THAMESLINK PROGRAMME

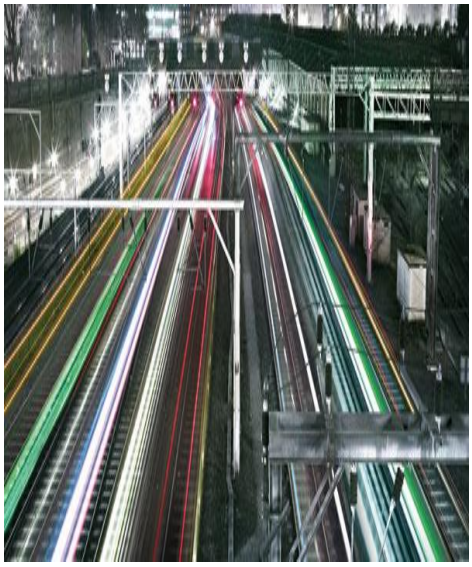
Sustainability Best Practice Case Study

Delivering low carbon transport solutions

The UK is legally bound by the Climate Change Act to reduce its carbon emissions by 80% by 2050 to prevent climate change. In response to this legislation the government and Office of Rail Regulation has asked Network Rail to reduce its carbon emissions over Control Period 5 and Infrastructure Projects has responded to this by committing to reduce its carbon emissions to meet UK targets.

Major infrastructure programmes such as the Thameslink Programme have an important role in helping the business and the UK in meeting its carbon targets. Whilst reducing carbon emissions and tackling climate change may be seen as long term problems not within our power to influence, the short term decisions we make when delivering infrastructure projects have significant impacts not just on our climate but on the sustainability of our business.

Over the last several years the Thameslink Programme has been tackling the complexity of reducing carbon emissions in the design, construction and operation of a large infrastructure programme to help meet the carbon targets for both the business and the UK. This best practice case study summarises our journey and highlights our successes and lessons learnt.



Carbon and climate change – a global threat

It is well documented that man-made carbon emissions has led to increasing global temperatures and climate change. Since pre-industrial time our carbon emissions have increased by 40% and global temperatures have risen by 1°C. As a country we are already feeling the effects of climate change through extreme weather events such as wide spread flooding and heat waves, which has had significant impacts on our economy, businesses, communities and individuals.

Extreme weather and climate change is one of the top global risks in 2016. One month of bad weather costs the UK economy £14 billion.

In 2008 the Climate Change Act was passed which requires the UK to reduce its carbon emissions to tackle climate change. This act legally binds the UK to reduce its emissions by 34% by 2020 and 80% by 2050 and recent reports show we are on track to meet our target.

However, despite the UK efforts to reduce carbon emissions tackling climate change requires a global approach. In December 2015 global leaders agreed at COP21 (United Nations Climate Change Conference) to limit the rise of temperatures to well below 2°C, with efforts to hold it to 1.5°C. For the first time in history this agreement has highlighted the global importance of reducing carbon emissions and temperatures to tackle climate change.

The rail carbon challenge

Rail is already recognised as a low carbon mode of transport and plays an important role in helping the UK deliver its carbon targets through delivering a low carbon transport system. However, transport as a whole is a growing market and its carbon emissions are amongst the fastest growing of all sectors therefore to continue to meet our business and UK targets industry efforts are required to improve energy efficiency.

In response to the challenge of climate change the rail industry acknowledges that it needs to deliver significant carbon savings even within the constraints of growth, improved service delivery and overall value for money. With continuing rising energy costs the decision to reduce carbon emissions is now both a business and environmental decision.

For further information on our best practice case studies please contact Amelia Woodley – Thameslink Programme Environment Manager Amelia.Woodley@networkrail.co.uk

To meet the rail carbon challenge the Office of Rail Regulation (ORR) has asked Network Rail (NR) to;

'Measure and reduce the amount of carbon embedded in new infrastructure and to publish regular, accurate data on carbon emissions and energy efficiency for both traction (train-related) and off-track operations such as offices and stations. It also needs to show how it will manage anticipated climate change'.

Plans are already underway through the electrification of a number of routes, delivering carbon reductions through our electricity supply, investing in new clean technology and building climate change planning into infrastructure plans. However, to meet this challenge further action is still required by the business across Control Period 5 (CP5) and beyond.

The RSSB (Rail Safety and Standards Board) has estimated that through implementing a number of interventions the rail industry could **save over 1 million tonnes of C02 and over £100,000,000 in CP5 rising to 2.8 million tonnes of CO2 and over £350,000,000 by the end of CP6 in 2024.**

Research by RSSB shows that the whole system carbon footprint of rail is comprised of **traction energy** (emissions from consumption of energy to move trains), **non-traction energy** (emissions from offices, stations, depots, signalling and transportation and installation of products on the railway) and **embodied emissions** (emissions from the extraction, transportation, manufacturing and fabrication of materials for the railway).

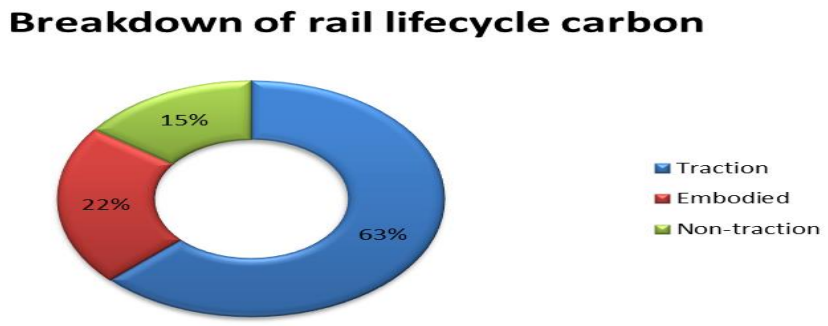


Figure 1 – whole system carbon footprint of rail industry

The RSSB highlighted that through implementing a number of interventions NR could help move us towards a genuine low-carbon, low-cost railway. Examples of these interventions include;

- Using an industry developed carbon accounting methodology in major infrastructure contracts and setting targets for reducing embedded carbon.
- Including whole life and whole system energy costs in investment decisions.
- Installing energy efficient lightning (LED (light emitting diodes)) into our estate.
- Fitting solar PV (photo-voltaic) to long life infrastructure assets at key locations.

The role of Infrastructure Projects in reducing carbon emissions

Infrastructure Projects (IP) is delivering the biggest investment in the railway since the Victorian era. When we design and build iconic new stations, signalling upgrades, electrification, track renewals and bridges the whole life cost investment decisions we make, the materials we select at design and the energy sources we procure during construction and operation all have an impact on the carbon emissions we emit over the life of that asset.

Our biggest impacts relate to non-traction and embodied carbon emissions therefore our focus should be on making investment decisions on a sound whole life cost basis as opposed to capital cost, designing assets that are energy efficient, using materials with a low embodied carbon and where possible incorporating alternative energy sources such as solar PV, ground source heat pumps and/or LED lightning. When we build assets we should also prioritise opportunities to reduce the carbon impact of construction works. In response to the ORR's requirements IP has committed to;

'Reduce carbon emissions to help meet the UK target'

'To champion the use of alternative material specification and technology to reduce embodied CO2'

'To design in the use of alternative energy sources in the operation of the railway'

'To reduce CO2 generated over the contract programme from construction activities'

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A sustainable Thameslink Programme

The Thameslink Programme (TLP) will transform travel north to south through London. When Thameslink completes in 2018 journeys and connections will be improved giving customers better travel options to more destinations than ever before and modern track and trains will make journeys more reliable.

Sustainability is right at the heart of the Thameslink Programme and our vision is to **'deliver transport benefits to budget that represents value for money and creates an overall positive impact on the community and the environment'.** To do this we're working to ensure that not only do we achieve the highest standards in sustainability, but we uphold this principle on all fronts.

As part of our vision the TLP has committed to **"minimise the levels of carbon generated over the whole life of TLP'** through **"delivering energy and carbon reductions in line with project targets and monitoring and reporting progress in line with the TLP Carbon Policy".**

In 2015 the TLP reported that it is now successfully delivering on its carbon objective as a result of several years of collaborative work between NR TLP project teams and suppliers. This case study summarises how we achieved this.

How TLP tackled the rail carbon challenge

Learning from our earlier successes and challenges

In the early stages of the TLP known as Key Output 1 (K01) a blanket carbon target of 20% reduction was applied to all projects and suppliers. This target was often difficult to achieve as different types of projects had different carbon impacts.

Our large station projects such as Blackfriars were successful in delivering carbon reductions through the installation of a large solar PV array across the station roof; however other projects such as Farringdon Station struggled to implement energy efficient measures above their legal requirements. Our track and signalling works also had different carbon impacts to our stations and civils and were only able to make modest carbon reductions primarily during construction. As a programme we also struggled to manage our construction carbon emissions as a result of the prevalent use of energy inefficient generators across our project sites. Through individual interventions we started to achieve carbon reductions in design and construction however we realised that further work was required going forward.

Upon completion of K01 the TLP partially achieved its design and construction carbon targets and recognised that a different approach was required for the next stage of the programme known as Key Output 2 (K02).

Understanding our carbon impacts

In K02 the TLP undertook a carbon footprint study of the programme to understand where our key carbon hotspots were so we could focus our reduction efforts on our biggest carbon impacts. The study identified that the total footprint of TLP was 800,000 tonnes of CO2 across three main carbon hotspots;

- Embodied carbon within materials such as concrete and steel
- Construction energy
- Operational (In use) energy

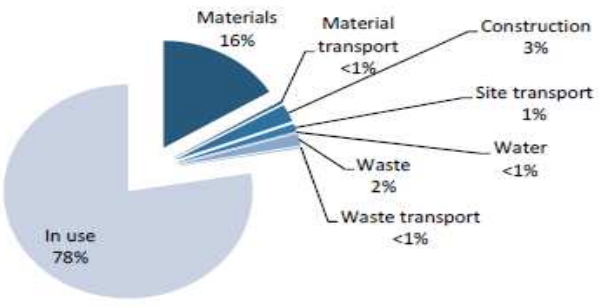


Figure 2 – TLP carbon footprint overview

Figure 3 - 1 million tonnes of embodied C02 in timber

At the time undertaking a carbon footprint was an innovative approach for the TLP as the NR business did not have a company-wide approach to measuring and managing its carbon impacts. Whilst the footprint provides us with an indication of our carbon impacts there were limitations to the assessment such as lack of available design information and data, time required to collect data and lack of consistent or agreed carbon conversion targets for railway projects.

Did you know?
NR has been working with other industry bodies such as TfL, RBBS, HS2 and Crossrail to develop a Rail Carbon Tool to help the industry measure, monitor and seek to reduce embedded carbon in railway infrastructure. The tool has been piloted IP to accurately and efficiently measure the embodied and whole life carbon on projects thus supporting the business to reduce embodied carbon on rail projects and reduce costs. The tool is aimed to be used during design and construction is available to all NR IPs and suppliers.

Setting clear objectives and targets for the programme and supply chain

Following the study the TLP developed a clear carbon objective and associated targets which were incorporated into our Sustainability Strategy and cascaded across the NR TLP project teams and suppliers.

Each project and supplier was required to develop a carbon and energy demand assessment based on their key carbon hotspots, to set appropriate carbon reduction targets for design and construction, to develop a plan to achieve these targets and to monitor and report on progress.

A workshop was held with each NR TLP project team and supplier to identify the project carbon hotspots and to set carbon reduction targets and implementation plans. The workshop also provided the opportunity for the TLP to raise awareness on our carbon impacts and to provide the project teams and suppliers with the skills and competence to deliver our objective and targets.

Implementing clear policies and procedures

The TLP also developed and rolled out a Carbon Policy and Energy and Carbon Reductions procedure, which our NR TLP project teams and suppliers were required to comply with to meet our carbon objectives and targets. Reflecting on our learning in K01 we realised that as a client we needed to raise the bar and be clear what we expected from our supply chain. Also at that time the wider NR business did not have a uniform approach or tools for managing its carbon impacts therefore the TLP felt it was important that we provided as much clarity and guidance as possible to our project teams and suppliers. Both our policy and procedure were embedded in our ISO14001 Environmental Management System and our requirements were cascaded to our suppliers through our contract and procurement process.

Building the business case

Incorporating energy efficient measures requires a robust whole life cost study early in the investment and design phase. For the TLP the business had not at that time released its whole life costing manual therefore the TLP Consents, Sustainability and Property (CSP) team worked closely with project teams, suppliers and the TLP executive team to develop and sell the business case behind interventions such as renewable energy and LED lightning. Incorporating energy efficient technologies require an initial capital cost therefore it is important that the operational costs and savings are captured to make such initiatives viable.

Driving our programme and supply chain to perform

Progress against our carbon and energy plans were monitored quarterly with the NR TLP project teams and supply chain and our performance was regularly reported to the TLP executive team. For several years the TLP were partially achieving its carbon objective as project teams and suppliers struggled to incorporate energy efficient measures into design and construction. To support this challenge we ran a programme wide internal carbon audit to assess and understand where we were in our carbon journey. The carbon audit provided an opportunity to delve deeper into the how our project teams and suppliers were meeting our carbon objectives and targets and to support them on overcoming any barriers they were experiencing. Our suppliers fed back that they found this process incredibly useful in helping them on their carbon journey.

As a programme we also measured our construction energy via the NR energy and carbon key performance indicators (KPIs) each period. Our KPIs were regularly reported across the programme and to our TLP executive team. We challenged our construction energy use on a continual basis to drive project teams and suppliers to look for alternative energy sources as opposed to relying on more conventional energy intensive sources such as generators.

Reducing carbon emissions in design – best practice

World's largest solar bridge

At Blackfriars station the NR TLP project team and suppliers Jacobs and Balfour Beatty undertook an energy and carbon assessment which identified the opportunity to install a PV array across the bridge's roof canopy to meet our carbon objective.

Working together with Solar Century the NR TLP project team and Balfour Beatty installed over 6000m2 of PV panels onto the new station roof making it the world's largest solar bridge. The installation was complex, working over a river next to live overground and underground railways. The roof provides 1.058MW of renewable electricity at its peak (up to 50% of the stations energy) powering lightning, ticket machines, staff accommodation and office facilities and any excess electricity is fed back into the national grid.

The energy generated by the cells will reduce CO2 emissions by 500 tonnes a year, equivalent to flying from London Heathrow to Paris (return passenger trip) approximately 4508 times. The scheme helps to demonstrate the benefits of solar power and renewables on Britain's rail network.

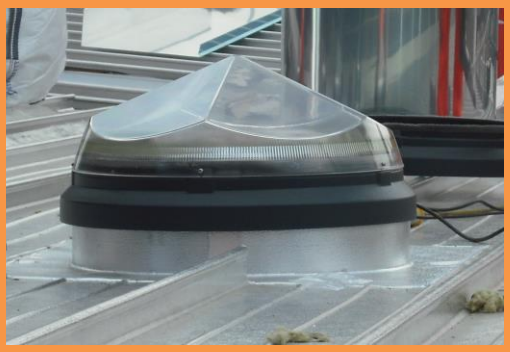
The project won a CEEQUAL Excellent Award, CEEQUAL Outstanding Achievement Award for energy and carbon, the Renewable Energy Association Project Award and was runner up for Best Initiative by a Large Business at the Climate Week Awards

In addition to the PV array Monodraught sun pipes were installed in the employees areas to reflect sunlight from the south facing roof to brighten areas where daylight cannot reach.

The pipes reduce the energy use from lighting by 75% in daylight hours, reduced the need for cooling from lightning and does not require any maintenance. The system also offers a better working environment and health benefits from increased natural lightning.

PV array at Blackfriars (above)

Sun pipes (below)



Ground Source Heat Pumps at London Bridge

At London Bridge the NR TLP team and suppliers Costain and GI Energy are installing 180 geothermal loops and a ground source heat pump into planned foundation piles to heat and cool the newly designed station generating 126 tonnes of CO2 savings per annum for the operational station.

The geothermal piles consist of 2 closed-loop ground source heat pump systems which span the length of planned foundation piles. Their purpose is to deliver support to the building at the same time as acting as a heat source in winter and a heat sink in the summer. They are able to do this by using the earth's natural heat which is collected through the loops and carried by a heat transfer fluid to a unit in the station building.

The piles were installed as part of the initial station design to deliver the TLP's carbon objective and were later supplemented by a change in design to include a ground source heat pump which increased the efficiency of the overall savings from an environmental and financial perspective.

A whole life cost study around the addition of the heat pump was undertaken highlighting the long term benefits it would provide to the geothermal loop system despite the higher initial investment costs. It is estimated that over 10 years the pump would help the geothermal loops deliver additional energy savings of £400,000. The cost of the system including maintenance over 10 years is £130,000 which will generate a return on investment within 2.5 years.

In additional to geothermal energy the team incorporated a number of other energy efficient measures such as optimising natural daylight on platforms and concourse, high performance building envelope for retail and station accommodation, natural ventilation and free cooling, a lightning strategy including LEDs and efficient escalator and lift equipment.

Energy piles

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Reducing carbon emissions in design – best practice

Turning on the LEDs at Brighton

At Brighton the NR TLP project team and suppliers Carillion and undertook a whole life cost study of traditional halogen versus alternative lightning technologies such as light emitting diodes (LEDs) in the early and detailed design stages. This study identified a number of financial and carbon savings from installing LED lightning as opposed to traditional luminaires such as;

- Lighting can be configured to turn on/off corresponding to sunset/sunrise
- 10% reduction in the number of light fittings reducing material and installation costs
- Reduced wattage of the bulkhead fittings from 70W to 24W while meeting design standards
- Payback achieved within first year
- LED lighting is expected to save £137,000 over a 25 year period
- 25 tonnes CO2 emissions savings annually leading to a 25 year saving of 625 tonnes
- A 40% improvement on the saving anticipated in the original Whole Life Costing assessment

Brighton lighting scheme

Energy profiling of signalling equipment – a TLP first

The NR TLP project team and Siemens signalling team completed a cradle to gate energy and carbon assessment of key signalling equipment to understand the energy profiling of our signalling portfolio and enable us to focus our reduction efforts on the most energy intensive equipment.

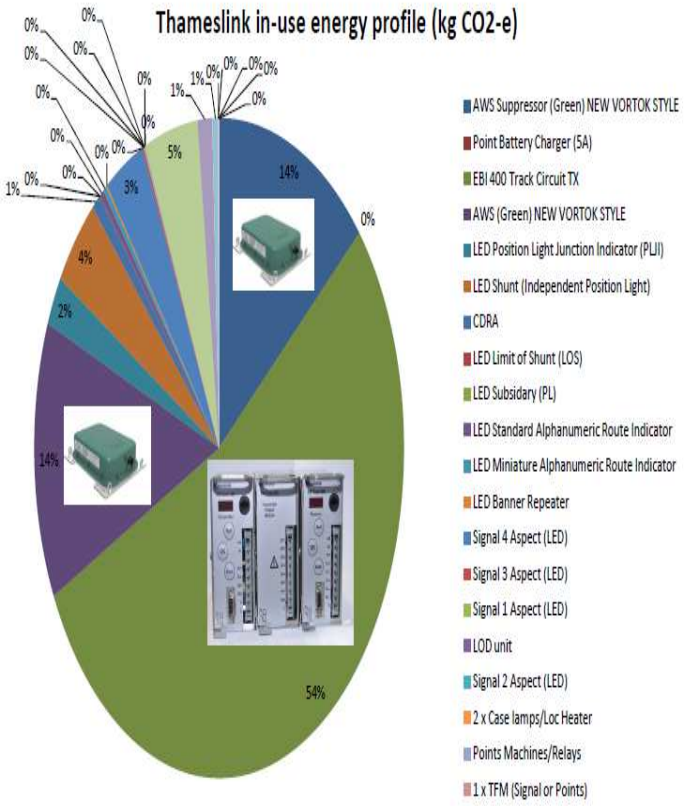
The study involved;

- breaking down each of the products into their numerous individual component parts
- determining the weight of each component
- assessing exactly what material type each component is comprised of

Each individual component was then modelled against industry carbon emission factors so as to calculate that components CO2 emissions and totalled for each product to provide that products overall carbon emissions (factor).

The team calculated that for our signalling works the annual in use energy use was 175 kg CO2 and the total project embodied carbon was 85 kg of CO2 for which they set themselves a 5% reduction.

The results highlighted that the three most energy intensive pieces of equipment were the AWS suppressor, point battery charger and EBI 400 track circuit TX which have been targeted for emission reductions.



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Reducing carbon emissions in construction – best practice

Low energy hydrogen fuel cell powered lightning

The NR TLP Structures Strengthening (SSP) and supplier Skanska have used low energy hydrogen fuel cell powered lightning system to significantly reduce disturbance to residential neighbours during construction.

The Ecolite H2 powered by the BOC Hymera fuel cell can be used in environmentally sensitive areas where emissions and noise pollution need to be minimised. There lights are virtually silent which is extremely important for works at night time in the centre of London. The Ecolite provides a number of environmental and business benefits including;

- Zero CO2 site emissions, noise, particulate emissions, fuel spills and servicing
- Operational in enclosed spaces
- Low energy LED lighting
- Fully autonomous run time between 15 to 900 hours
- Cheaper to run than standard tower lighting
- The light still offers the same performance levels to conventional solutions

Martian Lights

At London Bridge the NR TLP project team and supplier Costain have extensively used Martian Lamps. The lights provided in partnership between El Bjorn and Woodlands offer a safe lighting solution with a number of environmental and financial benefits including;

- Lights are omnidirectional and offer glare-free lighting with no shadows
- Fitted with low energy bulbs, which reduces energy consumption, extends operating life and reduces maintenance requirements
- Withstand extremely rough handling in the workplace and during transportation
- Placing these lights in a 5msq achieves a 100 lux illumination level
- Quicker to install than standard lights and extra safe due to an operational voltage of less than 50 volts
- Over 2 years the total cost per 80 lights including both running and capital costs, show Martian Lamps as a cheaper alternative than the typical fluorescent tube lights used. Although the original capital cost for the Martian Lamps is higher the running costs were considerably lower than the typical fluorescent tube lights.

Mobile hybrid lighting tower

At London Bridge the team also used a mobile hybrid lightning tower (VB9 LED battery Ibird manufactured by Towerlight) to help complete works safely during dark hours and well as offering a number of environmental and financial benefits including;

- Reduced fuel usage, carbon emissions and transport costs
- Weekly fuel savings of £118.00 per week
- The LED lamps are made from robust polycarbonate, with no glass or bulbs and offer a high resistance to breakage and explosion
- The lamps generate operative savings through reduced consumption yields (150 watts of LED power consumption yields an equivalent illumination level of 400 watts of metal halide) and a higher lifespan (70,000h as opposed to6000h life for metal halide)
- The VB9 incorporates a 170 litre capacity fuel tank, increasing the running time between refuelling. The smaller engine has reduced fuel usage by 72%, using just 3 litres of fuel per 12 hours. The tank is also bunded to avoid fuel spillage on the ground
- The air-cooled diesel engine is housed within a whisper-quiet sound proof canopy with easy access for maintenance via large lockable doors

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Reducing carbon emissions in construction – best practice

Saying no to generators

The use of generators on site has been a significant carbon and cost impact to the TLP. At its peak Blackfriars were consuming 100,000 litres of red diesel per period. To reduce our construction and carbon costs the TLP worked with site project teams and suppliers to identify opportunities to optimise mains electricity where possible.

At Blackfriars and Farringdon we redesigned the construction power to utilise mains electricity supply. The Farringdon team identified significant costs savings of £600,000 through converting to mains electricity as a result of the reduced fuel usage and generator hire costs. Mains electricity also reduced the environmental and health and safety risk from fuel movements and storage and had less impact on noise air quality.

The biggest barrier we encountered when procuring mains electricity for construction works was the long lead times required for utility providers (12-18 months) to connect supplies. Through early planning we were able to install mains supply on all our major construction sites for K02 thus limiting generator usage to small short term sites.

A small cost assessment identified that for one of our sites the cost of energy was reduced from £30,000 to £5,000 over 1 year and reduced carbon emissions by approximately 99%. Whilst the initial outlay for mains electricity is higher the system's payback was reached within 5 months.

At Blackfriars the team also took advantage of its position on the River Thames moving 22,000 of materials by barge. This removed 600 lorries from congested London roads and saved 9 tonnes of CO2

Keeping dry

With over 300 operatives at London Bridge the welfare facilities constant heating and drying to ensure both day and night shifts have dry clothing and personal protective equipment. This however is costly to run and uses a substantial amount of energy. To reduce energy usage and operational costs the welfare rooms were kitted out with two energy efficient dehumidifiers (El Bjorn A 155HW which uses a water-based auxiliary heating offering a more energy efficient solution to standard dehumidifiers and shorter drying times) offering a sustainable short term solution to the heating and draying of welfare rooms during the project construction phase.

Over a 4 year period the dehumidifiers will generate a carbon saving 167 tCO2, an energy saving of 181063 kWh and a financial saving of over £15000. The increased capital cost and small installation cost of the dehumidifiers is paid back in 14 weeks which means over the project duration total whole life saving of around £14,000.

Switching it off

With a large on site construction team at Beazley House the London Bridge project team and supplier Costain implemented a number of innovative solutions to reduce energy and carbon usage from computer usage and printing.

Through partnering with Streamwire London Bridge brought in a tool called 'Caretaker Software' to reduce the energy and carbon from computers being left on or on standby. The software connects to desktops and monitors the energy usage enabling the team to see where energy is being wasted and saved. When screens are locked the software will put the computer to sleep after a period of inactivity to reduce energy output.

The system also educates the user on where energy savings can and are being made. This has created more awareness of energy usage and savings encouraging a positive change in office behaviour with more staff shutting their computer down completely after work and turning their screens off when not at their desk. From an initial 3 month trial it is estimated that the system will save £85,000 and 430 tonnes of CO2 over the remainder of the project.

The team also installed an equitrac print management system to reduce printer wastage and costs. This system has provided a number of benefits including

- Reduced paper supply costs
- Reduced power consumption
- Reduced toner usage
- Less wear and tear on devices prolonging life
- Fewer maintenance visits and downtime
- Reduced carbon footprint through reduced paper needs, transport, manufacture, recycling costs
- When applied over 7 devices over 5 years the anticipated savings (after set up costs) are estimated to be £40,000.

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With Thanks

The Thameslink Programme would like to thank the following Network Rail project and suppliers

- London Bridge Station Redevelopment team and WSP and Costain
- Bermondsey Dive Under team and Skanska
- Blackfriars Station project team and Jacobs, Solar Century and Balfour Beatty
- Farringdon Station project team and Costain
- Track project team and Balfour Beatty Rail
- Signalling project team and Siemens
- Outer Areas project team and Carillion

Further information

For further information on the Thameslink programme please see below;

Thameslink Programme http://www.thameslinkprogramme.co.uk/
Thameslink Sustainable Development Policy http://www.thameslinkprogramme.co.uk/approach
COP21 http://www.cop21paris.org/about/cop21
RBBS http://www.rssb.co.uk/improving-industry-performance/sustainable-development/sustainable-rail-programme
Network Rail Sustainable Development Strategy
http://www.networkrail.co.uk/browse%20documents/strategicbusinessplan/cp5/supporting%20documents/transforming%20network%20rail/sustainable%20development%20strategy.pdf