

Further information
Skanska AB
www.skanska.com

Contact
Jennifer Clark,
SVP Sustainability &
Green Support
jennifer.clark@skanska.co.uk

Bentley Works, UK

Case Study 134

Aspects of Sustainability

This project highlights the following:

Green Aspects

- Energy
- Carbon
- Materials
- Water
- Local Impacts

Social Aspects

- Human Resources
- Corporate Community Investment
- Business Ethics
- Health and Safety

Bentley Works in Doncaster, northern England, is Skanska’s regional engineering, manufacturing and servicing hub that has been redeveloped into a state-of-the-art facility. The project achieved BREEAM design ratings of ‘Outstanding’ (workshop) and ‘Excellent’ (office), and is Skanska’s first Deep Green project in the UK, according to the company’s internal Color Palette™ tool.



Project Sustainability Highlights

Economic

- Total green payback period of 11 years, which decreases to 8 years when considering reduced absenteeism
- Creation of 70 new full-time positions

Green

- Net zero primary **energy** site
- Office building uses 67% less **energy** than UK building regulations
- 11% reduction in embodied **carbon**
- Zero construction waste **materials** to landfill
- Zero hazardous **materials**
- Net zero potable **water** & 70% less water than BREEAM benchmark
- Office building and workshop both certified to BREEAM ‘Outstanding’

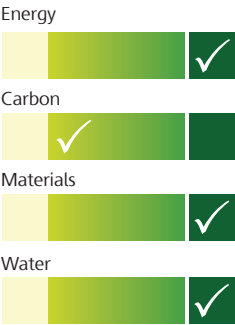
Social

- Healthy indoor and outdoor environments for building occupants and workers
- 3.5 fewer building-related sick days than other Skanska UK offices in 2015.

Project Introduction

Bentley Works is Skanska UK’s engineering and manufacturing facility situated 3 km north of Doncaster, South Yorkshire. The 7.5 hectare site has been used by the company for over a century and was in need of redevelopment and modernization. Skanska redeveloped Bentley Works into a state-of-the-art facility to provide high quality engineering, manufacturing and pre-fabrication services for various Skanska operating units working throughout the construction industry. The facility will serve as Skanska’s northern England hub and will support the company’s strategic ambitions to grow.

Skanska was the developer and main contractor for the US\$ 18 million Bentley Works redevelopment and modernization scheme. The project involved the demolition of the existing office and workshop buildings, and construction of a modern 1,800 m² two-story office building and a 3,135 m² fabrication and machine workshop. An existing workshop building was refurbished, along with an existing 112 m² paint shop building.



The project also included new cross-site cabling, external lighting and the relocation of an existing rig wash. The project was completed in March 2015, and Skanska has since divested Bentley Works to the company's UK pension scheme, which is considered a positive move for both Skanska and its employees.

The office building and the workshop both achieved separate BREEAM 'Outstanding' certification, which is the highest level possible. BREEAM is a leading design and assessment method for green buildings. Bentley Works is also Skanska's first UK project to be rated as Deep Green according to the company's internal Color Palette™ tool. A Skanska Deep Green project must achieve at least three of the following six objectives: net zero primary energy, zero waste, zero unsustainable materials, zero hazardous materials, near zero embodied carbon and net zero water. The Bentley Works redevelopment achieved net zero primary energy, zero waste, zero hazardous materials and net zero water. Bentley Works won the Energy Efficient Project of the Year award at the 2015 UK Energy Awards. The judges were impressed by the innovative, practical and consistent application of renewable and construction technologies to achieve the Skanska Deep Green Criteria, Zero Carbon and BREEAM Outstanding.

Contributing Toward Sustainable Development

Bentley Works is designed to promote environmental and financial savings throughout its lifespan. The site is designed to achieve net zero primary energy, and is equipped with a solar photovoltaic system and two biomass boilers that utilize waste biofuel. Zero hazardous materials were used on the project, and many construction materials were environmentally responsible. The site uses 70 percent less water in total than the industry benchmark, and meets Skanska Deep Green requirements for net zero potable water use.



The Bentley Works redevelopment project also improved stormwater management, enhanced biodiversity, promotes healthy working environments and contributed toward sustainable development by redeveloping an existing urban site and promoting more sustainable modes of transport. During construction, Skanska sent zero waste to landfill and reduced the project's embodied carbon footprint by 11 percent. The project promoted good relations with local residents, and sought to benefit the regional economy by using local workers, contractors and materials. 70 new full-time positions were also created as a result of the redevelopment.

Green Aspects

Energy

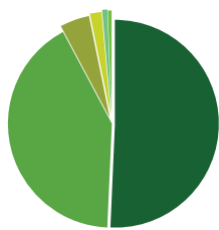
Energy efficiency

Skanska first sought to minimize the site's energy demand through an efficient design before offsetting the remaining demand with onsite renewable energy generation. This ensures that Bentley Works achieves net zero primary energy, or net zero carbon (2010 UK regulations), by generating more energy than it uses over the course of a year. Life-cycle costing analyses, based on the energy baseline model, were conducted to assess the feasibility of various energy solutions and ensure they will also be cost effective.

The workshop is designed to annually use 41.5 kWh/m² and the office building 47 kWh/m², which is 67 percent better than UK building regulations. Well-insulated building envelopes minimize heating and cooling demands with U-values of 0.26 W/m².K, 0.18 W/m².K and 0.22 W/m².K for the office walls, roof and floor respectively, and 0.2 W/m².K, 0.15 W/m².K and 0.22 W/m².K for the workshop walls, roof and floor respectively. Concrete building structures are designed to stabilize internal temperatures. High performance windows minimize heat loss and solar shading minimizes cooling requirements. The office building is constructed to be very air tight, which ensures that the air leakage of 2.5 m³/hour.m² is 75 percent lower than building regulations and 25 percent better than industry good practice.

An evaporative cooling system provides cooling for the workshop, which consists of roof fans blowing air onto moist pads and uses 70 percent less energy than conventional cooling systems by avoiding the need for mechanical cooling. Ventilation is optimized by variable speed drives, heat recovery units and demand control through occupancy sensors and/or carbon dioxide detection.

Bentley Works Actual embodied carbon emissions from building materials (%)



- Metal - 50.70%
- Concrete & concrete products - 41.50%
- Internal finishes - 4.6%
- Glass - 1.8%
- Insulation - 0.8%
- Other - 0.6%



The project installed a site-wide biomass-fuelled district heating system to provide efficient heating and hot water.

The new workshop and office buildings maximize daylighting through large windows and skylights to reduce artificial lighting requirements, and efficient LED lighting is used throughout to reduce lighting energy by around 20 percent compared with high frequency fluorescent light fittings. The workshop uses photoelectric dimming to automatically adjust lighting according to daylight levels and occupancy sensors are used in the offices, toilets and storerooms to help optimize lighting.

Other energy efficient measures include elevators with regenerative drives that realize 40 percent energy savings, efficient IT equipment, and a comprehensive Building Management System that monitors electricity, water and heating consumption to allow operation to be refined over time.

Renewable energy

The Bentley Works site is equipped with a solar photovoltaic system and two biomass boilers to generate on site energy and ensure net zero carbon. The roof-mounted photovoltaic system is designed to annually generate 43.5 MW of electricity, which amounts to around 70 percent of the site's energy (excluding tenant electricity loads) and offsets electricity costs through a Feed in Tariff.

Two 156 kW biomass boilers deliver heating to the site's district heating system and provide around 30 percent of the site's total energy. The boilers are fuelled by waste biodegradable oils used by Skanska's equipment and locally sourced wood pellets. Waste oils from the workshop provide around 25 percent of the site's heating and help to reduce operational waste.

Carbon

Carbon footprinting

The team conducted a preliminary embodied carbon footprint during the design phase and calculated the actual project embodied carbon emissions. The project's actual embodied carbon emissions amounted to 3,229 tCO₂e, which included 3,082 tCO₂e emissions from building materials, 141 tCO₂e from fuel and 6 tCO₂e from construction site electricity, heating and cooling during construction.

Embodied carbon savings

The team used the preliminary carbon footprint to identify potential carbon savings and ultimately reduce the total embodied carbon footprint by 403 tCO₂e or 11 percent. Carbon savings were realized through smart design by reducing the amount of building materials required. For example, the amount of floor slab concrete was reduced by over 800 tons by using hollow core slabs, piling concrete was reduced by over 400 tons and façade steel by around 30 tons.

Additional carbon savings, which have not been quantified, were achieved by reusing 6,000 m³ of material on site as fill material rather than transporting it off site, the reuse of a piling mat, and the usage of a geotextile in the carpark that avoided the need for excavation and aggregate. The early installation of the photovoltaic array provided zero carbon electricity during part of the construction phase.

Materials

Waste management during construction

The project met Skanska's zero waste criteria by not sending any construction waste to landfill. The team worked to minimize waste generation, which was 72 percent better than the industry norm (ton/m² gross internal floor area). Construction waste was minimized through the team's extremely resource efficient mentality prior to any recycling and recovery, including waste management planning and careful waste segregation.

Specific measures that reduced on site waste generation included off site modular construction, off site manufacturing of workshop steel and cladding, reusing the piling matt between the workshop and office building, and refurbishment of the paint shop rather than demolishing and rebuilding it. In addition, 6,000 m³ of material, including all demolished concrete and brick from existing structures on site, was crushed and reused on site as sub base to reduce demolition waste.

Environmentally responsible materials

Zero hazardous materials were used on the project, including non-toxic substances, natural materials and environmentally certified materials, as well as materials with recycled content. Zero Volatile Organic Compound (VOC) substances included the indoor and outdoor paint, internal glues, carpets, finishes and materials. Skanska replaced potentially hazardous PVC flooring with linoleum flooring made from natural pulp. All timber used on the project was certified according to the Forest Stewardship Council (FSC) and all main construction materials were sourced from ISO 14001 (Environmental Management certified) suppliers. Skanska also helped some local suppliers to achieve BES 6001 (Responsible Sourcing of Construction Products) certification during the project. Materials with recycled content included the feature reception flooring, which was made with recycled glass.

Operational waste management

Bentley Works already achieves zero operational waste to landfill. The redeveloped site helps to reduce operational waste through comprehensive waste sorting facilities and by using waste biodegradable oil for heating.



Water

Water efficiency

Bentley Works uses 70 percent less water in total than the industry benchmark (BREEAM). The site also meets Skanska Deep Green requirements for net zero potable water use, as potable water is only used for human consumption. A rainwater harvesting system meets the site's entire non-potable water requirements, such as for toilet flushing, the evaporative cooling system and the jet wash. Efficient water fittings, such as low-flow taps and dual flush toilets, have been fitted throughout the office and workshop buildings and toilet water connections are automatically switched off when not in use. Water is also harvested and reused from equipment wash areas.

Stormwater management

Bentley Works and the surrounding residential areas have been affected by localized flooding in the past. The redevelopment has reduced the risk of flooding by capturing and reusing stormwater on site. The site also now includes more landscaping, green roofing and a grass swale that has been created to help reduce surface runoff and increase rainwater infiltration.

Other Green Aspects

Promoting biodiversity

Bentley Works was part of the Natural Capital City Tool (NCCT) research project, which aims to evaluate and improve natural capital in cooperation with the University of Birmingham, Birmingham City Council and other partners. New landscaped areas were created on the site, including a variety of locally relevant species to promote biodiversity and improve ecology. The site's landscaping and green roofing can provide habitats for urban wildlife. Site landscaping also includes a living wall that provides an outdoor screen between the vehicle wash area and the car park.

Social Aspects

Community communication

Bentley Works is situated in a residential area and communication with local residents was an important aspect of the project. The team held public open days and consultations with local stakeholders prior to construction, which it won a Pre Construction Considerate Constructors Scheme award for. During construction, regular letter drops were made to inform neighbors of planned site activities.

An open day was held for the staff and pupils of a local primary school that provided an insight into the project and helped raise awareness of road safety. The school also supported the team with its entry for the Considerate Constructors Scheme Site Hoarding Competition submission, which it won the Runners Up Award 2014 for.

Occupational health and safety

There were two minor accidents on site during construction. The project embraced the Skanska Injury Free Environment (IFE) initiative, which seeks to embed a culture of care and concern for people. This has involved all contractors participating in Skanska funded safety training, with special focus and training on subcontractors. Occupational Health visits have also been organized on site. Other significant safety measures included establishing an excellent working relationship with the operator of the electrified rail line that borders the site's eastern boundary.

All work along the boundary was closely regulated and controlled with the operator to minimize risk.

Promoting healthy working environments

The Bentley Works office and workshop promote healthy working environments for occupants and workers. The buildings have good access to natural daylight, with skylights in the workshop and a central light well in the office. No substances that are hazardous to human health have been used in the construction. An environmental thermal comfort modeling analysis was carried out, which helped to select suitable ventilation and cooling systems. The workshop is equipped with a Local Exhaust Ventilation system to remove welding fumes from indoor working areas. Pre-move and post-move employee surveys were conducted that demonstrated a 34 percent increase in the overall perception of the office.

Promoting more sustainable modes of transport

The site has 24 bike spaces with changing and showering facilities to encourage employees to cycle to work. There are also electric vehicle charging points in the car park. Bentley Works has good access to public transport, with a bus stop immediately adjacent to the site entrance and a railway station 100m meters away.

Contributing toward sustainable development

The project contributed toward sustainable development by redeveloping an existing urban site. The site is situated in a built up urban area with good access to services and amenities.

Economic Impacts

Local economic benefits

Bentley Works has been an important local employer in Doncaster for over a century.



The redevelopment secured 170 existing jobs and created over 70 new full-time positions. The site also supports over 120 supplier jobs in various local companies.

During the peak of construction, 60 people worked on the redevelopment project. The main contractors were from the surrounding Yorkshire area, including the groundworks, structural steel, and mechanical and electrical contractors. Locally sourced materials included aggregate sourced from local quarries and structural steelwork.

Government Regional Growth Fund

Skanska secured a US\$ 2 million grant for the Bentley Works redevelopment project from the government's Regional Growth Fund, which is intended to secure existing jobs and create new jobs in the north east of England.

Financial savings

Skanska used lifecycle optioneering to identify the most optimal solutions that provide the best long-term value for money and environmental efficiencies throughout the lifecycle of the workshop and office. Consequently, the additional cost of the various green solutions incorporated into the project have a total payback period of 11 years. The payback decreases to 8 years when considering reduced absenteeism, which equated to US\$ 36,000 in reduced costs in 2015. This includes the biomass boiler with an estimated 3.8 year payback period and the photovoltaic system with a 7.4 year payback, which were both supported by Government incentive schemes. The team estimated that the use of external LED lighting systems annually saves around US\$ 2,000 and 3.2 tCO₂e.

Learning From Good Practice

Skanska's Color Palette and Deep Green objectives, combined with lifecycle optioneering, provided valuable guidance to cost-effectively redeveloping Bentley Works to high standards of green construction. The project showcases Skanska's approach to sustainability and is part of the company's work to green its business.