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A review of demand-side management policy in the UK

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ABSTRACT

Demand-side management (DSM) refers to actions undertaken on the demand side of energy metres. A broad definition of DSM is proposed to include current policy objectives for emissions reduction, energy security and affordability, and encompasses energy efficiency, demand response, and on-site back-up generation and storage. The paper reviews the concept of DSM, outlines the historical impacts of DSM globally since the energy crises of the 1970s, analyses UK DSM policy, and examines the influence of EU Directives on UK DSM policy, as the country is currently deciding on how to include the demand-side in its *Electricity Market Reform* proposals and wider energy policy. Much of the focus of previous research has been on DSM technological trials and modelling studies rather than DSM policy and the paper contributes to filling this gap. Policy recommendations for the UK context are discussed, and it is clear that the success of DSM policies is determined primarily by regulatory support and utility financial incentives. It is important that policy clarity is provided and that current and new policies do not overlap.

Contents

1. Policy objectives

Environmental and energy security issues are increasingly moving to the forefront of the political agenda, as governments seek to develop energy policies that meet objectives for carbon emissions reduction, energy security and affordability.

Energy production and consumption are widely regarded as key contributors to anthropogenic climate change. The International Energy Agency (IEA) estimates that ~70% of world energy production is produced through the burning of fossil fuels, primarily coal (42%) and gas (21%), and energy accounts for 40% of anthropogenic carbon dioxide and other greenhouse gas emissions (CO_{2e}). The demand for energy is growing as national populations expand, particularly in emerging economies, and the growth of gadgets and technology in society continues [1].

Balancing energy supply and demand has been a complex challenge in many countries, with reserve capacity margins of ~20% commonly used to deal with peak demands [2], such as when people turn their kettles on after a popular television programme or on a particularly cold winter night [3]. However, with flexible generation plants powered by fossil fuels, matching supply with demand has been effectively administrated in most

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countries. Traditionally, energy utilities have invested in expanding their capacity base to deal with long-term increases in energy demand [4]. With growing awareness regarding the contribution of fossil fuel generation to climate change, energy utilities are coming under political pressure to diversify their fuel mixes to lower carbon alternatives.

A growing number of countries are also becoming more dependent on fuel imports, such as coal, oil and gas, than domestic supplies. In some cases the imports are sourced mainly from specific regions, such as Europe's dependence on Russian gas and Middle Eastern oil [5]. Dominance of fossil fuel energy resources has increased the geopolitical power of the exporting regions as energy moves up the political agenda [5]. Hence, growing energy demands, the political drive to move to lower carbon energy sources and the growing dependence on fuel imports, have resulted in policy debates regarding the security of energy supply. Furthermore, these factors often contribute to increasing energy prices, which counters a fundamental principle of energy policy – affordability.

2. Proposed solutions

Proposed solutions to the energy security challenge include building new capacity, increasing interconnections with other countries, developing energy storage technologies, and demand-side management [6]. All of these options will be important in the future [7]. In regions like Europe, political pressure is mounting on energy utilities to invest in new capacity that is low(er) carbon. Nuclear power has been pursued in a number of countries, though following the Fukushima-Daiichi disaster in Japan in March 2011 many governments have started to question their nuclear policies [8]. Furthermore, nuclear power has been used as base load in a number of energy systems, due to its inflexible operational nature for technical and economic reasons [9]. Wind power, one of the more developed and favoured low carbon alternatives, suffers from variable power production due to wind speed variations, causing new challenges in matching supply and demand [4]. Other technologies are currently underdeveloped and at the demonstration stages, such as wave and tidal power, and carbon capture and storage (CCS). Many of these options are currently expensive as they are in the early stages of commercial maturity.

Building new capacity as back-up power is costly as the power plants are only used infrequently during peak times. Alternatively, there is a growing interest in the role that interconnection can play, particularly in the common European market. Interconnection refers to the cross-border transmission of electricity along high voltage power lines between countries, though this requires the right infrastructure and regulatory transaction processes to be in place ([10], p. 5). For example, the UK currently has interconnections with France, Ireland and the Netherlands with a combined capacity of ~3.5 gigawatts (GW), and is considering plans to build interconnectors with Norway, Belgium and Iceland [165]. Nevertheless, unless interconnections are more far reaching geographically, they may make little difference to countries experiencing the same weather patterns if wind is pursued as a major power source [11].

Energy storage is likely to play an important role in the future but storage technologies are currently at the research and testing stages. Pumped hydro is one of the only commercially developed and widely used technologies, but it has geographical limitations in the extent of its development [12]. Furthermore, the geographically distributed nature of variable renewable sources may prevent certain energy storage systems from being practicably installed [13]. Other storage options include flywheels, compressed air energy storage, electric vehicle batteries, and large thermal storage tanks [14].

Many of the proposed solutions to meeting the policy objectives come from the traditional approach of matching supply with demand. Demand-side management (DSM) aims to reverse this thinking by looking at how to match demand with the available supply. DSM complements the other solutions and actively engages consumers in a market that has historically been 'invisible' to them ([15], p. 3). Overcoming climate change and energy security issues involves significant changes in behaviour in addition to cleaner technologies [16].

This paper reviews the concept of DSM (Section 3), outlines the historical impacts of DSM globally since the energy crises of the 1970s (Section 4), analyses UK DSM policy (Section 5), and examines the influence of EU Directives on UK DSM policy (Section 6). The UK is currently deciding on how to include the demand-side in its *Electricity Market Reform* proposals and wider energy policy, and the final section of the paper provides policy recommendations to feed into this process (Section 7).

Much of the focus of previous research has been on trials of DSM technologies and studies that model the potential of DSM to meet certain objectives. However, much less attention has been given to reviewing DSM policies, which have been implemented by governments over national or regional scales. The paper aims to contribute to filling this gap. Work-in-progress is undertaking a Systematic Review of international experiences with DSM policies to determine how and why they work or fail and how transferable successful policies are between countries. This paper presents the results of an extensive two-year long review of over 200 publications and focuses primarily on an analysis of the UK context.

3. Demand-side management: contested definitions

The term 'demand-side management' (DSM) was first coined by Clark Gellings (Electric Power Research Institute, USA) in 1984 [17], which was historically known as load management:

> "DSM activities are those which involve actions on the demand (i.e. customer) side of the electric metre, either directly or indirectly stimulated by the utility. These activities include those commonly called load management, strategic conservation, electrification, strategic growth or deliberately increased market share [18].

In the past, DSM programmes have often concentrated more on the management of electricity demand rather than on (non-electric-based) heating and transport, though DSM can encompass non-electric energy measures, such as co-generation (the production of both heat and power), district heating/cooling and heat micro-generation technologies (such as solar thermal panels). The review found that the definitions of DSM vary in what they include or exclude. Some publications include the management of electricity demand but not other forms of energy demand (e.g. [19]), others use the definition synonymously with that of the smart(er) grid (e.g. [20]), some refer to DSM as measures that reduce energy demand at peak times (e.g. [21,22]), while others use a similar definition but also include the response of consumers to price changes and the shifting of load to off-peak times (e.g. [23]). Micro-generation is included in some definitions (e.g. [24]), and some include or exclude energy efficiency measures (e.g. [25]).

DSM aims to better match demand with the available supply as a cheaper alternative for energy utilities than investing in new generation capacity. Gellings and Chamberlin [18] argue that DSM tries to encourage utilities to put demand-side measures on an equal level with supply-side options (pp. 3–4). It also aims to actively engage consumers in the management of their energy use