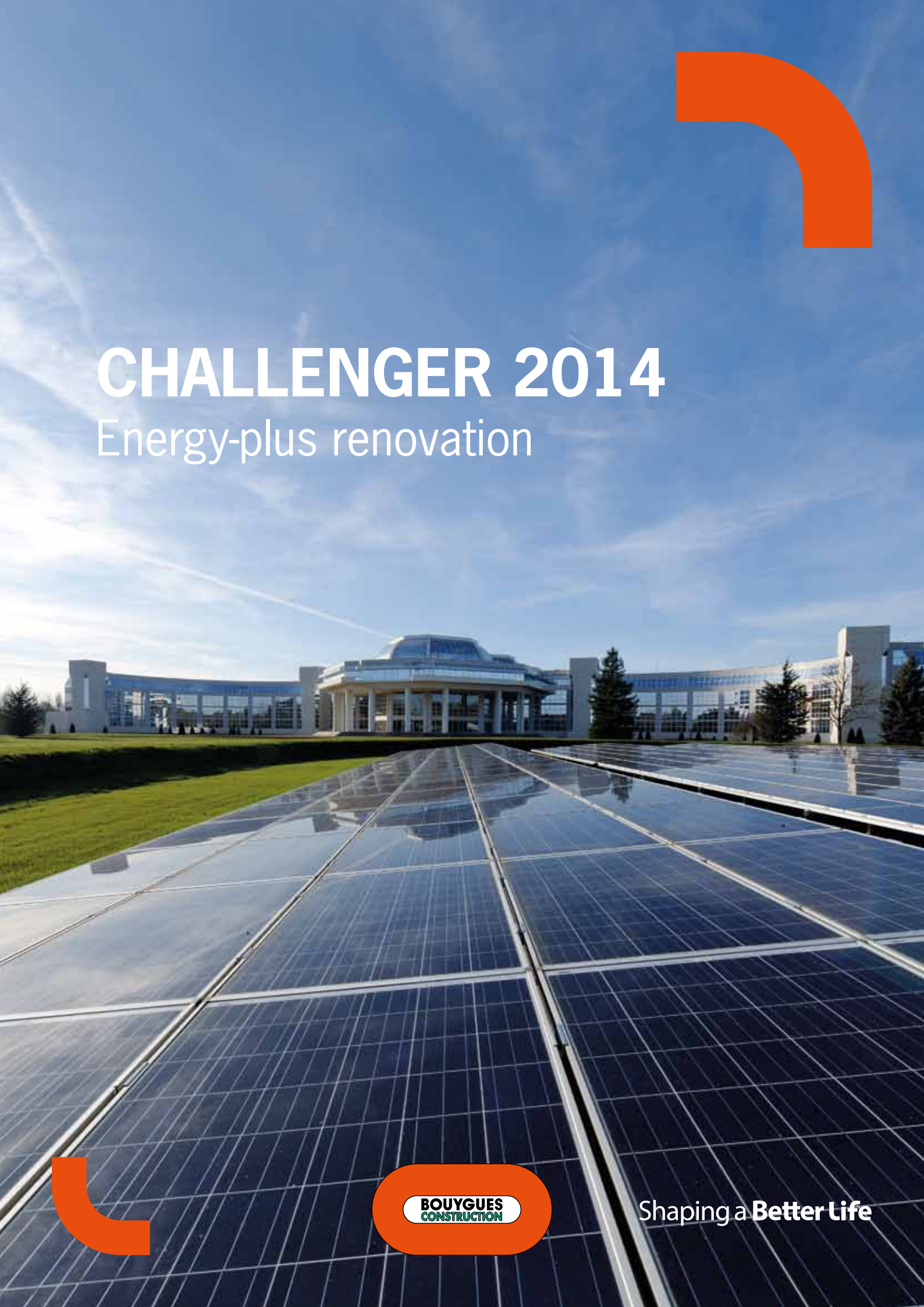
CHALLENGER 2014

Energy-plus renovation



BOUYGUES CONSTRUCTION

Shaping a **Better Life**

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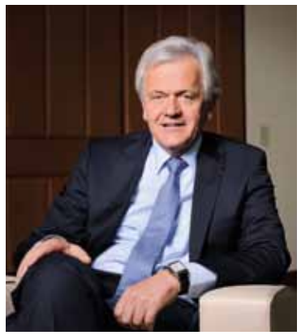
"Making Challenger the showcase of our expertise"

Challenger, the emblematic headquarters building of the Group, first opened in January 1988. Designed on the instructions of Francis Bouygues, in conjunction with architect Kevin Roche, even then it stood testimony to our innovative capacities.

Twenty years later we decided to undertake a complete renovation programme with an ambitious objective: enhancing the complex's performance with respect to energy and the environment and at the same time upgrading the working environment of our 3,200 employees at the site.
On completion of the works in 2014, Challenger will be one of the first ever tertiary buildings renovated to an energy-plus level.

Challenger will once again be a showcase of our expertise and know-how. And above all it will be a concrete demonstration of Bouygues Construction's ambition to be a leader in sustainable construction, not just for new-build projects but for renovation too.

Yves Gabriel
Chairman and CEO, Bouygues Construction



The showcase of the Group's know-how

More than 20 years after it was first built, the Group's emblematic headquarters is undergoing an ambitious renovation designed to make it a showcase of our know-how.

KEY ASPECTS OF CHALLENGER'S RENOVATION:

• The insulation of the buildings is upgraded: 88% of the cladding glass (more than 24,000 m²) will be replaced by a double-skin façade achieving very high thermal performance.

• The heating and air conditioning of the buildings use as their primary energy sources the energies naturally present in the ground (ground-source) and air (air-source).

• Part of the electricity necessary for operation of the site is produced locally by installing 25,000 m² of photovoltaic panels.

• Wastewater and rainwater is treated by filtering gardens, artificial wetlands which purify water naturally for re-use on site, for watering the grounds for instance.

A CONSTANTLY EVOLVING PROJECT

Since the beginning of Challenger's renovation in 2008, the project has benefited from several improvements:
- installation of LED lights to limit energy consumption from lighting
- development in partnership with LG of a VRF air conditioning system with variable water flow
- installation of an additional 3,500m² of photovoltaic panels

These innovations will allow a marked improvement in the energy performance of Challenger, thereby helping it to improve on the consumption objective of 31 kWhPE/m²/year set in 2008, in order to become an energy-plus site.

« WE WANTED TO PUT OURSELVES IN THE SAME CHALLENGING FRAME OF MIND AS THE PEOPLE WHO BUILT THE COMPLEX 25 YEARS AGO »

Philippe Metgès, Central General Business Manager with Bouygues SA, in charge of the Challenger renovation operation.

TRIPLE HQE®, LEED® AND BREEAM® CERTIFICATION

Designed as a means of assisting sales, as an ambassador-building promoting the Group's know-how, Challenger is aiming for triple HQE®, LEED® Platinum, and BREEAM® Outstanding certification.
Challenger's North Triangle is the first building in the world to receive triple certification at the highest-level for each, and achieved recognition from the BRE (Building Research Establishment) at the Ecobuild 2013 exhibition, when it was awarded the trophy for the building with the best score on the BREEAM® Europe Commercial index for 2012.

RENOVATION IN OCCUPIED BUILDINGS

Renovation work at the Challenger complex got under way in 2010 and will be completed in August 2014. Despite ongoing renovations, buildings will be occupied and work will continue as usual throughout this entire period.
Everybody involved in the operation signs a 'clean jobsite' charter outlining the requirements and recommendations for minimising site disturbance.

Companies involved

Owner
SNC Challenger (Bouygues Construction)

Owner's engineer for general works and triple certification
Elan

Architect
SRA

Main Contractors
DV Construction
Bouygues Energies & Services

Façades consultant
Emmer Pfenninger partner AG

Building services consultant
Ferro Ingénierie

Owner's engineer for energies, photovoltaic consultant
Amstein et Walthert

Structural engineering consultant
CEBAT 2000

Acoustics consultants
CIAL et LASA

External works consultant
LMP Conseils

Design & construction of filtering gardens
Phytorestore

Health & safety coordinator and building control body
Bureau Veritas

Fire safety coordinator
Eurocoord

Renovation of concrete façades
Tollis

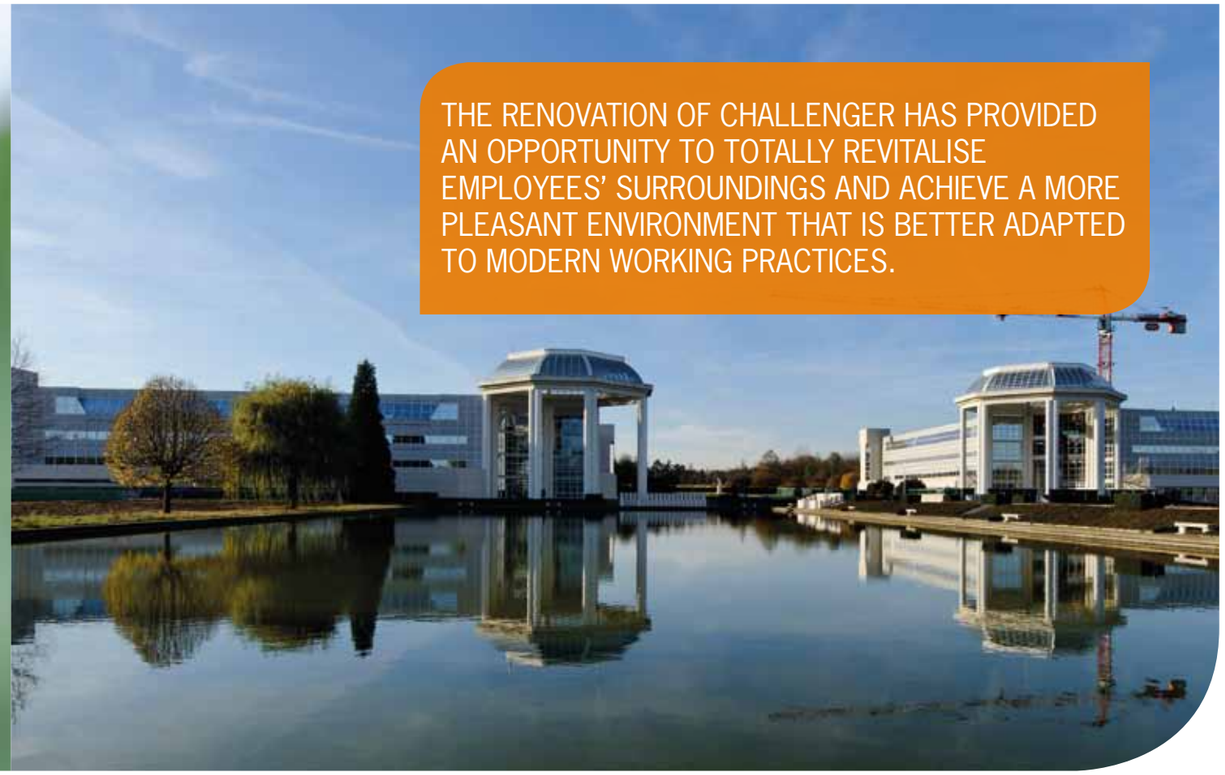
Signage
Alto

Earthworks
Screg

Gutting of buildings
Colas

Roofing
Smac

Greater comfort for employees



THE RENOVATION OF CHALLENGER HAS PROVIDED AN OPPORTUNITY TO TOTALLY REVITALISE EMPLOYEES' SURROUNDINGS AND ACHIEVE A MORE PLEASANT ENVIRONMENT THAT IS BETTER ADAPTED TO MODERN WORKING PRACTICES.

WORK AREAS HAVE BEEN COMPLETELY REDESIGNED

All the office furniture is replaced by custom-made items adapted to the specific requirements of the various Group businesses.

111 'think pods' are created on landscaped office floors; not requiring bookings, they can be used for short meetings or whenever staff need to 'chill out' briefly.

The 60 existing meeting rooms are renovated and a further 29 are created, all equipped with flat-screen TVs, videoprojectors, or videoconferencing systems.

VISUAL COMFORT

Corridor partitions are glazed to let in as much light as possible, carpets and furniture adopt light colours, and individual LED lamp stands with independent adjustment of intensity are installed, all for the greater visual comfort of users.

ACOUSTIC COMFORT

Acoustic comfort is enhanced by cladding cupboards and think-pod breast walls with acoustic wood panels, installing microperforated false ceilings to absorb a certain amount of noise, and having the ventilation system specially designed for greater silence.

THERMAL COMFORT

The temperature of office spaces is automatically regulated to always be between 20 and 26°C, adjustable by one degree up or down by members of staff.

OLFACTORY COMFORT

Materials with reduced VOC emissions are used to obtain better internal air quality.

OPTIMISED PARKING SPACE

Two new carparks have been built, each with around 200 places.
To meet the requirements of staff cycling to work, changing rooms equipped with lockers and showers have been built into the carpark areas.

The existing carparks are also renovated. They are fully repainted with different colours for different zones, and like the rest of the site they will receive new signage for easier wayfinding by staff and visitors alike.

In addition, 250 parking places have been earmarked for upcoming installation of the equipment necessary for recharging electric cars.

CHALLENGER, AN OVERVIEW

COCKPIT
Measuring energy consumption, production, and recovery in real time, and optimising staff comfort, that is what goes on in the cockpit, the Challenger 'control room'.
It includes a showroom where interactive pedagogical visits of the site can be conducted.

NATURALLY VENTILATED DOUBLE-SKIN FAÇADE
Thermal insulation is optimised by the natural circulation of air between the two skins.

INDOOR ENVIRONMENT
New air diffusers, individual lighting control, better acoustics, and new signage are just some of the many innovations contributing to an improvement in employees' everyday conditions.
All the existing office furniture (desks, chairs, meeting tables, etc.) is replaced.

PARKING
450 new parking spaces are created either side of the central basins, increasing the number of parking places to 2,880.
Of these, 250 places will be equipped ready to receive electric-car charging facilities. There will also be facilities for those cycling to work (changing rooms, showers, and bike parking).
The same facilities will be available to joggers.
The walls, floors, and ceilings of the existing carparks are repainted using different colours for different areas to facilitate wayfinding.

SOLAR ROOFS
Challenger is equipped with solar roofs whose panels will harness solar radiation and convert it into electricity. For architectural reasons the panels are placed horizontally.

SOLAR FARM
The solar farm represents 6,420 m² of photovoltaic panels producing 618 MWh/year. Tilted at 5° (instead of the more usual 30°), the panels form a 'photovoltaic lake'.

FILTERING GARDENS®
Challenger's wastewater and rainwater are treated by means of filtering gardens, wetlands creating ideal conditions for natural water purification and for the development of local biodiversity.
Treated rainwater is used to supply adiabatic coolers, washrooms, and washing stations.
Treated wastewater is used to water the lawns. As a result, water consumption is reduced by 60%.

GROUND-SOURCE ENERGY
Challenger uses the energy naturally present in the ground and groundwater as its primary energies for heating or cooling the climate-control loop running through the buildings.
Seventy-five vertical dry borehole collectors descend to 100 metres beneath the solar farm. They can be used to either heat or cool water in the climate-control loop.
Groundwater abstracted from a depth of 135 metres and subsequently reinjected at a depth of 152 metres also contributes to thermal control of Challenger.

THERMAL SOLAR PANELS
The thermal solar panels equipping the site meet more than half the domestic hot water demand of the staff restaurant and gym.

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Reducing consumption

Reducing Challenger's energy consumption and demand for mains water is a priority. Achieving the target involves improving the thermal performance of the buildings and installing a phyto-purification system.

PHYTO-PURIFICATION PURIFIES WASTEWATER AND RAINWATER WITHOUT USING PUBLIC SEWERAGE SYSTEM.

IMPROVING THERMAL PERFORMANCE

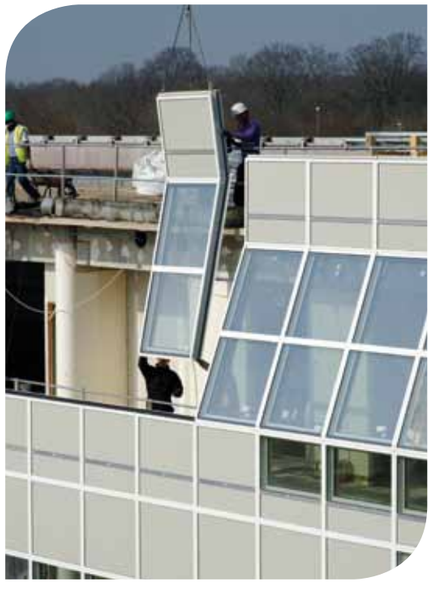
Renovation of Challenger started with an audit of the existing buildings aimed at identifying the insulation work required to improve thermal performance.

The insulation and impermeability of external walls and roofs are thus upgraded. In addition, 88% of the 24,150 m² of curtain walling is replaced by a ventilated double-skin façade. By allowing natural air circulation between the inner double glazing and the outer single glazing, this new façade-chosen from among ten different kinds-results in better building insulation:

- in summer, the sun heats the air sandwiched between the two skins first, and by thermal convection this hot air is discharged from the top of the façade;
- in winter, the air circulating between the skins is the first to cool down, which limits the effect the outdoor temperature can produce inside the building.

Between the two skins of the façade are blinds. These play an essential role in the enhancement of the buildings' thermal performance without introducing any detrimental effect to the architecture of the site.

- Above an energy value of 100 W/m² striking the façade, the blinds are automatically lowered to provide shading.
- During winter nights, the blinds are completely lowered to retain as much as possible of the heat stored in the building during the day.



WASTEWATER AND RAINWATER MANAGEMENT BY PHYTO-PURIFICATION

Water management is a fundamental issue if a site like Challenger is to address the principles of sustainable development. The solution adopted to meet this challenge is installation of a phyto-purification system. How does it work? Quite simply by creating a wetlands environment which naturally purifies rainwater and wastewater.
After treatment, wastewater is fed to a storage pond and can be used for watering the grounds. Recycled rainwater is used to operate toilets, for carwashes, and for adiabatic coolers.

Recycling wastewater and rainwater reduces mains water consumption and abstraction from the aquifer by close to 60%, i.e. it saves about 60,000 m³ of water per year.

What is more, the artificial wetlands create favourable conditions for the development of local biodiversity.

Using natural resources

In harnessing electricity from the sun and using ground-source energy for climate control in buildings, Challenger makes considerate use of the natural resources present at the site to produce the green energy necessary for it to run.

ENERGY FROM THE SUN

Photovoltaic energy
Part of the electric power necessary to run Challenger is produced locally by installing 25,000 m² of photovoltaic solar panels.

Each solar panel is equipped with a system for individually controlling its operation. Used for such a large area for the first time in France, this system has three main advantages:
• When a given panel is in the shade or faulty, the other panels in the photovoltaic chain continue to produce normally. The estimated productivity gain produced by this system is 20% per year.
• The production of a chain of panels can be interrupted to allow maintenance technicians to conduct their work in perfect safety.
• Photovoltaic chains can consist of a variable number of panels, making it possible to adapt to the architecture of the site.
Challenger is capable of generating more than 2,500 MWh of electricity per year. This output is chiefly intended for site use; only excess will be sold to the national power utility.

Thermal solar energy
The thermal solar panels are installed on the roofs at Challenger. They meet more than half the demand for domestic hot water.

GROUND-SOURCE ENERGY

Two ground-source energy systems are installed at Challenger for heating and air-conditioning all the buildings: 75 vertical collectors beneath the solar farm, and a groundwater doublet. In the case of the 75 vertical boreholes, a fluid is conveyed to a depth of 100 metres to collect the thermal energy in the ground.

As for the groundwater doublet, it harnesses the thermal energy in subsurface water which is at a constant temperature of around 14 to 15°C. This water is abstracted, its heat extracted, and it is injected back into the aquifer through a second borehole about 300 metres away.

> The principle of ground-source energy is to harness the energy naturally present in the ground to regulate building temperatures.

The environmental performance of Challenger

ENERGY CONSUMED (conventional scope)
Before: 310 kWhpe/m²/year
After: Positive energy building

PHOTOVOLTAIC ENERGY PRODUCTION
Before: 0 MWh/year
After: 2,500 MWh/year

CO_2 EMISSIONS
Before: 22 kg/m²/year
After: 0 kg/m²/year

MAINS WATER CONSUMPTION
Before*: 59,000 m³/year
After: 28,000 m³/year

*Year of reference 2008

The renovation of Challenger is being carried out with the financial participation of the ADEME, the Ile-de-France regional authorities and the Seine-Normandie water agency.

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