Conditions of behavioural changes towards efficient energy use – a comparative study between Sweden and the United Kingdom

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Abstract

The main objective of this study is to compare how specific conditions in certain countries (in this case, the UK and Sweden) can stimulate or attempt to compel householders to be more energy efficient, or can obstruct this. Each country is deploying different policies in differing contexts in the attempt to reduce carbon emissions. European goals for energy and emission reductions now constitute the main frame for long-term energy policy changes, but national governments develop and implement policy in contrasting ways. Important aspects are: geographical context, degree of liberalisation of electricity and gas industry, energy systems, metering infrastructure, and the nature of electrical load problems.

The following conditions are described and compared in this paper: (1) electricity and gas use; (2) role of utilities and other 'external' agents in residential demand reduction; (3) regulations; (4) quality of feedback on energy use to the householder; (5) customer behaviour.

The comparison shows the significance of factors that are sometimes overlooked when considering the potential for demand reduction and load management, and produces some lessons and questions that are widely applicable.

Introduction

Europeans are gradually becoming familiar with the '20/20' policy goals for a reduction of at least 20% in greenhouse gases (GHG) by 2020, along with a 20% increase in the share of renewables in the delivered energy mix (CEC, 2008). In this paper, we concentrate on the GHG reduction goal as it applies to residential buildings, assuming that households are expected to contribute substantial reductions in delivered energy, in addition to adoption of lower-carbon energy supply.

Patterns of energy use are associated with many variables such as climate/weather, social norms, income, market conditions, dominant technologies and infrastructure. Therefore the process of working towards these goals will vary considerably between member states of the EU. In this paper, we take just two member states, Sweden and the UK, and examine how specific conditions can encourage householders to lower the environmental impact of their energy consumption – or obstruct them. The paper attempts to look at the whole energy system in each country, in order to identify the most significant elements for change and to contribute towards a framework for comparison of energy and climate policies across the EU.

CLIMATE CHANGE POLICY AND TARGETS

Over the past 20 years, the UK has taken a lead internationally in setting ambitious climate targets. The government is committed to reduce GHG emissions by 12.5% by 2008-2012 (relative to 1990), under the Kyoto agreement. It looks as though this target will be met, but this is largely because of reduced emissions from power stations between 1990 and 2007, when coal was replaced by natural gas. Changes at household level have been far less significant.

UK climate policy is now governed by the even more ambitious 2008 Climate Change Act, under which 'It is the duty of the Secretary of State to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990

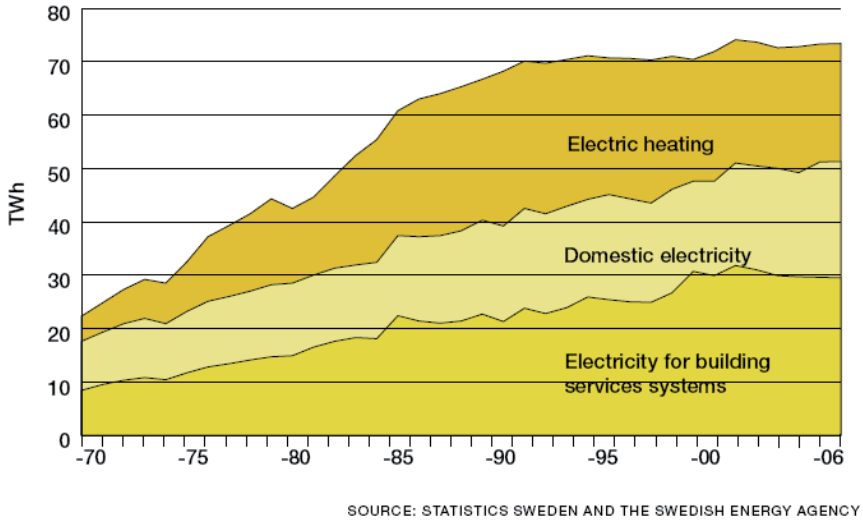


Figure 1. Electricity use in the residential and service sector in Sweden, 1970-2006, weather corrected (Swedish Energy Agency, 2008).

baseline'. Carbon budgets are to be set by an expert committee for five-year periods, and the budget for the period including the year 2020 must be such that 'the annual equivalent of the carbon budget for the period is at least 26% lower than the 1990 baseline' (UK Government, 2008, pp.1, 3). The Act states that carbon budgets should be set with regard to scientific knowledge, technology relevant to climate change, economic, fiscal and social circumstances, and 'circumstances at European and international level'. They are also required to take into account reportable emissions from international aviation and shipping. The Act represents a serious attempt to legislate for radical cuts in emissions, while leaving the government with escape routes from policies that it may see as unpopular or unachievable.

There is evidence from surveys that the public see the government as having a major role to play in mitigating climate change (e.g. CoI, 2007), so clear, consistent and credible policies are going to be important in terms of peoples' acceptance of the need to make changes. As supply, buildings and appliances become more efficient, additional emissions reductions will rely increasingly on user behaviour and on adoption of low-carbon technologies.

In Sweden, the Parliament decided in June 2006, according to a suggestion from the Government, that energy use in residential and tertiary sectors should be lowered by 20% per heated space unit, until year 2020 (Swedish Parliament, 2006). By year 2050, the energy use in these sectors should be halved (compared to today's level). By 2020, the dependence on fossil fuels for energy supply in dwellings should be broken, and ways of measuring and achieving this are being debated at present. According to the Kyoto Protocol, Sweden has a commitment not to increase its emissions by more than 4% (within the EU agreement) but has decided voluntarily to reduce its emissions by 8%. In the directive for renewable energy published by European Commission Sweden's target of renewable fuels amounts to 49% by 2020. The proportion of renewable energy used in Sweden has in fact increased from 33.9% in 1990 to 43.3% in 2006, mostly thanks to electricity generation in large scale hydro power plants (Swedish Energy Agency, 2008).

The Swedish Government doesn't intend to take any decisions about decommissioning of nuclear power stations during its present mandate period (2006-2010). Moreover, there is even a very new agreement between the government Alliance parties on replacement of existing 10 reactors in the future. New long term forecasts from the Swedish Energy Agency show that Sweden can export about 25 TWh electricity in year 2030, which means lower GHG emissions in the importing countries. The question is what impact those decisions will have on public perception of the need for demand reduction and on changing of energy behaviour patterns.

In summary, the two countries have comparable goals for energy use by 2020, (provided that the number of heated units does not rise substantially in Sweden). But both countries have a long way to go in order to demonstrate *how* they are going to reach goals and to come to terms with necessary changes. The public see government as having a major role to play in climate change mitigation, so clear leadership and credible 'maps' of how to achieve change are going to be important over the next few years.

Electricity and gas use

STRUCTURE OF CONSUMPTION IN HOUSEHOLDS

The differences in structure of consumption reflect differences in fuel mix, climate/weather and building standards. They are also affected by differences in lifestyle, such as household size and occupancy, appliance ownership and day-to-day usage patterns.

The residential sector in Sweden accounts for 32% of total final energy use, amounting in 2008 to 124 TWh. Electricity is a dominating energy carrier in this sector - about 73 TWh per year. Almost 60% of this energy is used for space heating and domestic hot water production (see Figure 1). The average annual domestic electricity use amounts to about 6,200 kWh per household in detached houses, and to about 40 kWh per m^2 and year in flats (Swedish Energy Agency, 2007).

The total statistically corrected energy use in this sector remained relatively stable in Sweden between 1970 and 2000, after which it has started to show a decline, mostly for space heating and domestic hot water supply. This decline was caused by different distribution and conversion losses at the point of use for fuels and other energy carriers as district heating or electricity. Another contributing reason for this reduction in energy use could be the increasing number of heat pumps. Other factors reducing energy use in residential buildings are various energy conservation measures (for example additional thermal insulation or upgrading windows in older buildings).

In the UK, the residential sector also accounts for roughly a third of delivered energy, but the distribution of end-uses is different. Approximately 60% is used for space heating alone (this figure reflects the low energy efficiency of UK homes, in a milder climate), with a further 25% for water heating (Utley and Shorrock, 2008). Each household consumes approximately 20 MWh of delivered energy per year, compared with roughly 21 MWh for each Swedish household. UK consumption per household is however finally beginning to fall, as shown in Figure 2, with an accompanying decline in overall emissions – a 5% fall in the domestic sector between 2006 and 2007 (DEFRA, 2008; BERR, 2008a). A rise of 140% in gas bills over the years 2003-8 and 93% in electricity bills will have been a major factor (Consumer Focus, 2008). The cost of fuel is a far more significant factor in the size of bills in the UK than in Sweden.

Sweden uses a relatively small quantity of energy gases when compared with many other European countries; the distribution network for natural gas in Sweden is being extended. Natural gas is at present distributed to about 30 municipalities meeting about 20% of their energy demand. On the national level, gas supplies cover almost 2% of total energy demand. About 0.4 TWh of natural gas was used for space heating and domestic hot water production in detached houses 2007 and the same amount was used for this purpose in apartment buildings (Swedish Energy Agency, 2008).

By contrast, around 70% of delivered energy to housing in the UK is natural gas; 22% is electricity. Domestic gas consumption in 2006 was approximately 400 TWh – five hundred times higher than in Sweden (BERR, 2008b). In 2006, 91% of homes had central heating. 87% of this was gas-fuelled and 6% electric, with just over half the electric central heating using cheap night-time electricity to charge 'storage heaters' which release the heat gradually in the course of the day (Utley and Shorrock 2008, Tables 32 and 21). These differences are reflected in the daily and seasonal load curves for each country. There are still concerns about increased installation of electrical heating in new buildings, particularly in social housing and high-rise dwellings, because of the relatively high emissions (see Figure 3). However, the main single area of growth in electricity demand is consumer electronics – an area where product policy can make a substantial difference but where householders also need to be aware of how their consumption is 'invisibly' rising (EST, 2007).

There is still some limited scope for reducing the number of homes heated by coal and oil in the UK; beyond that, the prospects for lowering emissions lie with demand reduction, decarbonising the electricity supply, and using gas more strategically. There is very little district heating, although there is plenty of scope in high-density urban areas. This is a legacy of bad experiences with district heating programmes in the 1960s; and partly due to an individualistic approach to home ownership (70% of householders own their homes and only 20% live in social housing).

The low energy efficiency of the housing stock, along with the lack of district heating, emerges as specific problems for the UK. There is a lot to be achieved through retrofitting of homes. Major changes are needed in the scale of district heating (urban areas) and micro-CHP or heat pumps (for suburbs and rural areas). The high carbon content of UK electricity, even after the 'dash to gas' in the 1990s, increases the urgency of investing in more renewable sources. Only 4% comes from 'new' renewables (see Figure 3). While Sweden is much less reliant on gas for heating than the UK, it needs to control electricity demand and maintain low-carbon supply. In both countries, the rise in use of consumer electronics poses a major challenge.

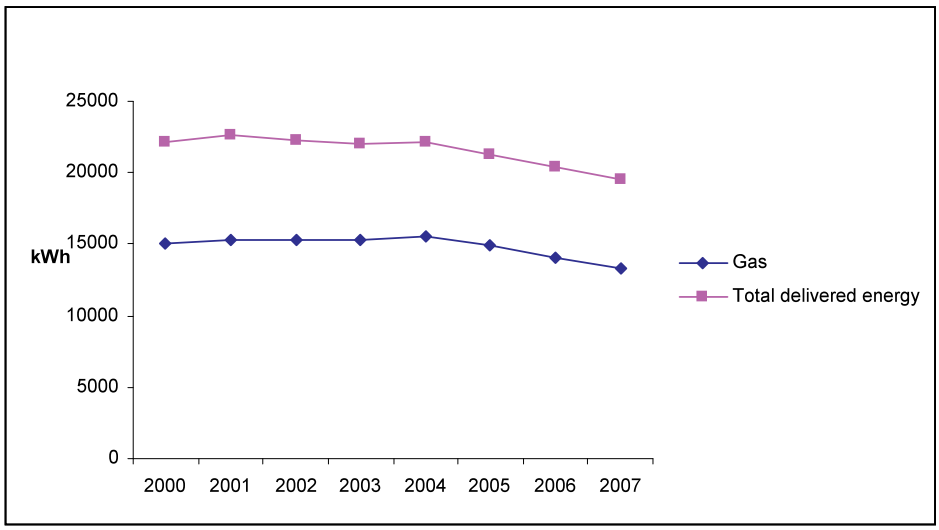
GRID INFRASTRUCTURE AND OPERATION

The UK electricity grid is largely self-contained, with a 2 GW interconnector to France and a smaller one to Ireland. The highest load has been 62 GW (BERR, 2008b). Ageing nuclear and coal plants mean an uncertain future for electricity supply; but replacing either is very controversial. The UK has recently become a net importer of gas, with gas interconnectors with the Netherlands and Norway. Government is keen to avoid over-reliance on imports, but there is little storage capacity, and little incentive for suppliers to invest in it. Reducing demand for both electricity and gas is becoming increasingly important for reasons of security as well as climate.

In Sweden, the energy market is liberalised since 1996. Total electricity production capacity amounts to about 32 GW of which 2 GW are secured by contracts with the industry. The highest load demand ever was 27 GW (Nordel, 2008). Electricity transfers between northern and southern parts of Sweden, mostly during very cold winters, can be uncertain because of the bottlenecks in the grid connections. Two nuclear reactors (Barsebäck 1 and 2) were definitely stopped but upgrading of the remaining ten plants means higher electricity production capacity in nuclear plants than ever before. Sweden has also AC power lines to Denmark, Poland, Germany and Finland; discussions on a new commission in Lithuania are in progress. The current plans for wind power production include requirements on local authorities to create opportunities for 10 TWh of wind power production by year 2015.

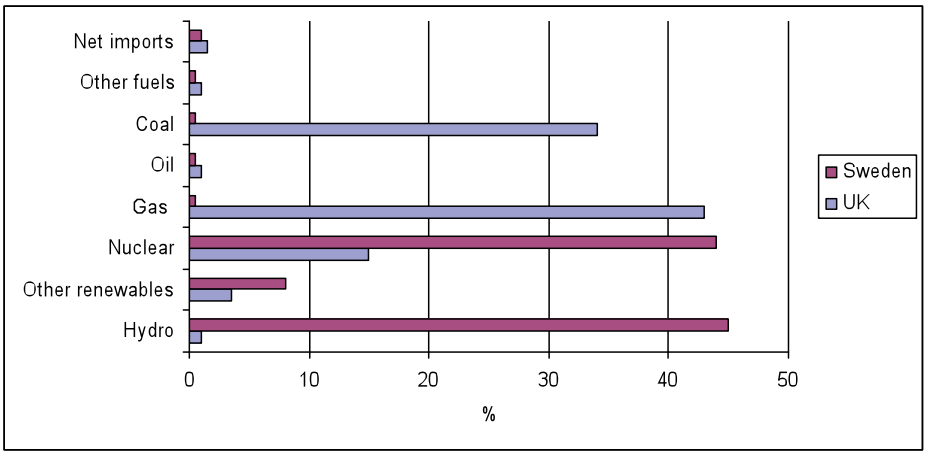
The UK energy market is fully liberalised and 'unbundled'. Suppliers do not own the pipes and wires through which their product is delivered; instead, they coordinate the transmission, distribution, metering and retail functions. As a result, infrastructure changes such as 'smart' metering and adaptation of the networks to accommodate distributed generation can only be introduced after legally complex changes in the market structure. By contrast, in Sweden the strong link between suppliers and distribution networks means that it has proved relatively easy to roll out automated meter reading in preparation for frequent, accurate billing from June 2009. These differences will affect the information on energy reaching customers and their relationship with suppliers.

Major changes have occurred in the electricity markets in the Nordic countries, moving away from national or regional



(Note: these figures are not weather-corrected. However, weather-corrected primary energy consumption for the country fell in a similar pattern over the years 2004–2007.)
Sources: http://stats.berr.gov.uk/energystats/dukes08_longterm.pdf
http://data.ukedc.rl.ac.uk/browse/edc/UKStatistics/doc/MTP_BNXS25_20070116_Population.pdf

Figure 2. Delivered energy per household in the UK, 2000 - 2007



Source: http://stats.berr.gov.uk/energystats/dukes08_c5.pdf, Chart 5.3 and Nordel, 2007

Figure 3. Generating mix of electricity supplied, 2007

monopolies to international markets. Today, electricity users can easily choose their electricity suppliers. All the Nordic countries, except Iceland, can trade on the Nordic electricity exchange, Nord Pool. The price of electricity within this area is determined mostly by hydro power in Sweden and Norway, nuclear power in Sweden and Finland, price levels of fuels and governmental policy and incentives. Increase of the consumer electricity price in recent years was due to increases in energy taxation rather than in generation costs (Swedish Energy Agency, 2008).

ELECTRICITY PRICING (TARIFFS)

Six suppliers account for over 90% of residential sales of gas and electricity in the UK. There is a large, confusing number of possible variable- and fixed-rate tariffs, which makes it difficult to choose between suppliers. 'Social tariffs' are available for those receiving certain state benefits, but many low-income customers in Great Britain (not Northern Ireland) pay higher-than-average unit rates, because they use prepayment meters and are charged more for these. Roughly 14% of electricity customers have a prepayment meter, and 11% of gas customers (Owen and Ward, 2007). Interestingly, the introduction of semi-smart prepayment meters in Northern Ireland for electricity, at no extra cost, has led to an increase in prepayment customers, to over 25% (Boyd, 2007).

When customers do switch suppliers – and the UK has the highest rate of switching in the EU - they almost always do so for reasons of price. Tariffs normally include a standing charge and are then either fixed-rate per unit of consumption, or declining block tariffs: there is normally no incentive to conserve by staying below a 'threshold' consumption level (Baker and White, 2008). New tariffs are beginning to give customers some

Table 1. Composition of average residential electricity bills, 2008/9, UK. Source: HoC, 2008.

Fuel, supply costs and profit margin	69%
Distribution	15
Transmission	3
Value-added tax	5
Cost of Renewables Obligation and CERT	7
Meter provision	1

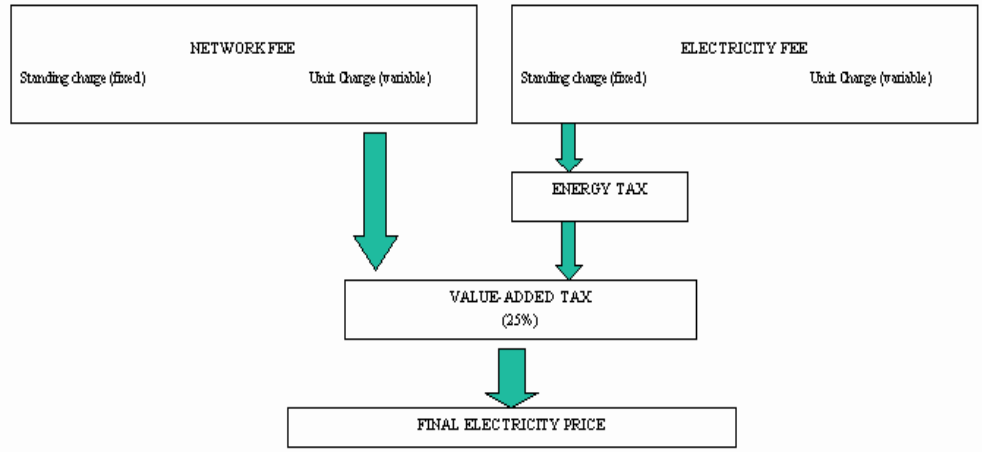


Figure 4. Residential electricity price structure, Sweden (Pyrko, 2006).

incentive to reduce their usage[1] but, given the lack of price regulation, it is not in a utility's interest to reduce volume sales for all its customers. The 'coordinator' role played by the supplier allows for relatively simple bills: customers are normally charged one or two figures for their consumption (for example, 250 units at 13 p/unit plus 114 units at 8 p), to which is added value-added tax at 5%. Network and 'environment' charges are incorporated in the basic charge per unit, as shown in Table 1[2], but this is rarely explained within the bill.

In Sweden, four electric companies are dominating on the market: Vattenfall, Fortum, E.On and Göteborg Energi. The total electricity price charged to the Swedish customers consists today typically of three parts: electricity fee, network fee and taxes.

The only part of the electricity bill that the customers themselves are able to influence is the electricity fee. All customers have the opportunity to switch their electricity supplier or renegotiate their existing contract, and, in this way, get a lower price.

The second part of the total electricity price, the network fee, is paid to the network owner in the area. The network owner provides the physical transmission of electricity from the generation plants to the end-user. Customers cannot choose their network provider so the network fee must be reasonable and non-discriminatory. Network tariffs are supervised and published by the Swedish Energy Agency.

The third part of the electricity charge is taxes. In Sweden, like in all the other Nordic countries, the consumption of electricity is taxed. Swedish customers have to pay two different types of taxes, an energy tax and a value added tax (VAT). The energy tax for domestic customers depends on the region. Industries pay no taxes at all at user level. The VAT is applied to the total price of electricity, including the energy tax.

About 40% of the total electricity price to a domestic customer is the price of electrical energy, 20% is the share of the network tariff and taxes account for 40% (Pyrko, 2006). Domestic users pay different rates of electricity tax, depending on where they live (in the north or the rest of the country). In addition to the various spot taxes on energy, there is value-added tax of 25%. The standing charge of the grid fee depends on fuse level, starting from 10A or 16A for flats, typically 20A or 25A for villas. In the UK, most homes effectively have a load capacity of 21 kW and there is no option for changing this – and no differential pricing according to fuse level.

In summary, the energy market is oligopolistic in both countries, with confusing tariffs for customers and a lack of price regulation so that there is little or no incentive for suppliers to move from volume sales to energy services. The higher standing charge paid by customers who move to a higher fuse level acts as some incentive to keep consumption from rising in Sweden. At the same time it can also reduce willingness to save kWh if only a limited part of the cost can be influenced by the customers.

In the UK, many tariffs are arranged so that the marginal cost of consumption falls as consumption rises, but the cost of fuel forms a higher proportion of the final cost to the consumer than in Sweden, so a reduction in kWh consumed will make

1. e.g. SSE 'Better Plan' and EdF Energy 'Read, Reduce, Reward'

2. The renewables obligation requires electricity suppliers to source an increasing percentage of their electricity from renewable sources. The current level is 9.1% for 2008/09, rising to 15.4% by 2015/16.

a more substantial difference to the final payment. The Swedish bill is more transparent about components of cost, but also more confusing to the customer. The price of electrical energy forms a lower proportion of the cost to the consumer than in the UK, where the tax is lower.

Role of utilities and other 'external' agents in residential demand reduction

The main single policy instrument for residential energy efficiency in the UK is the Carbon Emissions Reduction Target (CERT)[3]. This makes the energy suppliers into major agents of government climate policy. They spend a fixed amount per customer on efficiency measures or renewable technologies each year, which are accredited with carbon savings, and accounted towards the supplier's annual target. The measures can be installed in buildings anywhere – not just in the homes of their customers – but the suppliers are required to spend at least 40% of the money on 'priority' (disadvantaged) customers (EST, 2008). They are allowed a limited amount of experimentation with new measures and programmes. CERT and its precursors are widely cited as successful, in that they have led to the deployment of thousands of efficiency measures. Plans are being drawn up for a more ambitious Supplier Obligation, under which suppliers will operate under carbon caps and measurement of consumption (not estimation) will become central to evaluation.

In both countries, the question is raised of how much suppliers can be responsible for the behaviour of their customers, especially if they do not have a long-term contract with them. They are required by government to compete over lower energy prices (implicitly encouraging consumption), while at the same time encouraging conservation and promoting social equity.

No fee or tax paid by the Swedish customers is destined for energy efficiency measures. However, the customers buying electricity have to pay fees for "green" certificates intended to be invested in renewable electricity production. The utilities offer also different services helping customers to either save energy, to make their installations more efficient or to switch fuels used for space heating purposes.

Other agents in demand reduction (apart from individuals) are local authorities, the construction industry, the education and business sectors, and non-governmental organizations. There is scope for more recognition of the potential of these agents in reducing demand, because they tend to be closer to the public and/or may be trusted more than the utilities, or central government (Parag and Darby, 2008).

Regulations

LEGISLATION TO CONTROL RESIDENTIAL CONSUMPTION AND EMISSIONS

EU legislation on energy and climate is common to both countries (for example, minimum standards for appliances, Energy Performance Certificates for housing). However, there are differences in the extent of compliance/implementation of EC rules; there is also the effect of national and local standards and regulations.

In Sweden, the electricity certificate system was introduced in 2003 with the objective to increase the amount of renewable sources in electricity production by 17 TWh between year 2002 and 2016.

Another administrative policy measure is the Act concerning Energy Declarations for Buildings, based on an EU Directive. Owners of detached houses, apartment buildings and commercial premises are obliged to provide information on the energy demand of the building and other significant parameters of the indoor environment, in an energy declaration. The purpose is to promote efficient energy use and good indoor comfort in buildings. The energy declarations process should be fully implemented at the end of 2008 (Swedish Energy Agency, 2007). There are comparable provisions for Energy Performance Certificates on buildings in the UK.

SUBSIDIES/ALLOWANCES TO IMPROVE EFFICIENCY

Fuel poverty in the UK – that is the condition of needing to spend more than 10% of household income in order to be warm in winter – means that millions of homes need investment to bring them up to an acceptable standard, given the long history of poorly-insulated dwellings. The government funds efficiency improvements for elderly and vulnerable households through the Warm Front, Warm Deal and Warm Homes programmes. There is also the more recent Low Carbon Buildings Programme (LCBP), which gives grants towards the cost of renewable / microgeneration technologies. The Energy Saving Trust manages a network of energy advice centres. which concentrate on getting wealthier homeowners to invest in their properties; various agencies offer additional advice and support to homeowners and tenants, funded by local authorities, energy suppliers and a range of other organisations. There is a continuing shortage of face-to-face advice in the home, with follow up, which is more effective but more expensive than the norm.

Experience to date shows that more could be achieved if the Warm Front-type programmes were more flexible in the measure they funded, and if their assistance were to be targeted more on the worst housing; a promising development is the 'Warm Zones' programme, in which whole areas are tackled at once. The LCBP has suffered from inadequate and interrupted funding, making it difficult for the fledgling renewables industry to develop (Boardman, 2007).

A lot of work on energy efficiency in residential buildings was carried out in Sweden since late 1970s. Special renovation grants called "ROT" have been available for the building owners. A particular conversion grant, available until 2010, was introduced in Sweden at the beginning of 2006 in order to reduce the use of oil and electricity for heating purposes in residential buildings and certain commercial premises. It is available for conversions to district heating, biofuel-fired heating systems, heat pumps or solar heating. However, grants for conversion away from oil were withdrawn from the beginning of 2007, because all funding had been used up. Until the end of 2008, owners of public premises can apply for grants for conversion and energy efficiency improvement measures. Grants for installation of solar cells for use by public premises have also been available from 2005, and remained available until 2008. The previous tax reduction concession for the installation of biofuel

3. Previously known as the Energy Efficiency Commitment.

Contents Keywords Authors

fired heating systems and higher-performance windows in new detached houses have been replaced by a corresponding grant (Swedish Energy Agency, 2007).

In general, grants are now more geared towards efficiency improvements in the UK and to improving the lot of the 'fuel poor', while in Sweden, after a period of constant improvement of energy efficiency in the building stock and fuel switching from oil to electricity, there is now a trend towards converting heating systems from electricity to other energy sources (district heating, biofuels and heat pumps).

Quality of feedback on energy use to the householder

Article 13 of the EU-ESD of 2005 obliges governments to improve the state of feedback via metering and billing, but member states vary in the extent to which they are implementing this.

The normal state of residential energy feedback in the UK is poor, and so is the state of householders' knowledge about their consumption (Logica, 2006). Estimated bills are still common, and direct debit (with the customer paying the same sum every month, regardless of actual consumption) is the single most common payment method (approximately half of all customers). Prepayment customers have relatively good feedback, but most of these have limited ability to make reductions.

The government has begun to prepare the ground for a rollout of smart meters to all households, and define 'smart meter' as including some form of customer display. This rollout is unlikely to be complete until 2019, due to the scale of operation and the difficulties posed by a highly-liberalised market. In the meantime, there is debate over the best ways of improving feedback without smart metering, through displays and improved billing. Real-time electricity clip-on consumption displays have become quite popular among householders, but market penetration is still fairly low. The UK Demand Reduction trials of different types of feedback, with and without smart metering, are under way in over 40,000 households. These trials are carried out by four of the major suppliers, but suppliers are also carrying out their own trials. Full UKDR results will not be available until 2011, and data from most other trials is confidential, so there is something of an information vacuum at present. In the meantime, some smaller, niche suppliers are offering smart metering with feedback to commercial and industrial customers, and this is just starting to happen for residential customers as well (e.g. first:utility).

In Sweden, monthly readings for electricity bills are compulsory starting from June 2009. Millions of smart meters are at present installed in all residential buildings and the bills have to be based on monthly readings for all the customers. Some of the utilities are carrying out pilot trials with energy use feedback on the Internet or domestic displays: as in Italy, the definition of a smart meter does not necessarily include a customer display. Many trials and studies have been carried out on different ways of feedback to the customers: for example through bills (Hallin et al, 2007), information panels (Bartusch, 2007) and energy use statistics (Ersson and Pyrko, 2009).

Energy user behaviour

ATTITUDES TOWARDS ENERGY CONSERVATION

While there is increasing talk of energy conservation in the UK, practice lags some way behind. A report for the Sustainable Development Commission commented on how 'energy and power are not terms within the natural language of mainstream householders. Gas and electricity operate at the level of the subconscious within the home... Whilst there does seem to be some latent cultural guilt about the notion of waste... there appeared to be virtually no sense of being able to … significantly reduce energy consumption in the household…' (Dobbyn and Thomas 2005, p.6). There is evidence that average temperatures in homes have risen by around 6°C since 1970, often from a low base but sometimes to well over 21°C (Shorrock and Utley, 2003), and it is not usually thought abnormal to leave lights, heating and appliances switched on when they are not in use. Changing user behaviour is increasingly recognised as essential in order to bring emissions down, and the mantra of 'encourage, enable, engage, exemplify' has been adopted by government and some NGOs: they aim to put structures and programmes in place to get people acting (SCR 2006). Policymakers are recognising that attitudes may follow behaviour change rather than preceding them: hence the emphasis on action.

Energy displays and smart metering are seen as a way of engaging people with their consumption and promoting behavioural change, but displays are adopted on a voluntary basis only in both countries, while trials of different types of feedback continue.

There is some sense that Sweden's good and unlimited energy supply is treated as a "citizen right". In both countries, a lot of people just don't care about energy efficiency but there is a strong difference between generations: seniors are more aware and/or more frugal (Carlsson-Kanyama & Lindén, 2002), and between conditions of house ownership: owners are usually more aware than tenants (Pyrko et al, 2002); and they have more options open to them when it comes to acting to improve their environmental impact (Walker and Cass, 2007).

RESPONSE TO PRICE SIGNALS IN RELATION TO DEMAND RESPONSE

Sharp rises in gas and electricity prices have had some effect on overall consumption in the UK, as discussed above. But 'demand response' for better electricity load management is not yet a widely-used concept, partly because supply margins have been generous until recently. Most customers are only familiar with one type of time-of-use pricing: the 'Economy 7' tariff for cheap-rate electricity that is available over night, mostly used by those with electric storage heating. A three-rate time-of-day tariff is available in Northern Ireland, and has led to some reductions in peak demand (Boyd, 2008).

In Sweden, only one electric utility – Sollentuna Energy in Stockholm area – has a special kind of tariff with load demand fee. This solution probably could lower load demand with about 5%. However, in a survey carried out in 2006 more than 70% of the customers wanted to have their old "flat" tariff back! (Pyrko, 2005).

Some studies performed in Sweden 2005-2008 (Lindskoug, 2006) with critical peak pricing have shown that the customers

are willing to lower their load demand with about 50% during some hours if the electricity price was 3 times higher than normally. The Swedish experience with demand response is something for UK to learn from for the future, especially with its increasingly tight supply margins, and with more renewable electricity coming on-stream.

RELATIONS BETWEEN GOVERNMENT AND HOUSEHOLDERS: MUTUAL EXPECTATIONS

Most householders in the UK want government to give a lead on climate change (CoI, 2007) but do not necessarily like it when the government acts, especially when price increases are involved – for example, the protests over transport fuel price rises in 2000. Government has arguably spent too much time and effort 'individualising' the issue of energy conservation emphasising personal responsibility and small incremental steps (Hinchliffe, 1996), rather than spending more time on a more strategic approach, e.g. stronger market transformation/product policy, better training and regulation for the construction industry, better enforcement of building regulations, and improved feedback to end-users. Citizens, not very trusting of either government or business (Christie and Jarvis, 2001), may be willing to act independently of central government, on their own or as part of voluntary organisations or local initiatives. They recognise that moving to a low-carbon society is more than just a matter of individual responsibility.

Generally speaking, citizens in Sweden expect always that "someone does something". "This is an issue for politicians" is another expression very often heard in Sweden. Decisions should be made for the society's best. Then people should be informed about the "right" and "rational" way to be effectively involved in the process. This means that the society, in overall view, trusts or at least follows, the decisions taken by the government. (Daun, 1989).

RELATIONS BETWEEN CUSTOMERS AND UTILITIES

In the UK, the relations between customers and utilities tend to be poor (e.g. SDC, 2008; Devine Wright and Devine Wright, 2005). There is little loyalty to suppliers, and decisions to switch are made almost entirely on grounds of price (Boardman and Palmer, 2003). Although long-term contracts are now possible, they are unusual. It is normal to be able to switch suppliers within 28 days of signing up, so suppliers are unwilling to invest in the energy efficiency of their customers, on an 'energy services' model. As utilities have to expend a lot of time and money on recruiting customers, they would very much like to cultivate long-term customers. They see improved feedback as a service that they can use to encourage loyalty, and smart meters as a potential gateway into the home, that can allow them to sell other services, eg telecoms, security, home automation.

In spite of these drawbacks, government policy is strongly, and increasingly, geared towards using energy suppliers as agents for demand reduction, as they have been the agents for getting efficiency measures into homes through the EEC and now the CERT. There is a fundamental difficulty here, in that supplier profits are not decoupled from volume sales. Suppliers do of course have a relationship with each household, making them an obvious choice as agents for some government climate policy, but until they have an incentive to reduce the number of kWh they sell, it is hard to see why they should be the primary agents.

In Sweden, the relations are sometimes very poor between some bigger companies and their customers. Installation of smart meters has caused some conflicts in the initial stage. Local companies possess much more loyalty; the customers care about "their" company (Pyrko, 2005). New ideas are also developed to strengthen feedback and improve company's image and relations with customers. There is an expectation from the Swedish politicians that the energy utilities will take their "environmental and climate responsibility" and will act as principal agents in improving energy efficiency and encourage energy savings (SOU, 2008).

Discussion and conclusions

Both countries have comparable goals for energy use reduction by 2020. Many measures are needed to achieve these goals, and our analysis suggests that some of these will need to differ, in line with differences in the national context.

A comparison shows that Sweden is less dependent on gas and coal for heating than the UK but very reliant on electricity for this purpose. Sweden is also more linked into other markets than the UK. Sweden is part of the larger Nordpool, which is in turn joined up with a huge European grid; and it produces low-carbon electricity that will become increasingly valuable as emissions' trading becomes more important. The energy market is oligopolistic in both countries, with confusing tariffs and very low incentives for suppliers and/or customers to develop or demand energy services. Even if the Swedish bill is more transparent about costs, it is also more confusing to the customer. The price of electrical energy is lower in proportion to the total cost than in the UK, where the tax is much lower.

There are several substantial differences in terms of the conditions for behavioural change in relation to residential energy use. The UK still has to do a great deal to catch up with the quality of building in comparison to Sweden, and this is inevitably a slow process involving many actors and a great deal of education and training. The low-carbon electricity supply clearly affects Swedish climate policy and may lead to some complacency about the need to reduce demand. In the UK, where electricity is relatively carbon-intensive and where gas increasingly has to be imported, energy security concerns and price rises are having an impact on policy, and on public perceptions of the need to reduce consumption and diversify supply.

Ownership and operation of the utility networks have affected progress in metering and billing. It has been impossible to implement smart metering in the UK as yet, because of the fragmented nature of the supply industry (although the decision to install smart gas and electricity meters was made in 2008). Large-scale trials of different modes of feedback are under way in the UK. In Sweden, there is a full-scale smart meter rollout and obligatory monthly readings should start in June 2009. There has not been much progress yet in terms of improved energy feedback on the bills or domestic displays in Sweden, although there are some large-scale trials of web-based feedback.

Government support for efficiency measures, renewable energy sources, advice and advice programmes is undertaken in

Table 2. Summary

	Sweden	UK
Climate change policy and targets	Comparable goals to the UK. Renewable target 49% in 2020	Leading position within the EU
Electricity and gas use	High reliance on (low-carbon) electricity	High reliance on gas; electricity is high-carbon
Building infrastructure	Highly efficient buildings	High heat demand per household
Grid infrastructure and operation	Nordpool and wider European grid. Bottlenecks north-south	Grid is almost self-contained
Supplier-network relations	Strong link between suppliers and networks	Unbundled supply industry; suppliers separated from networks
Role of utilities and other external agents	Expectation to take 'environmental and climate' responsibility. Goodwill and image	Utilities are principal agents in moving towards residential energy efficiency targets
Pricing	Increases mainly due to taxation	Increases mainly due to fuel costs
Regulation	Subsidies for switching from electricity	Grants for energy efficiency
Quality of feedback	Improved bills Monthly readings starting from 2009 Development of new statistics services Trials on feedback	Poor feedback (e.g. about 1/3 of bills are estimated), but improving. Bills now contain a comparison with the same period of previous year. Smart meters to be introduced by 2020. Trials on feedback
Customer behaviour and perceptions	Think their electricity is already 'clean'; trust government	Think their energy is mostly 'dirty'; less trust of government

both countries, with a mixed record. A major policy question is however: how much should utilities be the agents of government policy on emissions reduction and energy efficiency? If utilities do not have incentives to lower consumption, how effective can they be? How much should other agencies and actors be involved, eg local government?

Utilities in both countries are trying to cultivate customer loyalty – and see improved feedback as a way to do this – but they have a difficult task ahead.

Swedish citizens are more trusting of their government, they often expect that "someone does something" and that the decisions are made for the society's best (Daun, 1989). UK citizens, not very trusting of either government or business, may be more willing to act independently of central government. However, they recognise that moving to a low-carbon society is more than a matter of individual, isolated behaviour. There is an urgent need to develop technologies and systems in such a way that end-users become more aware of energy and also have the incentives and the tools to manage their usage better. In order to do this, those who supply the technologies and systems also need to have an interest in demand reduction. At present, suppliers in both countries (but perhaps especially in Sweden, with its high reliance on electricity) have more interest in load management than in lower consumption levels.

20% emission reductions mean substantial changes in patterns of usage, with improvements in both energy efficiency and electricity load management. These reductions are intended as a prelude to sustainable low-impact energy systems in the long term, and for that they need public support. In looking at the context for public engagement and behaviour change in two countries in northern Europe, we have shown how, even in nations with many similarities, policies need to be sensitive to the context in order to succeed.

References

Baker W and White V (2008) Towards sustainable energy tariffs. A report for the National Consumer Council by the Centre for Sustainable Energy, Bristol

Bartusch C (2007) Visualisering av elanvändning i ferbostadshus. (Visualising electricity use in blocks of flats). Elforsk, report 08:18

Boardman B (2007) Home truths. A low-carbon strategy to reduce UK housing emissions by 80 % by 2050. Research report for the Cooperative Bank and Friends of the Earth, London. http://www.eci.ox.ac.uk/research/energy/downloads/boardman07-hometruths.pdf

Boardman B and Palmer J (2003) 4CE: Consumer Choice and Carbon Consciousness in Electricity. Final report. http://www.electricitylabels.com/reports.html

Boyd J (2008) Presentation to UKERC seminar, Managing residential electricity demand: Learning from experience in the UK and Ontario, May 21-23. http://www.ukerc.ac.uk/Downloads/PDF/Meeting%20Place/Events/2008/05UKcanadademandred/Boyd,%20Jenny.pdf

BERR (2008a) Energy Trends. Department of Business, Enterprise and Regulatory Reform, London
http://www.berr.gov.uk/files/file45397.pdf
Berr (2008b) Digest of United Kingdom Energy Statistics. Department of Business, Enterprise and Regulatory Reform, London
Carlsson-Kanyama A & Lindén A-L (2002) Hushållens energianvändning. Värderingar, beteende, livsstilar och teknik. (Energy use in households. Values, behaviour, life styles and technology)
CEC (2008) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 20 20 by 2020: Europe's climate change opportunity.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0030:FIN:EN:PDF
Christie I and Jarvis L (2001) How green are our values? In British Social Values: 18th report. SAGE, London
CoI (2006) Attitudes to climate change – wave 3. Research carried out for DEFRA by the Central Office of Information, London
Consumer Focus (2008) Ofgem energy supply market probe – initial findings report consultation. December 2008, Consumer Focus, London
Daun, Å (1989) Svensk mentalitet (Swedish mentality). Rabén & Sjögren, Stockholm
Devine-Wright H and Devine-Wright P (2005) Representing the demand side: 'deficit' beliefs about domestic electricity users. Proceedings, ECEEE Summer Study
Dobbyn J and Thomas G (2005) Seeing the light: the impact of micro-generation on our use of energy. Report for the Sustainable Development Commission, London
Ersson E & Pyrko J (2009) El-info via digitala kanaler. Fallstudie 1 "Min elförbrukning" hos Skånska Energi. (Information via digital channels. Case study 1 "My electricity use" at Skanska Energy). Lund University, Energu Sciences, ITRN LUTMDN/TMHP--09/3039--SE.
EST (2007) The ampere strikes back. How consumer electronics are taking over the world. Energy Saving Trust, London
EST (2008) A Quick Guide to CERT. Energy Saving Trust, London. www.energysavingtrust.org.uk/esr/content/download/80179/184319/file/CERT%20Quick%20Guide.pdf
Hallin et al (2007) Att presentera förbrukning grafiskt – den samlade kunskapen. (To present the usage graphically – the integrated knowledge) Elforsk.
Hinchliffe, S (1996) Helping the earth begins at home: the social construction of socio-environmental responsibilities. Global Environmental Change 6 (1) 53-62.
HoC (2008) Energy prices, fuel poverty and Ofgem. 11th report of Session 2007-8 of the House of Commons Business and Enterprise Committee, volume 1. London
Logica (2006) Energy efficiency and the consumer – a European survey. Logica CMG, London
Nordel (2008). Nordel's statistics.
Owen G and Ward J (2007) Smart meters in Great Britain: the next steps? Sustainability First, London
Parag Y and Darby S (2008) Demand reduction triangular relations: the effect of government, consumer and energy supplier inter-relations on carbon emissions reduction from the UK residential sector. Proceedings, 7th academic conference of the British Institute of Energy Economics, Oxford, September 24-25, 2008
Pyrko J (2005) Direkt och indirect laststyrning I samspel? – Fallstudier (Direct and indirect load control – case studies). Lund University, Energy Sciences.
Pyrko J et al (2002) Preliminär debitering och mätperiodens längd (Preliminary billing and the length of the billing period). Energy Sciences, Lund University.
SCR (2006) I will if you will. Towards sustainable consumption. Sustainable Consumption Roundtable, London.
http://www.sd-commission.org.uk/publications/downloads/I_Will_If_You_Will.pdf
SDC (2008) Supplier Obligation Project. Sustainable Development Commission, London. http://www.sd-commission.org.uk/pages/supplier-obligation-project.html
Shorrock LD and Utley JI (2003) Domestic Energy Fact File. Building Research Establishment Publications, London. http://projects.bre.co.uk/factfile/BR457prtnew.pdf SOU (2008) Vägen till ett energieffektivare Sverige (The way to a more energy efficient Sweden) Statens offentliga utredningar (State Official,Reports) SOU 2008:110
Swedish Energy Agency (2008) Energy in Sweden. Report ER 2008:15.
Swedish Parliament (2006) Bill no. 2005/06:145. National programme for improving the efficiency of energy use in buildings and smart energy construction.
UK Government (2008) Climate Change Act. http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080027_en.pdf
Utley JI and Shorrock LD (2008) Domestic Energy Fact File. Building Research Establishment Publications, London. http://www.bre.co.uk/filelibrary/rpts/eng_fact_file/Fact_File_2008.pdf Walker G and Cass N (2007) Carbon reduction, 'the public' and renewable energy: engaging with socio-technical configurations. Area 39 (4), 458-469

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