Smart Grids or Smart Pricing

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Feeding Renewable Policy Conference
Birmingham University
18th January 2013
Agenda

- Electricity
- Trading and Operating a System Without Storage
  - NETA, BETTA and the Balancing Mechanism
- Renewables and Flexibility
- Smart meters or Smart Pricing – Flowcost
- Settlement
- Discussion
Electricity

- A core enabler of the later Industrial Revolution
- Vital to our daily lives
- Instantaneous Transmission of energy through space – wires and transformers – from generators to consuming devices
- A system utterly without storage
  - Always constrained by energy conversion capability
  - No transmission through time!
- No credible technology alternative in prospect
- Vital change is Renewables not fossil-fuel generation
  - Which is (mostly) timed by nature, not by us
Electricity Supply Industry (ESI)

- “Deregulation” separates functions
- **System Operator** (and usually Transmission Operator) remains a statutory monopoly
- Wholesale competition among generators (who sell to Retailers)
- Distribution monopolies for each geography
- Competition among Retailers (known as Suppliers!) for customers
- Overseen by Regulator (Ofgem) & DECC
- EU now has ENTSO-E
Demand has been Largely Predictable

Figure 2.2 - Summer and Winter GB Daily Demand Profiles in 2005/06
Flat Tariffs do provide a view of the future.
Merit Order

- Schedule plant by Cost
  - But taking into account Constraints
  - Like Speed of change and Transmission
  - Charge SMP

![Diagram showing power generation by hour with various energy sources: Gas and Coal (55%), Peakers/Demand Programs (6%), Hydro (15%), Imports (11%), Renewables (5%), Nuclear (8%).]
NETA / BETTA Evolution of Markets

- Well-ahead Bilateral and Exchange **Wholesale** Trading between GenCos and Retailers
  - Scope for long term contracts?
  - Trading result should be SMP, but costs not revealed
- “Gate closure” when SO notified of contracts and despatch plans.
  - How far ahead? 1 – 1.5 hours. SO to plan reserve etc.
- BM (Balancing Mechanism) for near real time and balancing trading
  - System Operator buys or sells using BM bids & offers
  - Almost exclusively from large Generators
  - Costs passed to settlement
- Settlement amongst retailers “deemed” by “profiles” of statistically average consumers. Not actually measured
- NETA (New Electricity Trading Arrangements), extended to (BETTA) British Electricity Transfer and Trading Arrangements
Issues with BETTA

- No reliable “Spot Price” or Index – no long term contracts
- Retailers load (inevitably) differs from predictions (and so contracts), so they face unpredictable (and unmanageable) BM costs (to profit of generators)
- Favours despatchable generation & assumes predictable loads
- So Vertical integration (generators buy retailers & consolidate), and VILE Oligopoly
- Rewards market trading skills – bankrupt inflexible nuclear
- Retail competition leads to explosion of (incomprehensible) retail tariffs (bamboozlement)
- Renewable generation disadvantaged because uncontrolled (and harder to predict)
- So subsidised by obligations on Retailers (=regressive tax)
- What about zero (or negative) marginal price?
Feeding Renewable Policy
The New Need for Flexibility

- Much renewable generation is uncontrolled, but can be forecast
  - Wind when windy – forecast horizon 1 – 48 hours
  - Wave when rough – forecast horizon 2 – 48 hours
  - Tidal when flowing – forecast horizon – astronomical
  - Solar when sunny – forecast horizon – minutes to hours
  - Hydro when rainy – forecast horizon – months

- Adds up to high variability – albeit with variable predictability
  - Even with Diversity – of source type and Geography
  - Unlike conventional “despatchable” plant – under System Operator control

What has to become flexible?
The Core Renewables Issue

- System with 30GW average: 60GW peak; 25 GW min
- Target is (say) 50% wind, so average of 15GW
- So 45 GW nameplate. (33% output)
- Peak output 44GW. Minimum output 1GW
- Worst overload: 25GW demand and 44GW supply.
  - Excess of 29GW
- Worst Underload: 60GW demand 1GW supply
  - Flexible generation needed is 59GW
- While extremes are rare, the pricing & operations regime must cope
Flexibility Options

- NOT nuclear – merely intermittent – makes issue worse
- Coal – at a price in CO2 and bills
- Gas – reasonably flexible, and low(ish) capital costs
  - What will be the price of gas?
- Hydroelectricity – only nearly perfect
  - Needs mountains and rain (or snow) – Norway
  - May need pumping
- Demand was considered “inelastic”
  - Nuclear drove Off-peak
There is Flexible Demand

- Wet appliances – flexible deadlines
- Space and Water Heating (and cooling)
  - So long as space is well insulated, so stays warm
  - Gas has inherent storage, so peak demand is cheap
  - Heat pumps can displace gas
- Electric cars. Clearly batteries, but also hydrogen
- Fuel Manufacture. Hydrogen clear candidate, but other hydrocarbons (methanol) feasible
- Probably also peak waste avoidance
  - Floodlighting

Can demand be made to match available generation
The Smart Grid approach

- Make everything intelligent (including you!), and connected to the internet – the Internet of Things and Cloud approach
- So System Operators can monitor and control everything
- But
- Need Aggregators of many users to create Virtual Power Stations for SO
- Aggregators trade your flexibility in wholesale markets
- For discounts to you
- At risk of flat car, dirty dishes, cold water, ruined clothes
  - When you forget to tell them

There is no compelling consumer vision
“Smart” Meter Programme

- Multiple Registers, so more choices of flat tariffs & timing
- HCI – so you are informed (approximately)
- Separate secure network; Fiscal & Privacy demands
  - Remote switch off!
- Universal enrolment even when no flexibility
- Central (monopoly) Data Collection Comms
- Vast cost - £11 billion

VILE Oligopoly further dominates
Smart Prices Approach

Future (planning) Price

FlowCost Meter
- Flow Transducer
- Integration register
  - Quantity Consumed
- Transaction Value Calculator

Expected Future Price (broadcast)

Price (Adjusted to Spot by Frequency)

Bill
## Appliance Price Menu

- **Time Now:** 21.30

<table>
<thead>
<tr>
<th>Completion Time</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.40pm tonight</td>
<td>£1.50</td>
</tr>
<tr>
<td>7.00am tomorrow</td>
<td>£0.50</td>
</tr>
<tr>
<td>4.00pm tomorrow</td>
<td>£0.25</td>
</tr>
</tbody>
</table>

**Reschedule if price exceeds £0.60**

Such a price menu is only likely on a summer night, when sun is forecast for the whole day tomorrow.
# Car Charging Menu

<table>
<thead>
<tr>
<th></th>
<th>Distance</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.00pm this evening</td>
<td>30 miles</td>
<td>£4.50 (30%)</td>
</tr>
<tr>
<td>7.30am tomorrow</td>
<td>50 miles</td>
<td>£4.50 (60%)</td>
</tr>
</tbody>
</table>

- **Reschedule if price exceeds £10.00**

<table>
<thead>
<tr>
<th></th>
<th>Distance</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.30am tomorrow</td>
<td>110 miles</td>
<td>£9.00</td>
</tr>
<tr>
<td>3.00pm tomorrow</td>
<td>110 miles</td>
<td>£7.00</td>
</tr>
<tr>
<td>1.00pm Saturday</td>
<td>110 miles</td>
<td>£3.00</td>
</tr>
</tbody>
</table>
Dynamic Pricing

- Retailers can adjust prices at will and quickly
- Would you trust today’s VILEs to do this fairly?
- A completely new consumer proposition
- How can it be made compatible with Ofgem RMR
  - Or Cameron’s lowest cost
- Special “multi-account” meter to choose the cheapest in real time
Retail Price setting will need to be sophisticated
Key Opportunities

- Low cost broadcast communications
  - Price information passed rapidly to all participants
- Meaningful user transactions
  - Today perhaps £100 p.a. each consumer. More later.
- Can use variable price to pay small generation
- Selective Rollout
  - Flexible users and early adopters
  - Bundled with devices – appliances, cars, heating systems
- Demand can play in BM
  - Guaranteed Demand Response
  - Peak demand reduction – lower costs
Demand Matches Supply

- When Wind (or sun) is forecast, then suppliers will decrease prices
- When prices decrease, then more appliances will run

You (or your appliance) does your Laundry When the Wind is Blowing
Complications

- **Synchronisation**
  - Shock of dishwashers switching together => blackout
  - UCTE (now ENTSO-E) disturbance

- **Market Involvement**
  - “Blocks” of electricity traded for each hour or half hour
  - Although this is not how generation or demand behaves

- **Metering, Charging and Settlement**
  - Vast, inflexible, interlocked, complicated, expensive IT systems
  - And “Smart” metering will make it more so

These are non trivial problems
Fig. 3.1: Average frequency values in Continental Europe, June 2003 and June 2010, Source: Swissgrid
Meter Data Flows & Processes

Current and Smart Approach
Not fit for purpose

<table>
<thead>
<tr>
<th>Time Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>quarter</td>
<td>1</td>
</tr>
<tr>
<td>month</td>
<td>3</td>
</tr>
<tr>
<td>week</td>
<td>13</td>
</tr>
<tr>
<td>day</td>
<td>90</td>
</tr>
<tr>
<td>hour</td>
<td>2,167</td>
</tr>
<tr>
<td>half hour</td>
<td>4,334</td>
</tr>
<tr>
<td>minute</td>
<td>130,032</td>
</tr>
<tr>
<td>second</td>
<td>7,801,920</td>
</tr>
</tbody>
</table>
Settlement

- All contract notifications, BM trades and all wholesale meter readings fed in
- Each half hour all consumption divvied up to retail meters, and allocated to retailers, using
  - Statistical Profiles from of intensely measured samples
  - Historical consumption
  - And adjusted later in the light of actual meter readings
- BM Trades are allocated to retailers using
  - Notified contracts and allocations
  - Deemed allocations
  - Calculated System Buy & Sell Price

The rules are legalistic, bureaucratic, argued about and hard to change
Incentive Impact of Flowcost on Retailer

- Retailer influences a population of devices to reduce load to match contracts – consumers benefit; system benefits
- Settlement deems retailer consumption in settlement period against standard profiles – finds retailer short
- Retailer pays for “extra” consumption
- All other retailers benefit

A perverse incentive. Lose out from “good” behaviour
Some conclusions

- Retail electricity competition
  - Cannot offer useful innovations
  - Cannot encourage demand response
  - Makes everything complicated and very expensive
  - Entrenches generator market power
  - So encourages gas generation and greater emissions

- Smart Meter & Grid
  - Entrenches VILE oligopoly
  - Does not benefit consumers

- Monopoly area retailers (franchised?)
  - Can encourage flexible demand
  - And profit consumers and themselves

EMR rearranges the deckchairs
Thank you

Discussion?

For further collaboration contact david@davidhirst.com
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