COSMOS

Cultivate resilient smart Objects for Sustainable city application

Grant Agreement Nº 609043

D7.2.2 Smart heat and electricity management: Implementation and experimentation (Year 2)

WP7 Use Cases Adaptation, Integration and Experimentation

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SEVENTH FRAMEWORK PROGRAMME

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Annexes:

Nº	File Name	Title
1	Appendix A	Playbook
2	Appendix B	Definition of key terms

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1. Introduction

This document aims to update the COSMOS deliverable concerning the implementation and experimentation of the London Use Case Scenarios. This is with regards to the Smart Heat Scenarios with our partners, Camden London Borough Council.

In this Work Package deliverable we will:

- Provide background material describing the current situation and available resources in the city of London;
- Show the Use Cases that will be trialled in the second iteration of the project;
- Describe the work that is being carried out to implement systems for use within COSMOS;
- Provide operational plans on data flows and communications from the city partners, including dependencies; and
- Articulate some of the challenges that have been encountered and any anticipated challenges that may lie ahead.

In this Work Package deliverable, we cover the following projects:

- Window Contact Sensor and Heating Control Valve Project
- Temperature and Humidity Enriching Data Project
- UrbisAPI Project Developments
- The Playbook Document

The intended outcome of this deliverable is not only to update the project, but also to give future Smart City projects some working models for delivery of projects.

2. Current Situation of the London Borough of Camden

Camden is the beating heart of London – one of the most diverse places in the EU's largest capital and the UK. Stretching from Covent Garden to Hampstead and Highgate, it contains some of the poorest and some of the wealthiest neighbourhoods in London.

As one of the Inner London Boroughs, the majority of the area is classified as urban or, in some cases, dense urban. There are approximately 97,000 households within an area of 21.8 square kilometres from a wide range of ethnicities.

The COSMOS Living Lab is overseen by the Housing Sustainability team within the Camden London Borough Council. The role of this team is to deliver energy efficiency programmes to the council tenants and leaseholders of the 33,000 Camden-owned housing stock. The aim of the team is to improve the health and welfare of residents by reducing the risk of fuel poverty, making warmth affordable and reducing the risks to health caused by poorly-heated or uninsulated homes, such as cardiovascular disease and asthma.

In addition, by reducing carbon emissions, the team and the Council aim to improve air quality and contribute to both national and European CO_2 reduction targets.

The Ampthill Square estate will be used to demonstrate an interconnected IoT-based system for Smart Energy Management. This is a social housing estate that comprises three 21-storey tower blocks: Dalehead, Gillfoot and Oxenholme.

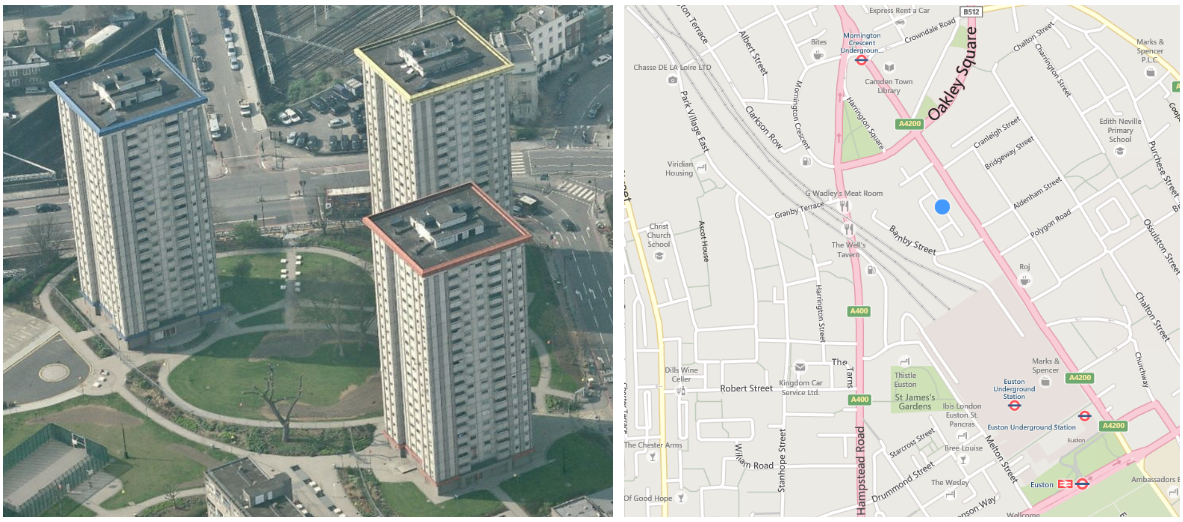

Figure 1. The Ampthill Square estate in LBC, marked in blue on the map (London NW1).

The Ampthill Square estate is a moment's walk away from Camden High Street, and has good transport links with nearby Euston and Mornington Crescent Underground stations. There are two gas-fired Combined Heat and Power (CHP) systems on the roof of each building, along with Solar Thermal panels for heating water (visible in Figure 1). Combined with an on-site boiler, the components form a complete District Heating system that can provide higher efficiency and better pollution control than an ordinary system.

Ampthill Square reflects the cross section of urban London and its rich mix of citizens; there are approximately 240 residents living in the Ampthill Square estate, with a mix of cultural and socioeconomic circumstances. A typical property size in the estate is two bedrooms, generally with between one and four occupants.

The overarching goals of Camden Council are set out in the 'Camden Plan'. The diversity of the Borough is at the centre of its ambition: for Camden to be a place where everyone has a chance to succeed, and where nobody gets left behind. The Council wants to reduce inequality while preserving Camden's social mix by building resilience in individuals, communities, businesses and the Council itself.

The COSMOS project will look at how council residents can better manage their heat and hot water consumption to improve the quality and comfort of their homes, make warmth more affordable (especially for the most deprived/vulnerable households), and promote better knowledge and understanding of heating and how to remain warm, debt-free and healthy.

3. Application Use Cases

This deliverable is an update of the Year 1 Scenarios, with six new Use Cases. These new Use Cases are extensions to the physical systems that were described in Year 1.

3.1. Heating Control

Use Case: Heating Control
ID: 5
Brief Description: The EnergyHive system is measuring the temperature of the properties where it is installed and has the ability to control the delivery of heat through a valve. A new tablet has been deployed within the property that allows for a set point and schedule to be entered. Feedback from users has been that they would like the system to automatically help them set a programme and manage efficiencies on an ongoing basis, for instance: detection of whether or not they are at home; using the weather forecast to help with program and supply-side management when the solar thermal is available for use. The tablet is a COSMOS-compatible device and it can act locally to run case-based reasoning in an efficient manner.
Primary Actor(s): Resident
Secondary Actor(s): Mechanical and Electrical Engineer; Sustainability Officer
Preconditions: EnergyHive system must be installed within a resident's premises.
Main Flow: 1) Resident will select an autopilot function on their tablet. 2) Autopilot will determine a recommended set point for the temperature in the house. 3) Set point can be overridden by the resident. 4) The system will learn the patterns of occupation and adjust the run programme to turn off the system based on un-occupied property; the resident can override. 5) Savings should be quantified over using a normal time-based programmer.
Postconditions: An improvement in the efficiency in the heating system should be reported.

3.2. Building Performance Management

Use Case: Building Performance Management
ID: 6

Brief Description: The boiler systems within buildings have master programmers and temperature settings that are controlled by a Trend boiler control system. There are also verification instruments installed within buildings to measure the effects of the boiler control; they can provide feedback to inform the run-time commands to the boiler control as well. A more granular view of the energy demand, including trade-offs with electricity usage, is desired so that individual residential premises are getting higher comfort while balancing the energy input.
Primary Actor(s): Mechanical and Electrical Engineer; Sustainability Officer
Secondary Actor(s): Energy Performance Officer; Resident
Preconditions: EnergyHive system must be installed throughout each building in the estate, as well as boiler controls and verification systems.
Main Flow: 1) Temperature readings are collected at distribution level within Camden heat networks. 2) The energy balance model will be run against the Trend readings, and the temperature/electricity readings showing performance indicators (degree hour per kWh) against a network model for the delivery. 3) Normalisation for seasons and weather conditions should be applied (subtract degree hours inside versus degree hours from weather). 4) Sensors will be installed wherever suitable on the district heat network to manage distribution losses.
Postconditions: Ranked performance of the buildings' heat networks is reported to enable interventions to improve network inefficiencies.

3.3. Capital Planning/Energy Performance

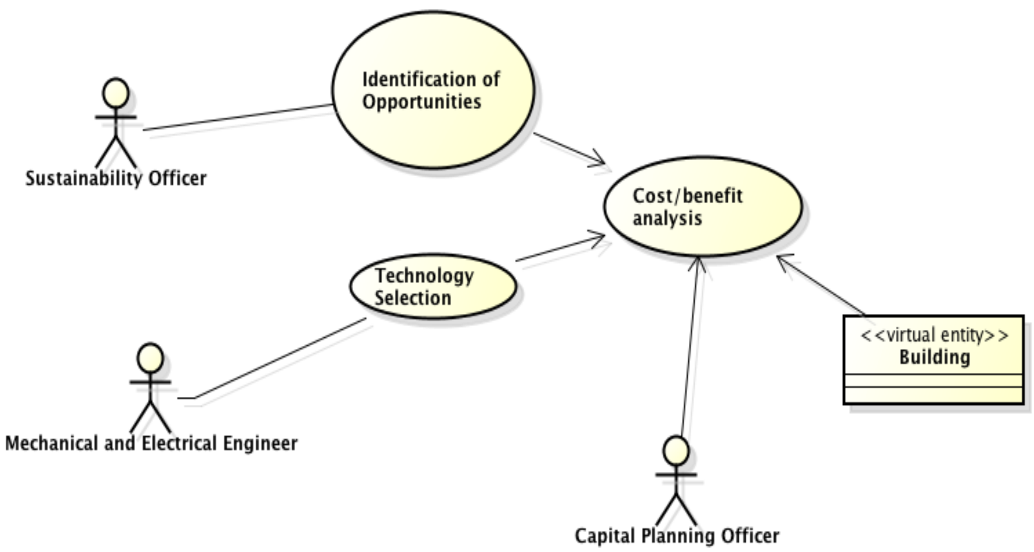

Figure 2. Use Case diagram for Capital Planning.

Use Case: Capital Planning/Energy Performance and Commissioning and Quality Assurance
ID: 1
Brief Description: The EnergyHive system in each building enables Capital Planning/ Energy Performance Officer to perform a more rigorous cost/benefit analysis of suggested programs or technology installations. The system provides accurate information as to the carbon/monetary saving of an implementation.
Primary Actor(s): Capital Planning/Energy Performance Officer
Secondary Actor(s): Mechanical and Electrical Engineer; Sustainability Officer
Preconditions: EnergyHive system must be installed throughout each building in the estate.
Main Flow: 1) Sustainability Officer identifies an opportunity for environmental improvement of system. 2) Engineer selects appropriate technology for instalment. 3) EnergyHive system provides detailed information as to the effect of the change in the system. 4) Capital Planning/Energy Performance Officer uses EnergyHive information to assist in cost/benefit analysis.
Postconditions: The Capital Planning/Energy Performance Officer decides whether to roll out the proposal.

3.4. Identification of Opportunities

Using machine learning, identify where energy savings opportunities exist. This will help Sustainability Officers to suggest projects that can then be put through the Capital Planning Use Case.

Use Case: Identification of Opportunities
ID: 7
Brief Description: The EnergyHive system running in planning mode can use machine learning to suggest opportunities for efficiency. This is largely an unsupervised learning exercise where cause and effect models can be run with comparisons to other like buildings or similar conditions that have been observed.
Primary Actor(s): Sustainability Officer; Energy Performance Officer
Secondary Actor(s): Rents and Billing Services; Air Quality Officer
Preconditions: EnergyHive system must be installed throughout each building in the estate.

Main Flow: 1) Sustainability Officer creates model constraints for parameters to optimise (i.e. cost or carbon savings desired with physical systems). 2) Model runs within system bringing up bands of savings that can be made from changes in input parameters. 3) System provides control ranges that would have to be implemented in order to make potential savings.
Postconditions: A quantified opportunity for efficiency within the energy system is presented for evaluation.

3.5. Minimising Carbon

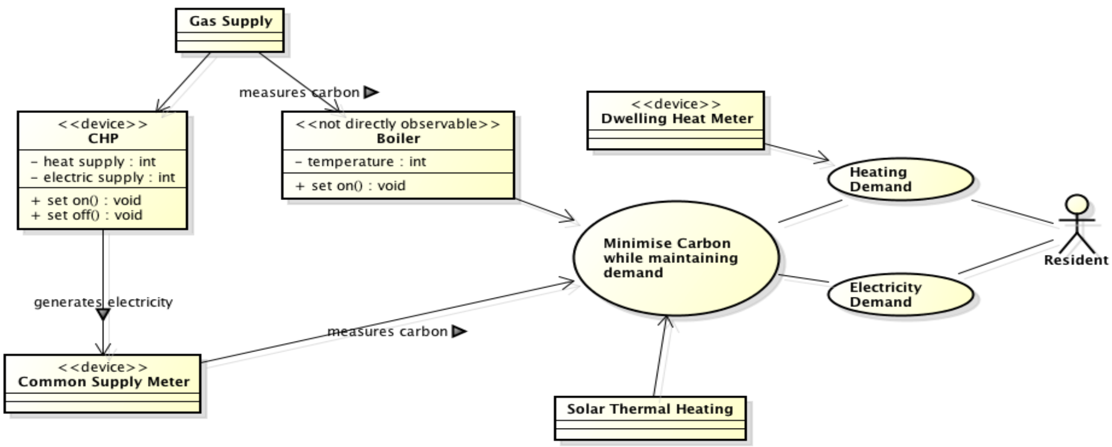

Figure 3. Use Case diagram for minimising carbon.

Use Case: Minimising Carbon
ID: 2
Brief Description: An effective way to minimise carbon is to give more weighting to processes with lower carbon production levels whilst maintaining the demand. The interconnected IoT-based system using an energy platform will make possible effective management of the energy supply in order to minimise carbon production. With minimal input by the resident or site staff, the system will predict the estate's heat in half-hourly intervals and manage the CHP and boiler accordingly.
Primary Actor(s): Resident
Preconditions: Specialised Instalments: 1) Gas Flow meter to CHP from boiler to regulate the Gas supply. 2) Control system with temperature sensor on boiler. 3) Flow meter/temperature sensor on Solar Thermal. 4) Heat meter in each dwelling. 5) Communication infrastructure between sensors and hub.

Main Flow: 1) System predicts the estate's heat and electricity demand for a half-hour period. 2) System calculates required gas supply and distributes to CHP and boiler accordingly. 3) Carbon produced is measured. 4) Individual resident heat consumption is monitored.
Postconditions: 1) The resident is charged for their personal heat consumption. 2) Prediction errors are logged to improve system on later iterations.

3.6. Minimising Demand

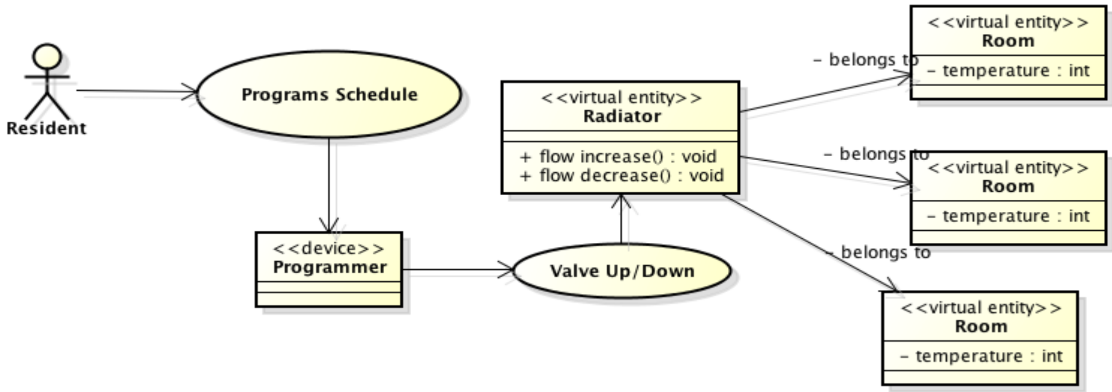

Figure 4. Use Case diagram for minimising demand.

Use Case: Minimising Demand
ID: 3
Brief Description: Another method of reducing carbon production is to minimise the demand for Heat Energy production. This is possible through the current IoT platform, namely EnergyHive (designed by Hildebrand). The EnergyHive system will use smart meters to report real-time energy consumption information automatically and remotely. The system, with support from a council Sustainability Officer, assists the user in setting a heating schedule in accordance with their budget.
Primary Actor(s): Sustainability Officer; Energy Performance Officer; Resident
Preconditions: 1) EnergyHive system implemented in each dwelling. 2) Valve up/down control system to the radiator.

Main Flow: 1) Resident accesses their customer account to view balance. 2) Resident can set a heating schedule. 3) Resident is given tariff and projected balance for a given schedule.
Postconditions: User can optimise their schedule to minimise their consumption.

4. IoT-A Model

In this section, we will remind ourselves of the IoT-A Model in the London Use Cases to provide a foundation for Section 5.

4.1. IoT-A Model for the Energy Scenarios

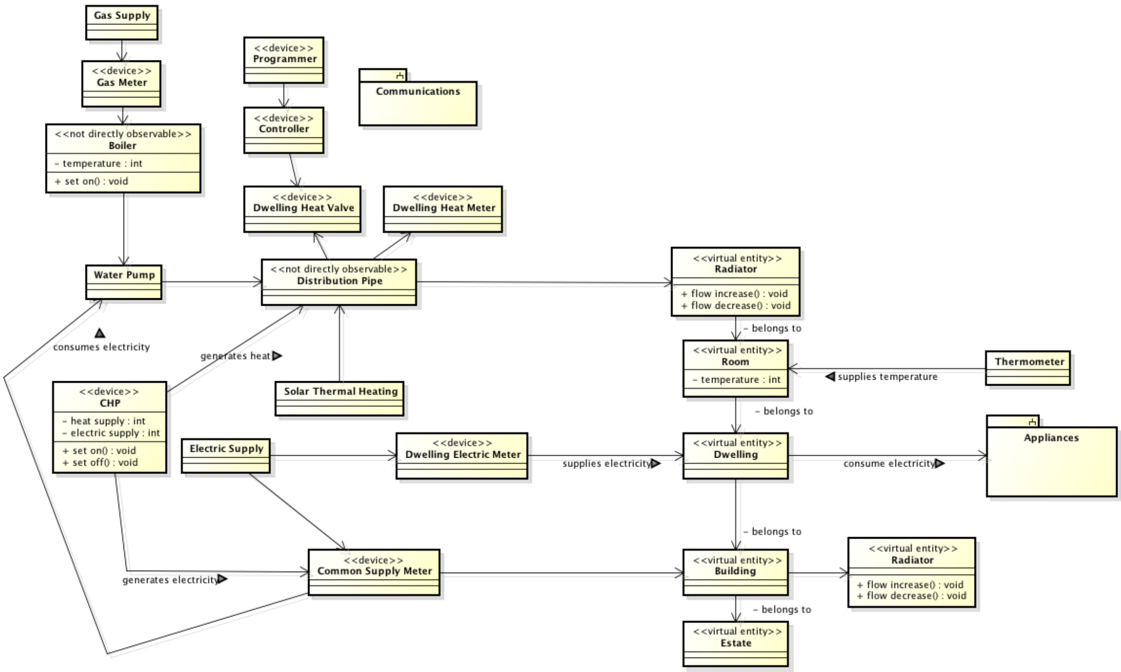

Figure 5. Model for the IoT system with adjoining description of components for the energy scenarios.

Component	Description
Gas Supply	Natural Gas supplied to the Ampthill Square estate. Consumed by the boiler and the CHP.
Electric Supply (National Grid)	Electricity supplied to the Ampthill Square estate from the National Grid. Electricity consumption of individual residents is taken from this supply. The National Grid also contributes to the common supply for building and estate utilities.
Boiler	Natural Gas-fuelled boiler. Contributes hot water on resident, building and estate level. The boiler is not directly observable, therefore it is monitored and controlled by the gas meter.
Solar Thermal Heating	Multiple solar thermal panels installed on the roof of each building. Contributes hot water on resident, building and estate level.
Combined Heat and Power (CHP) Engine	Natural Gas-fired Gas turbine engine. Contributes hot water on resident, building and estate level. Also contributes electricity to the common supply for building and estate utilities.

Water Pump/ Distribution Pipe	A system of water pumps transports hot water from each source through the distribution pipe. Consumes electricity from the National Grid and the CHP. The distribution pipe supplies water to each individual resident, along with utilities in the building and on the estate.
Gas Meter	Monitors the flow and temperature of gas through the boiler to indirectly regulate and control the boiler. Also monitors flow to the CHP, to indirectly measure electricity and heat energy from the CHP.
Common Supply Meter	Measures the total electricity supply on a building and estate level (excluding individual resident supply).
Dwelling Electric Meter	Measures electricity to individual resident dwellings. Electricity is only supplied by the National Grid.
Dwelling Heat Meter and Valve	Measures heat energy consumption for each resident dwelling. The valve is controlled by the programmed schedule.
Programmer/Controller	Receives/sets schedules for heating and operates the hot water valve accordingly.

5. Scenario Progression

5.1. Heating Scheduling

5.1.1. Concept

In order to illustrate and fully utilise the capabilities of the COSMOS platform in a real life scenario, we target a particular problem in the Energy industry: the issue of inefficient heating schedules. Research shows that residents, in Camden Council housing, for example, tend to adopt bad habits in terms of Energy efficiency when it comes to turning their heating on and off.

Some of the issues that Camden Council themselves have encountered include situations where residents turn on their heating to the maximum setting as they are cold without understanding that this does not make their flat heat up quicker; it simply means that their flat will eventually get to an extremely hot temperature and waste heat. In addition, Camden have noticed that many residents leave their heating on at the same setting all day and all night as they are comfortable with the current temperature and afraid of touching any of the heating control devices in case they accidentally change a setting. Further to this, if the weather gets warmer, for example in the summer, residents tend to open their windows to cool down and let the heat escape instead of modifying their heating settings, creating a wasteful cycle.

Furthermore, the greater the demand for heat that is not required, the greater the amount of heat that is also lost through the distribution pipework. The heat metering project in Camden has revealed distribution losses of up to 50%, i.e. 50% of the gas supplied is lost, as only 50% reaches homes as heat and hot water. For this reason, it is planned to install sensors on the Ampthill Square sites to quantify existing losses and see whether these can be reduced. This is important because it is the End User who pays, not only for the heat lost through poor control of their heating, but also for the heat lost between conversion from gas to heat and distribution to dwellings. At a time when domestic gas prices in the UK have increased by an average of 10% each year for the last ten years[1], Camden cannot ignore the risk to the health and welfare of its residents, especially those on fixed low incomes.

In an attempt to reduce energy waste and create a more efficient, smart solution, we will use an array of sensors and actuators to detect changes in the VE and respond accordingly to those changes. We will utilise certain COSMOS components to analyse both historical and real-time data and create a system where Heating Schedules cannot only be learnt for individual VEs, but can also be automated depending on the states of certain sensors. Furthermore, we will be able to utilise the social aspects of COSMOS to help VEs to learn from each other and share their Heating Schedules, when appropriate. Finally, sensors will be used to inform the Council of where distribution losses are occurring so that remedial measures, such as improving insulation, can be taken.

The idea behind this Use Case Scenario is to attach Contact Sensors onto windows to recognise when a given window is open or closed. If the heating is on when a window has been opened, COSMOS will send a command to the Heating Control Valve to turn off the heating until the resident shuts the window. To enrich the data we receive from this Scenario, we will also install temperature and humidity sensors to understand how the temperature fluctuates when this system is in place. This will provide us with the potential to explore and implement enhancements to this Use Case Scenario in Year 3.

5.1.2.COSMOS Integration

The COSMOS platform is able to carry out all of the logic in this scenario, making it not only easy to implement, but also highly scalable. This illustrates how simple it is to use a combination of sensors and actuators in an IoT framework to improve energy efficiency.

Once the sensors are installed in the residence and networks are communicating with the Gateway, data can be streamed up to the COSMOS platform. Much like the data being transmitted from the Temperature sensors, as previously described in other Use Case Scenarios, the data from the Window Contact Sensors also transmits frequently to the Gateway. The data simply describes the state that the sensor is in, i.e. open or closed. All of this data is sent frequently to the Hildebrand Servers, where it is processed and transmitted out on an MQTT feed in readable form. The JSON structure of the data being sent out on MQTT has been designed so that COSMOS services and components can interact with it easily. An example of a JSON object that will be streamed is as follows:


```
{
   "estate": "Oxenholm",
   "servertime": 1432892980,
   "hid": "cpWpv4Z7dFH2",
   "heatmeter":
          {
      "instant": 0,
      "flowTemp": 32,
      "returnTemp": 18,
      "flowRate": 242,
      "cumulative": 89522
   },
   "sensors":
          [
      {
         "type": "window",
         "state": "open",
         "ts": 1433838989,
         "sid": 13382
      },
      {
         "type": "window",
         "state": "closed",
         "ts": 1433838989,
         "sid": 13394
      }
   ]
}
```


Each sensor will appear at most once in each publish of an MQTT topic. COSMOS can then hook onto this data stream in different ways: IBM's message bus can subscribe to the topics and pass the data into the Object Store; similarly, the data can be pushed into a State Machine for the CBR Planner to make real-time decisions and action API calls.

In each of the VEs, Heating Control Valves will behave as Actuators in the IoT framework and APIs will be exposed to COSMOS to send actions to the Valves. This ties together the concept behind this scenario in an easy-to-follow process:

- Window Sensors detect when a window has been opened.
- Data from the sensors is sent to the Gateway, and then through Hildebrand's servers onto an MQTT feed.

- COSMOS detects a new JSON object has been published on an MQTT topic it is subscribed to.
- The COSMOS platform accesses this data in real-time whilst also storing it in the Object Store for historical reference.
- The CBR Planner makes a decision based on the states of sensors in the VE, e.g. if the window state is seen as “open”, make an API call to the Heating Control Valve to close.

This is a very simple yet effective way of reducing the amount of heat wasted by residents. This simple example also illustrates how this prototype has the potential to be utilised by other components in COSMOS. The option of adding more sensors and actuators to a VE enables the COSMOS platform to build more complex models and make smarter decisions based on more data sources.

We have noted that currently, if a Camden resident has not paid their Heating bills, a similar API call is made to the close the Heating Control Valve. Although the prototype would override this pre-existing condition, this is simply to illustrate how COSMOS can be used in a Use Case, and does not pose a problem at this moment in time.

5.1.3. System Outline and Dependencies

The prototype relies on sensors and actuators being installed in flats in the Ampthill Square estate. Camden Officers have evaluated all 240 dwellings to ensure that only suitable properties are used for the Pilot. These flats were selected at random from a sample of applicable candidates. To produce this sample, Camden firstly ruled out any residents who were elderly/vulnerable, including families with small children who could potentially tamper with any of the equipment installed. Excluding these residents from the Pilot is necessary, as COSMOS has been given access to Heating Control Valves and, on the unlikely occasion that there is a fault, Camden would not want to endanger any residents, especially those most at risk.

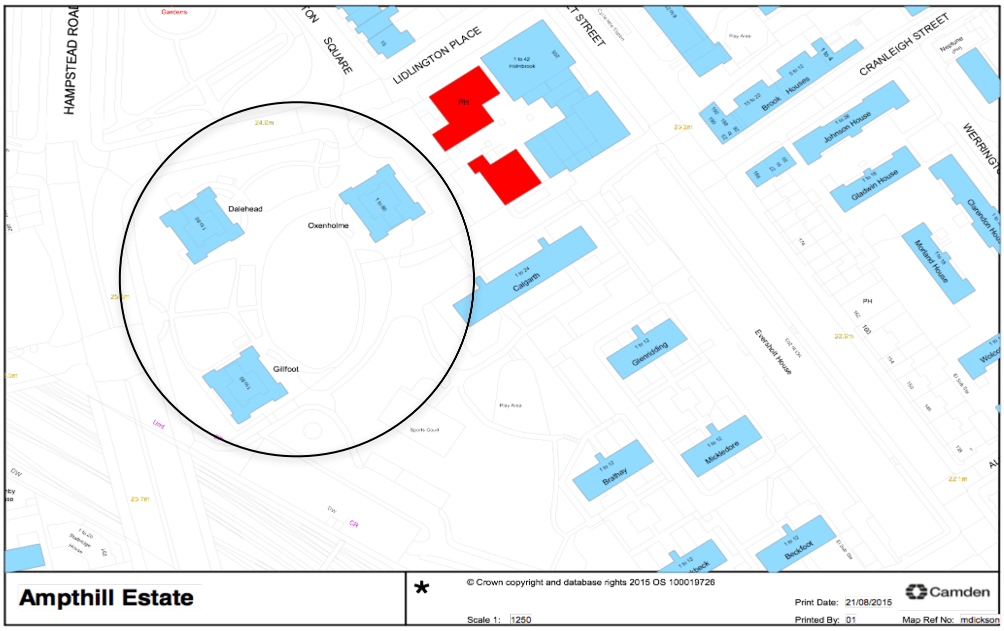

Figure 6. Ampthill Square estate blocks circled.

Next, the residents with the highest heat usage were identified so that Hildebrand's interventions would be more effective and the Heating Schedule Application would show noticeable differences when comparing results to historical usage values.

Oxenholme Flat Number	Energy Consumption (kWh) 2014-15	Gillfoot Flat Number	Energy Consumption (kWh) 2014-15	Dalehead Flat Number	Energy Consumption (kWh) 2014-15
1	19205	1	15006	3	13368
2	14158	2	22859	6	15762
3	14976	3	14291	7	22589
5	18524	9	14684	13	17386
6	15348	17	24216	21	13685
8	15714	24	13595	23	15115
25	13477	32	31092	61	16707
43	16101	45	14876	62	13429
44	19654	51	13858	64	13821
55	18375	52	21322	72	12636
59	17069	56	15574	74	14162
67	21375	58	15296	79	16431
-	-	60	14057	80	13593
-	-	75	16359	3	-
-	-	76	13966	6	-

Figure 7. Ampthill Square estate highest energy users.

Once the sample pool of flats had been identified, fifteen were randomly selected to be included in the Pilot study. This involved three Window Sensors and three Temperature and Humidity Multisensors being installed in each flat. The Heating Control Valves have already been installed, as have the Gateways; however, the firmware on these Gateways needs to be updated so that they can communicate with the new sensors.

Three windows have been selected for each flat: one in each of the two bedrooms, and one in the main living room (Camden decided that the risk of the kitchen and bathroom windows being opened to control humidity from cooking or bathing was too high for sensors to be installed in these rooms). As well as a Window Sensor on each of the windows, a Multisensor will also be installed in each of these rooms. This will enable the temperature and humidity to be tracked and enrich the data set when combined with the knowledge gained from the status of the windows.

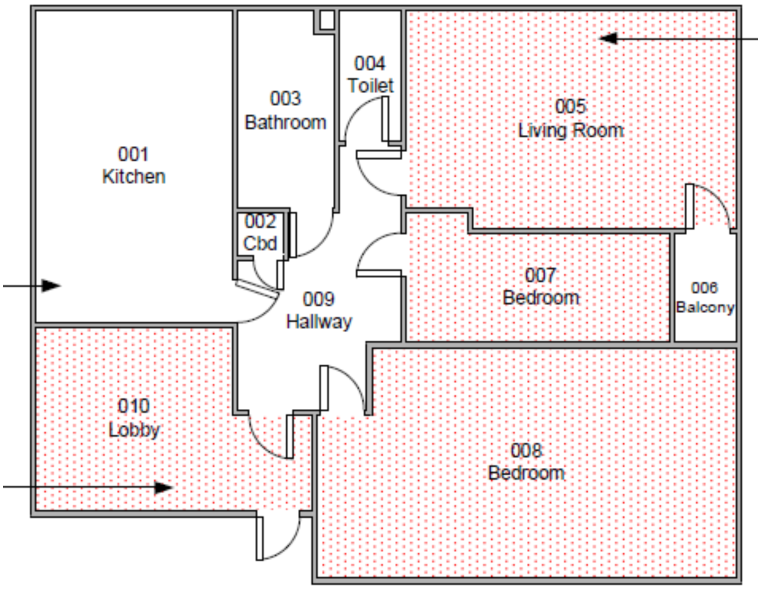

Figure 8. Floor plan example of an Ampthill Square estate flat.

A key consideration when designing the hardware is that residents should not find that the equipment interferes with their lives, e.g. tripping up over sensors. In order to make the sensors as unobtrusive as possible, they should be installed approximately one metre above floor level, perhaps attached to a wall behind a piece of stationary furniture. We have opted to use adhesive tape to secure the equipment, to ensure that we do not damage the properties.

Figure 9. Picture an example window frame in an Ampthill Square estate flat.

A new functionality will be exposed to COSMOS, namely the Actuators API calls. This will be done on a per-HID basis, as the APIs control the heat to individual flats and we must therefore treat these carefully. During the testing phase, we will ensure that COSMOS can accurately and autonomously send commands to the Heating Control Valves. This is extremely important, as the following stage will involve Camden residents.

As we are dealing with residents' heating, in the situation that any faults do arise, we must be able to fix the issue as soon as possible. For this reason, it is reasonable for us to only allow COSMOS to send commands to the Actuators during working hours. Furthermore, the prototype requires Camden Council (on behalf of COSMOS) to sign off on the responsibility of allowing an external entity to control the Heating Valves in their estates. It should be noted that the project is in contact with the Camden Team Leader for Information and Records Management, Busola Awani, regarding the management of residents' consent and the use and protection of their personal data.

There is an array of situations to consider when dealing with automated actuation based on sensor data streams. As the chain of events in this process is very long, there are many points of failure that we have to take into consideration when implementing a prototype of this nature. If data is not being captured by the sensors or is not being transmitted to the MQTT feed by the Communications Board, then COSMOS will trigger a communication error. This is driven by the fact that the Planner will have a case whereby, if the most recent JSON published on a particular topic has a timestamp that is more than five minutes old, for example, an alert is triggered. Similarly, if failures occur within the COSMOS platform, other components can have rules set to look for these.

We must note, however, that there are points of failure that can remain undetected without human interaction. For example, the magnets in the Window Contact Sensor might misbehave such that the data being transmitted to the Comms Board is persistently in the 'open' state, regardless of what is physically happening. In this event, every data point being passed through to the planner would trigger an API call to shut the Heating Control Valve, leaving the resident without heating even if all of their windows are closed. It is for this reason that we suggest testing in a void for a few weeks in September, and only letting COSMOS make API calls to the actuators during working hours for the first month.

In order to bypass this type of problem in the future, we are developing an override mechanism that will be accessible only to Hildebrand. This mechanism would refuse external access to the Heating Control Valve APIs and force open all of the valves to ensure that no residents are without heating. This provides us with a failsafe so that we can diagnose where the failure was and how we can prevent it from happening again. These steps are being made so that we will have the opportunity in Year 3 to embed COSMOS functionality into the diagnostics and failure detection processes.

5.1.4.System Testing Plan

Camden are allocating a void property for Hildebrand to use for testing from mid-September, so that the prototype can be ready to start showcasing the COSMOS components by the beginning of October. By this time, NTUA should have subscribed to all of the MQTT topics for real-time decisions to be made by the CBR Planner. Similarly, IMB should have subscribed to the MQTT feeds so that all the data captured is passed onto the message bus to then be stored in Swift. These mechanisms are already in place; however, at this point new data will be transmitted even though the architecture has not changed. The JSON structure, as explained above, is expected by the COSMOS partners as the components from WP3-6 know how to deal with the new schema.

5.1.5.Expected Outcomes and Benefits

The addition of the new sensor data described above allows the COSMOS platform to make smart decisions and act upon them through actuators in the VEs. This opens up the COSMOS services to infer more from the VEs and thus make more of an impact through different scenarios. In Year 2 we begin the illustration by showcasing a prototype primarily involving Window Sensor data and Heating Control Valve actuators. This enables COSMOS to make automated actions based on the state of the windows in a flat, all through the new data feed.

The prototype is simply an example of how the CBR Planner can develop Heating Schedules for residents in Camden estates. Another outcome that we will look at in Year 3 is using data collected from VEs near the residence in question and using a 'friend-sharing' mechanism to learn Heating Schedules from neighbours. This has huge benefits, such as being able to make decisions if the system fails at any point along the chain of events by using data from local VEs.

This Pilot provides a foundation for future Use Case Scenarios to be demonstrated through the addition of sensors and actuators in the VEs. When a resident wastes energy by leaving the heating on and opening a window to cool down, COSMOS is given the opportunity to intervene by closing the valve and allowing the flat to cool down without wasting heat. The use of Temperature and Humidity Sensors provides us with the capabilities to analyse these data streams alongside the Heat and Window Sensor data. This means that the CRB Planner has more cases to train on and can therefore make more complex decisions, whether for a Heating Schedule or for another Use Case Scenario.

The benefits of the COSMOS Platform for Camden are that, by learning from residents' behaviours (set temperature, humidity levels, heating usage), Camden can tailor assistance to suit residents' requirements. Camden can, in addition, provide support and/or education on how to operate heating systems more efficiently and save money on heating bills. The platform will also enable Camden to work towards reducing the impact from damp environments by having greater understanding of how heat, ventilation and humidity are experienced and managed by individual residents. We can identify technical faults more easily, and we can take quick action to resolve faults, especially with vulnerable residents.

The importance of good housing to health cannot be overstated: about 10% of Camden's households were in fuel poverty in 2013[2], and between 2008 and 2011 there were on average 66 Excess Winter Deaths per year in Camden[3]. This, coupled with increasing gas costs, has meant that some residents are having to choose between heating their homes and eating. Camden, through the COSMOS Platform, can identify residents at risk of fuel poverty or debt (by their high energy use), potential damp issues and health/vulnerability issues, so that the appropriate referrals can be made and the correct teams can be alerted. As a direct result of the platform, 150 residents have received home visits since October 2014, out of 1,200 potential households.

Managing district heating losses will benefit the End User by reducing the overall cost of heat and hot water. There will also be a more general benefit in that the management and co-ordination of Camden's services will be improved by having an increased knowledge base regarding where to invest to best improve services and buildings.

5.2. Residents' Engagement

Camden has a population of 97,000 households. 33,000 of these are council tenants, of which about 12,000 (over a third) are in District Heat networks and will be affected by the new metering and billing regulations, as set out in the 2012 EU Energy Efficiency Directive (made UK law in December, 2015)[4]. This regulation imposes an obligation on district heating suppliers to bill customers according to consumption by means of individual heat meters installed in their properties. There is a big push from central and local governments to expand existing heating networks and build new ones, with a projected 8 million UK users being connected by 2030[5]. The knowledge and understanding that will be derived from the platform offers a unique opportunity to use the required metering data to assess system efficiencies and implement better management practices. A new code of practice[6] has been released recently for designing district heating networks in a more efficient manner, and a best practice group called The Heat Trust has also been set up for district heat network providers on a voluntary basis. This will offer assurance for End Users that they are being billed fairly and transparently and that they are receiving good value for money. It is intended that this will eventually become a regulatory body for all heat network providers. Camden Council is the local authority represented on the Heat Trust steering group.

The towers at the Ampthill Square have been selected for the Use Case as the estate has received considerable funding to implement energy efficiency measures. In preparation for the Pilot, Camden revisited the Equalities Impact Assessment (EIA) originally undertaken for the heat metering project and developed a programme of visits to residents to understand their concerns around heating their homes, affordability and any issues with condensation.

Ampthill Square was one of the estates assessed under the EIA. The outcome of this assessment showed that the 30-45 age group made up the largest percentage at 44% (see Figure 10). Although there is no existing data that confirms whether this age group includes families with small children, all of the flats in the estate are two-beds that are only given to families, and feedback from the home visits carried out for the purpose of COSMOS, as well as previous visits done during the implementation of the heat metering programme, have confirmed that there is a large number of families with small children living in the estate. Official figures[7] indicate that child poverty may be as high as 41% across the borough of Camden. Therefore, our attention is also focused on child poverty and any direct links that this may have with fuel poverty. The COSMOS platform will enable Camden to mitigate this risk.

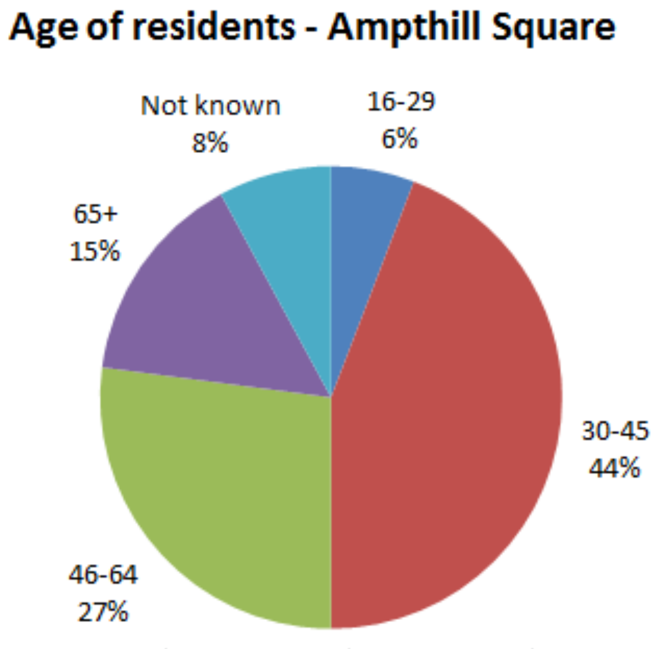

Figure 10. Age distribution at Ampthill Square.

Regarding disability, recent data from the Department of Work and Pensions for Households Below Average Income[8] shows that:

- Disabled adults are twice as likely to live in low income households as non-disabled adults; and

- Approximately one third of all disabled adults over 25 are living in low-income households.

There is currently no data available for the precise level of disability to be found in the Ampthill Square estate, although three residents were identified during the home visits as having a medical problem or disability. Adult Social Care records[9] show that, as of June 2012, there were 496 people with learning disabilities living in the Borough of Camden, of which 197 had their own tenancy. It is estimated that the learning disabilities population will increase by 20 people per year between now and 2020. 2011 Census figures[10] show that 22% of Camden households contain one or more persons with a disability or long-term medical problem. It would therefore be fair to assume that a similar proportion of households may apply to the residences participating in the heat meter scheme.

The home visits showed that a significant number of residents did not fully understand how to control the heating in their homes. The existing system provides three levels of control:

1. The user can set a time schedule to turn the heating on and off according to a temperature set in the thermostat;
2. The heating can be adjusted inside rooms through Thermostatic Radiator Valves (TRVs) installed on radiators;
3. The programmer can be set to automatically turn the heating on and off at designated times.

Some residents have opted to not use the programmer, and instead rely directly on the thermostat to turn the heating on and off, whereas others prefer to turn the TRVs on and off individually in order to control their heating. In most cases, it was evident that the controls were not used in the way that they had been designed.

Anecdotal evidence shows that some residents feel that the heating system is not powerful enough to heat up the flat. These are either elderly or have someone in the household with a medical condition. A larger number of residents feel that the flats are too warm in all seasons, and they hardly need to use the heating during the winter months. Some have indicated that their children suffer from skin allergies and they would therefore not want the flat getting too warm as it would worsen the condition.

In Camden, 500 council residents have reported condensation problems since October 2013. Poor ventilation, not heating the flat adequately or drying clothes on radiators were found to be the main causes of moisture build-up and condensation. Some residents also insisted on turning on the heating during the summer months to dry clothes, even when they had natural drying facilities. In addition, in many cases, not having humidity control in the properties to allow residents to monitor moisture build-up led to mould growth on walls and windows, and subsequently led to respiratory and health problems.

The home visits also revealed that there seems to be a misconception among some residents about the cost of using the individual electric immersion (back-up) heater, instead of the communal hot water supply, in the belief this would be cheaper. This is a common misunderstanding, as the cost of electricity per kWh for domestic use in the UK is on average four times the cost of gas[11].

The conclusions drawn from the visits were that residents' main concerns are the affordability of heating their homes to a comfortable level and the impact that their heating levels have on their health.

5.3. Recruitment of Volunteers

Camden has access to real-time energy data from the properties provided with individual metering. High-energy users were selected randomly and initially contacted by a letter which described the purpose of the project, the benefits to residents and the requirements to participate in the Pilot. Shopping vouchers were used to incentivise residents to participate. Due to low response, residents were then contacted again on the phone. This more personalised engagement proved more fruitful, and fifteen residents were recruited.

During the phone calls, a number of residents objected to participation as they were concerned about having to interact with the sensors. Once it was explained that these were passive devices used for monitoring purposes, they were more willing to participate. From this it can be concluded that a fear of technology and a lack of trust in public bodies could be barriers to exploiting the use of the platform in this scenario. It is intended that this be investigated more fully during engagement with these, and other, residents. This is explained further in Section 6, 'Evaluation and Next Steps' below.

5.4. Back-Office and UrbisAPI

5.4.1.Progress and Achievements

In Year 2, we built a prototype of the UrbisAPI platform (www.urbisapi.com) to test on a set of alpha users. At this point in testing, the platform had basic but still limited functionality in terms of API calls and interface capabilities. From our testing, we have learnt where to develop the platform further, and this lies mainly in the expansion of API calls and the improvement of the user interface. The backbone, i.e. architecture, of the platform is solid, but the functionality needs to continue to be baked into the product.

5.4.2.Future Plans

In Year 3 we aim to add additional key functionalities for user interface components to facilitate more types of requests and, therefore, improve usability. We also plan to industrialise the hardware, specifically the Gateway. Ensuring that the device is more durable and rugged will allow us to distribute and market the package product to a wide array of industries whilst maintaining the core benefit of the IoT system. We are targeting the commercial launch of the UrbisAPI platform in 2016.

5.5. The Playbook

5.5.1.Concept

Appendix A is the first draft of a document that Hildebrand has written to help COSMOS consider the users in the IoT framework. It is based on the knowledge of using data insight to drive behavioural change and has the end goal of benefiting the users.

The document is self-explanatory and fully articulates the goals that it is trying to achieve. It currently exists as a stand-alone document, and therefore does not require any further insight here into its contents.

5.5.2.Future Plans

The final aim for the Playbook is to publish it as a book that can be sold as a guide to using IoT to build businesses around End User satisfaction to companies such as utilities suppliers. In the short term, we plan on developing and refining the concepts articulated in this document in Year 3.

6. Evaluations and Next Steps

Year 2 has set a solid foundation for progress to be made in the following year. The research that we have conducted this year will help to guide us in improving the UrbisAPI platform to work with our set of beta testers.

Similarly, the Window Sensor prototype has been developed and is currently in the implementation stage. We are aiming to have the product tested and showcasing a month's worth of usable data by November.

The Playbook document and eventually book is the by-product of working with the IoT domain model and trying to focus COSMOS in the direction of considering users. This has been achieved through the writing of an early draft (Appendix 1) that focuses on walking Suppliers through the IoT and how it can be used to benefit them and their customers.

Our next steps for the UrbisAPI platform are to add additional key functionalities of user interface components so that the platform is ready to be sold to cities for IoT. Further to this, the hardware will be industrialised so that it is durable and compatible with any market and industry. This will facilitate the sales of UrbisAPI to as many cities as possible.

The Heating Schedule Use Case will be experimented with in Year 3 and will provide the CBR Planner with the opportunity to integrate with data streams both into and out of COSMOS components. Similarly, the message bus and Object store will see more data, enriching the quality of the data in storage.

In addition, we aim to use COSMOS components to create new Use Cases for the Camden Scenario, involving the new sensors and perhaps deploying more of different categories. The data accrued from the current prototype will illustrate the impact that we are making on the residents' energy bills, and that translates directly to cities' efficiencies.

In terms of the residents' engagement, Camden are planning a number of workshops to present the project and get residents' views on using ICT technology, the degree to which statutory organisations, such as local government bodies, are trusted by End Users and how this could impact the success of the platform. The outcomes will be used to tailor behavioural interventions using the Playbook/MINDSPACE framework. Camden will host feedback sessions with the residents participating in the Pilot, and will design a support package for residents based on the outcomes. The results will also be shared with the design teams to ensure that the platform is marketed in a way that maximises its take-up. Workshops and interviews with residents will be filmed, and a piece discussing the project and the residents' experiences will be published on YouTube and on the Council's website.

7. Appendix A

Playbook Framework

Version 1.0

SEVENTH FRAMEWORK PROGRAMME

The research leading to these results has received funding from the European Community's Seventh Framework Programme under grant agreement n°609043

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Revision History

Version	Date	Author	Notes
0.3	17 July 2015	Stella Doukianou and Abie Cohen	Updates from Joshua Cooper
0.4	21 July 2015	Jane Wilson	Content amends and formatting
0.5	01 Aug 2015	Jane Wilson	Updates from Stella Doukianou and Abie Cohen
0.6	14 August 2015	Jane Wilson	Post-Review meeting with Joshua Cooper, Stella Doukianou and Abie Cohen
1.0	10 February 2016	Katie Longman	Final changes and formatting

Related Documents

ID	Document Name	Version	Location
REF1	Spreadsheet	1.2	xxx

1. Effecting Behavioural Change

One of the challenges that organisations have always faced is how to effect positive behavioural change. From the early days of advertising to today's 'Nudge' unit at the heart of the UK Government, organisations have been looking for ways to encourage people to behave differently.

Today we live in a world which offers huge opportunities to encourage behavioural change driven by exploiting technological tools undreamt of even a few years ago. When we add the relatively new science of Behavioural Economics, the opportunities are limitless – but how can we bring technology and science together in a way that is relatively straightforward to implement? We also need solutions that provide measurable goals so we can assess whether or not our actions are working.

Our Playbook framework provides the detailed guidance to be followed for the system we have developed to change people's behaviour through interaction; we build on observed behaviour to determine effective interactions designed to modify behaviour. Because we continuously observe actual (versus claimed) behaviour throughout, we can determine whether the behaviour change occurs and, if so, how long it lasts. Likewise, the iterative and learning nature of the system means that it continues to be refined and enhanced throughout.

We bring together real-time information, big data management, analytics and the latest research in behaviour-change techniques to deliver measurable and actionable change. This paper explains how we do it and provides the toolkit to be followed. Our goal is to deliver data-driven insights into changing behaviours based on our clients' objectives.

Within this paper we:

- Explain the critical role of data and analysis within the Playbook framework;
- Define the Playbook framework;
- Demonstrate how the Playbook is used within an example sector;
- Provide a detailed explanation of Gameplans and Propositions, the core of the delivery of the Playbook.

2. From Data to Analysis in Real-Time

It starts with data, and lots of it. And it must be relevant data – data that represents real-time information about individual behaviours and the environment within which they occur. The solution captures, stores and retrieves massive volumes of time-sensitive data, and delivers real-time aggregation and comparison of that data. The data is analysed using our Analytics Engine which looks across multiple stores of data for patterns and trends, providing us with an array of new functionality that we deliver through our Playbook framework.

The Analytics Engine adopts iterative techniques – in effect, it is 'self-tuning' – providing us with a system that continues to evolve and provide new insights from the data.

2.1. Core Components

Our engine metaphor is made up of some core components:

Primary Measurement or Signal Data (parameters)	Provided directly from a sensor or Events generated from user interaction with a web-site or app.
Derived Signal Data (features)	Primary Measurement Data that has been manipulated and processed, e.g. a calculated average.
Reference Data	Proved by external sources or reported directly from a User, e.g. demographics, information about their environment.
Models	This is where the understanding and interpretation of data occurs and where we develop insights.
Events	Trigger conditions are set through the Models to generate Events that may be passed onto the User.

2.2. The Human Element

The missing piece in many discussions about big data, analysis or systems is people. Our goal is to provide a system that engages with people in both directions. Not only do we collect data from people (both inferred and actual), but we also use our system to define and deliver meaningful messages to build a relationship with our users – the people we need to engage. If they are not engaged, we cannot drive behavioural change.

Typically, people will engage with the system through some form of internet-based interaction. This may be a web browser or an app on a smartphone. In the future it could be through a smart TV – the possibilities are only just being explored.

2.3. Analysis

Now we have collected data and brought in the human element; next comes the analysis.

Put simply, analysis is what allows us to identify the important behavioural drivers to target in order to engage with people, but the process is much more complicated than that. Our system allows us to determine what behavioural drivers are most appropriate to which people down to an individual level (we describe this process later). The criteria and the framework that we employ are drawn from a theoretical body of research on Behavioural Economics.

Insight is understanding how to apply the analysis of data for a purpose. A key capability of the Analytics Engine is the ability to gather a wide range of data sources, both historical and in real-time, and feed them into statistical models to gain insight and continuously improve our models. By interpreting the data in specific ways, we are able to output accurate parameters and recognise useful patterns. This in turn enables us to make well-informed decisions on how to communicate with people and build relationships.

2.4. Developing propositions

Our objective is to take results from data-driven analytics, in conjunction with Behavioural Economic Models, to define a recipe for designing Customer Propositions. These Propositions benefit from using both Behavioural Science and Statistical Modelling in order to have the greatest impact on a User and the best chance of being effective.

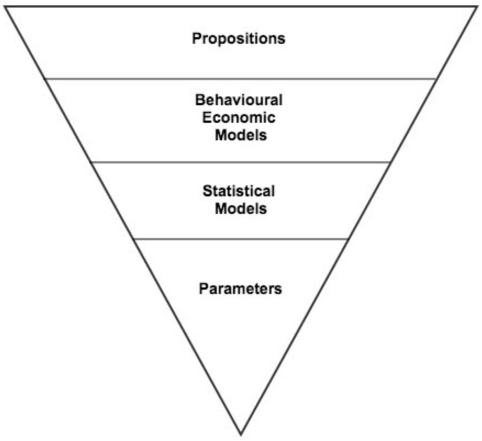

Figure 1. From Parameters to Propositions.

The pyramidal structure above represents how by starting off with only a handful of data signals (Parameters) it is possible to build many Statistical Models that capture different Insights from the raw data. By then including Behavioural Economic Models we enhance the Statistical Models and are able to identify insights on a per person basis which are used to generate propositions targeted at individuals and tailored specifically to them.

The diagram in Figure 2 (below) demonstrates how two different Data Signals can combine to create more propositions than they could both create separately.

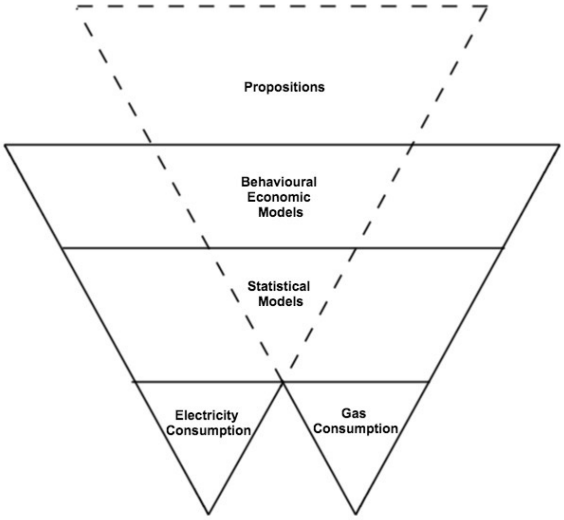

Figure 2. Multiple sensor data sources to Propositions.

In the chapters that follow, we define the Behavioural Science framework and explain how it sits on top of the Analytics layer of the system. Furthermore, we emphasise how this framework is used in the iterative nature of the system to both design and evaluate propositions. The Analytics Engine and the Behavioural Economics framework and the iterative nature of the system helps us to build a strong foundation and enables the system to not only be self-sufficient, but also self-tuning.

But first, we need to define the Playbook framework and explain how it brings everything together.

3. The Playbook

3.1. Customer Engagement

We define Customer Engagement as the "repeated interactions that strengthen the emotional, psychological or physical investment a customer has in a brand or a company".[12]

Customer Engagement should exist "beyond the purchase", and requires an emotional connection between the Supplier and their Customer. Engaging customers depends on:

1. Identifying their unique needs;
2. Following their behavioural habits; and
3. Returning value to them in an emotional context, based on what we learn from 1 and 2.

Perhaps the best metaphor is to compare the process of engaging customers to that of establishing a friendship with someone; we take time to get to know them, understand what they like and dislike, what motivates them and, over time, we build a relationship of mutual trust and loyalty.

Within a Customer-Supplier relationship, where we are working to establish a connection, the emotional context is the trust, commitment and confidence that the Customer has in their Supplier. To achieve a stronger relationship with customers, we need to: observe their decision points; examine what might be driving these decisions; determine the factors that may exhibit these specific behaviours, which might be emotions (e.g. loss aversion, impatience, social preferences) or a situation (e.g. unemployment, health issues) and; define what opportunities exist to intervene and influence the Customer's behaviour, in order to design effective plans to both determine and implement our behavioural change goal(s). We call these plans 'Propositions'.

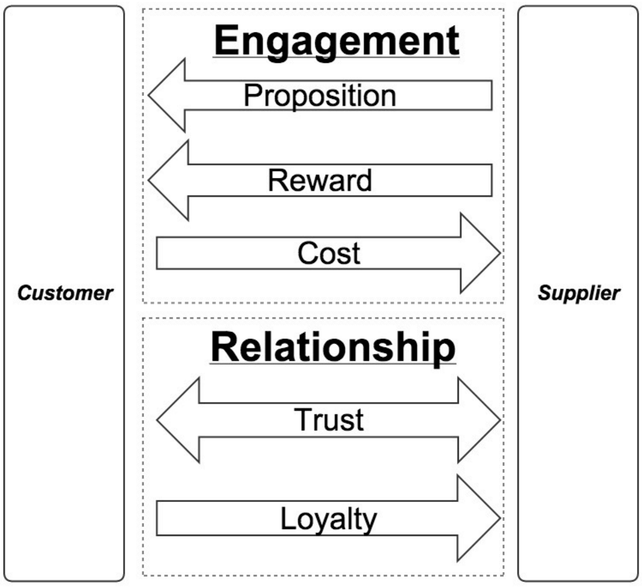

Figure 3. Relationships between Customer and Supplier.

3.2. Learning Systems to Deliver Customer Engagement

We need some form of systematic mechanism to build the emotional connection between Customer and Supplier in a low-cost, automated way. How do we do this?

Customers feel emotionally engaged with their Supplier when they receive messages that are designed according to their needs, and presented at a genuine and personal level. By this we mean that the interactions are thoughtful, informal and targeted. Customers also feel that they are receiving more from their Supplier than the Supplier is gaining from them.

Our Playbook framework is what we developed to answer this question; it is a system which evolves from data collection to build in Behavioural Economic Models and create Propositions. It provides a complete guide for an effective campaign to drive Customer Engagement.

3.3. Behavioural Economics

Behavioural Economics applies scientific insights from the field of psychology to help understand the drivers of human behaviour and potentially influence them; it is the discipline that implements traditional economic theories and fills in the gaps that arise from the fact that people's choices are often irrational or contrary to what Traditional Economics might predict. Scholars in Behavioural Economics assert that our decisions are 70% based on our emotions, and 30% on our rational reasoning.

3.4. Behavioural Economic Models

3.4.1. Background

In order to understand and predict a specific behaviour, we first need to observe the Customer's behavioural patterns. Data analytics help us to identify repetitive customer behaviour (behavioural patterns) over a particular period of time. The length of the period depends on what type of behaviour we are observing, and can range from several weeks to several months.

Having identified the behavioural patterns, we use psychology insights to create diagnostics about the reasons (behavioural drivers) that cause a specific behaviour or action. These behavioural drivers are often emotions or a situation (unemployment, pregnancy, health issue, etc.). The behavioural drivers are the additional parameters that enable us to create Behavioural Economic Models that predict behaviour.

Behavioural Economic Models extend rational choice and equilibrium models by adding new preferences and utility functions as parameters (behavioural drivers) to generalise the standard Economic Models. These parameters enable us to detect where the standard models do not work (e.g. they fail to predict the human behaviour), and are used to describe and influence people's behaviour.

The following table (Figure 4) describes the traditional models and the additional behavioural parameters:

Behavioural Characteristics	Traditional Economic Assumptions	(New) Behavioural Parameters
Reference-dependence and loss aversion	Utility theory	+ **ω** weight on transaction utility) **μ** loss-aversion coefficient.
Impatience and taste for instant	Exponential discounting	+ ß (preference for immediacy, "present bias")
Fairness and social preferences	Pure self-interest	+ γ (envy when others earn more) η (guilt when others earn more)

Figure 4. Traditional models to behavioural parameters.

3.4.2. MINDSPACE

We use a Behavioural Economic Model called MINDSPACE as our criteria to stimulate and evaluate Propositions. The MINDSPACE framework brings together emergent themes and behavioural influences from a large body of literature in order to improve and evaluate behavioural change strategies. It considers all the aspects that make a Proposition have the desired benefit and cost for the Customer. The largely qualitative criteria of MINDSPACE ensures a focus on the creative process of new Proposition design, as well as the evaluation of target groups for the Propositions.

MINDSPACE is an acronym:

MESSENGER

We are heavily influenced by the person who conveys information to us. This "Messenger" effect is based on credible individuals who communicate the information.

- We are more likely to 'trust' information when the Messenger has similar characteristics to ourselves. For example, a health research scheme "Healthy Buddy" (conducted to teach healthy living to young students) involved older students teaching younger students healthy living lessons. Compared with control students, the younger ones showed an increase in their healthy living behaviour.[13]
- Those from lower socio-economics levels are more sensitive to the characteristics of the Messenger being similar to theirs, e.g. gender, ethnicity, profession, social class/status, etc.[14]
- We are influenced by the way we feel about the Messenger; we may not accept a Proposition from someone we do not like.

INCENTIVES

This criteria refers to the economic law of demand, which says that we are sensitive to prices and costs[15]. For example, healthier food or drinking less alcohol can be promoted by offering incentives that encourage people to live healthier. The impact of incentives depends on their magnitude and timing. There are some factors that play important role in the way that people respond to them:

- **Losses loom larger than gains:** We prefer not to lose more than we like to gain – when the amount is equal.[16]
- **Our reference point matters:** It depends from where we see it – how big or small the change appears from our reference point.[17]
- **We overweigh small probabilities:** People believe that some events happen more often that their realistic frequency, e.g. plane crash accidents.
- **Delayed discounting:** £10 today may be preferable to £12 tomorrow.
- **We allocate money to mental accounts:** Labelling accounts encourages people to save or spend the money according to the label, without imposing any control or restrictions.

NORMS

We tend to be influenced by what other people do. Usually the norms are social or cultural. In a research project conducted at Arizona State University on how to get Americans to reduce their energy consumption, the only message that had a significant effect was the one that said that neighbours had already taken steps to lower their energy consumption.[18]

DEFAULTS

We 'go with the flow' when there is a pre-set option. Default options occur when we fail to make a decision. The optimal default significantly depends on the heterogeneity of the population.

SALIENCE

Our attention is attracted by what is novel and relevant to us. When we do not have information on something (or salience), we tend to look for an initial anchor. For example, if you are asked to write the last two digits of your National Insurance Number, this anchors the amount you would bid in an auction to those last two digits.

PRIMING

Our actions are influenced by what we are initially exposed to. This could be certain sights, words or senses. For example, asking people to create sentences using the words 'athletic', 'active', 'fit' and 'lean' resulted in them using the stairs instead of the lift.[19]

AFFECT

Our emotional connections can influence our actions. It has been proved that many people buy houses not because of floor quality or location, but because of the way they feel when they walk through the front door.[20]

COMMITMENT

We tend to be consistent with our public promises. Most of us are weak in achieving long-term goals, such as quitting smoking, and we use commitment devices for that reason. One effective method to commit is by making it public, as breaking that commitment will lead to potential reputational damage.

EGO

We tend to behave in ways that makes us feel good about ourselves. We also tend to think the same as others when part of a group, i.e. we adopt a group mentality. One example of this is the case of football fans, who systematically misremember or misinterpret their own team's behaviour compared to that of their opponents.[21] This validates the perception that we have of ourselves as being self-consistent.

4. Making This Work: the Energy Sector

As we have described, the goal of the Playbook framework is to deepen the relationship between two parties. To demonstrate the framework in action, we have chosen a particularly challenging scenario – the retail energy sector.

Why is this a challenging scenario?

1. Energy is largely unseen; it therefore lacks an immediate link to cost.
2. The relationship between the Supplier and the Customer is currently only developed through billing, (rare) support requirements, occasional marketing campaigns, and when the Customer moves/changes Supplier; there is an almost total lack of personal contact.
3. Knowledge is limited; meter readings are often estimated or the customer is asked to provide the readings.
4. Customers demonstrate apathy and unwillingness to invest time with their energy supplier.
5. If there is contact, the majority of these contact points are 'pain' points, e.g. loss of energy supply, home move.
6. Distrust often exists in general towards utilities.
7. Affordability is the final challenge: most customers feel that they overpay for their utilities but cannot be bothered to change supplier.

Our strategy involves the collection of real-time consumption data, presented back to the Customer through either a web browser or smartphone app. But we do not just playback their consumption data; we use analytics and Behavioural Economic Models to give the Customer something useful, including:

1. Access to data in a timely and reliable manner;
2. Better understanding of the services and products provided in simple terminology, and delivery of visual representation of their energy usage;
3. Information which is actionable and proactive;
4. A personal touch, by delivering information that is both personalised and highly relevant.

In the context of our Playbook, providing Customer Benefit through rewards strengthens the relationship between the Customer and the Supplier (see Section 8, ‘A Proposition Example: Save Energy’, for an example Proposition).

For the Supplier, engaging Customers by demonstrating a thorough understanding of their needs to deliver customised interactions leads to successful marketing outcomes (e.g. loyalty, word of mouth), and therefore enhanced profitability.

The following sections explain how to translate this vision into action.

5. Model to Deliver the Vision

The diagram below (Figure 5) depicts the critical elements of the Model which underpins our Playbook framework, specifically within the energy sector. We can use this Model to isolate and analyse key components in the system, and explain how they work at a functional level and how they are connected to other dependent components in the system. This gives us a frame of reference when narrating the process of using Analytics to develop Propositions for Customers.

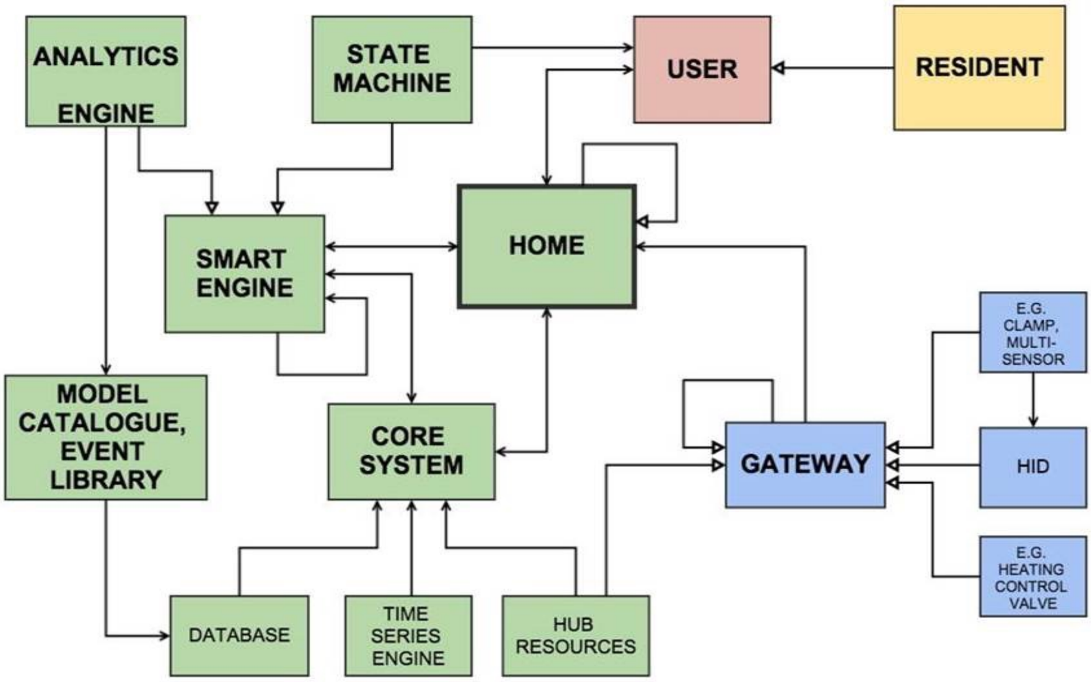

Figure 5. Home Energy Domain Model.

The Model consists of two distinct elements:

- **The Physical element** – The User (or Customer in our discussion), the home they live in and the various devices that deliver data into the Gateway are all physical elements that are managed by the Digital element:
- **The Digital element** – This consists of the various systems that are used to capture, store and analyse the data received from the Customer's home and from their behaviour that is recorded when they interact with the system (e.g. Do they read messages? How often do they log in?).

The Gateway device communicates with an array of actuators, tags and sensors. The actuator could be the switch in a Heating Control Valve, while a sensor could be an electricity clamp, a smart meter, an environmental sensor, etc. Both capture time-sensitive data and pass it through to the Gateway. All elements within the Home system carry unique identifiers which we hold against a unique identifier per Home; that unique Home identifier is one of the critical resources in the entire system.

On the digital side, there are a range of services running which include storage, information on network resources and on-device resources, as well as the interface between the Customer and the system (delivered by a web browser or an app). Storage comes in the form of an extensive Time-Series database, capable of storing mass amounts of time-dependent data points in a structured manner, so that they can be easily accessed by other services.

The critical visible element that the digital services deliver for us is intelligent messaging. We call it intelligent messaging because an Analytics Engine (described in the next section) determines the nature, content and frequency of delivery of targeted messaging to each Customer within the context of an over-arching goal. In turn, we learn from the response to these messages (which may or may not trigger a new Event) by building the Customer's response back into our system. That learning results in the creation of new data streams that, unlike the Primary Data that comes directly from an electricity meter, is Derived Data, as described in Section 2.

6. Data to Knowledge: the Analytics Engine at Work

Having explained the background and the context of the Playbook, we will now explore its core: the Analytics Engine.

6.1. Data

It starts with data: we exploit the potential power of the Primary and Derived Data, collected through implementing analytic techniques and developing statistical models. In our energy example, data from the Gateway is combined with data from external sources (i.e. demographic information about the customer, details about their home and household) to create a comprehensive array of useful data feeds, allowing us to gain insight on both individual customers, and on the customer population as a whole.

The act of establishing knowledge of both the individual and the population involves developing two distinct data flow concepts. Each concept relies on a fundamental flow of data from streaming signals through to the central point where statistical models are created.

6.1.1. Population Data

Meter data collected by the Gateway is passed through to the Analytics Engine following a strict yet simple path to derive information and, therefore, knowledge about the Customer Population. This data flow is represented in Figure 6 below:

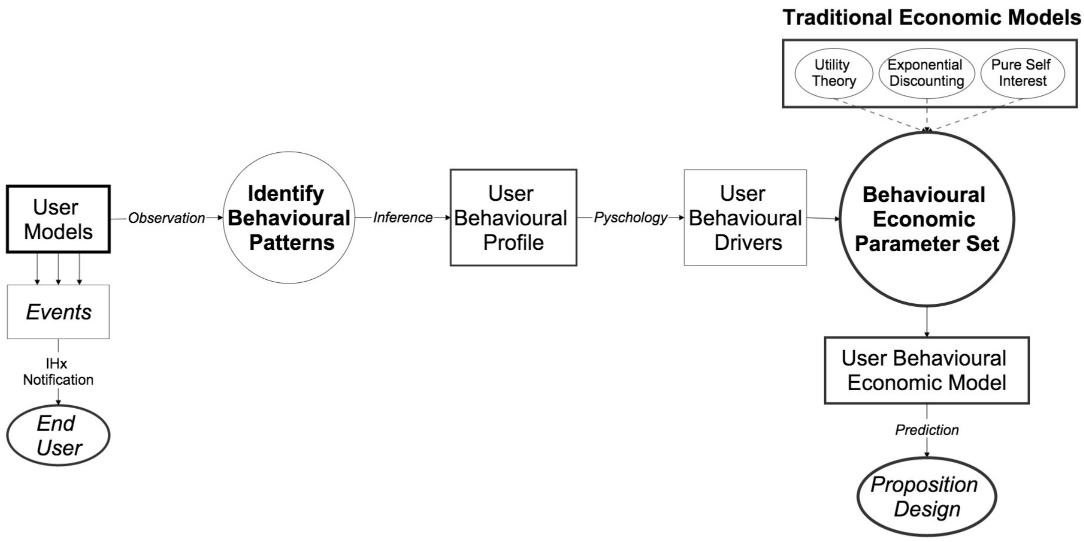

Figure 6. Data flow diagram.

All of the data that we collect, whether from a meter or other external sources, is passed through to the parameter set in the Analytics Engine. This set is automatically populated by all of its sources, and each parameter can then be classified as one of three types:

1. Primary
2. Derived
3. Reference

These parameters are then used to populate the Engine's Feature Set; the Feature Set contains the key parameters for the Predictive Models. The Models are used both to generate Event data streams (refer to the Event Library below), and also to segment Customers into smart groupings.

6.1.2. User Data

Once population-based analytics has been performed, the Analytics Engine is used to target specific User segments for further analysis and behavioural profiling. This profiling, through the use of the Behavioural and Traditional Economic Models described earlier, enables us to predict behaviour on a per-user basis, and thus provides direction and guidance in designing Propositions.

At the most basic level, User Models can be used to generate User-specific events. We use these data streams to push relevant notifications or messages to the Customer. Further value in the User Models can be unlocked by applying Behavioural Economics knowledge to aid in the design of targeted Propositions.

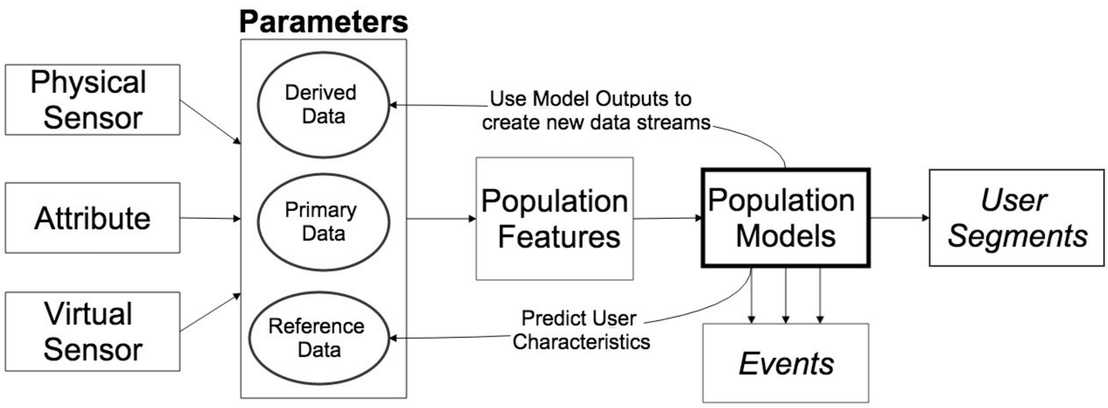

Figure 7. Segmentation data flow.

6.2. Data Streams

The building blocks of the Analytics process are the data streams that we capture from a variety of different sources. The different types of data stream we encounter are described in this section.

6.2.1. Primary Data

Primary Data is data that is observed from a physical phenomenon or action. Many of the Primary Data signals that we will be dealing with in our example system will be captured and/or generated by the meter. The most obvious Primary Data source, to use the example, is a household's energy consumption. Energy consumption data is a time series streamed from the meter to the core system, where it is stored and accessed by the Models (as will be explained later).

Other Primary Data sources are captured from Events that are generated, for example, button presses or monitored data from customer usage of the service to view and engage with the system. Once these Events are triggered, a data point is generated and fed through a data stream into a unique time series for that particular Event. These Primary Data signals are also used in the analysis stage to gain insight into achieving User-specific goals.

6.2.2. Derived Signals

Derived Signals are the result of applying specific functions to the Primary Data streams. For example, we use electricity tariff data in tandem with a Customer's electricity consumption data to produce a Cost Electric parameter.

Another example of how we can infer new parameters from Primary Data is by aggregating Events triggered by a Customer's interaction with the service to produce an engagement score. This score can change with time as the User gets either more or less involved with the system; it becomes another data stream which we can use for analytic purposes.

6.2.3. Reference Data

Reference Data describes a Customer's characteristics. For example, it is useful for our Models to use the age of the Customer's house as an influencing factor when looking at heating efficiency, for instance. We typically we ask the Customer to input their Reference Data; this means that it is extremely important that we think carefully about how we ask the Customer for their data. We must ensure that the nature of the request is non-intrusive and does not annoy. Part of our success in collecting the data depends on the level of relationship that the Supplier has built with the Customer; more questions can be asked more frequently as trust levels increase.

6.3. Data Flow

Once the data streams have been captured, the flow of data from its raw state to its enriched state begins. This flow of data is the backbone of the Analytics Engine. The key components of the data flow are the Parameter Set, the Feature Set, the Statistical Models and, finally, the Event Library.

6.3.1. Parameters

The Primary, Derived and Reference Data is collected to form a set of Parameters. Parameters all have a source, whether that is the service with which the Customer interacts, the meter or an external API. Furthermore, they all have a format, such as kilowatt-hours (rounded to 2 decimal places) or a basic true-or-false value.

Parameters are data streams that can be filtered and have logical functions applied to them to create statistical features for our predictive Models. Parameters are therefore inputs for our features.

6.3.2. Features

For each Feature, we explain how it is calculated from the specified source, what it means in real terms and how it is beneficial to the Supplier's Performance Measurement criteria. Many of the Features shown refer to a vector of values represented by X. X is a simple construct that is adapted to fit the requirements of the Feature it is being used to calculate. For example, Feature F1 uses Parameter P1 to calculate the average daily usage over a week-long period, in which case the vector X is a set of 48 data points calculated from P1. Each element in this vector represents that 30-minute period's average over the period of a week.

The system also supports the capability to use Features as sources of other Features; we can use the complete Parameter and Feature sets to create new Features.

6.3.3. Models

One of the key capabilities of the system is the Analytics Engine's ability to drive statistical model creation and refinement. The Analytics Engine uses the available Features to implement algorithms and predict threshold values, which are used in the Proposition Generator.

The Analytics Engine builds population-sized Models that use the customer-base as the entire analysis domain. Various clustering and pattern recognition techniques are employed to segment the population of customers into natural groupings. We call these groupings natural because they are constructed using the underlying characteristics of the data. These population groupings, or segments, are then used to target particular Propositions at appropriate customers; we use Behavioural Economics to predict which Propositions are likely to be more effective with which group/s of customers.

Another way in which the Analytics Engine operates is by driving customer-specific Models for tailored real-time Event detection. This level of personalisation contributes to an improvement in the relationship between the Supplier and the Customer, and creates trust as the Customer is presented with information that is targeted directly at them. The building and tuning of these Models allows the system to continuously generate significant Event data that can be fed back into the system in multiple ways.

One way, for example, is to refine the original Model that generated the Event. Another example would be to trigger a push notification to the Customer through a messaging system. These Events can also be funnelled into their own data stream to be used as a Parameter and, eventually, as another Feature to be used in other Models. The learning is thus iterative and continues to improve.

6.3.4. Event Library

The Event Library is where Events are generated, stored and used within the Playbook framework. An Event is simply a realisation of a certain occurrence, whether it is capturing a Customer's interaction with the service or a threshold being tripped on a particular environmental sensor. For now, Events are triggered and recorded on a per-Customer basis, in order to personalise Gameplans towards their behaviour. Furthermore, the real-time aspect of the Event Library allows the system to respond to Events and scenarios with minimal time lag.

Events can be stored in the system to be used as new Parameters in the form of Derived Data streams. These Parameters can then be used as Features in new Models for a particular Customer or cluster group, depending on how the Feature was formed. This vastly increases the Analytics Engine's predictive capabilities, by taking advantage of the system's iterative nature.

Events can be complex in nature, which is where our concept of State Machines comes into play. State Machines constantly run and handle all of the information and insight we have on each Customer, making up-to-date, responsive decisions when thresholds are reached and conditions are satisfied. Multiple Parameters are tracked simultaneously to implement complex logic and generate relevant Event streams. These types of Models can be used, for example, to identify whether a Customer would benefit from a particular Gameplan with a targeted proposition. It is these analytic capabilities that drive the behavioural targeting and position the Supplier to achieve the best results.

In summary, the Event Library represents the collection of data streams in the system and defines how they interact with each other in different parts of the Analytics Engine. The architecture is based on the principle of having a constant flow of data feeding into Models to refine them, and having mechanisms in place to propose new predictions. The input could be from Primary Data streams, as well as Events generated by other Models. Similarly, the outputs can range from creating new Parameters and Features to making API calls, as well as pushing personalised messages to Customers.

An example of using the Analytics Engine to build Models and gain insight for a specific Proposition is available in Section 8, 'A Proposition Example: Save Energy'.

7. Forming Gameplans

The important question is: How do we translate the intention of the Playbook into reality? And our answer is: we form Gameplans.

7.1. What is a Gameplan?

A Gameplan is a plan of action that includes two or three Propositions at its core. The Gameplan provides an overview of the strategy, and all the steps required to achieve the relevant goals, delivered through the Propositions at an individual Customer level. The other components of a Gameplan include: Performance Measurements, Reward Structures, Goals, Benefits, Costs, a Timeline and, finally, Evaluation; they provide the context within which the Propositions must function.

7.2. Performance Measurements

The Supplier's objectives for the system determine the Performance Measurements, against which we use the system to continuously assess and evaluate performance and ensure that results are in line with expectations. It is paramount that, throughout the process of creating, refining and evaluating Gameplans within the Playbook framework, the Performance Measurements of the Supplier are consistently in the forefront of decisions as they are made, and that these decisions are validated against them at every step. This section explains where in the Gameplan formation process the Performance Measurements are most significant, and why these are the key components that we use to evaluate Propositions.

Performance Measurements are heavily linked to the Gameplan's Goals, and are used to measure the performance of each goal. Goals are a key component of the Gameplan, as they represent the strategies the Supplier uses in order to achieve its objectives. The Goals component is linked to the Supplier benefit, and therefore Performance Measurements must be selected very carefully in order to assess each of those goals.

Performance Measurements are used internally to measure and optimise a Gameplan's performance, hence they should be:

- **S**pecific
- **M**easurable
- **A**ttainable
- **R**elevant to the goal and to the Supplier's business objectives
- **T**imely

These attributes, which form SMART criteria, are used to evaluate the relevance of Performance Measurements. They could be expanded with two additional attributes, evaluate and re-evaluate, as it is important to continuously assess and re-assess the relevance of our Performance Measurements with the Supplier.

7.3. Proposition

The core delivery mechanisms of the Gameplan are the Propositions within it. How do we design and develop a Proposition? By following the steps below, beneath which we have listed either examples or methods relevant to each step.

1. Define Objectives

- Engage the Customer
- Enhance the relationship with the Customer by building trust
- Identify which company objectives are satisfied by this Proposition

2. Perform Analytics

- Gather information
- Assesses the audience
- Segment the target audiences
- Prioritise – choose where to focus, balance costs versus benefits
- Identify behavioural patterns and opportunities

3. Set the Behavioural Goal

- Use behavioural insights
- Ensure goals are specific, time-focused and measurable

4. Develop the Strategy for the Proposition

- Make synergistic use of MINDSPACE criteria
- Make the criteria attractive and competitive to the target audience
- Develop a strategy that highlights the short- and long-term benefits to the specific audience

5. Create an Evaluation Plan

- Use MINDSPACE criteria
- Based on insight from data analytics and statistical models

6. Pilot Test

- Ensure that the Proposition works through observing the data, for example, if we see reduction in energy consumption, we know that the Proposition worked
- Measure and improve effectiveness
- Refine

7. Implement and Evaluate

- Use MINDSPACE criteria

- Draw on insight from data analytics and statistical models
- Select one (or more) control groups
- Monitor and compare results to control groups over time
- Consider whether the Proposition is sustainable
- Follow up

7.4. Reward Structure

A Gameplan must include a reward structure. The Customer Reward Scheme used in the Playbook framework aims to fulfil both the Customer's and the Supplier's goals. It helps to achieve attitudinal and behavioural loyalty from the Customer, and enables the Supplier to invest in their 'best' customers, with whom they are likely to have a good relationship in the future. In most scenarios, we identify 'best' customers as those who are the most profitable, but this could vary – in another situation we could be trying to identify a group who meet a different criteria, perhaps those who are most loyal, but not necessarily most profitable.

Positive reinforcement, used to increase the behaviour that we want to drive, is divided into three types of reward: low, medium and high. The low reward, which is easily achievable, sets the basis for developing the trust between the Customer and the Supplier. When trust starts to build, the medium reward is offered to maintain loyalty with the Customer. This is then followed by the high reward, which is unexpected, experiential and only available when we see the Customer's behaviour change. High rewards are offered to the 'best' customers in order to motivate them and influence their future behaviour. The aim is to reach higher level goals and influence aspects of the Customer's behaviour that are not necessarily met with ordinary rewards that competitive Suppliers offer.

The range of rewards will be customised to service customer heterogeneity across the target population. Since different customers are likely to value the same reward differently, we employ data analytics to help identify the Customer's behavioural and attitudinal dimensions, in order to design targeted rewards.

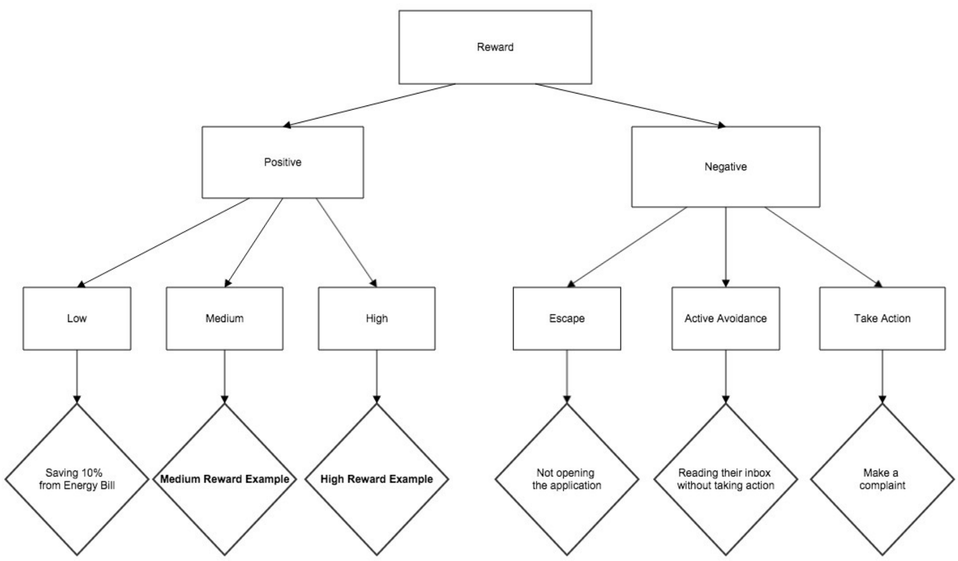

Figure 8. Reward path.

7.5. Goals

The Gameplan's goals are a series of requirements that we expect to satisfy before the termination point is reached. One of the main goals present in every Gameplan is to improve the relationship between the Supplier and its customers. The implementation of Gameplans gives suppliers an effective communication channel with their customers, allowing them to establish deeper relationships and thus increase customer retention. The Propositions included in the Gameplan aim to communicate the message "we recognise and value your loyalty to us" to the Customer.

Rewards act as Customers' obligations, encouraging them to respond in the form of engagement and loyalty back to the Supplier which, in turn, may lead to higher rewards offered being to them, and so on. The relationship between the two parties has to be sustained in a cyclical level that is both profitable and effective for the Supplier.

Behavioural Goals are set based on human behaviour, something that we know is influenced by a variety of factors, such as situation, personal characteristics, lifestyle, environmental factors, social factors, intention and demographics. An example of setting personal Behavioural Goals that are tailored to the Customer's lifestyle and characteristics for a Gameplan is found in Section 8, 'A Proposition Example: Save Energy'.

7.6. Supplier and Customer Benefit

These are unique to each Supplier and their respective customer sets. For each scenario, we produce a table where we clearly lay out the benefits to both parties that can be derived from the Rewards and Goals.

7.7. Supplier and Customer Costs

As for the benefits, we define the costs to both parties due to running the Gameplan.

7.8. Release Timeline

The following questions should be asked when forming a Gameplan:

- How long should the Gameplan run?
- How many phases do we roll out?
- How long are each of the phases?
- How often do we roll out each phase?
- When is the termination point?

Answers to these questions may have to be a compromise between the ideal scenario and constraints determined by the Supplier's circumstances.

7.9. Gameplan Evaluation

The process of evaluating a Gameplan comprises three assessments:

1. Each Proposition has to be evaluated against the MINDSPACE criteria.
2. The efficacy of the Reward Structure must be evaluated.
3. The Gameplan’s timeline must be considered and assessed.

7.9.1. Proposition Evaluation

Evaluating a Proposition involves testing it against each element of the MINDSPACE criteria, and looking at whether or not each element was effective. Examples of evaluations could include:

- Reviewing who the Messenger is when the Proposition is suggested to the Customer.
- Assessing whether the Customer has responded well to a Proposition for customers who respond to mentions of social norms.
- Was the Customer sufficiently primed? Did we capture any behavioural change due to subliminal gestures?

7.9.2. Reward Evaluation

Both positive and the negative factors should be considered in Reward Evaluation.

Positives

- Did they respond well to the reward?
- Did we jump too quickly from medium to high? Do the Models indicate am increase or a decrease in engagement?

Negatives

- Did we receive any negative feedback? If so, how does it link to the Proposition criteria (MINDSPACE)?

7.9.3. Timeline Evaluation

- Is the test time period long enough to gain statistically significant results?
- Do Models tracking commitment indicate that the phase rollout was too rapid or too slow? When is the appropriate termination point?
- Was the termination point too late, such that users lost engagement, or too early, such that we did not successfully achieve behavioural change?

8. A Proposition Example: Save Energy

8.1. Purpose

In this section, we illustrate a complete example of the Proposition design process. Our intention is to demonstrate how we follow the Playbook framework to discover opportunities, implement strategies and evaluate results over a complete set of criteria. The key components that form the outline of a Proposition are the Goals, Analytics, MINDSPACE framework and Reward Structure. We must always keep these in mind, as they dictate how and why we make certain decisions as we progress through the steps.

8.2. Proposition Creation

We follow the guidelines specified in Section 7.3 to structure the design and evaluation process. This example Proposition looks at how a retail energy utility would target their customers to save energy, as a way of building trust and enhancing the Customer-Supplier relationship.

8.2.1. Objectives

- **Engagement:** We design a reward structure that uses low rewards for easy-to attain-goals and medium rewards when the Customer reaches a milestone. This scaled progression of rewards keeps the Customer interested in the Proposition.
- **Enhancing Relationship and Building Trust:** As this Proposition is elementary, it is the first step in enriching the Customer's relationship with the Supplier, and starts to build trust.
- **Supplier Objectives:** As we would like to improve the image of our Supplier and portray them as being environmentally friendly, we will use data from all of their customers that have saved energy to calculate the total amount of energy that has been saved through the Proposition.

8.2.2. Analytics

- **Gather Information:** We observe high daytime usage trends through our Analytic Engine's Model visualisations.
- **Audience Assessment:** We notice that high daytime usage implies either occupancy during working hours (category label: home during day) or appliances being left on while vacant (category label: energy waster).
- **Segment the Target Audiences:** Use cluster analysis to segment customers and classify them into the two categories above (home during day or energy waster).
- **Prioritise:** Focus on the energy waster group and prioritise the goal of an energy-saving opportunity. The energy saving can be achieved by turning off appliances before leaving home, e.g. turn off the lights when you leave the room, do not leave TVs on standby. Due to the low cost and high benefit of

simply turning off the lights when leaving a room, we opt to set this as our number one priority in behavioural change. Other ways of saving energy, such as changing bulbs to LEDs, would impose higher costs to End Users, and therefore would not be the first recommendation.

- **Identify Behavioural Patterns and Opportunities:** In order to identify behavioural patterns, we look at clustering models that compare the average daytime usage with the ratio of morning usage over noontime usage. This allows us to classify users. We use this Model in particular because a high ratio value indicates home during day, whereas a high daytime usage is not sufficient to separate the two segments. This provides us with the opportunity to target users with the energy waster behaviour, and help them to save energy and money.

8.2.3. Set the Behavioural Goal

- **User Behavioural Insights:** According to empirical evidence, the most influential factors that can drive behavioural change in this particular Proposition are:
    - Cost awareness;
    - Environmental sensitivity;
    - Comfort levels;
    - Practical challenges.
- **The goal has to be focused and not too general/broad:** Turn off the lights when you leave home!
- **It needs to be realistically achievable in a comfortable time period:** For this month.
- **Measurable:** The Analytic Model based on the Parameter *av-daytime* will show a decrease in energy use.

8.2.4. Develop the Strategy for the Proposition

Using Reference Data and demographic Models, we can predict the target Customers' socioeconomic level and start to develop their behavioural profile according to the fact they are energy wasters, for example, as a way of further segmenting a cluster of similar users.

MESSENGER

People living in low socioeconomic neighbourhoods are more likely to be receptive to motivation from their peers or a local authority figure, whereas people who live in high socioeconomic neighbourhoods are more likely to respond more to an external authority figure (e.g. an MP).

INCENTIVES

For the low socioeconomic group, saving money will be one of the most powerful behavioural drivers. Therefore, the message structure targeted to them should be simple, and clearly state the benefits and the cost saving of turning off lights: “Did you know that turning off the lights when leaving the house can reduce your energy costs by up to 10%?”

NORMS

We will use behavioural profiling to target Customers from the same geographical area and display information to those Customers, informing them of the savings their neighbours have made (selecting the most impressive examples).

DEFAULT

Notify Customers if their daily usage is above average. Set the price in pounds to be the default view, rather than energy in kilowatt hours, for example.

SALIENCE

Delivered through a web or app service. The prominent visualisation will be a comparison of the day’s usage with average usage over a week, and this is to be updated every day. Customers can then choose to compare each of their daily usages over the last week/month. A prediction of daily usage can also be shown using the Analytic Engine’s Extrapolation Model.

PRIMING

Use weather feeds to update Customers on the day’s weather forecast, using ‘light’-related words: “Nice weather - it’s bright out, so let the light in!”

AFFECT

Encourage the Customer to feel proud about achieving their savings targets, using badges and other types of positive reinforcement.

COMMITMENT

The reward of energy savings for the cost of a small task will start building trust and loyalty between the Supplier and the Customer. Gradually, the rewards will be unexpected and of higher value to trigger their engagement.

EGO

Environmental benefits, well-being and general social good will be the main messages targeted to the higher socioeconomic group Customers. We assess how effective these methods would be on particular Customers according to their behavioural profile. Through our interaction with the Customer via the IHx Application, we enhance the behavioural profile and assess whether or not a leaderboard is appropriate.

8.2.5. Benefits for the User

- **Low Socioeconomic Group:** Short-term benefit: save energy. Long-term benefit: save money (we do not focus on the environmental aspect, as it is likely to be less of a priority).

- **High socioeconomic group:** Short-term benefit: save energy, environmental well-being. Long-term benefit: a surprisingly substantial amount of money saved.

8.2.6. Pilot Test

The Proposition should first be tested against a small Pilot test community. Evaluation depends on the design of the Reward Structure, and test Customers' responses to it. First, we must ensure that the Proposition itself works; this can be achieved by getting feedback from the Pilot Customers or by using the Analytics Engine's comparison functionality to measure efficacy. Based on the results, we can then decide whether the Proposition is ready to be rolled out on a larger scale or whether and where changes need to be made. For example, if we discover that many users did not accept the Proposition, we must go back to the design stage and re-evaluate the Reward Structure (see Section 7.4) and, perhaps, conclude that the incentives (see Section 3.4.2) were not strong enough to motivate the Customer. Similarly, if we observe that Customers accepted the Propositions but failed to meet their energy-saving targets (see Section 3.4.2), we could re-evaluate the analytics, measure how attainable the target was, and perhaps adjust our expectations for those Customer segments.

The Evaluation Criteria can be found in Section 7.9.1.

8.2.7. Implement

In this Proposition, we choose one control group where we do not intervene at all. The data from these Customers provide us with a mechanism to compare and measure the effects of our Proposition. As all of the Customers we target with this Proposition come from the same population segment (see Section 6.1.1), all Customers in the Pilot study (both intervention and control groups) have similar behavioural profiles and demographics, and are therefore comparable. The real value of this control group is that it provides us with the data from the scenario where we did not attempt to nudge the Customer in a particular direction. We can therefore build a scoring system that can be used as a measure of efficacy, e.g. 73% energy saving during weekday daytime periods. This provides us with a means of setting the minimum targets that must be achieved in order to validate the Proposition.

As explained in Section 7.3, it is important for us to monitor the results of the implementation as we progress through the release timeline, and not just at the termination point. Models from the Analytics Engine can be used to indicate whether usage is changing over time and whether behaviour has, in fact, been influenced. We can also take advantage of the Event Library (see Section 6.3.4) to provide us with indicators of when Customers have reached certain targets, not only to ensure that they are on their way to making energy savings, but also to know the rate at which they are doing so.

8.2.8. Evaluate

We take the MINDSPACE criteria and check each one individually to see if it has been used correctly and to its full potential. We can start, for example, by using the data accrued by the customer's actual usage to indicate how many customers accepted our Proposition, which then translates into how many participants responded positively to our message to take on the Proposition. If our analytics show us that the Proposition achieved a 95% acceptance rate in both groups, then we can deduce that our Proposition seemed desirable. If, however, there is a relatively low percentage of acceptance in the low socio-economic group, for example, (e.g. 40%), then we have to identify the reason behind this. One of the many causes could be that the message was poorly designed, or its content was not sufficiently motivating. Another cause could be that the Messenger was inappropriate for the specific group in question.

In general, the first component we investigate is the key trigger that attracts the customers' interest, and subsequently drives the commitment. In this particular case, the key component is the incentive. If the actual 'message' is not strong enough to attract the customers' interest, then the rest of the criteria will not be effective either.

Therefore, we start by checking the incentives:

INCENTIVES

- Evaluate whether the incentives are motivating enough for Customers from the low socioeconomic group to start displaying change.
- Explore if there is a possibility to maximise the potential to save energy by relating savings to costs.
- Form stronger messages, e.g. emphasise how much money Customers can save each time they act on something, show them examples of what actions they can take, etc.

After evaluating the Incentives criterion, we proceed by checking the following key components - the Messenger, Salience and Commitment criteria:

MESSENGER

- Firstly, did we use an appropriate Messenger?
- Are there any other factors that we forgot to consider for that particular group?
- Looking at the population segment in the low socioeconomic situation, it is still highly unlikely that an authority, celebrity or someone from a 'higher' income bracket would convince them, so we stand by our initial proposition and suggest a neighbour to communicate the message, perhaps, for example, the owner of a local shop.

SALIENCE

- Could the messages be more prominent?
- Is it possible to change the presentation style to maximise engagement?
- Maybe the message is too dull or not emphasised enough. How can this be rectified?

COMMITMENT

- Re-evaluate the Reward Structure:
    - Are the low rewards too low?
    - How can we adjust the jumps between reward levels to best trigger customer engagement?

These are the most important factors that have to be evaluated in order for the rest of the criteria to be most effective. We should also look at the reset of the MINDSPACE framework; however, it is imperative that we focus on these key components for the 'Save Energy' proposition.

8.3. Reward Structure

Low reward: Save energy, become friendlier to the environment, be top of the leaderboard.

Medium reward: If you continue saving energy over a period of two months, we will offer xxx.

High Reward: For the top 5 savers in the leaderboard over a period of 6 months, we will offer xxx.

8.4. Goals

Any Proposition that we define has to satisfy at least one overall Goal. The main goals are as follows:

- To reduce energy consumption;
- To save money on energy bills;
- To increase Customer Engagement;
- To build trust with the End User.

An effective Proposition should not have more than two goals; in this case, we suggest reducing energy consumption and increasing Customer Engagement.

Now we can start to design the Proposition according to results from the Analytics Engine and the criteria from the MINDSPACE framework. These goals must be at the forefront of the design process, and we must ensure they underpin every decision that we make.

8.5. Supplier and Customer Benefit

Supplier	Customer
Customer Engagement	Financial Savings

Customer Trust	Improved well-being: • Environmental awareness • Feeling that my utility company is looking out for me • Feeling like part of my community
Environmental Awareness	

8.6. Supplier and Customer Costs

Supplier	Customer
Financial	Effort
	Emotional (stressful)

8.7. Key Performance Indicators

- We measure whether the Customer has managed to reduce energy consumption by looking at historical data from over the implementation period and comparing it to their previous usage. The difference between these two usage values provides us with an indication of whether consumption decreased during our intervention.
- We tie the consumption data signal with tariff data (as a Derived Signal) and use a similar sort of comparison to see whether the Customer saved money and, if so, how much.
- We use data from the Event Library to measure Customer Engagement, e.g. what proportion of sent messages have been read by the Customer.
- One Proposition on its own is not sufficient to measure whether trust has been built between the Customer and the Supplier.

8.8. Release Timeline

How long should the Pilot be?	3 months
How many phases do we roll out?	6
How long are each of these phases?	1 month
How often do we roll out each phase?	Every month
When is the termination point?	6 months, from the start of the first phase rollout
Is the Pilot time period long enough to gain statistically significant results?	Not applicable
Do Models tracking commitment indicate that the phase rollout was too rapid/slow?	Not applicable

Was the termination point too late, such that Users lots engagement, or too early, such that we did not successfully affect behavioural change?	Not applicable

8. Appendix B

This section describes the key terms that are used in the development of Gameplans.

Playbook	A document containing the key terminology, framework, criteria and all the information needed to understand how to design and evaluate a Gameplan.
Proposition	A plan or scheme communicated to the End User that, if acted upon, should generate a Reward. Propositions can be free of charge or have monetary cost, but should always be rewarding for users.
Reward	The positive consequence that outweighs the cost of taking action. Specifically, it articulates and/or embodies the benefit of acting on a Proposition.
Benefit	The goodness that accrues to an End User; closely related to Rewards, but representing the sum total advancement in the monetary, health, social or well-being for an End User. Hard benefits are monetary- or health-related, whereas soft benefits offer social and well-being advantages.
Cost	The opposite of a Benefit, in that an End User spends or sacrifices money, health, social or well-being, i.e. if someone 'invests' time, it costs them time.
Relationship	Connectedness between the End User and the provider of the service or application; a shallow relationship would be a transactional one, and a deeper relationship would be one with emotional ties, whereby each party looks out for the other's interests.
Engagement	The level that the End User will maintain their relationship with the provider. During that period, the level should be sustained through Benefits and Rewards and measured by the level of interactions.
Behavioural Economics	Behavioural Economics takes the core principles of Traditional Economics and overlays them with the realities posed by human psychology.

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