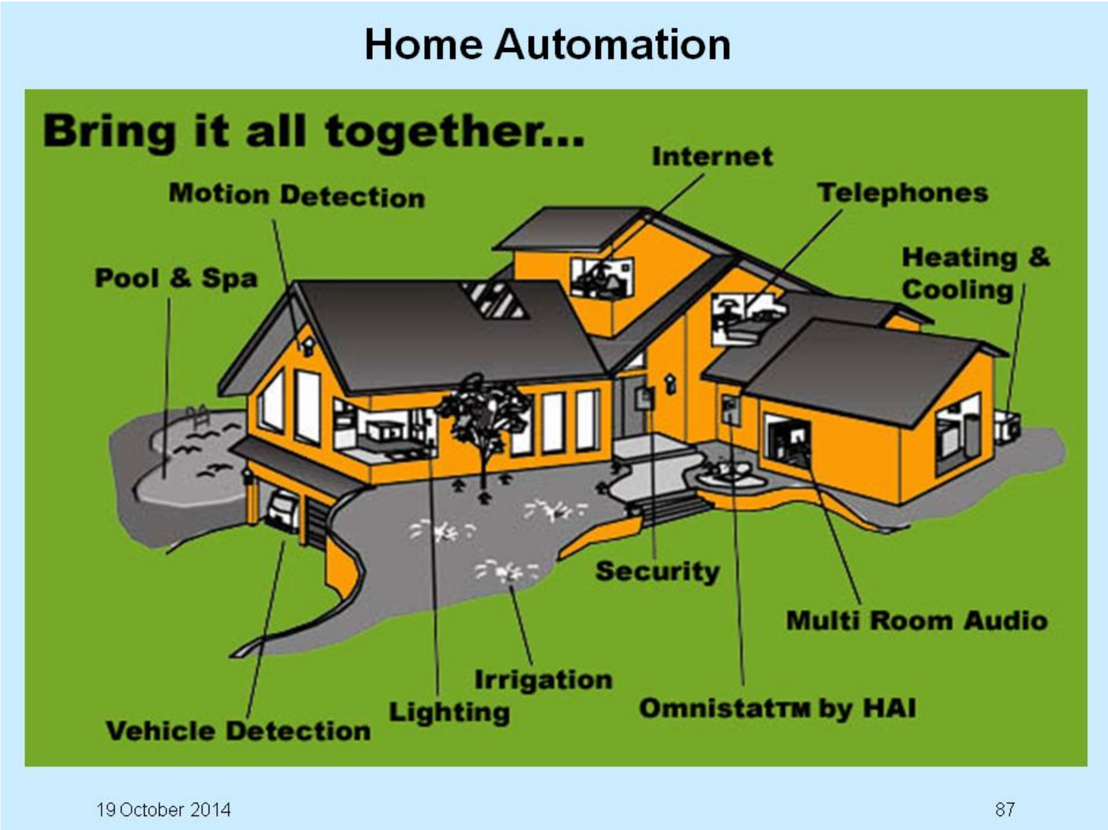
To look at a communication strategy from the bottom up, we need to start at premises level.

There is a considerable move to increase the level of communications within domestic premises for various uses.

At domestic level entertainment, computing and security are driving initiatives for both wired and wireless connections internally. Communication based on digital internet protocol (IP) is increasingly being adopted, apart from simpler analogue signals and commands. IP packet addressing obviously allows more flexibility in handling signals and data between different devices on a single network. There are a number of initiatives supporting home automation and the US HAN project (Home Area Network) is concerned with configuration and coordination of energy management systems. There are a large number of companies offering different solutions to a number of areas of home automation.



This gives rise to a number of different communication systems and it is imperative that standards for data traffic are developed. This will allow a single communication backbone and facilitate interoperability of communication and control units with peripheral sensors and controllers from various manufacturers. A single 'network' needs to be configured from the wired and wireless elements.

The data content standards for energy management need to be defined carefully. Segregated information on power flow for different demand, generation and storage appliances and control signals to same need to be managed to ensure simple analysis of current/predicted states and the ability to vary.

This all leads us to facilitation of intelligent control at premises level, within the overall framework of electricity supply and able to react to current and predicted generation-demand conditions. This can only really be handled by automatic systems and communication through to industry.

High demand (industrial) users can already enter into various schemes with their suppliers to reduce their tariff rates in exchange for participation in demand reduction, but these have tended to be simplistic in the past.

At domestic level, the capability to vary premises import-export power profile needs to be analysed by device type and ability to vary output or input to determine the capability for control. What we are looking at here is the ability to 'time-shift' demand and possibly generation.

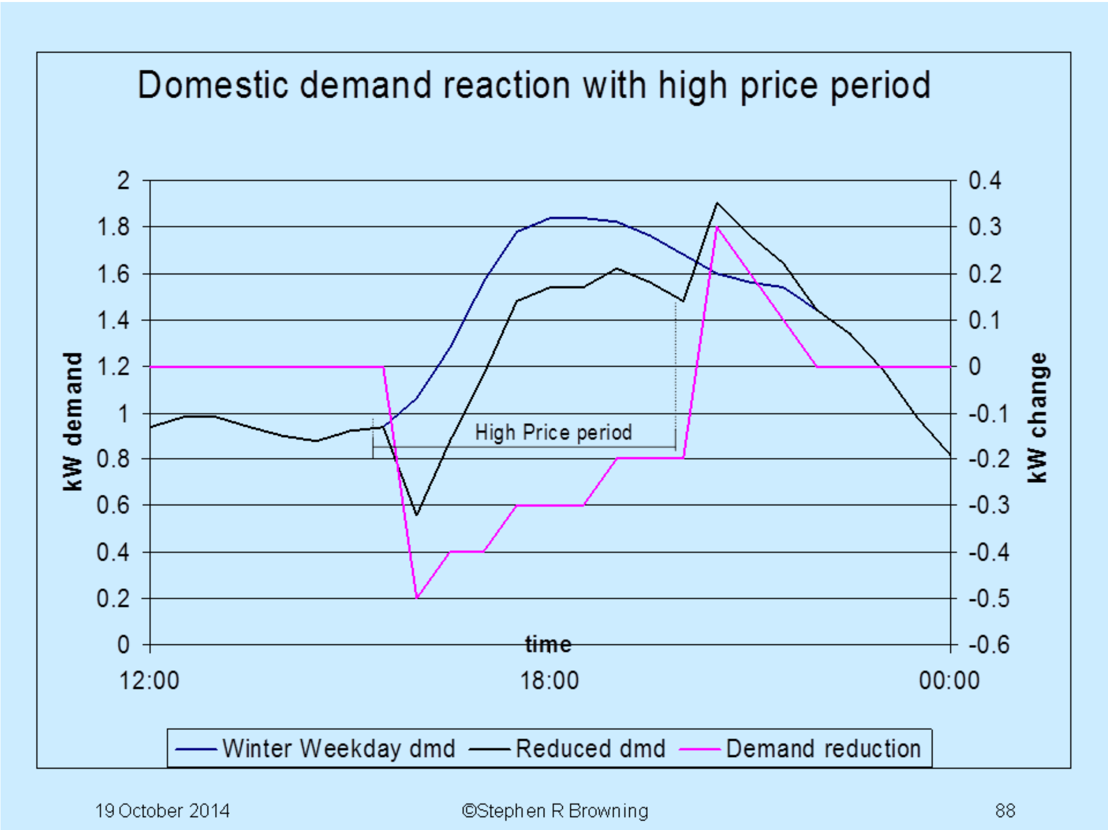
Lighting is time-critical and cannot really have its operating time period altered at domestic level. Likewise, instantaneous water heating, and in the main, cooking and entertainment are also fixed. It is interesting to speculate whether on-demand entertainment might alter time usage patterns, but that is unlikely. On weekdays, only the evening period is normally available to people for relaxation.

Fridges and freezers can have their duty cycles delayed to give some short duration demand reduction shift. However, it has to be remembered that that reconnection will cause a larger overall demand increase as more units simultaneously operate rather than the normal time diversity that would be expected. Control of refrigeration load is only really practical for short term ancillary services provision. The achievable reduction will of course depend on the appliance demand cycle which is in turn related to the temperature at its location.

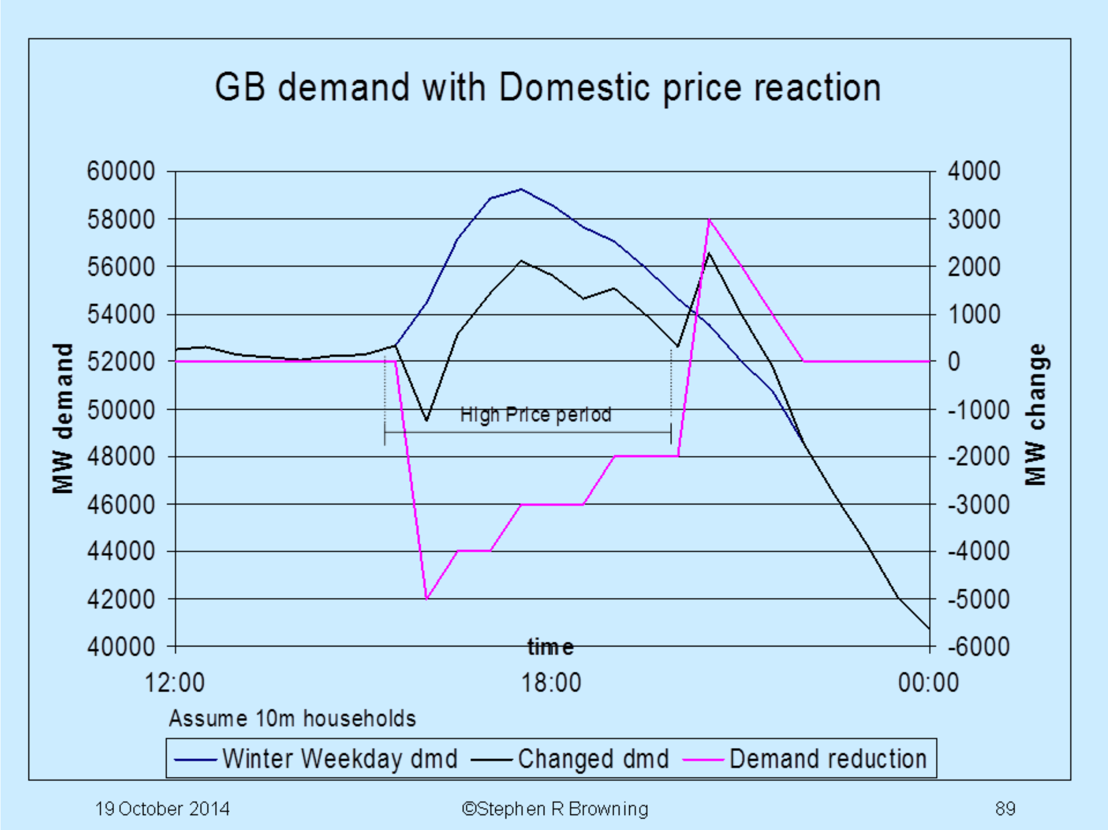
Laundry is a non-time critical load and has been an ideal target for domestic demand shifting initiatives (as in Italy.) The start time can be delayed by time or price signal, but once started, it is not efficient to interrupt operation of the appliances.

In hot climates air conditioning and air cooling are the most important loads to consider for time shifting. The peak demand will occur just after sundown, (combined lighting/cooling,) although some tests with price-varying thermostats have set the high price for a four hour afternoon block. The result of this is a large reduction at the start of the time block, then a gradual decay in the demand reduction over time. At the end of the period, there will be an increase above expected demand as delayed cooling comes back on. This results in a less than optimal reduction at the peak time with a sharper residual peak.

Here is a possible example of the effect of fixed period priced reduction in Great Britain. This is based on the average domestic load shape and includes the increased demand effect at the end of the period.



It requires a large number of households of this type to have a large cumulative impact on Great Britain's demand (see below.)

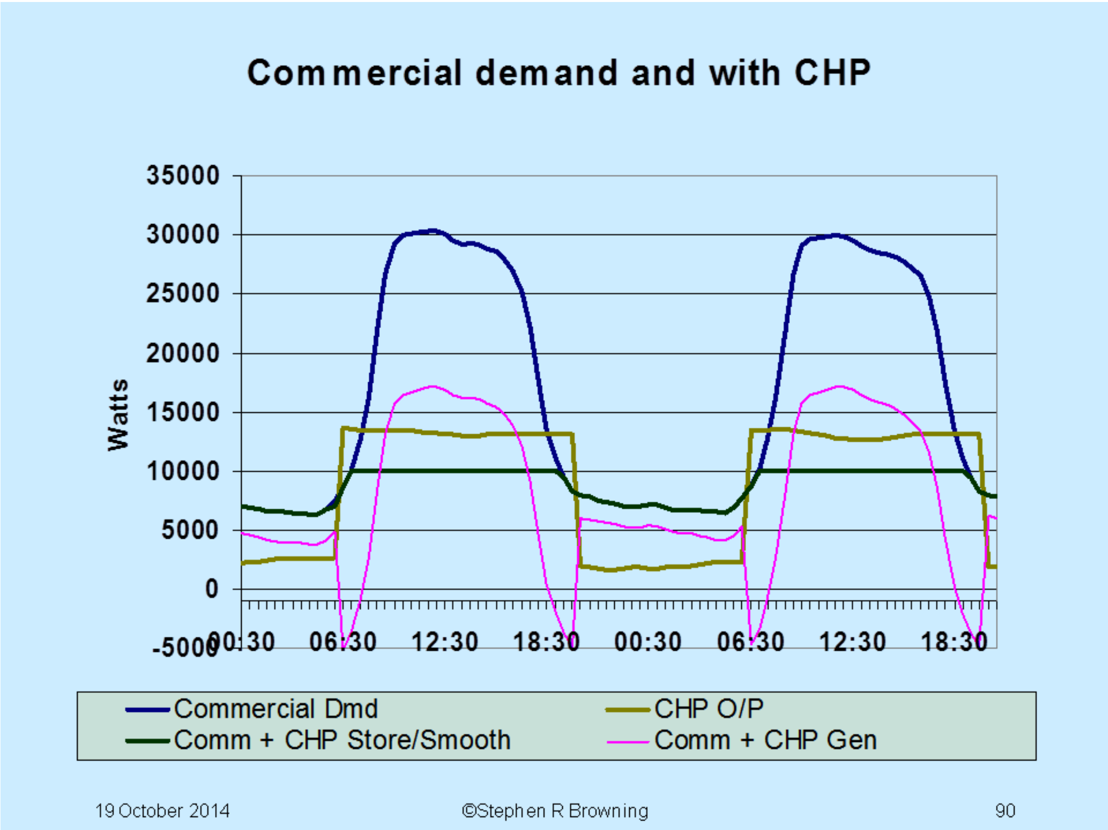


The main contribution the domestic sector can make is to shift the use of high energy non-time critical devices, primarily laundry to the off peak periods, which is already forming the focus of early smart metering applications. The use of dynamic pricing by sector, supplier group or geographical area allows more precise control of the demand to be time shifted (more below) as against simple timed techniques.

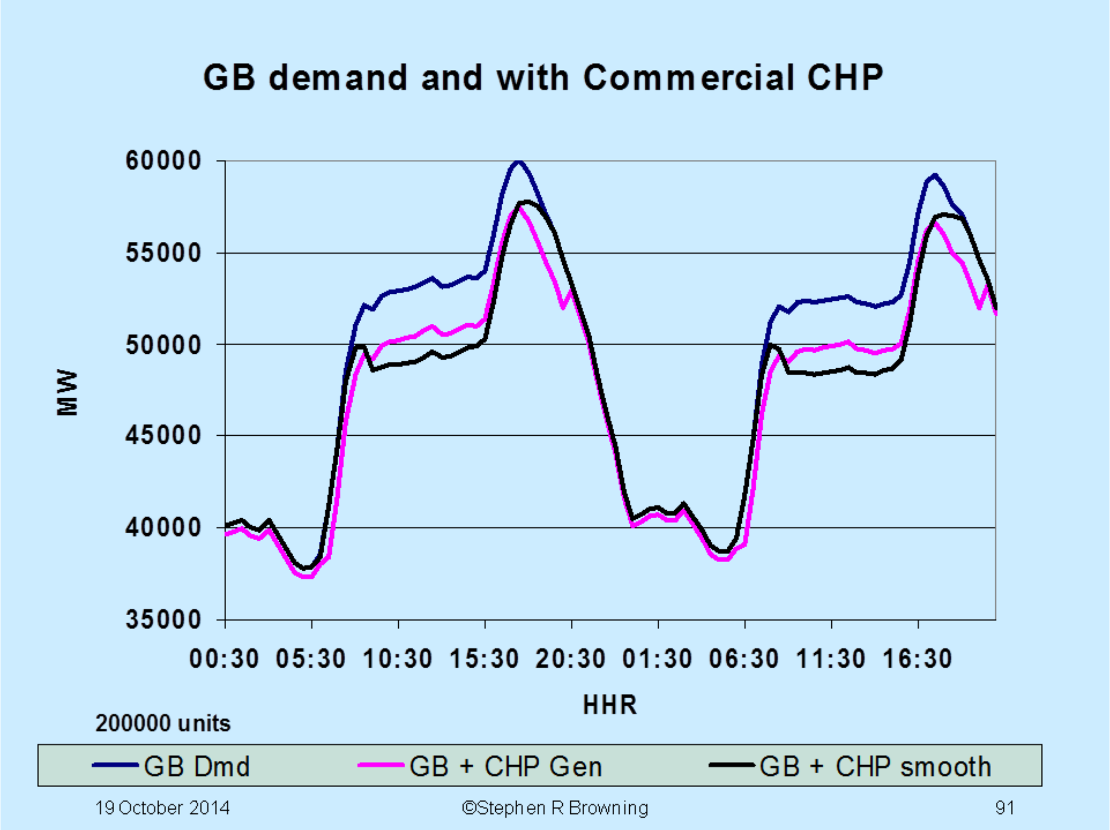
Small-scale renewable generation needs to be allowed to operate at maximum level; to curtail output is a waste of free energy and an extra control complication. However, as we saw earlier, high levels of generation in the low demand daytime period (especially PV) can cause voltage rise and the generation will trip as required by the distribution operator. Some intelligent compensation may be needed, either in terms of optional demand or intelligent voltage control. Storage at individual premises level may be appropriate, but again adds cost and control complications. Microgrid level equipment may be more appropriate.

Commercial premises have a steady daytime demand, mainly lighting and office equipment. The size and scale of larger commercial premises with renewable generation may make storage and intelligent control effective at this level. Intelligent control of lighting at the ends of the working day will also help alleviate local and national demand peaks at these times, caused by the cumulative effect of commercial and domestic demand.

Let us say that we have a large commercial premises with CHP. The following graph shows the premises Import-Export profile, CHP output, and the modified remises I-O profile without and with smoothing (storage). The storage removes export and the peak spikes of the remaining import, which thus alleviates strain on the local distribution system which will allow it to accommodate more customers.



However, against the Great Britain demand profile, the simple smoothing at local level does not improve the load shape. In fact, it actually increases the level of the demand rise for the peak itself, as against the unsmoothed condition.



This all goes to illustrate that dynamic control is necessary to improve the overall demand profile as each sector has a different influence on the load shape. As such, efficient external communication is important.

The industrial sector can control the production loading to some degree, depending on the nature of the manufacturing process. Some trials are already in place as regards short term interruption of heavy electric (induction) heating loads to provide operator ancillary services. Large scale changes to the timing of production runs will need carefully managed communication to co-ordinate.

The most critical area is handling the information on premises consumption and tariff rates and making the owner aware of critical periods, without overburdening and causing disinterest. Automatic monitoring of appliance power, storage and generation states allows estimation of what changes to the forward import/export profile are possible.

Dynamic pricing can improve the load shape further by grading the level of reduction over time. Also, applying price changes on an area by area basis over time will also avoid gross over-reactions. From the customer perspective, predictive price information in advance is also vital. When high prices are forecast, the customer systems can take anticipatory compensating action both before and after the high price period. This will avoid violent changes to the overall load shape across price switches and prevent too much decay in price related demand reduction over the period of application.