Net Zero Public Sector Buildings Standard

Overview of Standard Pathfinder Projects

December 2021

The Scottish Government
Riaghaltas na h-Alba

SCOTTISH FUTURES TRUST

ZERO WASTE SCOTLAND

NHS National Services Scotland

NZPSB 7CS1 Overview of Standard Pathfinder Projects v1

Contents

Introduction to the Standard & Pathfinders

The Net Zero Public Sector Buildings (NZPSB) standard ("the Standard") is a new voluntary standard that has been developed on behalf of the Scottish Government by Scottish Futures Trust (SFT), Zero Waste Scotland, Health Facilities Scotland and other stakeholders to support the public sector in setting ambitious targets to achieve net zero outcomes for new buildings and major refurbishments.

The Standard supports a challenging, credible path to net zero carbon materials and energy supplies for all non-domestic buildings.

The Standard and the exemplary public sector buildings it helps to deliver are important parts of Scotland's net zero strategy. They support the public sector to take a leading role, positively influencing the wider construction sector and its supply chains.

The Standard will provide a platform for new build and major refurbishment projects carried out over the next 25 years, ensuring that the right decisions are made now in their planning, procurement, construction and operation phases. The Standard sets out net zero requirements across six objectives, which together cover the themes of Place, Carbon and the Environment.

The aim of the Pathfinder projects was to review the performance of 10 public sector construction projects at stages 0 – 4 of the Royal Institute of British Architects (RIBA) Plan of Work against the Objectives of the Standard. These stages are: Strategic Definition (0); Preparation and Briefing (1); Concept Design (2); Spatial Coordination (3); and Technical Design (4).

The Pathfinder projects were:

- Penicuik High School (Stage 0), led by Midlothian Council
- Broadford Primary School (Stage 0), led by the Highland Council
- Currie High School (Stage 2), led by the City of Edinburgh Council
- University Hospital Monklands (Stage 2), Led by NHS Lanarkshire
- Dunfermline Learning Campus (DLC) College (Stage 2), led by Fife College
- DLC Schools (Stage 2), led by Fife Council
- Maybury School and Health Centre (Stage 3), led by the City of Edinburgh Council
- St. Sophia's Primary School (Stage 3), led by East Ayrshire Council
- Dunlop Early Learning Campus (Stage 4), led by East Ayrshire Council
- Kincardine Health Centre (Stage 2), led by NHS Fife

The Pathfinders considered the Standard at different project stages, with each project having its own specific opportunities and challenges in applying the Standard's principles. The Pathfinder process was conceived as an exploration of what it would take to apply the Standard. Given that the majority of the projects were already in development, it was not a requirement that Participants should go on to fully implement the recommendations, even where this may be possible. Nonetheless, a number of those who took part were so convinced of the benefits of the Standard's approach that they opted to implement some, or all elements going forward.

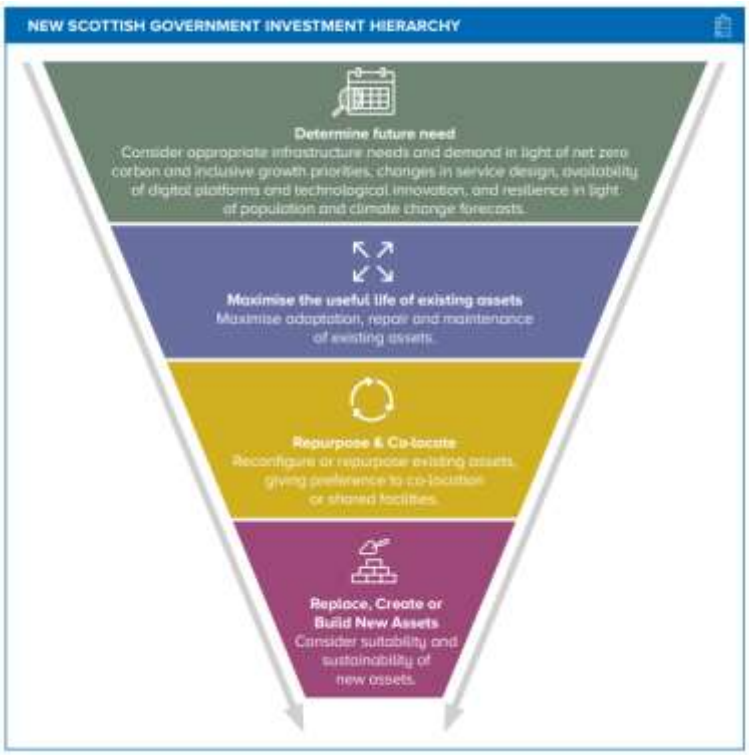
In summary, the Pathfinder projects have provided a valuable set of test cases for the application of the Standard. These have been used to fine tune the requirements of the Standard and provide an interesting perspective and insight into its application. Scottish Futures Trust and its partners would

like to thank all of the public sector Participants and their project teams for their participation in this process.

If you are interested in discussing the application of the Standard, please email here.

Place (Objective 1)

Objective 1 sets the Standard apart from other assessments of environmental performance and integrates a requirement to apply the place-based principles set out in the Scottish Government's Infrastructure Investment Plan. In many ways this approach, which ensures that we create the right buildings and match them with the right future needs, is the most powerful means at our disposal to minimise emissions.



The Scottish Government's Investment Hierarchy forms a key part of Objective 1

Of all the elements of the Standard, Objective 1 is the one which should be considered earliest in the process but with the Pathfinder projects at various stages it was not always possible to apply Objective 1 at the very earliest stages. Nonetheless each project gained something through consideration of Objective 1. Even where this was retrospective, it helped frame how each project could maximise its potential benefits in terms of Place. This aspect of the Standard rests upon the achievement of not just one, but all three of the ambitions of the Infrastructure Investment Plan (IIP):

- Progress towards net zero emissions and broader sustainability
- Inclusive economic growth
- Resilient and sustainable places

Stakeholder engagement forms a key part of this process and school projects such as **Currie Community High School, Maybury Primary School & Health Centre, Penicuik High School, St Sophia's Primary School**, and both the **DLC Schools and College** were able to show how application of Place-principles can shape a project. For **St Sophia's** the stakeholder engagement broadened the range of options being considered, and the project shifted from being about an assumed requirement for a new school in a new location, to becoming a means of preserving and enhancing a valued and existing asset in a community. This in turn led to a more expansive range of options being considered and the final decision to pursue the UK's first EnerPHit accredited refurbishment. If successful, this highly ambitious upgrade of a deteriorating 1950s building will signpost a broader range of options to those considering future educational estate requirements. This has many benefits in terms of embodied carbon, but it also preserves and strengthens an existing place.

Maybury School & Health Centre demonstrates the desired early-stage engagement with other public sector stakeholders and the resultant creation of a space that meets the requirements of the community and a number of public sector users.

Of all the Objectives, Objective 1 is the one which requires the most input early in a project. The intention of Objective 1 is not to add significantly to the burden in terms of staff and consultancy time, but recognises activities need to be scaled to the size of the place and project considered. An important concept from the Standard is the requirement for an **independent challenge** to the options, ideas and assumptions that the participant teams create in the early stages. This is a key part of the Objective 1 process and something that the Pathfinder process was able to bring to the Participants, for example the extent of refurbishment at **Penicuik** has been challenged and expanded through engagement prior to Brief finalisation.

Construction Embodied and Other Whole Life Carbon (Objectives 2 and 4)

Objectives 2 (Construction Embodied Carbon) and 4 (Other Whole Life) both set out requirements that a project must meet to achieve low levels of embodied and life-cycle carbon. In most cases the carbon emissions associated with the energy consumed during the day-to-day operation of a building is well understood. However, it is now recognised that embodied carbon emissions can make up between 30-70% of a building's carbon impact over its whole life. As Scotland's electricity supplies become further decarbonised, this percentage will continue to increase. These are the emissions that arise during raw material extraction, processing, product manufacture, transportation, construction, use and end-of-life (these stages are formally defined by BS EN 15978). For example, it is estimated that concrete accounts for 7% of carbon emissions globally, therefore considering and measuring this for the materials we use can have a profound effect on the carbon impact of our built environment and be a key factor in deciding whether Scotland achieves its goal of net zero carbon by 2045.

Objectives 2 and 4 establish a clear pathway where none previously existed for clients to begin to tackle the complex issue of embodied carbon. The Pathfinder projects adhered to a benchmark of 650kg/m^2 - this target has since been further reduced to 600kg/m^2 in the launch version of the Standard.

The support on Embodied Carbon and Other Whole Life Carbon was one of the elements of the Pathfinder process which Participants found most useful. There was a clear appetite from those involved to understand how they should target Embodied Carbon, and how they should incorporate and quantify it through the design process. Other Whole Life Carbon is also quantified in the Standard without specific targets at present but was also something which Participants were keen to understand. It was acknowledged that the consideration of these Carbon categories added to the complexity of design for Participants and that in some cases there can be trade-offs between these Objectives and others (e.g. the incorporation of solar photovoltaic panels to generate renewable electricity, but for which there is an element of embodied carbon to consider).

St Sophia's Primary School, East Ayrshire Council - Impressive reductions in Construction Embodied Carbon were possible through a refurbishment rather than new build approach

For many of the project teams, the incorporation of Construction Embodied Carbon into their design decisions was a novel concept but there were some who took quite radical steps which would help minimise the amount of Construction Embodied Carbon. This included projects with significant elements of refurbishment, and in some cases, Participants looked to maximise the level of refurbishment at least partly to reduce the level of embodied carbon.

Operational Energy (Objective 3)

Perhaps the main impetus for the creation of a Standard is the identified gap between targeted and actual energy performance in many buildings. Aspirations are very often not met and yet we need consistently good energy performance in our new and refurbished buildings to achieve net zero.

A number of observations can be made on the basis of the Pathfinder projects and the other research undertaken as part of the Standard development:

- The energy performance gap is a persistent problem with new build and refurbishment projects
- A small but increasing number of high performing buildings are being created that can be shown to close this gap, for some sectors (schools) there is good understanding of what can be achieved

- Despite this progress our understanding of what 'good' looks like across all building types is not well developed

Central to Objective 3 is the application of an Operational Energy Target in kWh/m² which is set early in the process. This Operational Energy Target then drives the decision making and design process, with the aid of dynamic simulation modelling to refine the target as the project progresses. Scottish Futures Trust and its partners believe that for many public sector building types, it should be possible to achieve 100 kWh/m²/year or less.

Dunfermline Learning Campus, Fife College and Fife Council – Both Council and College sought to apply ambitious operational energy targets

The Pathfinder projects themselves were excellent opportunities to consider what is possible in terms of good performance. The **Monklands** and **DLC College** participant design teams both accepted the challenge to consider what might be possible for their buildings at a very early stage and before any building modelling had been undertaken. **DLC College** noted that there was little information available regarding high energy performance buildings of the size and scale they were considering. This presented a problem – 'what should the team be aiming for?' To overcome this the team undertook a detailed review of the composition of the proposed building and considered the extent to which they could achieve improvements in performance over and above benchmark data. Much of this proposed potential for improvement related to space heating requirements.

Working together, the Pathfinder consultancy team and designers considered a broad set of energy options. The **Monklands** design team worked to understand how ambitious Operational Energy Targets, and the requirement for Zero Direct Emission Heating (ZEH) could be made compatible with their central requirement to create a modern, reliable, and cost-effective hospital design. This included a very broad review of energy options, to include ZEH technologies and energy reduction and minimisation options. They were also conscious that target setting for a large, complex hospital building could carry risk, but steps were being taken by the designers to consider how the original typical targets could be made more ambitious and how this would actually be achieved and modelled through the process.

The **Monklands** design team worked to understand how ambitious Operational Energy Targets, and the requirement for Zero Direct Emission Heating (ZEH) could be made compatible with their central requirement to create a modern, reliable, and cost-effective hospital design. However, our Pathfinder consultancy team were able to help steer the designers to a much broader set of energy options, and by the end of the Pathfinder process the designers had very much taken the lead and were themselves exploring options for ZEH technologies and energy reduction. They were also conscious that target setting for a large, complex hospital building could carry risk, but steps were being taken by the designers to consider how the original typical targets could be made more ambitious and how this would actually be achieved and modelled through the process.

Many of the Pathfinder projects, particularly those for education, were already working towards Operational Energy Targets which were generally compatible with the Standard. This included schools under Learning Estate Investment Programme (LEIP) or others that had targeted Passivhaus performance standards. **DLC Schools, St Sophia's, Penicuik High School, Currie High School** and **Broadford School** were funded through LEIP whereas **Maybury School and Health Centre** sought to achieve the Passivhaus standard. In each case the ambitious performance metrics and requirement for iterative modelling through the design process were already well understood.

The following conclusions were drawn from the Pathfinder process:

- It is important that dynamic simulation modelling is included as part of the process, and that this modelling is given some level of challenge (such as independent review) at the right time.
- Equipment and internal loads should be understood in detail, as soon as possible during the design and modelling process. Reliable information, as well as an understanding of the risks of changes to equipment and Heating, Ventilation and Air Conditioning system (HVAC) profiles is extremely important. Early simplifications and omissions can lead to problems later in the design when it becomes difficult and expensive to change aspects of the fabric, form, and spatial arrangements.
- Ambitious Operational Energy Targets and compliant ZEH systems can be successfully integrated into projects, even in cases where there is little initial understanding of what good looks like or where there are few comparable example projects to draw upon.

Indoor Environmental Quality (Objective 5)

The Standard places a great emphasis on the interface between operational energy performance and the creation of internal spaces which promote a healthy lifestyle, increase productivity, and add value to buildings. A tenet of the Standard is that it is possible to have buildings with have very good thermal performance that also offer wonderful internal environments, even with the improvements to air tightness and reductions in uncontrolled ventilation. Achieving this balance needs an understanding of the internal environmental requirements at Application Stage and thereafter careful management and development of dynamic simulation modelling through the design. The Standard also stresses the importance of Post Occupancy Evaluation.

Many of the Pathfinder projects were educational buildings for which it was found Participants had already taken steps to specify high quality internal environments by mandating well recognised

performance requirements such as BB 101: Ventilation, thermal comfort and indoor air quality 2018 and BB93 Acoustic design of schools.

Setting good initial targets is a necessary first step, and for some specialist buildings this may in itself be an involved process. It is also crucial thereafter that the right information is built into the dynamic simulation modelling process as early as possible. A useful outcome of the Pathfinder process has been to help identify potential oversimplifications or misinterpretations of equipment load profiles, of occupancy patterns and of heating, ventilation and air conditioning modelling. Catching these early can help to ensure that the design does not reach a stage where it is difficult to make meaningful changes without incurring significant additional cost.

This need for attention to detail is also reflected in requirements such as the need for Climate Based Daylight Modelling and the need to account for future climate weather scenarios (as demonstrated by **Kincardine Health Centre**) in thermal modelling. In many cases our Participants noted that this was a welcome added level of detail from the usual, compliance orientated approach. Building in the right information at the right stage involved the efforts of all parts of the Project team not just the modeller themselves.

Maybury Primary School and Health Centre, City of Edinburgh Council - Maybury, like many of the other pathfinders, included careful consideration of indoor and external environmental peformance

Environmental Aspects (Objective 6)

The Standard allows flexibility and tailoring of targets for the specific place and circumstances in each case for the assessment of Environmental Aspects. The options for good project-specific initiatives are numerous and a wide variety were noted within the Pathfinder process including green infrastructure, biodiversity, landscaping, flood risk management, climate change adaptation and resilience, health and wellbeing and active travel.

Even with this flexibility some of the Pathfinders were committed to taking steps which could be considered as radical, for example **Maybury School and Health Centre** project sought to completely omit car parking spaces from the scheme design, thereby maximising the use of active travel.

In other cases, the projects reflected not just the specifics of the buildings in question but also the ambitions of Strategic Local Plans, for example **Currie High School** included a sustainable urban drainage system with an increased allowance for climate change as per the Local Authority's own specific requirements. This can mean that Objective 6 is an opportunity to apply wider organisational goals.

Indeed, the outcomes of Objective 1 (the assessment of Place) should inform what is possible and desirable from Objective 6. This could be seen in a number of the Pathfinders to include **Dunlop Early Childhood Centre**, where early assessment of the actual need helped guide the project ambitions to enhance outdoor areas and to retain biodiversity and a natural landscape in the project proposals.

Standard Interface with other Initiatives and the Inclusive Net Zero Champion

The Standard does not seek to add significantly to the burden of time and resource needed to deliver projects. The Standard should, if applied correctly, interface well with supporting initiatives such as Soft Landings, the Standard Information Management Plan and the Construction Quality Assurance Initiative. The Standard should draw from and reinforce these other approaches and where other building Environmental Standards are applied (e.g. BREEAM, the WELL Building Standard) the Standard can complement these without adding significantly to the overall project burden.

Important to all of the Pathfinders, and particularly those which sought to take the application of the Standard beyond the Pathfinder support through to the later stages of their project, was the Inclusive Net Zero Champion, who knits together the efforts and technical expertise from the Project Team and beyond. It is not necessary that they themselves have a particular technical expertise, but they must have an overall understanding of the design and construction process and where the greatest risks lie for success using the Standard. It's also important that the individual chosen has the right standing within the project team and that they have the seniority to motivate and manage others.

The Pathfinder process has highlighted the crucial role of the Inclusive Net Zero Champion and as such Scottish Futures Trust and its partners have developed a suite of tools and documents to assist them in their role.

Impact on Costs

The Standard is designed to be easy to apply and not to add to the burden of time and cost for projects, but it does represent ambitious leadership in the public sector estate and is indicative of something exceptional. As with other standards, such as the Passivhaus Standard and BREEAM, there is a cost associated with the consultancy required, the project team time and the actual project capital costs but, on balance, it is thought that the Standard will help public sector organisations to ensure that they are making the right decisions to achieve the best value route to net zero now.

Projects adopting the Standard, or other exemplary approaches to energy efficient and net zero buildings, could require additional consultancy and support in relation to:

- Support to Inclusive Net Zero Champion
- Additional dynamic simulation modelling, both for operational energy and indoor environmental quality (IEQ) purposes
- Measurement and verification planning and implementation
- Costs associated with independent assessment, checking or verification

In many of the Pathfinder projects, these consultancy tasks and the required costs were covered at least in part by the time, and information management expertise related to other existing requirements, such as Building Information Modelling (BIM) / Standard Information Management

Plan (SIMP) and Post Occupancy Evaluation (POE) analysis for Monitoring and Measurement activities under the Projects' existing, wider management, and soft-landing costs.

In some cases, the Pathfinder intervention actually led to, or highlighted the potential for cost savings. For example, a detailed review of kitchen equipment loads led to the realisation that some of this equipment's specifications could be downgraded, resulting in capital cost savings. The application of more sustainable concrete mixtures can, in some cases lead to material cost reduction.

The variation in capital cost was also considered in some detail as part of the Pathfinder projects and in cases where ambitious targets for performance were already incorporated (e.g. LEIP, Passivhaus) there were thought to be little or no increases in capital costs associated with the Standard.

In cases where capital costs are based on typical or statutory compliance cost models, cost increases could be expected to achieve the exemplary Requirements of the Standard. However, for all of the Pathfinder projects, LEIP projects and any new build projects that aim to achieve safe, well ventilated and thermally comfortable indoor environments it is clear that the minimum standard of statutory compliance is no longer relevant as a base case for comparing the costs of design options.