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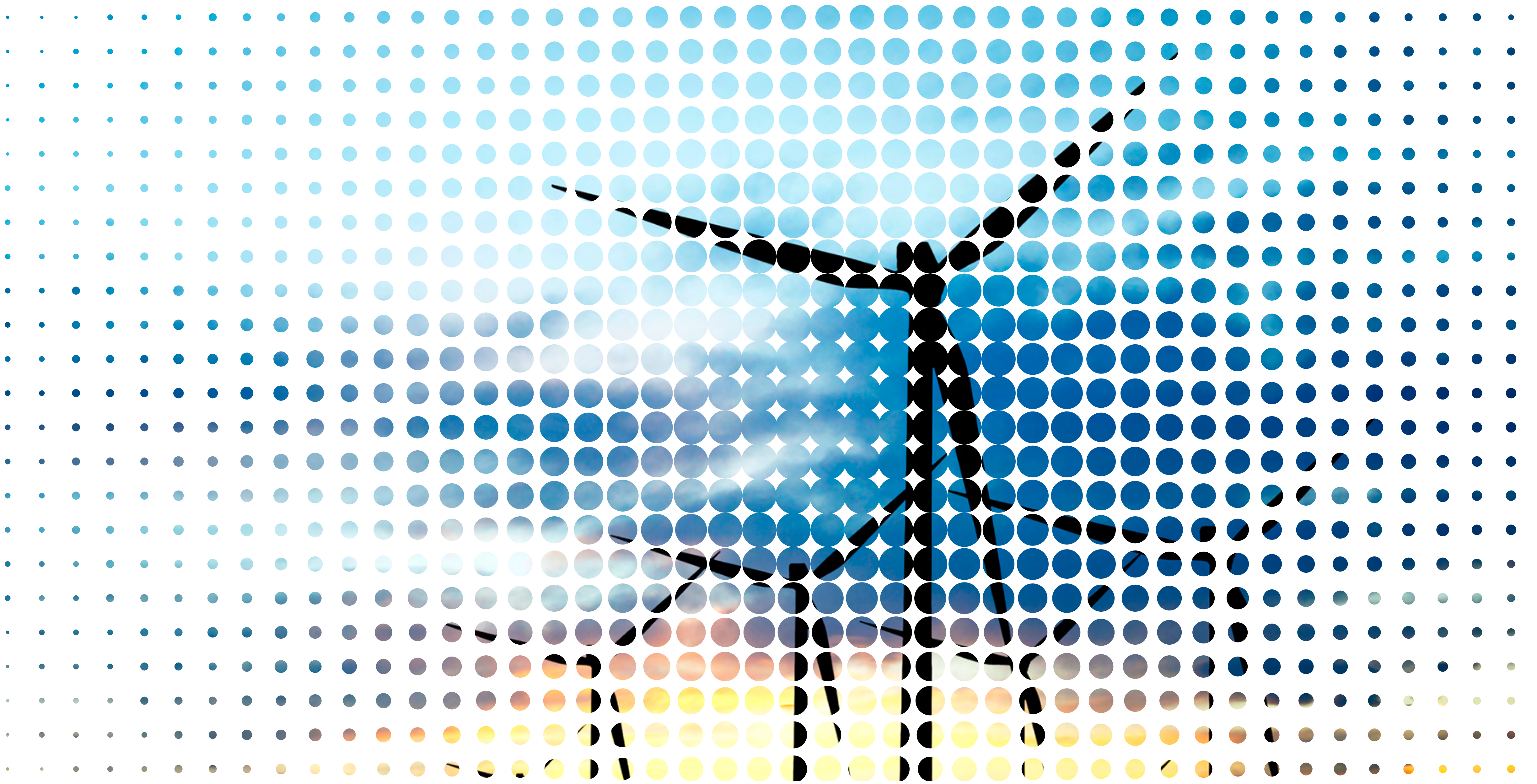
SMART LIGHTING ENGINEERING



ENERGY SAVING

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INTRODUCTION

We must fight for a sustainable future through cooperation on an individual and professional level.

The term ‘energy saving’ has entered our everyday vocabulary due to the ever-present personal and economic strain of increasing energy prices and collective anxiety about the environmental consequences of energy production. Only part of an overall solution, the effort to reduce energy consumption has become a key topic on a global scale as one of the most accessible and viable ways by which we can positively influence energy consumption and environmental impact now. Although that drive has been a cornerstone of the lighting industry for many years, it is vital to realise that the only way to achieve the necessary goal of an efficient and sustainable future is to take a truly holistic approach that involves open minds and extensive cross-industry cooperation.

CONTENT

We cannot stop population growth and we do not want to stop economic growth, but we must do all we can to control the negative environmental impacts of both.

THE GLOBAL ENERGY SCENE

Energy consumption continues to grow rapidly worldwide, a trend that will only escalate in future. According to studies by the International Energy Agency, general consumption will increase 30 % by 2035 from what is was in 2011, with electricity consumption specifically increasing more than 60 % within the same timeframe.

The key drivers behind this growing demand for energy are population and economic growth. It is estimated that, by 2035, the global population will have risen to an astounding 8.7 billion, while researchers expect a considerable GDP growth, especially in emerging economies. What this means in basic terms is more people, buildings, industry, transport and manufacture, all of which will need energy. To cover this escalating demand we will need more energy resources. However, as we know, primary energy resources are rapidly depleting and renewables, although more technologically and financially viable than before, are simply not ready to take over on a large enough scale to cover requirements for several decades yet.

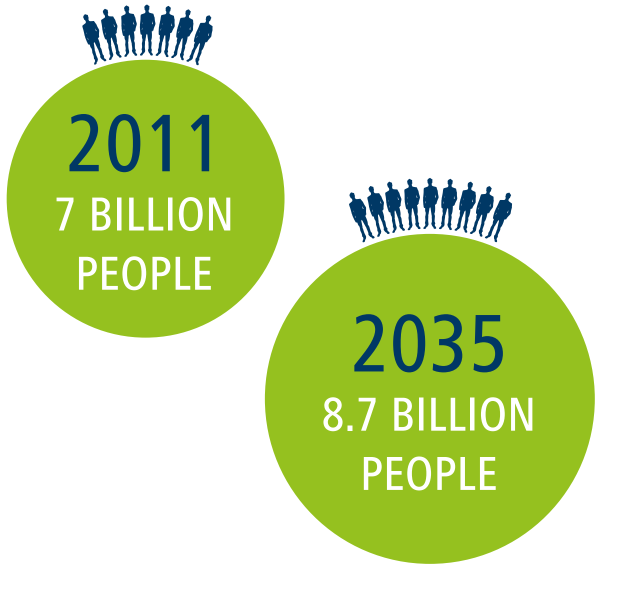


Figure 1
The global population is growing and will continue to do so rapidly

Yet, this is not the whole story. Energy production accounts for two thirds of all CO_2 emissions, and as energy consumption increases so does the amount of resultant pollution we release into our already overloaded atmosphere. The majority of that increase comes from emerging economies, especially non-OECD countries that will continue to depend on coal, oil and gas for energy far into the future. Fortunately, as energy production from primary resources becomes cleaner and renewables take a stronger hold in the global energy market, CO_2 emissions will not increase at the same rate as energy usage. However, this does not lessen the necessity to take swift and appropriate action to limit and control both the production of greenhouse gases and their all too familiar negative effects.

As the primary source of CO_2 emissions, the energy sector plays a pivotal role in determining whether or not global climate change goals are achieved, making it vital that every government make environmental and energy policies that work towards a greener future and that consumers adhere to them. We cannot and should not stop economic growth, but we must act to counteract the destructive impact it has on the environment. Currently, in this context, the best tool for this is energy saving.

Cleaner energy production from non-renewable resources in combination with the use of renewables will help to control the increase in CO_2 emissions but cannot stop it, making it necessary to do all we can to reduce the amount of energy we use.

THE BUILT ENVIRONMENT

Our built environment accounts for the majority of energy consumed, more than either transportation or industry. Energy is needed for heating, cooling, the powering of appliances and provision of lighting. It is estimated that lighting uses 35 % of a building's energy on average, with an additional 4–5 % being used to remove the heat emitted by that lighting. This makes the combined optimisation of lighting and HVAC systems a key tool by which to reduce the energy consumption of the built environment.

Our built environment accounts for 40 % of overall energy consumption and 33 % of CO_2 emissions. By broadly utilising new and more effective technologies, we could achieve a 28 % reduction in the amount of energy used by the built environment of the EU28. That is equal to 11 % of overall consumption.

SAVING ENERGY

Saving energy is not as complicated as we may think, if only we approach it in the right way. Technological advancements in almost every area of our lives means we can find more effective and efficient solutions for everything around us that consumes or influences the consumption of energy. This requires higher general levels of education about technologies, their use and the idea of individual responsibility in saving energy.

The first step, and possibly the most difficult, is to change how we think. Energy is not something we can take for granted. We are used to having light when we press the switch on the wall and heat when we turn on the radiator. However, these comforts must be powered, and only by thinking about and taking seriously the whole process that leads to the provision of that light or heat can we begin to make effective and lasting changes to our behaviour.

One of the easiest and most effective methods by which to save energy is to make small behavioural changes such as making it habit to turn off lighting and appliances when we do not need them. Next, we can opt to buy more efficient devices such as light sources and appliances, which are more expensive to purchase, but easily compensate for that with the amount of energy and money they save. Then we can think about the insulation of buildings and the fitting of better quality windows, doors and shading devices. Of course, all of these things we can do with or without professional advice and assistance, but we are assured of the most effective results when we consult the experts. Furthermore, the greatest savings can be made in cooperation with those professionals who take a holistic approach to energy and its provision to all building services, because, in reality, everything is connected.

In a building, and on a larger scale in a city, every system is connected and influences the others. To illustrate this, we can look at a simple example: solar shading. What most of us will think of here are the blinds or shutters we use to block the sun when it is too strong. However when we think of it in terms of energy we start to see a different picture. Blinds and shutters control the penetration of sunlight into a room and modify the light distribution of that which still enters. This affects both heat gain and lighting conditions and, as a result, the need to heat or cool the room and the provision of lighting. This means that the blinds or shutters are immediately connected to two other systems, HVAC and lighting. We could even add another system here, a building automation system. In specific terms, shading here affects the air conditioning and lighting requirements of the room and, therefore, the energy consumption required to ensure that the room is comfortable. A carefully designed building automation system can adapt all systems in connection with each other to ensure an optimised state at all times. By taking all systems into account in the design of a building it is possible to save not only consumption but also investments costs, as we will know exactly what is needed and what is not.

OMS Lighting is an expert in the provision of interior and exterior lighting solutions that are designed to work in harmony with other building systems to provide optimised energy usage. We consistently strive to raise awareness of the fact that good lighting design and consultancy does not stop at lighting alone.

We can find more effective and efficient solutions for everything around us that consumes or influences the consumption of energy.

It could be argued that the most important building service is lighting as 80 % of our perception of the world around us is visual and light has a profound impact on our physiological and psychological wellbeing. It, therefore, comes as no surprise that it uses a significant proportion of the energy consumed in our built environment. We need artificial lighting in our homes, workplaces and public spaces and on our roads. It is an inevitable need in a modern world where human activity continues regardless of the availability of sunlight. To operate artificial lighting we need energy, the majority of which is still supplied from non-renewable energy resource production, which is neither good for the environment or the budget. The drive to reduce energy consumption and dependence on fossil fuels cannot be undervalued. That drive currently has a particular focus on lighting, among other areas, as lighting offers some of the easiest to implement, affordable and effective ways to save energy.

The greatest energy savings can be made from combining the most effective light source and luminaire technologies with some kind of system control. Many current lighting systems use out-dated and ineffective technologies that not only consume a lot of energy, but also cannot provide satisfactory light. If you have such an installation, there is a huge potential just waiting to be taken advantage of. By choosing to upgrade your lighting with LED luminaires you can immediately make savings of up to 60 % based on installed power, from which an additional 40 % can be saved based on the incorporation of a suitable Lighting Management System (LMS). The potential to save more than 80 % of the energy consumed is not only appealing but provides viable payback times as well as contributing to the achievement of building ecology targets.

If you are wondering how it is possible to achieve such savings, all you need to do is take a closer look at the technologies used and understand the difference between a controlled LED-based lighting system and a conventional one.

The use of modern lighting technologies is one of the easiest, most financially viable and effective ways by which to save energy.

LIGHT SOURCE

The history of lighting started with fire. Then came artificial light in the form of the incandescent bulb, followed by various types of discharge lamp such as sodium and fluorescent lamps. Now, LED is rapidly taking over as the light source of choice. The future of lighting clearly belongs to LED and their efficacy is now in the same range as the most efficient conventional light sources with a great potential for improvement. However, the true savings come when we compare system efficacy and not only light source efficacy, and here too there is great room for improvement, with LED-based technologies constantly becoming better and better. Conventional technologies simply do not have the potential that LED does as many of them have reached the end of the development cycle and have little left to offer besides improved version of old ideas. LED is still a relatively young technology in terms of how long it has been seriously under development. Although the life of LED started several decades ago, it was only in the last few years that breakthroughs led to the technology we now know that can bring many benefits both in terms of energy saving and other environmental considerations.

- LEDs radiate very little heat, which when compared to conventional light sources, drastically reduces the cooling load of a lighting system. This in turn reduces the amount of air conditioning required to maintain comfortable temperatures and, as a result, indirectly reduces energy consumption. It also means that smaller and/or simpler HVAC systems are needed, which reduces associated investment and maintenance costs. It is also appropriate to mention here that the amount of energy required to cool a room is much higher than that needed to heat it, so it is especially beneficial to reduce heat gain generated by light sources and leave the heating to more effective and efficient systems.

- LEDs contain negligible amounts of hazardous material and contrary to most conventional light sources, no mercury at all. Mercury is the most dangerous component of light sources in terms of its effects on human health and the environment, but has, up until now, been impossible to replace by an alternative and safer material in those technologies that require its properties.

- LEDs have very long lifetimes, up to 100,000 hours. This minimises the environmental impact of both their production and disposal and reduces replacement and maintenance costs, as the light sources need replacing very rarely.

- Last but not least, LEDs are very small, an often underestimated feature. This reduces environmental impact because less material needs to be used in the production of the LEDs themselves and the luminaires that house them. Furthermore, smaller luminaires result in lower building and investment costs if factored into a building design from the very beginning.

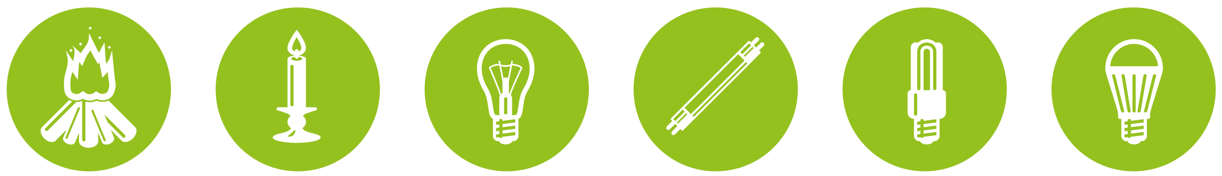
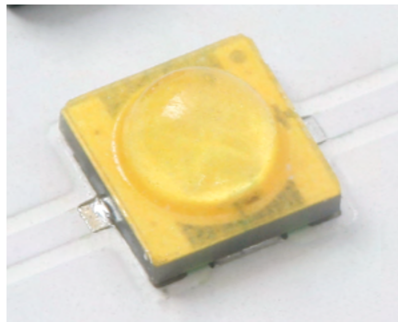


Figure 2
Theevolution of light sources

Figure 3
By comparing the many properties of light sources, we can make informed decisions about which is best for our needs

Light source	incan-descent	halogen	CFL	fluo-rescent tube T8	fluo-rescent tube T5	mercury vapour	metal-halide	high-pressure sodium	low-pressure sodium	com-mercial white LED	labo-ratory white LED	com-mercial OLED	2018 esti-mated OLED
Light source input power range [W]	25–100	10–100	5–80	18–58	14–80	100–400	50–2000	35–1000	18–180	up to 450	wide	wide	wide
Lumen output range [lm]	300-1400	150–2500	200–6000	1300–5400	1300–7000	4200–21,000	4000-220,000	3500–130,000	1800–32,000	up to 50,000	wide	wide	wide
Lifetime [hours]	1000	1000–2000	10k-20k	15k–45k	20k–45k	15k–24k	6k–20k	10k–40k	18k	100k+	100k+	15k	40k
CRI	100	100	80–90	70-98	80–98	20–50	60–93	25–70	>20	60-97	97+	90+	95+
CCT range [K]	2700	2700–3500	2700–6500	2700–6500	2700–6500	3500–6000	2700–6700	1800–2100	1800	2500–10,000	2500–10,000	2500–10,000	2500–10,000
Other important properties	high IR radiation	high IR radiation	contains mercury	contains mercury	contains mercury	contains mercury	contains mercury	long heat-up delay	monochro-matic light	sensitive to overheating		flexible, transparent, thin	
System efficacy in luminaire [lm/W]	5–10	10–25	30–60	30–80	40–90	15–30	40–90	70–110	90–130	123	200	55	120



LEDs already offer substantial energy savings as well as improved light properties such as colour rendition and light colour temperature, but technology continues to advance rapidly, with research and development taking place on a large scale. One technology that is particularly interesting is the AC LED. The light source itself operates on the same principles as standard DC current driven LEDs. The difference lays in the fact that DC LEDs require an LED driver to convert mains AC supply to DC whereas AC LEDs can be driven directly from the mains current, negating the need for an LED driver and removing associated losses, resulting in a more effective and efficient light source.

Another area of interest is OLED (Organic Light Emitting Diode). OLEDs have an organic electroluminescent layer that emits light when an electrical current passes through it between two electrodes. OLED is advantageous because the light is emitted evenly across a large surface rather than from small and bright pinpoints like standard LEDs. This results in lower glare levels and less concentrated heat output, which means heatsinks can be smaller or omitted altogether. These properties make OLED more flexible than standard LED and opens up new avenues in luminaire design. However, OLED is still not widely used as their efficacy is lower but expected catch up within a few years.

LUMINAIRE AND OPTICAL SYSTEM

However, a sustainable lighting system is not only about choosing an efficient and ecologically sound light source. The system must be a whole solution, with the choice of light source being only the first step. The second step is the choice of luminaire. The seemingly unimportant details of a luminaire design can have a profound impact on its effectiveness and, therefore, on the efficiency of the lighting solution. As already stated, the future of lighting belongs to LED, the development of which is heading in two distinct directions. First is that of retrofit technologies that use LEDs in conventionally shaped and sized devices that can be used to replace conventional light sources. For example, the LED 'light bulb' that can be used in a light fitting designed for use with incandescent bulbs. These are suitable for domestic application where most light fittings use standard sockets, such as the E27. Retrofits are not, however, suitable for larger-scale or industrial use, as their light distribution does not match the luminaire optics designed for the light distribution of a conventional light source. The second direction of LED development is that of LED specific luminaires that have optical systems designed to utilise the light distribution properties of LED light sources. LEDs emit light in a very direct manner, which when suitably controlled results in 100 % of the emitted light being directed to where it is needed, an optical effectiveness impossible with conventional technologies. Furthermore, LED luminaires are designed to take into account all the needs of LED light sources, including their thermal requirements, which are vital in ensuring the optimal output and lifetime of the light source.

To demonstrate the difference between retrofits and properly designed LED luminaires, let`s look at an 'LED tube' designed to substitute a fluorescent tube in its luminaire. Fluorescent tubes radiate light 360° along their whole length. The luminaires designed for them utilise the light falling on the optical parts, forming an engineered light distribution. If we change the fluorescent tube for an LED one, we do not use the luminaire's optical system at all and are limited to the light distribution characteristic of the LED light source, which is most likely not the same or even similar to that which is needed. Although retrofit LED light sources are still more effective than many conventional ones, as their specific needs cannot be accounted for in a conventional luminaire their lifetimes and efficacies are not comparable to those of LEDs used in luminaires designed for the purpose.

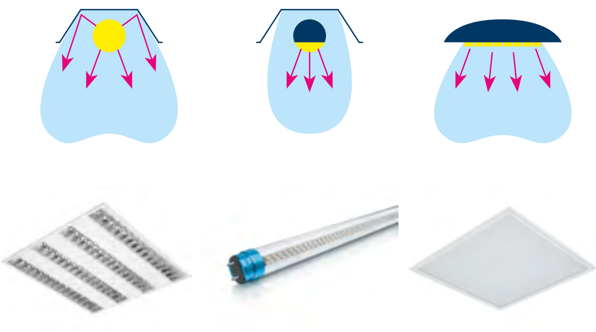


Figure 4
A comparison between a conventional luminaire using a conventional or retrofit light source and an LED luminaire

1 The light emitted by the fluorescent tube is controlled by the optical system to provide a desired light distribution.

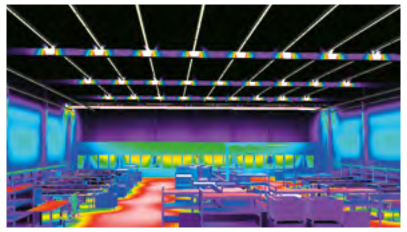
2 The light emitted from an LED 'tube' cannot be controlled by the luminaire optical system and cannot match the desired light distribution.

3 A luminaire designed for use with LEDs has an optical system designed for the purpose and ensures the desired light distribution as well as caring for other LED specific needs such as thermal management.

An appropriate lighting design ensures that the right amount and quality of light is provided where needed as well as making sure that no light is wasted.

LIGHTING DESIGN

Once you have chosen the most efficient light source and a suitable luminaire, you need to move onto the lighting design. It is vital that a lighting design be suitable for its use, as even the most effective luminaires will be wasteful if used incorrectly. A lighting design is based on the level and type of light needed in any given location depending on the activity being carried out. It is often the case with old lighting systems that were not professionally designed that a huge amount of light is wasted illuminating the tops of shelves, racking and even machines, where the light is of no use. This could also happen due to lack of knowledge at the time of design regarding the use of the space, or because the space is now being used for a different purpose or with a different layout and the lighting was not adapted or updated accordingly.



For more information about lighting design and the many other project services we offer, please take a look at the new LIGHTING SERVICES book.

And to learn more about Lighting Management Systems, you can find out all you need to know in our LMS book.

LIGHTING MANAGEMENT SYSTEM

Now you have a suitably designed lighting system, you can begin to think about how to control it. By controlling your lighting in an automated way it is possible to achieve even greater energy savings as well and improving user comfort. Control systems enable lighting installations to operate according to the presence of people within a space, the availability of daylight, and the amount of light required for each task, among many other possibilities. Depending on the type of LMS used, the operator of a building or public lighting system can not only control the illumination levels from a single location, such as a computer or a hand-held device like an iPad, but also get real time feedback about the status of the system, including warnings about such events as luminaire failures and information about energy consumption. This enables users to track energy consumption over periods of time, and find weak points in the system where light and energy are being used unnecessarily, allowing adaptations to be made that eliminate losses and provide further savings.

Energy saving potential according to control system used (%)

	manual control	automatic control														
types of control	switching on and off	motion sensor			lighting intensity sensor			combined control system								
method																
progress of control																
office	0	20	10	0	34	52	60	47	62	68	41	57	64	34	52	60
meeting room	0	40	35	30	32	50	58	59	70	75	56	67	72	53	65	70
corridor	0	50	30	0	34	52	60	67	76	80	54	66	72	34	52	60
classroom	0	40	20	15	33	51	59	60	70	75	46	60	67	43	58	65
shop	0	10	5	0	31	48	56	38	53	60	35	51	58	31	48	56
industrial space	0	10	5	0	31	48	56	38	53	60	35	51	58	31	48	56
warehouses	0	30	20	10	19	29	34	43	50	54	35	43	47	27	36	40

explanations:

	occasional movement		low light intensity
	normal movement		medium light intensity
	greater movement		high light intensity

Figure 5
Energy saving potential of various LMS control methods across several areas of application

SOLAR SHADING AND HVAC

As mentioned before, all building services influence each other, and to achieve the highest energy savings it is important to take a holistic approach, especially in terms of the three building services previously illustrated as inextricably linked together: lighting, solar shading and HVAC. Lighting is OMS' area of expertise and there is much that can be done within the arena of lighting alone to provide energy savings. Yet, we fully appreciate the need to consider its partner services as part of the whole, and to consider the effects they have on lighting and that lighting have on them.

Daylight is not always appropriately utilised within buildings and can cause glare and heat gain if not controlled. Solar shading regulates the incidence of daylight into interior spaces and thereby helps to minimise its negative effects.

Glare is caused by the presence of areas in the field of vision that have a significantly higher luminance than that of the background or task being performed, which results in excessive contrast and ultimately reduced visual acuity as well as potentially causing headaches. In the case of sunlight, glare is the result of direct or diffused light coming in or from around the window area, light that is significantly brighter than that in the interior of the room. Generally, when such bright sunlight is entering a room, people will use some form of artificial lighting to offset the difference between light levels near the windows and further into the room to make the general lighting level more uniform, even if the lower light level is, in fact, sufficient for the performance of tasks. Solar shading minimises the incidence of glaring light by blocking direct beams and redistributing the light that enters the room evenly throughout the entire space. This results in more uniform illumination of the room and comfortable levels of contrast, removing or at least reducing the need to use supplementary artificial light to ensure visual comfort and performance.

Figure 6
The effects of using solar shading to redistribute light within a space

Uncontrolled sunlight causes areas of extreme brightness that contrasts against areas with much lower luminance levels. This results in visual discomfort and reduced perception. Often, people will turn the lighting on to try and balance the difference.

Solar shading distributes the light entering the room more evenly, minimising differences between brighter and darker areas. If the resultant overall light level is sufficient it is not necessary to turn any artificial lighting on at all.

Solar shading, however, is not only influential on lighting but also has a significant bearing on the use of HVAC. Sunlight entering a room through windows or falling on the wall of a building causes heat gain. Proper shading on windows, doors, skylights and walls can limit the amount of light, and, therefore, heat that accumulates in a building. This reduces the overall cooling load of the building, meaning that HVAC systems such as air conditioning units need work less to maintain a stable and comfortable ambient temperature. If this is planned into the design of a building it can reduce investment costs as smaller and/or simpler air conditioning systems can be used. Studies by the American Society of Heating and Air Conditioning Engineers show that the use of fabric shades on a south-facing wall can reduce heat gain by as much as 65 %. The same shades used on a west-facing wall can reduce heat gain by up to 77 %. However, the shading of a building depends on its orientation and various other factors. The most effective shading is that provided by neighbouring buildings and any nearby vegetation such as trees. Furthermore, the elements of a building's structure that have the greatest impact on heat gain are windows and other openings where sunlight can directly enter a building. By blocking the incidence of direct sunlight into a building, it is possible to reduce the cooling load and related energy consumption considerably. But, bear in mind that reductions in heat gain should not be achieved at the expense of sufficient illumination or ventilation.

HVAC systems are among the biggest consumers of energy in the built environment.

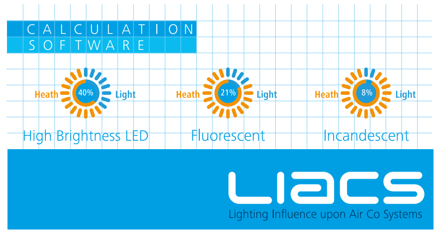
HVAC stands for Heating, Ventilation and Air Conditioning and is often supplemented by the word Refrigeration. HVAC systems are responsible for the heating, cooling, ventilation and filtration of air within our buildings in order to ensure suitable air quality and humidity levels, and refrigeration for the preservation of delicate foods. HVAC systems are one of the largest consumers of energy in the built environment, where heating and the provision of hot water can alone account for up to 60 % of overall building consumption in cold locations.

We have already brought to your attention the fact that the heating of a building uses less energy than cooling it. Although the proportions will very much depend on the dominant weather conditions where you are, this remains the case, as cooling systems, by nature of their functionality, are far less effective than heating systems.

The ideal way to regulate indoor air temperature and quality is to use natural ventilation with no mechanical support. This is, of course, often simply not possible. In most cases, it is necessary to use some form of active air conditioning, the energy efficiency of which is most improved by preventing its excessive use. Within a building, there are many sources of heat, from the solar gain previously discussed, to appliances and lighting. The need to dissipate heat is inevitable; a law of physics, but the differences between the heat emitted by various technologies are larger than you may think. Let's go back to the idea of the highly inefficient incandescent bulb with its very poor efficacy of only 13 lm/W. If you compare LED to incandescent it immediately becomes clear than a simple change of light source and luminaire can have a huge effect as LEDs are now available with well above 200 lm/W. This means both a higher efficacy in terms of lighting, but also means that a very small amount of the consumed energy is emitted as heat, which reduces the cooling load of the lighting. That means LED lighting brings energy savings in two very effective ways, and although people tend to not look at lighting in this way, it is a very valid part of an overall energy saving concept.

OMS Lighting has developed LIACS, a calculation tool designed to show the impact of lighting systems upon the cooling load of a room.

www.liacs.omslighting.com



We will always consume energy. It is an inevitable part of life. Yet we can do much to make the energy we produce and use as clean and environmentally responsible as possible.

RENEWABLES

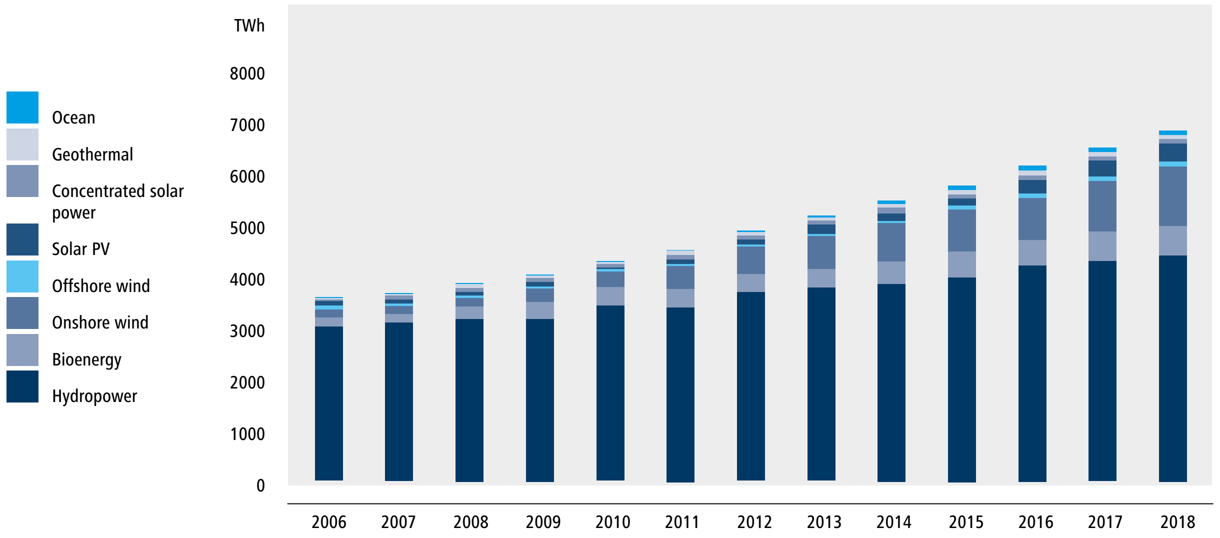
Energy saving is by far the most viable and effective solution to the current energy and environmental crises, and even though the cleanest energy is the energy not used, we will continue consume energy in increasing quantities into the future. Non-renewable energy resource production processes and products are consistently becoming cleaner and more effective, yet those resources are finite and their negative impacts must be reduced. This leads to the inevitable conclusion that, in the future, energy must be produced from renewable sources, eventually in its entirety.

There are already many highly effective renewable energy production technologies available, and development continues at a rapid pace. The most commonly used renewables are solar, wind, hydro and geothermal power. The amount of energy recoverable from each resource depends greatly on geographical location, but technological advancements make it possible to use all to at least some degree in almost every location worldwide.

Today, renewables can be used to supplement conventional electricity production for distribution through the grid as well as for independent, off-grid production for small- and large-scale application. An off-grid application can be anything from a solar-powered street light to an entire residential complex. This brings obvious benefits such as the flexibility of use or development in areas without access to the grid as well as advantages such as the reduction of installation and building costs thanks to not needing a connected electrical infrastructure.

Renewable electricity production is gaining popularity globally, currently accounting for a little under 20 % of overall electricity production, yet larger-scale application and significant growth is something that will come slowly over the next decades. This is due in part to the fact that, even though accessible, technologies that depend on renewables, especially unpredictable wind and solar power, cannot consistently provide energy. Furthermore, the incorporation of these technologies, with their production intricacies, into standard distribution networks is technologically difficult, costly and to a large degree preventative. The development of smart-grids that integrate conventional and renewable production into a streamlined distribution network is shaping the future of energy use, but as yet is still very much in its infancy.

Figure 7
Global renewable electricity generation by type including estimations until 2018



On a smaller scale, local renewable production that can support or supplement conventional provision for a single home or industrial facility is gaining in popularity as the technology becomes more affordable, effective and accessible. There are also many very small-scale uses such as solar-powered parking meters and handheld battery packs that allow us to charge mobile phones and laptops on the move using solar energy. much in its infancy.

However, these technologies are modern, but the idea of using the power of nature is as old as life itself. We have found evidence of the use of daylighting and natural ventilation across all civilisations, and now all we need to do is find out how to again implement these natural resources into our modern lives. An excellent example of this integration is the so-called wind tower built in Masdar City in Abu Dhabi. The simple structure, merely an empty cylinder, rises above the rooftops of neighbouring buildings and displays adjustable louvres atop its height. It requires little to no energy or maintenance, yet manages to cool the city at street level by as much as 5 °C by provoking a convection current that causes hot air to rise and be ventilated from the street, or using the louvres, allows the wind to be directed down to the street from above.

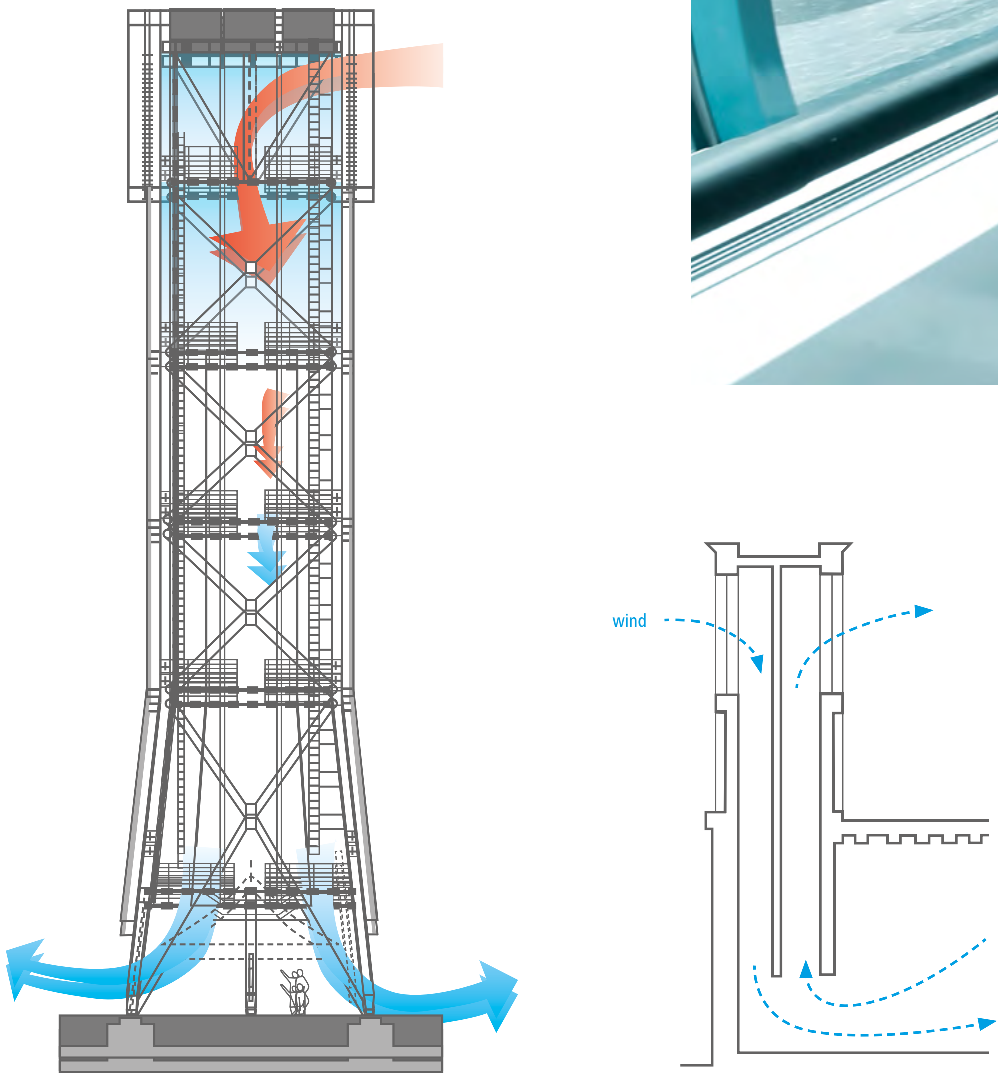


Figure 8
The functionality priciples of the wind tower in Masdar City can be applied in various way in everyday applications

Another way in which we can introduce nature into our modern lives is by using daylight. Ancient civilisations used daylight extensively in their buildings, something that is again becoming popular in modern architecture. However, there are now many ways to bring daylight indoors, ways that the ancients did not have access to that allow us to harness natural resources in a new way. In recent years, the use of skylights has been growing, with highly reflective materials and light concentrating optical systems making their use very effective. In openings the same size as a standard roof window, these devices enable the introduction of significantly more light into a room as well as allowing for that light to be delivered elsewhere than directly below. In the case that this technology is not suitable, maybe due to the structure of the roof, it is possible to use a light concentrator and fibre optic system that can transfer light across larger distances. There are, of course, losses in the system, but the use of such a fibre optic system enables light from outside to be provided in spaces that would otherwise have no access to daylight. This is advantageous because daylight is good for our health and wellbeing, and its provision in spaces such as hospital rooms, can have a significant positive impact on patients staying there. And, it goes without saying, that the use of daylighting provides great energy savings too.

GREEN BUILDINGS

Green buildings are the result of an equation that includes lighting, solar shading, HVAC, renewable energy resources and a sustainable and holistic approach to their use. Green buildings have little negative environmental impact, have low to zero CO2 emissions and are built using ecologically sound materials and methods. Such buildings are not only good for our ecosystem but also for the inhabitants, as sustainability is about our way of living and working as well as our way of protecting the environment.

It is clear that the development of green buildings is taking hold in modern life and rapidly increasing in popularity. They represent a financially viable choice, but most importantly, by being responsible for 40 % less energy consumption than a traditional building have a significant impact on energy saving. It is even possible, with the use of suitable technologies, to build net zero energy buildings that consume no conventionally supplied energy and may even produce more than they use. One of the many EU energy performance goals is that, from the end of 2020, every new construction must be nearly zero energy and must largely depend on renewable energy sources. That goal is not far into the future, so we better start thinking about how to make it a reality.

The One World Trade Centre in New York is the most environmentally sustainable building of its size in the world and has been awarded the LEED Gold certification

Green building activity is booming across many countries, showing a promising trend towards recognition of its viability and uptake.

There are several ways by which to assess the efficiency and sustainability of buildings, developed by various environmental agencies. The two most popular and widespread are the BREEAM (Building Research Establishment Environmental Assessment Methodology) and LEED (Leadership in Energy and Environmental Design) methods from the UK and US respectively. One of the most important requirements of both schemes is that a holistic approach be taken to the design and realisation of a building as well as its impact on the environment. To focus on a holistic approach is important not only because of the current environmental impact of our buildings, but also based on the expected population growth and lifestyle of the coming decades. According to studies carried out by the UN, by 2050 it is expected that 70 % of the world's population will live in urban areas, which are the biggest consumers of energy and contributors to CO_2 emissions and, therefore, represent the greatest threat to reliable and safe energy supply and the environment. For this reason, energy saving is of high importance for us all and must be a priority in every innovation, whether it be of a product, a building or a city.

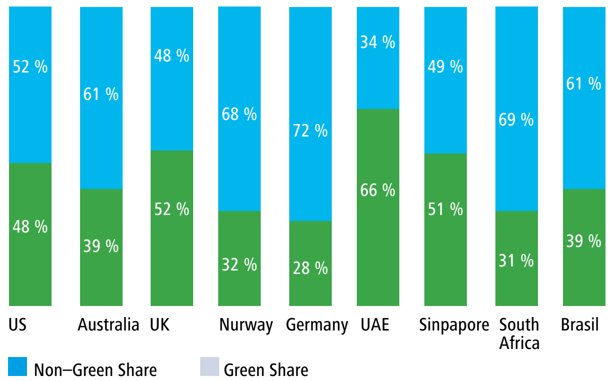
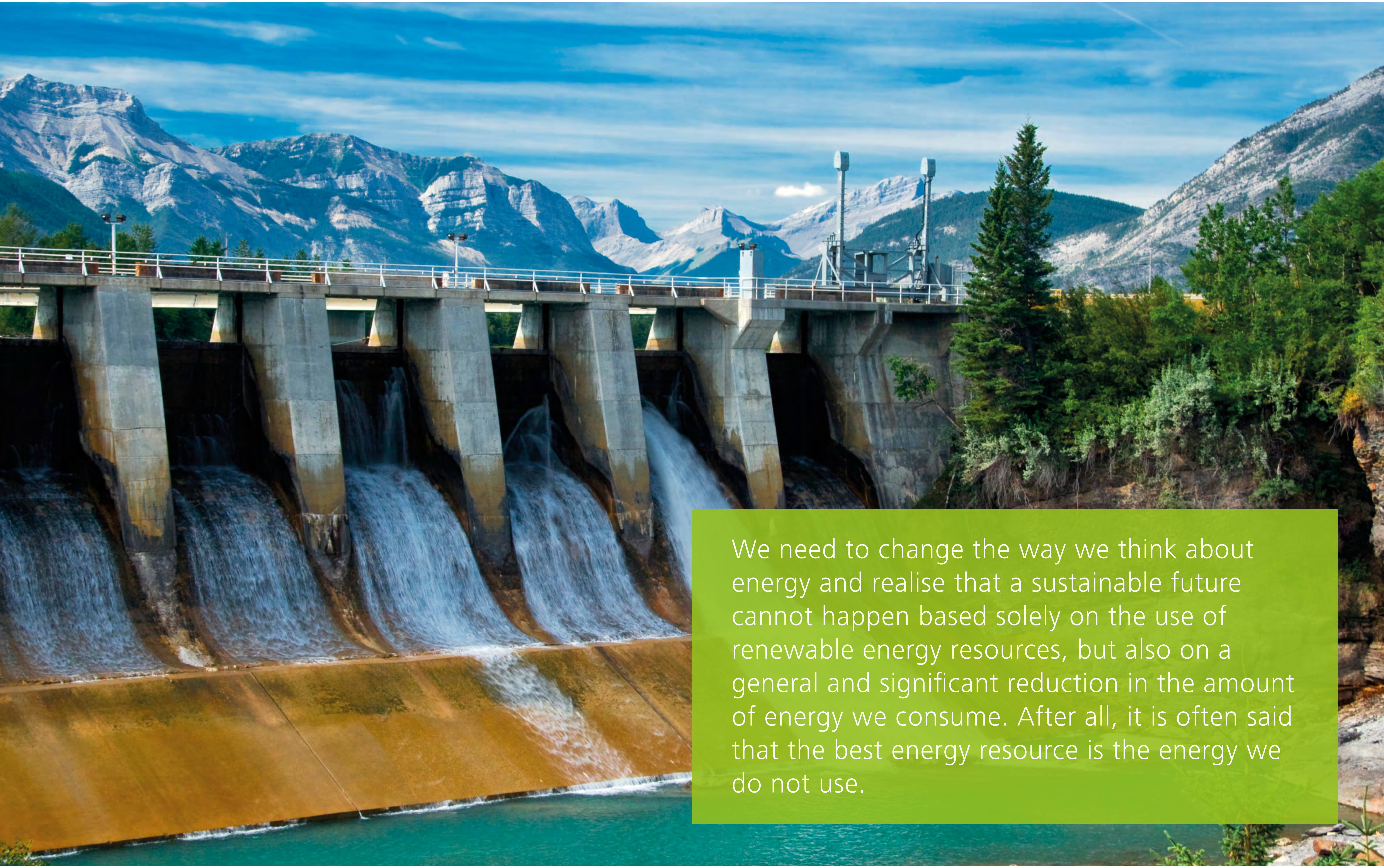


Figure 9
Average share of green building activity across the most active countries

Source: McGraw-Hill Construction, 2013



We need to change the way we think about energy and realise that a sustainable future cannot happen based solely on the use of renewable energy resources, but also on a general and significant reduction in the amount of energy we consume. After all, it is often said that the best energy resource is the energy we do not use.