A new design for European wholesale electricity markets

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Contents

1. Introduction

While the high electricity prices of 2021/22 were not caused by a failure of the EU's electricity markets, the problems were widely seen as being exacerbated by flaws in the electricity wholesale market design. In August 2022, President von der Leyen stated[1]:

> "The skyrocketing electricity prices are now exposing, for different reasons, the limitations of our current electricity market design. [The market] was developed under completely different circumstances and for completely different purposes. It is no longer fit for purpose. That is why we, the Commission, are now working on an emergency intervention and a structural reform of the electricity market. We need a new market model for electricity that really functions and brings us back into balance."

This report is divided into the following sections:

- Why has the existing market design failed?
- What should a good sector design achieve?
- A new electricity sector design.

2. Why has the existing market design failed?

EPSU has consistently argued over the past two decades that the form of model required by the EU for national and regional wholesale energy markets would not work. This model is based on the international commodities market model used for almost all internationally traded commodities.

2.1. The commodities model

The commodities model is based on international spot markets in which the commodities are traded at visible prices with sellers offering quantities of their commodity and buyers deciding whether to accept the offer. The spot price is effectively set by the price offered by the highest cost producer and all sellers can set their price offers to achieve this price. The market would also include derivatives and instruments such as long-term contracts, futures, and options but the price for these should be strongly influenced by, and generally indexed to the spot price of the day. The claimed advantages of this model are:

- It would provide a visible, easily accessed reference price that would determine, or be a strong influence through indexing, the price paid for the commodity.
- Supply and demand would balance because the market would pay enough to meet the costs of the most expensive producer needed to meet demand.
- Price signals from the market would stimulate the required investment in new capacity. When prices are high, usually because of a shortage of capacity, potential producers will have an incentive to enter the market. If the spot price is low, usually because of capacity surplus, producers with production costs higher than the market price are forced out of the market. High prices would also tend to reduce consumption reducing prices and low prices would tend to increase consumption increasing prices.

Because the spot price reflects the costs of the highest successful producer, most producers will have lower costs than the spot price and will receive more income than is needed to cover their

[1] https://www.euronews.com/my-europe/2022/08/29/energy-crisis-ursula-von-der-leyen-calls-for-emergency-intervention-in-electricity-market

costs because successful bidders receive the highest successful bid price. So, for example, Saudi Arabia produces oil are far below the spot price but still receives the spot price. It is usually expected that the producer country would tax its producers so that at least some of these super-normal profits or 'rent' goes to the people of the country that owns the resource.

In times of shortages, there is often a price premium on top of the costs of the marginal producer as buyers bid against each other to ensure their demands are met. However, in times of surplus, prices will plummet with producers willing to sell at prices as low as their marginal costs rather than their total costs. This will mean they if they bid low enough to attract a buyer, they will have at least some net income that will cover their marginal costs even if this does not cover their total costs. This income may allow them to survive until prices increase but the position of not covering costs in full is only sustainable for a short period of time and eventually the supplier would have to exit the market if prices paid continue to fall short of their costs.

A dramatic rise and fall of prices, known as the 'hog cycle', is characteristic of commodities markets. Shortages lead to investment which pushes down prices, which in turn leads to high-cost producers exiting, pushing prices up again. The range of these fluctuations will depend on the characteristics of the commodity. For example, a commodity with ready substitutes and that is easily stored will be able to tolerate an imbalance between supply and demand much more easily than one without these characteristics. Electricity is expensive to store and is a vital purchase with no ready substitutes so buyers will have an incentive to pay very high prices rather than face the economic and welfare disaster of power cuts.

The inevitable fluctuations of prices that come with the commodities model, well-illustrated by the impact of the 2021/22 high gas prices, are not appropriate for an essential commodity like electricity with strong welfare implications.

2.2. Power Exchanges and Power Pools

Nearly all European wholesale electricity markets are based on the Power Exchange model, but an alternative, the Power Pool, has been used. Under the Power Pool, generators wishing to be used must place a bid with a central authority, often the Transmission System Operator (TSO), and the lowest price bids necessary to meet demand are chosen and only generators placing a successful bid can operate. With the Power Pool, all successful bids are explicitly paid the price bid by the highest successful bidder. In essence, this is how electricity systems were operated before liberalisation with utilities using their lowest marginal cost generators to meet demand, the so-called merit order. The Power Pool essentially replaces cost with price bid. While there is no scope for futures and other derivatives, hedging contracts outside the market, at prices not related to the Pool price, are allowed. If a generator has such a contract, it need only bid low enough to get dispatched. The difference between the contract price and the Pool Price is settled bilaterally between the generator and the retail supplier, a so-called Contract for Differences. By contrast, the Power Exchange model does not require generators that want to be dispatched to place a bid. If they have a bilateral contract, they simply inform the TSO when they wish to operate.

For these purposes, the Power Pool and Power Exchange models have the same claimed advantages. Both designs offer a reference price, there are strong forces to ensure supply and demand balance (assuming there is enough capacity available to meet demand) because the price should provide enough income to meet the costs of the highest cost producer. Most important, the prices generated should give signals that will stimulate entry and exit from the market.

2.3. Why existing electricity market have not and will not work

EPSU has always argued that electricity has special characteristics that make the commodities market model unsuitable. These characteristics are summarised in Appendix 1. The consequences of these characteristics are:

- The overwhelming need for supply and demand to balance precisely at every instant and the difficulty of storing electricity mean this balance cannot be left to the vagaries of the market.
- The lack of substitutes and the vital role of electricity in modern society mean that at times of shortage, prices are likely increase dramatically as buyers compete to ensure their demands are met causing consumers to face difficult decisions – 'heat or eat'.

These shortcomings were covered up for a long time by the dominant position of incumbent suppliers which made it difficult for new entrants to come into the market. This kept prices higher than was necessary to meet costs and profits high. In many countries integrated generator/retailers, who simply bypassed the market by selling their generation to themselves, dominated meaning the market prices had no credibility. So, the market failings were being covered up by these distortions. In this situation, the dominant companies were able to invest in new capacity (generally gas-fired) to ensure security of supply. There was a brief period around 2000 when it appeared that 'merchant' plant, that is, plant that relied solely for income from prices achieved in the Power Exchanges, would be built. However, the collapse in 2001 of the main proponent of this model, ENRON quickly put paid to these plans.

Both the Power Pool and Power Exchange models usually allow bilateral contracts and self-dealing within integrated companies, at prices with little or no relation to the spot price. If these contracts account for a significant proportion of the market, the spot price may differ significantly from the price most power is bought and sold at, and new entrants cannot rely on buying from or selling to the Power Exchanges. Low liquidity of Power Exchanges has been a constant problem across the EU member states.

However, as the need to replace fossil fuel generation with low-carbon generation became the overriding policy priority, the flaws in the market became clear and the factors that allowed the dominance of the incumbent companies were eroded.

The two basic problems were that there was no indication that new low-carbon capacity would be provided by the market and that peaking plant would not receive enough income to stay in the market.

2.3.1. Building new capacity

On the issue of building new low-carbon capacity, renewables, and nuclear power, are high fixed cost options with relatively low operating costs. Renewables technology is developing fast with costs coming down and performance going up. For nuclear, construction risks are high and real costs are rising. The risks for all low-carbon capacity are large enough that new capacity will only be built if it is fully protected from the market. This might be, for example, via Feed-in Tariffs (FiTs) or long term take-or-pay power purchase contracts at prices not related to the market such as Contracts for Differences (CfDs). These mechanisms are set by government, which is often the purchaser of the power, selling it on at cost to electricity retailers. Unless and until the market shows an appetite to build new low-carbon capacity as 'merchant plant', the future appears to be a market increasingly dominated by power bought and sold at non-market prices set by government. Electricity retailers are obliged to buy the power at the same price as their competitors. As a result, the scope for the Power Exchanges will diminish, their liquidity will decline, and the Power Exchanges' role will be no more than balancing, that is buying or selling small amounts of power to fine tune the supply-demand balance. It will not set prices; it will not offer a mechanism for new entrant retailers and generators to enter the market; and it will not provide investment signals.

To ensure new capacity is built when required, for relatively large sources, countries are introducing 'capacity auctions' under which the lowest bids needed to provide the capacity required are given long-term fixed price power purchase contacts. This effectively ensures this capacity is available for the duration of the contract.

The European Commission has tried to make the prices paid under any FiTs, usually for smaller capacity sources like solar photo-voltaic, related to the power exchange prices. This seems ill-considered partly because the power exchange prices are likely to become increasingly unrepresentative of the wholesale electricity price and partly because those using FiTs, often small companies, are unlikely to have the skills to make a commercial judgement of whether the risk from an unpredictably variable price of investing in, say, solar panels, is justified by the return. The risk of making FiT prices market-related is that investment in small-scale renewables will be choked off.

2.3.2. Retaining peaking plant

For peaking plant, the risk with the current market design is that plants that are needed to ensure security of supply will not receive enough income and will be closed. Shortages of capacity might arise from an abnormally cold winter or hot summer, or poorer than expected reliability of power plants. The consequences of power cuts are increasing as society becomes more dependent on a continuous supply of electricity. If, for example, we were to require there be enough generating capacity that power cuts might happen no more than one in 20 years, that would imply the most expensive peaking plant would be required in very few years. The influence of weather will become larger as electricity takes over from gas as the method of space-heating and cooling needs increase. For example, already in France where electric space-heating is common, a drop in temperature of 1°C increases demand by the equivalent of the output of a large nuclear reactor.

To counter this, Member States have begun to introduce 'capacity payments', under which, a generating plant receives income simply for promising to be available when required, regardless of whether it is used. While the issue is retaining specifically peaking plants, it has proved difficult to design schemes that just target peaking plant and most schemes provide payments to enough plants in total to meet expected peak demand. Capacity payments are usually only available to dispatchable plants, that is, plants that can generate at any time and can guarantee to be available to generate whenever required.

2.3.3. Impact of capacity payments and capacity auctions

While the rationale for these schemes is clear, they are overriding a key element of the market design, that is that market entry and exit should be driven by price signals from the spot market.

They are a serious market distortion. This suggests that there has never been a functioning free market, it has always been a political project with need for continuous patches.

2.4. The market problems of 2021/22

The European Commission was quick to put some of the blame for the high electricity prices on the design of electricity markets claiming the market was "no longer fit for purpose".[2] Particular criticisms are that gas generation is setting the power price and that inframarginal generators are making large profits.

We argue that design was never fit for purpose, for example, in driving entry and exit from the market. However, in 2021/22, the market was setting prices in the way it was designed to. The market design is that the most expensive source needed to meet demand sets the market price and gas-fired generation clearly was the most expensive source. Except when the market has a significant surplus in generating capacity and prices fall sharply, inframarginal generators make more than a normal rate of profit, precisely because the price is set by the costs of the most expensive available source needed to meet demand. The promise of these extra profits is part of the incentive for new sources to enter the market.

Some free-market advocates would argue that there should be no market intervention. The high prices would stimulate the gas market to supply more gas and would stimulate consumers to reduce their demands and these two factors would work together to reduce prices. Whether this would happen is not the point. The social consequences of allowing prices to rise with no mitigation are unacceptable and we must be wary, given our climate change objectives, of giving incentives to invest in new gas production capacity.

3. What should a good electricity sector design achieve?

There are usually seen to be three major requirements for a good energy sector design. It should provide supplies that are affordable, reliable and environmentally acceptable or sustainable for short. These requirements are easier to state than they are to define. Some of the arguments on these factors are set out in Appendix 2. How do we turn these aspirations into specific design criteria? There will often be a trade-off between these factors, for example, the cheapest method of generation might have poor sustainability characteristics.

3.1. Affordability

In practice, this means providing power at the lowest price consistent with meeting the other two objectives of reliability and sustainability. A free market is often seen as the best way to minimise prices but as argued in Appendix 1, an efficient free market is not feasible for electricity. There is no reason to assume an imperfect free market will be as good as the alternatives, which are likely to include a much greater level of planning. A problem with most designs of electricity system whether or not they are competitive, is that they are very supply-side dominated. From the point of view of meeting the consumer's needs, it is irrelevant whether demand is met by increasing supply or by reducing demand by efficiency measures. However, utility planning processes do not consider demand-side options because energy efficiency measures reduce utilities' income. The result is that highly cost-effective demand side measures are not implemented, and additional supply is built raising rather than reducing

[2] https://www.politico.eu/article/ursula-von-der-leyen-state-of-the-european-union-soteu-speech-ukraine-russia-gas-energy-war/

the cost to consumers. Energy efficiency measures tend to increase security of supply and sustainability, so unlike supply side options, there is no trade-off between, say, affordability and sustainability, and energy efficiency measures almost inevitably have good sustainability and reliability characteristics.

In regulated monopolies, 'least cost planning' has been employed. Under this, the lowest cost combination of resources needed to meet demand reliably is identified, and system planning is based on this combination of resources. This process is generally carried out by an independent body that has no vested interest in the options selected. If applied correctly least cost planning treats supply-side and demand-side measures on an equal basis avoiding the problem of supply side bias that utility planning processes always suffer from.

In practice, rigorous least cost planning requires large amounts of future cost data for all the options to be considered. These are often difficult to forecast. If there are errors in these forecasts, the combination of resources identified will not be the least cost option. Nevertheless, the least cost planning philosophy, that consumers want the lowest overall price for the service, not the lowest kWh price, should be the basis of electricity sector design.

3.2. Reliability

Reliability is a complex characteristic that is difficult to characterise in simple measures. Diversity and self-sufficiency are often used as a proxy for reliability, but they are poor proxies. For a system to be reliable, it needs to meet demand fully so if, say, supply is spread between several sources, even if only one fails, the whole system will fail unless there is enough spare capacity among the others to compensate. Increased self-sufficiency is important to insulate a country from arbitrary measures under the control of a foreign country. Even so, it does not automatically mean a self-sufficient system is more reliable as there are other factors at play. Low-carbon sources tend to be based on national resources such as wind and sun so the transition to low-carbon generation will inevitably increase net self-sufficiency. To smooth out fluctuations in availability of resources, so that when, for example, the sun is not shining in one location, power from a sunny region can be exported to the country in need. So, there may need to be a greater gross volume of international trade, but not necessarily an increase in net trade.

3.3. Sustainability

Climate change means that the priority must be to phase out fossil fuels for new investment. This leaves renewables, nuclear power, and energy efficiency measures as the main options for new investments. Another proposed option, Carbon Capture and Storage (CCS) technology would mean the CO_2 emissions from fossil fuel burning are captured and do not go into the atmosphere and would make fossil fuel use effectively low-carbon. There may be uses for CCS where alternatives to fossil fuel are particularly difficult to design, and projections by the IEA do see a role for CCS in reaching net zero. That said, CCS has been discussed for at least 20 years but seems far from commercial deployment.

Renewables are difficult to generalise about as every country has its own distinctive set of resources. The main renewable options are offshore wind, onshore wind, solar photovoltaic, and biomass. Concentrated solar power may emerge as a useful option for countries with reliable sun. In the future, renewable resources such as wave power and tidal power may also become commercial options. The cost of all the options has fallen significantly in the past two decades with good prospects for further cost reductions and performance improvements. Of the current options, only biomass can be seen as dispatchable. Other options could be combined, for example, with battery storage to make a dispatchable package. It is not clear whether such packages would be more cost-efficient than standalone renewable generation with storage centrally controlled. Concentrated solar power can include storage in the form of molten salts.

4. A new electricity sector design

The main barrier to reforming the electricity sector into a form suitable for the current realities of climate change may be the vested interests in retaining competition. The European Commission has a strong prejudice in favour of free markets. In its latest Electricity Directive (EU 2019/944[3]) it requires that there be: "Competitive, consumer-centred, flexible and non-discriminatory electricity markets" and that: "Member States shall ensure that all customers are free to purchase electricity from the supplier of their choice." This seems to suggest a mentality that markets are a worthwhile end in themselves rather than just a means of helping consumers to get the best deal. If competitive markets do not produce lower prices than the alternatives, they are not justified. For a wholly standard like electricity, the only consumer consideration, assuming reasonable consumer service is offered – this should not be difficult given that all a supplier must do is read the meter and send the bill – is price. Increasingly, new generation capacity will be determined by government and retail suppliers will have little or no role in this.

The risk is that rather than take the logical decision of abandoning the illusion that a system driven by competition is feasible, there will be evermore 'fixes' imposed on the market such as has already happened with capacity payments and capacity auctions. These distort prices leaving a system that has lost any of the advantages of a fully competitive market but has few of the advantages of a properly planned system.

Since the passing of the first Electricity Directive in 1996, EPSU has argued that a free-market electricity sector design is not feasible or sustainable. The economic characteristics of the low-carbon options make them even less suited to a free market than the fossil fuel options that dominated in 1996. However, this does not preclude the use of competitive mechanisms. For example, capacity auctions have been very successful at driving down consumer prices and could be a useful mechanism to ensure new capacity is built at low cost. Public ownership either at national or regional level will be an attractive option. The key is the return of control of the system to fully accountable public authorities, whose priority will be to design a system to meet climate change objectives, not provide the best return for their shareholders.

4.1. General considerations

The significantly differing renewables resources from country to country and the differing demand pattern mean that the market design must be adaptable to the characteristics of the country. For example, the design for a Southern European country with good decentralised solar PV potential installed with the consumers and a summer demand peak (cooling demand) will be very different to a Northern European country with a winter peak (heating demand) and a good offshore wind resource.

The system must also fit in with the economic and political culture of the country. The system that would fit well in a country with a high level of local public ownership would be different to a highly centralised country where private or national public ownership dominates. One of

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944

the major failings of the liberalised energy market model promoted all round the world was that it was a 'one-size-fits-all' model taking no account of specific national characteristics.

A particular problem that has always existed in the electricity sector is that supply side measures have always had a disproportionate size than demand side measures. This is because for the supply side, large generation companies can take a long-term view of investment and can afford amortise their investments over the life-time of the plants, usually 30 or more years. By contrast, consumers, especially small consumers, often do not have the cash to pay for very attractive energy efficiency measures or if they do, they require a pay-back of only a few years. If capital is used in investments that make a much lower rate of return (in this case new generation) than the most attractive investments (in this case energy efficiency) this is a misallocation of resources that will lead to lower economic growth than would be the case if investment went to where it would earn the best rate of return. From a welfare point of view, low-income households, who would benefit most from the reductions in energy bills energy efficiency measures would bring are least likely to be able to fund such measures. Where they are in rented property, they are unlikely to have the scope to carry out energy efficiency measures. Energy efficiency programmes should have strong targeting to low-income households. A well-designed publicly owned system not driven by profit motive would help rectify the imbalance between supply-side and demand-side measures.

Solar PV raises similar issues. Subsidies for installation of solar panels have had an important impact lowering prices and building up a support industry but the subsidies are regressive, most likely going to those who can afford their proportion of the cost. There is increasing talk about large numbers of consumers becoming so-called prosumers, in short consumers with their own generation, normally solar panels. Prosumers will be less dependent on grid supplies and less exposed to fluctuations in the power price. If they have more power available than they can immediately use, they can either store it in batteries or sell it to the grid. From a system perspective, battery storage would be preferable as it would tend to smooth demand curve while selling it to the grid at times of high renewable availability would tend to accentuate supply peaks and troughs. From a price point of view, as the system transitions to low-carbon sources that are dominated by fixed costs and not dependent on buying fuel from the market, the scope for price fluctuations ought to diminish.

Those most likely to be able to take advantage the option of being a prosumer are property owners with available financial resources. So, if there is to be active promotion of the prosumer option, careful attention will have to be paid to ensuring the measures do not simply benefit richer consumers.

4.2. Generation

The design of the generation sector will depend strongly on the renewable resource base in the country. A country with a strong resource base of large-scale renewables will require a different design, much simpler, to one where small-scale resources dominate.

For the former, experience with capacity auctions suggests they are a useful mechanism especially for renewables, producing remarkable price reductions. The very restricted field of nuclear suppliers and the specific characteristics of nuclear power mean that capacity auctions are not an option for nuclear power and in the few countries in Europe planning new nuclear orders, the process has been driven by government.

For countries where small-scale resources dominate, capacity auctions are not appropriate, for example, for solar PV installed on residential roofs. In the past, Feed-in Tariffs (FiTs) have been successful in increasing the capacity of small resources but these rely on government being able to set tariffs that are just high enough to stimulate the installation of the level of capacity needed. If the tariff is too high, too much capacity will be built and if it is too low, not enough. The attempt by the EU to make FiTs market related is misconceived. It will introduce a level of investment risk that households will not be willing to take and as the Power Exchanges wither away the market price will become meaningless.

Existing large generation companies that currently mostly rely on fossil fuel generation will have to transition gradually to clean energy sources. Where they do not succeed, these companies will naturally lose their position in the market. A just transition for workers is crucial to ensure the success of the transition.

The wholesale generation sector will increasingly be controlled by the contracting organisation for capacity auctions, and it would seem sensible for this to evolve into a 'Single Buyer'. As well as giving long-term contracts to new capacity, it would need to offer shorter term contracts, for example to renewables reaching the end of their initial contract including some on a day-ahead basis so that supply and demand balance as precisely as is needed. Whether this is done by some form of clearing market or by a bidding process is a detail that Member States may be best placed to determine.

The variability of renewable generation will tend to lead to a requirement for strengthened international connections so that when, for example, the sun is not shining in one location, power from a sunny region can be exported to the country in need.

4.3. Retail

The influence of the competitive wholesale market on the price paid for wholesale power will diminish as fossil fuel generation is replaced by low-carbon generation. Costs will still fluctuate but in response to varying weather conditions, not fossil fuel markets and without the spot market, the peaks and troughs in prices can be smoothed. This means the scope for meaningful competition between retailers will disappear. The wholesale price will be determined by the prices achieved in capacity auctions and, logically, should be the same for all retailers. Network prices will be set by the regulator and the same for all companies, so all that will be left to compete over are the small costs of meter-reading and billing.

It seems highly unlikely that any consumer savings resulting from competition will balance the costs associated with competition, such as lost scale economies, advertising costs, and switching costs. So, a return to a regulated monopoly either at a regional or national scale seems logical. The case for public ownership of regulated monopoly retail companies is strong. For countries that has been more successful in breaking up the existing market dominance of the former regional companies, this will be more difficult than for countries where the previous monopoly companies still dominate.

4.4. Networks

The only rationale for unbundling networks was to try to ensure fair competition between generators and between retailers. However, in most countries unbundling is a *fait accompli* and low-carbon generators would have little or no interest in network operation. For distribution and retail, there would need to be careful consideration of whether the costs of re-bundling were justified by the benefits. The networks would remain regulated monopolies.

4.5. Regulation

The main function of sector regulators in the current market design should have been to set monopoly prices for network access and this function will remain whatever design is chosen. However, a large proportion of their time has been consumed with monitoring and regulating markets where the markets are failing. A return to a more planned system would remove this need. If retail returned to a monopoly, consumer prices should be regulated but given that the components of the price, network charges, wholesale purchase prices and retailer costs are well-defined and would not need major analysis, this should not be a major task. Indeed, in the UK where a retail price cap has been introduced because of failures in the retail market, the regulator is effectively already setting the tariffs for household consumers.

5. Conclusions

It is important to spend the time needed to design a new sector structure rather than just rushing through more and more ‘sticking plasters’ on a market design that is widely seen as failing and has been for at least a decade.

What must go is the prejudice that a market is always superior to a planned system. The philosophy of least-cost planning that the objective is to deliver the required service at the least cost to consumers consistent with the requirements of reliability and sustainability being met is key.

Appendix 1 Why free markets in electricity are not achievable

There is often an assumption that simply removing regulations will be enough to create a free market. In practice, there are a significant number of conditions that must be fulfilled if a market is to be judged efficient, that is, it minimises prices to consumers. Some of these include:

- Many buyers and sellers.
- Anti-competitive regulation.
- Homogeneous products.
- No barriers to entry or exit.
- No externalities: Costs or benefits of an activity do not affect third parties.
- Perfect information.
- Profit maximization of sellers: Firms sell where the most profit is generated, where marginal costs meet marginal revenue.

Most of the conditions above are not met by current electricity markets, for example, many buyers and sellers, and it seems unlikely that some of these ever could be met, for example, perfect information. If the market is 'imperfect', the assumption that it will be superior to any other organisation of buyers and sellers is not valid. Specifically for electricity, there are a few its specific characteristics that mean an efficient free market is unlikely to be feasible.

Inability to store power and expense of storing gas. Storing products allows consumers and producers to smooth out demand and price peaks by drawing down stores when prices are high and building stores when prices are low.

Need for supply and demand to always match. In an electricity system, supply and demand must always match if the whole system is not to collapse. Without control over producers, a system operator does not have the tools to ensure security of supply. A free market implies free entry and exit and does not oblige producers to offer their products to the market. For gas, the requirement for supply and demand to match is not quite so stringent but still strong.

Lack of substitutes. For most products, there are ready substitutes that can be used if supplies are scarce, or prices are high. The threat of switching to substitutes acts as a discipline on producers on price and availability. For many uses, electricity has no ready substitutes and even where substitution is theoretically possible, consumers are generally locked into electricity by the equipment they use. For gas, there are substitutes in some cases, mostly for large industrial users, albeit not so convenient but users are again often locked into gas by the equipment they use.

Vital role in modern society. Modern society is now dependent on reliable supplies of electricity for it to function. A failure of the electricity system will lead to immediate and serious welfare and economic impacts, as the blackouts of 2003 amply demonstrated. For most products, a market failure can be mitigated by use of substitutes and stores, but this is not possible for electricity. As a result, the demand for electricity cannot easily be influenced in the short-term by price changes.

Electricity and gas are standard products. In an interconnected network, electricity and gas are standard products. Switching to another supplier does not produce 'better' electricity or gas, so markets are price driven and will be exploited by those who have most to gain by cheaper power (large users) as well as the skills and negotiating power to get the best deal. If the market is functioning well, prices will inevitably be driven down to the short-run marginal cost, too low a level to justify new investment.

Environmental impacts. The environmental impact of electricity generation and gas use must be added to the traditional list of special features. Electricity generation and gas combustion play key roles in greenhouse gas emissions and attempts to deal with climate change must focus on the electricity and gas sector (and transport). The market will not deliver the necessary emissions reductions and market mechanisms are no more than one of many tools that will have to be used, not the complete answer.

Appendix 2 What are affordability, reliability & sustainability

Affordability

Affordability is a rather vague term, and the price of electricity may be determined by factors, for example, the international wholesale gas price, which are not under the control of government of the country. If the price of the input factors is high, the only way to keep down electricity prices is to provide subsidies, i.e., a transfer of resources form taxpayers to electricity consumers.

Nevertheless, electricity is an essential purchase and governments have a responsibility to ensure that, as far as possible, consumers can afford the electricity supplies they need to maintain their health and wellbeing. In practical terms consumer prices will be minimised if prices are cost-reflective and least cost technologies are chosen.

One often discussed problem is that of fuel poverty amongst residential consumers. This is often defined as occurring if more than 10% of a household's disposable income would have to be spent to provide sufficient energy for the household's and heating/cooling and other energy needs. To measure the extent of this would require knowledge of each household's income, the quality of the housing, the amount of energy needed to meet the household's energy needs and the prices of the energy sources. This level of detail is not known and estimates of fuel poverty must rely on modelling of households, likely to provide a relatively crude estimate.

Reliability

Any failure of electricity supplies, even for a short period could jeopardise the safety of consumers. Reliability is more easily defined than affordability. The main factors determining this are the adequacy of generating capacity, the adequacy of fuel supplies and the reliability of the transmission and distribution networks. This is often measured by the number of minutes of supply lost per year, but this statistic does not tell the full story. For example, in a very cold winter, there may be repeated shortages of power but over, say, a 10-year period the average minutes lost may be similar to a system where the shortages are more spread, but the disruption would cause much greater social and economic damage.

Sustainability

The dominance of climate change, and the resulting need to reduce greenhouse gas emissions, in environmental thinking has meant that low greenhouse gas emissions is often effectively used as a proxy for sustainability. However, we should not lose sight of other important factors, for example, the need to deal with long-lived radioactive waste, so far not demonstrated, loss of biodiversity, destruction of habitats. Often there might be trade-offs, for example using nuclear power to replace fossil fuel generation would result in creation of more long-lived hazardous material.