ORIGIN and Beyond

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Current Energy Issues include

- Resource depletion
- Ongoing concerns over climate change
- Intermittent generation
- Electric cars may significantly increase demand for electricity
- Fuel poverty
German Wind Generation 2012 – Capacity Factor = 18%

Grid Curtailment / Too much wind

Orkney January 2013
Efficient and effective storage is required if benefits of renewable generation are to be realised.

Without storage - nuclear and fossil fuel generation will remain the dominant generation technology.

Supply management - changes supply to meet demand.

Demand management – changes demand to meet supply.

Sara Campagna
ORIGIN Project
(EU FP7 Cooperative project)

Demand Management at a community level
ORIGIN – The Concept

• Begins with our national obsession – the weather

http://gowerkitecentre.org.uk/wind_forecast.cfm
https://dqbasmyouzti2.cloudfront.net/
An accurate local weather forecast enables us to forecast

• Wind Generation
• Solar Generation
• Demand for Energy

ORIGIN Forecast

- Wind
- Temperature
- Cloud Cover
- Energy Demand
- Hence predict Demand Shifting Opportunities
- At a local / community level
• Captures web enabled observations and forecasts for c37 sites around Findhorn
• Every hour predicts next 48 hours weather at hourly precision
• Highly localised weather forecasting

Corne et al, Heriot Watt University
MetOffice forecast errors (in m/s, showing mean absolute error) vs ORIGIN error, for forecasting wind speed at Findhorn. Horizontal axis is ‘hours ahead’.
Orchestration algorithm

- Current and Historical Data
  - Highly Local Weather Forecast
  - Demand Prediction
  - Forecast Surplus of Renewables
- Renewables Prediction
- Participatory Response
- Automated Response

- Energy Academy
- Heriot-Watt University
- Origin Concept
Customised feedback is important!

Figure 2.4: How input from the community participatory design workshops was translated by the design team to create the ORIGIN UI.
Moving Demand to Meet Supply

- **Power (kW)**; **Wind speed (m/s)**

- **Time of day on the 26th January (h)**

- **Original load profile**
- **Load growth - low response**
- **Load growth - high response**
- **Wind speed**
- **Curtailment signal**
• Changing the way we sell electricity would help – variable tariffs
• 5p when the wind blows – 15p when it doesn’t - would guarantee a response from the public
• Truly smart meters enable time of day billing and make this possible
• New business models would be needed
• However people tend to revert to their norm after initial period of enthusiasm. - with the exception of enthusiasts – gamification
So what did ORIGIN find?

Increasingly active consumer

Informational system

Plethora of active consumer definitions

Closed actuation system

Passive Consumer

Figure 2.1: Boundaries of active consumer participation in a demand response system
<table>
<thead>
<tr>
<th>Demand response project</th>
<th>Type of response</th>
<th>Percentage increase in use of Community Renewables</th>
<th>GHG Emissions Savings / kgCO₂e per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building electricity demand (Italy)</td>
<td>Informational – feedback (Measured)</td>
<td>3%</td>
<td>374</td>
</tr>
<tr>
<td>Total Demand Response (Italy)</td>
<td></td>
<td>3%</td>
<td>374</td>
</tr>
<tr>
<td>Improved micro-grid control (Portugal)</td>
<td>Modelled Actuation</td>
<td>22%</td>
<td>5,400</td>
</tr>
<tr>
<td>Electric Vehicle Charging (Portugal)</td>
<td>Modelled Actuation</td>
<td>10%</td>
<td>1,250</td>
</tr>
<tr>
<td>Total Potential Demand Response (Portugal)</td>
<td></td>
<td>32%</td>
<td>6,650</td>
</tr>
<tr>
<td>Household electrical demand (Findhorn)</td>
<td>Informational – incentivised</td>
<td>5.8%</td>
<td>12,900</td>
</tr>
<tr>
<td>Household thermal demand (Findhorn)</td>
<td>Actuated (Modelled)</td>
<td>11%</td>
<td>24,400</td>
</tr>
<tr>
<td>Community electrical demand (Findhorn)</td>
<td>Informational - with feedback (Measured)</td>
<td>2.5%</td>
<td>5,500</td>
</tr>
<tr>
<td>Total Response with tariff incentive (Findhorn)</td>
<td></td>
<td>16.8%</td>
<td>37,300</td>
</tr>
</tbody>
</table>
## Scenario Matrix

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Simple Monitoring</th>
<th>Advanced Monitoring</th>
<th>Informational Demand Response</th>
<th>Automatic Actuation Demand Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informational Demand Response</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Actuated Demand Response</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

## Scenario Details

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Deployment Difficulty</th>
<th>Cost</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informational Demand Response</td>
<td>Easy</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Actuated Demand Response</td>
<td>Medium / Hard</td>
<td>Medium / High</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
Dynamic Wind Tariff field trial

- New tariff covering 24 hour period from 00h00 to 23h59 issued each day at 17h00
- Tariff based on forecasted availability of surplus power from the community owned wind park
- Std tariff = 17p/kWh, low tariff = 4.2p/kWh
- Tariff was a rebate scheme
- 40 participants – trial ran for circa 9 months
Response – all participants

Bars show response that was statistically significant
Line shows the distribution of tariff periods throughout the day

Figure 5: Demand response disaggregated by time of day
DR in individual households

My love for you has become a pleasurable obsession, and I tune into you several times each day.

Please give me at least a little GREEN everyday to retain my playful energies – but as a tease never give me a GREEN for a full 24 hours – to keep me on my toes.

ORIGIN is an exciting initiative that I would like to engage in... I try to live lightly and consistently. I have a kettle, washing machine, computer and sound system.

I have not engaged with you. When I am spending my time in my home with you, I might as long as the whole process and you does not become militant.

I sometimes am only home for a few hours a day & need to do what I need to do, regardless of you. I wish you success.
Figure 7: Average demand response of continuously active participants disaggregated by time of day.
ORIGIN Innovations/Outputs

- Automated Forecast Informed Vehicle Charging System (AVC):
- Residential Heating Control (RHC):
- Heat Pump Control (HPC):
- District Heating Optimisation (DHO):
- Thermal Storage Optimisation (TSO):
- Accurate Localised Weather Forecasting (AWF):
- Socially Inclusive Energy Tariffs (SET):
- Energy User Interface (UI):
After ORIGIN – what’s next?

• Can we change how we sell electricity from passive to active consumption?
• What business models might this realise?
• Demand response through variable tariffs and participation of end users
After ORIGIN – what’s next?

- Distributed Storage - Electric and Thermal

The need for storage has been realised
Electric Vehicles are a challenge—but also an opportunity!
With the cruise control set to 75 mph and the climate system set to 72 degrees, we drove the battery to exhaustion in 190 miles. Chevy Bolt
New (and exciting ) Projects

- SMART Fintry (LECF Project)
- COSY (Findhorn)— Occupancy informed energy control
- Community based nursing services — can they be provided via electric vehicles without compromising patient care?
• “Ruggedised” SMART Cities award
• Battery storage in social housing
• Wheatley Group, Glasgow City Council
SCORE India (Innovate UK)
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• www.origin-energy.eu