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THE NEW ENERGY MANAGERS
Regional Electricity Companies and the 'Logic' of Demand-Side Management

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Abstract

This working paper unpacks the emergence of demand-side management strategies in the privatised electricity industry in England and Wales. The paper identifies the shifts in the approach of the electricity industry to supply network management motivated by the privatisation process. Changes to electricity pricing tariffs, demand-profiling techniques and network development strategies illustrate the developing interest of Utilities in demand-management. Two model typologies of energy service characterising the monopoly and competitive eras of electricity supply are then developed. The supply or demand orientation of these variant 'logics' is highlighted. The paper goes on to locate these shifting supply practices in local development processes. Two detailed case studies of the design, supply and use of electricity in two new factory developments, one driven by a supply-oriented logic, the other by a demand-management logic, are presented and the resulting re-orientation of development practices effected by a DSM initiative appraised. Finally, the paper points both to the regulatory and commercial shifts encouraging the acceleration of *DSM* activity and the future technical, informational, spatial and policy issues such changed utility activity raises.

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The views expressed are provisional thoughts based upon work in progress.

Contents:

1. Introduction

Energy-related questions pervade debates around sustainability and the built environment. Whether related to the energy performance of individual buildings or the environmental costs of electricity generation, energy efficiency is becoming a high priority for both users and suppliers. Matching end-use efficiency with reduced infrastructure investment, American inspired "Demand-side Management" (hereafter *DSM*) has become the source of much interest and excitement (Prindle,1991). Feted by environmental pressure groups as the 'green-dream' solution to sustainable electricity production and supply, the electricity industry is being urged to "learn the lessons" of the American approach (Brown,1985). Alongside this enthusiasm there are lingering doubts about the potential *DSM*. Sceptics argue that importation of US-style electricity planning is unfeasible due to the contrasting technical, organisational and political circumstances of Anglo/American electricity markets (Davison,1991). Within the American electricity network, utility companies generate, distribute and supply energy locally, on a monopoly basis and within a tightly regulated planning system (Sant,1984). This system provides financial and political incentives for American Utilities to avoid new infrastructure investment through a commitment to *DSM* (Sioshansi,1992). In contrast, the increasingly competitive, privatised electricity industry in England and Wales has surplus generative capacity, a vertical dis-aggregated organisational structure and experiences little legislative control over network planning[1]. This would not seem to be fertile ground for *DSM* (Woolf & Mickle,1992).

[1]The organisation of the electricity industry in Scotland and Ireland differs to that of England and Wales; generation, distribution and supply are vertically integrated. The focus of this paper is the electricity industry in England and Wales.

Yet local examples of *DSM* initiatives can be found. There appears to be growing interest amongst Regional Electricity Companies (hereafter *REC*'s) in the contribution of *DSM* to a more efficient, flexible style of network management, appropriate to an increasingly competitive energy marketplace. Proponents of US-style DSM often miss the potential significance of this shift in commercial strategy. Looking beyond the apparent determinism of technical, organisational and political conditions of successful *DSM* initiatives, this paper avoids speculative visions of what utility provision could look like, or what it appears to resemble in far away places. Instead, emphasis is placed upon the refashioned priorities of privatised Utilities in England and Wales; the commercial shifts towards "consumer satisfaction", the questioning of all-embracing technological solutions and importantly, changing patterns of electricity provision.

The paper suggests that a new 'logic' of electricity supply, DSM, may be emerging. Slowly, and selectively, the relationship between Utilities, developers and electricity users is being transformed. REC's are beginning to take the energy-saving initiative, becoming the "new energy managers" of the privatised world of electricity provision.

This is not a seamless process. Instead such changes are haphazard and unpredictable, rooted in the pragmatic responses of Utilities to specific technical and operational challenges. Routing out the ebb and flow of these situationally specific compromises is a troublesome business. In particular, the paper will stress the complexities surrounding the adoption of *DSM* techniques within everyday construction processes, where energy decisions are shaped by conflicting pressures and priorities. There are no standardised solutions to 'sustainable' electricity supply and demand within these unpredictable and often chaotic development dramas.

Unpacking the energy-related choices of *REC's*, developers and users calls for sensitivity to the uniqueness of each building project. Previous research into the potential of *DSM* has tended to ignore this complexity.

This paper highlights the competing interests and conflicting priorities fashioning negotiations over electricity supply between *REC's*, building developers and commercial electricity users. Locating the connections and discontinuities between the aims and strategies of these fast changing "worlds" provides a key to discerning the technical/environmental potential of *DSM* in England and Wales. This requires close attention to the way Utilities 'service' new buildings. By comparing the provision of electricity to two new commercial buildings, one supplied within a traditional supply-oriented framework and the other through an innovative *DSM* strategy, the impact of re-modelled utility practices on energy-saving action can be assessed. Tracing the connections between supply and demand within routine development processes, the paper asks two central questions about an Anglicised *DSM* approach to the provision of electricity in the built environment;

- The organisational, technical, regulatory and commercial market conditions of the electricity industry in England and Wales is rapidly changing. H*ow are these market-shifts shaping the implementation of DSM initiatives by REC's?*

- Successful *DSM* programmes critically rely on the adoption of more efficient end-use technologies in buildings. H*ow is the demand-profile of new developments re-modelled when REC's take a pro-active energy-management role?*

Approaching these questions demands an understanding of a diverse range of social, technical and commercial processes which hitherto have been studied in isolation. Over five sections this paper will uncover the resonance's and dissonance's between the disparate aims and approaches of Utilities, developers and users in the design, supply, and use of electricity:

- *Electric Shocks* will identify the shifts in the approach of the electricity industry to supply network management motivated by the privatisation process. Changes to electricity pricing tariffs, demand-profiling techniques and network development strategies illustrate the developing interest of Utilities in demand-management.
- *Emerging 'logics' of electricity provision* develops two model typologies of energy service characterising the monopoly and competitive eras of electricity supply. The supply or demand orientation of these variant 'logics' will be highlighted.
- *Electricity in Development* locates these shifting supply practices in local development processes. Two detailed case studies of the design, supply and use of electricity in two new factory developments, one driven by a supply-oriented logic, the other by a demand-management logic, will be presented.
- *The New Energy Management?* appraises the re-orientation of development practices effected by a DSM initiative. The forms of negotiation and electricity-saving action shaping the energy profile of each new development will be compared and contrasted.
- *Live Issues and Developing DSM* point both to the regulatory and commercial shifts encouraging the acceleration of *DSM* activity and the future technical, informational, spatial and policy issues such changed utility activity raises.

2. Electric Shocks

Prior to the privatisation of the electricity industry the supply of energy to building developments was considered a relatively unproblematic issue. As a matter of professional pride electricity planners would quickly satisfy new energy needs with fresh supply. Of course there were always difficult technical problems to be resolved in such a complex venture. In fact the over-coming of these difficulties provided the defining logic of the nationalised electricity industry, the unfolding of an all-encompassing technological network embracing the nation. As the country grew so did the network, a literal current of vitality providing the spark of economic growth. As state economists forecasted national growth, the electricity planners of the Central Electricity Generating Board (hereafter *CEGB*) commissioned extra power stations. With an emphasis upon safety of supply, generous margins of extra capacity were built in to the network. Large remote power stations were built to achieve economies of scale. The electricity network, integrated from generation through to supply, operated like an irrigation system - delivering 'electrons' from a large reservoir to distant customer sites (Weinberg,1994). The nationalised Electricity Supply Industry was then committed to large scale engineering management, with the focus directly on supply capability. Whereas new generation and transmission investments represented "visible and attractive signs of progress", distribution and loss-reducing improvements were "unglamorous and unseen" (Berrie,1992,pxx). Systematic *DSM* therefore played little part in electricity network management in the monopoly era. In the space of twenty years following the second world war, generative capacity multiplied seventeen fold (Reid & Allen,1970, p9). This attachment to a monolithic structure driven by generative concerns has been heavily criticised. In its commitment to achieving economies of scale in the generation and sale of electricity, its monopolistic, prescribed pricing structures and its inflated capacity, the *CEGB* was often seen as an arrogant producer, uncaring of local demand (Bonner,1989).

The process of privatisation aims to strike at the heart of this "production ethos". According to the Government's 1988 White Paper, *Privatising Electricity*, "decisions about the supply of electricity should be driven by the needs of the customers" (DTI,1988). Replacing the notion of "public service" with a profit motive, the provision of electricity is to become more responsive to the needs of local consumers. To this end command of the industry has been wrested from the generators with specific responsibility for understanding and satisfying demand handed to a new "front line" of supply, *REC*'s. While the bulk of new generating plant would still be built by the generating companies[2], it is unlikely that new construction would occur without contractual agreements with REC's, or large-scale industrial users (Roberts, Elliot & Houghton,1991, p62). The potential impact of this shift is profound. Justification for any fresh investment in supply capacity now depends upon localised-demand profiling undertaken by the *REC*'s, replacing the national, macro-economic demand modelling of the *CEGB*. Emphasising consumption rather than production, the 'logic' of electricity supply is being re-shaped. No longer wholly driven by supply-side engineering techniques, leaner, demand-focused network management strategies can now surface. This is not an isolated phenomenon. World-wide there is pressure on traditional, supply-led, vertically integrated electricity industries. Similar re-structuring is underway in Sweden and Norway, while in America a powerful new independent power production industry is threatening the monopolies of traditional Utilities (Weinberg,1994). The acceleration of commercial competition, concern about the economic and political costs of energy, and environmental fears about the

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[2]REC's are permited to build and operate their own generating stations up to a maximum of 15% of their total capacity. This is to prevent the rise of local, vertically integated monopolies.

impact of electricity production and use, is stimulating rapid change within utility industries after almost a century of relative stability. As Carl Weinberg points out, the forces driving these changes are not unique to the electricity industry. Rather;

> ...they are contributing factors to the increased emphasis on sustainability across commercial sectors and throughout society. They bring together the industry challenges (competition, growing environmental restrictions, rising costs associated with old technologies) and opportunities (new technologies and markets, and industry restructuring). (Weinberg,1994)

However, in the process of addressing the perceived failures of the monopoly system, the new, privatised regime has generated a host of deep uncertainties. If one opinion now unites the electricity industry it is that no traditional practice is sacred. While the 'physical connections' of wires and cables between production and consumption appear unchanged, the organisational shape of the industry is experiencing a process of rapid, dislocating shifts with far-reaching implications. The industry has become dis-aggregated; generation, transmission, distribution and supply now operate as independent business sectors, each seeking individual commercial success (Vickers & Yarrow,1989). No longer driven by a common logic of supply network expansion, a questioning of priorities has ensued. What is at stake seems nothing less than the identity of "electricity companies" as providers of an essential resource. The impact of this transformation on REC's, taking up the challenges of competitive electricity supply, is particularly acute. While urged by the Government to competitively pursue profit, the action of the regulator in trimming the "volume driver" in the supply price review has re-emphasised the novelty of this commercial market (OFFER,1994)[3]. What other industry would have to accept the de-linking of profit and volume sales? Clearly, more is at stake in supplying electricity than generation and sales. With public perception of electricity provision as a civic service remaining powerful, there are mounting tensions over the social, environmental and commercial aims of privatised electricity supply.

Identity Struggles

Evaluating the potential for *DSM* means engaging with the identity struggles of *REC's* as they juggle the old and the new. Caught between an inherited duty to provide and the commercial ability to turn in a profit, *REC*'s are having to re-invent themselves. No longer acting as quasi 'regional sales offices' for the *CEGB*, they are having to re-orientate their operations in an effort to protect and maximise current resources while pursuing avenues of future commercial growth. Their quiet struggles are beginning to be noticed. Paying the price of utility services in open competition has raised a variety of concerns; social, technical, political and environmental. Critics of the privatisation process have questioned the commitment of the *REC*'s to less lucrative consumers. The temptation to "cherry-pick" large users through the provision of high quality service while "dumping" poorer customers is becoming evident (Marvin & Graham,1994). There is also concern as to the likely maintenance of technical standards achieved in the monopoly era. Will the search for profit lead to cost-cutting and a diminution of standards, especially in areas of low profitability, thereby exacerbating inequities of service provision (Bonner,1989)?

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[3] The "volume driver" refers to the componant within the pricing formula which relates quantity of electricity sold to the final cost. Trimming this componant reduces the link between level of sales and profit, so reducing the incentive to accelerate electricity usage.

The environmental impact of these changes is dependant upon a revised commitment to energy efficiency. While the wise owl of the nationalised electricity industry always urged the efficient use of electricity (McGowan,1988), explicit consideration of energy efficiency as a tool of network management was rare. However, the new, privatised regime of electricity supply is arguably providing new incentives for increased energy efficiency. As Tom Berrie has pointed out ;

> ..much greater emphasis is given today in electricity supply to the following: consumer response; private capital; private Utilities; demand management; energy efficiency; conservation; environmental maintenance (Berrie,1992).

This novel interest in DSM is being driven by a variety of related innovations; the rise of energy services; commitment to enhanced network efficiency; the introduction of dynamic pricing structures; development of sophisticated communication technologies:

1. *Energy Services* - With customers consuming more than 100kW now able to choose their supplier irrespective of location, (around 55,000 users, representing around half of all electricity consumption), there is re-newed focus on the kinds of service provided to users (OFFER,1993). Threatened by the "cherry-picking" strategies of rival suppliers a growing number of *REC*'s are offering new kinds of "energy services" to key customers. Energy audits, more detailed demand profiles and multiple tariffs are increasingly offered by *REC's* in order to win new customers and to promote a sense of 'brand loyalty' with existing clients (Owen,1994). These novel energy choices may encourage users to alter their patterns of demand, their "load profile", to achieve significant electricity savings

(Bennell,1994). As Weinberg puts it, Utilities "have learned that their survival in a competitive world depends on an ability to understand what it is their customers want", and that "customers are not necessarily interested in low-cost kilowatt hours, but instead in low-cost, high-quality energy services" (Weinberg,1994,p291).

2. *Network Efficiency* - In the 'monopoly era' the Area boards, responsible for regional electricity supply, were less sensitive to the demand profiles of their customer base. Demand profiling was the responsibility of the *CEGB* who placed more emphasis upon the avoidance of spectacular "blackouts" than the less dramatic concern of distribution losses (Berrie,1992 pxx). With investment in new infrastructure now in the hands of the *REC*'s, closer attention is being payed to the operational efficiency of the distribution network feeding electricity supplies. While flat, predictable demand has always been the idea goal of electricity planning (Nye,1992), *REC's* have a particular interest in minimising distribution losses in order to avoid any unnecessary purchase of electricity from the national 'Pool'. This is stimulating refined management of regional supply networks. Greater efforts are being made to tailor the demand profiles of inter-connecting spatial elements to smooth local demand-profiles, thereby minimising the loss of 'electrons' that could be translated into profit.

3. *Dynamic pricing structures* - During the monopoly era, electricity prices were set well in advance of usage. Tariff variations were limited, based upon estimation of future demand-profiles resulting from past experience of the market. Such a

prescribed pricing structure presented little incentive for users to alter their daily patterns of usage. This is changing. Increasingly, real-time "spot-pricing" is being utilised, encouraging the treatment of electricity as a commodity (Berrie & Hoyle,1985). This dynamic pricing structure allows a continuously varying price (per kWh), matching as near as possible the actual costs of generation, transmission and distribution. As Berrie points out, such 'spot' pricing has benefits for producers and consumers alike, encouraging; operating efficiency improvements, "capital investment reductions, improved consumer options on supply quality or reliability, and lower electricity prices" (Berrie,1992,pxxvi). Dynamic pricing presents real incentives for users to tailor their electricity needs to a changing structure of supply. The avoidance of electricity use at peak periods may then help to smooth the demand-profiles of individual spatial segments of a *REC's* supply network. An increasing number of electricity users, large and small, have even demonstrated a willingness to agree to load reductions at periods of high demand through a process known as "demand-bidding" (OFFER,1991). These electricity users would immediately save money, while their estimated response can be taken into account by electricity industry planners when forecasting future generation requirements.

4. *Communication technologies* - The rise of energy services, refined network management and real-time pricing has been made possible by significant improvements in the technology and cost of metering and communications. These technical innovations are having a major impact on the management of electricity networks, permitting the introduction of; new dynamic pricing regimes; remote load management techniques; feedback on the operational state of the system; real-time communication between supplier and user. All these

managerial features have contributed to the potential of more efficient supply and use of electricity.

These technical, organisational and commercial innovations are not unfamiliar to the electricity industry. Each represents a development of previously marginalised electricity planning practices which make increasing sense in a dis-aggregated, competitive regime. In particular, it is important not to overstate the novelty of the attention of the electricity industry to energy efficiency. Suppliers of electricity have always been interested in efficient uses of electricity (Rosenberger,1993). Widening the base of customers taking electricity as their main fuel source, by attracting users away from gas, has consistently proved a more effective mechanism of 'spinning meters' than the piecemeal extraction of a few extra therms here and there! Seen this way, the provision of miscellaneous energy services is merely an extension of established marketing strategies, now aimed at the attraction and retention of key customers. Similarly, *DSM* strategies have been employed at different times in the history of the electricity supply industry, for a variety of reasons; Conservation has been encouraged at times of electricity shortage while strategic growth has been planned to optimise supply assets (Redford,1993). Chopping peaks and filling troughs in demand has been widely practised in safeguarding the supply capability of electricity networks, while the development of sophisticated remote tele-switching can be seen as an elaboration of 'night-storage', load-shifting techniques (Berrie.1992,p57).

But as the rationale of volume driven expansion make less and less sense, *DSM* is taking on a new coherence. Adding the changing concerns, priorities and strategies of *REC*'s together we can begin to locate the emergence of new logic's driving electricity provision. The signs are that *REC*'s are questioning the 'logic of resource intensification', the maximisation of kW/hr supply. Instead, a more demand sensitive approach to selling energy is appearing. A 'logic of diversification'. The aim is a "flexible load shape", with *DSM* techniques employed to influence load profiles as required (Redford,1994). These variant logic's, supply vs *DSM*, are not mutually exclusive. A logic of diversification does not exclude the motivation to sell more electricity! Rather, the strategic point of contrast lies in the 'signals' these different logic's send to network management. Different signals place contrary pressures upon network expansion, upward or downward. The resulting maximisation or minimisation of resource use distinguishes these opposing logic's of electricity supply;

supply-logic	*signal*	*demand-logic*	*signal*
monopoly supplier	^	choice of supplier	v
network expansion	^	network flexibility	v
prescribed pricing	^	dynamic pricing	v
fixed tariffs	^	real-time tariffs	v
kWhrs	^	energy services	v
one-way control	^	interactive control	v
macro profiling	^	micro profiling v	

As more demand-oriented signals are sent; from regulatory bodies through revised pricing regimes; through Government commitments to economic competitiveness and environmental efficiency, from the novel demands for energy services from users and critically; through more exacting market conditions; we are beginning to witness a shift in the 'logic' driving electricity provision. *DSM* is part and parcel of this transformation. The desire for close control of local network operations is encouraging experimentation with more sophisticated demand-management techniques than hitherto practised. It is in this context that we find American style *DSM* receiving wider attention amongst *REC*'s.

3. Emerging Logic's of Electricity Supply

As these changing practices and strategies of electricity supply enter the gaze of planners, policy-makers, social scientists and development professionals it becomes essential to locate infrastructure provision in a wider context than hitherto. This entails explicitly labelling processes of infrastructure provision to new developments which have previously remained 'un-named'. We can begin this exercise by highlighting the ways in which American *DSM* strategies can be distinguished from conventional 'Anglo' approaches to service provision. This has the virtue of stressing the contingency of what was previously taken for granted. Simply that there are a variety of ways of providing electricity to end users. Calls for the importation of *DSM* strategies to the Anglo-electricity industry pre-supposes a critical stance towards traditional practices of infrastructure investment. By highlighting American style attention to demand-management, the conventional Anglo emphasis on accelerating "electricity through-put" can be illustrated. In this way we can begin to unpack what re-orientation of infrastructure provision is likely to follow a shift in supply logic:

Facilitating Infrastructure Supply - FIS

> The mode of service provision characteristic of the monopoly era can be distinguished as one of *Facilitating Infrastructure Supply* (hereafter *FIS*). Shaped by a marketing strategy directed towards volume sales through network

expansion the logic of the *FIS* strategy is to maximise the capacity of the system. This encourages standardised practices of infrastructure provision aimed only at extending the network and 'spinning the meter'. Requests for increased supply are rarely questioned and users are encouraged to 'plan-ahead' by installing increased capacity transformers. Such a mode of provision tends to generate little debate about the energy performance of new buildings during the development process. Simple compliance with regulated standards of energy efficiency is routine practice, with little explicit consideration of social or environmental issues.

Demand-Side Management - DSM

Incorporating the provision of electricity to new developments within a wider *DSM* strategy encourages consideration of the impact of new demand on the existing network. This in itself is not new or different. Electricity suppliers have always had to plan and manage networks in order to service new demand. The difference in a *DSM* scenario is that extending or re-inforcing the network is not the automatic impulse of the utility. Desire to maximise the efficient use of the existing network may encourage the utility to intervene in the shaping of demand 'beyond the meter'. In the case of planning infrastructure provision to new developments this may result in both retrospective energy-saving action in existing buildings serviced by the local network, and direct intervention within the current development process. Escaping the routine interaction of Utilities and developers/builders, *REC*'s involving themselves in this active shaping of demand are likely to be directly participating in micro-debates about forms of heating, lighting and services control that *REC*'s have traditionally ignored.

Labelling 'ideal types' of infrastructure provision in relation to their primary focus on 'supply' or 'demand', *FIS* or *DSM*, is a simplification of complex processes. The dynamics of electricity provision are unlikely to be so neatly captured. Echoes of past supply network management styles will certainly colour the emergence of any future electricity planning strategies. Nevertheless, constructing such a vocabulary allows us to cautiously assign generalised organisational, procedural and technical characteristics to different modes of energy provision. We can then locate tensions between these opposing "logic's" of electricity supply;

FIS	*DSM*
maximise supply capacity	balance supply/demand
separation of *REC*/user by meter	*REC* intervention 'beyond meter'
little concern for current demand	retrospective energy-saving
little debate over new demand	energy audits/advice
standardised practices	practice locally determined
compliance with building standards	building standards exceeded
No social/environmental interest	Social/environmental benefits

Uncovering the extent to which *FIS* and *DSM* strategies of electricity supply creates an upward (*FIS*) pressure or a downward (*DSM*) pressure on resource utilisation illustrates the environmental impact of utility practices. We have seen how within *FIS* logic there is little sense in *REC*'s extending their influence beyond the meter. With less stress put on network efficiency utility planners are content to leave 'cold' parts of the network, where surplus supply capacity exists, until new demand 'appears'. Similarly, 'hot' parts of the network, which experience excessive demand, tend to be re-inforced if further demand is generated. In this traditional mode of practice, utility services are limited to advice on the cost and availability of electricity. Marketing is limited to encouraging the individual use of 'more' kilo-watt hours through the capturing of investment in electric rather than gas manufacturing plant. For energy to be taken more seriously the normalisation of *FIS* development practices clearly needs to be shaken. A change in emphasis, from the enhancement of supply to the modification of demand, suggests a new form of identity for *REC*'s. Shifting from a logic of supply to a logic of services, *REC's* have the opportunity to re-invent themselves.

Viewed this way, we can locate a proliferation of *DSM* initiatives within a wider re-orientation of electricity supply strategies as Utilities evolve into an increasingly uncertain future. While REC's employing a *DSM* strategy may be happy to see meters spinning in 'cold' parts of their network, they make take rather a different view about 'hot' elements. Rather than investing heavily in new infrastructure or turning simply away new customers, REC's will maximise the performance of the network through strenuous load management techniques.

The emergence of this 'new' energy management strategy depends upon extending traditional utility services 'beyond the meter'. Instead of merely re-acting to new demand, as in the *FIS* model, *REC's* must begin to actively manage the development of new demand in real-time. This means anticipating and shaping new demand as it emerges through the development of the built environment. Identifying the 'energy managers' of the future means tracing the networks of power that thread their way through everyday construction processes.

4. Case Studies:

4.1 Electricity in Development.

Until now little attention has been paid to the provision of infrastructure within development processes (Marvin,1992). Given the force of debates around the construction industry and 'sustainability' (SPR,1992) this seems surprising. Opportunities for shaping the intensity of energy use are embedded within seemingly routine choices taken in the process of construction. Not that is simply a case of identifying a standardised, procedural chain of 'energy' related decisions. The process is more messy. Complicated by a contradictory mix of a users idealised demands, budgetary constraints, occasional delays and organisational conflicts, the final specification of a new building development is rarely a text book design. The energy profiles of new buildings rarely escape these pressures. While model guidelines for the planning and installation of utility supplies to new building developments exist, the reality is often different (NJUG,1983). The internal procedures and priorities of developers, builders and Utilities often conflict. Co-ordination of service provision with wider construction activities can be a fraught affair with mutual incomprehension characterising negotiations. Privatisation of Utilities has compounded this confusion, adding the uncertainty of choice to what was a fixed necessity. Charting the emergence of a building's energy profile demands picking through an uneven set of decisions embedded within broader building processes.

Standardised Practices, Variable Processes

Production of the built environment is shaped both by the rules and standards of traditional, almost standardised practices and the unpredictability of building processes. It brings together a diverse group of tradesmen, designers, labourers, engineers, financiers, together with potential occupiers, who often have little idea of the building process. Within this ordered, but often chaotic endeavour, a series of choices are made which influence and mould the eventual form and specification of the building. Not all of these relate to energy of course. But different patterns of choice can constrain or encourage enhanced energy performance. Recognising patterns of negotiation between *REC's*, developers and users on energy issues demands tracing paths of accommodation and resistance to increased efficiency. These "trails" tend to be elusive, lost in the undergrowth of mundane familiarity. However, somewhere within these ordinary development processes lie the opportunities and "about-turns" of current practice which may lead to more efficient buildings.

Changed practices do not come about without good reason. Relationships between Utilities and developers/builders have been ordered by many years of routine interaction. While specific technical challenges may vary from project to project, negotiations and solutions have become relatively standardised. Alternative development practices will only emerge from a re-ordering of priorities by an active player in the development game. In America, Local Government and Utilities have taken such an initiative (Fickett, Gellings & Lovins,1990). With the British Government presently taking a backseat on energy policy a rather different community of interests must be developed before *DSM* programmes appear (Taylor

& Vilnis,1992). Mutual interest, between Utilities, builders and users, in the tailoring/reduction of electricity demand, needs to evolve. This would encourage a new emphasis on the minimisation of resource use in the development of new buildings. Energy-related specifications would be reviewed and spiralling energy requirements questioned.

Such dramatic transformations in the role of Utilities is unlikely to occur instantaneously! The re-modelling of Utilities will take place gradually as the contexts of service provision alter. We are only at the beginning of this process. Happily, there are a few 'first flowerings' of the *DSM* logic appearing. Most notably MANWEB have adopted a *DSM* strategy on the island of Anglesey. The MANWEB scheme allowed assessment of the impact of a *DSM* strategy of electricity provision on the final energy profile of a new factory. Comparing the negotiations between utility, developer and user in the construction of the new Wells Kilo factory with those of a similar factory, for Fluoracarbon, conventionally (*FIS*) supplied by NORWEB, presents a number of key questions about the shift from energy supplier to energy manager encouraged by *DSM* logic;

- What pressures and priorities shape user/utility choices of service provision?
- What re-modelling of interests takes place when *DSM* principles are adopted?
- 'Who' exactly is managing the flow of energy resources to new building developments?

Case Studies

4.2 Building in Energy: Facilitating Infrastructure Supply:

- (the case of Fluoracarbon: Irlam, Manchester)

The new Floracarbon factory on North bank industrial estate near Irlam, Manchester, is noteworthy both for its typicality as a purpose built 'design and build unit' and at the same time for the history of disagreement, delay, compromise and resolution which marked its construction. Indecision, additional requirements and confusion over pricing emphasised the degree of uncertainty marking Fluoracarbon's grip of the construction process. Fluoracarbon's initial specification 'wishes' were frequently tempered by stringent auditing. Attention payed to energy performance was similarly characterised by innovative proposals conceded to wider priorities. This is a familiar construction story, confirming the maze of decision-making which surrounds the implementation of *DSM*.

New Factory Developments

Having grown to become one of the United Kingdom's largest manufactures of PTFE lined pipework systems for the chemical industry, Fluoracarbon had become increasingly aware of the limitations of its previous factory location. The main problem was the split nature of the site. The 'linings' division was located in two closely situated, but quite separate factories. This meant transferring material across an open courtyard which was both undesirable and inconvenient. These sites were rented. The 'sheet and tape' process was located in a further isolated building, owned by Fluoracarbon itself. With the lease coming up for renewal on the rented property, and the linings division growing steadily, the decision was made to centralise production in one, company owned building. Having decided on ownership, the first of a string of decisions presented itself. To buy a used or ready built factory or to build themselves. In terms of the growth of electricity demand these decision are immediately important. With an existing construction there is less room for energy innovation. The electricity supply is established and heating, ventilating and lighting systems are in place. A new building presents wider scope for highlighting energy efficient features. Thermal regulations will be stiffer and specifications can be developed from an ever expanding range of novel conservation technologies.

Designing and Building

Negotiations between Fluoracarbon and Manchester's Trafford Park Development Corporation inspired the purchase of some reclaimed land on the site of what was Irlam steel works. Reclaimed and prepared for construction by the Corporation, the land came at a reasonable price encouraging Fluoracarbon to custom-build their factory. This pitched Fluoracarbon into a long series of decisions for which experience had not prepared them. This had consequences for the building's energy profile. The first judgement concerned the procurement option (Turner,1990). Traditional, design and build, or management. Each system has its own pros and cons, and each presents a different order of opportunity for energy innovation. Briefly, in the 'traditional' system, design and construction are contracted separately. Specifications are more rigidly 'set' before the start of construction. This splitting of responsibility between the design and construction teams can discourage innovation filtering up from the building contractors. High energy standards then become dependant upon initial commitment of the clients themselves, who must normally approve specifications before commencement of construction. In contrast, the 'management' system encourages the involvement of the contractor, who is engaged as the specification is being developed. It also allows more on-going, interactive involvement of the client with the development of specifications but demands relevant skills/knowledge beyond the grasp of most clients. This system further increases the risk of the client to escalating costs. Fluoracarbon's preferred choice of 'design and build' meant they would know the scope of their financial commitment before construction commenced. Unlike 'traditional' procurement options, the contractor would be responsible for failures and delays, meaning the project would be more swiftly completed. But design and build also tends to place responsibility for specification proposals with the contractor who must juggle the clients often contradictory concerns about quality and cost (Franks,1990). On-going improvements to specifications are therefore unlikely due to the disruptive and relatively high price to both contractor and client. Moreover, the finalising of specifications involves a continuing process of translating idealised client 'wish lists' into workable proposals, only for the clients red pen, driven by bottom line cost, to cancel 'superfluous' details. Energy considerations are, again, likely to be a victim of this process.

Technical Editing

This 'technical editing' occurred constantly at Fluoracarbon where the cost imperative was paramount. The production of a services specification was typical. Concerned to limit expenditure Fluoracarbon commissioned a consultant to draw up a detailed proposal of electrical services. The specification was based upon the requirements of Fluoracarbon, expressed partially through an informal roundtable meeting in which senior staff requested particular facilities. Conservation measures were among these, with remote sensored, 'high/low', energy-saving lighting control system requested as part of the specification. Interestingly, the consultants themselves made no special recommendations as far as conservation or efficiency were concerned. Standard practice advocates the simple reflection of clients wishes. This conservatism was endorsed when, having been put out to tender, the resulting quotes shocked Fluoracarbon. The contractors felt this expressed the naiveté of the company who had little experience in building procurement. Nevertheless, out came the red pen again, requesting potential sub-contractors find ways of reducing costs. At £3,500 the 'high-low' lighting control was an obvious target and both competing contractors deleted it from their specification.

NORWEB, Electricity Supply - High or Low voltage?

The light electrical contract was won by NORWEB themselves. It was hoped that this might speed up the delivery of the main electrical supply, also the subject to delay as the internal organisational cogs at Fluoracarbon wound slowly on. The wrangle over electrical supply centred on the choice over low or high voltage supply. In one sense this decision may seem a marginal, almost 'irrelevant', technical issue. But in terms of the growth of electricity networks such choices are critical. At issue is potential growth in energy consumption and expansion of the electricity network. Again the debate at Fluoracarbon was over cost. A Fluoracarbon manager at a different factory, in Hertford, was buying low voltage electricity from Eastern Electricity at a cheaper rate than high voltage electricity from NORWEB. In this era of privatisation, why couldn't Eastern supply Fluoracarbon in Manchester? This query set the scene for a drawn out debate over initial cost, on-going charges and long term viability. Here projections of future growth had to be balanced against the extra costs, transformer and cabling, of installing a powerful high voltage supply. Appraisal of energy 'needs' became critical. Different factors can influence this assessment. Calculation of current consumption was problematic given the previous split of each production process into three sites, each with its own heating and lighting systems. Estimation of single site requirements, based upon current demand, had to be set against assessment of future growth. The *REC*'s mediate this appraisal, recommending purchase of a higher rated transformer (the increased cost of which they make relatively marginal). While users are not immediately charged for full use of the higher rated transformer it does mean consumption can be raised later without additional capital outlay, 'safeguarding' the user. But the *REC* must immediately cater for this potential growth in consumption through their own internal network planning. This means the network is effectively expanded before new demand occurs. With marginal costs between the two systems rising in favour of high voltage as anticipated consumption grew, Fluoracarbon decided to opt for a high voltage supply.

Construction and the Logic of Supply

This supply-oriented logic of 'anticipated growth' is characteristic of *FIS* approaches to infrastructure provision. If neither the utility or user prioritises energy performance, there are likely to be few checks on growth of demand. Similarly, with the client constraining the overall project through close attention to cost, the contractors involved are unlikely urge greater attention to energy efficiency. The lack of attention to energy questions at Fluoracarbon is typical of construction processes. The thermal requirements of the building regulations were not exceeded, while service specifications were closely scrutinised for cost and feasibility rather than performance. Utilities tend to have little interest in challenging these standardised procedures. Options for greater efficiency are only explored in relation to potential capital savings. In the case of the Fluoracarbon factory the sub-contractors suggested switching from high to low bay lighting, effectively halving lighting lux levels requirements. Having witnessed a similar system in a nearby factory Fluoracarbon were happy to make this revision to the specification - saving money and, by the by, some energy.

Already we can see the muddy path that stretches from the idealised realm of the user's energy efficient 'wish list' to the final energy profile of a new factory. The adoption of proven, effective technologies takes place within a commercially charged space overwhelmed by competing claims for attention. Technical choice is not simply related to the knowledge or ignorance of electricity users, Utilities or building developers. Other demand management strategies occur spontaneously at Fluoracarbon, as a matter of good business practice. Curing ovens are started up overnight so they are already hot, and therefore only operating on one fifth of the power, by the arrival of peak cost band. Shot-blasting is performed over lunch periods while other machines are off-load. Even the lack of automatic energy-saving light switching can be compensated for by effective factory management, manual switching! Lack of any more co-ordinated conservation strategy is due to the overwhelming immediacies of standardised, paired-down construction practices. Capturing the full sense of this layering of considerations demands sensitivity to a process in which costs rose from £900,000 to £1,300,000 as a result of indecision, uncertainty and delay: Confusion over the source of the electricity supply resulted in a much longer cable run becoming necessary, adding £4,500 to the services bill; indecision over the situation of special 'pits' for heavy presses meant late revisions to construction costings; contractual liabilities meant the roof had to be installed, removed for the emplacement of heavy machinery, and refitted, increasing installation expenses. Making it through this maze of co-ordination necessitated novel 'ideas' fitting the no-frills character of a project. This pressure on innovation is further highlighted by comparing the cost of the factory project with the overall cost of Fluorocarbon's capital equipment outlay. In this harsh commercial environment energy innovations were simply squeezed out. Resisting the squeeze of commerce requires the appearance of a powerful new energy-saving interest. Comparing the energy-story of Fluoracarbon with that of a similar factory, built and serviced within a DSM scenario, reveals a different ordering of development priorities.

4.3 Building-in Energy Efficiency - Demand-Side Management:

- the case of Wells kilo

As the branch of the MANWEB's distribution network serving the island of Anglesey started to become 'hot', an ideal opportunity presented itself for evaluating a *DSM* strategy. With only two 33 KVA sub-stations meeting a peak demand of around 9 mega-watts, growing 2% per year, expensive network re-enforcement (roughly £1 million) seemed inevitable. Here, it seemed, was the ideal opportunity to implement a *DSM* scheme. By reducing demand peaks by one mega-watt clear savings in infrastructure investment could be identified. Further benefits would accrue in terms of reduced refurbishment outlay and beneficial publicity.

It was estimated that £0.5 million would be spent on the project. The European Community contributed £80,000. MANWEB spent £420,000 on the scheme which would lead to a saving of £430,000 by avoiding the need to invest in a new transformer. Further savings would be achieved through delaying refurbishment costs. Wear and tear on the network on Holy Island is particularly severe because of the harsh coastal environment. An electricity network runs much more efficiently and needs less upkeep where the demand curve is flat - the higher the peaks, the quicker the network will deteriorate. By reducing peaks in demand, DSM expected to reduce refurbishment costs considerably. The associated savings are difficult to quantify, but the capital costs of new equipment in an electricity supply network are immense. If the life span of equipment is increased by 50% significant economic savings are possible. For instance MANWEB has 1.3 million customers and spends £50 million per year on their distribution network. If applied on a large scale, DSM holds the potential for cutting costs in refurbishment as well as in costs of new supply and transmission (Kelly & Marvin,1994).

Holyhead Powersave Project

The Powersave project was inaugurated with great publicity. Research was conducted into the energy profiles of the islands housing stock, through detailed questionnaires about current insulation levels and more complex monitoring of selected industrial and domestic buildings (Simmons,1993). On the basis of this profile numerous energy-measures were introduced;

- Two energy-saving light bulbs were offered to approximately 3,500 households on Holy Island, at a cost of 70 pence each (normal retail price would be around £10 each). The exercise was administration by the Holyhead Opportunities Trust, who installed the bulbs to ensure their usage.

- MANWEB installed roof insulation and comprehensive draught-proofing for £16, a fraction of the real cost. Hot water cylinders were lagged and inadequate lagging brought up to standard, free of charge. A local installer approved by NEA undertook this work, again paid for by MANWEB.

- MANWEB granted £70 to customers replacing their appliances providing they choose an energy efficient model.

- Small commercial customers received the same low energy light bulbs and hot water cylinder insulation offers as householders. In addition a "switch off" night was promoted, aimed at significantly reducing evening peaks.

- Individual energy audits/advice was offered free of charge on request.

Take-up among domestic users was surprisingly high, with about 80% of MANWEB's customers responding to the offer of cheap compact fluorescent lights. However, much depended upon the response of the 37 industrial users. Here implementation was more difficult. Delays in take-up of energy-efficient technologies was more protracted with investment decisions depending upon drawn out management negotiations. But success was also evident here. Most notably in the adjustment to development processes effected by MANWEB's direct approach to users through free energy audits.

Wells Kilo - Shifting Sites

Wells Kilo is one of four big industrial plants on Holyhead, producing children's toys and play apparatus - slides, swings, prams, push-chairs. At the time of the Powersave project they were occupying a relatively small, post-war factory which was both inefficient and gloomy. Their situation was complicated by the fact that the factory was being replaced in 18 months to make way for a major new road. This meant they were in the process of building a new factory, developed by the Welsh Development Agency (hereafter *WDA*) as part of a compensation deal. Wrapped up with surviving in rapidly decaying accommodation and untutored in the complexities of factory construction, Wells Kilo were following a standard development pattern, with the *WDA* acting as construction managers. Energy considerations were again falling by the wayside. The production of service specifications had followed a similar path to that of Fluoracarbon. Consultants produced a design which costed, tendered and won by small contracting company. Little attention had been payed to energy efficiency in the design of the specification, despite the building exceeding thermal requirements of the building regulations as part of the *WDA*'s corporate environmental commitment.

Auditing Energy Change

MANWEB approached Wells Kilo and introduced the idea of Powersave project. Initial contact was limited to a free energy audit, involving a couple of days of monitoring individual pieces of equipment. This provided a profile breakdown of demand 'beyond the meter'! The result were astonishing.

The factory, dating back to the war, was typically dark and dingy. The lighting and heating system was old and inefficient. Production was labour intensive, with lots of energy used in manufacturing through energy expensive machinery. Consumption was measured at around 300 Kwatts, varying at different times of the year, at a cost of £57,000. Importantly, both costs and demand were expected to rise in the near future, a scenario which would not have worried a REC driven by *FIS* logic. But, given MANWEB's *DSM* criteria, this was of great concern. Walking around the factory

- locating possible improvements to lighting, cooling systems and identifying the more inefficient machinery, injection moulding machines and compressed air apparatus - the potential for energy-savings were clear.

Some savings became immediately obvious from historical billing data. The most stark example was the power-factor correction, designed to off-set supply losses introduced by the phasing of Wells Kilo's machine plant. Wells Kilo were paying more than £2,500 per year in kVar charges. Investigation soon provided an explanation. One power-factor unit was only working at 40% capacity while the other was completely out of action. This had been the case for as long as anyone could remember. While evidence of technical failure existed in each bill, the necessary community of knowledge (utility) and interest (user) had not conspired to provoke a query. Powersave provoked this blending of interest. MANWEB concluded that these kVar charges could be entirely avoided with minimal investment, with further improvements releasing around 97kVar to the network.

There were many other energy-saving avenues. Lighting contributed another 40kW of demand annually, at a cost of almost £8 000. Again there was terrific scope for increased efficiency; Some twenty 100W lamps could be replaced with 15W compact fluorescent lamps saving 1.7kW of demand and £400 per year. The simple reduction of yard lighting form five tungsten halogen lamps, (three of which were permanently off and two of permanently on), with two higher efficiency SON or SOX lamps would reduce winter demand by 0.5kW. At £300 the payback would only be three years. The majority of remaining lamps, conventional 38mm florescents could be replaced with 'thinner', 26mm models (more efficient, higher light output). Savings here would be two-fold. The number of necessary lamps would be reduced while the remaining lamps would consume less energy. Altogether 6.1 kW could be saved at a cost of £1700, payback less than a year. Improved lighting control could save a further 7.7 kW.

The list went on. Reducing leaks and stepping down the pressure of the compressed air apparatus would reduce demand by 5.8kW, while introducing a simple thermostat to a water cooling system and cleaning the pump filters would save a further 9kW. Adding these savings together would reduce electrical demand by some 40kW (13%) and costs by £9 600 (17%). Notably, none of these potential savings necessitated advanced conservation technologies. The power of the *DSM* strategy is the simplicity of demand measures involved in the re-shaping of electrical loads. The success of MANWEB's strategy was again apparent in the electricity bill. Comparing May 1993 with May 1994 we find a reduction from £ 5,273 to £3,770. This highlights the stark contrast between *FIS* and *DSM* approaches to service provision. When the meter no longer acts as the frontier of utility activity novel energy questions arise. Electricity ceases to be taken for granted and greater attention is directed to the factory as an energy system. In the case of Wells Kilo's new development this was critical. Without the action of MANWEB it is even conceivable that the faulty power factor correction system could have been transferred, installed and forgotten in the new factory!

This new wave of energy awareness did not stop at the heating, lighting and control systems. MANWEB were particularly interested in the impact of the production process on Wells Kilo's energy profile. Most strikingly, monitoring revealed the gross inefficiency of the injection moulding machines, which were costing between £3.50 and £5 an hour in electricity charges. A quick bit of market research concluded that 'state of the art' machines, of comparable capacity, could run at 80 pence an hour. The latest machines were also quicker, safer, and operated automatically allowing overnight production runs. Interestingly, the factory manager had been aware of the operational difficulties of the machines, but lacking 'evidence' found it difficult to approach the directors. But with the capital costs of a new machine covered by energy savings over three to five years, the energy argument proved persuasive and a new machine was purchased.

Given that Wells Kilo were preparing to move to a new factory the following year, all the savings identified would clearly not be cost effective. Each energy-saving measure had to be assessed against its payback period, or transferability to the new factory, and a decision made on implementation accordingly. Moreover, the long term aims of the Powersave project depended rather more on the energy profile of the new factory. MANWEB came in late on design of new factory - the physical body had already been erected - but there was still time to comment on the services specification. MANWEB offered their energy consultancy services free of charge. A series of recommendations were presented to the hired contractors including the latest high frequency lighting, effective thermostatic heating regulators and magic eye energy-saving lighting controls. There was little debate and the specification was upgraded.

5. The 'New' Energy Management?

Electricity in Development Dramas

The development dramas of Fluoracarbon and Wells Kilo are not unique. In fact, those involved concurred on the relative ease of each project. The tensions that surfaced were the standardised strains that tend to accompany any construction project. Within the development process energy questions tend to become trapped somewhere between the standardisation of building processes and the haphazard nature of their execution. While appearing quite contradictory, these processes rely on and re-inforce each other. Increased competition and greater attention to costs is accelerating the standardisation of development, thereby extending control over the complete project. The growing popularity of 'design and build' is evidence of this. Yet the unpredictability of building processes is never quite contained within this organisational ordering. Careful management of the disparate element of design and implementation is evaded by unforeseen events and changing circumstances, prompting a struggle between clients, builders, designers for even closer control of construction. Energy-related concerns become sandwiched within competing spheres of concern; spatial flexibility, speed of construction, durability and commercial viability. While energy considerations slice through these disparate elements they lack any degree of priority and so rarely make an impact. Each 'layering' of choice - technical, spatial, organisational, procedural - opens or closes avenues of opportunity for influencing the eventual energy profile of a building. Spontaneous 'ideas' for energy efficient innovation - such as energy-saving lighting controls - are trapped or released depending on the degree to which these 'ideas' accord with technical, commercial or production priorities.

This is a problem as demand-management strategies depend upon technical choices which conserve energy. But without some additional stimulus to energy-saving action there is little incentive for construction professionals, or Utilities, to emphasise energy questions. Driven by a *FIS* logic *REC*'s are unlikely to actively promote energy efficiency beyond promoting the traditional 'wise use of electricity'. This limits channels available for energy efficient innovation. Improvements are always likely to be piecemeal, partial, with limited effect on the final energy profile of a building. We have seen how in the case of Fluoracarbon ideas floating up from the shop-floor came to be tossed aside as they clashed with competing claims of budgetary priority. If energy-related decisions are to have a more substantial impact they have to escape their customary place at the margins of the development process to take a more pivotal role. But how does this happen given the standardisation of construction practices?

Competitive Energy

Privatisation has begun to send ripples of change through this strategy. Whereas in the past re-enforcement of 'hot' elements of the network would occur almost automatically, now the capital outlay must be closely considered. With kilo-watt allowances per customer presently worth around one fifth of pre-privatisation allowances, most of the costs will be passed onto the customer. This can influence location decisions of companies seeking new space and of existing companies considering changing their production processes from gas to electricity. Just such a situation exists at North bank industrial estate where Fluoracarbon is now situated. Here the network is getting increasingly 'hot'. Any new arrival at North bank with a large electrical demand will be asked to pay around a million pounds or more for a new sub-station. An existing customer already wants to change his heat treatment facility from gas to electricity but, requiring an additional eight mega-watts, is faced with a potential investment of 1 & 1/3 million pounds for a private sub-station.

This hiatus in approaches to network management is being breached by cautious experimentation with demand-management techniques. In the case of NORWEB 'hot' networks in the Lake District have been 'cooled' by staggering automatic control of economy-seven heating systems. In Grasmere NORWEB prevented expenditure of one quarter of a million pounds on re-inforcing the network by simply spending fifteen thousand pounds, around five pounds per customer, on the use of remote switching. This reduced load by twenty per cent, postponing further action for another five years.

Importantly, this demand management was achieved without conventional energy efficiency techniques. Achieving a similar load reduction through the use of increased insulation would have cost about three hundred pounds per customer. This initiative is perhaps best seen as an extension of traditional load management methods, encouraged by a new found hesitancy to invest in new infrastructure with quite the same enthusiasm as in the past. More radical *DSM* initiatives are dis-trusted. Again, this is not just wilful conservatism. NORWEB have conducted a six month, thirty thousand pound evaluation, which sought to cost necessary load reduction in Keswick, thereby preventing capital expenditure of half a million pounds. Unfortunately, they found it would cost almost as much to *DSM* the system which, with current load growth profiles, would only defer re-enforcement by six months. Instead they are putting in more tele-switches and some additional cabling to allow connection of a mobile generator when required.

While the relationship between *REC*'s and their customer is still governed by the meter as the frontier of utility activity, there are signs of new network management strategies developing. Despite eschewing full, American style *DSM*, NORWEB and other *REC*'s are increasingly venturing 'beyond the meter' in an effort to control, or at least shift, electricity demand. This gradual movement from 'supply' to 'demand' - from *FIS* to *DSM* - is not by any means an homogenous strategy. *DSM* techniques are taking root only when and where they make sense.

Shaking the Development Process

Comparing Fluoracarbon with Wells Kilo it is clear that *DSM* strategies can make a difference to development, opening new channels energy efficient innovation. 'Grassroots' knowledge and action can surface, as with the replacement of the injection moulding machines, at the same time as a greater commitment to energy-efficiency in consideration of heating, lighting and control systems. Only through the action of an efficiency motivated *REC* is this 'shaking' of the development process possible. There was no compulsion in co-operating with the Powersave scheme, but the free audit meant users had little to lose. On the basis of this newly generated knowledge, most industrial users co-operated, introducing some demand measures.

Of course, the intervention of MANWEB didn't result in a wholesale re-orientation of the development process. Some of the key development professionals, such as the architect, had little or no knowledge of the Powersave scheme. But this may simply suggest that effective energy-saving action is less the domain of the architect, as implied by the flood of material on 'green architecture', and more the sphere of the privatised Utilities. Certainly *DSM* seems more effective method of stimulating energy concerns than conventional Energy Efficiency Office campaigns. Drawing together Utilities and users has a rippling impact on cultural, organisational and economic priorities shaping development practices. Consequently, in contrast to *FIS* modes of electricity supply, *DSM* initiatives encourage the take-up of specific energy-saving opportunities that would have conventionally been missed. Comparing 'beyond the meter' energy management by each utility reveals the impact of *DSM* logic;

Wells Kilo (DSM)	*Fluoracarbon (FIS)*
Aim: Balanced network	Aim: Expanded network
Dynamic utility strategy	Passive utility strategy
Flexible strategy	Standardised strategy
REC as energy manager	*REC* as energy facilitator
Focus on energy efficiency	Focus on energy growth
Energy audit of previous site	No retrospective energy audit
Energy-efficient specification advice	No specification advice
Support in resource-use minimisation	Energy-use ignored

6. Conclusion:

6.1 Live Issues

It is clear that *DSM* can provide social, environmental and commercial benefits for Utilities, building developers and electricity users. However, MANWEB are still evaluating the success of the Powersave scheme. Meanwhile, re-enforcement of the network goes-on. Experimentation with *DSM* is part of an on-going strategy of cautious shift from supply to service. On a one by one basis MANWEB are weighing up the benefits of *DSM* in terms of reduced infrastructure investment, efficient network management, customer loyalty and innovative environmental image. Meanwhile other *REC's,* consumer and environmental pressure groups, and Utility commentators wait and watch. There is much to learn with *DSM* raising numerous questions about knowledge and information and changing territorial processes;

Knowledge and Information

- *Experience* - *DSM* allows Utilities to learn about the behaviour of users. MANWEB are interested in how users react to a utilities presence as an overt 'energy manager'; ie what sort of schemes users are willing to co-operate with, what kind of paybacks they are looking for in any energy investment.

- *Knowledge* - *DSM* raises the issue of measuring/estimating demand. MANWEB are now working very closely with their network services department to monitor the growth of their network. This will allow them to map the operation of the network over the next decade. In this way MANWEB can both "take load back off customers", by releasing identified pockets of spare capacity back onto the network for other users, while locating priority areas for demand-management in order to reduce load levels.

- *Metering* - With *DSM*, new, 'smarter' electronic meters are becoming significant. These 'smart' meters provide more detailed/focused information on user-demand. In Crewe they have offered industrial users free 1/2 hourly smart-meters, covering the communications charge for two years as they pursue research. Metering makes it possible to map in detail the load profiles of their most significant users against MANWEB's overall distribution network. MANWEB can then locate the energy impact of particular production processes in different areas, at varying times of day/night. The potential for *DSM* is then enhanced. Such a process suggest a much deeper, 'beyond the meter', relationship with the customer, while also encouraging users to take a greater interest in their own energy usage by offering the possibility of switching between different tariff regimes.

- *Risk* - there is always a risk element to *DSM*. All *DSM* activity must take place with a cautious eye to the future. Even after MANWEB spent £1/4 million on Anglesey, they may still need to re-inforce in two years time due to rapid economic development in the form of a new, European Community funded harbour.

Changing Territorial Processes

- *Spatial Planning* - *DSM* signals a shift in the way Utilities and customers are relating to one another. Previously MANWEB would have simply talked to users about bulk-tariffs, size of supply, promoting electric heating, air-conditioning and ventilation, in order to expand the network. With *DSM,* MANWEB could end up trying to sell energy efficiency to some users in one part of the city, while trying to stimulate sales of electricity to another user in order to best utilise their network resources.

- *Utility Strategy* - MANWEB have network problems in Crewe (ie. network "hot" - at the point of requiring re-enforcement). There is also a high level of energy intensive industrial users which MANWEB wish to capture as the industrial market is opened to competition. MANWEB's strategy in Crewe is to act as project managers of new and retrofit energy-efficiency programmes. Rather than subsidise customers (as in Holyhead) MANWEB are seeking to actually pay for all efficiency-measures themselves. The "energy-savings" will then be shared to recover the costs/financing. MANWEB hope this strategy will "push" the market in a *DSM* direction while promoting a sense of 'brand loyalty'.

- *City Planning* - *DSM* presents an opportunity for town planners to become more closely involved in infrastructure planning. In Crewe, MANWEB are working closely with Crewe and Nantwich Borough Council in assessing the energy needs of future development activity. Here, development and infrastructure planning can be more closely co-ordinated. For example in the proposed development of an industrial park into which any spare capacity released by DSM measures can be fed. Interestingly, the Borough Council are now asking MANWEB for comments on the energy specification of new development proposals, for example types of lighting in a new office block.

- *Sustainability* - *DSM* faces problems of theft, transfer of technologies (ie low-energy lightbulbs) between domestic dwellings. Another problem is rising productivity due to lower energy costs raising consumption! This makes estimation of *DSM* gains more complex.

6.2 Developing *DSM*

This paper has questioned the notion that US-style *DSM* can simply be copied in an Anglo-electricity market. As many electricity planners and commentators have pointed out, the dis-aggregation of the privatised electricity industry and a franchised pricing structure which has rewarded volume sales does not provide fertile ground for *DSM* initiatives (L&E,1992). It is not surprising to find *FIS* logic guiding *REC* planning strategies. However, the fast-changing pace of the Utility business is leading to constant re-modelling of the conditions shaping strategies of electricity provision. The question we must pose as we gaze into the future is what signals might be sent to *REC's* to encourage them to adopt the role of the 'new energy managers'? Some recent changes to the regulatory regime governing electricity pricing is a good place to start;

Regulating Electricity Costs

- The recent adjustment of the pricing structure of supply of electricity to limit volume related profits is reducing incentive to merely supply more "product". Under the latest supply price control only 25% of the revenue will be directly related to the number of units sold. The reduces the unit related term to less than one-fifth of its previous level (OFFER,1993).

- The new supply price control also grants the REC's an additional revenue allowance of one pound per customer for the next four years (the life of the control) to fund energy efficiency projects. Over the four years this will finance nearly £100 million of new expenditure on energy efficiency (OFFER,1993).

- New 'Standards of performance' have been introduced to monitor energy efficiency spending. Total energy efficiency expenditure of the REC's will be expected to save over 5.000 gigwatt hours (GWh) by 31st March 1988. These 'standards' will be monitored by the Energy Savings Trust (OFFER,1994a).

- The new pricing structure of the distribution business has also reduced the volume incentive by 50% (OFFER,1994b).

- The market for Gas will be opened to competition from 1995, encouraging REC's to diversify, effectively ending the need to promote electricity over gas.

Commercial Responses to Regulatory Shifts

These economic-regulatory changes are likely to re-focus the (*FIS*) supply-demand commercial strategies of *REC's*, prompting local energy-use characteristics to be re-modelled (Mickle,1993). As profits are gradually de-coupled from electricity sales, REC's are likely to diversify around their core business by promoting energy services, including the sales of gas. A new interest in *DSM* may develop as part of these wider commercial shifts;

- A reduction in volume-related supply and distribution profits will mean that new sources of revenue will have to be found to return profit curves to previous growth levels. *Energy services within a DSM framework may fulfil this role.*

- By 1998 an open electricity market for all classes of user will accelerate the competitive struggle between *REC*'s (and other utility companies). This will make commercial growth still more difficult. Unable to rely solely on increased sales revenue *REC's* will have to look at the efficiency of their own networks to raise their profitability. *DSM will help focus this refinement of network management.*

- This competitive process will be further motivated by the increased mobility (and service diversification) of Utility companies. it is likely that a process of organisational cherry-picking will ensue in which poorly performing companies will be picked off by larger, more efficient organisations. *DSM will help capture new consumers while retaining existing users.*

So while it is clear that *DSM* cannot be merely seen as a de-contextualised economic/technical practice that can be mimicked as a "lesson from America", there does seem to be growing potential for *DSM*! Critically, *DSM* will unfold in many guises, depending on the local context of development. In this light we can identify MANWEB's Holyhead project as a 'first flowering' of an increasingly "integrated" approach to utility provision. A more demand-oriented 'logic' of network planning that made less sense in an era when electricity provision was saturated with an *FIS* logic of network expansion. As Ian Brown has put it, changing the basis under which electric utilities perform is beginning to;

"provide the opportunity for utilities to operate in a more environmentally sensitive manner without compromising their commercial viability (Brown,1991)".

Energy utilities are therefore at a "crossroads" (Brown,1991). *REC's* must decide between a 'business as usual' approach, gradually expanding their technical network when and where new demand appears, or to employ new tactics. As elsewhere in the international utility market, *REC's* may begin;

"using DSM as a tool to defend their market share against new competition by making their non-residential service more efficient and economical, via lower bills, not lower rates" (Swisher & Christiansson & Hedenstrom, 1994).

Nothing is certain in the future of the Electrical Supply Industry (Rosenberger,1994). However, *DSM* offers a new image of electricity supply/demand dynamics in which the supply network as an "irrigation system", delivering electrons from a central reservoir to remote customers, is replaced by a system resembling a computer network. Such an electricity system would have;

"...many sources, many customers, and continuous re-evaluation of delivery priorities and management of faults. All customers and producers will be able to communicate freely through this system to signal changed priorities and costs. A modern system would, in effect, facilitate a constantly shifting market for electricity producers and consumers", (Weinberg,1994).

Such a re-ordering of supply/demand priorities provides the key to successful *DSM* initiatives in the future supply of electricity in England and Wales.

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