
of which:													
Hydro*	1488	2845	32	27864	6	3463	26388	66456	1264	47262		2463	781
Geothermal										4662			
Wind	57		4877	15856		651	8704	268	388	1404	0	11	
Biomass	1655	498	2502	7688	30		2970	3515	82	2371		10	4
Conventional Thermal	31500	54265	31858	355395	8490	50494	145001	53144	23461	228702	3785	1491	2794
Coal	10029	50005	18257	284545	7748	34566	81182	21179	8893	35447		38	0
Oil	972	384	4011	4342	29	8633	28593	4522	3738	87767	3785	139	547
Gas	20999	3685	9590	61060	713	7061	33661	27437	10830	104435		1314	2109
Others	0	191	0	5448	0	234	1565	6	0	1053	0	0	138

2002 GWh	LU	HU	MT	NL	AT	PL	PT	SI	SK	FI	SE	UK	EU-25
TOTAL	**4556**	**36157**	**1987**	**95965**	**64552**	**145753**	**46468**	**14786**	**32642**	**74899**	**146768**	**390158**	**3051522**
Nuclear		13953		3915				5528	17953	22295	68111	87848	964461
Conventional Thermal	2595	21937	1987	88030	18704	139732	35658	5656	8991	32024	7292	285678	1638664
Pumped Storage	881				2073	1627	457		215		35	2652	32018
Renewables	1080	267	0	4020	43775	4394	10353	3602	5483	20580	71330	13980	416379
of which:													
Hydro*	994	194		108	42004	3906	8257	3404	5483	10776	66395	7439	329272
Geothermal								96					4758
Wind	25		0	910	203	61	362			64	608	1256	35705
Biomass	61	73		3002	1568	427	1734	102		9740	4327	5285	47644
Conventional Thermal	2595	21937	1987	88030	18704	139732	35658	5656	8991	32024	7292	285678	1638664
Coal		8983	0	23936	6614	132953	15212	5302	5155	19059	2357	124297	895757
Oil	0	2137	1987	2819	1314	2377	11407	66	704	601	3089	7108	181071
Gas	2593	10820		59948	10464	3938	9037	288	2932	11974	1669	153931	550488
Others	2	-3	0	1327	312	464	2	0	200	390	177	342	11848

Source: Eurostat

European Union: Gross Electricity Generation

** Note: Does not include pumped storage presented above*

In distribution, losses through transformers and checks on the integrity of the cabling can make savings. Judicious sizing of transformers can also maximize the available capacity to the consumers.

In fact, the consumption from the generation and transport of electricity are generally three times the primary energy actually consumed. Due to the efficiency of the whole chain, saving one unit of electricity in a home or business obviates the consumption of three times that amount of primary energy at a power plant (this is true of oil, gas, or coal). One unit of electricity saved by an end user triples the benefit - and this is true of all thermal energy!

However, because the issues affecting power generation are still to be resolved nationally, regionally, and internationally, the primary target remains the quest to conserve what electricity we currently produce and reduce consumption wherever possible.

Member State	Consumption GWh
Austria	56.971
Belgium	86.546
Czech Republic	59.893
Germany	541.003
Denmark	35.210
Estonia	6.581
Spain	238.443
Finland	84.646
France	464.757
United Kingdom	348.560
Greece	53.585
Hungary	38.418
Ireland	25.068
Italy	320.659
Lithuania	9.465
Luxembourg	6.188
Latvia	6.337
Netherlands	109.564
Poland	138.310
Portugal	46.824
Sweden	144.956
Slovenia	13.046
Slovak Republic	26.384
EU TOTAL	2.861.414

Internal Electricity Consumption in Europe 2003 (GWh)

Sources: ETSO, UCTE online data for 2003, Nordel annual report 2003. Figures are representative of the 100% internal consumption, comprehensive of losses and pumped storage power.

Energy efficiency

Responsible equipment manufacturers are continually developing more efficient products. However, while for the most part the efficiency of the equipment is a fair representation of its energy-saving potential - say, in the example of a domestic washing machine or refrigerator - it is not always the case in industrial and commercial equipment.

In many cases the overall energy performance of the system is what really counts. Put simply, if an energy-saving device is left permanently on stand-by it can be less efficient than a higher consuming device that is always switched off when not in use.

It is also important that all the elements in a system combine to bring about the maximum energy efficiency possible. For example, it is well understood that energy efficient (Eff-1) AC electric motors save significant amounts of energy. Some argue that such efficient motors are more expensive, but the purchase price of such equipment is a very small part of the true costs. For example, the lifetime energy cost in running an Eff-1 or lower rated AC motor is often 100 times its purchase price over a lifetime expectancy of 13 years (average). An 11kW motor costing perhaps 400 euros to buy can consume in its lifetime up to 80 000 euros at current electricity prices.

But, once coupled with a variable-speed drive (AC inverter), savings can be multiplied many fold. Indeed, savings are typically three times greater for a high-efficiency motor fitted with a VSD rather than using ordinary fixed-speed starters.

Adopting Eff-1 motors can be considered a passive response to energy efficiency, while using VSDs represents an active approach.

Whatever the scenario, maximum energy efficiency comes from taking a view of the complete picture.

Managing energy with electricity

Managing energy is the key to maximizing its usefulness and economizing on its waste. While there are increasing numbers of products that are now more energy efficient than their predecessors, controlling, switching, or reducing settings of variables such as temperature or speed makes the greatest impact.

It is not just by reducing electricity consumption that savings can be made. In fact, the judicious use of electricity in controlling other energy can bring huge reductions in the use of fossil fuels, gas, and fluid power such as hydraulics and compressed air.

The key to controlling energy is the use of technology.

In commerce, it is estimated that as much as 90% of all building controls currently in use are deficient when it comes to energy efficiency.

In industry, some 90% or more of all AC electric motors are totally uncontrolled. In the home, simple lighting controls, energy saving lamps and better heating controls can all be installed quickly, simply, and cheaply.

In industry and commerce it is not just the equipment that is powered by electricity that presents opportunities for better management. Power quality issues, such as improving a site's power factor can make substantial savings. Energy auditing can enable more power to be usefully deployed from existing infrastructure - overcoming the need for additional capacity in many instances.

For most commercial and industrial consumers there is a lack of understanding of how power is used, coupled with general ignorance of what technologies are available to manage and save energy. Equally true is the failure to realize that other energy consumption can be reduced by using electrical control technology. Apart from building management systems, there are also advanced heating, ventilating, and air conditioning controllers, boiler controls, and even lift drive systems that can all contribute to maximizing efficiency. Energy audits by qualified experts, however, are readily available. What is needed is the will to undertake such auditing.

In the home, most people are aware of energy saving lamps, but figures from most countries suggest that only a small proportion of people use them. Most people do not realize that simple but effective control equipment is available or affordable.

The challenge is therefore to build a better general understanding among people about what can be achieved and how to achieve it.

Managing energy in commerce

There are three areas to be addressed in commercial energy use:
- The planning of energy-efficient buildings and systems in new developments
- The refurbishment of existing buildings and systems to make them more energy efficient
- The use of buildings; and the energy-saving regimes of the owners, tenants, or occupiers

There is evidence that new projects are being designed with energy efficiency in mind. Some of this comes from the initiatives of architects, building services engineers, and building owners. To an increasing extent, particularly where large corporations are likely to take tenancy of the building, there is a requirement from the occupiers - who want to exercise corporate governance over environmental issues.

The extent to which such stakeholders understand energy management and efficiency is variable - some know a great deal, others know very little. It is beholden on equipment and building management systems manufacturers to partner closely with those responsible for the building's energy and infrastructure control.

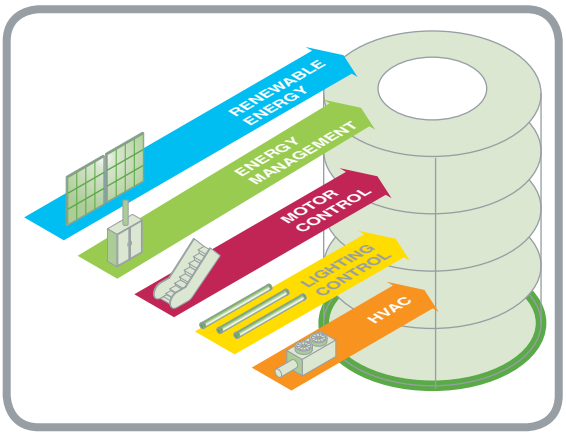
In building refurbishment there is the challenge of communicating what is possible. Much attention is usually applied to glazing and insulation in such projects, but energy control and management must also rank high on the agenda if the modernized building is to satisfy its potential for energy efficiency. Retrofittable electrical and building management systems can be easily implemented during refurbishment projects, but the stakeholders, such as building services engineers and facilities managers, must understand what can be done.

Occupiers of buildings often believe they have little or no control over the infrastructure of that building. Yet there are some simple steps that can be taken to understand their energy consumption and reduce usage. One factor that appears to be a general impediment is the lack of understanding as to where energy is used and when. Here, simple metering can provide a wealth of data that can bring about easy changes and huge energy reductions. Heating, ventilating, and lighting unoccupied areas is very common. Uncontrolled external lighting and lighting internal spaces even when there is adequate daylight are also frequently encountered.

Once identified, excessive or unnecessary energy use is easily alleviated by simple controls or a more disciplined behaviour among the occupants of the building. Again, this is an area requiring a change in the hearts and minds of those in charge of businesses.

Buildings

Renovation can yield up to 30% of energy savings

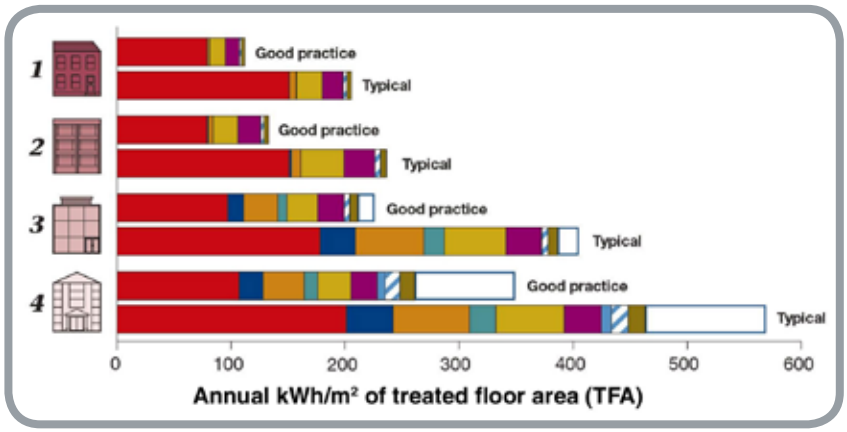


Consume 20 % of total energy

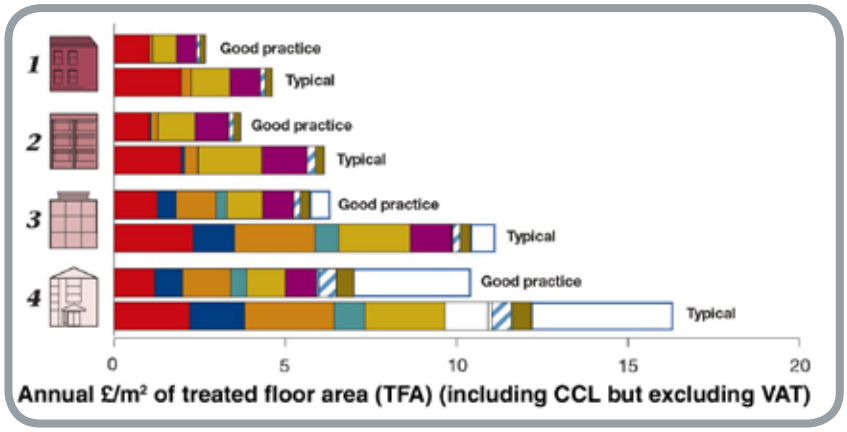
3 Key areas: HVAC, lighting, & integrated building solutions

Motors consume 35%+ of electricity

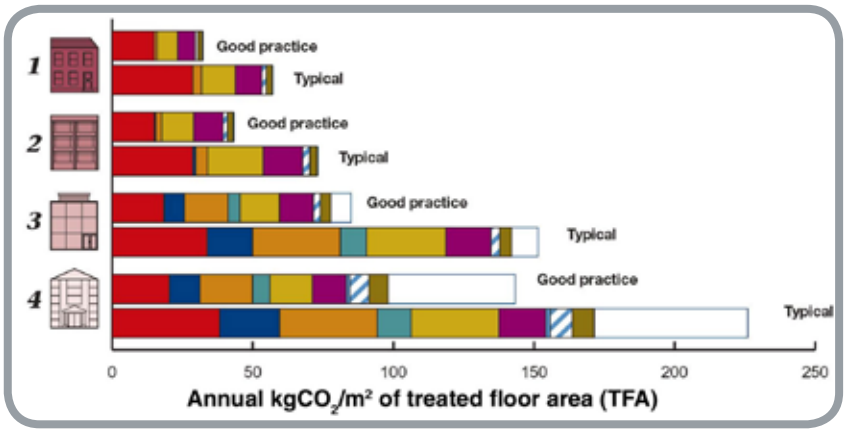
The diagram below shows figures for office buildings produced by the Carbon Trust in the UK. This data highlights a summary of energy usage that has parallels throughout the developed world. The potential for savings is immense.



Energy use indices (EUIs) for good practice and typical examples of the four office types



Energy cost indices (ECIs) for good practice and typical examples of the four office types



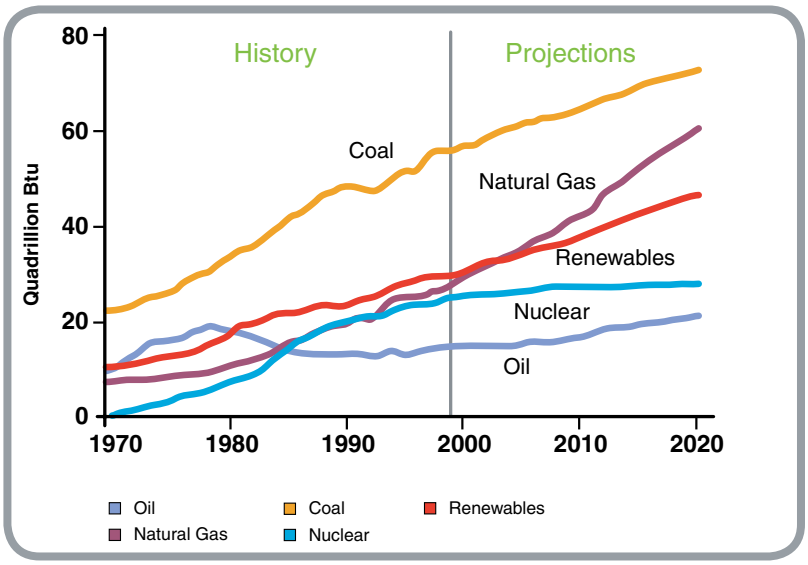
Carbon dioxide emission indices (CEIs) for good practice and typical examples of the four office types

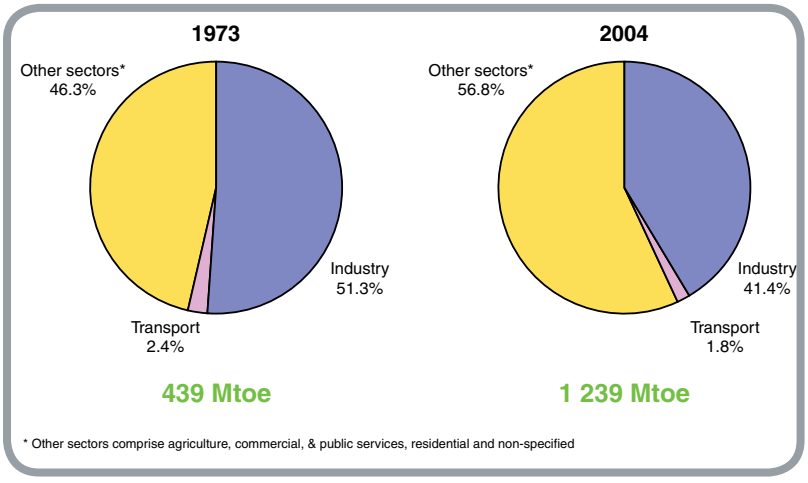
Managing energy in industry

Energy-intensive industries such as metals manufacturing, glass and plastics processing, and food and beverage production understand the need for energy management because their processes involve great amounts of heat. These businesses have traditionally sought ways to maximize their return on investment from the energy used in their primary processes. However, even these energy-aware businesses often fail to realize how much more can be saved through building controls and a company-wide energy policy.

All industries can benefit from energy policy, but it must extend beyond the production environment and into every aspect of the sites. Offices, for example, stand to save just as much as in the commercial sector.

While in many countries industrial energy use has now been slightly outweighed by that consumed by commercial and residential buildings, it is a fact that industry consumes huge amounts of electrical power. About two thirds of that is typically consumed powering electric motors. Of these, an overwhelming majority can be made significantly more energy efficient by controlling their switching on and off or by controlling their speed.





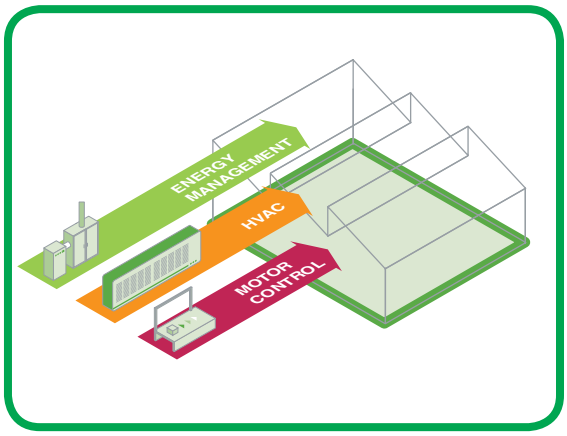
This is a relatively simple task of equipment retrofitting, yet it is clear that most manufacturing and process plants fail to take the step. The reason is often because those that control the costs of an industrial operation are not communicating with those charged with the management of the production processes.

For example, if a painting plant uses hundreds of AC motors on fans, pumps, and compressors (continuous duty applications) it could readily benefit from the use of variable-speed drives. However, while the plant manager, as an engineer, understands this, he or she is invariably responsible only for improving productivity or output and not for the overhead costs. Higher management is concerned with paying the overheads but remains unaware that such a saving could be made because it is never on the agenda in engineering meetings.

In industry, senior management and plant engineers must learn to talk if comprehensive energy efficiency is to be achieved. In no other sector is the communication gap wider than between those charged with making energy decisions in industry, and those who actually know how energy can be saved.

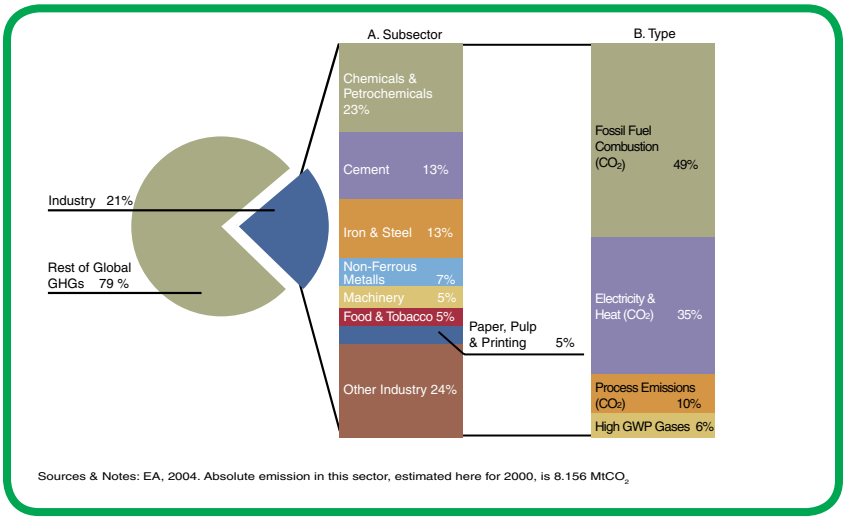
Industry & infrastructure

Average facility can reduce consumption by 10 to 20%



A 25% savings would save 7% of the world electricity

The largest consumer, motors account for over 60% of electricity usage



GHGs from Industry

Managing energy in residential properties

The residential sector breaks down into three distinct areas as far as electrical energy efficiency is concerned:

- Private home owners/tenants
- Builders/architects/developers
- Public and residential social housing

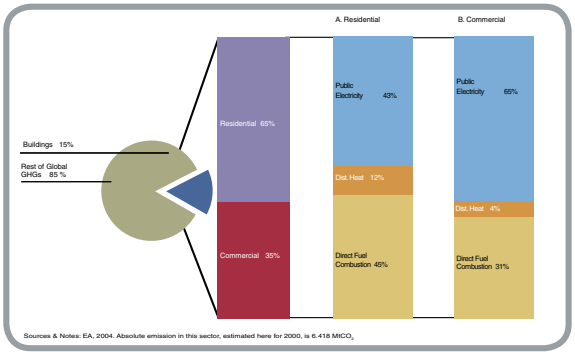
Private occupiers of houses and apartments represent the market 'pull through' on electrical energy efficiency. This group makes its own decisions on whether or not to buy energy efficient lamps and tubes, or to install lighting controls and so forth.

Home buyers and tenants will become an increasingly influential group if people begin to demand energy-efficient homes or houses with better controls. Until such time, the quest is to ensure that the public is informed as to where technology can play a part in saving energy.

Builders, architects, and surveyors have a direct influence on the electrical energy efficiency of the dwellings they build. However, as in the commercial sector, most attention has focused on thermal measures such as insulation and glazing. In most regions, builders will only invest in features within their properties that will enable them to sell or be rented quickly. Hence, the greatest investment in enhanced living tends to be the installation of luxury kitchens and bathrooms, rather than in practical energy efficiency systems. This group needs to understand that if presented to the public attractively, the benefits of, for example, zone or occupancy lighting controls can be great.

Those responsible for the building and refurbishment of social residential housing should, one might expect, be aware of electrical energy efficiency. However, again there appears to be widespread lack of knowledge of the controls available and the relatively low cost of installing them.

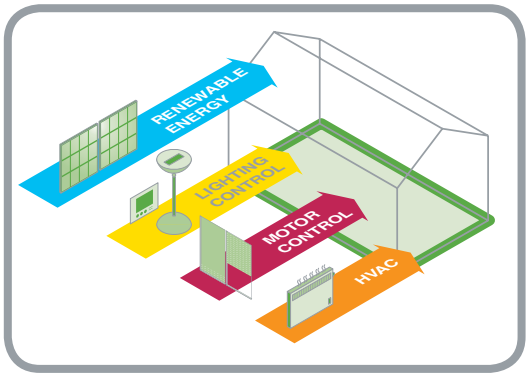
In all cases in the residential sector, the need for builders, landlords and tenants to understand all the ramifications of electrical energy efficiency is a priority, if targets for emissions reductions from the sector are to be realized.



CO_2 from Building use

Residential

Energy Efficiency products may save 10 to 40% in electricity



20 to 25% of the consumed energy (EU & US)

Heating is 30% of energy usage

Lighting & appliances are over 40%

Energy efficiency in the public sector

Given that governments are driving energy efficiency measures forward, one can imagine that the public sector must be leading by example. Within the public sector are schools, colleges, hospitals and health estates, police, military, and both national and local government. One might imagine that this sector above all others is energy astute and efficiency aware. This is rarely true.

While public buildings are an obvious demonstration for the public to see its authorities putting into practice what they preach, this is rarely the case. Again, this is largely because of a lack of understanding of what can be achieved and how much it costs - budgets are frequently the excuses given for lack of action in the public sector.

For example, attention is often paid to heating and thermal management, but lighting is ignored. Outside, car parks are maintained, but lit for far longer than necessary.

In many large public buildings there is enormous scope for intelligent building controls that can impact substantially on energy consumption. This is particularly true in hospitals, schools, and colleges - all of which have many areas unoccupied for example at any given time.

Depending on the country or region, the spheres of influence in energy efficiency decision-making can be highly complicated and often disjointed. The need is for a coherent and holistic understanding by all the stakeholders in the public building sector to understand the broadest possibilities for electrical energy conservation and management.

Conclusions

There is not a single person that can afford to ignore the potential for saving energy - particularly electrical energy.

There is no option; if individuals, organizations and management do not act now, they will be forced to act with no control over timescales or requirements. The fact is that there is available expertise through the likes of Schneider Electric™ and there are easily affordable technology investments that can be made simply and payback quickly.

In most cases however, there is still the battle to win the hearts and minds of people to focus on energy and think about it differently.

Few people fully appreciate how much energy they use, how and where they use it, and how much they actually need. This is possibly even truer of those in industry and commerce than for the general public.

In many cases there is a lack of understanding about how energy can be managed and how energy efficiency can be achieved.

Those with the expertise, experience, knowledge, and technology must concentrate their efforts on educating, informing, influencing, and persuading people to conserve electrical energy. Everybody's future depends on it.

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