St George's Barracks, Rutland

Masterplanning for Sustainable Design and Construction

Daedalus Environmental Limited

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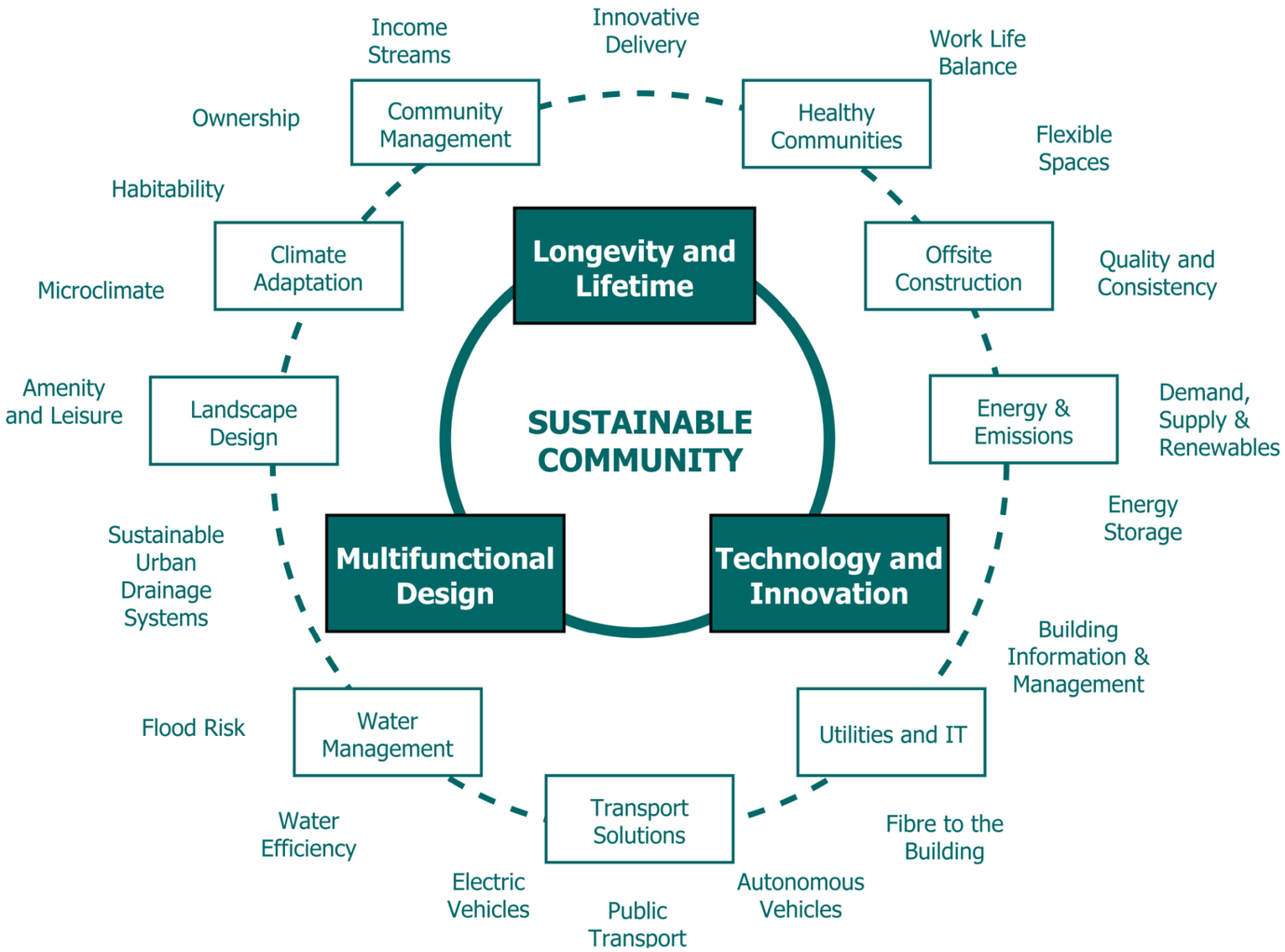
Introduction



Guiding Principles

This document has been compiled to support and inform the masterplanning process for the redevelopment of the St Georges Barracks site, a 300Ha MOD site in Rutland. In putting this document together we have considered a number of different sustainable design aspects in the context of a rapidly changing society, and sought to future proof the proposals for this anticipated change.

We have further examined what the important considerations for incoming residents are likely to be and how they can be attracted to the site. Beyond excellent schools, well considered and managed facilities/services (e.g. health centre, retail), good transport links and value for money property, this includes, for example, the provision of:

- An affordable place to live (or work), which minimises running costs
- An attractive, and well/easily maintained, external environment that reflects and enhances the existing high quality rural location
- Opportunities for employment (including home working)
- Leisure opportunities
- The development of a real 'community'

We have therefore addressed 'sustainable construction' from three guiding principles, and outlined what these are, what they might include and how we can ensure they will be taken forward over time:

- **Longevity and Lifetime** – how we can ensure that the development will meet the needs of its population over time (and through different stages of life)
- **Multifunctional Design** – making sure that the design and construction solutions implemented demonstrate excellent design sense and value for money by performing a range of roles or 'services'
- **Technology and Innovation** – considering emerging technologies and anticipating occupants needs now to ensure that the development is future-proofed for those changes

We then go into detail in relation to specific aspects of the proposals, including energy demand and supply, anticipating future needs such as transport and the implications of a changed climate, construction techniques and how the site can take advantage of innovative community management structures, all of which will contribute to the sustainability of the proposals.

Planning Policy Context for Sustainability

National Planning Policy Framework

The NPPF, published in 2012, contains a 'presumption in favour of sustainable development', which is defined by five principles as set out in the UK Sustainable Development Strategy. In order to clarify what sustainable development is, the Government has stated that it can play three critical roles:

- an economic role, contributing to a strong, responsive, competitive economy;
- a social role, supporting vibrant and healthy communities and;
- an environmental role, protecting and enhancing our natural, built and historic environment.

Emphasising design, the NPPF states that "*good design is a key aspect of sustainable development, is indivisible from good planning, and should contribute positively to making places better for people*. "The NPPF sets out 12 core planning principles which "should underpin both plan-making and decision-taking", and of which five are particularly relevant to this document. In this context planning should:

- Seek to secure a high-quality of design and a good standard of amenity for occupants;
- Support the transition to a low-carbon future, take account of flood risk and coastal change and encourage the reuse of existing and renewable resources;
- Help conserve and enhance the natural environment and reduce pollution, allocating land of "lesser environmental value";
- Manage development to make full use of public transport, walking and cycling; and
- Take account of local strategies to improve health, social, and cultural wellbeing.

The Planning Practice Guidance documents to accompany the NPPF contain further details in how to respond to the NPPF, in particular the following are relevant to this report:

- Climate Change: which 'advises how planning can identify suitable mitigation and adaptation measures in plan-making and the application process to address the potential impacts of climate change'
- Renewable and Low Carbon Energy: which 'assists local councils in developing policies for renewable energy in their local plans, and identifies the planning considerations for a range of renewable sources such as hydropower, active solar technology, solar farms and wind turbines'.

Rutland Local Plan – Core Strategy

The Rutland Local Plan was adopted in 2011, but is now being reviewed in order to extend the plan period to 2036 and also in light of the revised NPPF released in 2018.

The wider issues of planning policy are addressed within the masterplan document, and we focus here only on sustainable design and construction matters. The following Strategic Objective provides initial impetus:

Strategic Objective 14: Resources, waste and climate change
• To reduce the impact of people and development on the environment by sustainable design and construction, reducing pollution, encouraging the prudent uses of resources, including minerals, waste management and recycling, increased use of renewable energy and provision of green infrastructure and addressing the implications of flood risk and climate change.

It is also supported by Policy CS1 – 'Sustainable development principles' – which requires that:

New development in Rutland will be expected to:

a) minimise the impact on climate change and include measures to take account of future changes in the climate;
b) maintain and wherever possible enhance the county's environmental, cultural and heritage assets;
c) be located where it minimises the need to travel and wherever possible where services and facilities can be accessed safely on foot, by bicycle or public transport;
d) make use of previously developed land or conversion or redevelopment of vacant and under-used land and buildings within settlements before development of new green field land;
e) respect and wherever possible enhance the character of the towns, villages and landscape;
f) minimise the use of resources and meet high environmental standards in terms of design and construction with particular regard to energy and water efficiency, use of sustainable materials and minimisation of waste;
g) avoid development of land at risk of flooding or where it would exacerbate the risk of flooding elsewhere;
h) contribute towards creating a strong, stable and more diverse economy
i) include provision, or contribute towards any services and infrastructure needed to support the development

In addition, policy CS19 (promoting Good Design) describes how new developments are expected to meet high standards of design across a range of different issues, and CS20 (Energy efficiency and low carbon energy generation) requires that:

Renewable, low carbon and de-centralised energy will be encouraged in all development. The design, layout, and orientation of buildings should aim to minimise energy consumption and promote energy efficiency and use of alternative energy sources.

All new housing developments will be encouraged to meet the minimum energy efficiency standards of the Code for Sustainable Homes in accordance with the government's proposed timetable for improving energy efficiency standards beyond the requirements of the Building Regulations. All new non-domestic buildings will be encouraged to meet BREEAM design standards for energy efficiency.

The current local plan position, whilst providing useful support for sustainable design and construction generally, inevitably fails to really drive development to be more sustainable, relying often on (sometimes out of date) minimum standards without any real commitment to innovation or anticipating future needs.

Overall, therefore, the creation of an acceptable, new and sustainable garden community at St George's Barracks will require a more thoughtful and considered approach to sustainability issues, one that embraces the future, innovation and opportunity whilst preserving the essence of Rutland as a county. We have therefore built on the policy position to inform a masterplanning process with sustainability at its heart.

Longevity & Lifetime

Background

Provide an **internal environment** that fully meets the needs of individuals and families throughout their lifetime. In many ways it is about anticipating future needs, and designing the development and construction process, as well as considering long term management, to enable to facilitate that change.

In order to deliver this, the development will:

- Create flexible **internal** spaces enabling:
  - Home working
  - Live in and/or remote care
  - Optional bedroom spaces/locations
  - Ability to easily extend or reconfigure layout (move walls)
  - Garage conversion
  - Intergenerational (3G) living
- Ensure flexible and accessible **external** spaces in and around properties
- Enable excellent connectivity for delivery of services – health care, elderly care, transport, lifestyle choices, utilities management
- Anticipates future climate change and be designed to proactively cope with those changes at minimal cost
- Innovative integration of long term management and ownership of the site and necessary management fund(ing)
- Delivery of complementary building uses that promote cohesive communities within the masterplan
  - Leisure
  - Community building
  - Schools (with multifunctional spaces?)
  - Local retail
  - Commercial space (including start-up / collaborative business premises)

This can be achieved through:

- Off-site / modular construction – enabling flexible design and layout, and high quality construction, future structural replacement of building elements
- Fibre to the home / business (not the cabinet)
- Innovative services design
- Threshold levels, Part M Building Regulations etc
- Commencing the business planning for the structure and ownership of the management company early in the process (i.e. soon after masterplan agreed)
- Mixed use masterplanning (already in hand!)
- Provision of an **external environment** that meets the needs of the community in the face of a changing climate (see Multifunctional Design, below).

Within this section, we cover the following issues in more detail, although there are clear links to other key design principles in order to facilitate them:

- Long term, sustainable community management
- Reducing energy demand and costs
- The use of off-site construction
- Healthy communities

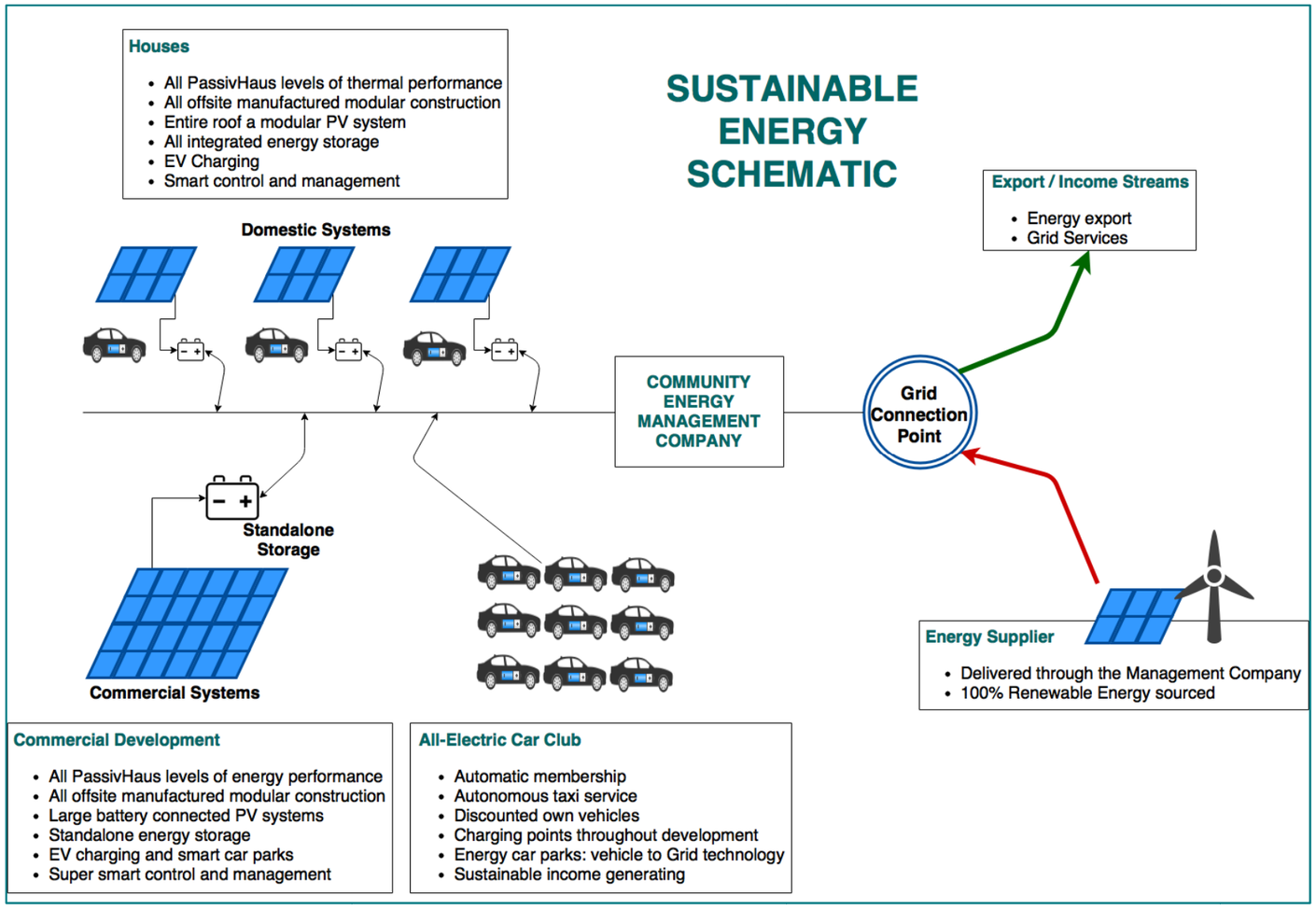
Long Term Community Management

Successful, sustainable developments need to create a sense of community, which can be achieved in multiple ways. The wider masterplan for the development sets out a number of key design approaches and considerations which, along with a viable mix of different uses, will create a vibrant and thriving new community.

At St George's Barracks, we propose that this is taken further still. The long term management of developments – maintaining external spaces, community buildings and infrastructure, etc, to the highest standard – can be achieved in a number of different ways, through the form of a community development trust or similar structure, concepts which originated during the early garden city movement and which retain relevance and success today. These structures however represent an ongoing cost to communities, with little opportunity for long term sustainable income beyond regular contributions from the community themselves (for example through ground rent), third party funding etc. Therefore, we suggest that the long term role of the management company needs to include a wider set of services that generate profitable income that can be reinvested into the community, for community benefit. Nowhere does this opportunity exist more than in the operation and maintenance of fundamental infrastructure, such as energy supply, shown as an example to the right.

By managing assets (including energy generation and storage systems) and controlling supply, there are strong commercial and environmental arguments for this approach. Each individual building owner, occupant, or tenant, whether domestic or commercial, will effectively be a shareholder in a community energy company from which a long term cost benefit will be derived. This cost reduction will be both in the form of reduced energy bills, but also income streams from those assets which will provide services back to the Grid. Crucially, the application of these technologies should reduce the upfront capital cost associated with utilities infrastructure (as peak demands will be reduced), another benefit which will be built into the long term business plan for the site.

An ownership structure such as this can also be used for a much wider variety of 'community services' and investment opportunities, including transport, leisure and local retail for example. Creating actual 'legal' ownership, rather than just 'a sense of' ownership, we therefore view as important to the long term success of the development.

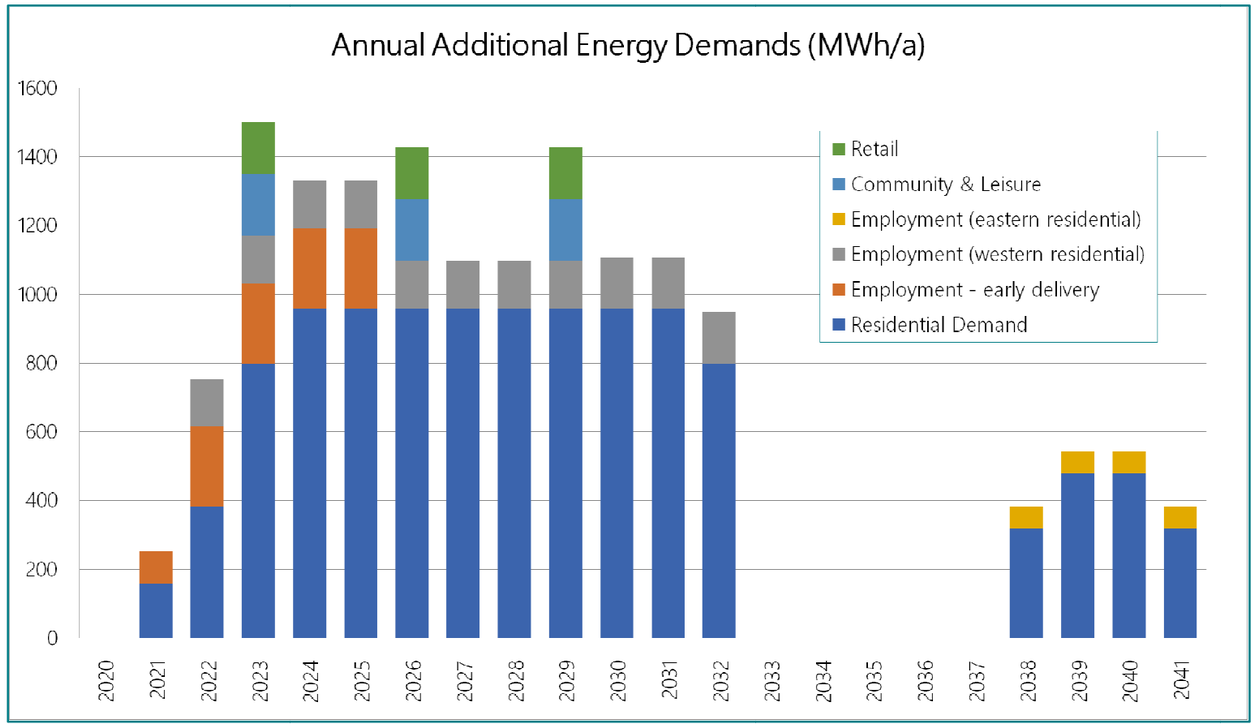


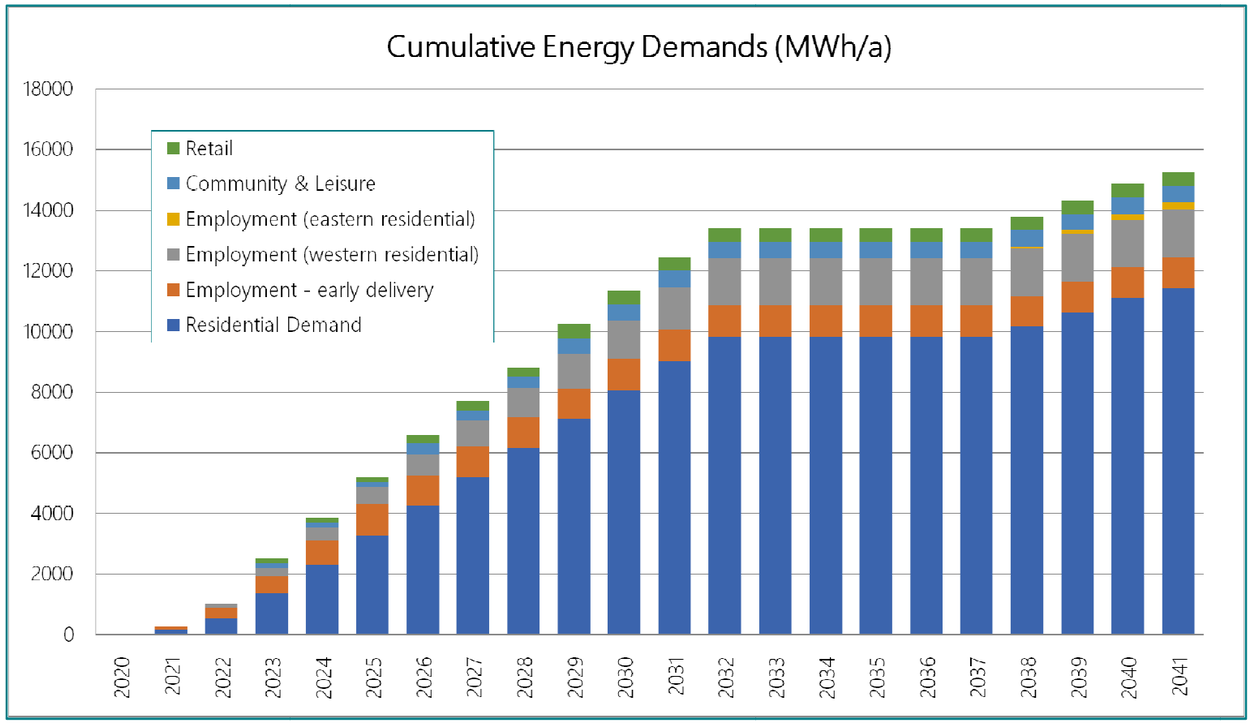
Energy Demand

One core aspect of running costs associated with buildings is energy. We describe innovative approaches to energy supply in the Technology section, but providing buildings that are affordable to run from the outset is critical. This is especially the case when bearing in mind that ongoing energy costs are set to continue to rise into the future. The energy demands associated with the site have been estimated based on the emerging mix of properties, and the associated phasing plan.

It should be borne in mind that these are demands from the new development, and are not (entirely) additional demands as the site is already operational. Nevertheless there will be an impact on existing utilities infrastructure as a result of the development, as energy demand is expected to be far higher post construction. We have therefore sought to minimise this impact based on reducing demand for energy (below) and finding alternative – and more innovative – forms of energy supply.

The diagrams to the right show how energy demand will grow – the first showing the new energy demand for energy each year, and the second the cumulative demand over time.





Energy efficient design

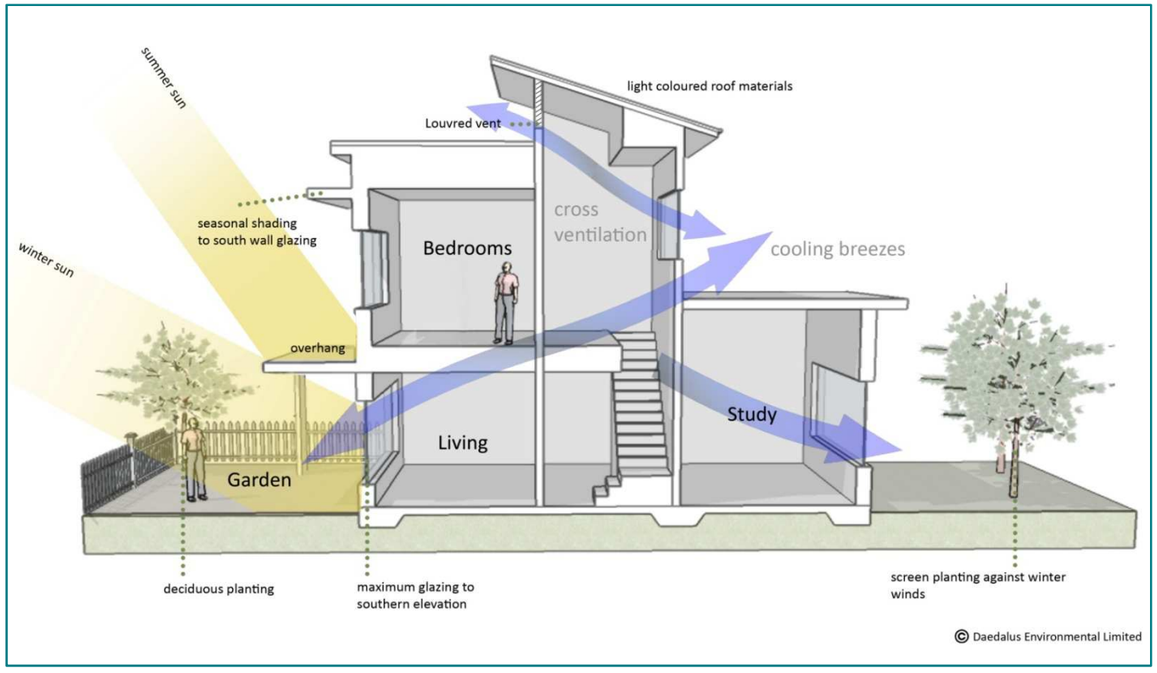
The basis of any sustainable design approach in relation to energy is the elimination of as much energy demand as possible. This clearly resonates with a design philosophy predicated on quality and longevity. The reduction of demand for energy through the development of super-insulated structures, driven primarily through the application of off-site manufacture, forms the basis of the approach. The use of off-site construction (see next section) not only speeds up the development process on site, it also minimises issues of on-site workmanship and should increase build quality.

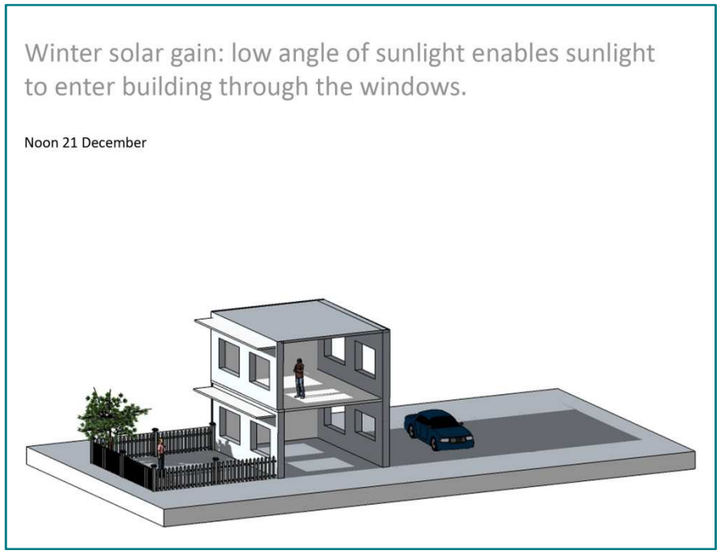
The aim of the design of property will be to eliminate the need for comprehensive ('wet') space heating systems through highly insulated structures and properly designed ventilation that helps manage the quality of the indoor environment. It is strongly recommended therefore that the thermal performance characteristics of properties are agreed early in the process, and ideally as the Development Plan Document for St. Georges Barracks is developed.

This development will therefore go well beyond the basic (Part L) Building Regulations performance requirements and in so doing reignite the sustainable construction sector within Rutland and surrounding region.

In addition to the structural performance of the buildings, as the detailed phases of the masterplan are brought forward, further consideration will be given to the detailed layouts, to maximise the benefits of managed solar gain to generate high levels of daylight, additional (free) warmth/heating, and healthy internal environments.

The ability for residents and non-domestic users to actively manage their energy use – as 'prosumers' – will be facilitated through the installation of super-smart monitoring and control systems with additional functionality (such as remote control through smart phone apps, warnings and alerts, and third party monitoring for those with care needs).





Offsite Construction – Benefits and Opportunities

Traditional construction processes on development sites typically suffer from inefficiency and low levels of productivity, and inevitably varying degrees of quality in the end product. This is the result of a number of key factors including poor site management, lack of availability of well-trained labour or site materials, ineffective sequencing, poor information flows and communication, and so forth. Traditional construction is typified by productivity of less than 50%, with every pound invested resulting in only 50p of value.

Conversely, the opportunities presented by the offsite manufacture and construction industry, where factory built, quality controlled assembly can lead to a development process which is far more efficient on site, and can improve significantly the quality of the end product, with lower on site labour costs. This includes far more easily achieving high levels of thermal performance (typified for example by PassivHaus). Quantity of construction wastes can also be substantially reduced through offsite manufacture.

Offsite construction enables greater long term flexibility in design, with opportunities to adapt internal spaces over time without major structural issues to overcome. This may include the conversion of garages to living spaces over time, or the installation of lifts for those in need of them.

It also provides greater certainty of delivery, and return on investment. Overall it should not necessarily be considered a 'cheaper' option, but will be comparable in cost when delivered at scale, an opportunity which St George's Barracks provides.

Use of offsite manufacture also facilitates innovation through the integration of technologies, and enables their maintenance and easy replacement over time. This could, for example, include whole roof replacement, where a roof is entirely covered in energy generating solar photovoltaic panels. Services can be designed into the structure from the outset, minimising complications on site during the installation of mechanical and electrical works and the potential damage it can cause.

Offsite, Onsite

The availability of commercial space – up to 12.7Ha within the masterplan – also provides a further valuable opportunity. Previous studies in the south of England have shown that the following the levels of added value related to construction projects can be achieved:

- Importing offsite manufactured systems from outside of the local authority area will contribute approximately £1.25 to the local economy for every £1 spent
- Construction *generally* will provide up to around £2.84 for every £1 spent to the local economy (but only in the area the construction takes place)
- A local offsite manufacturing facility providing outputs for local construction projects could provide up to £4 to the local economy for every pound spent.

Therefore, the value created from 'keeping it local' can create social and economic drivers which often reflect the objectives local authorities. Actual figures in practice will fluctuate between different areas because it remains a complex interaction of many different factors and values. Whilst it is not therefore a simple calculation, it could be worthwhile in due course given the potential outcomes.

Therefore, further development of the masterplan into detailed planning submissions could include a detailed analysis of the opportunity to locate offsite construction facilities within the boundaries of the commercial portion of the site, which would then be used as part of the construction supply chain for the development St Georges Barracks.

Even where it is established that this is not practical, creating and engaging with a network of offsite suppliers within a 'reasonable' distance of the site (approximately 50 miles) would still bring economic value to the region, albeit less so within Rutland itself.

Healthy Communities

In many ways all the design elements brought together under the masterplan – including those described within this document – are important in creating a built and external environment which enables healthy living.

The 2015 Healthy New Towns programme, a joint initiative between NHS England and a selection of communities across the country, sought to establish new housing developments offer '*the opportunity to encourage healthier behaviours through the built environment and urban design, preventing ill health and encouraging greater independence and self-care*'.

The masterplan (and any subsequent design code type documentation) encourages healthy living, both in terms of mental and physical wellbeing, and facilitates this by planning and providing services for the long term, catering for people at different life stages.

In terms of general physical health, the location offers immediate opportunities for sports and recreation, in particular related to Rutland Water and the rural surroundings. Within the site itself, the masterplan is designed to create a walkable and cyclable community, with fitness trails and walking routes through the open green space provided.

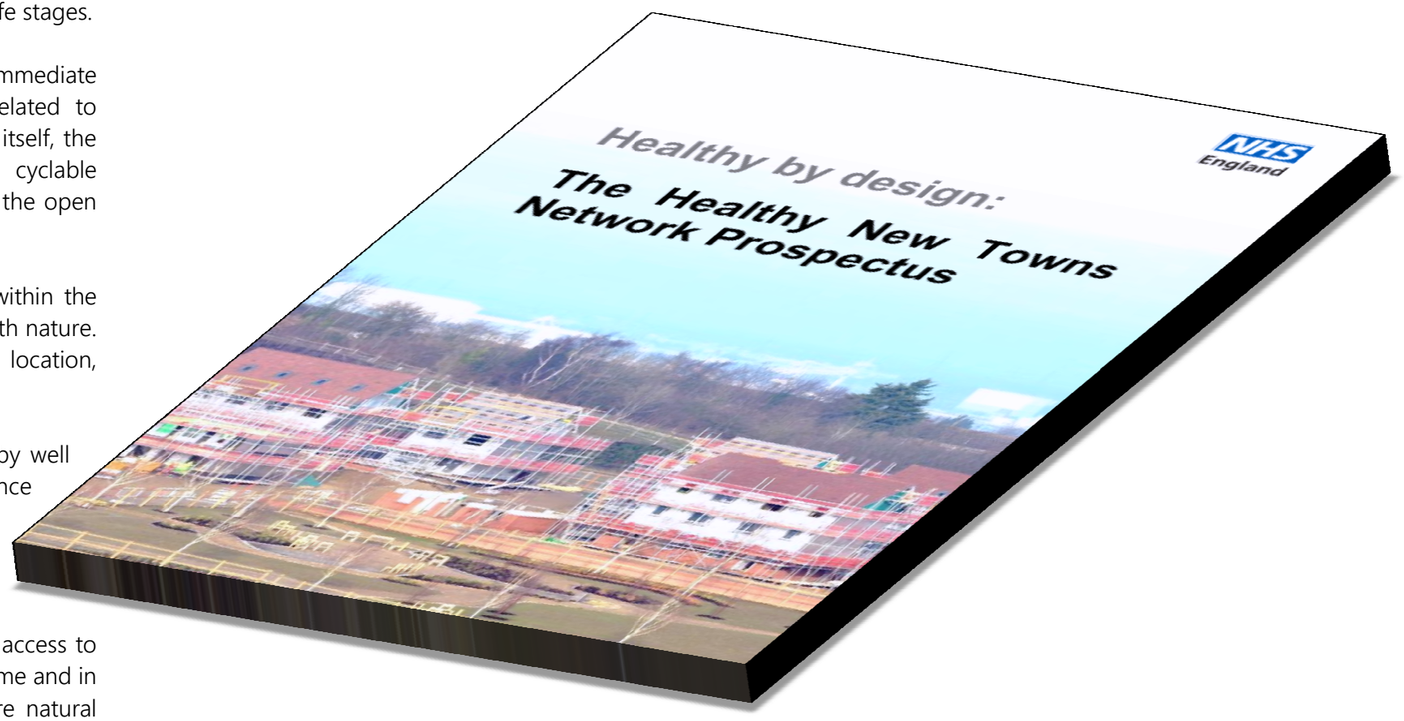
This will be complemented by high quality landscaping within the community itself, encouraging walking and engagement with nature. School playing fields offer an additional sport and play location, both for the existing and new community.

Mental issues are complex and cannot be solved simply by well designed development. However, there is significant evidence of the mental health benefits of access to, and indeed sight of, green space and access to nature, which will be promoted through the masterplan.

Moreover, the quality of internal spaces, and in particular access to sunlight and daylight, also has wellbeing effects both at home and in the work place. The buildings will be designed to capture natural light (see section on Energy Demand, above, for more information), as part of an energy efficient structure which reduces running costs of the building. This in turn helps alleviate financial pressures and associated stress.

Health care services – in the form of a health and wellbeing centre – are also proposed as part of the development, and in line with wider NHS priorities will not only provide treatment, but also focus on prevention. Indeed the ability to communicate proactively with residents as a result of the ultra high speed broadband provision opens up a range of opportunities related to low cost healthcare.

The ability for NHS healthcare providers to engage – remotely and efficiently – with residents will significantly reduce costs. Over time, we expect that technology will enable remote consultations and care to become the norm, and the infrastructure to support this revolution will be included from the outset at St George's Barracks.



Multifunctional Design

Background

Multifunctionality is the ability of elements of the development to provide a range of different functions or services. This helps to maximise the ability of the development to create a sustainable environment in the most efficient way possible. This approach then creates multiple benefits for the environment and the community.

Multifunctionality is therefore the application of design ideas and solutions that will be introduced because they can really contribute meaningfully in a number of different ways to the development, achieved through:

- Integrating these principles – and assessing design development from masterplan to construction – into the development design
- Wherever possible quantifying benefits for viability studies, cost models and business planning
- Considering the longer term implications for the management planning for the site

Many off the different aspects of sustainable design interact, and much of the work around multifunctional design will need to be undertaken at detailed design. As part of the masterplanning process we are able to describe examples of this in more detail, however, and therefore we cover:

- Climate change adaptation and the use of landscape
- Sustainable water management – efficiency and drainage

Adapting to Climate Change and the Importance of Landscape

Introduction

The UK Climate Impacts Programme (UKCIP) indicate that parts of England may experience significant rises in temperature with coastal water temperatures increasing, whilst colder winters will become rarer. The warming will be greater in summer and autumn than in winter and spring, and there may be greater warming in the nights in winter and during the days in summer.

In the near term, the next 10-20 years, there is a projected average 1.5˚C summer temperature rise and an average winter increase in temperature of 1˚C. By the 2080s, the UKCIP 'high emissions' scenario may mean that the region is an average of 5˚C warmer than at present. A particularly hot summer, such as experienced in 1995 and 2003, may occur every one in five years by the 2050s and three in five years by the 2080s.

Adaptation is seen as distinct from mitigation, and adaptation measures thus assume climate change is already happening, and will continue to do so. Measures need to be integrated into the design of the St George's Barracks development from the outset, anticipating this change and enabling it to adapt accordingly. Importantly, many of the solutions will be multifunctional too, as described above.

Building Overheating and Urban Heat Island Effect

The effects of climate change need also be taken into account – longer, drier summers and warmer, wetter winters with an increased likelihood of storm events – all have implications for the proposed development. Just as importantly, under a changing climate the way the external environment interacts with the built environment becomes more of a concern too. If, for example, we are to have far higher temperatures in the summer, and we do not want to use air conditioning because of the carbon emission impact, then other solutions must be sought, which include the use of external planting schemes and building integrated measures such as improved glazing to enable consistently habitable internal environments.

Addressing the issue of overheating as a result of a changing climate can be dealt with through a combination of building specific, and external environment focused, design solutions. By ensuring these elements are embedded in plans from the outset, a more functional development in the long term, that has minimal impact on resources and the surrounding area, can emerge.

The following measures are examples of solutions that should be introduced which can enable the physical structures of the buildings to cope with the changes in climate, help reduce the need for other human interventions such as mechanical cooling, and reduce the otherwise high costs of maintenance in the longer term:

- Use of low flow fixtures and fittings for reduced potable water demand, and use rainwater harvesting for non-potable uses, including the irrigation of public open space and other landscape planting
- Application of lighter coloured finishes reflecting more intense sun rays helping to maintain a cooler internal environment in warmer summers
- Ensuring a high proportion of the area of (low emissivity) glazing is openable within buildings and create the ability to naturally ventilate spaces
- Ensuring high build quality and better air tightness of structures to avoid unwanted air infiltration
- Design and sizing of guttering / downpipes and drainage infrastructure to cope with increased rainfall and storm events.

Landscape Planting

The natural environment is a complex and interconnected system that needs to be considered carefully. Different elements of design will interact in different ways, and these need to be fully understood. For example, a landscape scheme will not only provide additional ecological habitats, but also affect surface water management and the natural cooling of outdoor spaces and buildings in adapting to a warmer climate. The SUDs system will affect the amount of water available for planting, which in turn affects the types of habitats that can be created and the level of biodiversity that develops over time.

Planting and landscape design will therefore need to be developed to help create a local network of microclimates that provide a habitable environment in the long term. The site will include significant large areas of landscape and planting that will help towards the facilitation of a healthy and habitable microclimate whilst providing amenity open space and a more pleasant in which to live and work. Furthermore, the introduction of building specific features such as green walls and roofs will further enhance the quality of the external environment whilst assisting in adapting to climate change.

An increase in trees across the site will deliver local food growing opportunities and food sources for local wildlife. The trees are largely native species but a variety of ornamental species can further enhance levels of biodiversity. The careful location of new trees will not only help shade some of the site from prevailing winds from the southwest but also provide shading and microclimate enhancement within specific localised areas.

The integration of SUDS enhances the visual aesthetic for residents, with swales providing transportation of water through the site and providing irrigation to the new landscape design. Thus the landscape and green space is able to deliver a range of environmental services: microclimate cooling, building shading, enhanced biodiversity, water management, amenity and food growing capability.

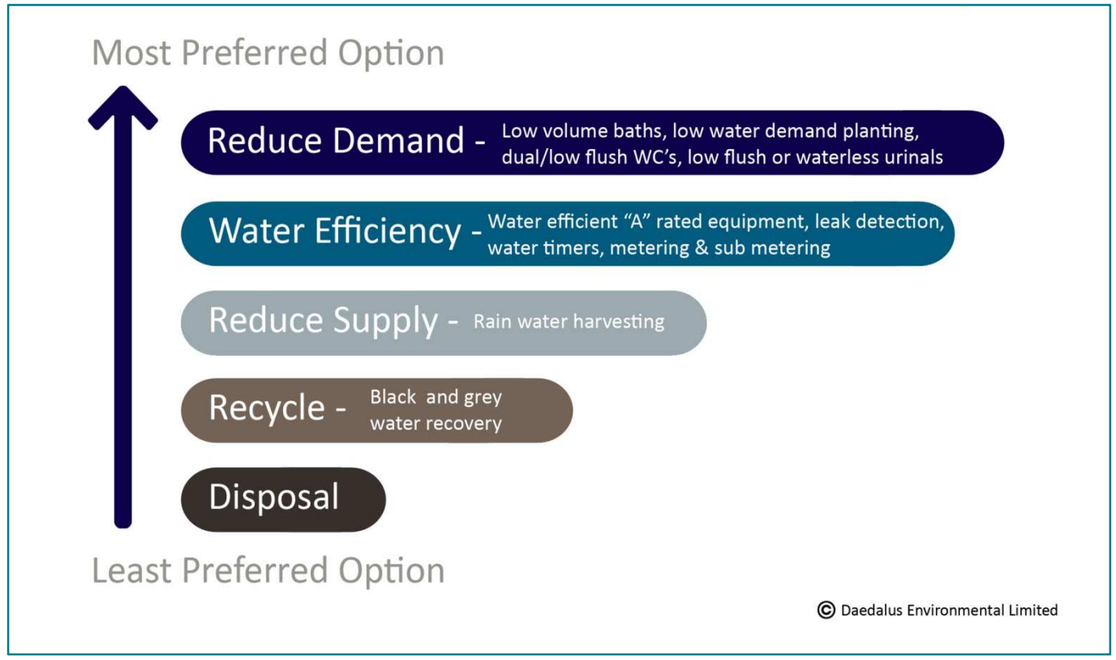
Sustainable Water Management

Water Efficiency

Water efficiency becomes increasingly important in a changing climate with diminishing water resources. We consume a vast amount of potable water in non-potable situations, including flushing the toilet, washing the car and irrigating our gardens. Only a small proportion of our *potable* mains water is used for drinking, cooking and personal washing.

The national average for water consumption is around 158l/p/d. In order to reduce this figure – we anticipate an eventual 'target' of 110l/p/d - the management of water in the proposed development will follow the principles of the water hierarchy, shown right. Driving down water use through reductions in demand through fixtures and fittings, and increasing efficiency of residual water use by specification of technology and appliances will underpin the approach.

The use of rainwater for irrigation purposes, also enabling the landscape design to thrive with only minimal recourse to the mains at times of drought, will also be an important part of the design and construction. Ensuring sufficient water for the landscape, and in particular street trees, will be a key aspect of detailed landscape design.



Flood Resilience and Surface Water Management

Rainfall levels in 30 years' time are expected to be very different from what they are currently, not necessarily in annual total volume, but with respect to the rainfall distribution throughout the year and the number of heavy downpours and storm events.

From an adaptation perspective, it is important that there is sufficient management of those rainfall volumes to enable the new landscape planting to thrive, to ensure that areas of grassland can be irrigated if necessary, and that high volumes of rainfall in short periods can be managed without causing flooding (either locally or further afield).

As such, volumes of attenuation will take account of more frequent intensive storms, allowing for an increase in volume of water resulting from a changed climate. Good design of SUDS features will enable these to be integrated into the landscape, facilitate higher levels of biodiversity and a more interesting natural environment.

The extract from the Environment Agency's flood mapping, shown to the right, indicates the potential level of flood risk for St George's Barracks, which as can be seen is very low, in Flood Zone 1. The development will inevitably increase the level of run-off and so in order to mitigate back to greenfield levels, SUDS measures will be introduced which will be fully integrated into the design of the landscape and create the necessary multiple benefits from which the whole community – as well as surrounding communities – will benefit.

Technology & Innovation

Background

With unprecedented change and evolution of technology, a number of opportunities present themselves in a number of different, but interconnected fields. Their application will also help anticipate the needs of, and therefore future proof, the development, and over time. This can be achieved over time by:

- Establishing the current infrastructure cost baseline for the emerging masterplan / planned development and create a business plan for the alternative for discussion / implementation with RCC/DIO. This will require further work with Western Power Distribution, amongst others.
- Implementing a joined up approach to building design (including M&E design) to enable widespread introduction of energy generating (PV) and energy storage (battery) technologies (including allocating space within properties and at street level)
- Integrating agreed plans with the procurement of contractor / developer partners in due course
- Consideration at early masterplanning stage of the required space and suitable locations for new technologies
- Integration of the costs of the technology into overall viability analysis (see accompanying study), as well as the long term management strategy for the site

There are a significant number of technology opportunities that could be applicable and which would drive innovation within the new community, although, guided by the principle of multifunctional design, we need to ensure that these, wherever important, provide a range of different services. We have examined the following aspects in more detail at this masterplanning stage:

- Changes in utilities infrastructure and associated opportunities
- Energy – demand, supply, storage and trading
- Facilitating the future of sustainable transport
- Future work patterns and associated infrastructure needs

Utilities Infrastructure Opportunities

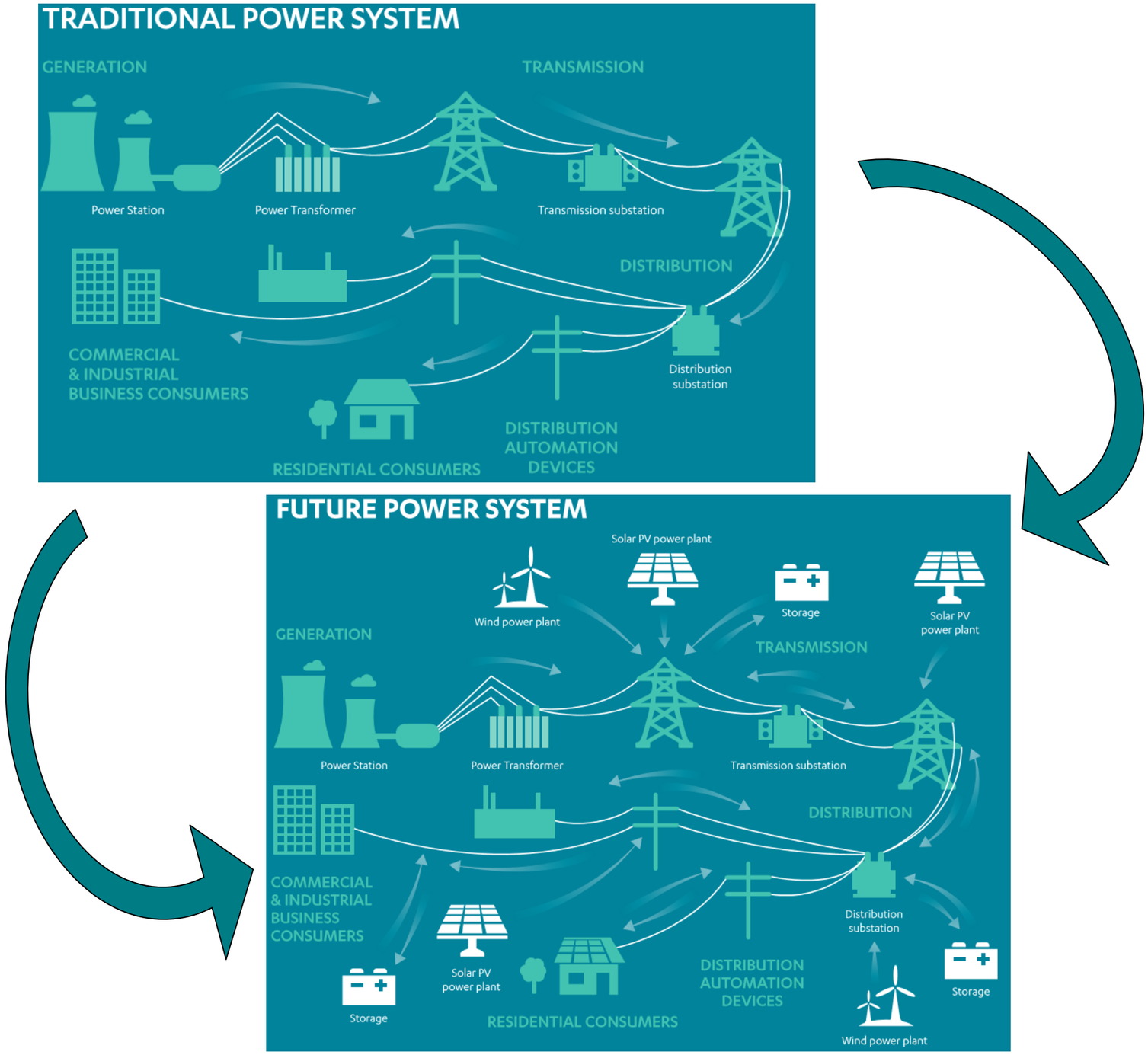
The country is rapidly moving away from a monolithic system of power generation at large scale power stations towards a far more flexible system of smaller (community and building) scale generation and storage. This has significant implications for the network, and network operators are now charged with becoming service operators who can facilitate the implementation of this technology. St George's Barracks presents an ideal opportunity with sufficient scale to enable flexible Grid management and alternative ownership of both infrastructure and electricity generation (and sale).

The ability to 'time shift' energy demands, trade energy between users and generators on a local basis, and extract value from energy generating assets (even at the level of an individual house) has now become viable. We move from being consumers of energy to 'prosumers' – *proactively* engaged in the energy market.

Whilst potentially complex, the technology exists to facilitate this in a simple and user friendly way – and ultimately really reduce the ongoing running costs for users. Simultaneously, it can be part of a wider ownership structure which reflects the essence of a garden community and can play an important part in generating income streams for long term community benefit. Our approach to this is described within the final section of this report.

The diagrams to the right are taken from the National Infrastructure Commission's Report on Smart Power, and show the transition to more flexible infrastructure, the implementation of which will be crucial if developments such as St George's Barracks are to proceed smoothly without significant or excessive infrastructure costs.

The opportunities for sustainable, long term community management have been described above, and the changes to utilities in the future, particularly around electricity supply, could form a fundamental element of that approach, and create sustainable income streams for wider benefit of the community.



Energy Supply Opportunities

The availability of new sustainable energy generation and supply technologies in recent years has opened up a whole new range of opportunities that move us well beyond the concept of district heating or individual gas boilers. Through this development the level of energy demand for heating will be significantly lower than comparable scenarios. Nevertheless power demands will still exist and are likely to increase over time, and these needs must be met as sustainably as possible, and this can be achieved by the wide scale implementation of photovoltaic technologies with accompanying energy storage (battery) facilities.

The cost of these technologies will continue to fall over the coming years, and is, in many cases, already viable. We are seeking to anticipate these needs, and future proof for those needs through the masterplan. All dwellings, and all non-domestic structures, will therefore need to accommodate this technology.

PV Roof Tiles

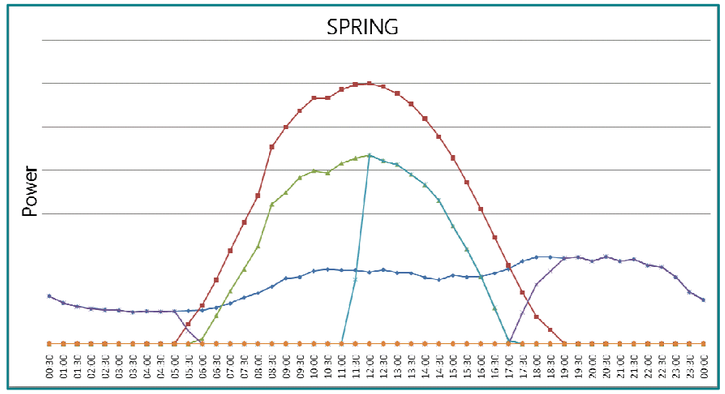
All properties will therefore accommodate PV roof tiles with total system sizes to be defined as the detailed design phases of the development come forward. However, we would anticipate whole roof systems would present a wholly viable technological opportunity with systems capable of generating a minimum 4kW of power, with significantly larger systems within the commercial development (for which more standard panel systems may be appropriate.

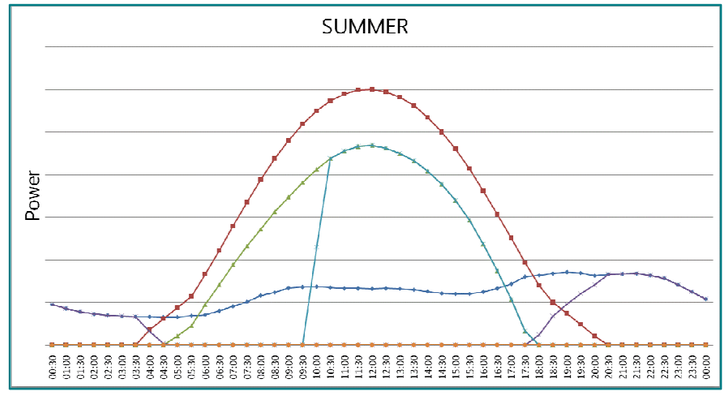
Domestic Energy Storage

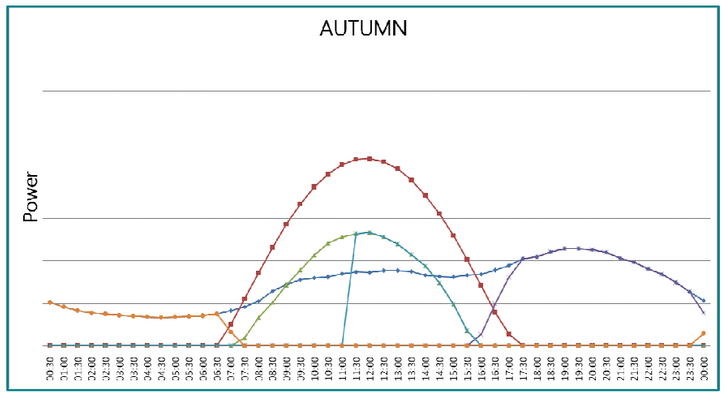
Each property will house its own c.5kWh energy storage device, integrated into kitchens or utility spaces in much the same way as a conventional refrigerator. This will enable residents to benefit much more from the energy that they generate and increase the income from the system in three ways:

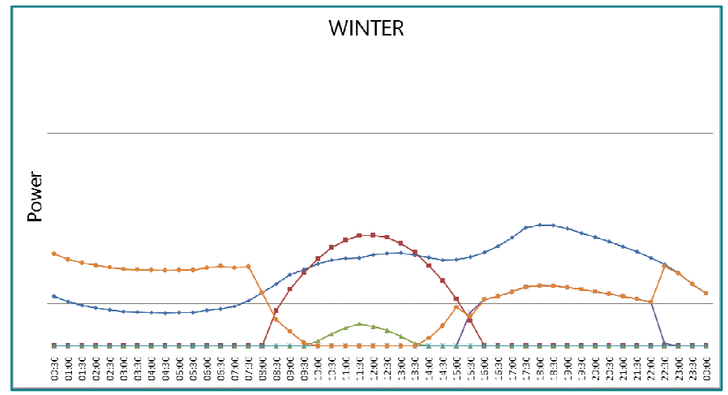
- Firstly, by removing the need to draw energy in from the Grid at peak times
- Secondly, by being able to trade that energy with other energy users on the site, including the commercial sector and the Grid
- Thirdly, by being able to offer Grid services such as valuable 'frequency response' and other balancing services.

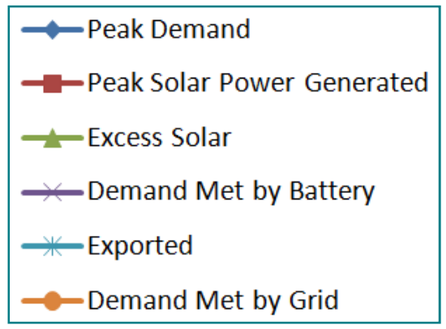
Management of this system is described below, as we develop an 'energy community' over time.











Commercial / Larger Scale Energy Storage

The commercial land allocation also offers the potential to include larger scale energy storage devices that can 'mop up' any electrical generation that cannot be stored within the domestic environment, and to help balance the Grid and maximise the value of the energy generated within commercial buildings.

It is too early to be specific regarding the sizes of the storage devices but we anticipate they will be of low megawatt capacity, and in a similar vein to the domestic sector, will generate income in a number of different ways. The aim to capture all energy generated within the site, minimise the energy exported to the Grid, and therefore minimise the capital cost of network infrastructure reinforcement that would be needed to service the development.

As the development progresses, through the development of the site SPD and into planning and design stages, the specification of larger storage devices will need careful consideration, with associated business planning and finance packages to underpin them. In line with the wider ethos of the site, however, the initial preference will be for these to fall within the wider, long term, sustainable management and ownership structure, so that income streams from the assets can be reinvested within the community.

Energy Trading

During the course of the development of St. George's Barracks, the ability for energy consumers to proactively trade energy that they generate and store will become possible. A structure for how this could operate in practice is discussed in the Longevity Section of this document – under the auspices of the community management organisation.

Accounting for the potential costs and benefit of design, installation and operation of these technologies is therefore important at this masterplanning stage, within the viability assessment. Importantly, the practical application of the ability to trade energy with emerging sustainable transport options – electric vehicles are, after all, another accessible form of energy storage – should enable a comprehensive, joined up and sustainable approach to energy demands across different sectors.

Facilitating this will require the introduction of high quality information technology infrastructure (underpinned by innovative block-chain software technology) which is discussed in more detail below.

Facilitating Sustainable Transport

Electric Vehicles

The Transport Minister also announced in July 2017 there will be a ban on the sale of petrol and diesel cars by 2040. This is largely a moot point - it is currently anticipated by GoUltraLow, a government and industry backed body, that electric vehicles will outsell diesel and petrol cars by 2025. Crucially, therefore, the need for charging infrastructure to support this wholesale shift to cleaner vehicle technology needs to be implemented now. There needs to be particular focus on this in relation to the design and management of the power network, and the introduction of more flexible power supplies to cope with this change.

The masterplan seeks to ensure that the impact of existing transportation methods is minimised whilst providing the necessary opportunities for new, cleaner technology to be supported. The impact on air quality by enabling this shift to the use of electrical vehicles will also be very positive. All dwellings will therefore be provided with the latest rapid charging points, and the energy management technology installed within each property will enable the cars to be charged at lowest cost – by utilising any excess solar power and / or using the cheapest available energy during the day or night.

Autonomous Vehicles

The speed with which the transport industry is changing has, heretofore, never been seen. The advent of hybrid technology is rapidly being usurped by wholly electric vehicles as well the introduction of autonomous vehicles, which the Government recently stated in the 2017 budget would be rolled out on UK roads by 2021.

It is expected that over time, the opportunities for autonomous technologies could reduce the total number of vehicles owned, because people will be able to order vehicles for individuals on demand, significantly reducing the cost of personal transport for many people. Whilst this may have limited impact initially – it actually presents a range of design opportunities related to the buildings themselves. For example, it will free up garage (and driveway) space for alternative uses, increasing property sizes and enabling greater flexibility (which conversely will need to be considered during the detailed design and construction process).

Car Club

In line with this, the creation of a car club for St Georges is a very realistic possibility. In order to be successful, a single car typically needs a user base of at least 30 individuals, of which 15 use the car regularly. Within a development of 3,000 homes, we can reasonably assume that car club implementation would be possible – and probably for a fleet of cars, building over time. Allocation of space for this within developments, to enable convenience for users, is therefore critical.

Personal Transport Drones

The first personal drones are anticipated to be commercially available by the end of 2018, and in principle could become commonplace with 10-15 years, well within the lifespan of the development. The lower density nature of the development at St George's Barracks could facilitate the necessary space for storage, take-off and landing of this mode of transport, and therefore this should be accommodated within later phases of the masterplan.

Future Working Patterns and Associated Infrastructure

St George's offers a key opportunity to embrace and anticipate future working patterns, many of which will reflect the ability to constructively work from home. Rutland also sees a generally higher proportion of small / micro businesses, and enabling the expansion of this and supporting start-ups will be a key feature of this masterplan. This will be facilitated by:

- The use of offsite design and construction will enable flexible internal layouts with properties, which will include live/work spaces within houses.
- Community located, flexible work facilities will enable people to access more specialised office and meeting facilities at a competitive rate, whilst creating local business networks
- The introduction of the highest broadband speeds creates the foundation upon which flexible work practices can be facilitated
- Commercial space – which will include start up and grow on space – enabling businesses to grow and thrive, and create the jobs, many of which will be filled by the community itself.

These elements will help the community facilities to draw in additional sources of income and become sustainable in their own right, helping the new development thrive.

However, in order to enable this option, the quality of broadband / telecommunications infrastructure will need to be high, and therefore the introduction of fibre to the building across the site will be necessary. Including this as a core requirement of the development, rather than a 'nice to have', is vital. It will underpin many of the wider sustainable development opportunities described in this document, and moreover will be a key feature of attracting a new, younger demographic into the area. Sustainable economic growth will, inevitably, be predicated on the ability to provide the most advanced infrastructure available, and will future-proof the development for decades to come.

Acknowledgements

Image Sources

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Healthy Communities (page 10)
- NHS England (Healthy New Towns prospectus)

Landscape (page 13)
- City of Portland (bioswales)
- www.euac.org.uk (green wall)

Water (page 14)
- The Environment Agency (flood map)

Utilities Infrastructure (page 16)
- National Infrastructure Commission (smart power)

Energy Storage and Trading (page 18)
- Tesla / cleantechnica (commercial energy storage)
- Tesla (solar house)

Transport (page 19)
- Car club car (E-Car Club)
- Autonomous bus (BestMile)
- Human transport drone (Volocopter)