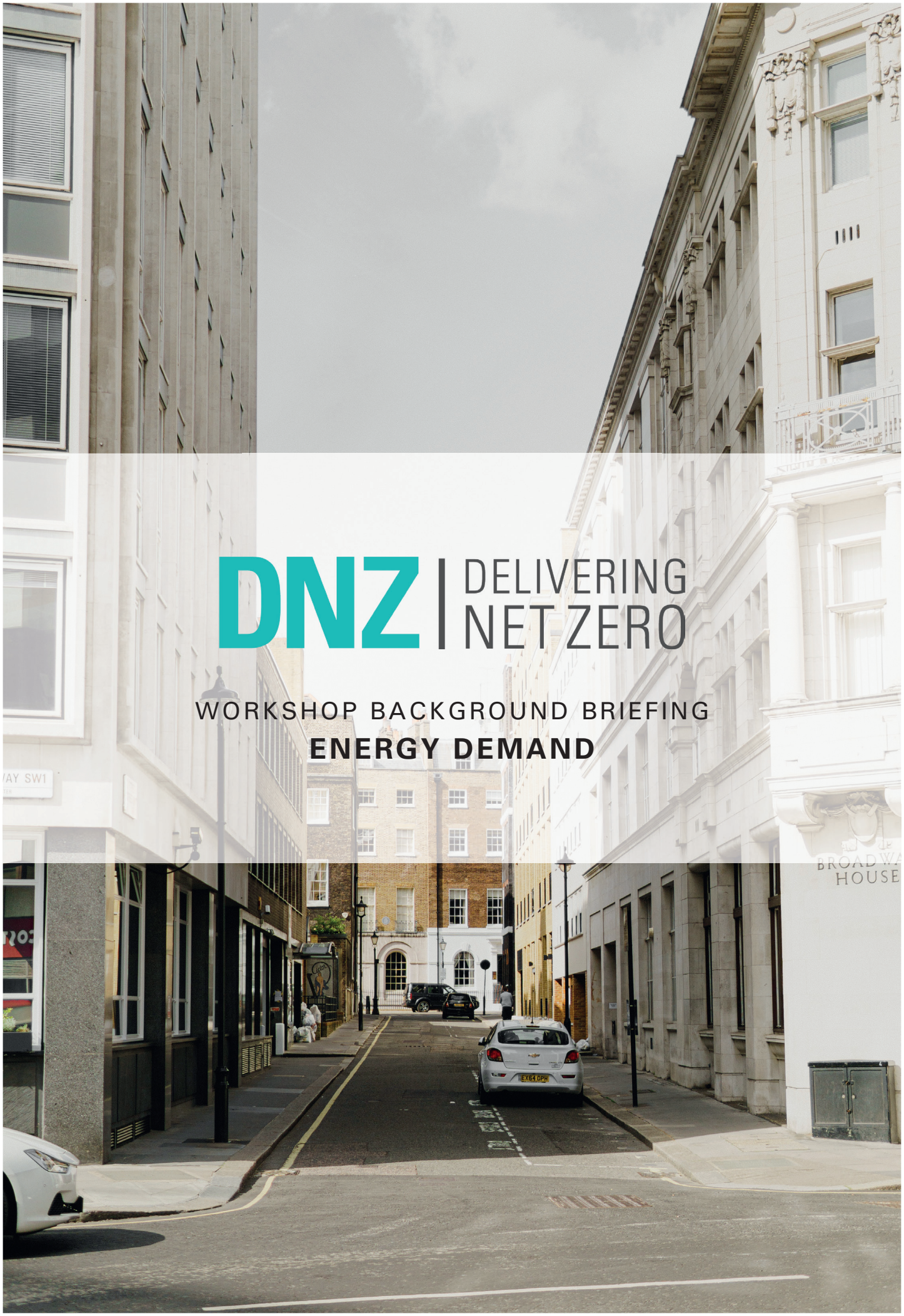

DNZ | DELIVERING NET ZERO

WORKSHOP BACKGROUND BRIEFING

ENERGY DEMAND

INTRODUCTION

Energy demand is defined as the product of demands for energy services (such as thermal comfort, nutrition, and mobility), and their energy intensity. It determines the size of the energy system and therefore the scale of decarbonisation required to mitigate climate change. Global primary energy demand has grown at 2.4%/year (±0.08%) since the 1850s, and has historically been closely associated with economic growth[1]. Despite a recent decline in energy intensity in developed countries, with current policies and targets global energy demand is on track to grow at 1% per year to 2040[2], placing increasing pressure on decarbonisation and greenhouse gas (GHG) removal strategies.

The UK government's reference scenario for primary energy demand projects a modest reduction of 5% by 2024, with demand increasing thereafter to exceed current levels by 2035[3] [Fig 1]. To reach net zero, the Energy White Paper looks at larger reductions of around 30% by 2050[4], which will require significant interventions to achieve. Larger reductions to energy demand can ease the pressures of decarbonising energy supply (storage, peak load, updating infrastructure), whilst also reducing reliance on greenhouse gas removal (GGR). In fact, the only Intergovernmental Panel on Climate Change (IPCC) scenario which stays within the 1.5°C target with no use of negative emissions technologies is the "Low Energy Demand" (LED) scenario[5]. Based on the low energy demand scenario by Grubler et al.[6], global energy demand is reduced by 40% despite increases in population, incomes and activity.

Other research shows that with significant energy efficiency improvements, energy services could provide a decent standard of living at energy consumption levels 60% lower than today[7]. In countries with the highest rates of energy consumption per-capita, 95% reductions are theoretically possible[7]. These scenarios also acknowledge that there is a larger responsibility to reduce energy demand in developed countries like the UK, which consume far more energy than developing countries.

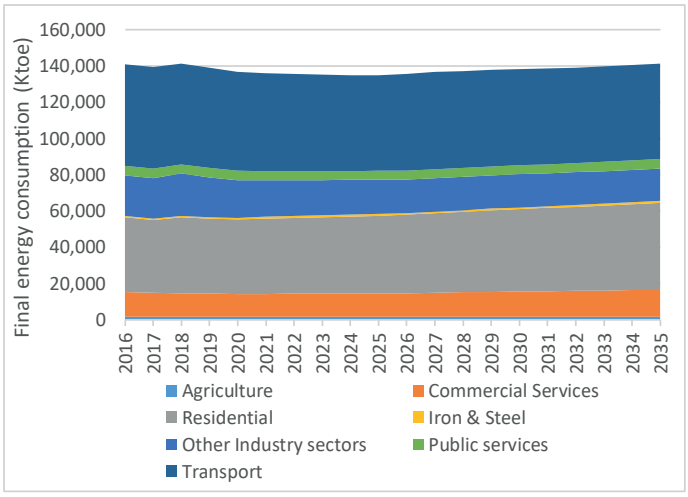

Figure 1 - Reference scenario for UK final energy consumption 2016-2035 (BEIS, 2018)

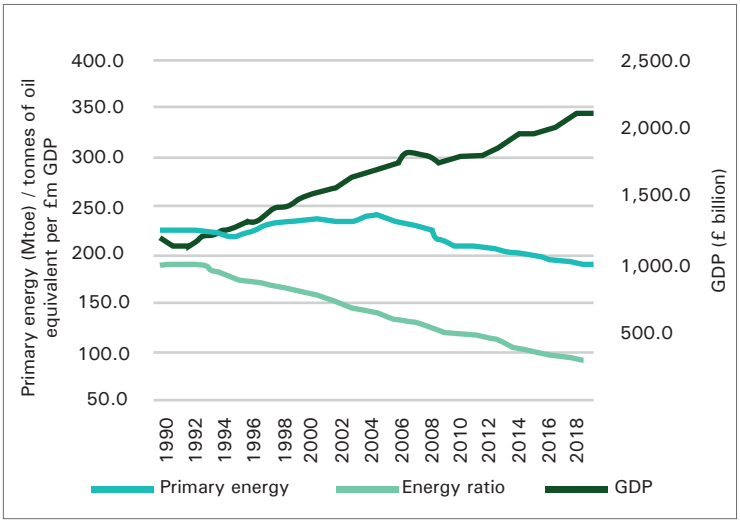

Figure 2 - UK primary energy, GDP and the energy ratio, 1990-2019 (DUKES 1.1.4)

UK ENERGY DEMAND

Since 1990, UK GDP has grown 44% while energy demand has reduced by 13.5%[8] [Fig 2]. However, there has been a limited reduction in the last decade and UK energy demand is projected to plateau [Fig 1]. The driving forces behind these changes have been, in roughly equal measure; improvements in energy efficiency, the off-shoring of energy intensive manufacturing industries, and the shift from an industrial to a service based economy[9]. However, the displacement of industries which make products consumed in the UK to other countries means that while UK territorial emissions have declined by 33% since 1997, consumption based emissions have declined just 4% over the same period[10]. Similarly, consumption-based accounting of energy produces estimates 45% higher than UK territorial energy demand[11]. Furthermore, since 2012 reductions in energy demand have slowed, and reversed in the transport sector, coinciding with notable cuts to energy efficiency policies and initiatives[12]. This has created a substantial policy gap to achieve energy demand reduction. While the government's recent green industrial strategy includes funding for the expansion of public and active transport infrastructure and an extension of the Green Homes Grant, without more significant action to reduce energy demand, rapidly reducing GHG emissions in line with UK carbon budgets becomes an almost impossible task.

REDUCING ENERGY DEMAND - AVOID, SHIFT, IMPROVE

Strategies to reduce energy demand have focused largely on improving energy efficiency over options to reduce demand for energy services or to change the way that services are delivered[13]. This unnecessarily limits options whilst failing to consider the underlying drivers of energy demand. As there are also limits to the technical potential of efficiency improvements, particularly in energy intensive industrial processes[14], it is important to consider a full range of demand side strategies.

Several approaches exist for identifying strategies to reduce energy demand. One approach is to integrate energy efficiency with the concept of energy sufficiency, in which the input of energy is reduced by transforming the quantity or quality of an energy service through changes to technologies, lifestyles or behaviours[15]. The IPCC adopts an alternative heuristic, Creutzig et al.'s "Demand-side assessment framework"[13]. Through this framework, we can avoid unnecessary energy services (e.g. reducing the need to travel), shift to the lowest intensity mode to deliver a service (e.g. modal shift from car to public or active transport), and improve energy efficiency. While there is some dispute over how to categorise strategies which may overlap in this framing, this can be a useful tool for identifying a broad range of strategies that can be applied to a range of energy services. Table 1 provides a non-exhaustive outline of short term (2020-2030) and long term (2030-2040) strategies to reduce energy demand for four key energy services; mobility, shelter, goods/services, and nutrition, with further detail given below. Most of these strategies do not require technological advancements and therefore can be implemented in the short term. This highlights a key advantage of energy demand reduction as a mitigation strategy, through its ability to provide short term reductions to cumulative emissions.

	AVOID	SHIFT	IMPROVE
MOBILITY	Reducing passenger miles per capita	Shifting from cars/planes to public and active transport	Improving energy efficiency of vehicles
Short term strategies	Changing work patterns – teleworking Increased online shopping Ride sharing/car clubs Avoiding air travel	Expanding public and active transport infra-structure	Electric Vehicles to replace Internal Combustion Engine Smaller, lighter weight vehicles Use of eco-driving techniques Fuel efficiency in aviation
Long term strategies	Integration of transport and land use planning – compact cities, localism	Expanding public and active transport infra-structure	Low carbon fuels in aviation
SHELTER	Reduce energy demand for thermal comfort and other energy services in the home	Shift in system of shelter provision	Improve thermal and appliance efficiency
Short term strategies	Reduce average room temperature Reduce number/use of appliances	Shift to multi-family dwellings	Retrofit existing building stock Passivhaus new building standards Heat pumps and heat networks Improve efficiency of boilers and appliances Use of smart meters
Long term strategies			Fuel switch to hydrogen Further expansion of heat network
GOODS + SERVICES	Reduce demand for goods and services	Shift to less energy intensive materials	Industrial and service sector process and energy efficiency
Short term strategies	Improve longevity of products Repairing and refurbishing rather than replacing Renting or sharing infrequently used products Recycling instead of disposing	Substitute steel for less intensive materials Increased use of recycled materials Material substitution in construction	Improve energy efficiency in material processes Light weighting of products and packaging Design optimisation and yield improvement
Long term strategies		Further increased use of recycled materials	
NUTRITION	Reducing calorific intake in line with government guidance	Shift to less energy intensive foods	Improve food system efficiency
Short term strategies	Reduce intake of unhealthy/fast foods Improve access to healthy foods	Reduce consumption of animal products, particularly ruminant meat Shift towards seasonal diets of locally produced food	Reduce food waste Improve efficiency of agricultural services.

Table 1 - Strategies to reduce energy demand across four key energy services. NB: 'long term' refers to strategies where impacts will be realised in the long term, it does not mean that these options should not be considered for implementation before this.

MOBILITY

Mobility accounts for the largest sector of energy demand, at 40% of UK final energy consumption[16]. 73% of this demand is road transport[17]. Despite significant energy efficiency improvements in vehicles in recent decades, energy demand for mobility has remained steady due to growth in traffic flow. There are significant opportunities to reduce demand by avoiding unnecessary journeys, utilising ride sharing and car clubs[18]. Shifting away from cars as the dominant mode of transport towards cycling, walking and public transport could be prioritised where possible, and switching to more efficient, smaller electric vehicles could be supported for remaining mobility needs. Research shows that lifestyle change strategies (avoid/shift) can have a larger impact on energy demand and emissions in the short term than the switch to electric vehicles, however a combination of both strategies will be required to reach net zero[19]. A key challenge in this sector will be breaking away from social norms around private car ownership, especially following the negative impact of COVID-19 on the attractiveness of public transportation. However research shows that particularly in younger generations, transport demand is already changing[20], and following the huge impact of the pandemic on travel demand, policies should be designed to lock this in[21].

SHELTER

29% of final energy consumption is used domestically to provide energy services relating to shelter[16]. Over 70% of demand is used for heating, with the rest used for hot water, cooking and appliances. Domestic energy demand declined from 2004-2015 due to energy efficiency improvements including the switch to condensing boilers, but recently is rising again. The UK has an old and highly inefficient housing stock, meaning that there are large opportunities to reduce energy demand through improving the heat retention of buildings. As heat is a difficult sector to decarbonise, retrofitting the UK housing stock with insulation, improved glazing and draught-proofing should be an immediate priority. New buildings can be built to very high standards which require just 10% of current average energy use. There are also substantial efficiency improvements available in lighting and electrical appliances (40-60%)[23]. Modelling indicates that implementing a range of cost effective efficiency measures could reduce household energy demand by 25% by 2035, resulting in £270 average saving per household per year[22]. By 2050, the technical potential for efficiency savings is up to 50%[22]. Policies to deliver these changes should consider how to overcome supply chain barriers, how to reach rented properties and avoid rebound effects from more efficient buildings[24].

GOODS AND SERVICES

Whilst there has been a consistent decline in energy consumption in UK industry since the 1980s, the consequent emissions reductions have been largely offset by a growth in consumption based emissions from imported goods[10]. Furthermore, the majority of available efficiency options in energy intensive industrial processes have already been realised[14]. While there are some efficiency options still available in non-intensive sectors, the biggest potential for energy demand reduction in energy intensive industries lies in reducing demand for materials and products themselves[24]. Strategies to do this can improve

the material productivity of production (through light-weighting products, material substitution, design optimisation) or can reduce consumption levels (through buying less, improving longevity of products, repairing and refurbishing, renting and sharing). At a high level of adoption, research shows that these strategies could reduce emissions by 210 MtCO2e by 2032, with the largest emissions savings from vehicles, construction and clothing (43%, 24% and 23% reductions in sector's embodied emissions respectively)[25].

NUTRITION

The largest potential to reduce energy demand for nutrition comes from dietary shifts away from animal products, particularly ruminant meat, towards a plant based diet. Garvey et al.[26] estimate that demand side changes could reduce emissions from food by 52%, 44% of which comes from a dietary shift towards plant-based diets. Smaller contributions could be made from reducing food waste, and reducing consumption in line with government guidance, however the latter must be balanced with eliminating food poverty.

CHALLENGES/AREAS TO BUILD CONSENSUS

Successfully reducing energy demand requires increasing the rate of energy efficiency improvement and a broader range of changes to social practices and infrastructure. Many of these changes can significantly improve lives: more active travel, healthier diets, warmer homes and less air pollution. However achieving this requires a systematic, coordinated approach. Currently there is a severe lack of targets, policies and initiatives to drive energy demand reduction[24]. A key challenge is designing policy mixes which can systematically realise changes to infrastructure and social practices, rather than the 'nudge' interventions that dominate current thinking[12]. Policy mixes must also be designed in consideration of equity and justice concerns as there is unequal access to energy services in the UK. A final issue to consider is how to minimise rebound effects that may arise from strategies which reduce the cost of energy services. Rebound effects have been shown to occur a) directly, with lower prices allowing for increased energy consumption, b) indirectly, with increased consumption of other energy services, and c) on an economy-wide scale, by stimulating economic growth[27],[28]. If ignored, they have the potential to significantly reduce energy demand savings[29]. However, if these challenges are overcome, energy demand reduction could play a highly important role in rapid reductions to the UK's emissions.

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