

Draft

Carbon Reduction and Sustainable Retrofit Guidance for Historic Buildings

Technical Advice Note (TAN) 15



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1. Introduction

Alongside our partners across the city, the Council has set an objective for Oxford to be a net zero carbon city by 2040. As is identified in the Zero Carbon Oxford Partnership roadmap to 2040, this will require significant adaptation of our built environment to reduce emissions of carbon over the coming years.

A key source of the carbon emissions which contribute to climate change is that of energy use in our buildings. The energy used to heat our homes, to produce hot water, to cook, to light rooms and power appliances all makes a contribution to carbon emissions where this is sourced from fossil fuels. The City Council recognises the need for retro-fitting of existing buildings, including historic buildings, so as to reduce their impacts on climate change and the environment and is supportive of measures intended to deliver this through sustainable design and construction, renewable energy technologies and low carbon technology.

Scope of this guidance

This Technical advice Note (TAN) includes general advice on how to approach retro-fitting projects aimed at reducing energy demands (and reducing carbon emissions) within heritage assets including older and historic buildings, and buildings within conservation areas. The guidance seeks to help applicants in several ways:

- Section 2 – gives you an overview of the key factors which the Council needs to consider when it makes decisions on applications that relate to these kinds of projects. Ensuring you are familiar with these will help you in putting together your application and ensure the best outcome from it.
- Section 3 and 4 – sets out a step-by-step framework for thinking about how to approach these projects focused on achieving energy efficiency. It highlights particular sensitivities and considerations in relation to heritage assets and aims to provide greater clarity on the factors that you should take into account when considering particular interventions.
- Appendices – these include more detailed information on other sources of guidance as well as the particular interventions that are discussed throughout the TAN.

The guidance will supplement any additional specialist and site specific advice and can be used to inform other submission documents that may form part of an application such as a heritage or Design & Access statement as required.

What we mean by heritage

Heritage is a broad concept. Generally speaking, the scope of this guidance would be applicable to the following building categories:

- Listed buildings
- Buildings located in conservation areas
- Buildings which are of particular architectural and historical interest to the local area.

More broadly, the scope of this advice would encompass most buildings erected prior to the 1930s, including those built pre 1919 using traditional or vernacular techniques. Although cavity walls were introduced as early as 1900, it was only in the mid-1930s that it began to predominate house construction and mark the time for what can be understood as modern housing in the UK. The emphasis is on individual residential dwellings, which make-up a significant proportion of the historic building stock in Oxford, however many of the principles can be applied at larger scales or to non-residential buildings.

This note will eventually be updated with local best practice case studies which help to illustrate the application of such an approach.

Where you can get more support and information from the Council and others

Before embarking on any work that might affect the significance of a heritage asset, it is always advisable to seek [pre-application advice](#) from the council's planning department. Through this service, we can advise you on the key issues that you need to consider when you are designing your scheme. We can also help you to identify whether planning permission, listed building consent, or other consents (e.g. Tree Preservation Order consent) would be required for the

intended work and sometimes you may require more than one type of consent before you can carry out any work¹. Section 4 of this guidance also touches upon other consents you may need to attain.

This guidance note is intended as a beginner's resource flagging key issues to consider and does not replace the need for specialist advice which is considered to be important in many cases. For further information you can find extensive specialist guidance on this subject from various heritage organisations, some of which are listed in the Advice and Guidance and Contacts sections of this guidance. The [Planning Portal](#) is also a source of helpful information, as is the [Historic England](#) website. This advice should be consulted as a minimum prior to the start of any project.

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¹ It is an offence to carry out any work to a listed building that affects its architectural or historic interest without the Council's approval. You could be liable to prosecution, and be made to put right any changes you have made.

2. How we approach decisions on applications for retro-fitting measures on heritage assets

We recognize the pressing need for retro-fitting measures that can bring about reduction in the use of carbon, and discharge of carbon emissions in existing buildings across the city, including our historic buildings. The supporting text to policy RE1 of the Local Plan sets out that *the Council supports all measures to retrofit listed and historical buildings in a sensitive manner*. Equally, we have a statutory duty to protect the special values of our heritage assets so that they can continue to be enjoyed by future generations. Our focus as a planning authority is ensuring that we manage change to these valuable and irreplaceable resources in a sustainable way, supporting carbon reduction whilst also preserving and enhancing their special values. It is extremely important to understand that these aims are not mutually exclusive.

Ultimately, there isn't a single answer as to what adaptations may be appropriate for all historic buildings or buildings within a Conservation Area. Each case must be considered individually on the basis of a really good understanding of the building's existing fabric and how that performs at present. Solutions will depend upon the impact that they will have on the important values of the buildings, the special character or appearance of a conservation area, and ultimately, the impact on the significance of both designated and non-designated heritage assets.

When an application is registered, officers are required to identify and weigh up a whole variety of issues and matters that relate to the planning context and how the proposal meets the objectives of the local plan policies and the national policy framework. In the particular case of historic buildings and buildings in conservation areas, when considering the introduction of energy efficiency and renewable energy measures, a couple of key principles factor into the consideration, which are discussed next.

Thinking about harm to significance of the asset

National policy, as set out in the National Planning Policy Framework (NPPF)², para 199, is clear that great weight should be given to a designated heritage asset's conservation (and the more important the asset, the greater the weight should be). It sets out that any harm to, or loss of, the significance of a designated heritage, should require clear and convincing justification.

For non-designated heritage assets, like those adopted onto the city's local list or identified as being locally important through the planning process, national policy is less onerous. In such cases, a balanced judgment will be required having regard to the scale of any harm or loss and the significance of the heritage asset.

A key consideration is the level of harm that proposed alterations or interventions could make to the architectural or historical significance of a listed building, or the special character or appearance of a conservation area for which they have been designated. The National Planning Policy Framework identifies two levels of harm: **substantial harm**, or **less than substantial harm**. What constitutes substantial harm and less than substantial harm is a complex question and some guidance is set out in the PPG^[1] though it is ultimately down to the decision-maker to make a professional judgement based upon the evidence in the case. Examples of what might constitute each level of harm are set out in Figure 1.

Substantial Harm	Less than Substantial Harm
<ul style="list-style-type: none"> • Permanent change to or loss of features that create conservation or heritage value. • Significant alteration of particular elements that have been identified as contributing to the important value of the asset • Alterations to the interior of a listed building that would result in damage, change or the loss of significant internal features or layouts 	<ul style="list-style-type: none"> • Impact on the special values of the building or conservation area but do not result in complete loss of features that create those values. • Alterations are fully reversible.

² [National Planning Policy Framework](#)

^[1] [PPG Guidance – Decision-making: Historic environment](#)

Figure 1: Examples of what may be considered substantial or less than substantial harm to a heritage asset.

Judging whether harm will be caused to the significance of a heritage asset by an intervention (such as the installation of solar panels for example) will require consideration of the reason and manner of designation of that heritage asset. You will need to think about questions such as: *how important is the heritage asset? What are the values that contribute to that importance? And how would those values be affected by the intervention?*

When a building is listed, all of the building itself, anything fixed to it, as well as any buildings and structures in its grounds (the curtilage) are included in the protection given by the listing. In addition, it is not simply the outside of the building but also inside, its plan form, the size and arrangement of rooms, fixtures and fittings that date from its original design or construction.

Meanwhile, a conservation area, is also a heritage asset but one for which the character and appearance of the place, rather than of an individual building or structure within it, is important consideration which contributes most to its significance. In conservation areas, it is this overall special character of the area and the particular things that contribute to that which need to be considered as being significant. Conservation area appraisals for each of the designated conservation areas within the city can be found on the Council's website and these documents set out clearly those things that contribute to the area's special character and appearance and would therefore need to be considered when assessing harm from a particular intervention.

National policy again clearly sets out expectations for how applications should be determined based upon the level of harm to significance or special character or appearance that is expected to be caused by the proposed intervention as is highlighted in Figure 2. Any proposal resulting in **substantial harm**, or **total loss of significance of designated heritage assets**, should be refused, unless it can be demonstrated that it is necessary to achieve a substantial amount of public benefits that would outweigh the level of harm. This test is an extremely high bar to pass, planning case law has established that even the smallest amount of harm would require an enormous weight of public benefit to outweigh it. Proposals will be expected to show that there are no feasible, alternative measures that would deliver the same or similar benefits without causing a lesser amount of harm (or none at all).

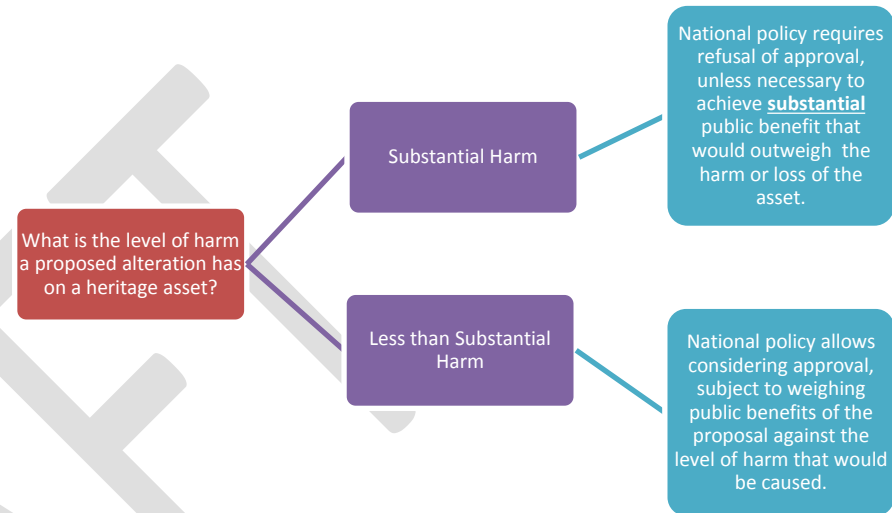


Figure 2: Assessing Level of Harm to Heritage assets

Where the level of harm would be **less than substantial** but still involving some level of harm, national policy allows for decision makers to consider approval. In these circumstances, the level of harm will need to be weighed against the public benefits of the proposal.

What constitutes public benefit?

The Planning Practice Guidance (PPG)³ sets out that public benefits can be anything that delivers upon the three principle economic, social and environmental objectives that are highlighted in paragraph 8 of the NPPF. This includes mitigating and adapting to climate change, including moving to a low carbon economy. Indeed, the Council has a recognized objective of Oxford being a net zero carbon city by 2040 and has worked with stakeholders from across the city through the Zero Carbon Oxford Partnership to establish a road map with a number of milestones focused on reducing emissions in the built environment to help achieve this target.

³ [PPG Guidance – Decision-making: Historic environment](#) (para 020)

Crucially, the PPG states that public benefits *should flow from the proposed development and be of a nature or scale to be of benefit to the public at large and not just be a private benefit*. Essentially, this means that they need to be clearly public benefits and not simply private or personal benefits, and they need to be clearly deliverable by the proposed development/intervention so directly arising from it.

In the process of weighing up public benefit against the potential for causing harm to, or loss of, the significance of a designated heritage asset, it is important to remember, that because national policy currently affords great weight to the asset's conservation (and the more important the asset, the greater the weight should be); there is a great weight given to even the smallest amount of harm so that the level of public benefit needed to outweigh harm before a proposal might be deemed acceptable will be considerable.

How to get the best outcome from your application

The determination of applications seeking permission for change and intervention to heritage assets requires consideration of a number of important factors. Every case will have its individual factors that will need to be taken into account, but to make a better application and get the best outcome, it is important that:

- Before embarking on any work, particularly where it might affect the significance of a heritage asset, you should consider making use of the Council's [pre-application service](#) where you can obtain guidance and support on what you need to be aware of.
- Your proposal has been designed to minimise (and ideally avoid) harm, or loss of, the significance of the heritage asset.
- Where there is potential for harm, your proposal has clear and convincing justification, and sets out clearly the public benefits that will arise as a direct result of the intervention.
- Where your proposal seeks to deliver retro-fitting for energy efficiency/carbon reduction, the public benefit of climate change mitigation is a material consideration in decision-making, so remembering to set out clearly how your proposal delivers upon this form of benefit can help in justifying your approach.

Following the guidance in this TAN and using it to help demonstrate that your proposal has been informed by a sound and in depth understanding of how your building performs at present (and has taken that performance into account when

choosing and designing the proposed changes) will be an important element in justifying any changes proposed.

3. Approaching a retro-fitting project on historic buildings/ or buildings sited in conservation areas

We have a statutory duty to conserve the historic environment whilst also supporting the transition to net zero. As part of a planning application, or application for listed building consent which relates to retro-fitting for energy efficiency/carbon reduction, you will need to demonstrate that your project has been informed by an appropriate assessment of the current building and how it performs. One of the sustainability principles applicants should follow as set out in Local Plan policy RE1 is that of 'maximising energy efficiency and the use of low carbon energy', and a key way of helping to demonstrate this is through using the energy hierarchy (Figure 3) to help inform your design. You should show that you have considered the energy hierarchy, and that you have selected the most appropriate improvements for delivering carbon reduction/other sustainability benefits which will minimise, or result in no harm to those elements of the building that contribute to its significance and/or the significance that it contributes to a conservation area.

The guidance in this TAN has been aligned to a number of steps adapted from the energy hierarchy and moving through these steps should put you in the best place possible for your application to be successful. The steps are summarised in Figure 4, with the remainder of the guide then going into greater detail on each step.

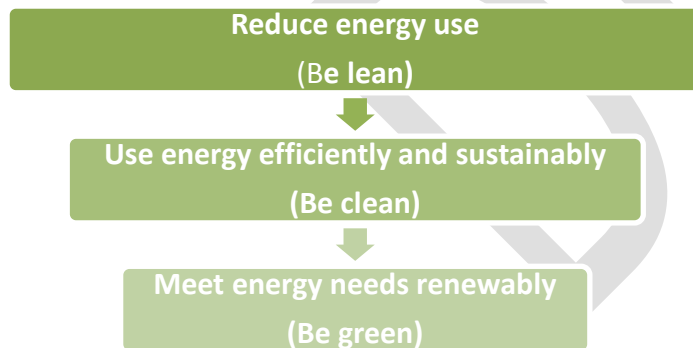


Figure 3: The energy hierarchy

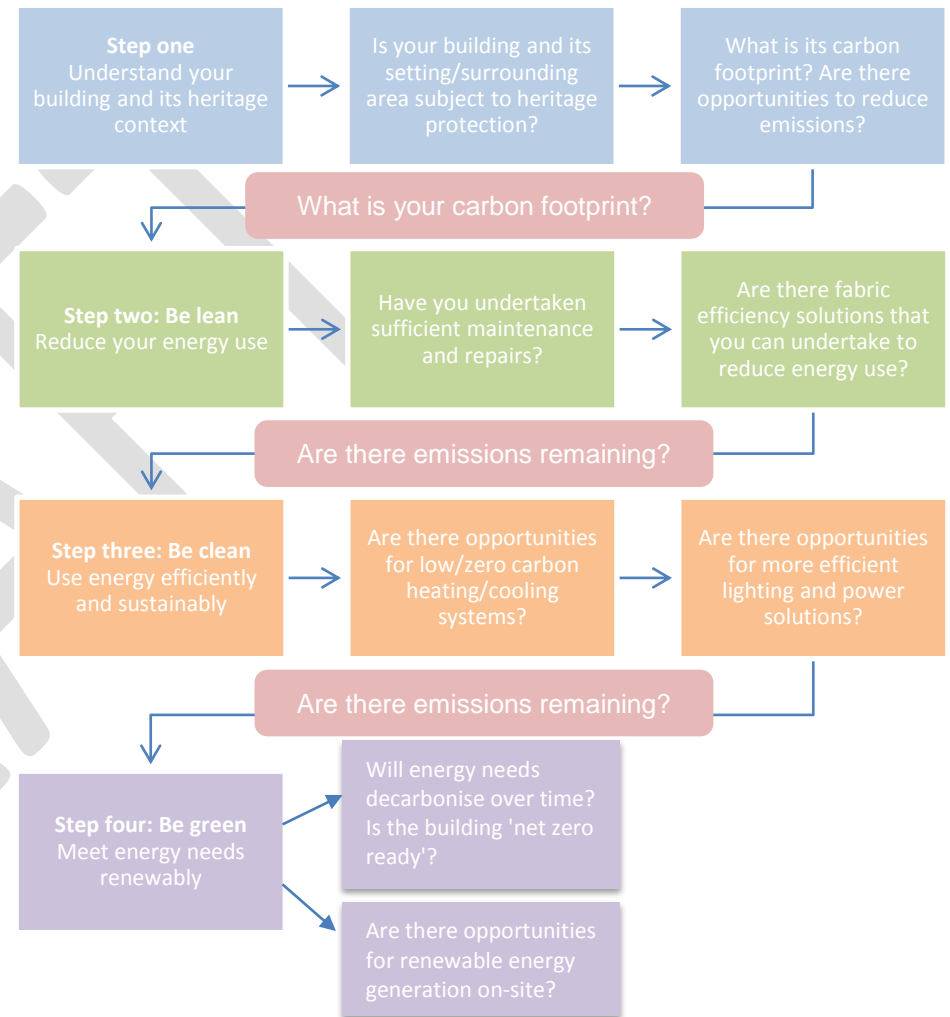


Figure 4: The steps to approaching a retro-fit project for your historic buildings in the context of their surrounding area

3.1. Step 1 - Understand your historic building/context

At a glance:

- Before commencing with any retro-fitting project, it is crucial to have a thorough understanding of your building.
- You need to think about what makes it special with regard to its heritage value, as well as how it currently performs in relation to energy efficiency and carbon emissions.
- A comprehensive assessment will enable you to identify quick wins and less resource-intensive improvements that may be more suitable than large scale changes.

Oxford City Council, Low Carbon Oxford (now the Zero Carbon Oxford Partnership), Oxford Preservation Trust and Building Research Establishment (BRE) have developed [Oxford's Heritage and Energy Efficiency Tool](#) (HEET) and have produced some local case studies with the help of architects West Waddy ADP. HEET is made up of a work sheet and a set of guides that have been developed to assist with assessing your building's heritage value and condition and exploring options for energy efficiency improvements and renewable technologies.

Whilst we will refer to the HEET tool in this section, other tools may help you with understanding your building and what opportunities exist for retro-fitting, such as the independently produced [Plan Builder tool](#), by [Cosy Homes Oxfordshire](#).

Understand what makes your building special with regard to its heritage value

Your building may have been nationally listed, which protects both the inside and outside of a building, as well as fixtures and fittings (like windows, doors or staircases) and subsidiary buildings that lie within the 'curtilage' of the building. You can find more info on this here⁴. Equally, it may be subject to a local listing, more info can be found on this here⁵.

⁴ [Historic England – Listed Buildings Guide](#)

⁵ [Oxford Heritage Asset Register](#)

Equally, the property may not be directly listed but could sit within one of Oxford's 18 conservation areas, identified for their special architectural or historic interest that makes them worth protecting and improving, more information on these can be found [here](#).

The main purpose of creating a conservation area is to preserve and enhance the unique and distinctive character of an area through planning and other environmental measures; but inclusion within a designated conservation area doesn't mean every building should be preserved as it is and that no changes will be allowed. It instead helps to ensure that any changes made respect and ensure preservation of the area's special character and appearance.

The HEET tool includes a guide that can help you to consider whether your building or its setting has a particular heritage value due to its appearance, form of construction, the history it has witnessed, or the place it occupies in an historic neighbourhood. Equally, there is a worksheet that you can use to identify and record your building's special features helping you to understand and value these.

Understand how your building performs in regard to its energy efficiency and carbon footprint

Traditional building techniques often made use of a variety of passive design measures that allowed them to stay warm and cool as the seasons changed. It's important to ensure that you have an understanding of any such features to make the best choices for how you approach any retro-fit project. Equally, however, there are often opportunities to address issues or weaknesses in the building's performance.

The HEET tool includes a health check worksheet that can support you in looking for evidence of where simple maintenance of the existing building fabric may increase energy efficiency and also includes a list of basic maintenance tasks.

You could also make use of more extensive assessment approaches to understand building performance, or source expertise from energy/sustainability experts. Calculations such as the Standard Assessment Procedure (SAP) or Simplified Building Energy Model (SBEM) can model the performance of a building, as well as the Passivhaus Planning Package (PHPP). There are also other

practical methods such as air pressure testing, which can identify ventilation performance and draughts.

The need for a different approach to retrofitting historic buildings

Modern buildings are typically built with synthetic or natural insulation, vapour barriers, double glazed windows and mechanical ventilation in certain areas. By contrast, older buildings are often built using naturally water vapour 'permeable' materials and techniques, which are also described as 'breathable'. Older and traditional historic buildings were typically built using materials like stone, timber and lime that soak up moisture from rain, rising damp, cooking, washing and breathing and then let it evaporate gradually. The draughts of windows, fireplaces and roofs provide ventilation that also prevents a build-up of moisture within building fabric and inside buildings.

Older buildings therefore need to breathe and should not be made airtight in the same way as newer buildings are. Breathability is generally considered to be a core principle of the performance of the fabric of historic buildings and ensuring that this is preserved needs to be factored in to any changes and interventions in these buildings.

When considering modern energy efficiency, generation and storage measures, you will need to think about how they affect moisture movement to avoid creating problems with damp that might have additional negative implications e.g. for health and wellbeing of occupants.

Once you have a good understanding of your building, you can begin to consider the best approach to improvements.

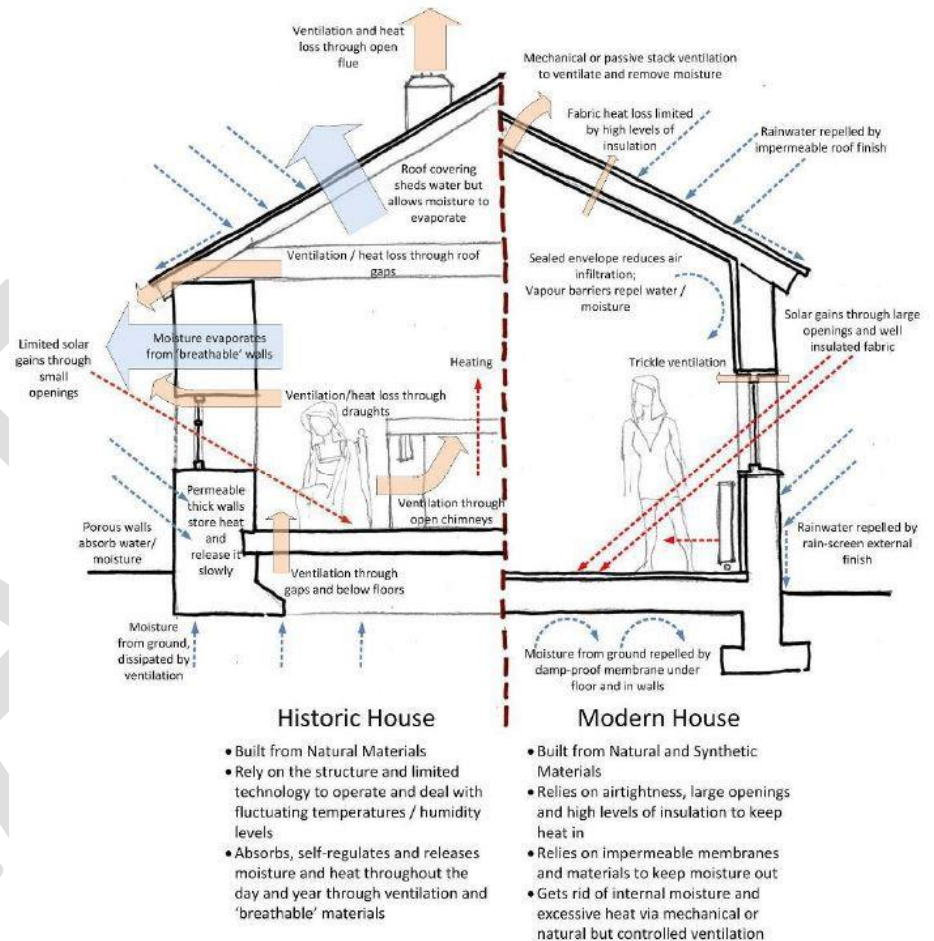


Figure 5: Differences in the movement of moisture for a historic and modern building

3.2. Step 2 - Be lean – reduce energy use

At a glance:

- Many older buildings are already fairly efficient due to passive design measures incorporated into traditional construction.
- Keeping up-to-date with maintenance and repair can help your building perform as efficiently as possible.
- There could be opportunities to improve efficiency of certain elements of your building – a range of options are available that should be informed by an understanding of the importance of heritage features, and an assessment of current performance of the building's fabric.

The first step in the energy hierarchy is about seeking to reduce energy demands associated with the operation of the building as much as possible by improving the performance of various elements. It's important to remember that many traditional buildings already perform very efficiently due to passive design measures.

Importance of a maintenance and repairs regime

All buildings need regular maintenance and repair, but with older buildings there is potential for problems to become serious over time if this hasn't been kept up. Resolving causes of leaks and unwanted draughts and promptly preventing new ones developing, along with other routine maintenance, will make your building work more efficiently and help protect its heritage value and the health of its users.

It is always advisable to follow a systematic approach such as beginning with the largest building elements such as walls, roofs and floors, then moving on to openings, chimneys and rainwater goods before moving on to fixtures and fittings, internal finishes and heating and lighting systems.

When making repairs to the building (cracks, broken windows, leaky pipes, etc.), it is best practice to use traditional materials and methods, and where replacements are needed ensure they are 'like for like'. This is important not only help to maintain the building's character, but because introducing modern materials that have different physical properties could cause more damage. For

example, the materials could trap moisture and reduce permeability resulting in rot and decay, or could have a different rate of thermal expansion and contraction resulting in cracking, both of which could adversely affect the building's structural integrity. It is always best to seek a conservation specialist's advice if ever in doubt, more information on our planning advice service can be found [here](#).

Fabric efficiency improvements

There are a range of fabric solutions that could help to improve efficiency of the building in order to help it retain heat in winter or keep it out in summer. The analysis conducted at stage 1 should have helped you to identify which features are most important to protect and conserve for their historic value, as well as which features offer up opportunities for improvement. Further information on the different measures touched upon in this section can be found in the appendix 2.

When considering fabric efficiencies, upgrades to some elements of the building are likely to garner more benefit than others when set against their potential for harm (and overall cost). For example, a targeted system of draught proofing of gaps can be fairly cheap and low impact to overall visual appearance. Meanwhile, historic windows often play a significant role in contributing to the character and appearance of a property or area and replacement needs to be approached with care. Equally, works that involve replacing flooring can have a substantial impact on internal features, particularly where these (including the floor itself) are of heritage significance.

Draught-proofing – A low cost solution that can be an effective first step in upgrading thermal performance of a building which is likely to have a minimal impact on visual appearance of the building. This essentially involves sealing up gaps that can allow cold air into the building and warmer air to escape during winter (and vice versa in summer). Fan pressurisation tests can help to identify draughts and air infiltration spots. Effectiveness can be reinforced by having an efficient maintenance regime for your property.

Roofs – depending on the style of roof (pitched or flat for example) there are various forms of additional/replacement insulation you could put in place. In pitched roofs there may be options for insulation above rafters, above or in

between joists. On flat roofs there could be opportunities to replace decking, or add a membrane to retain warmth. It is always important to consider ventilation of voids to prevent condensation from occurring.

Walls – Solid walls can potentially have a layer of thermal insulation added to the internal surfacing facing indoor spaces. Alternatively a layer of insulation can be added to external surfaces, which can be more effective and may be less disruptive for internal occupants but will have a higher visual impact on the external appearance. For those walls that have been built with internal cavities, which is a more modern construction feature that began to appear more prominently after the 1930s, cavity insulation that is placed into the gaps within the walls could be an option with less visual impact. With older buildings it is important to consider the impact of alterations to the permeability/breathability of the walls. It is also important to realise that changes to walls may have an impact on important proportions of spaces inside a building, or result in the loss of important, decorative or joinery features.

Windows – Options for improving energy efficiency of windows have improved as the market has adapted to catering to historic properties. You may be able to consider installing supplementary glazing on the inside of an existing single-glazed window (secondary glazing), which can be lower cost than full replacement and if carefully designed, have minimal impact on appearance. Benefits extend from thermal efficiency to sound reduction too. Equally, where replacement of window panes is necessary, the use of vacuum thin double glazing, or high performance laminated glass panes can deliver the energy efficiency of a double or triple glazed unit with the slim profile of single glazing.

Floors – Aside from the substantial impact changes to flooring can potentially have to the heritage significance of a property, there is also the potential for underlying archaeology to be discovered, which needs to be considered and any finds recorded. Interventions may also be less beneficial than upgrading other elements of the building due to typically lower heat loss through the ground. Where replacement is considered to be appropriate, with solid ground flooring, it may be possible to install an insulating layer, which is often covered by tiles, brick or stone work. With timber flooring, vapour permeable insulation could be laid beneath the floorboards between joists.

Other considerations

As touched upon earlier, traditional construction often utilises a range of passive warming and cooling features which should be supported and complemented to get the most out of the building. When selecting materials for any retro-fit project, remember to consider:

- Vapour permeability and breathability of the materials and of the building features where they are to be implemented. Failing to do so could lead to reduced efficiency instead of improvement, as well as problems with damp, rot and ultimately, harm to the health of occupants.
- Locally sourced, natural materials, such as wood, can help to reduce embodied carbon cost of the project in terms of its production and transport.

Overall, a well thought out and informed system of fabric efficiency upgrades to a property can potentially garner significant improvements in energy efficiency. Where implemented carefully, they be done without compromising the special features that contribute to the character and appearance of the building or area, they can complement existing efficiencies and passive design features, and can secure wider benefits in terms of fuel poverty.

3.3. Step 3 - Be clean – use energy efficiently and sustainably

At a glance:

- Once you have reduced energy demands as much as possible, you should use energy efficiently and sustainably.
- A range of technologies and solutions are available for lighting, powering and heating your building.

After reducing operational energy needs as much as possible through informed and targeted fabric efficiency interventions, the next step in the energy hierarchy which should inform your retro-fit project is about ensuring that remaining energy needs are met as efficiently and cleanly as possible. In this context, 'clean' is about low and zero carbon energy systems for lighting, space heating (and cooling) and hot water, and a range of options are available.

Again, the choice of option should be informed by the needs of your building and its heritage context. Older buildings are likely to rely on boilers for meeting their heating and hot water needs at present and more sustainable alternatives may be able to be located into the same spaces these systems currently take up within the building. Some measures are likely to cause more significant harm than others, equally, some will garner a better return on environmental sustainability including carbon reduction, as well as cost and time, particularly where these have been supported by strong fabric efficiency performance. Again more information on most of the measures touched upon below can be found in appendix 2.

Lighting – Older bulbs used in internal (and external) lighting fixtures can be fairly easily upgraded to more efficient systems that use less energy e.g. LEDs. Current technologies mean that colour temperature can easily be matched to that of a 'traditional' incandescent bulb, and if a light fitting is of significance in and of itself, it is possible that it could be re-wired to take LEDs.

Heat pumps – Air-source heat pumps extract heat from the outside air and release it into a building, meanwhile, ground source heat pumps make use of the latent heat from just below the surface of the ground that comes from solar radiation. These are highly efficient systems in terms of the energy used to power them, versus the heating they supply. Equally, some systems can provide cooling too.

The level of impact on the features of the building will depend on the system. Ground source technology requires lengths of piping to be installed below ground that may be impractical for many properties in the city (and could have impacts on archaeology). Air source units are generally less intrusive, external equipment can often be placed in locations where they are not visually intrusive, such as along hedge lines, or a screen of planting may be erected to reduce their visual impact, though consideration needs to also be given to how improper placement might impede function (e.g. disrupting air flows into/out of unit), as well as potential for noise disruption.

Heat pumps are most effective in buildings that perform well at keeping the heat in and so require little energy to maintain a temperature once it has been reached. It is therefore advisable to have a well-insulated building (as covered in Step 2 earlier) with high standards of air tightness. Where this is not possible or practical, a supplementary system may be required.

Direct electric heating – These types of systems provide heat directly from electricity and cover technologies such as electric boilers and storage heaters. They provide a low carbon heat source similar to heat pumps, particularly as the energy grid decarbonises. These systems are relatively low cost to install and require little maintenance. They also offer the benefits of flexibly heating individual rooms in a property where needed (rather than all at once), as well as topping up other heating systems.

Solar thermal – these are typically roof mounted panels that convert solar radiation into heat which can then be used for space heating and hot water needs of occupants. This technology is fairly low cost and generally requires little maintenance. It works most efficiently on south facing facades and can be effective even during colder months.

As with solar PV technology, due to the external, prominent nature of these features, they are likely to have a visual impact on the appearance of the building and/or character of an area. Where this is likely to be an issue, the harm can be lessened in some circumstances through thoughtful placement (for example in areas that are not facing the street). The particular considerations are the same as with solar PV which is discussed more in section 3.4.

Biomass heating - This involves using organic material – usually wooden logs, chips or pellets – to provide heating, either for a single room or an entire property. This option is workable where there is reliable wood supply, storage space and delivery access and may be challenging to implement for properties that do not have these facilities.

Whilst biomass technology can be considered ‘low carbon’ because the amount of CO₂ released when wood fuel is burnt is approximately the same as that absorbed by trees when they are growing, there are other negative impacts that may make this inappropriate within Oxford. Principally this is because of the pollutants, such as particulate matter, that are released into the atmosphere, which can exacerbate air quality problems.

Gas boilers - In line with the projected trajectories of decarbonising the built environment necessary for mitigating future climate change, new fossil fuel burning boilers are *strongly discouraged* and should only be considered as a *last resort* in historic buildings. Every additional boiler adds to our carbon footprint unless these emissions are mitigated elsewhere, and ultimately, they are likely to require replacement with zero carbon alternatives at some point in the future (which could be more costly).

For some historic buildings it could be fairly straightforward to retrofit them to a standard where a heat pump or similar low carbon heating method would be suitably effective; for other buildings, this can require a lot of money and resource which may make these options prohibitive. Equally, for some structures (particularly listed buildings) retro-fit to alternative heating methods is not possible without causing an unacceptable level of harm and a boiler may be the only option for the time being.

EV charging points – The phase-out of petrol and diesel vehicles over the next decade will see a shift towards more electric vehicles on the road and more electric vehicle chargers installed at home. The installation of EV chargers is often covered as permitted development (where design meets certain specifications and conditions as set out in the General Permitted Development Order legislation⁶), however, there are situations where these rights do not apply and full planning permission (and listed building consent) would be required, particularly for buildings without a driveway; for listed buildings/scheduled

monuments; or where an article 4 direction limits these as permitted development rights (the Article 4 directions in Oxford⁷ do not restrict EV charging however).

Where EVs are being proposed in the setting of heritage assets, design choices can help to limit impact, such as size, colour, position of the charge unit and the method of mounting (wall or upstand). For properties without a driveway, a pavement cable channel can also be an option⁸.

Whilst conventional three point plugs could, in theory, be used to charge an EV, this is strongly discouraged as the high powered supply could cause overheating of electrical circuits and result in fires. Older buildings and older electrical circuits are particularly at risk.

Other good practice principles:

- With any heating system, it is important to ensure it is appropriately sized and specified to the building it will be used in once all other fabric efficiency measures have been considered, this will help to reduce impact on the building and the environment.
- With any heating system it is also important to consider installing heating controls, such as thermostatic radiator valves and intelligent control systems, to dynamically adjust settings to avoid wasted energy, which can further reduce emissions and have added benefits for reducing heating bills.
- The appliances you use day-to-day such as televisions, computers, refrigerators etc. are all sources of energy demand within the building. Ensuring you use devices and appliances correctly, keep them in good working order, and switching them off at the plug when not required will further help to reduce energy demands.

⁶ [The Town and Country Planning \(General Permitted Development\) \(England\) Order 2015](#)

⁷ In place in Jericho and Osney Town conservation areas

⁸ [Oxfordshire County Council – Information about electric vehicles](#)

3.4. Step 4 - Be green – meet energy needs renewably

At a glance:

- After reducing energy demands and incorporating efficient energy systems, remaining energy should be sourced from renewable technology. This may take the form of on-site renewable energy generation where appropriate, which in Oxford is likely to come in the form of solar pv.
- Historic buildings and conservation areas have additional sensitivities which are not always compatible with traditional solar technology and require additional care.
- Where on-site renewable energy generation is not the right fit for your building, following steps 1-3 of this guidance can help to ensure that your building is 'zero carbon ready' – any remaining emissions associated with energy sourced from the national grid will then reduce as the grid itself decarbonises.

The final step in the energy hierarchy. Once you have reduced energy needs and selected the most efficient energy systems possible, you may wish to consider sourcing remaining energy needs renewably through on-site generation. This can be desirable for a couple of reasons:

- Reducing strain on national energy grid systems through decentralising energy sources.
- Reducing our contribution to climate change from electricity use in advance of decarbonisation targets for national energy systems.

On-site renewable energy generation

The large-scale uptake of on-site renewable energy generating technologies is an important component of the city's roadmap to net zero. In a constrained urban environment like much of Oxford, the predominant renewable energy technology is most likely to be forms of solar photovoltaic panels (solar pv). Indeed, the zero carbon roadmap includes targets for installation of this technology over the next few decades on many domestic properties in the city.

Solar photovoltaic (solar pv) panels – these systems turn sunlight into electricity through the 'solar cells' made up of semiconductor material between layers of glass. In an urban setting, a solar pv array is typically installed over the roof of a

building, but it can also be integrated into the roof in the form of solar tiles or slates. As with solar thermal, these systems work best when oriented on a south facing surface for optimum sunlight.

There are many positives to solar pv technology. Installation costs have reduced in recent years and they are fairly low maintenance. They can work during cloudy conditions when sunlight is reduced and they can be coupled with other solar technology (e.g. solar thermal). Inclusion of a battery within the system can store surplus power and optimize the use of the electricity for when it is needed most.

Installation of a certain amount of solar-pv on residential properties is often classed as Permitted Development (PD). PD rights for domestic solar PV are set out in part 14 of the General Permitted Development Order (GPDO)⁹ – there are however certain conditions that need to be met in order to qualify for permitted development rights and there are restrictions on the type and location of installations in conservation areas which you will need to comply with (included in text of the GPDO). In some conservation areas, PD rights are further restricted or removed through an Article 4 direction and this can include restriction on the installation of solar PV, which is the case in the Jericho Conservation Area (where the roofscape makes a significant contribution to the special character and appearance of the conservation area). This means that you would need to apply for planning permission to install solar PV. Installation on listed buildings will always require consent.

Solar technologies and historic buildings/conservation areas

The key issue for solar panels when installation is proposed on a designated building or within a conservation area is one of visual impact. Determining the level of visual impact on an historic building or conservation area is a matter of professional judgment about whether these are visually intrusive, and whether they would impact upon the preservation of the special character of the property/area – which were designed at a time when solar pv technology was not a feature of the built environment. Unlike other low carbon technologies, such as heat pumps, which can be more easily concealed from view by screening or by being placed out of the way, the nature of solar technology means that it needs to be placed in an open area exposed to a large area of sky and is more difficult to conceal. Where a building or area is valued for its architectural

⁹ [The Town and Country Planning \(General Permitted Development\) \(England\) Order 2015](#)

interest, a prominent array can detract from this and may mean it is unsuitable in some locations, however, it may be possible to consider an installation in a less visually prominent location, such as freestanding or on a suitable outbuilding.

Our starting point is to be as pragmatic and positive as possible towards onsite energy generation. Despite its challenges, solar technology can be acceptable in areas or sites with historic value, but this needs to have been thoughtfully designed and shown to be the most appropriate choice for delivering upon retrofit objectives, after measures in accordance with the previous steps in the energy hierarchy have been fully explored. However, it should be recognised that opportunities for installation may be reduced and the specific design of the array and its siting needs to be considered carefully, making use of screening if possible. Particular considerations that can help to overcome this challenge include:

- **Consider the placement of components carefully.** Attaching to the main elevation of the building i.e. the face(s) of the building as seen from the direction it is most commonly viewed, is likely to be more visually intrusive due to their prominence in view. Placement on a less prominent elevation may be preferable to reduce the visual intrusiveness of the installation.
- Besides the visual impact on a building, **the impact on the setting should also be considered.** It would usually be measured against the views to and from the installation where they would be visually prominent.
- **Any impacts should be mitigated as much as possible.** Aside from careful placement, there are other options to explore including: choosing less reflective panels and frames whenever possible, or through the use of screening or the characteristics of the building e.g. shallow roof pitches to make panels less prominent.
- **It is vital that all required consents are obtained before carrying out any works** especially if they affect any designated heritage assets. **Installation must be carefully planned**, with consideration as to how damage to the building fabric can be minimised, how it is installed and maintained, and how the equipment can be removed at the end of its useful life.
- **Consider bespoke solar technologies**, there is also a growing market of solutions that have been designed to reduce visual impact, such as solar tiles/slates that can be incorporated directly into the roof. Where

roofing material is not specific feature that has been listed for its heritage value, these may offer a less harmful alternative.

In the most constrained situations, where there is a risk of harm from a proposed solar technology, we will follow the decision making process as set out in Section 2 earlier. In particular, we will need to be confident that:

- Where this is proposed in order to mitigate carbon emissions, the earlier steps in the energy hierarchy (reduce energy needs, use energy efficiently) have been fully explored and put into effect first.
- That the design of the installation has been tailored to reduce harm as much as possible.

On the rare occasion where these considerations cannot help to overcome risk of harm, it may be concluded that solar energy generation is not acceptable. In instances where on-site renewable energy generation is not feasible, the earlier steps in this guidance should have enabled you to ensure that any remaining emissions associated with the operation of your property would continue to reduce over time because of wider changes that are being made to the way we source our energy nationally.

Is your building net zero ready?

The national grid has been steadily decarbonising as the mix of electricity generation sources it relies on steadily shifts from fossil fuel based to renewable technologies. As such, the carbon footprint associated with grid electricity used to power homes and buildings is steadily reducing.

Following steps 1 to 3 in this guide will help to ensure that your building uses as little energy as possible and that what energy is required is used in an efficient way. A proportionate approach to steps 1 to 3 could mean that your building is effectively 'zero carbon ready', (where fossil fuels are not being utilised to power/heat the building) and as such, should require no further retro-fit to reduce emissions, as those emissions associated with grid electricity use will reduce automatically over time as grid energy decarbonises.

4. Other considerations/consents

Making changes to a listed building

Statutory listing protects both the inside and outside of a building, as well as fixtures and fittings (like windows, doors or staircases) and subsidiary buildings that form the 'curtilage' of the building. You can only make alterations to a listed building if the Local Planning Authority (LPA) grants Listed Building Consent for any changes that might affect the special architectural or historic interest of the building.

Carrying out work without Listed Building Consent could result in the LPA requesting that features and fabric that have been removed are reinstated and/or later additions removed. *Unlawful alterations to a listed building is also a criminal offence punishable by up to two years in prison, or an unlimited fine.* Some minor, like-for-like repairs may not require listed building consent but this depends on how the repairs are undertaken and advice must be sought from the Local Planning Authority to establish what can and cannot be undertaken without consent via our planning advice service.

Depending on what you propose and how you use the building, you may well need planning permission in addition to listed building consent and approval under building and fire regulations.

Making changes to a building within a conservation area

Oxford currently has 18 conservation areas identified for their special architectural or historic interest that makes them worth protecting and improving, more information on these can be found on the [website](#). The main purpose of creating a conservation area is to preserve and enhance the unique and distinctive character of an area through planning and other environmental measures, it helps to ensure changes respect the area's character and appearance.

The City Council will support changes that help to reveal the special features of the conservation area and enhance its character and appearance. This may mean that some changes are acceptable. Permitted development (PD) rights that normally apply to relatively minor alterations will be reduced in conservation areas, so planning permission will be needed for changes such as the installation of solar panels or air/ground source heat pumps. More info on permitted development rights can be found on the planning portal [website](#).

Article 4 directions

In some cases, conservation areas will place additional restrictions or compliance conditions on what PD rights you have. In two of our conservation areas – Jericho and Osney Town – we have removed some PD rights through the making of an Article 4 direction. These restrictions remove PD rights for changes to roof materials, alteration and replacement of windows, and the rendering or plastering of external brick and stone walls (potentially impacting the installation of external insulation).

In Jericho specifically, PD rights have also been withdrawn for installation, alteration or replacement of solar PV or solar thermal equipment on a roof of a dwellinghouse; or a building situated in the curtilage of a dwellinghouse and visible from a highway or waterway. Full planning permission would be needed when installing this technology in these locations in order that the impacts on the important roofscape of the conservation area can be fully assessed.

Making changes where there is potential archaeological interest

The fabric of your building or the ground upon which it stands may have archaeological interest. Internal alterations to improve energy efficiency or below ground works (including ground source heat pumps for example) may impact on archaeological remains. If you are planning substantial works to a historic buildings or ground works in an area that you suspect may be of archaeological interest then you may wish to establish whether there may be archaeological implications. Information on the archaeological potential of your building may be available via [Heritage Gateway](#), [Oxfordshire Heritage Search](#) and the [Oxford Archaeological Plan](#) websites.

Building Regulations and Building Control

Most types of building works have to conform to the Government's Building Regulations. Part L of the Regulations relates to conserving energy and sets out a requirement to improve the thermal performance of the building. The accompanying Technical Guidance states that the aim should be to improve energy efficiency as far as is 'reasonably practicable'. Where this affects existing buildings, the regulations also set standards of energy-efficiency requirements for extensions and other significant changes to a building. More info can be found [here](#).

Appendix 1

The following web based resources provide further information and detailed assistance regarding retrofitting, renewable energy technologies and energy efficiency in the context of the historic environment. Much of the content of this TAN has been derived from these and similar resources. It is not an exhaustive list but includes some of the most up to date and relevant guidance available.

Oxford City Council Heritage Energy Efficiency Tool (HEET)

Designed to help assess energy efficiency upgrades for historic buildings in the city. The tool comprises of a worksheet and a set of guides intended to help assess a building's heritage value and condition and explore options for energy efficiency improvements and renewable technologies. Available from the Council website [here](#).

Oxford City Council Sustainable Design and Construction Technical Advice Note (TAN)

A companion TAN which sets out guidance on interpreting the requirements of Local Plan policy RE1 (Sustainable Design and Construction), including additional guidance on achieving net zero in new development. This TAN is likely to be more relevant to new build development, but also includes relevant advice and support that is applicable to updating existing buildings.

Centre for Sustainable Energy

The Centre publishes a good range of [information leaflets](#) on various subjects including introductions to renewable technologies, energy saving tips and general advice to householders.

Cosy Homes Oxfordshire – Plan Builder tool

An independently produced resource that enables Oxfordshire residents to look up details about their property and find suggestions for retro-fit improvements. More information [here](#).

Historic England

There are a range of [publications](#) with guidance and advice on sustainability, energy efficiency and renewable technologies with a specific focus on their impacts on historic buildings and heritage assets.

Sustainable Traditional Building Alliance (STBA): ‘Planning responsible retrofit of traditional buildings’

This is a comprehensive guide on retrofitting traditional buildings for energy efficiency purposes. A download is available from [STBA](#) and [Historic England](#).

Warmer Bath: A Guide to improving the energy efficiency of traditional homes in the city of Bath

This [guidance document](#) was produced by Bath Preservation Trust in collaboration with the Centre for Sustainable Energy. Whilst it focuses on the city of Bath, much of the advice and practical guidance it contains is also relevant in Oxford.

Institute of Historic Building Conservation (IHBC): ‘A Stitch in Time’

Advice for building owners relating to repairs and maintenance of historic properties, including checklists and links to further resources. A download is available from [IHBC](#) and [Historic England](#).

UKGBC website

The UKGBC represents a range of building industry organisations and regularly publishes resources on its [website](#) that can assist with working towards net zero and other climate change and sustainability goals.

LETI website

LETI is a network of more than 1000 built environment professionals who have come together to work towards putting the UK on the path to a zero carbon future. They have various resources available on their [website](#) which can help with interpreting what net zero means for the built environment.

Archaeology Resources

Heritage Gateway

This [webpage](#) allows you to cross-search over 60 resources, offering local and national information relating to England’s heritage.

Oxfordshire Heritage Search

The [Heritage Search](#) is a catalogue of Oxfordshire's cultural and heritage resources. Use it to find a wide range of materials relating to Oxfordshire's past.

Oxford Archaeological Plan

The city council has produced a series of documents aimed at improving access to information on Oxford's rich archaeological and built heritage which can be accessed [here](#).

DRAFT

Appendix 2

This appendix includes additional guidance and considerations for the different efficiency measures and energy systems referred to in the TAN. The context of every building/site will be different and this guidance is general and high-level, helping to flag key areas to consider more, without making any recommendations about which measure is better.

The guidance does not replace the need for expert, technical advice where relevant. *Planning permission will be required for many of these alterations, as would listed building consent*, and we recommend that advice is sought from the Council's pre-app service before commencing with any project to ensure you know what is required of you.

Draught proofing

At its most basic level, it involves preventing cold air from the outside entering into a building through gaps, and keeping warm air in. Gaps can form in the building fabric or fittings, as well as openings such as doors and windows or even letterboxes and keyholes. This is perhaps the most basic measure possible and should be the starting point when looking to upgrade the energy efficiency of your property in accordance with a 'whole house approach'. These measures are often done without significant cost.

Benefits

- One of the least intrusive measures to improve energy efficiency on a buildings appearance.
- Effective in bringing about energy efficiency and relatively low cost outlay.
- Likely to have a lower embodied carbon cost associated with production/transportation as likely involves fewer materials.

Challenges

- Poorly fitting timber sash frames could cause major heat losses. Repairs can be carried out by a specialist carpenter.
- Periodic checking of draught-proofing system should be part of maintenance regime.

- Not as effective in leaded windows where heat losses can also come from around the lead.

Other considerations

- Its effectiveness is dependent on the state of repair of the building fabric, so an ongoing maintenance regime is important. Prioritise repair of windows and doors before draught-proofing them.
- Before draught-proofing, a fan pressurisation test may be needed to identify the extent of air infiltration and to locate draughts. Note that older buildings need a certain degree of background ventilation to enable them to breathe, and cannot be expected to be completely air tight.

Roof

Pitched Roofs: warm roofs

Insulation is placed above the roof rafters, with a vapour barrier installed under the insulation. Ventilation is not usually required due to the placement of the insulation. Main considerations include:

- The vapour permeability of intended insulating materials should be carefully considered.
- Be aware of cold bridges at junctions between roof and walls.
- It is likely that the height of the roof will need to be raised and the structure may also need reinforcing.
- If the building has a vaulted or ornate ceiling, any related works would have to be carried out as part of already planned roof replacement works.

Pitched Roofs: cold roofs

Insulation is placed above or in between the ceiling joists with a ventilated roof space above it. Main considerations include:

- The main risk of a cold roof is condensation caused by the warm air rising from the building below and meeting the cold air above the insulation layer. Condensation is prevented by using vapour-permeable insulating materials and by keeping ventilation patterns. Ventilation should be maintained at eaves level e.g. using soffit vents or tile vents.

Note that depending on the type of roof construction, ventilation may also be needed at the ridge or at the abutment with a wall.

- For sloping ceiling insulation – they should be applied between and to the underside of rafters retaining ventilation above.
- Water tanks in the loft space and pipework should be insulated.
- Need to consider if the ceiling finish presents special features that would be damaged or hidden.
- If installed beneath the rafters, it could be done without stripping the roof covering or changing the roof height.
- It leaves the maximum room for natural air circulation under the roof covering.
- It may reduce the amount of usable floor space.

Flat Roofs

Flat roofs typically have a relatively simple structure; historically they are constructed with a waterproof covering laid over timber decking on timber joists. Small gaps were left between the decking to allow for ventilation and movement. Modern upgrades to timber decking include plywood and other sheet materials. Metal roof coverings have always been recognised as being durable, with lead commonly used historically, along with zinc and copper. Upgrades to these can include metal coverings milled using modern techniques as well as synthetic membranes. Some key considerations for improving efficiency of these types of roofs are based upon how insulation is applied and as follows:

Insulation above existing structure

- Attention should be given to the gaps between insulation and structure through which moisture vapour can penetrate and condense.
- Ventilation patterns should be maintained to avoid condensation and mould.
- This would be an option if the roof covering is being replaced. Works for this option may involve an increase to the roof height which may be an issue from a planning or listed building consent point of view with potential negative impacts on the historic environment.

Insulation in between existing structure

- This is an option if the ceiling is not of historical value and can be, or is going to be, replaced, and when the existing roof covering is not being replaced.

- Attention should be given to the gaps between insulation and structure, through which moisture vapour can penetrate and condense.
- Ventilation should be installed if not already provided, in order to avoid condensation and mould.

Insulation below existing structure

- This may be an option if the ceiling is not of historical value and can be, or is going to be, replaced, and when the existing roof covering is not being replaced. If the ceiling finish does not present special features that would be damaged or hidden by the works then the heritage impact could be considered neutral.
- Attention should be given to the gaps between insulation and structure, through which moisture vapour can penetrate and condense.
- Ventilation should be installed if not already provided, in order to avoid condensation and mould.

Walls

Up until the 1930s, house construction was most commonly in brick solid wall construction. Stone built walls were also the norm in some areas, sometimes with brick backing. Mortars and plasters were mostly lime based, although bulking with cheap materials was common. There are a couple of approaches to improving efficiency of walls, which are discussed below.

Solid Walls: Internal Insulation

Internal solid wall insulation works by adding a thermal layer of material to the existing solid wall facing the indoor spaces. These take the form of rigid insulation boards, or more innovative materials such as aerogel. Where novel materials or products are used, it is important that they have an independent third party certification such as from the British Board of Agrément in order to ensure that they are fit for purpose.

Benefits

- Thick solid walls already have the capacity to absorb heat over time and release it relatively slowly as the surroundings cool down, which will have a stabilising effect to the indoor conditions. But this does not mitigate heat loss entirely.

- Internal solid wall insulation may be a useful option in a heritage context where the external appearance of the building has to be maintained.
- It may be convenient when other, more effective solutions are not feasible.

Challenges

- Internal insulation does not have the best insulating performance overall as it will only reduce short term heat losses to the outside, while isolating the indoor environment from the benefits of solid walls' thermal mass. Installing internal insulation will add to the thickness of the wall and may result in a loss of internal area, even if minimal.
- The condition of the wall underneath would be hidden so a means of continuous monitoring would be recommended to reveal problems as they occur.
- Installation is a major undertaking that would almost certainly create significant disruption to the normal running of a household. Rooms rendered unusable until after works are complete, removal and reinstallation of fittings.

Other considerations

- Only vapour permeable insulating materials (e.g. wood fibre boards) should be used. Cold bridges must be minimised, especially around windows and doors and at the junctions between walls and floors. Walls should also be free from moisture/damp, otherwise existing condensation issues will be exacerbated.
- Does the internal wall present special features that would be damaged or hidden by the works? Would the insulation interfere with original cornicing, skirtings, or window surrounds? Does it alter the internal character of the building? If not, then this is likely to be a neutral option.
- It is important to realise that changes to walls may have an impact on important proportions of spaces inside a building, or result in the loss of important, decorative or joinery features.

Solid Walls: External Insulation

External solid wall insulation involves adding a layer of insulating material to the outside walls of a building and coating this with a protective render or cladding.

Benefits

- It is likely to be more effective than internal insulation at keeping comfortable levels of warmth over the day/night heating and cooling cycles, however walls should also be free from moisture/damp, otherwise existing condensation issues will be exacerbated.
- It can be less disruptive to the household than internal wall insulation.

Challenges

- The increased depth of the external render will require adaptation of the roof and wall junctions, the repositioning of installations such as soil and vent pipes, boiler flues or rainwater downpipes, and potentially the repositioning of doors and windows. Scaffolding access will also be required.
- The condition of the wall underneath would be hidden so a means of continuous monitoring would be recommended to reveal problems as they occur.
- Solid wall insulation is very expensive and is unlikely to be suitable for listed buildings, either internally or externally. This is due to the visual alteration to the character and appearance, and to the structural and thermal qualities of the walls, which can be severely damaged if not permitted to breathe.

Other considerations

- Thick solid walls already have the capacity to absorb heat over time and release it relatively slowly as the surroundings cool down, which will have a stabilising effect to the indoor conditions. But this does not mitigate heat loss entirely.
- If used, should only be vapour permeable insulating materials (e.g. wood-fibre boards, mineral wool, hemp-lime composites) with a moisture permeable protective (e.g. lime render, tile rain screen cladding).
- Installation of external insulation is very likely to change the appearance of a building, and potentially alter its character even when already rendered. If used, careful design, correct choice of materials, good

detailing and extremely high standards of workmanship would be required.

- Equally, changes to walls may have an impact on important proportions of spaces inside a building, or result in the loss of important, decorative or joinery features.
- Care must be taken in relation to adjoining properties.

Cavity Wall Insulation

External cavity walls are made of two 'skins' with a small gap between them. This means that the gap between them can be filled with insulating material to stop the warmth escaping to the outside. Although cavity walls were introduced as early as 1900, it was only in the mid-1930s that it began to predominate house construction and mark the time for what can be understood as modern housing in the UK.

Benefits

- Low visual impact as insulation would be invisible both internally and externally
- Cavity wall insulation is highly efficient and there are noticeable gains in heat retention.
- There is potential to use alternatives to synthetic insulating material.

Challenges

- Extraction of cavity insulation, and therefore reversibility of works, is very difficult. Loose fill materials as opposed to foam based material can improve the situation.

Other considerations

- Early cavity walls had a special bonding brick to connect the layers of bricks, which creates a potential moisture path and thermal bridge. If this is present, the wall needs to be treated as a solid wall, and therefore the cavity cannot be filled with insulation. This construction type is often not easily recognisable from the outside. Measurement of the wall thickness and a careful survey needs to be carried out to ensure the wall has a continuous cavity.
- The external and internal appearance of the wall would not be affected by this measure.

Windows

Secondary glazing

Secondary glazing involves installing supplementary glazing on the inside of an existing single-glazed window.

Benefits

- Lower cost outlay than double glazed windows or replacement of existing units.
- Heat losses from a window can be reduced by using secondary glazing with a low emissivity (low E) glass hard coating facing outside. It can last longer as it is not exposed.
- Transmitted noise from the outside is also reduced.
- If carefully designed and installed it has a low heritage impact and is easily reversible

Other considerations

- When secondary glazing is the preferred option, draught proofing should not be applied to the original window to allow ventilation and prevent condensation.
- Primary and secondary windows must open and shut with ease where natural ventilation is required
- Poor heat conductors make better frame materials (for example, wood rather than metal)

Vacuum, thin profile double glazing

Slim-line double glazing is the preference for historic buildings (over standard double-glazing) because its appearance can better match the traditional style of windows. This is a very innovative product developed for some historic buildings. It has the energy efficiency performance of a double glazed unit with the slim profile of single glazing.

Benefits

- Performance of double glazed unit with the slim profile of single glazed gives the potential for reduced visual impact.
- Where historic windows, or replacement windows of historic pattern, survive without historic glass it may be possible to introduce slim-profile double-glazing without harming the significance of the building.

Challenges

- There is often a high cost outlay.
- The replacement of original window and glass fittings may result in the loss of attractive features.
- Metal frames are cold bridges and are especially likely to attract condensation.

Other considerations

- Traditional windows and their glazing make an important contribution to the character and appearance of historic buildings and areas.
- Windows are an integral part of the design of older buildings and can be important in their own right, often made with great skill and ingenuity and with materials of a higher quality than are generally available today. The distinctive appearance of historic hand-made glass is also not easily imitated in modern glazing. This option should therefore only be considered after all other lower impact alternatives have been explored. Replacement of historic fittings should only be considered on a case by case basis where originals have no historical value and/or are obviously beyond repair.
- Many windows have lasted a long time and are capable of being repaired by a specialist carpenter rather than being replaced – more guidance can be found on care, repair and upgrades to traditional windows via Historic England.

Floors

Solid Floors

Solid ground floors have traditionally consisted of lime-based ground floor slabs or tiles laid straight onto highly compacted soil, they were the predominant form of floor construction until the early 18th century. The most obvious 'modernising' measure would be to install an insulating layer below the earth floor, which is often covered by tiles, brick or stone work. The removal of the solid floor would also be required if underfloor heating is being considered. Key considerations include:

- Excavating or removing original solid floors should only be an option of last resort, particularly if floor or other building elements are of

recognised heritage significance unless the floor is already in poor condition and needs to be taken up or re-laid.

- Where a floor is to be excavated, the archaeology should be recorded.
- Heat loss through floors can be less than from other elements of a building. Given the costs, potential disruption and potential heritage impacts it may be better to focus on measures that would give greater benefits in a shorter time frame.
- If earth or stone floors do not already have a damp-proof membrane, then any measure adopted must retain the breathable qualities of the original floor system.
- What is needed is a permeable but water resistant system. Vermiculite or clay beads are examples of materials that can provide an insulating layer below bricks, stones or flags.
- If underfloor heating is considered in this situation, consider using 'limecrete' insulation and a permeable floor finish – in keeping with original finish or a sympathetic alternative. Limecrete also benefits from being an environmentally friendly material as it has the ability to absorb carbon dioxide as it cures.

Timber Floors

Suspended timber floors appeared in the UK in the early 18th century. Air flow was maintained between the ground and the timbers above by vents in the external walls, to ensure that the air did not become too damp.

Replacement with heritage compatible flooring to modern standards

- Because of the risk of causing substantial harm to existing elements, replacing timber floors should only be an option of last resort, particularly if floor or other building elements are of recognised heritage significance. This should only be considered if the floor is already in poor condition and needs to be taken up or re-laid. Such works should only be carried out by a specialist carpenter.

Installation of vapour permeable insulation

- This would involve lifting the floor boards and inserting vapour permeable insulation suspended in netting between the floor joists.
- If the flooring is accessible from underneath it may be possible to place vapour permeable insulation fitting tightly in between joists with additional vapour permeable insulation board below if required.

- The ideal time for this option may be when plumbing or other works are already scheduled.
- Many forms of vapour permeable insulation that are suitable for insulating a suspended timber floor (for example those derived from wood, cork, wool, hemp and flax) are sustainable materials with low carbon footprints.

Draught-proof gaps between boards

- This is the lowest impact option and is a good consideration if the flooring elements are in good condition and where gaps in the flooring have been identified as a source of heat loss. However air bricks and ventilation should not be covered up.

Ground source heat pump

A method of heating that makes use of the latent heat from just below the surface of the ground that comes from solar radiation. This low-grade heat is taken from the ground using a buried pipe network, around which a mixture of water and anti-freeze is pumped. This heat is then taken from the liquid within the pipework by the heat pump and upgraded to a higher temperature and more 'useful' heat. Heat pumps work most efficiently with a low temperature distribution circuit, which means systems like underfloor heating, warm air heating or radiators will be good methods of distributing the heat.

Benefits

- System can be used for both heating and cooling.
- Low maintenance once installed.
- Once the pipework is buried the surface, the ground can return to being a field, garden, drive etc.
- Heat pumps are highly efficient because they produce much more heat than the amount of energy (electricity) it takes to power them.
- Thermal output is not dependent on external weather conditions.

Challenges

- Heat pumps are most effective in buildings that keep the heat in and so require little energy to maintain a temperature once it has been reached. It is therefore advisable to have a well-insulated building with high standards of air tightness. Where this is not possible or practical, a

supplementary system may be required, in the first instance, this should ideally be renewably powered.

- Installation can be a significant undertaking, involving an extensive amount of ground works and works to the internal and external fabric of the building. These can create a notable level of disruption and also have significant impacts on the building fabric, the landscape, existing services and potentially important archaeological remains.
- Because of the level of works, consents may be required from several agencies.
- Space may have to be set aside for associated plant equipment, usually internally, although it may also be possible to utilise the space left over from the previous heating systems.

Other considerations

- This type of system is electrically powered and its carbon footprint is tied to how that electricity is sourced, though this will be lower than more traditional fossil fuel burning boilers. Where power is derived from the national grid, which is decarbonizing over time, the heat pump will have a reducing carbon footprint over time too. As such, it can be considered to be a low carbon alternative, particularly when taking into account its efficiencies at generating heat.
- A pre-existing heating system can sometimes be integrated or repurposed to work with a heat pump. The capacity of an existing system should be determined after a careful survey.
- Older properties may have microbore pipework which would need replacing to work with this system. Great care must be taken when laying replacements to ensure that historic fabric is not damaged.
- Where there are significant undisturbed historic elements, installing this system can put these at risk, particularly if they are floor surfaces. Great care should be taken when deciding if this is an appropriate option and appropriate advice sought where an historic or traditionally built building is involved.
- Potential impact on archaeological remains – advice will need to be sought from archaeological experts before commencing any works.
- Where there is clear evidence that historic surfaces have been disturbed or lifted, or there has been poor quality modern replacement fittings and finishing to historic fabric, this system may potentially be integrated into a building with more sympathetic and appropriate finishing.

However consider how the system can be removed without permanently damaging the building.

Air source heat pump

Air source heat pumps extract heat from the outside air and release it into a building. Outside air is drawn in by a fan and some of the heat energy is removed. This heat is then upgraded to a higher temperature in the heat pump. This can then either heat air to be distributed around the property (air-to-air) or heat water for a conventional low-temperature hot water system (air-to-water).

Benefits

- System can be used for both heating and cooling.
- Low maintenance once installed.
- Heat pumps are highly efficient because they produce much more heat than the amount of energy (electricity) it takes to power them.

Challenges

- Heat pumps are most effective in buildings that keep the heat in and so require little energy to maintain a temperature once it has been reached. It is therefore advisable to have a well-insulated building with high standards of air tightness. Where this is not possible or practical, a supplementary system may be required, in the first instance, this should ideally be renewably powered.
- There may be noise considerations depending on where the technology is to be deployed, though these may be limited relative to the wider noise/sound environment within the city itself, however they should be appropriately assessed where relevant.
- Also need to consider how inappropriate placement of the unit can potentially impede performance (e.g. disrupting air flows into/out of unit).

Other considerations

- As with other types of heat pump, this system is electrically powered and its carbon footprint is tied to how that electricity is sourced, though this will be lower than more traditional fossil fuel burning boilers. Where power is derived from the national grid, which is decarbonizing

over time, the heat pump will have a reducing carbon footprint over time too. As such, it can be considered to be a low carbon alternative, particularly when taking into account the efficiencies at generating heat.

- An internal heat pump will have a lesser visual impact on a buildings external appearance. However the external parts will require some space outside, so the location of these should be carefully considered. They can often be placed in locations where they are not visually intrusive, such as along hedge lines, or a screen of planting may be erected to reduce their visual impact. Some manufacturers colour the external units so that they blend into their surroundings more easily.
- Whilst the heat pump itself is located externally, the system will require some equipment to be located within the building and connecting pipework, which has the potential to affect the historic fabric of a building. As with other alterations, if your property is listed, you will require Listed Building Consent to install an ASHP.

Solar Photovoltaic (PV) panels/ Solar thermal

Solar panel systems turn sunlight into electricity through the 'solar cells' made up of semiconductor material between layers of glass. Electricity leaves the panel as direct current (DC) and passes through an inverter that converts it to 240V alternating current (AC), so that it can be used in your home. Meanwhile, solar thermal uses sunlight to generate hot water for use in a building.

Inclusion of a battery within the system can help to optimize the use of the electricity generated within the building, particular at times when generation potential is reduced/negated. Locations of a domestic battery either internally or externally will depend on the manufacturer's specification and the specifics of the building/site.

Solar arrays can be installed in a variety of ways and include:

- Fixed over the roof covering – standard solar panels
- Integrated into the roof covering – solar tiles and slates
- Ballasted or fixed on a flat roof – usually fixed and tilted to get the best orientation towards the sun
- Free-standing ground-mounted, set away from the building
- Inclusion of an immersion heating control in the system design, which diverts unused electricity to heat domestic hot water – where an

existing hot water cylinder exists or can be added to the current main heating system.

Benefits

- Solar power is truly a renewable energy source and contributes to reduction of carbon emissions.
- There is potential for savings in fuel costs, especially if the system has battery or hot water optimisation.
- Low running costs.
- Relatively low maintenance with the potential for a long operating life.

Challenges

- The effectiveness depends on several factors, including the geographical location of the site, orientation of the installation, weather/cloud cover.
- They can have high upfront costs although prices have been falling rapidly for many years.
- There is often a level of visual impact on the building and setting which can be particularly challenging in many heritage areas.

Other considerations

- With roof-mounted installations it is necessary to check that the roof is able to support the wind, snow and static load.
- The means of fixing and operating the panels and other equipment should not impede the building's functioning, such as rainwater disposal and ventilation, and should also not hinder maintenance work.
- Solar panels benefit from maximum exposure to the sun, achieved by facing panels in a direction between south east & south west. East and west facing roofs are also suitable for solar panels and will still see a good deal of energy generation throughout the course of the day.
- Shadows cast on panels by trees, buildings and other features can greatly reduce the amount of electricity generated, even if it is only part of the panel is in shade. However recent advances in solar technology have started to reduce this issue. Many panels are also capable of generating energy even on overcast days.
- Depending on the system chosen, you may also want to consider the suitability for a battery, or hot water optimization, to maximize the use of the generated energy.

Reducing impacts on heritage assets

- Consider the placement of components carefully. Attaching to the main elevation of the building i.e. the face(s) of the building as seen from the direction it is most commonly viewed, is likely to be more visually intrusive due to their prominence in view. Placement on a less prominent elevation may be preferable to reduce the visual intrusiveness of the installation.
- Besides the visual impact on a building, the impact on the setting should also be considered. It would usually be measured against the views to and from the installation where they would be visually prominent.
- Any impacts should be mitigated as much as possible. Aside from careful placement, there are other options to explore including: choosing less reflective panels and frames whenever possible, or through the use of screening or the characteristics of the building e.g. shallow roof pitches to make panels less prominent.
- It is vital that all required consents are obtained before carrying out any works especially if they affect any designated heritage assets. Installation must be carefully planned, with consideration as to how damage to the building fabric can be minimised, how it is installed and maintained, and how the equipment can be removed at the end of its useful life.

'A' or better rated gas boiler

In line with the projected trajectories of decarbonising the built environment necessary for mitigating future climate change, installing new fossil fuel burning boilers are *strongly discouraged* and should only be considered as a *last resort* in historic buildings. Every additional boiler adds to our carbon footprint unless these emissions are mitigated elsewhere, and ultimately, they are likely to require replacement with zero carbon alternatives at some point in the future (retro-fit can potentially be at a significant cost).

For some historic buildings it could be fairly straightforward to retrofit them to a standard where a heat pump or similar low carbon heating method would be suitably effective; for other buildings, this can require a lot of money and resource which may make these options prohibitive. Equally, for some (particularly listed buildings) retro-fit to alternative heating methods is not

possible without causing an unacceptable level of harm and, as such, a boiler may be the only option for the time being, hence it is touched upon here.

Benefits

- Can be very energy efficient and a highly efficient boiler would be a preferable option when replacing a more inefficient system – such as oil/LPG/solid fuel systems or electric convection/storage heaters or old style gas boilers (rated E or worse).
- They are often compact in design and situated internally and as such would have a minimal heritage impact.

Challenges

- Other more climate-friendly and sustainable alternatives now exist and it needs to be recognized that a fossil fuel burning boiler will produce additional greenhouse gas emissions that will further contribute to climate change and that will need to be mitigated via other means.
- Fossil-fuel boilers can also be a source of pollutants that contribute to poor air quality.
- High initial cost outlay and effectiveness may be dependent on the size of the property and how well it is insulated.
- In order to meet future net zero targets, every new fossil-fuel burning heat system is likely to require retro-fitting to zero/low carbon alternatives at some point in the future – this requirement introduces a potentially costly action for future occupants.

Other considerations

- Its effectiveness is dependent on the state of repair of the building fabric, so an ongoing maintenance regime is important. It is advisable to undertake repairs and upkeep of more passive measures prior to making an investment in a new heating system.

Domestic electric vehicle (EV) chargers

From 2030, householders will no longer be able to buy a new petrol or diesel car. Under the city's zero carbon action plan, alternative transport modes, such as cycling, public transport and car club vehicles are anticipated to replace around a quarter of these vehicles in the city. Electric vehicles (EVs) will be an important element in the transition to net zero for many in the city – this will require large

scale charging infrastructure provision at various scales across the city as is identified in the Oxford Electric Vehicle Infrastructure Charging Strategy (OxEVIS).

The installation of domestic electric vehicle chargers is often covered by permitted development (PD) rights, however there are situations where planning permission will be required. These situations are set out in the specifications within the national permitted development order and include charging units over a certain size; installation in certain locations such as proximity to a highway, or in an area not lawfully used for off-street parking; installation on listed buildings or near to scheduled monuments; or where an Article 4 Direction prevents relevant alterations under permitted development. Listed Building consent may also be required.

Benefits

- Relatively short payback time.
- Facilitates a shift to lower carbon transport options, particularly for those who cannot walk/cycle far.
- Design of units is varied and there are choices available that can minimise visual impact.
- It is hoped that EVs will be able to double up as energy storage (V2G) in the future.

Challenges

- Requires existing driveway, or must be combined with licensed pavement crossing solution.
- Additional electricity demands on the building where charging unit is to be installed.
- Poor design choice can have impacts on visual amenity which could be a challenge in conservation areas and in proximity to listed features.
- May incentivise the creation of new driveways, leading to the loss of green space and causing visual harm to properties with front gardens.

Other considerations

- Need to consider size of unit, colour, materials and other design features.
- Need to consider mounting method, positioning, driveway permeability, and how cable will reach vehicle to be charged (safety and movement implications will depend on the site).

- Should consider “smart” options to enable off-peak charging, when energy is abundant and cheaper.
- Properties without a driveway should consider availability of public charging, including public charge point requests, as well as potential for pavement cable channel as a priority over the creation of new driveways.

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Optional text can go here

Further text from here

Use Arial in bold, roman or black as required.

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