working with

# National Library of Scotland
# Carbon Management Programme
# for smaller organisations

## Carbon Management Plan (CMP) 2010 - 2015

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**Approval route: Senior Management Team**

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# Contents

## Foreword from Martyn Wade, National Librarian and Chief Executive

The National Library of Scotland (NLS) is an information treasure trove of Scotland's knowledge, history and culture, with millions of books, manuscripts and maps covering every subject. Its collections have their origins in the Advocates Library which opened in 1689. They have been growing ever since and today over three kilometres of material is added every year.

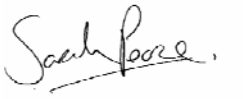
As custodian of such a rich resource, NLS has always had to have an eye on the medium and long term future. Through its lead by introducing the most ambitious climate change legislation anywhere in the world, the Scottish Government has demonstrated the importance that it places on the challenge of climate change. The Climate Change Delivery Plan and the recent consultation paper on the Energy Efficiency Action Plan give a clear lead as to the path NLS should take to both contribute to the move to establish Scotland as a low carbon economy and ensure that it continues to be an efficient, thriving organisation.

This Carbon Management Plan firmly demonstrates the commitment of NLS to reduce its carbon footprint and deliver energy efficiencies. The target which has been set is challenging, but through the creativity and energy of its staff working at all levels it is achievable.

Martyn Wade
National Librarian and Chief Executive

## Foreword from Sarah Pearce TUC GreenWorkplaces Project Leader

The TUC welcomes the strong focus within the Carbon Management Plan at NLS on staff engagement and behaviour change activities that will help reduce energy and resource use at NLS. The plan, through the GreenWorkplaces project, creates a genuine opportunity for union reps and members to play a key role in securing consultation and the active participation of union members in climate change initiatives at NLS.



Sarah Pearce
TUC GreenWorkplaces Project Leader

## Foreword from the Carbon Trust

Cutting carbon emissions as part of the fight against climate change should be a key priority for public sector organisations - it's all about getting your own house in order and leading by example. The United Kingdom government has identified the public sector as key to delivering carbon reduction across the United Kingdom inline with its Kyoto commitments and the Public Sector Carbon Management programme is designed in response to this. It assists organisations in saving money on energy and putting it to good use in other areas, whilst making a positive contribution to the environment by lowering their carbon emissions.

National Library of Scotland was selected in 2009, amidst strong competition, to take part in this ambitious programme. National Library of Scotland partnered with the Carbon Trust on this programme in order to realise vast carbon and cost savings. This Carbon Management Plan commits the organisation to a target of reducing CO2 by 30% by 2014/15 and underpins potential financial savings to the organisation of around £620k over the course of the project and £160k annual recurring savings thereafter.

There are those that can and those that do. Public sector organisations can contribute significantly to reducing $CO_2$ emissions. The Carbon Trust is very proud to support the National Library of Scotland in their ongoing implementation of carbon management.

Richard Rugg
Head of Public Sector, Carbon Trust

## Management Summary

In recent years a significant number of documents have been produced by both the United Kingdom and Scottish governments on the matter of climate change and energy security. Two separate issues, which have become inexorably enmeshed with one another. How do we meet the multiple challenges of generating sufficient supplies of affordable low carbon energy, reduce the United Kingdoms increasing dependence on imported fossil fuels as North Sea reserves decline and manage the problem that many of our power stations are coming to the end of their lives?

The fundamentals of the United Kingdom Low Carbon Transition Plan are also the fundamentals of the energy security strategies, namely:

1. First minimise energy use
2. Diversify the energy mix
3. Deal with the residual risks

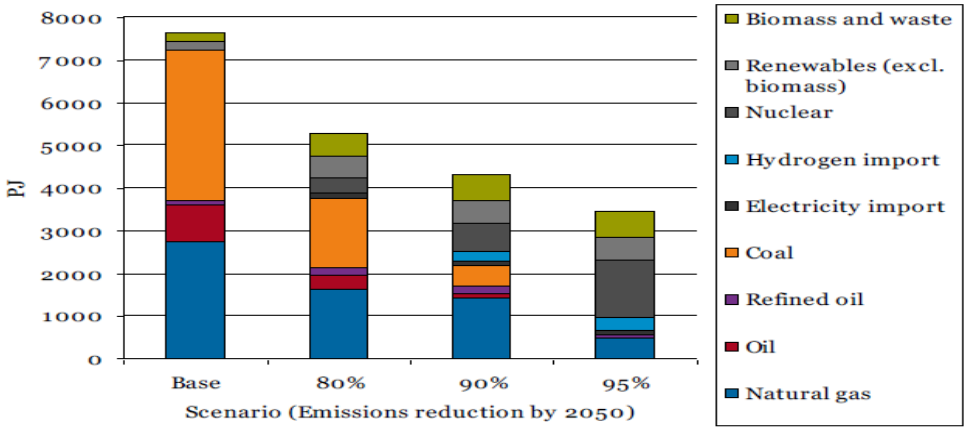



**Figure 1 Scenarios for United Kingdom energy demand in 2050** [1]

By 2050 virtually all United Kingdom oil and gas requirements will have to be met through imports. Figure 1 shows the predicted United Kingdom energy mix which would result by 2050 if we do nothing and under scenarios in which United Kingdom carbon emissions are reduced by 80%, 90% & 95%.

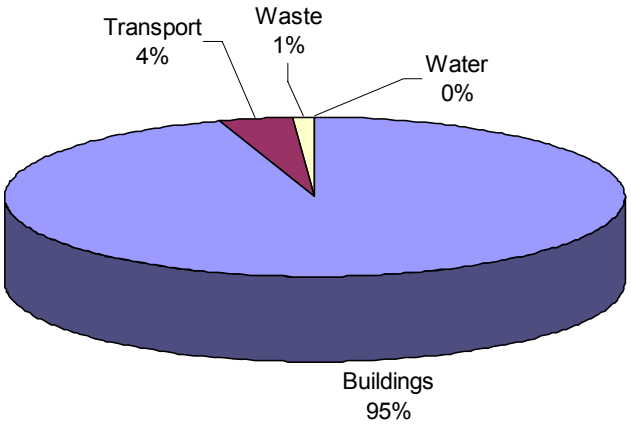
This is important to NLS because the United Kingdoms increasing dependence upon imported fossil fuels will make it more reliant upon energy from regions of the world which are potentially politically unstable, at a time that it is anticipated that the global demand for energy will rise by 50%[2]. The United Kingdom and by default NLS exposure to energy price volatility is therefore increasing. The United Kingdom mitigation strategy must therefore also become an NLS strategy.

During the period 2008/09 NLS produced 3390 tonnes of $CO_2$ emissions from the delivery of organisation functions. This represents 9.3 tonnes per day, equivalent to 9300 1kg bags of sugar.

**National Library of Scotland will reduce $CO_2$ emissions from its operation by 30% by the end of financial year 2014/15 from 2008/09 levels.**

[1] AEA (2008) MARKAL-MED model runs of long term carbon reduction targets in the UK for the Committee on Climate Change report “Building a low-carbon economy – the UK’s contribution to tackling climate change” Dec 08

As can be seen in Table 1, 95% of these emissions were the result of the 7.8 Megawatts of energy that were consumed within its properties at a cost of £585k. Placing this cost in context, it equates to almost half of the total Collection Purchase Fund or 25 band 3 posts[3] for the same period.




| | Total | Buildings (energy) | Transport | Waste and Water |
|---|---|---|---|---|
| **Baseline $CO_2$ emissions (tonnes)** | 3390 | 3228 | 130 | 33 |
| **Baseline Cost (£)** | £ 752,557 | £ 585,247 | £ 105,264 | £ 78,254 |

**Table 1 Summary table of emissions and value at stake for baseline year 2008/09**

Electricity consumption accounted for the majority of these carbon emissions, and incidentally the majority of the cost. The NLS carbon reduction strategy, whilst comprising of many initiatives and projects, is essentially therefore very simple:

NLS will target electricity consumption as this will have the most significant impact in reducing both carbon emissions and cost.

[2] Cabinet Office, National Security Strategy of the United Kingdom – Security in an interdependent world, 2008, p18, 3.38

[3] Inclusive of salary, pension contribution and NI

## How will this be achieved?

For this CMP to be successful, carbon reduction and energy efficiency have to become part of the way NLS does things. This will need changes to policies, procedures and processes, financial investment and engagement with other organisations, but above all it will require the creativity, knowledge and energy of staff and contractors to make it happen.

NLS will pursue seven strategic themes:-

1. Harnessing the creativity and knowledge of staff
2. Integrating carbon reduction in policy, processes and planning
3. Robust data gathering, monitoring and reporting
4. Primacy of energy reduction
5. Integrating the CMP and Property Asset Management Plan
6. Specific focus on environmentally controlled collection storage
7. Secure capital funding

Figure 3 (over leaf) shows the predicted carbon reductions by project over the course of the project and Figure 4 shows the predicted cost savings. Table 2 shows the predicted cost profile required to achieve this, together with the anticipated recurring annual savings on completion of each project.

These predictions do not however include project NLS12 - Low Energy Collection Storage. This is potentially the most significant project within the NLS Carbon Management Plan. Success will not simply be in terms of energy and carbon reductions at NLS, but also influence upon the wider debate within the museums, galleries and archives communities surrounding the future of internationally agreed standards for environmental conditions for collections.

During the development of this CMP the National Library of Scotland and the National Galleries of Scotland undertook a shared services initiative which brought together Tim Padfield[4] and conservation and estates professionals from the two organisations and the National Archives of Scotland to begin to explore this field. NLS will actively develop this project during the course of this CMP.

A high level study of the microclimate at the Causewayside property, prepared by Tim Padfield is appended in Appendix C

[4] Tim Padfield has a chemistry degree from Oxford University and a PhD in building physics from the Technical University of Denmark. He has worked as a conservation scientist at the Victoria and Albert Museum, the Smithsonian Institution and the National Museum of Denmark, with periods away from the conservation community in the Earth Sciences Department of the University of Leeds and the Civil Engineering Department at the Technical University of Denmark. He is now an independent consultant specialising in microclimate studies of museums and historic structures.

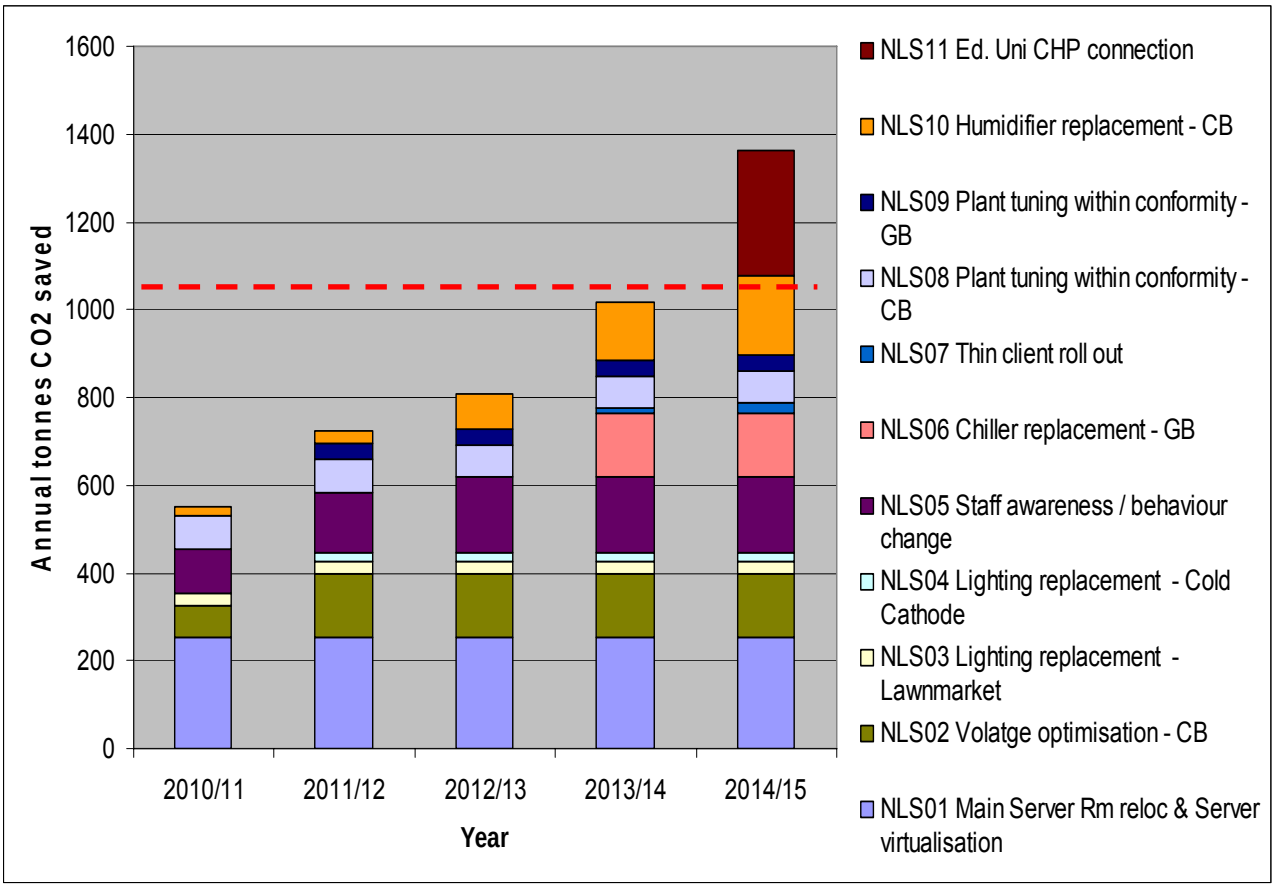



**Figure 2 Predicted annual carbon reduction by project over the CMP**

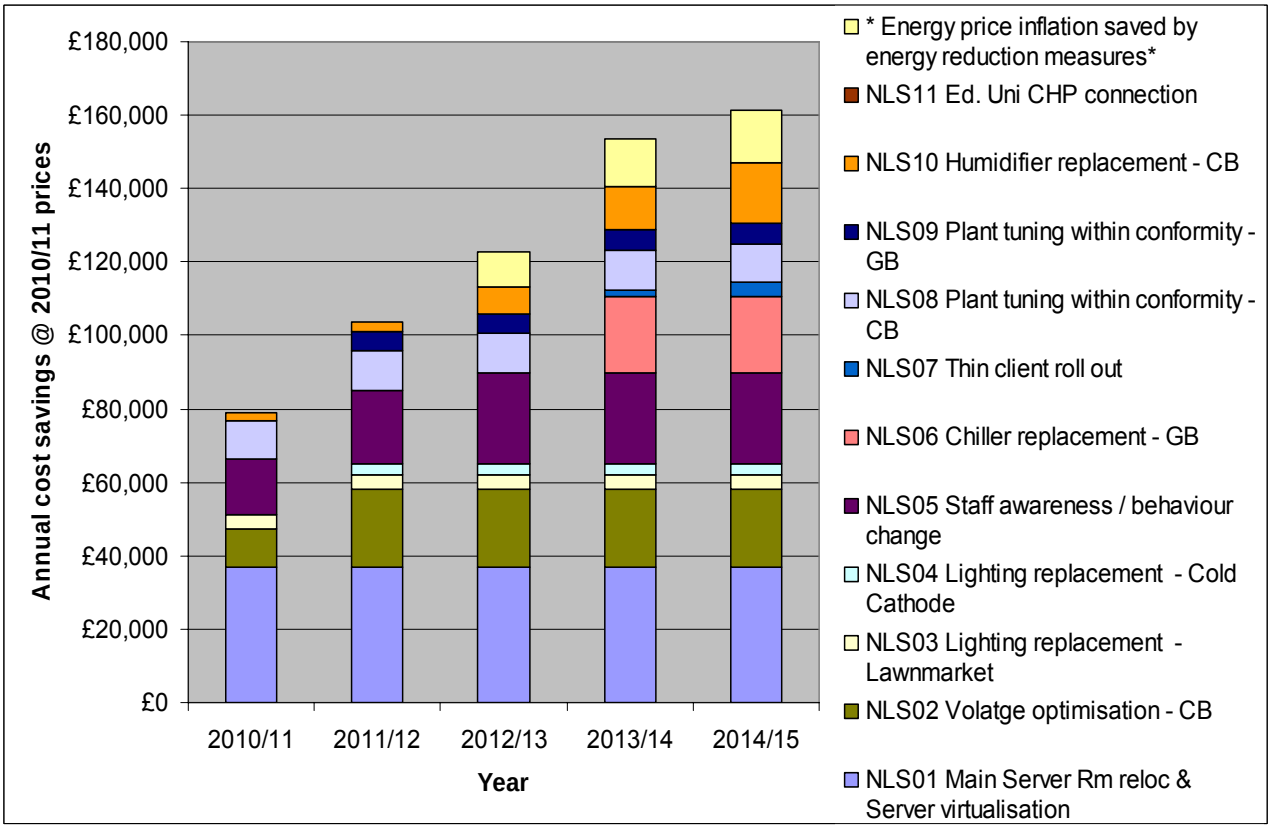



**Figure 3 Predicted annual cost savings by project over the CMP**

| Project | | Capital Requirement over CMP | | | | | Total capital over CMP (£) | Total annual recurring CO2 savings (Tonnes) | Total annual recurring savings (£) |
|---|---|---|---|---|---|---|---|---|---|
| | | 2010/11 | 2011/12 | 2012/13 | 2013/14 | 2014/15 | | | |
| **NLS01** | Main Server Rm reloc & Server virtualisation | £138,000 | £0 | £0 | £0 | £0 | £138,000 | 253 | £36,700 |
| **NLS02** | Voltage optimisation - CB | £50,000 | £0 | £0 | £0 | £0 | £50,000 | 147 | £21,500 |
| **NLS03** | Lighting replacement - LB | £50,000 | £0 | £0 | £0 | £0 | £50,000 | 27 | £3,900 |
| **NLS04** | Lighting replacement - Cold Cathode | £0 | £30,500 | £0 | £0 | £0 | £30,500 | 21 | £3,100 |
| **NLS05** | Staff awareness / behaviour change | £0 | £0 | £0 | £0 | £0 | £0 | 170 | £24,600 |
| **NLS06** | Chiller replacement - GB | £0 | £0 | £0 | £350,000 | £0 | £350,000 | 145 | £21,000 |
| **NLS07** | Thin client roll out | £0 | £0 | £0 | £0 | £0 | £0 | 24 | £3,500 |
| **NLS08** | Plant tuning within conformity - CB | £0 | £0 | £0 | £0 | £0 | £0 | 74 | £10,800 |
| **NLS09** | Plant tuning within conformity - GB | £0 | £0 | £0 | £0 | £0 | £0 | 37 | £5,400 |
| **NLS10** | Humidifier replacement - CB | £20,000 | £10,000 | £50,000 | £50,000 | £50,000 | £180,000 | 180 | £16,500 |
| **NLS11** | Ed. Uni CHP connection | £0 | £0 | £0 | £0 | | | 285 | £0 |
| | Energy price inflation saved by energy reduction measures* | | | | | | | | £14,510 |
| **Total** | | £258,000 | £40,500 | £50,000 | £400,000 | £50,000 | £798,500 | 1,363 | £161,510 |

**Table 2 Predicted capital requirements and recurring annual savings**

To be quantified

# 1.0 Introduction

The National Library of Scotland (NLS) began working with the Carbon Trust on the Carbon Lite Programme on 11 November 2009, together with the National Galleries of Scotland, National Museums of Scotland and the Royal Botanic Gardens.

Over the following five months the Carbon Trust facilitated the process through which NLS has established its carbon footprint for the baseline year 2008/09 and developed this Carbon Management Plan (CMP). At a basic level the CMP establishes an action plan by which NLS will reduce its carbon impact over the next five years, but more importantly the document and the process through which it was created has provided a vehicle through which disconnected individuals, organisations, projects and agendas have been pulled together in a coherent way, unleashing a significant amount of activity.

During the five month programme many seeds were sown which have the potential to make this initial piece of work a starting point for much more interesting developments in the future, for example:

- Connections with the TUC Green Workplaces Project were renewed. This, together with the filling of the Prospect Green Representative role which had been vacant for some time, has revitalised the Green NLS group, which is proving key to releasing the energy and ideas of staff to make permanent, positive change in the way in which NLS operates sustainably, including, carbon reduction and energy minimisation

- The National Galleries of Scotland (NGS) and NLS began a dialogue regarding the future of collection storage standards and low energy storage, which resulted in a shared services initiative in which Tim Padfield, an internationally renowned expert in conservation physics, who spent two days working with NGS & NLS, bringing conservators and estates professionals from both organisations and the National Archives of Scotland together

- A staff energy and carbon awareness survey was undertaken. 141 responses were made. The survey gave an invaluable insight into staff perceptions, led to many good suggestions and allowed information to be disseminated on actual energy and carbon facts in an interesting way. This will provide a good basis for future campaign work

- The NLS Facilities Manager has been working with the Plant Operations and Maintenance Contractors on an experiment at one of the collection storage properties to establish a temperature below which the mechanical cooling can be switched off, whilst maintaining environmental compliance within the collection areas

- The Carbon Trust made NLS aware of future proposals that Edinburgh University has to extend its district heat and power scheme and early discussions relating to a possible connection for the George IV Bridge property have occurred. NLS is working with Edinburgh University and Scottish Courts Service to produce an initial feasibility study

- The Carbon Trust provided consultancy support to enable NLS to appraise the different technical solutions open to it in its chiller replacement project

- One pilot office lighting replacement scheme has been installed for evaluation and another is planned for early summer 2010

# 2.0 Carbon Management Strategy

## 2.1 Context and drivers for Carbon Management

### The perfect storm

The Scottish Government Energy Efficiency Action Plan consultation paper (2009), describes the combined circumstances of energy scarcity, climate change and population growth, as the perfect storm. It states that the convergence and interaction of these challenges will demand a radical change to our patterns of energy use in the years to come. [5]

This is one of many United Kingdom and Scottish Government documents to have been produced in recent years on the challenges of climate change and energy security. The latter being prompted by the decline in North Sea oil and gas reserves. As Figure 4 shows the United Kingdom changed from being a net exporter to net importer of energy in 2004. The United Kingdom now imports 25% of its energy requirements and it is predicted that this will rise to a minimum of 45% by 2020[6]. Supply of this energy is dominated by regions of the world which are potentially politically unstable, and will be increasingly required at a time that it is anticipated that the global demand for energy will rise by 50%[7]. The United Kingdom and by default NLS exposure to energy price volatility is therefore increasing.

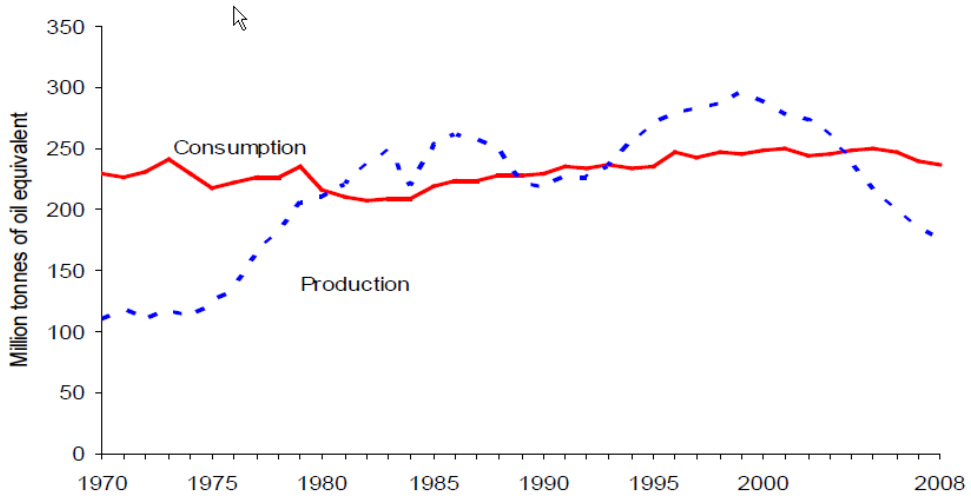



**Figure 4 United Kingdom energy production and consumption 1970 to 2008** [8]

Which ever the document, the key elements of the mitigation strategy are similar to that proposed in the National Security Strategy, i.e. a shift to a low-carbon economy, improving energy efficiency, increasing supplies from renewable sources and putting a value on carbon emissions. [9]

**The** United Kingdom **shift to a low carbon economy has moved beyond the boundaries of the green agenda to being a key national strategy aimed at addressing significant national issues. NLS recognises this change. Moving toward being a low carbon, energy efficient organisation is no longer a nice to have optional extra, but a core objective, which will contribute over the medium and long term to ensuring that NLS remains a thriving organisation.**

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[5] SG0087747 Conserve and Save – a consultation on the energy efficiency action plan for Scotland, Para. 1.19

[6] Wicks. M, Energy Security: A national challenge in a changing world, 2009, p1

[7] Cabinet Office, National Security Strategy of the United Kingdom – Security in an interdependent world, 2008, p18, 3.38

[8] The Digest of United Kingdom Energy Statistics 2009, Chart 1.1.3

[9] Cabinet Office, National Security Strategy of the United Kingdom – Security in an interdependent world, 2008, p51

## The national context

### The Climate Change (Scotland) Act 2009

Scotland has set the most ambitious climate change legislation anywhere in the world. The Climate Change (Scotland) Act 2009 commits Scotland to reduce its emissions by at least 80% from 1990 levels by 2050; with an interim emissions reduction target of at least 34% by 2020, increasing to 42% if the EU increases its 2020 target to 30% in the event of a global deal on climate change.

The Act places duties on public bodies which come into force on 1 January 2011. The duties require that a public body must, in exercising its functions act:

- in the way best calculated to contribute to delivery of the Act's emissions reduction targets
- in the way best calculated to deliver any statutory adaptation programme
- in a way that it considers most sustainable

**NLS is committed to playing its part in the delivery of the Acts national emissions targets. If they are to be achieved, public organisations such as ourselves must lead by example by setting and achieving challenging carbon reduction targets.**

### Scotland Performs: National Outcome - Environmental Impact

"Scotland aims to become a leading nation in developing a sustainable way of life, reducing the impact we have on our local and global environment … First and foremost, we must play our part in the global effort to reduce greenhouse gas emissions…"[10]

**Environmental impact is one of fifteen National Outcomes set by the Scottish Government. As a public body with direct funding from the Scottish Government, NLS will act to support this target.**

### The Carbon Reduction Commitment (CRC)

The Carbon Reduction Commitment is a mandatory "cap & trade" emissions trading scheme for organisations whose total electricity consumption is greater than 6,000MWh. From 2010 participating organisations will have to purchase allowances sold by the Government, for each tonne of $CO_2$ they emit from their total energy consumption. This will initially be set at £12 t/ $CO_2$, although the Scottish Government Climate Change Delivery Plan anticipates a price around £40 t/ $CO_2$ by 2020.

During 2008/09 NLS produced over 3,228 tonnes $CO_2$ from energy consumption. NLS has two properties with half hourly metered electricity. Consumption for 2008 was 4,385 MWh[11]. It must therefore make an information disclosure, but will not have to purchase allowances in the Introductory Phase. There will be another qualification round in 2010/11. It is unknown if the threshold will be lowered in future years.

**It is in the NLS interest to remain under the CRC threshold for full participation. Failure to do so at current emissions would incur a charge of at least £38k p.a, equivalent to the post of a skilled member of staff. Investing in infrastructure maintenance is preferred to having to buy carbon allowances.**

### Grant in Aid

NLS is currently required to make recurring efficiency savings of £270k p.a. The level of forthcoming Scottish Government budget allocations is as yet unknown, however, it is expected that all public bodies, including NLS, will be awarded significantly reduced allocations over the near to medium term. This creates a paradox between a lack of funding to invest in the NLS infrastructure and the necessity of doing so in order to realise the carbon and energy reductions which will contribute to Government carbon emissions targets and provide part of the recurring efficiencies required of NLS.

[10] http://www.scotland.gov.uk/About/scotPerforms/outcomes/envImpact

[11] Total electricity consumption for 2008 was 5,025 MWh

**NLS will work with Scottish Government to secure capital funding for major projects within the CMP on the basis of the Scottish Government commitment within the Climate Change Delivery Plan to "make funds available to ensure that all public sector buildings are brought up to standards required, rather than pay the [CRC] "fine"[12]**

## The NLS strategic context

NLS made the following sustainability commitment in its Corporate Strategy, Expanding our Horizons: National Library of Scotland Strategy 2008 - 2011

"In all our plans and activities, we will work to be fair, equitable and environmentally sustainable"

**The NLS Carbon Management Plan provides a significant element of the framework required to deliver this strategic commitment.**

## The NLS operational context

NLS is Scotland's largest library and one of five Legal Deposit Libraries within the United Kingdom. Its collections are of world-class importance. In addition to 14 million printed items, it has several million sheets of manuscript, around two million maps, and 25,000 newspaper and magazine titles. NLS receives roughly 320,000 new items every year. The collections take up 192km shelving, and a further 3km p.a is required for new acquisitions. The environmentally controlled storage they occupy accounts for 46% of the NLS estate.

Since 2008 NLS also incorporates the Scottish Screen Archive, Scotland's national moving image collection. It holds more than 32,000 films and videos presenting over 100 years of Scotland's history.

In 2008/09, 71,495 reader visits were made to its reading rooms and 62,048 visitors attended events and exhibitions. Its staff dealt with 83,149 enquiries, digitised 29,809 items and conserved or cleaned 19,034 items[13]. A total of 305 Full Time Equivalent (FTE) staff directly or indirectly supported this work.

All of this immense outpouring of activity is accomplished from a property asset base comprising five properties within Edinburgh and two properties in Glasgow, with a total Gross Internal Area of 37,600 $m^{2.}$ . The estate includes three listed buildings and one modern iconic property.

## Summary: What does this context mean for the National Library of Scotland?

Over the medium to long term the external environment in which NLS operates is likely to be one of a rapidly developing climate change agenda, government driven carbon reduction targets with associated carbon trading, reductions in Grant in Aid and potential energy insecurity and price volatility. In this context NLS energy consumption, with its associated carbon by-product will be increasingly effected by fundamental changes out with NLS control. These changes are likely to happen and have the potential to significantly affect the NLS. The way in which NLS plans for, and reacts to, these challenges will impact upon the ability of NLS to operate successfully over the medium to long term.

The NLS CMP forms a key element in enabling NLS to support the Scottish Governments sustainability targets, fulfil its own strategic objectives and put in place measures which will mitigate the impact of changes in the sustainability agenda landscape and increasing United Kingdom exposure to the global energy market.

[12] Scottish Government, Climate Change Delivery Plan June 2009, p 19, Table 3

[13] NLS Corporate Statistics 2008/09

## 2.2 Our low carbon vision

NLS will rise to the ambition demonstrated by the Scottish Government and play its part in the transformation of the nation into a low-carbon economy

NLS will work to become a low-carbon, energy efficient organisation. In doing so it will mitigate against the challenges that climate change and energy security poses to NLS in the medium to long term

## 2.3 Strategic themes

In order to achieve the carbon emissions reduction targets within this CMP, NLS will pursue the following strategic themes:-

**Harnessing the creativity and knowledge of staff**

Without staff engagement at all levels, policy changes will remain dormant, data will be gathered for the sake of reporting it and this CMP will become an exercise in infrastructure replacement. With the creativity and energy of staff this CMP becomes the starting point for a whole range of dynamic activities. To support this NLS will:-

1. Adopt a transparent, pro active approach to information and data
2. Encourage creative dialogue and provide ways to capture good ideas. Investigate all suggestions and implement them where feasible
3. Actively communicate with staff

**Integrating carbon reduction in policy, processes and planning**

To maximise the effectiveness of efforts to reduce carbon emissions NLS must adopt a comprehensive approach to ensure that carbon reduction is integrated throughout NLS operations and carbon impact is factored into all project planning. NLS will therefore:-

1. Establish carbon reduction and energy minimisation as a Corporate priority. NLS will require that it is integrated into relevant policies, processes and procedures and that carbon and energy impact is accounted for in all project planning. This will include a commitment to the CMP targets within the Corporate Plan.
2. Reinforce existing organisational structures which have influence over carbon reduction and energy minimisation in order to increase the level of activity throughout NLS and provide responsive and robust mechanisms which are not personality dependant.
3. Actively engage with Scottish Government to ensure that NLS is able to fulfil its duties under the Climate Change (Scotland) Act 2009

**Robust data gathering, monitoring and reporting**

Robust data is essential in order to be able to establish annual $CO_2$ emissions, prioritise projects, monitor effectiveness and identify opportunities and issues. NLS will therefore:-

1. Continue to gather robust carbon emissions data, making improvements were weaknesses are identified.
2. Regularly monitor data
3. Include CMP targets in NLS Key Performance Indicators
4. Provide regular reporting of data in accessible form to all levels of the organisation

**Primacy of energy reduction**

The baseline clearly demonstrates that energy consumption is the primary contributor to the NLS carbon footprint. Priority will therefore be given to cost effective energy reduction measures, with particular emphasis upon electricity.

**Integration of the CMP and Property Asset Management planning**

The impact which the NLS estate has upon the overall carbon footprint means that maximising the efficient use and operation of the existing property assets is essential, whether that is using space efficiently or replacing old, inefficient plant. NLS will therefore:-

1. Assimilate the rational of the CMP into the Property Asset Management planning process.

2. Incorporate infrastructure projects which demonstrate carbon reduction / energy minimisation and value for money cost savings into the rolling programme.

**Specific focus on environmentally controlled collection storage**

NLS is the only organisation in Scotland to have been granted the right of deposit under the terms of the Legal Deposit Libraries Act 2003. This means that it is entitled to request a copy of all printed items published in the United Kingdom, and in the Republic of Ireland. As a result its collections grow by three kilometers per annum.

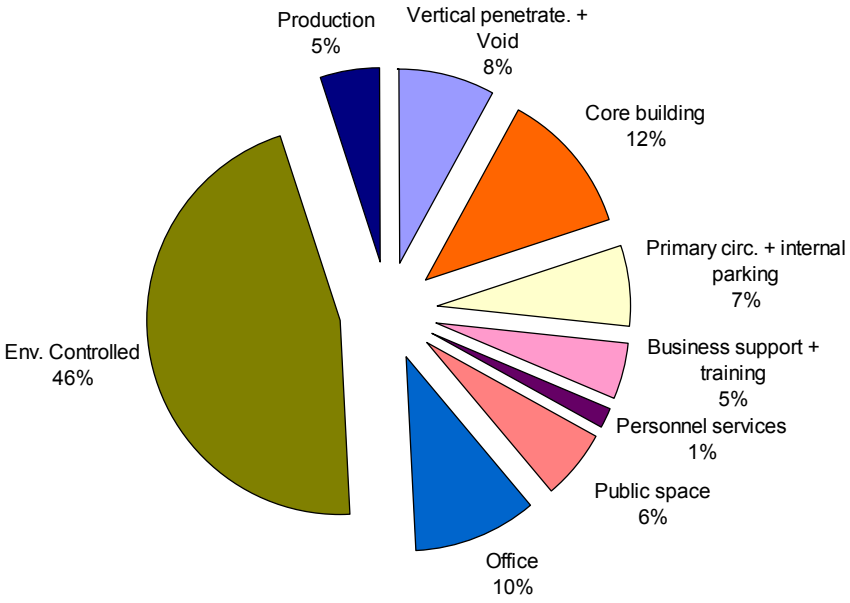


**Figure 5 Property utilisation analysis**

As Figure 6 shows 46% of the estate is used for collection storage. All of this space is environmentally controlled within narrow temperature and relative humidity ranges. This is an inherently energy intensive activity. The way in which the collection storage facilities and the annual growth is managed therefore has huge significance to carbon reduction and energy minimisation. NLS will therefore:-

1. Maximise the efficient utilisation of the existing collection storage capable facilities.

2. Adopt a strategy of separating operational and collection storage activities

3. Remove energy waste within these areas as a priority to reduce internal heat gains

4. Work to reduce air leakage.

5. Establish the capacity of the storage facilities and collections to maintain agreed conditions without artificial intervention

6. Maximise the efficiency of the plant necessary to maintain conditions when necessary

7. Engage with the wider national and international debate on collections care, energy constraint and carbon reduction

**Secure funding**

This CMP comprises a mix of initiatives. This begins with NLS developing its understanding of the way in which it consumes energy, improving structures and planning processes and eliminating unnecessary energy waste. Much of this activity will be low cost. However, elements of the NLS infrastructure will have to be upgraded if full potential of the recurring emissions and cost savings identified within this CMP are to be realised. This will require capital funding.

1. NLS will first aim to identify ways of funding CMP projects from its own resources

2. NLS will work with Scottish Government to identify ways of funding CMP projects where internal funding can not be identified

## 2.4 Targets and objectives

**National Library of Scotland will reduce $CO_2$ emissions from its operation by 30% by the end of financial year 2014/15 from 2008/09 levels.**

**To provide the project with a highly motivating short term target National Library of Scotland has joined 10:10 and will reduce $CO_2$ emissions from its operation by 10% by the end of calendar year 2010/11 from 2009/10 levels.**

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[14] www.1010uk.org "10:10 is an ambitious project to unite every sector of [UK] society behind one simple idea: we all commit to reduce our emissions by 10% in 2010, then work together to make it happen"

# 3.0 Emissions Baseline and Projections

## 3.1 Scope

The NLS baseline includes all of the significant sources of $CO_2$ emissions from the delivery of organisation functions. It covers all NLS operations on all of its sites. NLS does not outsource any of its services off site. It relates to the utilities used in buildings, waste and transport of delivering the functions of an organisation, but not the embedded emissions in the goods procured by the organisation.

The baseline is made up of $CO_2$ emissions from:

owned buildings energy use

owned/Leased Fleet Fuel Use

business travel

waste produced by buildings and operations (excluding waste from the Agency for Legal Deposit Libraries)

water used in buildings and operations

## 3.2 Baseline

The baseline data has been take for the financial year 2008/09.

**Data sources**

**Stationary sources – Electricity and Gas**

This data was gathered from weekly meter readings taken at each of the NLS property assests[15]

**Waste**

The landfill waste data for the baseline period was compiled by converting volumetric data into tonnage equivalents, based on a waste mapping excersice conducted by Leeds Metropolitan & Bradford Council and the compaction factor of the NLS compactor.

Since October 2009 NLS has been weighing the majority of its waste on site. Data from this date onwards is therefore significantly more acurate and will provide reliable data for future carbon submissions. .

The weighed waste data indicates that the conversion factors for 2008/09 are probably too high, however, due to the very low contribution of waste to the NLS carbon footprint this inacuracy does not impact upon the overall carbon profile.

**Water**

This data was gathered from weekly meter readings taken at each of the NLS property assests

**Transport**

Fleet travel data was compiled from milage log sheets for each fleet vehicle

Buisness travel data was taken from a six month study of all of the business travel conducted by the Library. The task of calculating exact kilometers travelled was simplified by looking at the prices and modes of transport and bracketing them into groups, and then conducting some research to establish

[15] With the exception of the Kirkintilloch property (241$m^2$) which is read monthly

what typical journey a cost could account for. We ended up with the following system of allocating distances to costs (which was also influenced by what we know about our business movements). The figures for six months were then multiplied by two.

All domestic flights assumed to be Edinburgh to London return
International flights £10 – £500 = Edinburgh to Munich return
International flights £501 – £800 = Edinburgh to New York return
International flights £801 – over = Edinburgh to Cape Town return

Train £3 - £20 = Edinburgh to Glasgow return
Train £21 - £50 = Edinburgh to Dundee return
Train £51 - £75 = Edinburgh to Birmingham return
Train £76 – over = Edinburgh to London return

All taxi journeys converted at £1 = 1 kilometer.

Car mileage as recorded.

NLS is working to develop a Travel Policy during 2010/11 which will include for improved methods of gathering travel data.

**Conversion factors**

The following conversion factors were used to calculate the baseline[16].

| Conversion factors | Units | Conversion factor |
|---|---|---|
| Electricity (grid) | kg CO2/kWh gross | 0.537 |
| Natural Gas | kg CO2/kWh gross | 0.185 |
| Waste (Black stream - Domestic – Landfill) | kgCO2e/tonne | 447.0 |
| Water | kgCO2/m3 | 0.404 |
| Transport : Medium/large diesel van (>1.25 ≤3.5t) | CO2 factor (kg/km) | 0.27 |
| Transport : Small diesel van (≤1.25t) | CO2 factor (kg/km) | 0.18 |
| Transport :Taxi – Average car (unknown fuel) | CO2 factor (kg/km) | 0.20 |
| Transport : Medium diesel car, from 1.7 to 2.0 litre | CO2 factor (kg/km) | 0.19 |
| Transport : Air - domestic | CO2 factor (kg/km) | 0.19 |
| Transport : Air - short haul international | CO2 factor (kg/km) | 0.11 |
| Transport : Air - long haul international | CO2 factor (kg/km) | 0.12 |
| Transport : Rail - national rail | CO2 factor (kg/km) | 0.06 |

**Table 3 Conversion factors**

[16] Defra, Guidelines to Defra's GHG Conversion Factors 2008

### 2008/09 baseline $CO_2$ emissions

During the period 2008/09 NLS produced 3390 tonnes of $CO_2$ emissions from the delivery of organisation functions. This represents 9.3 tonnes per day, equivalent to 9300 1Kg bags of sugar per day.

| | Total | Buildings | Transport | Waste and Water |
|---|---|---|---|---|
| **Baseline $CO_2$ emissions (tonnes)** | 3390 | 3228 | 130 | 33 |
| **Baseline Cost (£)** | £ 752,557 | £ 585,247 | £ 105,264 | £ 78,254 |

**Table 4 Summary table of emissions and value at stake for baseline year 2008/09**

Ninety-five percent of the NLS carbon emissions are due to electricity and gas consumption within the NLS buildings.

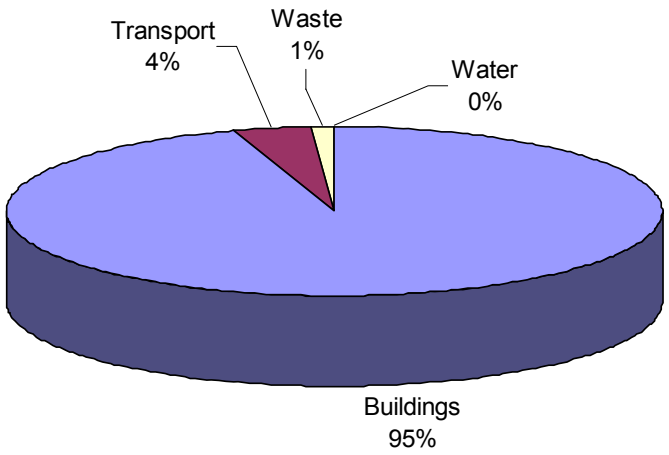


**Figure 6 Summary of carbon emissions (tonnes) for baseline year 2008/09**

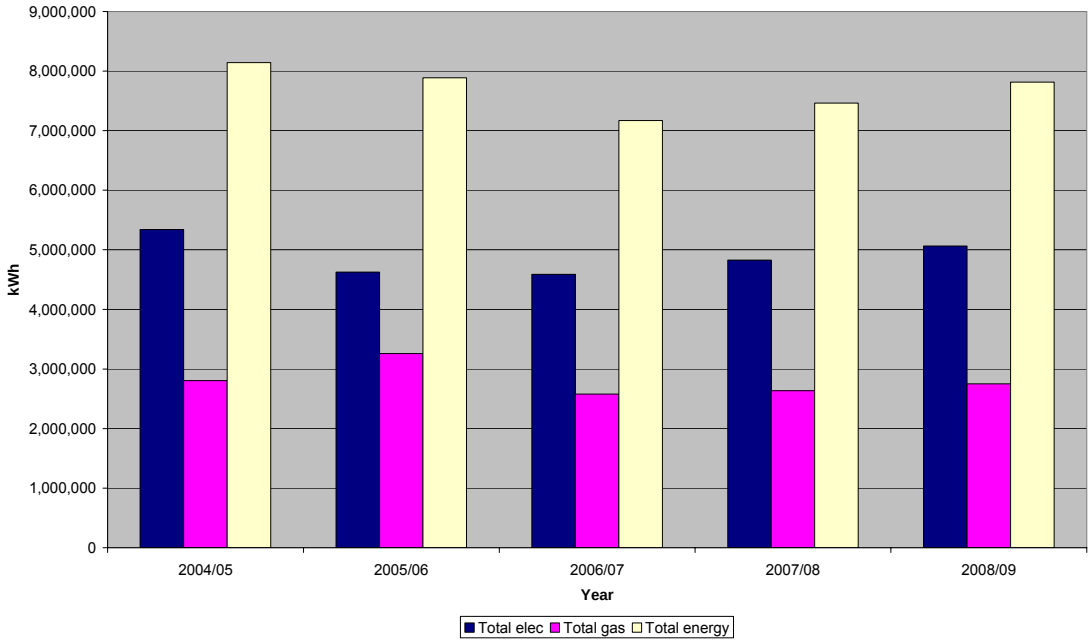


**Figure 7 Energy consumption profile by fuel**

Of this ninety-five percent Fig 7 demonstrates that in 2008/09 electricity consumption was almost twice the gas consumption

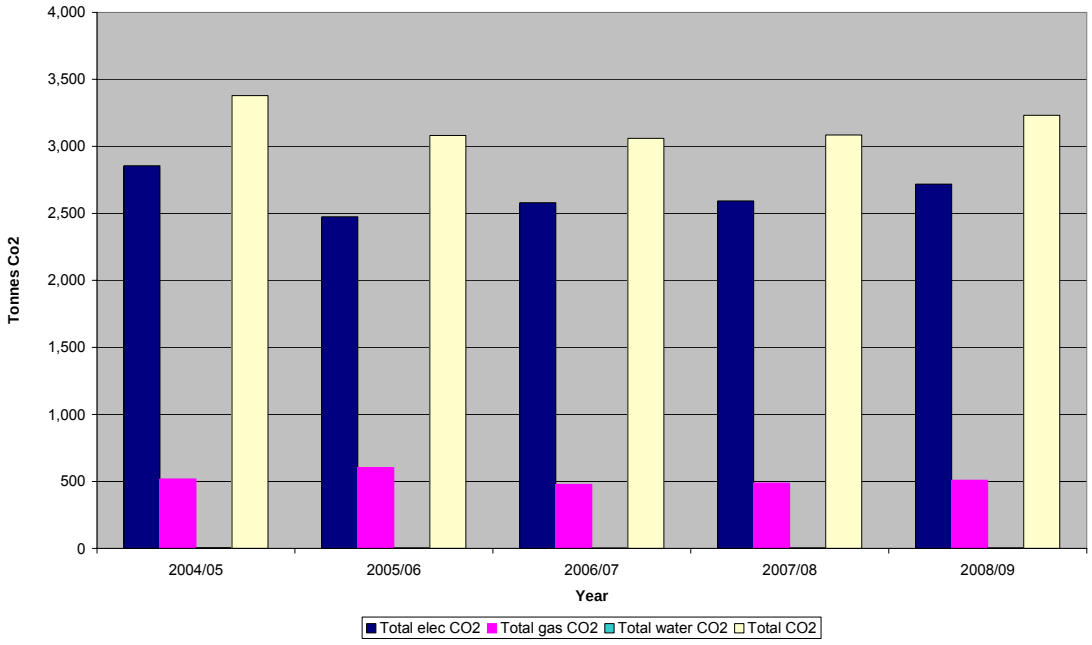


**Figure 8 Total NLS carbon emissions profile of fuel / water**

However as can be seen in Fig 8 the $CO_2$ emissions which resulted from the electricity consumption are 5.8 time greater that those emitted from the gas consumption. The significant gas use arises from heating, hot water and humidification (George IV Bridge building only). Electricity is used for all other NLS energy requirements.

NLS will target electricity consumption as this will have the most significant impact in reducing carbon emissions.

## 3.3 Projections and Value at Stake

### Carbon emissions value at stake

Figure 9 shows a projection for the NLS carbon emissions under two scenarios, business as usual and if NLS achieves its CMP target of reducing carbon emissions by 30%.

The business as usual scenario assumes a 0.7% consumption growth over time, based on Department of Trade and Industry projections[17]. Actual carbon emissions data for the period 2004/05 to 2008/09 demonstrates that for years in which significant one off events did not take place i.e. plant replacement or property acquisition, the carbon emissions increased by 0.75% and 0.82%, which suggests NLS consumption growth is consistent with this generic assumption.

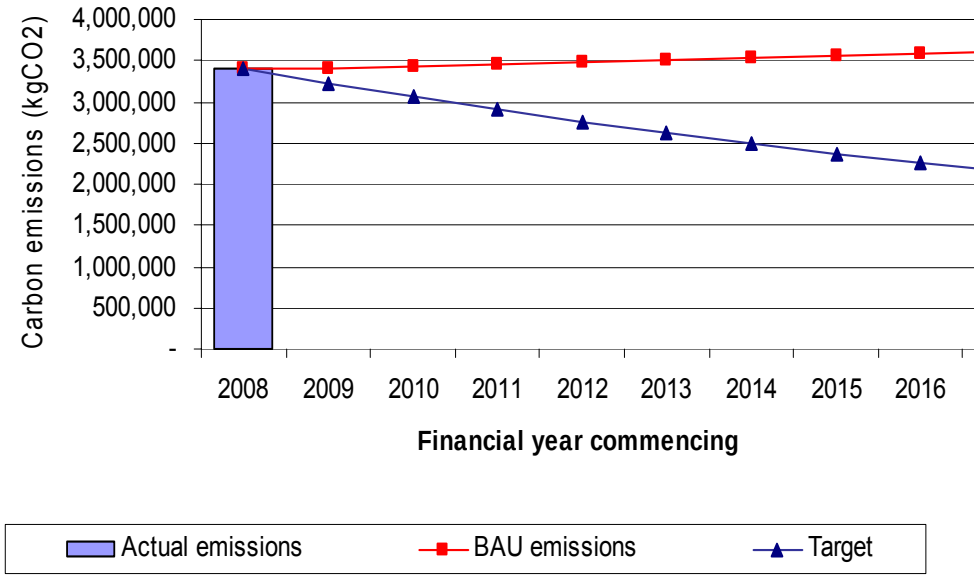


**Figure 9 Comparison of actual emissions with business as usual (BAU) increases and reduction target of 30% carbon emissions**

### Planned property asset developments and their carbon impact

The NLS collection is predicted to grow by approximately three kilometres per annum. NLS has developed a collection storage strategy which will contain this growth within its existing estate and which will not require any significant increase in energy consumption; however this will require approximately 80 to 90 staff to relocate from one of the two main collection storage facilities to an unidentified property by 2016.

The effected staff currently occupy space which is capable of providing environmentally controlled collection storage. It is fully air conditioned 24/7 and 21 of them work in an area with no natural light. This situation places staff in high energy consuming accommodation with environmental conditions which many of them do not like.

NLS will seek to acquire a property with a low carbon footprint as one of its main specification criteria. The carbon impact of this is as yet un-quantified.

[17] DTI/DBERR EP68

### Financial value at stake

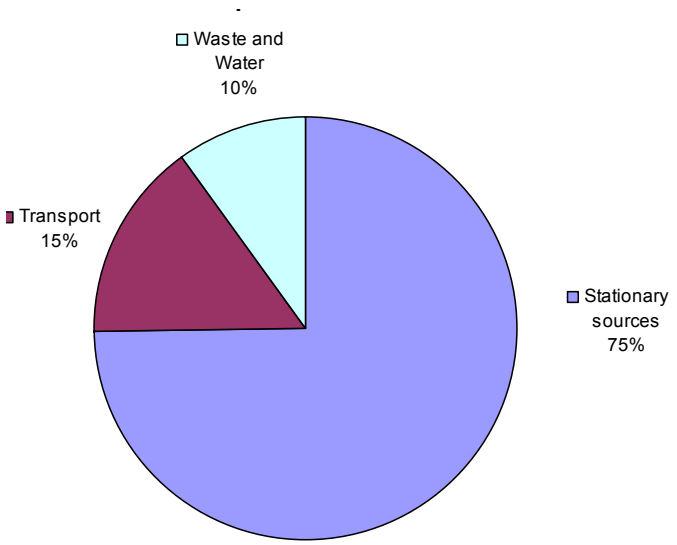


**Figure 10 Composition of financial value at stake for 2008/09**

Figure 10 shows that 75% of the NLS spend on carbon producing activities relates to stationary sources, i.e. energy consumption.

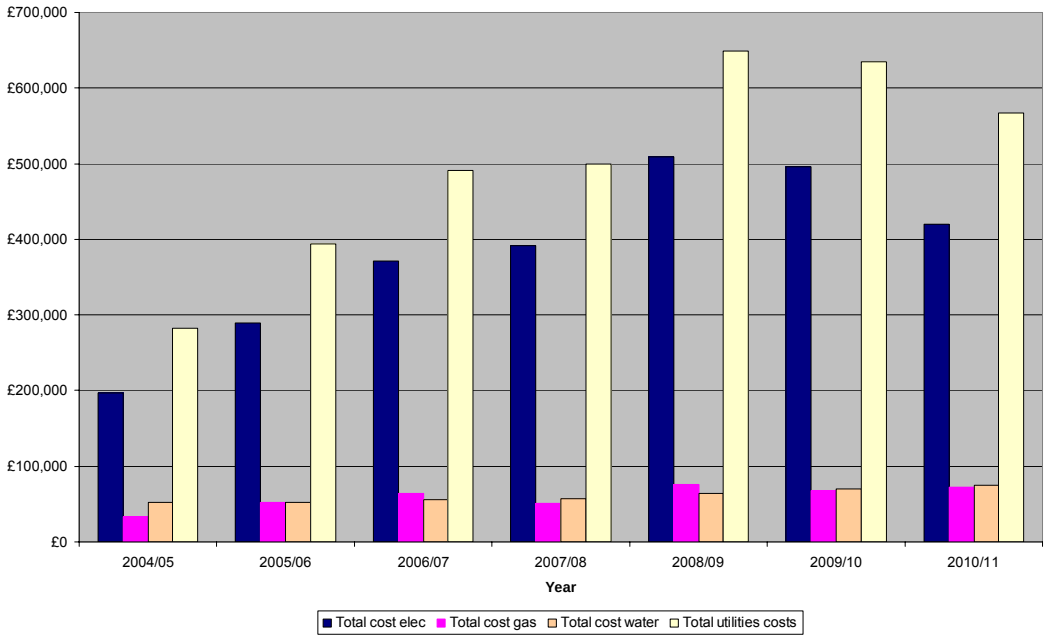


**Figure 11 NLS utility costs (Nett) - actual and forecast[18]**

Of this energy consumption, Figure 11 shows that electricity consumption dominates NLS utilities costs. The unit price of electricity is almost twice the unit price of gas.

[18] 2009/10 costs are predicted outturn figures. 2010/11 are budget figures.

This graph also demonstrates the volatile nature of energy inflation. Energy costs rose from £499K in 2007/08 to £649k in 2008/09, an increase of 30%. This stabilised in 2009/10. The budget forecast for 2010/11 is £567k a reduction of 13%.

Whilst significant year on year cost rises in themselves are an issue for NLS in an increasingly restrained Grant in Aid environment, the wild volatility that has already been experienced, and is likely to reoccur as the United Kingdom becomes increasingly exposed to the global energy market is a more significant budgeting issue.

At 15% the transport component is significant. 84% of these transport costs relate to business travel. NLS will conduct a more detailed analysis of its business travel with a view to using its financial resources as efficiently as possible; however, the only component which might realistically be changed to reduce carbon emissions is domestic flights. This is unlikely to yield more than a 0.5% carbon reduction[19] and will therefore not be included as a quantified project within this Carbon Management Plan.

The waste and water component is dominated by water costs. Water costs are heavily influenced by meter sizes, which mean that reducing water consumption does not directly impact upon cost.

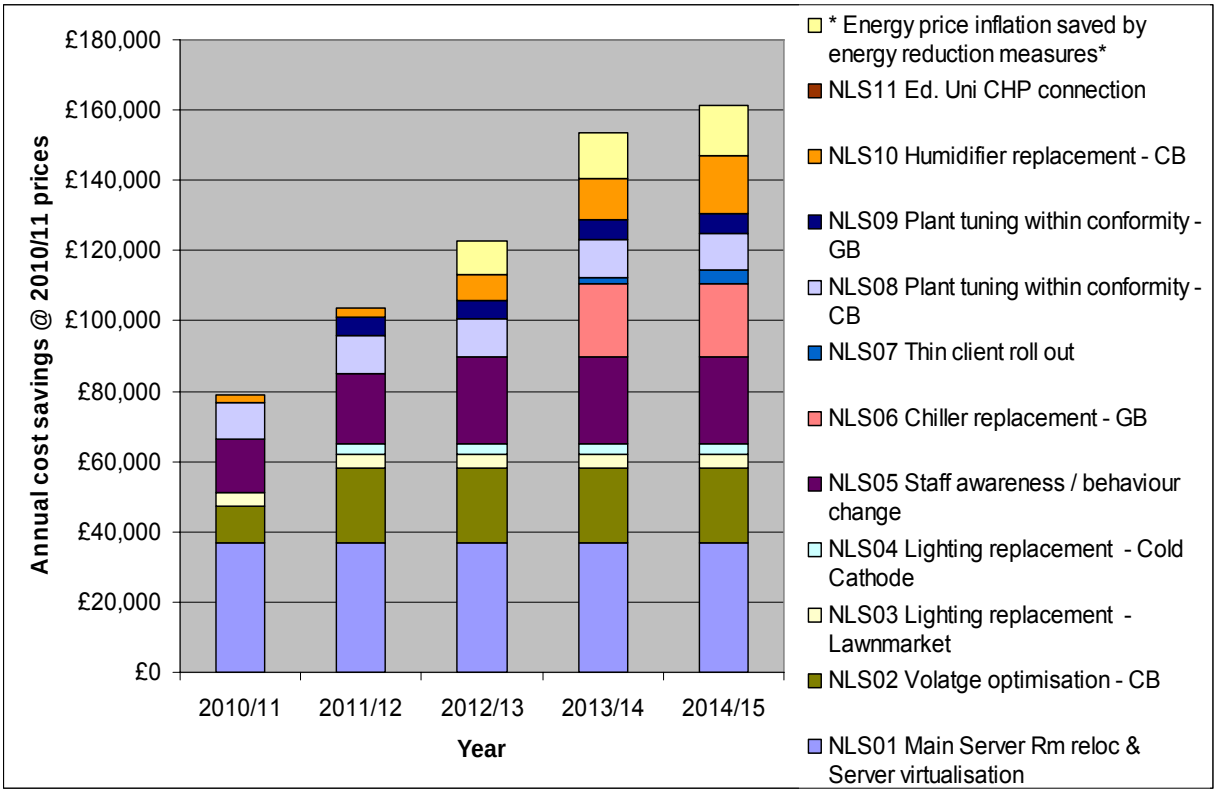


**Figure 12 Predicted annual cost savings by project over the CMP**

Figure 12 shows a simple prediction of the potential cost savings to NLS if it takes the action to reduce its carbon emissions by 30%.

[19] Based on the premise that the most practical areas for action are increased use of video conferencing and reduction in domestic air travel and a move to rail travel.

Energy inflation savings are based upon a baseline price set at a 2010/11 unit price for electricity of 0.078p / kWh, and an assumption of no cost increase in 2011/12, followed by an average cost increase of 8.4% p.a [20] from 2013/14 onwards. Energy inflation will not in reality be steady and predicable

During the period of this Carbon Management Plan this simple prediction would result in a total potential financial savings to the NLS of around £620k over the course of the project and £160k annual recurring savings thereafter, if the target of reducing carbon emissions by 30% by 2014/15 is achieved

NLS will target electricity consumption as these will have the most significant impact reducing costs.

[20] Source – Carbon Trust, calculated by ESD based upon a high gas scenario reported in Department for Enterprise & Regulatory Reform, Communication on BERR fossil fuel price assumptions – Update to present the latest fossil fuel price assumptions following the January 2008 Call for Evidence, May 2008

# 4.0 Carbon Management Projects

## 4.1 Existing projects

The following projects are underway and will be completed in financial year 2010/11

| Ref | Project | Lead | Cost | | | Annual Saving | | Pay back | % of Target | Year |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cap'l | Rev'ue | Res'ce | Fin | $CO_2$ | | | |
| NLS 01 | Main Server Rm reloc & Server virtualisation | IS Manager | £138k* | £0 | £0 | £36,700 | 253 | 3.7 | 24.9% | 2010 |
| NLS 02 | Voltage optimisation - CB | Facilities Manager | £50k | £0 | £0 | £21,500 | 147 | 2.3 | 14.6% | 2010 |

*The project cost of relocating the main server room and virtualising the servers is £345K, however over half of this cost relates to the physical creation of a new server room, which, has become necessary for reasons unrelated to carbon reduction.

## 4.2 Planned / funded projects

The following projects will commence during 2010/11. Behaviour change and plant tuning will continue throughout the course of the CMP

| Ref | Project | Lead | Cost | | | Annual Saving | | Pay back | % of Target | Period |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cap'l | Rev'ue | Res'ce | Fin | $CO_2$ | | | |
| NLS 03 | Lighting replacement - Lawnmarket | Facilities Manager | £50k | £0 | £0 | £3,900 | 27 | 12.8 | 2.65% | 2010 |
| NLS 05 | Staff awareness / behaviour change | Green NLS Group | £0 | £0 | £0 | £24,600 | 170 | N.A | 16.7% | 2010 - 2014 |
| NLS 08 | Chiller plant tuning within conformity - CB | Facilities Manager | £0 | £0 | £0 | £10,800 | 74 | N.A | 7.3% | 2010 - 2014 |
| NLS 09 | Chiller plant tuning within conformity - GB | Facilities Manager | £0 | £0 | £0 | £5,400 | 37 | N.A | 3.6% | 2011-2014 |

## 4.3 Near term projects

The following projects are planned but do not yet have funding allocated

| Ref | Project | Lead | Cost | | | Annual Saving | | Pay back | % of Target | Year |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cap'l | Rev'ue | Res'ce | Fin | $CO_2$ | | | |
| NLS 04 | Lighting replacement - Cold Cathode | Facilities Manager | £30.5k | £0 | £0 | £3,120 | 21.5 | 9.8 | 2.1% | 2011 |
| NLS 06 | Chiller replacement - George IV Bridge | Facilities Manager | £350K | £0 | £0 | £21,000 | 145 | 16yr | 14% | 2013 |
| NLS 07 | Thin client roll out upon routine PC replacement | IS Manager | Cost neutral | £0 | £0 | £3,475 | 23.9 | N.A | 2.3% | 2012 – 2014 |
| NLS 10 | Humidifier replacement - CB | Facilities Manager | £180K | £10k | £0 | £26,500 | 181 | 10.9 | 17.7% | 2012 – 2014 |

### NLS06 George IV Bridge chiller replacement project

NLS has commissioned a Cooling Options Strategy Report[21] for the George IV Bridge property (See Appendix B) which has assessed the remaining life of the plant at five years. In addition the current chillers use the refrigerant R22 which is a HCFC. The report continues:-

HCFC refrigerants are currently being phased out with only limited quantities of recycled R22 being presently available. By 2014, R22 and all other HCFC's are due to be completely phased out. The lack of availability of R22 presents a serious risk to the operation of the chiller plant post 2014…

The replacement of the refrigerant has the effect of reducing the efficiency of the chiller plant by approximately 30%. This means that the installed capacity is reduced, and the electrical energy consumption is increased per kilowatt of cooling generated. The decrease in chiller efficiency would also reduce the amount of surplus cooling that is available as well as increasing the carbon footprint of the National Library.

Replacement of the George IV Bridge chillers is therefore unavoidable and must be completed before 2014. Completion before this date would enable NLS to realise the recurrent carbon and cost savings that will result earlier than shown in the predictions within this CMP.

## 4.4 Medium to long term projects

The following projects are not planned in detail and will require further work

| Ref | Project | Lead | Cost | | | Annual Saving | | Pay back | % of Target | Period |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cap'l | Rev'ue | Res'ce | Fin | $CO_2$ | | | |
| **NLS 11** | **GB- Ed. Uni CHP connection** | **Estates Division** | To be quantified | **£0** | **£0** | **£0** | **285** | **TBQ** | **28%** | **2014** |
| **NLS 12** | **Low energy collection storage - CB** | **Estates Division** | **See below** | | | | | | | **2010 - 14** |

### NLS11 George IV Bridge - Edinburgh University CHP connection

NLS has submitted a note of interest to the University for connection to the next phase of their district heating and power scheme which could provide a connection point at the rear of their Minto House property, off the Cowgate. Connection to the CHP electricity supply would reduce the kg CO2/kWh conversion factor from 0.537 to 0.304, giving an instant carbon saving.

### NLS12 Low energy collection storage

This is potentially the most significant project within the NLS Carbon Management Plan. It is also the most sensitive. Success will not simply be in terms of energy and carbon reductions at NLS, but also influence upon the wider debate within the museums, galleries and archives communities surrounding the future of internationally agreed standards for environmental conditions for collections.

These standards demand tight control of temperature and relative humidity. The conditions are often applied to large floor areas[22] and are almost always achieved through the operation of plant 24/7, 365 days per year.

Many organisations are beginning to recognise that the high energy use and carbon production that results from this is untenable in an increasingly demanding context of grant restrictions, rising energy costs, the Carbon Reduction Commitment and a growing sustainability agenda.

[21] Wallace Whittle National Library of Scotland George IV Bridge, Cooling Strategy Review – Feb 2010

[22] In the case of NLS the area is nearly 18,000 $m^2$

During the development of this CMP the National Library of Scotland and the National Galleries of Scotland undertook a shared services initiative which brought together Tim Padfield, and conservation and estates professionals from the two organisations and the National Archives of Scotland to begin to explore this field.

The initiative coincided with experimentation which NLS has been undertaking to establish the effects on environmental conditions of reducing the use of plant. During this exercise NLS has established that conformity requirements are maintained at its Causewayside property without running the chiller plant if the external temperature is below 10 deg C. A high level study of the microclimate at the Causewayside property, prepared by Tim Padfield is appended in Appendix C

Further controlled experimentation will be undertaken during 2010/11 with a focus on reducing internal heat gains and establishing the boundaries of the capabilities of the property without the intervention of plant.

## 4.5 Projected achievement towards target

The projects outlined above will be actioned at varying times over the course of the CMP. Some projects are discrete and will be accomplished within one financial year, others will be ongoing, such as behaviour change and the thin client roll out. Figures 13 shows the predicted annual carbon savings in relation to the target 30% saving of 1017 tonnes.

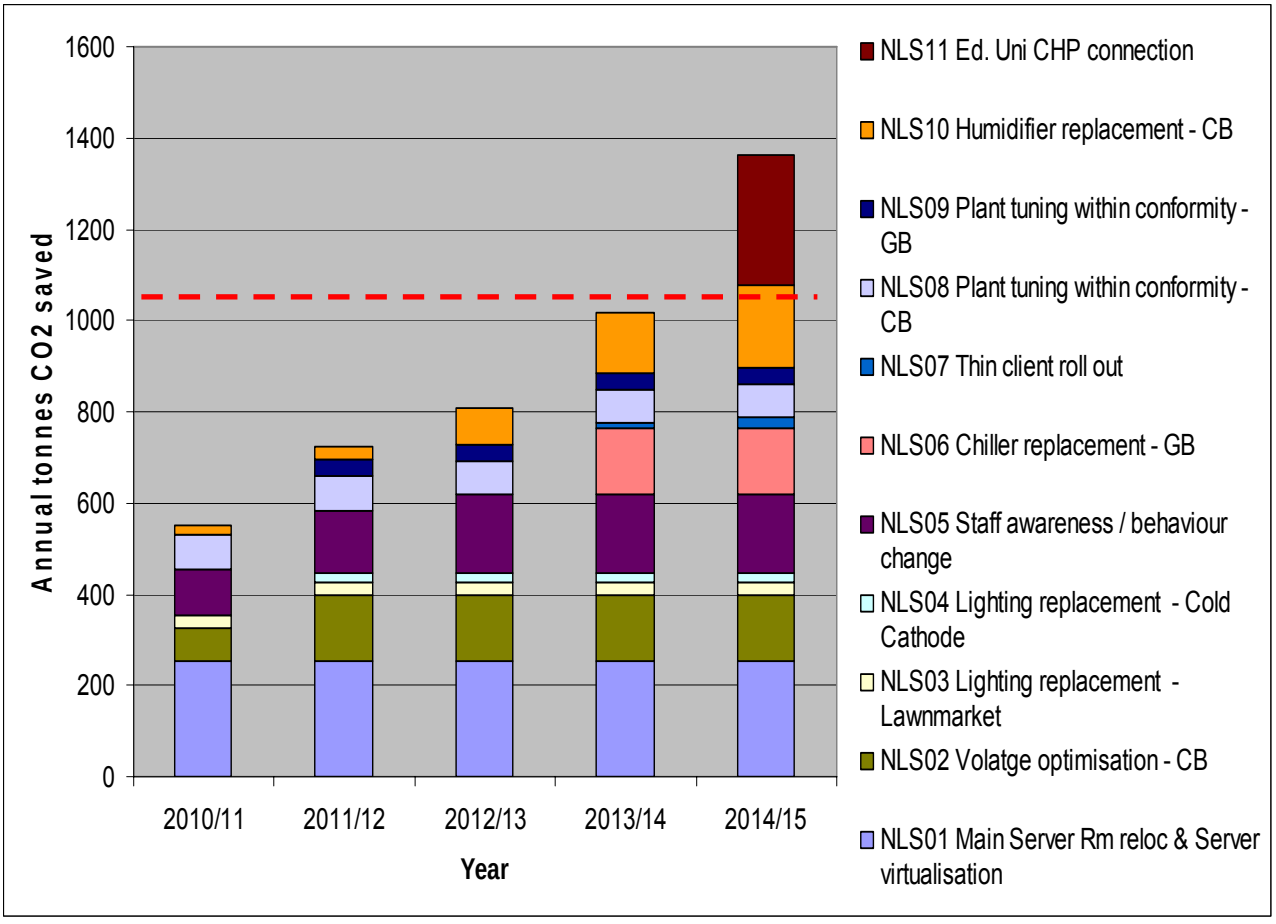


**Figure 13 Predicted annual carbon savings by project**

# 5.0 Implementation

## 5.1 Financing

The financial calculations within the CMP are based on the following assumptions:-

- The unit price of electricity during 2010/11 will be £0.078 per kWh
- The unit price of electricity will not fall below this figure
- There will be no increase in energy costs in 2011/12
- Energy inflation from 2012/13 will be a minimum of 8.4% p.a.
- NLS will remain outside the CRC threshold at which it will be required to pay carbon
- Project costs are provided at 2010/11 levels. No allowance for inflation has been added. Project costs for projects toward the end of the CMP must therefore be updated as they are developed.
-

### 5.1.1 Benefits / savings – quantified and un-quantified

## Quantified benefits:

| | 2010/11* | 2011/12 | 2012/13 | 2013/14 | 2014/15 |
|---|---|---|---|---|---|
| **Annual cost saving** | **£78.8k** | **£103.8k** | **£122.8k** | **£153.5k** | **£161.5k** |
| **Annual $CO_2$ saving** | **549** | **725** | **809** | **1016** | **1363** |
| **% of target achieved** | **54%** | **71%** | **79%** | **100%** | **134%** |

* The total annual financial savings and carbon savings during 2010/11 will be dependant upon progress of the server virtualisation project completion date. If it completes later in the year than expected, which appears increasingly likely, then these savings will be reduced in this financial year.

## Unquantified benefits:

Not all of the benefits which will arise from the CMP can be quantified, examples of these are:-

- NLS participation within the emerging low energy collection storage debate offers the opportunity for NLS to take an influential roll in this subject. This has already begun with joint working with the National Gallery of Scotland to facilitate Tim Padfield visiting both institutions.
- Revitalisation of the Green NLS team and the contribution made to this by the TUC Green Workplaces Project offers an opportunity to harness the energy and ideas of all NLS staff at all levels, which could create a modle for empowering staff to effect positive change.
- The Carbon Management Plan when taken together with the NLS Collection Storage Strategy and the Property Asset Management Plan forms an interelated strategy triptic which will create an extremely robust basis with which to manage the NLS physical resources.

### 5.1.2 Financial costs and sources of funding

| Project | | Capital Requirement | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2010/11 | 2011/12 | 2012/13 | 2013/14 | 2014/15 | Total over project | Funding source |
| **NLS01** | Main Server Rm reloc & Server virtualisation | £138,000 | £0 | £0 | £0 | £0 | £138,000 | SG - secured |
| **NLS02** | Voltage optimisation - CB | £50,000 | £0 | £0 | £0 | £0 | £50,000 | Under discussion |
| **NLS03** | Lighting replacement - Lawnmarket | £50,000 | £0 | £0 | £0 | £0 | £50,000 | NLS - secured |
| **NLS04** | Lighting replacement - Cold Cathode | £0 | £30,500 | £0 | £0 | £0 | £30,500 | Required |
| **NLS05** | Staff awareness / behaviour change | £0 | £0 | £0 | £0 | £0 | £0 | N.A |
| **NLS06** | Chiller replacement - GB | £0 | £0 | £0 | £350,000 | £0 | £350,000 | Required |
| **NLS07** | Thin client roll out | £0 | £0 | £0 | £0 | £0 | £0 | Inc in standard PC replacement |
| **NLS08** | Plant tuning within conformity - CB | £0 | £0 | £0 | £0 | £0 | £0 | N.A |
| **NLS09** | Plant tuning within conformity - GB | £0 | £0 | £0 | £0 | £0 | £0 | N.A |
| **NLS10** | Humidifier replacement - CB | £20,000 | £10,000 | £50,000 | £50,000 | £50,000 | £180,000 | Required |
| **NLS11** | Ed. Uni CHP connection | £0 | £0 | £0 | £0 | | | Required |
| **Total/yr** | | £258,000 | £40,500 | £50,000 | £400,000 | £50,000 | £798,500 | |

**Table 5 Capital requirements to achieve CMP targets**

To be quantified

## 5.2 Governance for Implementation

### 5.2.1 Embedding Carbon Management

#### Structures

During the course of this Carbon Lite programme, NLS has revitalised and reinforced existing organisational structures to support the implementation of the plan. This has resulted in the reformation of two dormant groups:-

The Sustainability Steering Group (SSG), chaired by the Carbon Management Plan Project Manager and on which the Director of Corporate Services and the Prospect Green Representative sit. The purpose of this group is to embed sustainability, including carbon reduction, in policy and procedure and monitor implementation. SSG meets quarterly. The SSG is composed of members of staff who have influence over key areas which impact upon sustainability in NLS

The Green NLS Group chaired by the Prospect Green Representative. The purpose of this group is to provide a forum through which staff can contribute to the development of sustainable policy and activity and to provide a forum to facilitate staff engagement. The Green NLS meets a minimum of quarterly and is open to all staff.

#### Policy

The Carbon Lite Project Manager has given a presentation explaining the Carbon Lite Project to the Management Forum. The National Librarian and Chief Executive made a statement in support of the project on this occasion.

The following statement has been included within the Corporate Plane 2010/11

“As with any public body, NLS must comply with a range of legal, regulatory and policy requirements, including financial, audit and Health and Safety. Particular effort in 20010/11 will be directed towards improving sustainability and equalities. We are working towards reducing our carbon footprint by 30% by 2015, in line with Scottish Government targets, and have committed NLS to the 10/10 initiative. We will be doing this through carrying out plans to introduce more sustainable travel planning, waste management and especially energy consumption. …, Success measures - Reduce carbon footprint by 10% by end of 2010…”

This is supported by the inclusion of the CMP targets within the Corporate Services Divisional Plan, which is the divisional plan under which carbon management sits

#### Key Performance Indicators (KPIs)

NLS has opted to adopt the Sustainable Operations on the Government Estate (SOGE) targets. These are not mandatory on Scottish Non Departmental Government Bodies; however they do offer a useful framework of targets.

SOGE targets for carbon, waste, water and energy reduction form the basis of the NLS sustainability KPIs and are consistent with the CMP targets

#### Projects and procedure

It has been agreed that a sustainability impact assessment will be required as part of all future papers submitted to the Senior Management Team. The assessment will require an estimate of the impact of a proposal on energy and water consumption, waste, travel and carbon.

### 5.2.2 Data Management – measuring the difference, measuring the benefit

**Sub metering**

NLS already collects robust utilities and waste data, which will be used to assess the impact of projects.

One of the main collection storage properties is sub metered by both area and use e.g. lighting. The use of this will be developed to monitor the effect of projects within the property. Similar sub metering will be progressively introduced to the other main Edinburgh property.

NLS has purchased two portable electricity data loggers which will be used to measure the effect of specific interventions.

NLS has also purchase six portable temperature and relative humidity monitors to supplement the existing Visala environmental monitoring system. These will be used to provide more comprehensive monitoring of conditions within environmentally controlled collection storage areas while plant tuning is being undertaken.

**Half hourly meter data**

The two main Edinburgh properties have half hourly metered electricity supplies. These will be used more widely to assess projects. The following two graphs were produced during the Causewayside chiller shut down experiment. They clearly show the effect of shutting down the chiller plant.

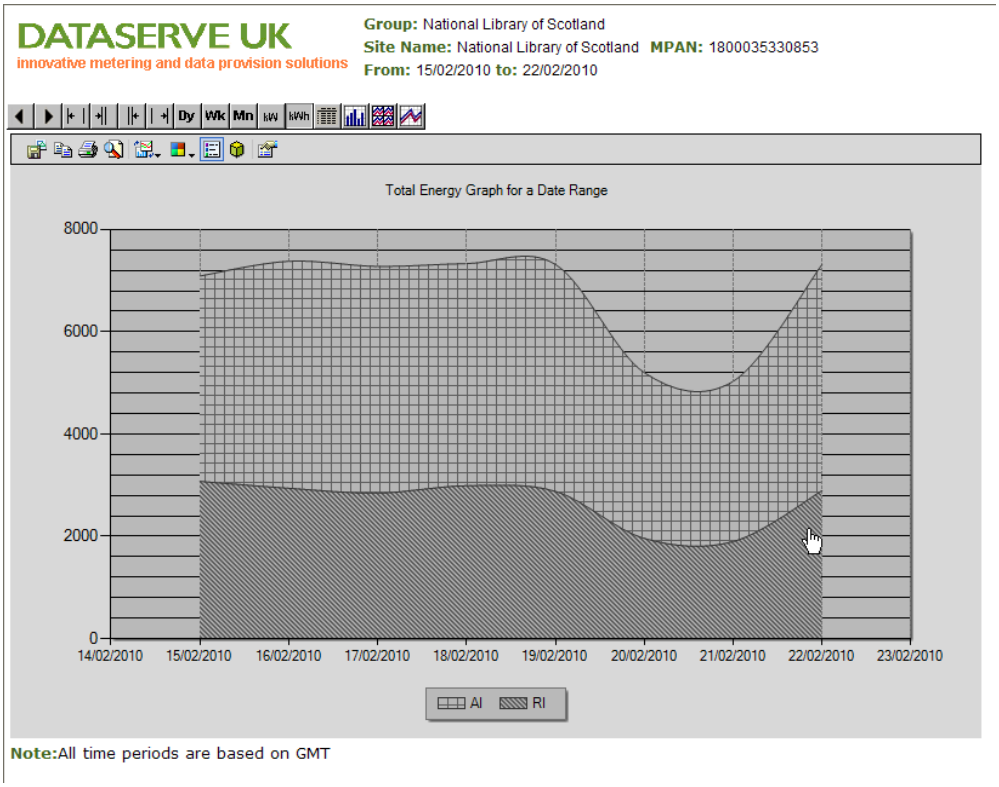


**Figure 14 Causewayside electricity consumption with chillers operational**

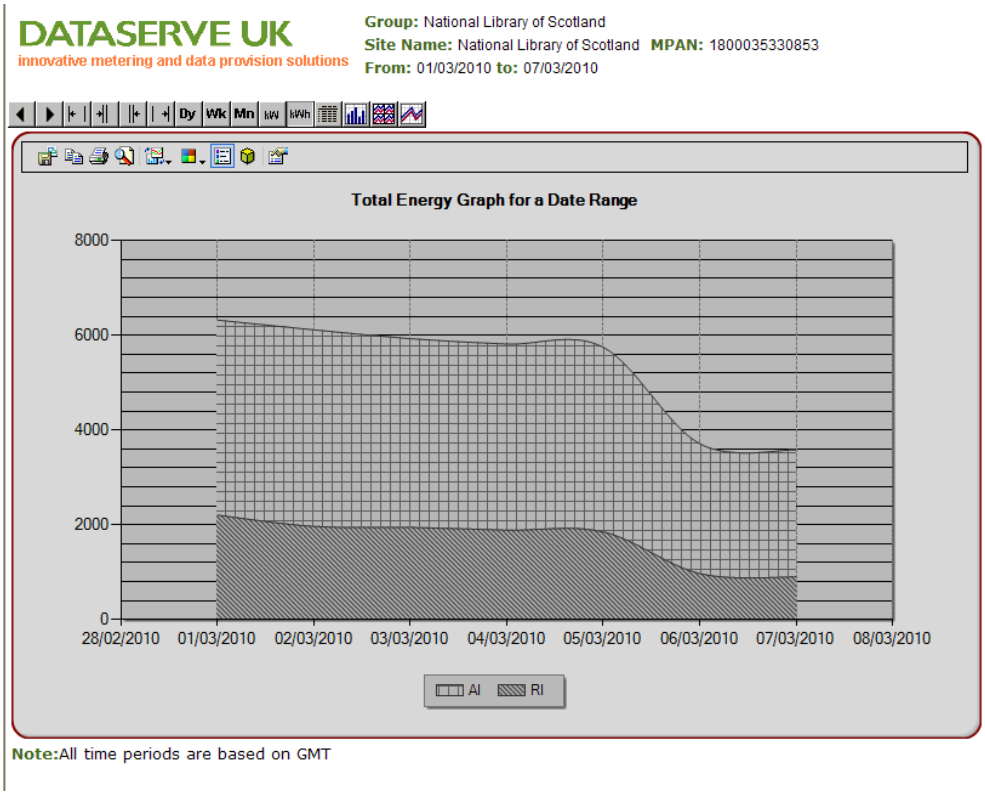


**Figure 15 Causewayside electricity consumption with chillers shut down**

### Travel data

Business travel is the area where data collection needs to be improved.

NLS has developed a new travel plan, which incorporates sustainable travel policies and includes a move to have all staff book travel through a travel management service. This will provide significantly improved business travel data.

Work will be undertaken to improve the capture of car mileage which is obtainable via expense claims. forms

A new room booking system is due to be rolled out in autumn 2010 which will be able to capture data on the use of video and telephone conferencing. This will help NLS to monitor data relating to journeys saved

### Disseminating information

Disseminating data and information is regarded by NLS as key to support staff engagement. To this end utilities and waste data is now freely available to all staff on the NLS intranet Green NLS site and is updated once a month. Green NLS members regularly receive briefings on ways to use information which is available, and further innovative ways of providing easily accessible information will be rolled out during 2010/11

## 5.3 Resource commitment

### 5.3.1 Implementing the Initiatives

The project management role for specific projects will be allocated to the member of staff best able to see the project through to successful completion.

The chair of the Sustainability Steering Group (SSG) will remain the Carbon Management Plan Project Manager. The Project Manager will be responsible for co-ordinating activity, monitoring progress and providing quarterly reports to the SSG and a minimum of bi annual written reports to Senior Management Team. The SSG chair will be responsible for managing the action plan for all sustainability activity, including carbon management.

The SSG will act as the Project Board for the Carbon Management Plan. The SSG will oversee the Programme and act as the vehicle through which issues effecting delivery of the plan are progressed if the Project Manager has been unable to reach a satisfactory resolution.

Annual progress will be included within the Sustainability Report which goes before the Board of Trustees once a year. The carbon reduction KPIs will be included in these reporting processes

### 5.3.2 Maintaining quality over time

This agreed version of the Carbon Management Plan is a starting point for establishing a carbon emissions reduction strategy for NLS. Some of the most significant elements within it are at an embrionic stage. Projects will develop and new ones will be identified.

Legislation, government initiatives and good practice are continually emerging and NLS itself is becoming more competent in the field of sustainability

This CMP must therefore be regarded as a live, dynamic document, which will require regular revision and it is hoped will itself become a component of a wider Environmental Management Strategy over the medium term. The Carbon Lite Project Manager will manage this process, which should be carried out annually, or on the occurance of significant events which impact on the CMP, such as a change in legislation.

The new requirement for all future project proposals to include a sustainability impact assesment will be a useful tool with which to capture positive and negative carbon impacts. Good ideas from staff are now captured through their own e-mail address and the Carbon Lite Project Manager, Project Assistant and Prospect Green Repersentative will continue to act as focal points for gathering information.

### 5.3.3 Succession planning for key roles

NLS is an organisation with just over 300 employees. There is a relatively small group of staff who have roles which impact directly upon the delivery of the core element of the Carbon Management Plan, although of course total staff engagement is vital to generate ideas and minimise energy waste. There is also a high instance of staff who are sole practitioners, in the sense that they are the only people within the organisation who work within a particular area of expertise. This has been a recognised risk to various aspects of the NLS operation for many years. It is also a situation which is unlikely to change.

The NLS strategy to mitigate the risk that the loss of key personnel may have to the successful delivery of the Carbon Management Plan is to:-

- Deliver a simple carbon reduction strategy with a very simple message, which all staff, at all levels can engage with.

- Raise the overall level of awareness amongst staff and ensure wide access to information, particularly statistical data, so that it does not rest solely with key individuals

- Focus on embedding sustainability, including carbon management as widely throughout the operation of the organisation as possible.

- Refocus some of the activity of the Plant Operation and Maintenance contractors toward energy reduction and build this in to the performance targets of future contracts

- Develop a pool of external links so that NLS is not solely dependant upon internally held knowledge and expertise

# Appendix A: Definition of Projects

| **Project title** : Main Server Room relocation and Server Virtualisation | **Ref:** NLS01 |
|---|---|
| **Brief description**<br>The main server room which serves the NLS Edinburgh estate is currently located on the fifth floor of an office building located on the Lawnmarket, Edinburgh. The accommodation is not fit for purpose and the space has reached capacity. Ongoing cooling and backup power problems, poor internal and external access and the expanding requirements of the digital library are drivers for this project. | |
| **Deliverables**<br>• to form a new server room within the Causewayside property.<br>• to virtualised the servers as they are relocated | |
| **Carbon reduction measures**<br>• More efficient plant<br>• Server virtualisation | |
| **Time scale:**<br>• Works commenced on site Jan 2010 and are due for completion June 2010<br>• Relocation of the servers will take place over the course of 2010/11 | |
| **Total project cost (nett):** £138k | **Payback period:** 3.7 years |
| **Funding**<br>Scottish Government capital funding - secured | |
| **Benefits** | |
| **Carbon reduction:** 253 tonnes p.a | **% of target:** 24.9% |
| **Energy reduction:** 471,000 kWh p.a | **Energy costs savings:** £36.7k p.a* |
| **Other benefits:**<br>• Significant increase in server room capacity<br>• Resolution of overheating issues<br>• Resolution of back up power issues. Causewayside building has a backup generator with capacity to run the entire building 24/7<br>• Direct access from the properties loading bay | |
| **Risks**<br>20010/11 element of the recurring savings will be reduced if project completion is delayed and occurs at the end of the period | |
| **Notes**<br>The project includes the addition of new Digital Library Servers from the British Library = 135,700 kWh p.a. The anticipated reductions are nett after and inclusive of this additional load.<br>* at predicted 2010/11 tariff £0.078 / kWh | |

| **Project title** : Voltage optimisation - Causewayside | **Ref:** NLS02 |
|---|---|

**Brief description**

In conjunction with the Main Server Room Relocation project NLS01 NLS will install voltage optimisation at the Causewayside property. This will optimise the incoming voltage, dealing with the discrepancy between the actual supply voltage of 207V - 253V and the optimum voltage that electrical equipment needs 220V

**Deliverables**

- Voltage at 220V
-

**Carbon reduction measures**

- Voltage optimisation

**Time scale:**

- Autumn 2010/11
-

| **Total project cost (nett):** £50K | **Pay back period:** 2.3 years |
|---|---|

**Funding**

Under discussion

| **Benefits** | |
|---|---|
| **Carbon reduction:** 147 tonnes p.a | **% of target:** 14.6 % |
| **Energy reduction:** 275,000 kWh p.a | **Energy costs savings:** £21.5k p.a* |

**Other benefits:**

- Protect electrical equipment from transients (power spikes)
- Substantially improve power quality and power factor
- Suppress harmful harmonics that damage sensitive equipment

**Risks**

**Notes**

***** at predicted 2010/11 tariff £0.078 / kWh

| **Project title** : Lighting replacement - Lawnmarket | **Ref:** NLS03 |
|---|---|

**Brief description**

The project will target lighting installations which are either ageing or have high energy consumption and which are used consistently for long periods of time.

**Deliverables**

- Provision of low energy lighting installations within all offices and corridors in the Lawnmarket building

**Carbon reduction measures**

- Office lighting lux levels to be reduced from an average 300 lumin to CIBSE guide lines
- Office lighting installations to be fitted with PIRs and photosensitive controls
- LED tubes to be fitted within corridors

**Time scale:**

- Two pilot office and corridor lighting schemes to be completed by Apr 2010
- Works to be undertaken over the period 2010/11

| **Total project cost (nett):** £50K | **Pay back period:** 13 years |
|---|---|

**Funding**

Internal funding – secured

| **Benefits** | |
|---|---|
| **Carbon reduction:** 27 tonnes p.a | **% of target:** 2.7 % |
| **Energy reduction:** 50,000 kWh p.a | **Energy costs savings:** £3.9k p.a* |

**Other benefits:**

- Reduced glare issues within offices
- Significant reduction of maintenance and lamp replacement of corridor lighting

**Risks**

**Notes**

***** at predicted 2010/11 tariff £0.078 / kWh

| **Project title** : Lighting replacement – Cold cathode | **Ref:** NLS04 |
|---|---|

**Brief description**

The project will target lighting installations which are either ageing or have high energy consumption and which are used consistently for long periods of time.

**Deliverables**

- Replacement of all cold cathode lighting within the public areas of the George IV Bridge property

**Carbon reduction measures**

- Install LED luminaires

**Time scale:**

-

| **Total project cost (nett):** £30.5K | **Pay back period: 10 years** |
|---|---|

**Funding**

Internal funding required

**Benefits**

| **Carbon reduction:** 21.5 tonnes p.a* | **% of target:** 2.1 % |
|---|---|
| **Energy reduction:** 40,000 kWh p.a* | **Energy costs savings:** £3.1 p.a* |

**Other benefits:**

- Significantly extended periods between lamp replacements

**Risks**

Work is within the main public area of the George IV Bridge property and will require to be scaffolded. Public events will restrict windows of opportunity for undertaking the work

**Notes**

***** at predicted 2010/11 tariff £0.078 / kWh

| **Project title** : Staff awareness, behaviour change & workplace monitoring | **Ref:** NLS05 |
|---|---|

**Brief description**

Through a series of staff awareness campaigns and ongoing workplace monitoring to reduce energy waste by:-

- Harnessing the energy and on the ground knowledge of staff to identify areas of energy waste
- Providing useful information which will encourage and empower staff to be able to reduce energy waste e.g. labelling of confusing light switches
- Creating a culture with a collective sense of responsibility for energy consumption

**Deliverables**

- Staff awareness survey
- Regular presentation to Service Managers
- Establishing a system for recording and actioning staff suggestions
- Development of a system of Energy Champions based on the existing NLS Green Team
- Roll out of a series of targeted awareness campaigns
- Introduction of workplace monitoring

**Carbon reduction measures**

- Identifying areas of energy waste
- Empowering staff to take appropriate direct action
- Incorporating remaining areas within defined energy reduction projects

**Time scale:**

- Ongoing 2010 -2014 with a target to reduce total emissions by 3% in 2010/11 and 2% over the remainder of the project

| **Total project cost (nett):** Min. cost | **Pay back period: N.A** |
|---|---|

**Funding**

N.A

**Benefits**

| **Carbon reduction:** 170 tonnes p.a* | **% of target:** 16.7% |
|---|---|
| **Energy reduction:** 316,500 kWh p.a* | **Energy costs savings:** £24.5k p.a* |

**Other benefits:**

- If carried out in a positive way, this should be an enjoyable and motivating project which has the potential to collectively engage staff across all divisions and at all levels in a common cause, to which every one is able to contribute and everyone is able to share the success.

**Risks**

Reliance on key personalities to drive the project

Failure to follow through campaigns and maintain the momentum of the project.

**Notes**

***** at predicted 2010/11 tariff £0.078 / kWh electricity

| **Project title** : Chiller replacement + free cooling - George IV Bridge | **Ref:** NLS06 |
|---|---|

**Brief description**

The existing NLS chiller plant is 15 years old and uses R22 coolant, which can now only be purchased on the second hand market and which will become illegal in 2014. The coolant can be replaced, however this is an expensive procedure and the replacement coolant will cause the chillers to be 30% less efficient. The chillers have a predicted maximum further life expectancy of 5 years

This project will replace the chillers with significantly more efficient models and introduce free cooling to this property

**Deliverables**

- Replacement of the NLS chiller installation

**Carbon reduction measures**

- Free cooling
- Increased energy efficiency of new chiller plant

**Time scale:**

- Design and quantification – 2010/11
- Replacement of NLS chiller installation – no later than 2013

| **Total project cost (nett):** £350k | **Pay back period: 16 yrs** |
|---|---|

**Funding (NLS component)**

- Design and quantification – internal / Carbon Trust - secured
- Replacement of NLS chiller installation – capital bid to SG – to be submitted

**Benefits**

| **Carbon reduction:** 145 tonnes p.a | **Carbon reduction:** 14% 2008/09 baseline p.a. |
|---|---|
| **Energy reduction:** 270,000 kWh p.a | **Energy costs savings:** £21k p.a |

**Other benefits:**

- Elimination of R22 coolant from the NLS prior to its 2014 ban

**Risks**

Failure to secure necessary capital funding

**Notes**

***** at predicted 2010/11 tariff £0.078 / kWh electricity

| **Project title** : Desktop computer replacement to thin client technology | **Ref:** NLS007 |
|---|---|
| **Brief description**<br>The project will be rolled out as part of the normal PC replacement programme. Existing standard desktop PCs will be replaced with thin client terminals. There are 47 public PCs and 381 staff PC's. The project assumes that 100% of public PCs and 80% of staff will be replaced.<br>The thin client terminals will be supported by 9 servers. | |
| **Deliverables**<br>• PC replacement programme | |
| **Carbon reduction measures**<br>• Thin client desktop PCs | |
| **Time scale:**<br>• 2012 - 2014 | |
| **Total project cost (nett):** Cost neutral | **Pay back period:** N.A |
| **Funding (NLS component)**<br>Internal – to be undertaken as part of the ongoing PC replacement programme | |
| **Benefits** | |
| **Carbon reduction:** 23.9 tonnes p.a* | **% of target:** 2.3% |
| **Energy reduction:** 44550 kWh p.a* | **Energy costs savings:** £3.5K p.a* |
| **Other benefits:**<br>• Significant reduction on IS staff time on future hardware and software replacements and roll outs | |
| **Risks** | |
| **Notes**<br>***** at predicted 2010/11 tariff £0.078 / kWh electricity | |

| **Project title** : Plant tuning within compliance parameters - Causewayside | **Ref:** NLS08 |
|---|---|

**Brief description**

This project seeks to harness the high thermal mass of the collection storage areas to allow chiller plant to be switched off when external temperatures are such that internal temperatures can be maintained without mechanical cooling. Following tests run during February & March 2010 compliance was maintained up to 8 deg C external temperature. Whilst this test requires to be run for a longer period of time to firmly establish the limits of the project, it is estimated that chiller plant could be switched off approx 14 weeks of the year.

**Deliverables**

- Periods of chiller plant shut down

**Carbon reduction measures**

- Improved monitoring and plant operation routines

**Time scale:**

- 2010 - 2014

| **Total project cost (nett): £0** | **Pay back period: N.A** |
|---|---|

**Funding (NLS component)** N.A

| **Benefits** | |
|---|---|
| **Carbon reduction:** 74.4tonnes p.a* | **% target:** 7.3% |
| **Energy reduction:** 138,600 kWh p.a* | **Energy costs savings:** £10.5K p.a* |

**Other benefits:**

- Extended life expectancy of plant

**Risks**

Abnormally mild weather during winter months will reduce the period of time during which the chillers can be switched off

**Notes**

*at predicted 2010/11 tariff £0.078 / kWh electricity

| **Project title** : Plant tuning within compliance parameters – George IV Bridge | **Ref:** NLS09 |
|---|---|

**Brief description**

This project follows on from project NLS008. During the winter of 2010/11 NLS will experiment with the possibility of shutting down the chiller plant and harnessing the high thermal mass of the collection storage areas to maintain internal temperatures within environmental compliance.

**Deliverables**

- Periods of chiller plant shut down

**Carbon reduction measures**

- Improved monitoring and plant operation routines

**Time scale:**

- 2011 - 2014

| **Total project cost (nett): £0** | **Pay back period: N.A** |
|---|---|

**Funding (NLS component)** N.A

**Benefits**

| **Carbon reduction:** 37 tonnes p.a* | **% target:** 7.3% |
|---|---|
| **Energy reduction:** 69,300 kWh p.a* | **Energy costs savings:** £5.4K p.a* |

**Other benefits:**

- Extended life expectancy of plant

**Risks**

- George IV Bridge is a very different property to Causewayside. Due to the uncertainty to how it will behave an estimate of 50% of the Causewayside findings has been for the predicted savings. NLS will not be able to verify this until the weather cools down in winter 2010/11
- Abnormally mild weather during winter months will reduce the period of time during which the chillers can be switched off

**Notes**

Due to the significant differences between the CB & GB properties for the purposes of the CMP the predicted savings have been set at half of those of CB, until such time as they can be tested. This can not be done until winter 2010/11

***** at predicted 2010/11 tariff £0.078 / kWh electricity

| **Project title** : Humidifier replacement – Causewayside | **Ref:** NLS10 |
|---|---|

**Brief description**

The Causewayside property has 18 electric fired steam humidifiers. These account for 24% of the energy consumption of the building during the 6 months of the year that they operate.

Adiabatic humidifiers use water mist technology and have very low energy consumption. They are currently in use at the National Portrait Gallery.

**Deliverables**

- 18 adiabatic humidifiers

**Carbon reduction measures**

- Adiabatic humidification

**Time scale:**

- Pilot of two units in 2010. Phased roll out 2011 -2014

| **Total project cost (nett): £180k** | **Pay back period: 10.9** |
|---|---|

**Funding (NLS component)**

Pilot phase – NLS funding. Remainder required

| **Benefits** | |
|---|---|
| **Carbon reduction:** 181 tonnes p.a* | **% target:** 17.7% |
| **Energy reduction:** 340,000kWh p.a* | **Energy costs savings:** £26K p.a* |
| **Revenue costs:** £10k p.a | **Nett cost savings:** £16.5k p.a |

**Other benefits:**

**Risks**

Increased legal compliance maintenance required due to the water mist technology

**Notes**

***** at predicted 2010/11 tariff £0.078 kWh gas

| **Project title** : Edinburgh University / GB district combined heat & power scheme connection | **Ref:** NLS11 |
|---|---|

**Brief description**

This project involves connection of the George IV property to the next phase of Edinburgh University district combined heat & power scheme to provide hot water and electricity.

**Deliverables**

- 

**Carbon reduction measures**

- Reduction of the kg CO2/kWh conversion factor for electricity from 0.537 to 0.304

**Time scale:**

Note of interest placed. Feasibility study underway. Connection circa 2014

| **Total project cost (nett):** unquantified | **Pay back period:** unquantified |
|---|---|

**Funding (NLS component)**

To be determined

| **Benefits** | |
|---|---|
| **Carbon reduction:** 285 tonnes p.a* | **% target:** 28% |
| **Energy reduction:** 0 kWh p.a* | **Energy costs savings:** £0K p.a* |

**Other benefits:**

- Disconnection from the grid at Cowgate, which is a very unreliable supply
- Increased resilience
- Option to remove gas from GB, and thus remove a significant hazard within one of the two main collection storage buildings

**Risks**

The extension of the scheme

**Notes**

***** at predicted 2010/11 tariff £0.078 / kWh electricity

# Appendix B: NLS06 George IV Bridge Cooling Strategy Review Feb 2010, Wallace Whittle – Executive Summary

## Executive Summary

The purpose of this report is to review the current cooling installation at the National Library of Scotland, George IV Bridge, with regards to either modifying the existing chiller plant or replacing it.

The current Chillers use the refrigerant R22 and this is due to be phased out and withdrawn by 2014, the existing chillers will either have to be modified to run on an alternate refrigerant or be replaced. As HCFC refrigerants are currently being phased out only limited quantities of recycled R22 are presently available. The current lack of availability of R22 presents a risk to the operation of the chiller plant due to increased costs in obtaining recycled R22. After 2014, the chiller plant will be shut down and the R22 removed for disposal unless the refrigerant is replaced. This will mean the George IV Bridge building will no longer be able to house archive material stored in accordance with BS5454:2000.

Currently the installed cooling capacity is 800kW, with the current cooling demand being 500kW, which gives a reserve capacity for resilience purposes of 300kW.

The existing heat rejection plant is located in the generator room to the rear of Parliament House. As this area has been earmarked for future redevelopment by the Scottish Court Service, an alternative location for the heat rejection plant needs to be identified. It is not viable to relocate the existing heat rejection plant, and it is proposed that new air blast coolers are installed which will enable NLS to take advantage of similar “free cooling” techniques being used at the Causewayside property. The preferred location for these is the Cowgate roof area of the George IV Bridge building, however planning consent will be required for this.

This report considers the following cooling strategy options:-

**Option 1: Replace the R22 refrigerant within the existing chillers**

The existing chillers have a life expectancy of less than five years

The manufacture does not recommend the use of drop in replacement refrigerants and will not support the chiller plant following the installation of replacement refrigerants.

The replacement of the refrigerant has the effect of reducing the efficiency of the chiller plant by approximately 30%.

Estimated cost of refrigerant replacement = £30k

**While this option represents the lowest capital expenditure, it is detrimental to the energy consumption and carbon footprint of NLS. The remaining life expectancy of the plant is also low, which means that this would be a short term measure, and one of the further options will be required in the medium term.**

**Therefore Option 1 is not recommended.**

**<u>Option 2</u>: Replace the existing chillers with two new chillers modified for "free cooling" to provide a central shared installation to serve both the NLS and Parliament House.**

NLS potentially has circa 300kW spare cooling capacity. There is an opportunity to utilise the surplus capacity to serve part of the cooling load for Parliament House.

The anticipated energy savings of Option 3a are 15% per annum of the total electrical supply to building, on the basis that the 300kWh additional cooling used within Parliament House is charged to Scottish Courts.

Estimated capital cost = £350k + Parliament House infrastructure costs which remain unquantified.

**While this option would provide a shared services facility, it would use up all the surplus capacity available to meet any future NLS expansion or cooling upgrades, and lead to reduced resilience for both organisations. In addition the technical difficulties were found to be significant and the timescales too tight to coincide with existing refurbishment works within Parliament House. Scottish Courts are unable to contribute to the capital costs of the proposal. The carbon footprint of NLS was also liable to increase due to a lack of clarity on over how to account for the carbon emissions within the NLS baseline.**

**Option 2 is therefore not recommended**

**<u>Option 3a</u>: Replace the existing chillers with two new 400kW chillers, modified for "free cooling"**

The existing chillers could be replaced with 2 No. 400kW modern screw chillers using a HFC refrigerant. These chillers would be direct replacements and be installed in the current chiller location. The immediate advantages would be reduced energy consumption, with an associated reduction in running costs and carbon emissions due to the increased efficiency of the replacement chillers and "free cooling".

The anticipated energy savings of Option 3a are 15% per annum of the total electrical supply to building.

Estimated capital cost = £350k

**Whilst this option represents the highest capital expenditure of all of the options, it retains sufficient capacity to meet any future expansion or cooling upgrades. More importantly, if one compressor were to fail then the full of the full cooling demand could still be met, ensuring that environmental conditions for the collections.**

**Option 3a is therefore recommended**

**<u>Option 3b</u>: Replace the existing chillers with two new 300kW chillers, modified for "free cooling"**

The existing chillers could be replaced with 2 No. 300kW modern screw chillers using a HFC refrigerant, these chillers would provide the current installed cooling requirement and be installed in the current chiller location. The immediate advantages would be reduced energy consumption, with an associated reduction in running costs and carbon emissions due to the increased efficiency of the replacement chillers and "free cooling".

The anticipated energy savings of Option 3b are 15% per annum of the total electrical supply to building.

Estimated capital cost = £320k

**Whilst this option represents less capital expenditure than Option 3a, it precludes sufficient capacity to meet any future expansion or cooling upgrades, also the resilience of the cooling system is reduced. If one compressor were to fail, only 90% of the full cooling demand could be met. During high periods of demand in the summer, NLS would fail to maintain environmental conditions the collections under these circumstances.**

**Option 3b is therefore not recommended**

# Appendix C: NLS12 Study of the microclimate [Causewayside], T Padfield, 18 March 2010

## Abstract

The design of the Causewayside building of the National Library of Scotland appears to be well suited to passive climate control, even though it has always been air-conditioned. Some environmental measurements are needed to give quantitative support to this assertion which is based on observation alone. These measurements, if they hint at the prospect of success, can be followed by tests in which successive floors have their air conditioning stopped. A pre-requisite for passive air conditioning is that the main lights in the stacks must be turned off nearly all the time, leaving only emergency lighting permanently activated. This is evident from the cooling necessary even when the outside temperature has been around 2°C for months. Even so, some light energy needs to be retained to give the small temperature rise above ambient which is needed to maintain a moderate relative humidity.

It is likely that this shift to very low energy environmental management (in both fuel and human effort) will occasionally, or permanently, move the temperature and relative humidity outside the very narrow ranges recommended by BS5454:2000 for archives. Overriding the recommendation of the relevant British Standard is not a trivial decision. The evolution and present status of the standard is therefore discussed in detail in this document. The fundamental problem is that the standard was based on the best available control technology, in an age which believed in unlimited funding and availability of energy. There is no scientific evidence for the need for such constancy.

The changes recommended, after suitable preliminary checks, will be very cheap, probably paying for themselves in a very short time. However, the planned replacement of the top floor offices by archive stacks will involve considerable expense in bringing the roof to a high performance in resistance to heat flow, resistance to rain and to condensation from within. This medium term ambition has repercussions on the suggested immediate action to improve the energy efficiency of the existing archive volumes.

## Introduction

The Causewayside building was designed as an archive and is generally well suited to the purpose, though the complexity and novelty of the building envelope results in leaks and high maintenance cost. Most of the archive rooms are separated by a corridor from the outer skin of the building. It is not clear how much the corridor climate influences the stack areas. The corridor is used for many purposes. It has service conduits and merges into the corner towers which get very hot, being mainly glass.

Figure 1: The Causewayside building of the National Library of Scotland, viewed from the north west.

The air conditioning is by air forced through ducts above the rolling book shelves. The air returns through floor grilles into an underfloor plenum. The building has always been air conditioned.

The top floor is mainly offices and cafeteria.

## The building structure

Levels 1 and 2 are below ground, sitting in a concrete tank. The book stacks at these levels are separated by a corridor all around. The archive walls are of concrete, not very thick and perforated for services, doors and lifts. The isolation of each stack volume is therefore not complete and not consistent. Nevertheless the inner wall provides a measure of isolation to the archive content. Level 3 is at ground level but is still ringed by a corridor. Level 4 is also surrounded by a buffer corridor but this may not provide an ideal climate buffer because there are glass towers at corners of the building. These get very hot in sunlight. This is probably a disturbing climatic influence on the building but it can also be put to use to provide natural ventilation through entrainment of archive air in the rising stream of warm air. It would also be conceivable to use the towers as dehumidifiers.

Level 5 is the first level which has outside walls to the archive room. Its climate would therefore be more influenced by the weather, in the absence of forced air conditioning.

Level 6 is also exposed to the influence of the weather on one side and part of the ceiling. It also has a separate room without air conditioning. The climate

of this room is not currently measured but it would surely provide a worst-case prediction of the consequences of stopping the air conditioning in other parts of the archive, being less protected from the weather.

Level 7 has no archive space but has a considerable climatic influence on the archives below because it is full of people who demand a congenial temperature around 20°C. This temperature therefore defines the temperature at the top of the archive stack. The temperature at the bottom of the archive stack is also around 20°C, defined by the decade's long history of heat diffusing into the ground.

Heat transfer horizontally from the outside is difficult to assess, but the need to cool in winter suggests that heat movement through the envelope is quite small.

### The potential for simplifying climate control

The building has always been air conditioned, so its natural climate can only be guessed. However, experience from other archives and museum stores, which are described in the documents listed in the bibliography, suggests that air conditioning is probably unnecessary.

The building is compact, with a relatively small area of wall exposed to the weather compared with the volume. The only significant heat source in the archive rooms is the lighting. This lighting is on all the working day but its energy efficiency in leading people to the required document is tiny, if measured in watts per item retrieved. It seems that even in a cold winter, much of this lighting energy has to be sucked out again by a cooled air stream. So the direct energy expense of lighting is probably doubled, considering that energy is also contributed by the fans used to circulate the air. To put it bluntly - it is a crazy system but entirely orthodox at the time it was built, and to be fair, subtle control of lighting at the moment of need has advanced much in recent years.

If one makes the simplifying assumption that the corridors provide a total barrier to heat flow through the archive walls, the archive should maintain a constant 20°C throughout the year because it is sandwiched between the top floor, which must be kept at a temperature comfortable to humans, and the ground of Edinburgh, which is now, after many years under a heated building, at 20°C to a considerable depth, representing an enormous heat buffer.

The relative humidity (RH) of the air will be determined by this temperature operating on the moisture content of the outside air, which will leak in at a small but significant rate. The table shows the relevant data, derived from weather measurements at Edinburgh airport.

One should probably aim for a lower temperature, say 17°C, which would give an annual average RH at about 47%. By chance of the local climate, this is close to BS 5454:2000 recommendations for archive climate. For even greater control, air can be pumped in when the outside water vapour concentration is appropriate to correct the indoor RH.

Although one can be confident that the RH will be very steady through the year, the temperature may stray beyond the strict limits imposed by the standard. Whether this matters is discussed in a later section.

### Temperature uniformity without air movement

According to both the standard and popular advice, air movement is good for preventing mould growth, so the air conditioning performs the supplementary function of suppressing biological deterioration. This is a simplification which is

| Month | Dew point °C | RH outside | RH at 20°C |
|---|---|---|---|
| Jan | 1.0 | 85 | 28 |
| Feb | 0.6 | 76 | 27 |
| Mar | 0.7 | 74 | 28 |
| Apr | 2.9 | 76 | 32 |
| May | 5.8 | 79 | 40 |
| Jun | 8.5 | 78 | 48 |
| Jul | 11.3 | 82 | 57 |
| Aug | 10.0 | 77 | 53 |
| Sep | 8.6 | 79 | 48 |
| Oct | 6.4 | 82 | 41 |
| Nov | 3.3 | 82 | 33 |
| Dec | 1.8 | 84 | 30 |

Table 1: Monthly average dew point temperatures at Edinburgh airport converted to indoor RH at 20°C. In practice, the archive will so effectively buffer the indoor climate that the RH will only vary by a few percent around the annual average 39%.

often uncritically used as an argument in favour of forced air circulation. Mould growth is not directly affected by air movement. The role of air movement is to move heat around, forcing a uniform temperature in the space. This prevents high local RH due to locally low temperature, typically against an outside wall in winter. Thus mould growth is prevented by an indirect process. However, if the temperature of the space is naturally uniform, then air movement serves no useful purpose and can be regarded as undesirable because it moves dust and pollutants around the archive. I emphasise that air velocity has not been shown to have any influence on mould growth. Books do not rot from the middle outwards and boxed papers do not suffer more than loose paper stored in the same environment but fluffed out to harvest the breeze.

A prerequisite for switching off the air conditioning is that the enclosure of the archive stacks does not have hot and cold spots. The surrounding corridors are connected to glazed towers and contain service ducts and pipes, so only measurement can demonstrate adequate temperature uniformity. It may turn out that some walls need added insulation before stopping the air pumps.

## Vertical temperature distribution

The higher levels of the building will become warmer than the bottom levels if the air conditioning is turned off. It is difficult to predict the degree of stratification, because of the variation in temperature both in time and space caused by the glass towers. The top floor will certainly get hot in summer, so there is advantage in keeping it full of air conditioned people whose sensitivity will provide extra security to that provided by inanimate sensors. This top floor acts as a buffer against heat leakage through the top of the stacks and would eventually be the only air conditioned level.

One should also consider the possibility of semi-passive control where heat is pumped between levels. This will probably prove to be an unnecessary refinement. The planned replacement of people by books on the top floor will considerably influence the vertical temperature distribution. This matter is discussed in a later section.

## A progressive and cautious optimisation process

Because of the imperfect isolation of the archive rooms from outside influences, attempts to reduce energy consumption by reducing the influence of the air conditioning must be implemented cautiously and gradually. If the National Library is interested in pursuing this route towards a very low energy archive, some changes are necessary beyond just switching off the air handlers.

The passive archive concept depends on a controlled release of energy within the space, to raise the temperature enough to lower the RH from the average 80% outdoors.

At present the energy release is far too high for passive climate control, because the air conditioning is cooling the air even when the outside temperature has had a daily average around 2°C for several months.

The only source of heat is the lighting. It is always on during working hours. This is bad economy even with air conditioning, because all this heat has to be removed by the circulating air, and the air circulation fans also produce heat.

An easy and non-controversial improvement would therefore be to turn off the lights when they are not needed and then to reduce the air re-circulation rate to the minimum necessary to ensure temperature uniformity in each space.

Here is a suggested sequence of actions to slim down the energy use without risk of damaging the archived material.

### 1. Measurement and analysis

The light energy released into the archive spaces must be estimated or measured. This can be compared with the energy removed from these spaces by the air conditioning, which is already measurable from the building management computer, using the temperatures of flow and return cooling water, and the flow volume. If the light energy approximately matches the cooling energy the case is made for dimming the lights when people are not present in the immediate environment.

Measure the performance of the presently uncontrolled space 676 at the south end of level 6. Measure with and without lighting. This will surely imitate the worst possible result of turning off all the air conditioning to the stacks. I suggest not only measuring temperature and RH in a typical location within this space but also measuring temperatures at places where it would be expected to vary with the weather, such as low down against the outside wall. The south east corner is also directly under a roof terrace. A measurement campaign of hourly measurements from now until after midsummer would provide essential information to support switching off the air conditioning to other archive rooms.

### 2. Reduce light energy

Given confirmatory results from the measurement campaign, I suggest you take one of the underground levels and re-organise the lighting so it is off when it isn't needed. Something like low level LED lighting for navigating the aisles combined with a head torch for finding the exact document. If you think this a too radical introduction of miners' age-old techniques, the existing security system using personal cards can be used to light up the archive only when a person is inside.

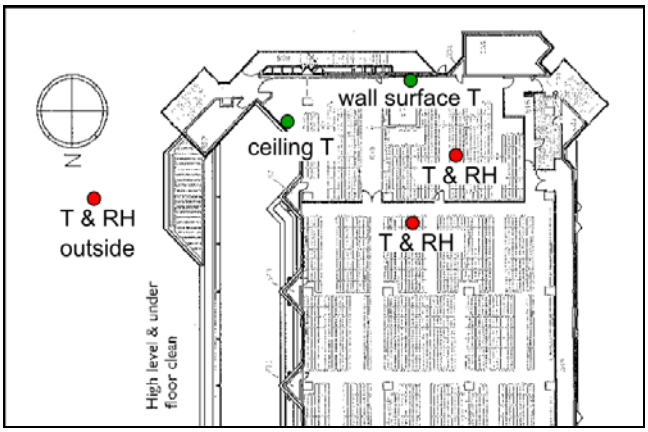


Figure 2: The south end of level 6 with suggestions for temperature (T) and RH measurements.

### 3. Stop the air conditioning on one level

When the lighting has been much reduced, turn off the air conditioning for this level, or at least half the level, and follow the climate development through the year, monitoring system as recommended in item 1 above.

### 4. Repeat prescription

If this shows perfect climate stability and a temperature between 17–22°C, shut off the air conditioning successively for all levels.

### 5. Refine the temperature control

Both temperature and relative humidity can be adjusted (though not independently) by pumping in outside air (through filters) when, by chance, it has the right water content and temperature to push the interior climate to the ideal set point. This is analogous to the 'enthalpy control' which has been used for decades to improve the economy of air conditioning.

### 6. Refine the ventilation

After this first pass at passive control, the measurements may show some irregularities which could be smoothed out by using the glass towers for ventilation control according to item 5 above, but driven by the buoyancy of rising air in the towers rather than by a mechanical fan. Ventilation of the towers may need to be moved up the list of jobs if a survey shows that heat leaking from the towers into the corridors is materially affecting the temperature in the archive rooms.

## The present status of BS5454:2000

It is impossible to comply with the strict environment limits recommended (but not imposed) by the British Standard, without air conditioning. It has proved difficult to comply even with air conditioning. A more fundamental weakness of the standard, and a strain on our acceptance of it as a worthy guide to running an archive, is that it is clearly influenced by what is possible to achieve in the way of climate constancy, given abundant money, technology and human competence. The standard document is notably deficient as a bibliography of the relevant science of material degradation - all its references are secondary sources. It

includes assertions that are unsupported by scientific evidence. These serious failings are discussed in detail in an article included in the bibliography to this report.

There is sufficient unease with the standard in the conservation world that an official review is underway, led by Chris Woods of Conservation Ltd.
http://www.conservationltd.com/about/index.asp

However, this process may take years to replace the existing standard, and the process should not be rushed. We need the courage to question the validity of the existing standard. It is not just that energy is more costly and its possible influence on the earth more worrying; the standard is simply not scientifically stringent

### Is such a radical change in climate control feasible?

The sequence of measurements and events is designed to allow the gradual but finally complete abandonment of the air conditioning except on the top floor, and maybe on the bottom floor, to define the required temperature at intermediate levels. This might seem too bold a change, but for the existence of archives which actually function without air conditioning, or with minimal mechanical aid.

This particular building is constructed in a way that is basically favourable to natural climate control, but the isolation of the archive spaces from the weather, and from internal services, is not complete. This means that a campaign of measurement of climate and energy use is a necessary prelude to action. This measurement should be aimed towards understanding the metabolism of the structure, rather than its percentage of time in compliance with the standard, which is an arbitrary, man-made criterion, of little use in understanding the behaviour of the building.

An advantage of this stepwise approach to saving energy is that it will provide a succession of savings over several years, which in this age of arbitrary targets will allow you to claim serial successes in saving energy.

For year one, switching off the lights will get you a significant saving.

### Perturbation of the climate by removing people from the top floor

The improvements to energy efficiency sketched out in this document are expected to be so cheap that the process can be started immediately, within the existing budget for building maintenance, using immediate savings to fund further progress.

There is, however, an ambition to extend the capacity of the building by bringing the top floor into use as storage. A beneficial effect of this will be to allow the ceiling temperature of the next level to be lower, with consequent reduced temperature right through the sequence of levels. However, making the top floor entirely passive requires providing very good resistance to solar gain in summer and heat loss through the roof in winter. This is not a trivial ambition. It may require complete replacement of the roof and of the glazed parts of the upper floor. The calculations of heat balance through the year will be complicated. The glass towers may be an asset: giving some solar gain in winter, compensated by thermal ventilation in summer. I suggest that a thorough design study should be done before making an irrevocable decision.

The usefulness of people on the top floor should not be underestimated; they

will reliably complain if the temperature strays much from 20°C and will notice water leaks before advanced electronic sensors react.

## Further support

This report is written on the basis of a two hour inspection, aided by useful insights from well informed library staff. It is written in a didactic manner, to ensure brevity and clarity. I am confident that the measurement campaign will not be wasted effort. The subsequent actions must depend on the outcome of the measurements. I have extrapolated from anticipated measurement results to sketch the probable sequence of useful actions. I predict a really large saving in energy use with no loss of preservation quality.

If you require help in making the measurements, interpreting the results or using them to model the likely consequences of various actions, I can offer the services of the museum design group at the National Museum of Denmark, which I am informally linked with. Its typical activities are documented in the bibliography [Ryhl-Svendsen]. Design refinement, particularly of the roof renovation will surely benefit from computer modelling, as will modelling the heat exchange with the ground. Thermal influences from the glass towers will benefit from computational fluid dynamics studies. These specialist services are available in a collaborating institution, the Civil Engineering department of the Technical University of Denmark. However, I suggest you also check for more local expertise at the Department of the Built Environment at Heriot Watt University.

This building is an example from which we can all learn much which will be useful elsewhere, so we are interested in participating in any further work that arises from this report.

## Bibliography

The articles cited here are available as full text from the website reference.

**The scientific quality of BS5454:**
Tim Padfield, 'Simple climate control in archives is hindered by too strict standards', Proceedings of the 8th Symposium on Building Physics in the Nordic Countries. Department of Civil Engineering, Technical University of Denmark, (2008) pp 1429-1436 ISBN 978-87-7877-265-7.
http://www.conservationphysics.org/ppubs/simple_archives.pdf

**Archives which use minimal energy to ameliorate the local natural climate:**
Morten Ryhl-Svendsen, Lars Aasbjerg Jensen, Poul Klenz Larsen and Tim Padfield 'Do standard temperatures need to be constant?' - Paper presented at the Going Green conference at the British Museum, April 2009. Due for publication in Meddelelser om Konservering.
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Tim Padfield, Poul Klenz Larsen, Lars Aasbjerg Jensen and Morten Ryhl-Svendsen, 'The potential and limits for passive air conditioning of museums, stores and archives.' in: Tim Padfield and Karen Borchersen, Editors, Museum Microclimates. Contributions to the conference in Copenhagen, The National Museum of Denmark, November 2007 pp 191 - 198.
http://www.conservationphysics.org/musmic/musmicbuf.pdf

These are peer reviewed papers. An open debate about archive climate control is here:
http://www.conservationphysics.org/standards_debate/standards_debate.php

## About the author

Tim Padfield has a chemistry degree from Oxford University and a PhD in building physics from the Technical University of Denmark. He has worked as a conservation scientist at the Victoria and Albert Museum, the Smithsonian Institution and the National Museum of Denmark, with periods away from the conservation community in the Earth Sciences Department of the University of Leeds and the Civil Engineering Department at the Technical University of Denmark. He is now an independent consultant specialising in microclimate studies of museums and historic structures.

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