

E.ON Power Predictions

The Office of the Future



Welcome

to the **smart office** of 2020

Self-cooling, energy intelligent and energy positive

This E.ON Power Predictions The Office of the Future report highlights the views of a number of leading experts at E.ON on how future energy demands and usage will change the way our office spaces are designed and used.

Led by Dave Clarke, Head of Research and Development at E.ON Engineering, they considered the physical, commercial and cultural impact of the changing energy needs of workplaces in the future, focusing on the offices in which many of us now work.

Together, they predict many exciting developments in the future of office design and technology.



Executive summary

E.ON's experts conclude that tomorrow's workplace will be smart both inside and out. The workplace will be constantly thinking and learning about how it uses energy, deciding how and when to draw it and even subtly managing how its inhabitants use it without them realising. Much of the technology already exists or is on the horizon, but it needs bringing together to deliver the most benefit.

Smart networks

These will be built into the very fabric of new office buildings and other workplaces. Smart networks will learn how an office's inhabitants work, monitoring and adjusting energy usage to cut wastage and create a more comfortable, productive workplace.

Digital desks

These will make the hot desk phenomenon of the 1990s a practical reality. Networked, interactive touch surfaces will link the worker to the world, with no need for a monitor, while personalising the look of whichever desk they choose to use.

Energy positive workplaces

These will generate their own energy from the sun, wind and earth, making the excess available for the local community.

Walls of light

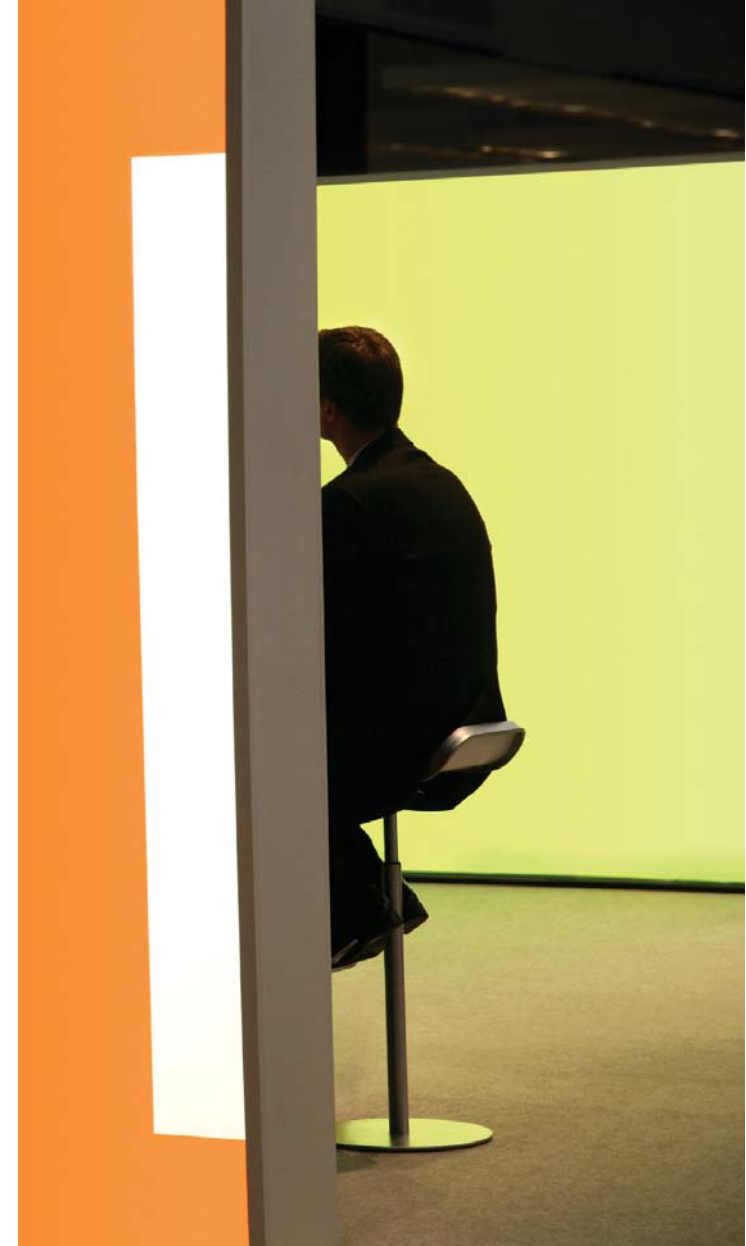
These will replace antiquated light bulbs and striplights, to create entire walls and ceilings that bathe rooms in simulated natural sunshine. They will also be able to simulate landscapes and display important messages.

Kinetic capture

This will harvest the energy generated naturally by workers as they go about their daily tasks, including dynamos linked to office chairs and impact capture steps on stairways.

Workplace constellations

These will mean the decline of long commutes to business parks at the side of the motorway. Nowadays, many businesses have several small sites in the same area encouraging employees to 'hot desk'. Businesses will also support the continued growth of home-working and serviced offices, along with the return of workers living nearer to their place of work, perhaps even benefiting from free energy.



"Demand from customers and shareholders and a new generation born with a green streak will combine so that organisations in 2020 will be much more environmentally conscious".

Dave Clarke, Head of Research and Development at E.ON Engineering.

How changing energy demands will affect the way we all work

The workplace of the future will have very different energy demands, the way they're run and their function must also change.

How will energy use in workplaces change?

Customers are already demanding that companies are more environmentally responsible, and this scrutiny is only going to increase.

Within a generation's time, environmental thinking will be a green streak running seamlessly through people's lives. General awareness of energy as a finite, valuable resource will be much higher than today, with workers bringing good energy-saving habits with them from home to work.

Workers with home microgeneration, micro CHPs (Combined Heat and Power) in their kitchens, ground source heat pumps or solar panels on their roof will expect their workplaces to make similar contributions.

While many major companies currently include environmental policy statements on websites and in annual reports, customers in the future will demand proof of tangible steps being taken.

This will lead to companies undergoing an independent energy audit and being benchmarked against similar best practice premises. They would earn a green score for responsible energy usage that others could insist on before doing business with them.

Greater regulation is also likely in the future, with rewards for an organisation's responsible energy usage and penalties for wastage. An organisation's entire environmental footprint will be taken into account, including how employees get to work every day and how far they have to travel.

Smart meters and intelligent displays will be able to provide companies with accurate live energy data. This allows them to identify unusual consumption patterns and act quickly to diagnose and address a problem, such as faulty machinery or a building where lights are left on overnight unnecessarily.



The typical time spent commuting to work has doubled in the last 5 years, from 35 minutes in 2003 to 1 hour and 5 minutes in 2007.

Source: study, Peninsula 2008, www.guardian.co.uk/money/2008/feb/09/workandcareers

48% of consumers actively try to buy energy efficient products or appliances.

Source: Neilson for BBC, 2007.

Environmental change

Climate change will also be a factor in the design and location of the Office of the Future. Warmer, drier summers and wetter winters will mean greater demand for energy to run cooling systems in the summer and a reduction in winter heating demands. E.ON has already noticed this shift amongst business customers in recent years.

How will the typical office adapt, in response to changing energy demands?

Changing energy needs and environmental concerns will be major factors in companies deciding where to build their new office, factory or warehouse.

Traffic congestion will mean new big business parks with hundreds of car parking spaces near a motorway junction, simply won't be viable in 2025. Increasingly, the answer will be constellations of offices and other workplaces integrated more closely within their communities to help attract the best workers.

The need to reduce their carbon footprint, coupled with fewer suitable new sites, will lead to businesses turning to several smaller sites in city centres and urban areas. This will mean more workers live nearer to an office, in effect meaning the business takes its operations to its workers.

The continued boom in digital networking will offer greater opportunities for home working, further reducing the strain. Workers in a different office will be able to pick up exactly where they left off thanks to the digital desk (see page 13).

Traffic congestion and result in smog will also mean workers themselves will increasingly want to work nearer to where they live. They will also want to find greener ways of working, including much shorter commutes and home working.

This would see much closer ties between home and work, and a partial return of sorts to benefactor inter-dependence last seen in Victorian times, when business owners provided housing and other community facilities for workers living nearby.





Death of the big business park?

Intelligent energy use will prove a major factor for many businesses choosing a location in 2020, with many basing it on their proximity to renewable energy sources.

More office and commerce based businesses will move to locations that they previously considered too remote, such as mid-Wales or the Scottish Highlands, which have wind farms or hydro-electric energy sources nearby. The benefits of a free source of renewable energy will outweigh any increased transportation cost.

Alternatively, popular sites could include those with businesses generating their own energy. Or, bio-waste could be used as a fuel source, positioned near to residential areas, supplying any excess heat or power to the local community or to other nearby businesses.

Building locations will integrate much more fully with their surrounding community. Locations with an integrated transport strategy at their heart with cycle paths, tram stops and hydrogen-powered buses will ensure employees always make it to and from work on time.

For those who still need to drive, companies will provide priority parking at the front of the building for those driving electric or other environmentally friendly vehicles, with free charging points.

E.ON is actively helping reduce its own employees' carbon workprint with a Green Travel car sharing scheme at many of its sites that also rewards workers for travelling by foot, bus, tram or bike rather than by car.

Employees receive 10 points, worth 50p, for each day they car share or use alternative transport, which can then be used in the staff restaurant, or to claim High Street or leisure activity vouchers. The scheme has already saved over 9 million travel miles and prevented more than 1,986 tonnes of carbon dioxide being released into the atmosphere.

The Confederation of British Industry calculates that traffic congestion costs employers £18 billion per year in lost time and lost business caused by delays.

Source: CBI 2002.

Sustainable energy sources

By 2020, workplaces will draw their energy from many sources rather than simply from the local distribution network as happens today.

By adopting a mix of these renewable generation sources, workplaces could generate a proportion of the energy they need themselves, with some even creating a surplus that could be used by the local community.

Renewable technologies include:

- Ground Source Heat Pumps (GSHPs)
- Tilting solar photovoltaic (PV)
- Medium scale wind turbines
- Water cooling
- Combined Heat and Power (CHP)
- Biomass boilers
- Water cooling





Ground Source Heat Pumps (GSHPs)

Also known as geothermal heat exchange pumps, GSHPs use the earth beneath the pump as either a heat source in cold weather, or a heat sink in warm weather.

A loop and refrigerant are used to extract the heat, which can then be distributed efficiently, especially when combined with underfloor heating in an open plan office. GSHPs can be fitted at existing sites as well as within new buildings.

A Ground Source Heat Pump could achieve a reduction in carbon dioxide emissions of over 17 tonnes each year – that's over 340 tonnes over its lifetime.

Source: E.ON. Assuming a heat load of 60,000kWh and a 55°C water temperature. Calculation based on a co-efficient of performance of 3.00 and a 20 year operational life. Carbon dioxide savings based on 0.287kg/kWh, compared to electric heating.

Tilting Solar Photovoltaic (PV)

Solar panel array with solar trackers.

Solar PV panels use daylight to generate direct current electricity from the sun, which can be used to recharge batteries or power equipment.

By 2020, arrays of PV panels arranged on solar trackers will ensure they stay orientated towards the sun throughout the day. They will be able to provide a steady supply of energy for low-level applications, such as lighting.

A solar PV system could achieve a reduction in your carbon dioxide emissions of over one tonne each year – that's over 20 tonnes over its lifetime.

Source: E.ON. Subject to site location, orientation and inclination. Calculation based on 20m² Vitovolt 300 with kWp of 2.64. Assumes 2.64kWp generates 2,000 to 2,500kWh. Based on a 20 year operational life.

Biomass boilers

A low carbon source of energy, providing up to 100% of heating and hot water needs. The boilers burn wood or other organic matter. Automated pellet burners can be switched on at the touch of a button.

A biomass boiler could achieve a reduction in carbon dioxide emissions of over 15 tonnes each year – that's over 300 tonnes over its lifetime.

Source: E.ON. Calculation based on 80,000kWh and carbon savings (compared to gas) of 0.19kg/kWh and a 20 year operational life.

Medium scale wind turbines

Small turbines that serve one or more businesses could also help to generate energy for the local community, putting any excess electricity generated back into the grid via a two-way meter.

Building design - outside

With greater pressure on greenbelt and protected land, workplace design in 2020 will have to be increasingly innovative to blend in with the environment and reduce the impact.

Constructors and renovators of office buildings will use energy efficiency as a major selling point in 2020. Green thinking will see the current trend to use more sustainable materials in landmark buildings continue in all workplace construction, and others such as straw that have previously been considered waste increase. Natural timber, stone and slate used both inside and out will help re-connect workers with their natural outside environment and ensure buildings help to blend in with their surroundings.

The trend towards buildings clad in glass will continue but with windows with sophisticated photocromatic properties, which darken in bright sunlight to improve worker comfort and reduce energy usage. These will save on the need for air conditioning in summer.

Employees themselves will also give much greater consideration to their working environment when choosing a job, with greener workplaces making the company more attractive to work for.

City Hall, London.

The Mayor of London's building was designed by Norman Foster and Partners and opened in July 2002. City Hall runs on a quarter of the energy consumed by a typical high specification office building.

Green features include:

- its South-leaning globe shape - which helps to reduce solar gain
- increased natural ventilation
- heat recycling from computers/lights
- ground-source cold water cools the building before being used to flush toilets.



Building design - inside

Intelligent energy management systems

Sophisticated energy management systems will become part of the fabric of every well-managed building, built into new buildings and installed wirelessly into existing ones.

The new management systems will give every business, from major manufacturers to the smallest family-run small business, the same ability to manage their energy usage effectively. Software will link directly to smart meters, giving live usage statistics for both the company and its energy provider, meaning accurate printed bills and even live billing as needed.

Wireless sensor networks

These will combine data from temperature, lighting, airflow and activity level monitors to regulate usage, as well as weather forecasts to anticipate future energy demand.

Heating and lighting will be intelligently controlled to make sure occupants are comfortable at all times, regulating the heating, lighting and air circulation levels depending on the number of workers in the building and the amount of equipment in use.

Ordinary three-pin plugs will become smart, communicating to wall sockets the type of device that is plugged in, how much energy it is using and, if applicable, who owns it.

This data will then be beamed, either via Radio Frequency Identification tags to collectors or sent directly down a nearby data line, to a central software programme.

Devices left on, such as printers or mobile phone chargers, will be automatically shut down or switched to deep sleep. The traditional standby function on all devices at work and at home will have been phased out. The owner will be sent a gentle reminder to switch off by email, text message or electronic sticky note to their desktop.

Energy consumption displays, already in use in a handful of locations in the UK, will become commonplace in company reception areas, reflecting back the building's energy usage to all employees through a series of easy-to-understand graphic displays.



The suggested temperature for office activity is 19-20°C.

Source: Carbon Trust

Intelligent energy management systems in action

The average 9-to-5 office is actually typically in use from around 8.15pm to 6.45pm.

At 8.15am, the receptionist usually arrives. The building's smart system, recognising their usual arrival pattern, checks the smart entry pass ID against its facial recognition system before disarming the alarm in that zone. It also turns on the lights, reception PC and energy mirror's display. Knowing that they always make a drink before other workers begin arriving, it then enables the light switches in the kitchen and turns on the hot drink vending machine.

Because it's winter, the temperature has dipped, the system does not turn on the water cooler until 8.55am when more workers start arriving, as it knows the first cold drink in winter is not normally dispensed until at least 9.20am. But a thirsty new employee who cycles to work overrides the system, turning it on when he arrives earlier. The system remembers this and adjusts accordingly, even reverting back when it knows that employee is out of the office.

Workers sitting near the windows on the east side of the building are bathed in bright sunlight for most of the morning, so their overhead lights are disabled, heating lowered and window glass automatically darkens, making them more comfortable and avoiding energy wastage. The same happens in the afternoon on the opposite side of the building.

At lunchtime, lighting directly above workers' desks is switched off as the system detects they leave their floor, while their thin-client computer terminals are turned off. They can be shut down and rebooted almost instantly.

At the end of the working day, the reverse procedure happens, with individual workstations and areas powered down as workers leave for another evening.

These simple improvements in the visual workplace environment will help to greatly reduce stress and absences through ill health, and improve motivation and productivity to the benefit of both workers and the organisation.



As workers start arriving, their entry tags identify exactly where they work and unlock the regular power supply to relevant lifts, turn the lights on in nearby stairwells, the lights on the way to their desks and their PCs.

Lighting

Traditional, energy-hungry electric light bulbs will long be a thing of the past, superseded many years before by low energy light bulbs or CFLs (compact fluorescent lights) and developments in LED technology.

Advances in lighting technology will help to regulate employees' mood, helping to make them happier at work whatever the weather outside.

Electroluminescent (EL) paint containing millions of microscopic phosphors will allow office walls and ceilings to be bathed with more naturalistic light using a fraction of the energy. The colour could be adjusted to simulate natural daylight changes, with 'the sun' passing across a cloudscape through the workplace from east to west in real time during the day.

For existing premises, a small, safe charge could be passed through the paint behind a clear, protective coating. In new buildings, lighting panels could be installed in the same way as current drywall plasterboard but with no need to paint.

On dark winter days, simulated summer sunshine could be emitted, reducing cases of Seasonal Affective Disorder and helping to regulate workers' natural bio-rhythms. Local lighting could also be varied by individuals to create a calming effect when concentrating. Walls could be used as a giant video screen, to display text messages or even seasonal images such as swaying summer cornfields or snowfall at Christmas.



Instead of dimly lit workplaces with hanging fluorescent striplights, lights will become part of the walls and ceiling themselves.

The digital desk

The move to save energy, space and developments in technology will filter down to everyone's own desk space, signalling the end of the bulky desktop PC in favour of the digital desk.

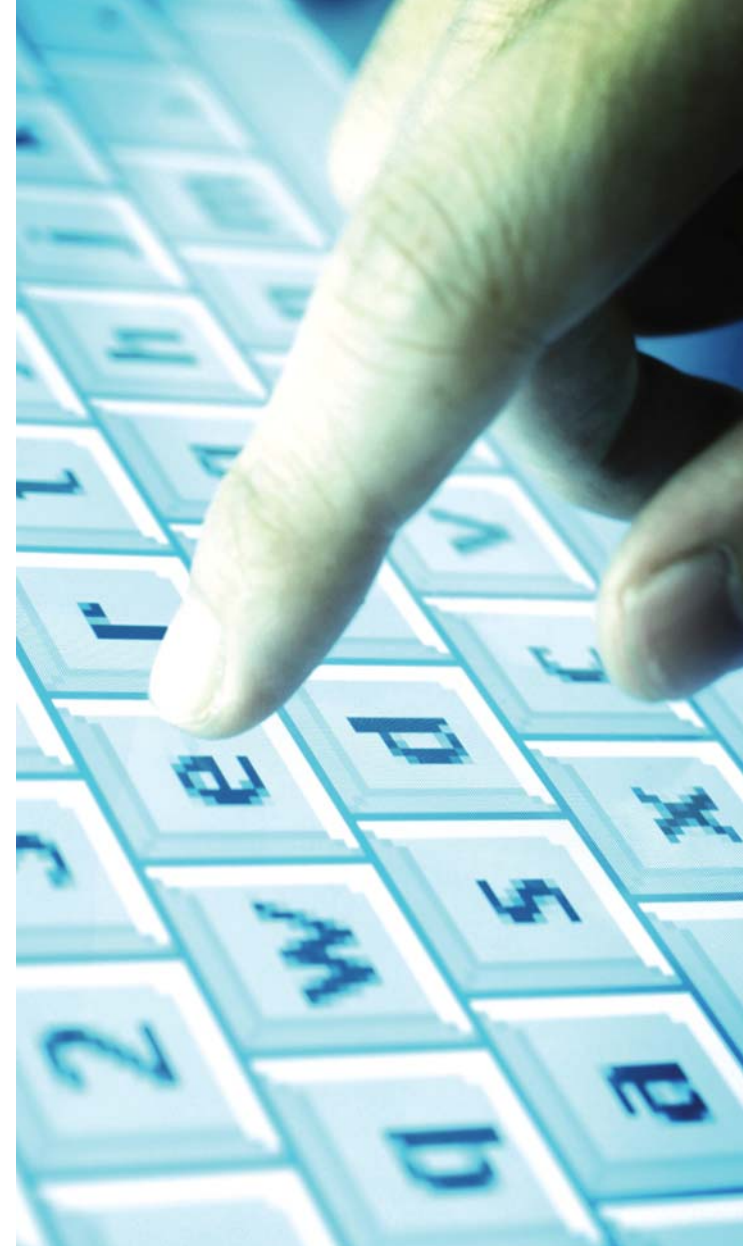
Fully networked desks will replace the screen itself, creating a virtual personalised desktop with the image created by millions of low energy LEDs hidden behind a protective surface. Keyboards will be built into a textured area of the desktop surface itself. The mouse will be superseded by motion detection technology, with the user simply moving their hand to control the cursor. All programmes and files will be saved instantly on central servers, as with current thin client technology.

The digital desk will also help to increase the feeling of a personal space. Users will be able to personalise areas of their desktop with electronic sticky notes, family photos, e-birthday cards and personal messages.

Personal virtual networks will be increasingly adopted as tools for essential business communication through the digital desktop. Real-time streamed images of close colleagues will be shown along the desk display to create a digital working group, helping to build working relationships and allowing customers, partners or key contacts from around the world invited to join your network.

When the network detects that the user has left the building, the digital desk will simply close itself down, turning off completely.

Workers on the move will no longer need to carry around an expensive, fragile laptop. Digital desks will appear in coffee shops, airports and public areas, creating the ability for everyone to work easily on the move and stay connected to the office and the world.



Using a digital desk interface and display that shuts down fully and automatically (instead of a traditional PC and monitor left on standby) could save around 45% of the energy each night.

Source: E.ON, based on standby consumption of 70% of full power for 14.5 hours.



Energy harvesting

Workers themselves could provide a source of energy with no extra effort. Energy will be captured and stored, 'harvesting' the kinetic energy generated as workers walk around, climb stairs and even move their office chairs.

Layers of piezoelectric material will form the floor, with each contact generating a small amount of energy that would otherwise be wasted. This will be used to power low voltage devices such as sensors and LED displays for the rest of the year.