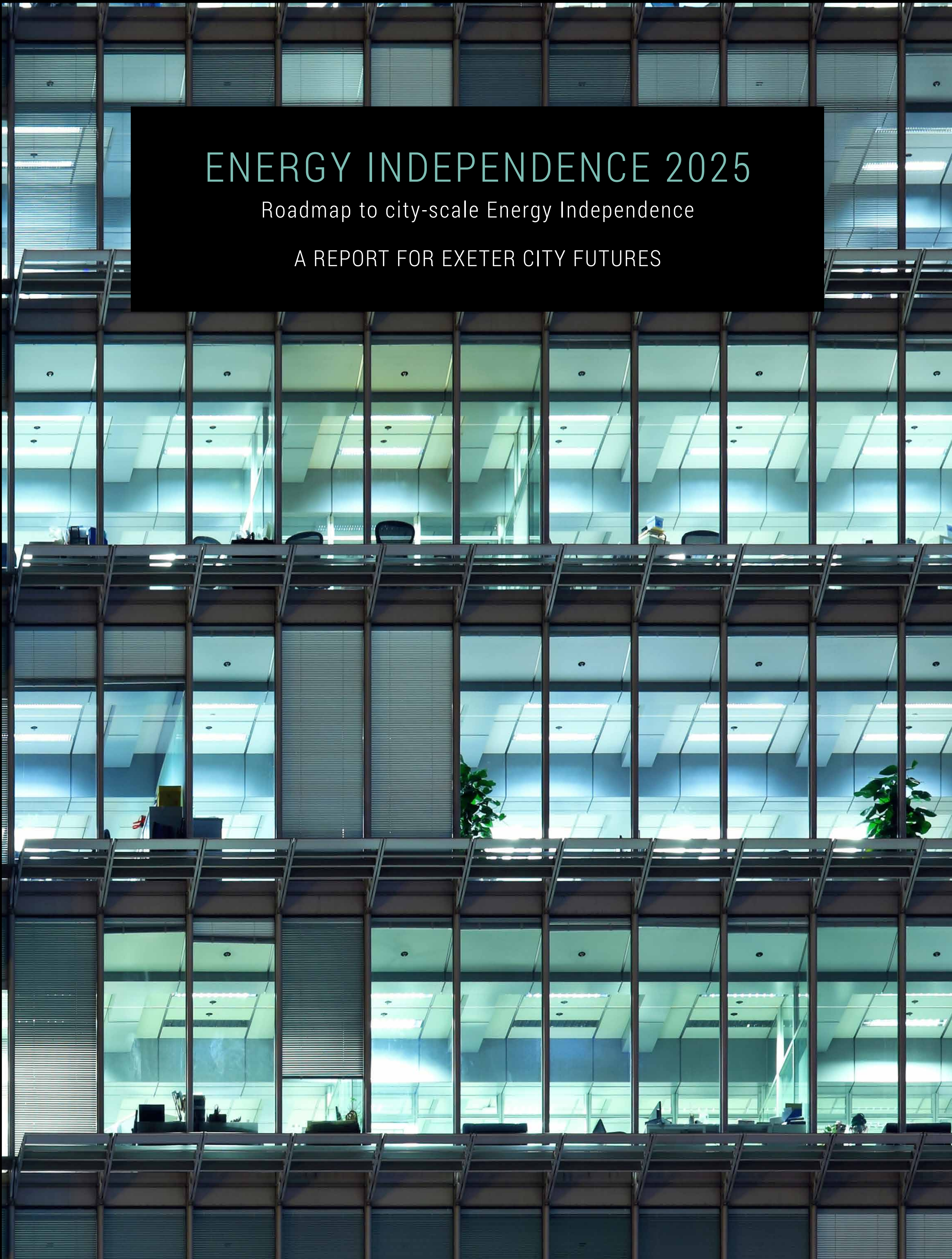
ENERGY INDEPENDENCE 2025

Roadmap to city-scale Energy Independence

A REPORT FOR EXETER CITY FUTURES



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EXECUTIVE SUMMARY

Cities and the unprecedented growth of urban environments present both the greatest challenge and opportunity of our lifetime. As drivers of economic growth, cities are essential to modern life. But unsustainable trends in energy use, congestion and associated negative consequences threaten their health and the health of their residents and workers. Exeter City Futures has commissioned a series of three reports to examine the potential options and roadmaps that would enable Greater Exeter to develop a path towards a sustainable future. The stated goal of Exeter City Futures - an energy independent and congestion-free city region by 2025 - is without precedent in the UK.

Robust evidence is required to demonstrate whether this ambition is achievable and, if successful, what its economic impact might be. This first report undertakes a detailed assessment of potential energy resources and uses in Greater Exeter and across the wider South West region. The second report assesses the transport situation and the options available to alleviate congestion and deliver further efficiency. The final report pulls together economic evidence to provide an independent analysis of the impact of the programme's goals and proposed delivery plans.

This report examines the current energy consumption profile for Greater Exeter across domestic, industrial, commercial and transport sectors and develops three potential scenarios for the 2025 reference year. The first scenario, Business As Usual, projects 2025 energy consumption based on forecast growth rates. Potential energy demand reduction and energy generation measures are then explored in detail across a range of technologies and settings. In each case political, financial, social and other non-physical or landscape constraints are initially set aside in order to ambitiously assess overall resource availability. This Maximum Technology scenario demonstrates what is possible if current barriers can be overcome. These barriers are then discussed in detail for each technology and further major constraints applied to identified onshore generation measures. This produces the Maximum Deployment scenario which is then compared to the Business As Usual projection to determine the extent to which Exeter City Futures' energy independence target can be realised. A series of recommendations, governed by identified barriers, that would unlock the path towards the desired ambition are then presented.

By 2025, annual energy consumption in Greater Exeter is expected to grow to 11.3 TWh from the current 10.0 TWh. This is predominantly due to forecast household and business growth and the associated increase in transportation demand. Excluding transportation, it is anticipated that 2.6 TWh of demand reduction is possible. This estimate is based largely on reductions in domestic space heating demand. For existing properties, the installation of an ambitious suite of retrofit energy efficiency measures (including insulation and electrification of heat using heat pumps) would reduce demand by an estimated 1.8 TWh/year (60%). Tightening building regulations to Passivhaus standards and adopting heat pumps for the additional 29,600 properties expected by 2025 would limit energy consumption by a further 161 GWh compared with the Business As Usual scenario. A further 104 GWh could be saved in the domestic sector through upgrading appliances to the most efficient models.

Commercial demand is currently responsible for 1.3 TWh (13%) of energy consumption, forecast to increase to 1.5 TWh by 2025 at current sector growth rates. The variety of commercial businesses and building types means there are wide variations in energy end uses. Space heating, as in the domestic sector, is thought to represent a significant level of demand (36%), with lighting being the next largest end use (27%). Building fabric efficiency retrofit measures, similar to those applied in the domestic sector, would address space and water heating and lighting energy use. However several sector-specific issues would also need to be addressed, for example, refrigeration in supermarkets. Based on available data, a saving of 359 GWh is estimated to be achievable with the net resultant demand 9% lower than 2014 levels.

Industrial demand is responsible for 1.6 TWh (16%) of current energy consumption. As in the commercial sector, patterns of energy consumption vary significantly according to the the type of industry. Consequently, potential energy savings are highly sensitive to the mix of industries in the region and the specific operational processes in each. For example, 2020 carbon reduction targets set under the Climate Change Agreements for different industrial sectors range from about 5% for non-metallic minerals (cement, ceramics, glass) to 11.3% for chemicals, to about 15% for food and drink. Several assessments have been produced at national level which identify efficiency roadmaps on a sector-by-sector basis, developed from detailed work involving specialists in their respective sectors. This report suggests that Greater Exeter could reduce industrial energy consumption by 250 GWh (16% of industrial demand) by 2025, in line with national studies.

Greater Exeter has access to abundant natural energy resources due to its position in the South West. Analysis indicates that 153 TWh/year of unconstrained low carbon energy resource remains untapped in the region, comprised mostly of solar (111.1 TWh) and wind (41.6 TWh). A geothermal hotspot with an energy potential of 139.0 TWh per year is believed to extend through much of Cornwall and Dartmoor National Park and into the western fringe of the study area. Further assessment would be required to quantify to what extent this could be exploited for use in Greater Exeter. After applying major constraints such as those entailed by sensitive landscape designations, radar areas, urban development and roads it is estimated that the Maximum Technology Potential, i.e. the potential energy which could be captured, is 16 TWh.

Comparing the anticipated 2025 Business As Usual energy demand of 11.3 TWh with the Maximum Technology potential of 2.6 TWh of demand reduction and 16.0 TWh of new generation suggests that energy independence at regional level is possible. However, the inclusion of further non-physical constraints, in particular those associated with cumulative visual impact, means that the Maximum Deployment scenario is expected to be limited to 6.5 TWh, due principally to removal of onshore wind generation potential. Considering only the Greater Exeter area, this constraint results in a residual energy requirement of 4.8 TWh per annum from 2025 onwards. This estimate of residual energy requirement is pessimistic in that it does not include any energy saving potential from the 4.4 TWh annual transport demand anticipated by 2025, which is the focus of another report. It also excludes potential technology efficiency improvements, such as in solar cells. Energy from other large regional sources, such as the Alderney tidal stream interconnector that is proposed to land in East Devon, is also excluded from the analysis as it originates from outside the Greater Exeter boundary.

The barriers that must be overcome to achieve both proposed energy savings and new generation are significant and are reviewed in detail throughout this report. Political barriers, particularly in relation to planning consent, are likely to have the greatest impact on the region's ability to achieve energy independence. Planning policy related to local generation, particularly approaches to cumulative impact of large-scale installations, removes 12.1 TWh of potential generation between the Maximum Technology and Maximum Deployment scenarios in this analysis. For example, cumulative impact policies materially affect the available onshore wind resource, which could range from 157 GWh, when cumulative impact is assumed to be based on a 15 km offset between each 10 MW wind farm, to 1,479 GWh, when a 5 km offset is assumed. It is also likely that cumulative impact considerations would feature in applications for new development of onshore solar generation. In this context policy should be directed towards advancing demand reduction initiatives. These are already viewed positively from a planning perspective but the code should be improved to establish the highest energy efficiency standards as the norm.

Financial barriers are also widespread. While the costs of more mature generation technologies and components are falling and considered likely to fall further to 2025, techno-financial barriers are especially high for demand reduction initiatives. Supply chains are insufficiently mature to deliver components at low enough prices to enable cost-effective retrofit roll-out at the levels required to deliver the proposed savings. Significant co-ordinated responses are required to create viable business models and stimulate the market for retrofit products to make inroads in energy demand reduction. Financial barriers are also acute for technologies still at the demonstration stage in the UK, particularly those where regional resources are plentiful: tidal range and geothermal. The financial issues here are complex and closely linked to high levels of technology and deployment risk, the continued fall in the price of alternatives (wind and solar) and long-term energy policy at national level. Significant public and private investment in these technologies will be needed to reach commercial viability.

While the Maximum Technology scenario assesses Greater Exeter's potential position without technology constraints, the reality is that considerable technical barriers remain, most notably the South West regional grid infrastructure. This constraint impacts the majority of generation options reviewed in this study as well as the electrification of heat using heat pumps across all sectors. National government could choose to see this issue either as a costly barrier or as an industrial innovation challenge that would enable the UK to take a leadership role. Smart grid concepts have been around for a long time, but city-scale solutions have yet to be demonstrated. Greater Exeter, with leadership, investment and national assistance, could embrace new technologies and models to unlock the grid. A further technical barrier is posed by radar interference from onshore wind generation. This should not be an impediment to change: a co-ordinated approach linking strategic land use and consultation with air traffic users can achieve a framework in which safety is maintained while generation is accelerated.

Based on a quantified assessment of the barriers that currently stand in the way of delivering the Maximum Technology scenario, this study proposes a series of recommendations. These define a set of actions that should be progressed across the range of options available to Greater Exeter to maximise the likelihood of achieving energy independence by 2025.

RECOMMENDATIONS

1.1 | RECOMMENDATION 1:
FACILITATE THE DEVELOPMENT OF NET ENERGY POSITIVE BUILDINGS

The development of a supply chain and policy environment that ensures the delivery of net positive energy buildings is an urgent priority. New developments that positively contribute to city energy use will mean that less onshore generation development and retrofitting of older building stock will be required. Greater Exeter already benefits from progressive local authorities which actively pursue building energy efficiency objectives, in particular in their own properties. The next steps are to further encourage innovative solutions, combine insights and analysis to support tighter planning policy and develop mechanisms to significantly expand the project base.

1.2 | RECOMMENDATION 2:
DEVELOP CREDIBLE ROADMAPS TO LARGE-SCALE DOMESTIC RETROFIT

A key assumption in the Maximum Technology scenario is that viable business models which deliver large-scale retrofit will be developed over the time horizon. The development of credible roadmaps that deliver comprehensive intervention in this area is essential. This is a challenging undertaking which requires significant investment in skills, new solutions and the development of businesses that can integrate, finance and deploy the roll-out of multiple technologies at scale.

1.3 | RECOMMENDATION 3:
ENCOURAGE AND DEMONSTRATE INNOVATIVE SOLUTIONS TO REDUCE DOMESTIC APPLIANCE ENERGY USE

While space and water heating consume the largest proportion of domestic energy, appliance use represents 0.5 TWh of Greater Exeter demand. The benefits of upgrading to the highest efficiency appliances should be promoted and systems developed which enable and manage behavioural change to both optimise use and reduce overall cost. Identified technologies should be trialled and best practice fostered.

1.4 | RECOMMENDATION 4:
DEVELOP COMMERCIAL AND INDUSTRIAL CASE STUDIES

This study identifies 359 GWh of potential savings from commercial buildings and 250 GWh of potential savings from industrial processes, based on current understanding of technical opportunities. More specific demonstrator projects are required to advance and promote greater understanding of what is achievable across a varied range of end users. A diverse group of local commercial and industrial partners should be brought together to develop leading-edge strategies to encourage potential energy savings.

1.5 | RECOMMENDATION 5:
DEVELOP CREDIBLE ROADMAPS TO CUT TRANSPORT CONSUMPTION

Transportation is expected to represent 4.4 TWh of annual energy consumption by 2025. Developing roadmaps to significantly address this consumption is an essential priority, and is the focus of a forthcoming report. In this context, wider participation in the development of various options should be encouraged, in particular through Exeter City Futures' innovation programme.

1.6 | RECOMMENDATION 6:
CO-ORDINATE SOLUTIONS TO ADDRESS GRID CONSTRAINTS

The grid is a critical technical constraint that impedes the viability of projects across the region. Moving past this barrier is essential if the regional energy industry is to thrive. Several options exist including capacity amnesties, the socialisation of upgrade costs and technology-led options such as smart grid infrastructure. All would need considerable co-ordination with the local grid operator to progress, but should be seen as a pivotal issue for the South West economy and Exeter City Futures' goals. If this barrier can be overcome, Greater Exeter could play a key role in stimulating a regional approach to energy independence, drawing on the skills, expertise and innovation of local research and industry. Close collaboration with the Department for Business, Energy and Industrial Strategy (BEIS) and other national stakeholders is required to develop policy and technology mechanisms to realise the potential local benefits of regional generation.

1.7 | RECOMMENDATION 7:
STIMULATE ONSHORE GENERATION

In the face of considerable planning barriers, improved stakeholder understanding of the impact of onshore generation options - principally wind and solar - is required. Co-ordinated Greater Exeter multi-authority strategic planning is needed to optimally locate new generation and work openly and collaboratively with the public to identify solutions that would be acceptable in the context of the energy choices available. Furthermore, the exploration of generation technologies that achieve higher levels of aesthetic acceptability should be encouraged. This is already happening within the solar industry, with the introduction of technology integrated into rooftops and roads. Further integration into other standard infrastructure could achieve both new generation and cost reduction without facing political barriers.

1.8 | RECOMMENDATION 8:
PROVIDE AN ECONOMIC EVIDENCE BASE

Evidence for the economic benefits of the proposed approach to energy independence and the opportunities afforded by being at the forefront of integrated smart energy infrastructure development should be provided, and is the focus of a forthcoming report. Demonstrating significant potential for increased local productivity, jobs and growth will enable the development of a wider network of support for this approach.

1.9 | RECOMMENDATION 9:
ENCOURAGE AND SUPPORT RESEARCH INTO ENHANCED GENERATION EFFICIENCY

Estimates of generation made here are potentially conservative. While they are based on widely accepted methodologies, the efficiency of many technologies can be expected to improve with time. Extrapolating the historical trends in technology efficiency would increase the estimates of generation made in this report. Research into areas with the potential to improve natural energy resource conversion efficiency, for example, solar cell technology, should be prioritised.

1.10 | RECOMMENDATION 10:
ENCOURAGE INVESTMENT IN MARINE AND GEOTHERMAL TECHNOLOGIES

In the wider South West region, geothermal and marine technologies offer sizeable generation potential in the Maximum Technology scenario. These capital-intensive sectors require significant levels of investment to reach commercial viability. High technology and deployment risk, alongside falling substitute technology prices, mean public sector support is likely to be required to achieve long-term market development. Private investment and innovation in these sectors should be supported and promoted, alongside strategic engagement with policy-makers at national level.