

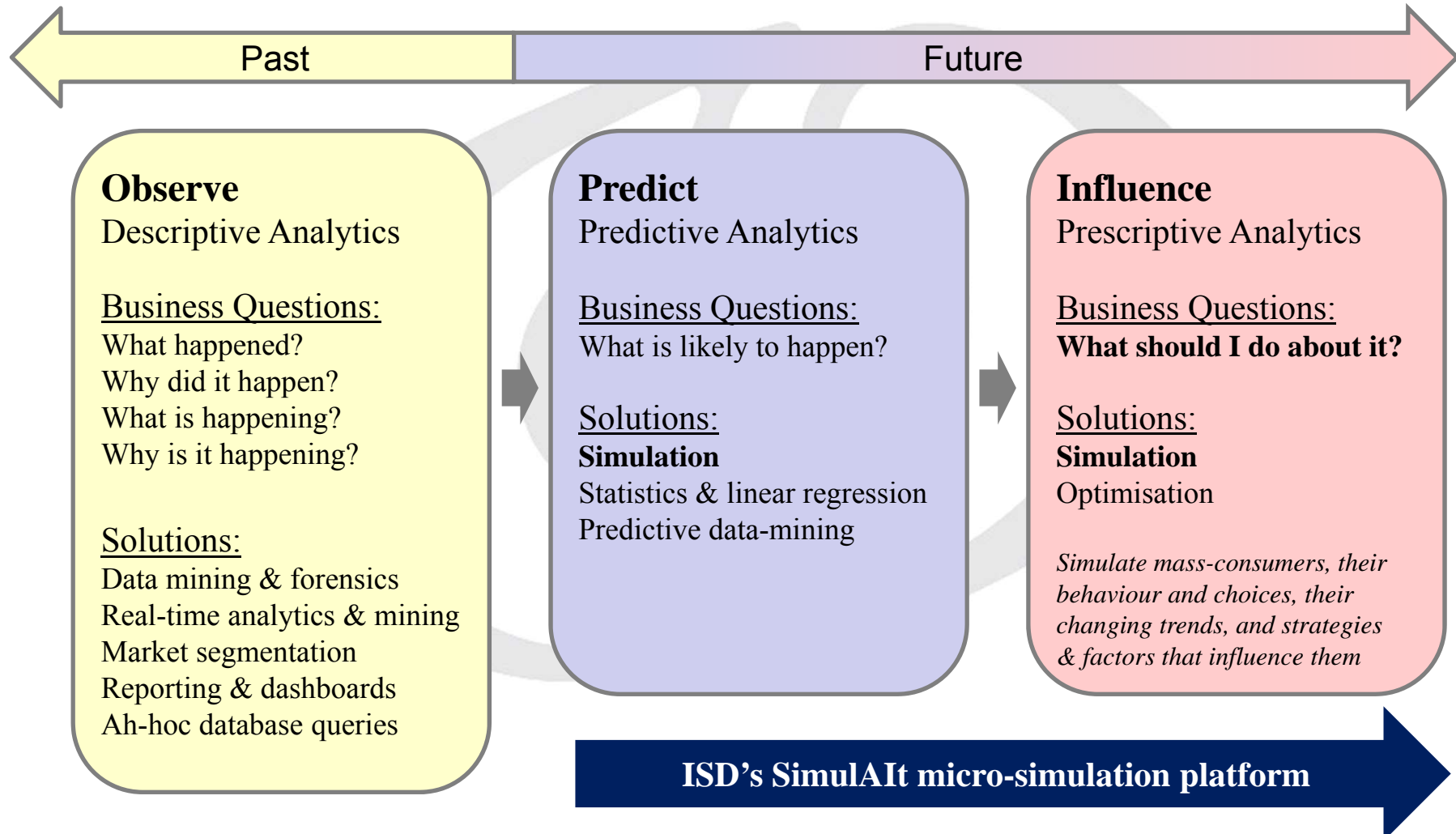
# **SimulAIIt: Water Demand Forecasting & Bounce back**

**Intelligent Software Development (ISD)**

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# Data Analytics & Decision Process



\* Based on Gartner's model of analytics

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# Factors that impact water demand

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- Population trends and dynamics
  - Population growth & demographic change – e.g. household structure and size
  - Change in household allotment/garden size – e.g. getting smaller
- Products or appliances used
  - Uptake and penetration
  - Efficiency and consumption (water, energy, carbon) – e.g. becoming more efficient
- Consumer behaviour
  - Consumers usage of appliances – range of *possible and rational* behaviours
  - Frequency and duration of use, per household or per person
  - Interdependencies: seasonal factors, demographic factors (e.g. age & bath use)
- Behaviour change & maintenance from influences (strategies and policies)
  - Factors: social, economic, environmental, political
  - Water conservation: restrictions (gardens, cars, pools), rebates, retrofit
  - Price: discretionary and non-discretionary
  - Marketing & media on the water situation – e.g. drought & water levels
  - Different consumers respond differently within range of behaviours – e.g. income level, preferences for different demographics, duration persisting with behaviour, etc.

**SimulAIIt considers all these factors**

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# Current limitations

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## Spreadsheets

- a 2D tool (rows and columns) to tackle an multi-dimensional problem
- Limited scalability

## “Econometric Only” models

- Limited in addressing these non-linear, dynamic, human-centric problems
- Limited detail, unrealistic assumptions about decision making, ...

## Statistics, data mining, and mathematical models

- Observes and forecasts what people do, no insight into “why” they do it
- Inability to effectively represent complex consumer behaviour, and the impact individual behaviour has on aggregated results
- Single purpose (forecasting) – difficult to address other business problems
- **Past demand may not be a good predictor of the future**

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# What is SimulAIIt?

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**Business tool to help you accurately predict and explore options to influence mass-consumer behaviour and decision making**

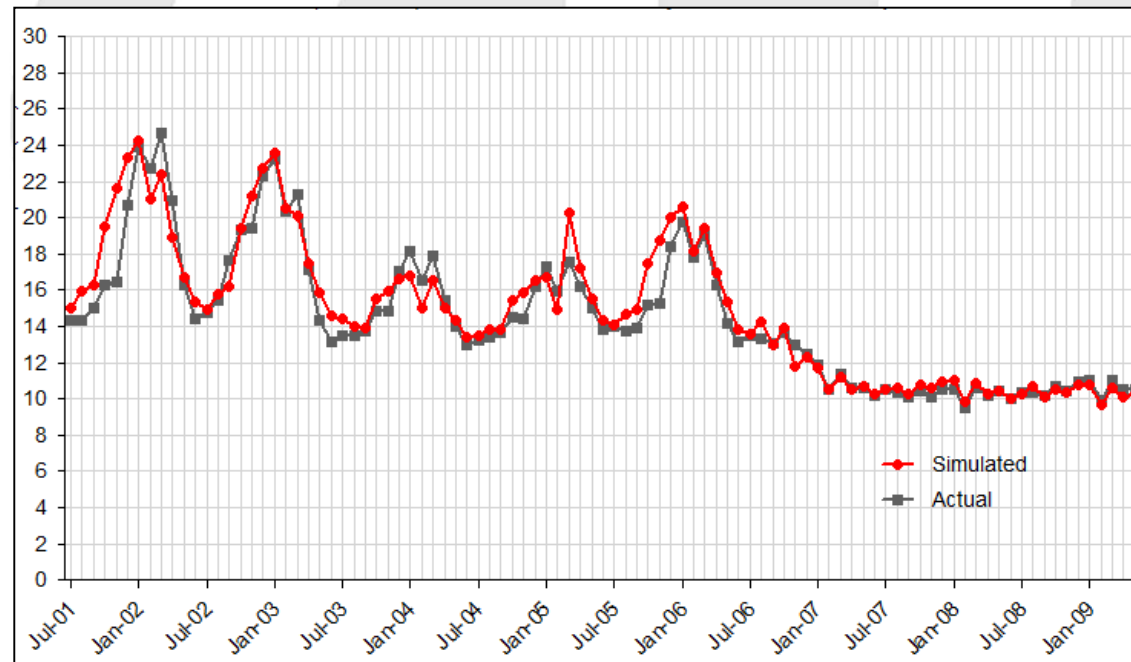
- Simulates populations of all sizes with regional breakdown
- Model reactions and behaviours of individual consumers to new strategies, policies, products, prices and competitive strategies
- Handles different types of data to incorporate many consumer decision making factors
  - Qualitative and quantitative data
  - Social, economic, environmental and political data
- Incorporates different technologies from Defence
  - AI & Micro-Economics, Agent-Based Modelling, Human Cognition Reasoning Engine, Dynamic Multi-Dimensional Database, Micro-simulation



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# Accurate Validated Models

- Water forecast with different restrictions, prices, marketing and media (2010)
- **Accurate:** proven approach, demonstrated over **95% accuracy**
  - Model not built on past demand data – demand data used to validate the model
  - Accuracy due to greater representation of a broad range of consumer factors
- **Decision support:** can assess different options and strategies through what-if scenarios to improve future outcomes

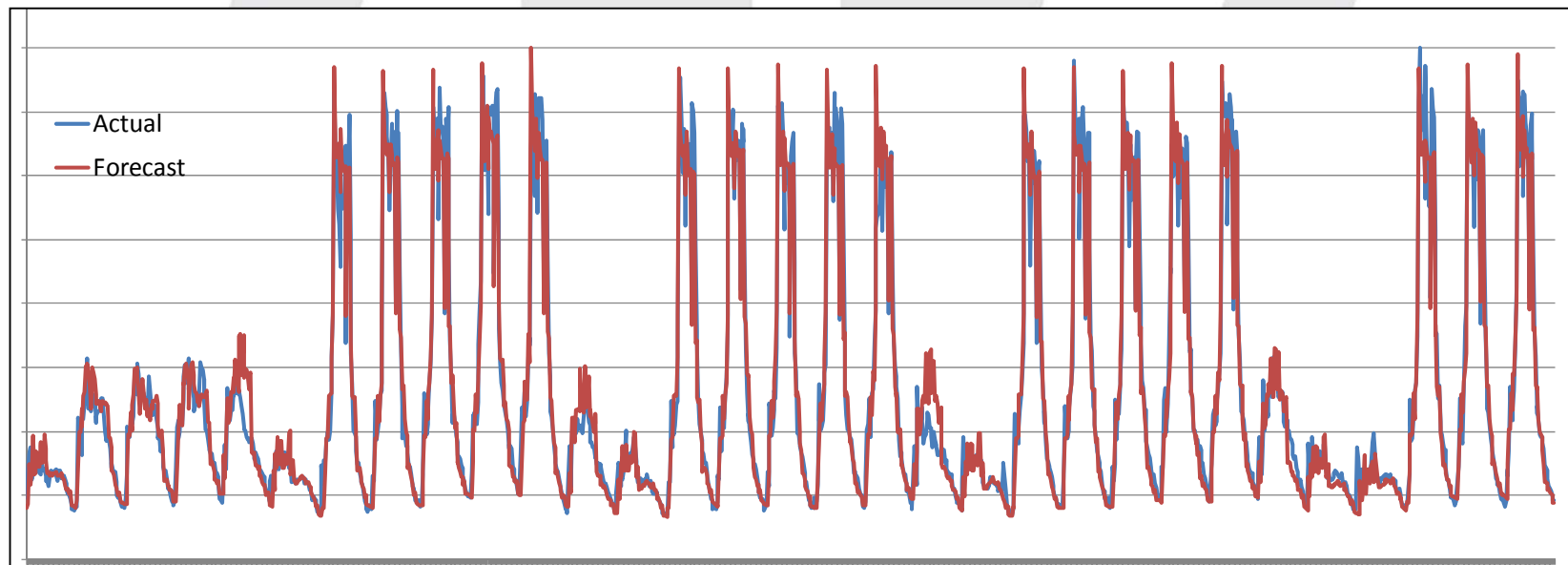


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# Energy Forecasting: Non-Res, 30mins

Energy load forecasting accuracy

	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>2008</b>	<b>99.0%</b>	99.2%	97.9%	98.8%	98.0%	95.0%	98.5%	99.6%	97.0%	99.6%	98.7%	96.5%	85.0%
<b>2009</b>	<b>99.8%</b>	96.7%	99.3%	99.3%	99.0%	98.9%	98.4%	98.8%	95.1%	97.3%	93.1%	98.6%	98.3%
<b>2010</b>	<b>98.3%</b>	91.9%	97.9%	97.1%	97.6%	98.6%	98.1%	99.1%	97.1%	87.8%			



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# Benefits: more than just accuracy...

## Multi-purpose forecasting and decision support tool

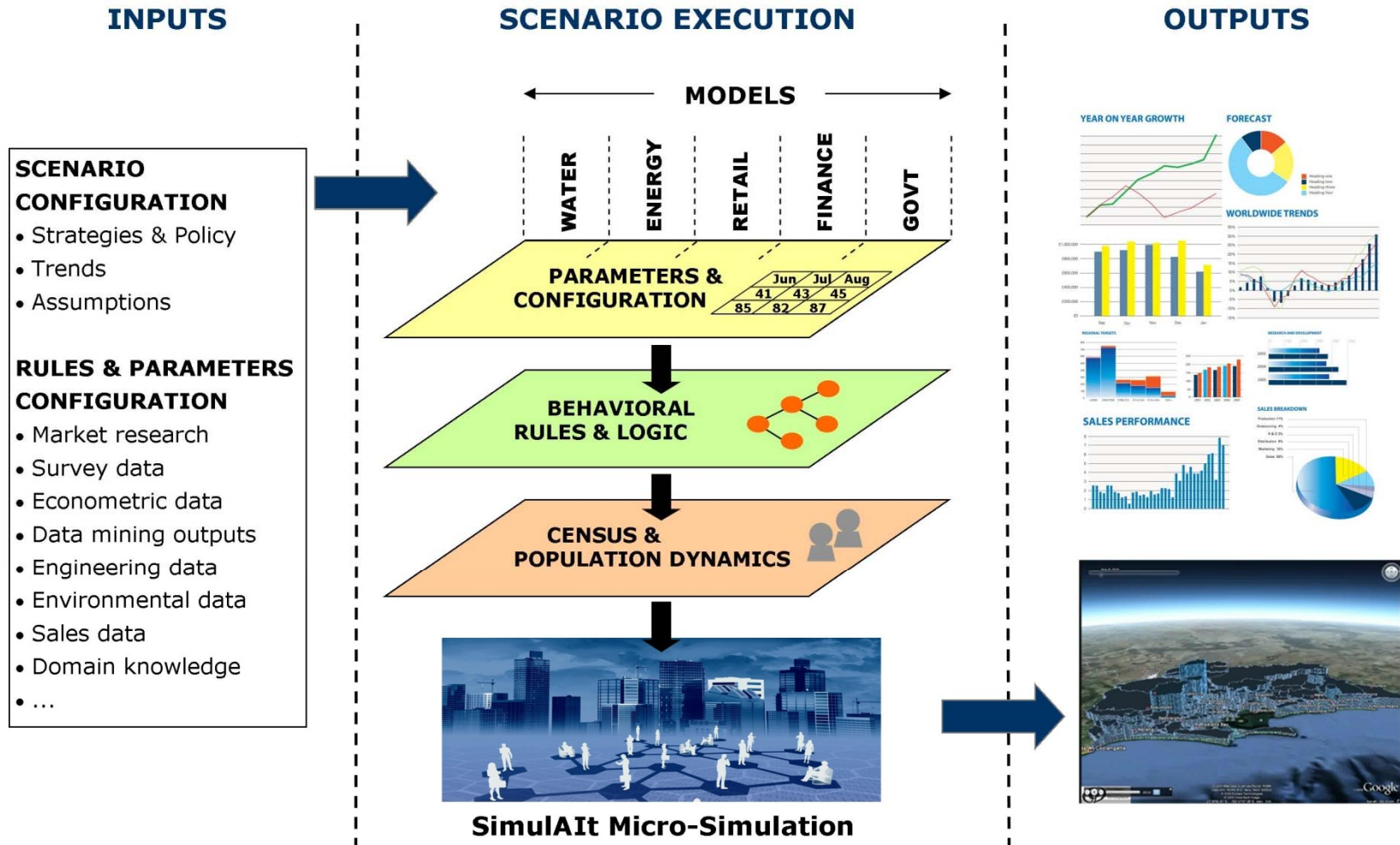
- Address a broad range of strategic business and policy problems through what-if scenarios
  - More consumer/human decision making variables to analyse and test
- Isolate and understand significance of strategies
  - Better define relationships between strategies & decision variables
  - Forecast the impact of new strategies or disruptive events
- Test & optimise strategies and return on investment (ROI)
  - Evaluate past and future strategies, support business cases
  - *Testing consumer “influences” enables greater control over future outcomes/forecasts*



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# SimulAIIt Overview



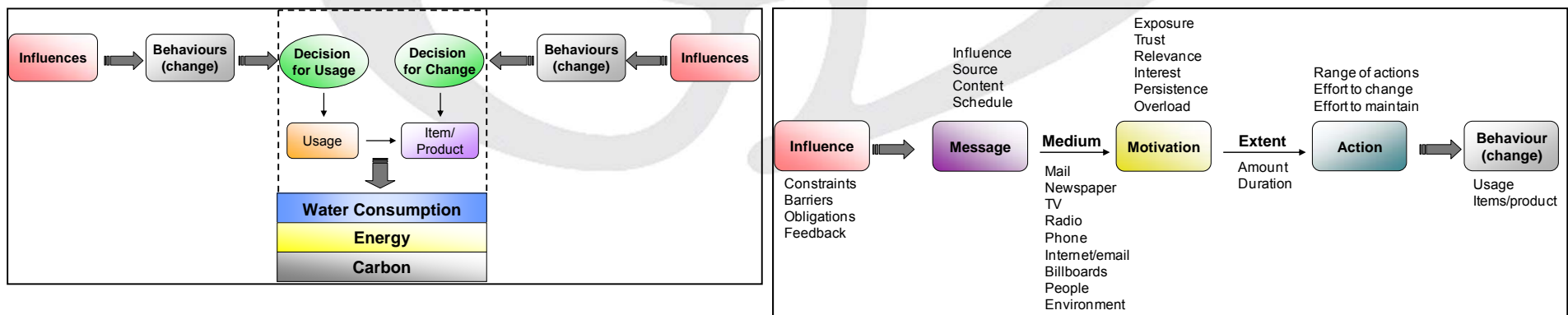
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# Water Forecasting Model

**SimulAIt is used to create a detailed simulation of your water customers**

- Simulated how consumers use water and make decisions in the garden, kitchen, bathroom, laundry, etc.
  - What products they use, how they use the products, how this changes over time
- Simulate how consumers' decisions are influenced by different policies and communication signals, such as media communications

## Behavioural Model



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# Customers

## Customers



## Awards



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# MW, YVW, CWW & SEW

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## Objective

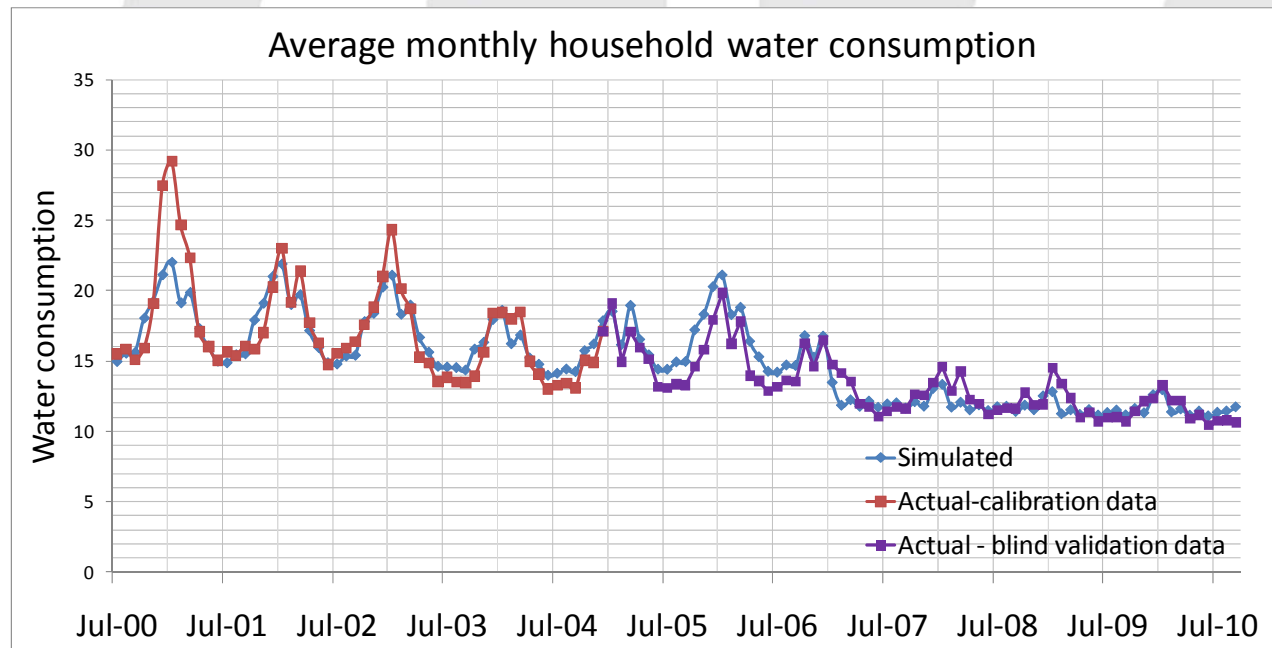
- Blind validation: Used 4 yrs of demand data to calibrate outdoor water use and then forecast next 6 years of demand without access to actual demand data
- Separate models created for YVW, CWW and SEW
- Forecast bounce-back in demand from easing restrictions & price increases
- Flexibility to investigate customer water use behaviours and uptake of efficient appliances

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# MW, YVW, CWW & SEW

## Key outcomes and benefits

- Blind validation provides greater confidence in the model and forecasts
  - Minimizes risk and enables optimisation of strategies
  - Potential use in pricing submissions to regulators
  - Ability to investigate bounce-back in demand
- Share a consistent and accurate model: for the wholesaler and retailers



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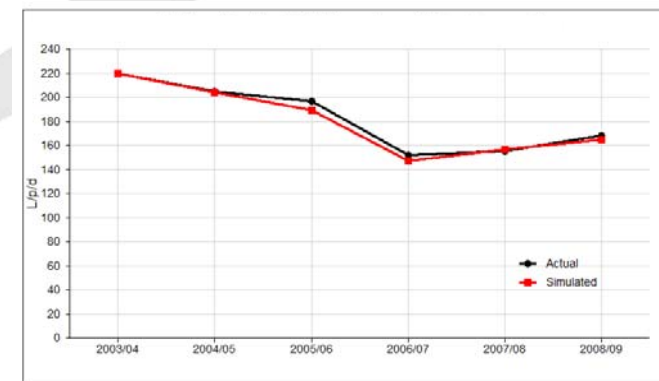
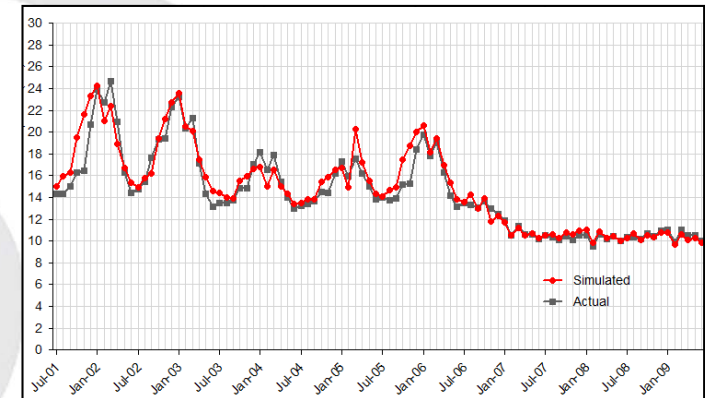
# CHW/DSE – Bounce-back

## Objective

- Evaluate past strategies, and forecast bounce-back in demand from easing restrictions
- Pricing impact on consumption
- Impact of product uptake on revenue
- Business case to regulators
- Demographic analysis

## Key outcomes and benefits

- Informed capital expenditure, corporate plans, restriction setting
- Rigorous business case to industry regulators
- Isolated and quantified the effectiveness of past & future strategies (campaign analysis)
- Inform & increase ROI on future strategies

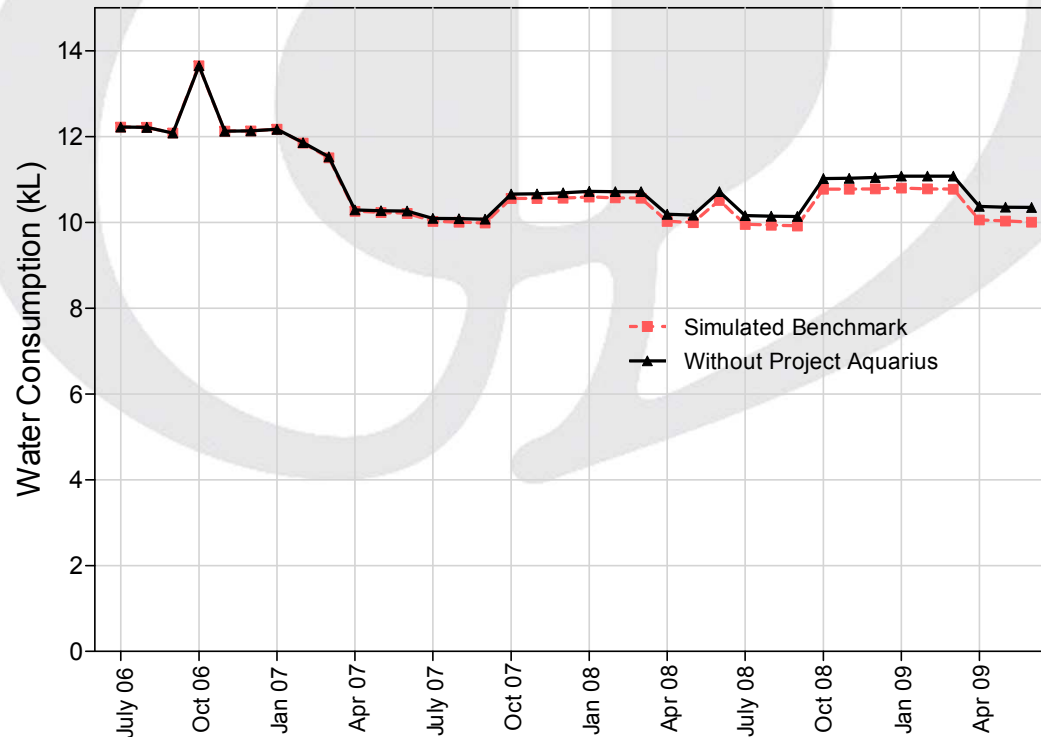


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# Project Aquarius

SAVINGS	Water	Energy	Carbon
<b>Total</b>	199.2 ML/2.34yrs; 85.2 ML/yr	4.3 GWh/2.34yrs; 1.8 GWh/yr	1664 tonnes/2.34yrs; 711 tonnes/yr
<b>Per HH</b>	37.4 KL/yr	815 KWh/yr	0.32 tonnes/yr
<b>\$</b>	\$52.36/yr	\$58.72/yr	

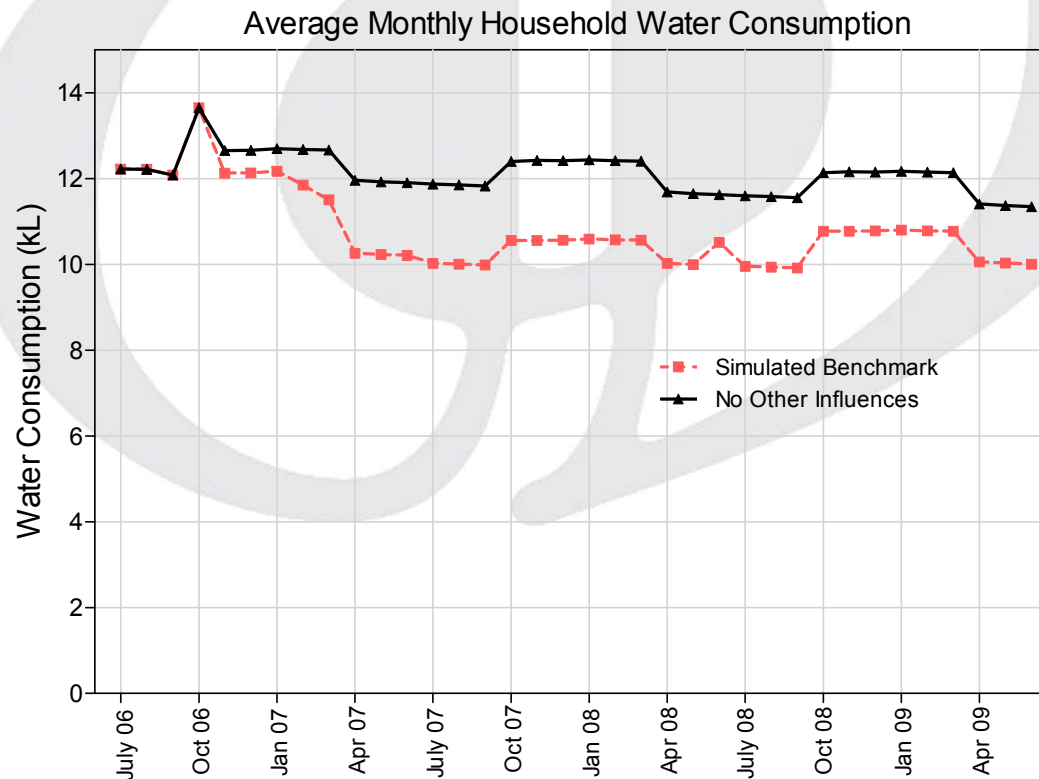
Average Monthly Household Water Consumption



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# Other influences

SAVINGS	Water	Energy	Carbon
<b>Total</b>	<b>1.9 GL/3yrs 624 ML/yr</b>	39 GWh/3yrs; 12.9 GWh/yr	16,706 tonnes/3yrs; 5,900 tonnes/yr
<b>Per HH</b>	15.1 KL/yr	973 KWh/yr	0.14 tonnes/yr
<b>\$</b>	\$21.14/yr	\$23.35/yr	

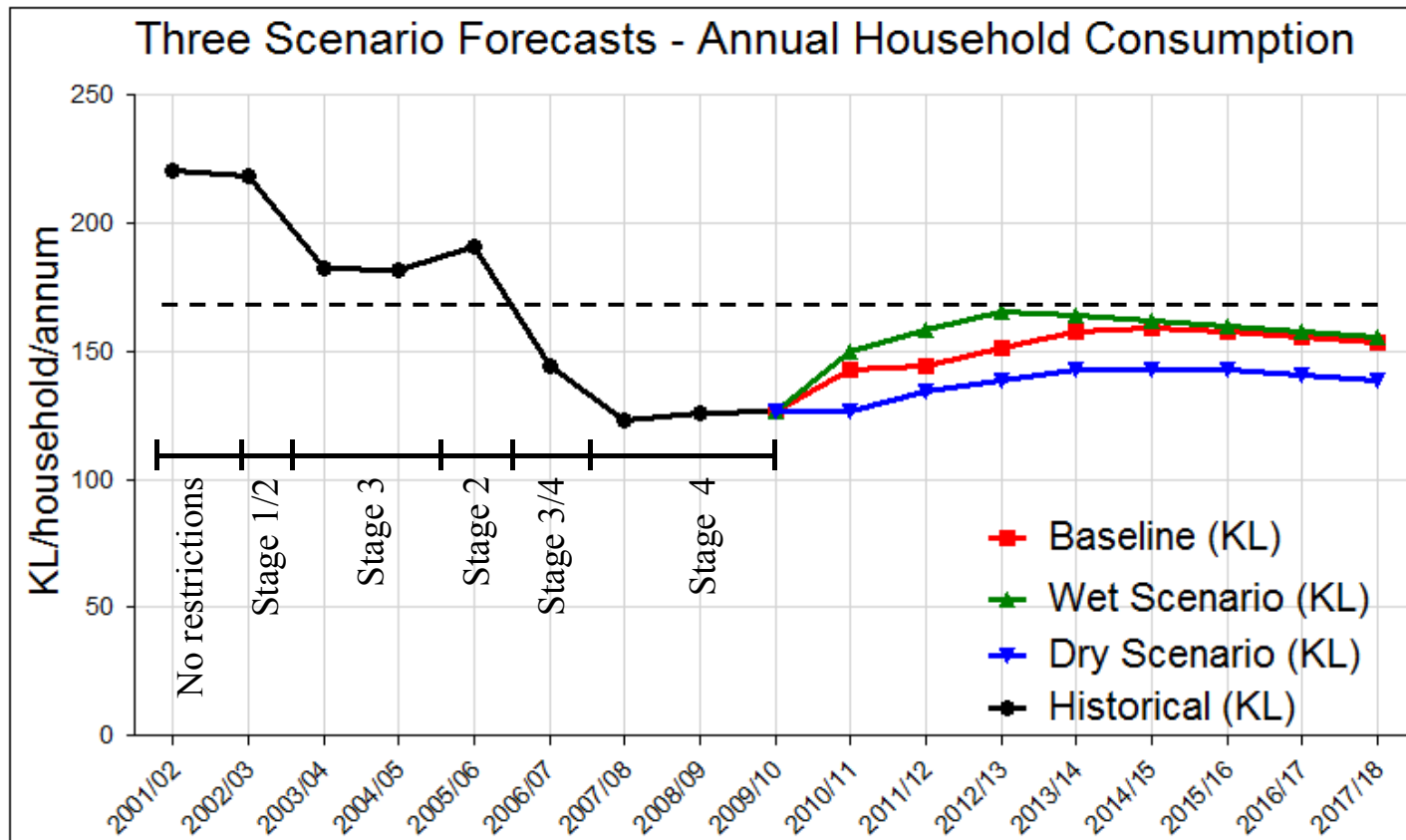


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# Results – future forecasts

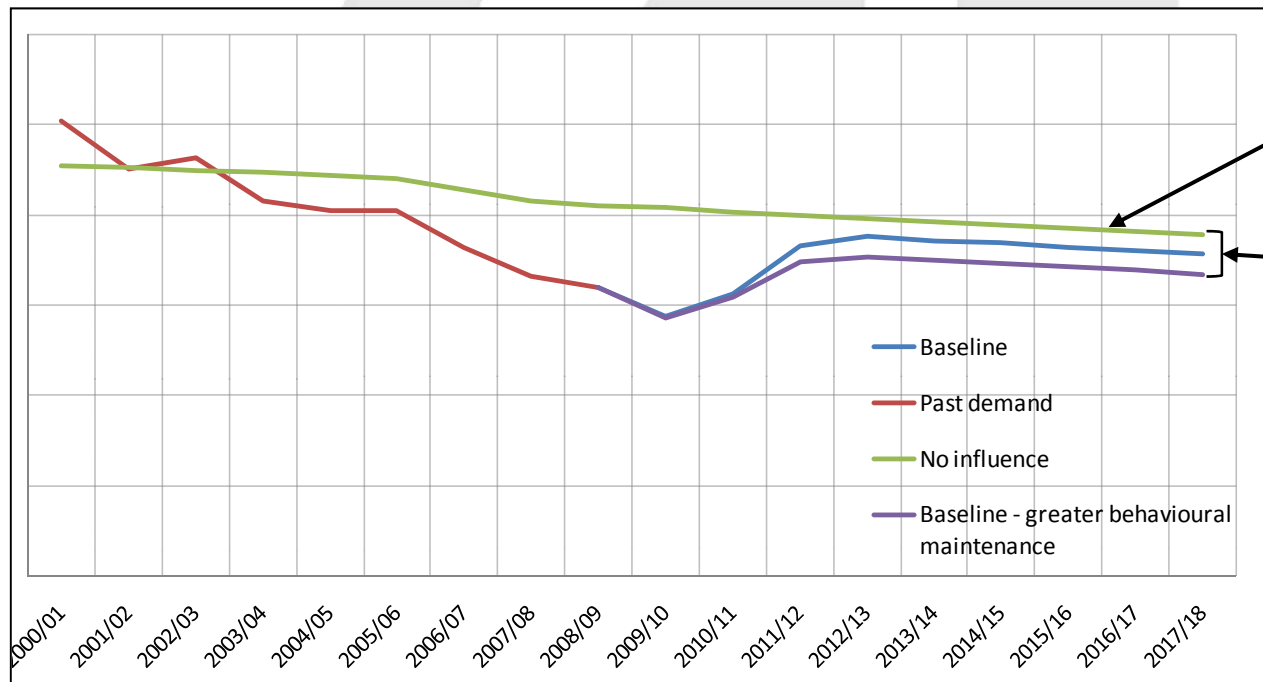
## Comparison of scenarios (KL/HH/yr)



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# Bounce back components

- Theoretical maximum bounce back
  - Natural decrease in demand from uptake of efficient appliances and population dynamics
- Behaviour maintenance/change
  - Test different levels of behaviour maintenance (sensitivity analysis)



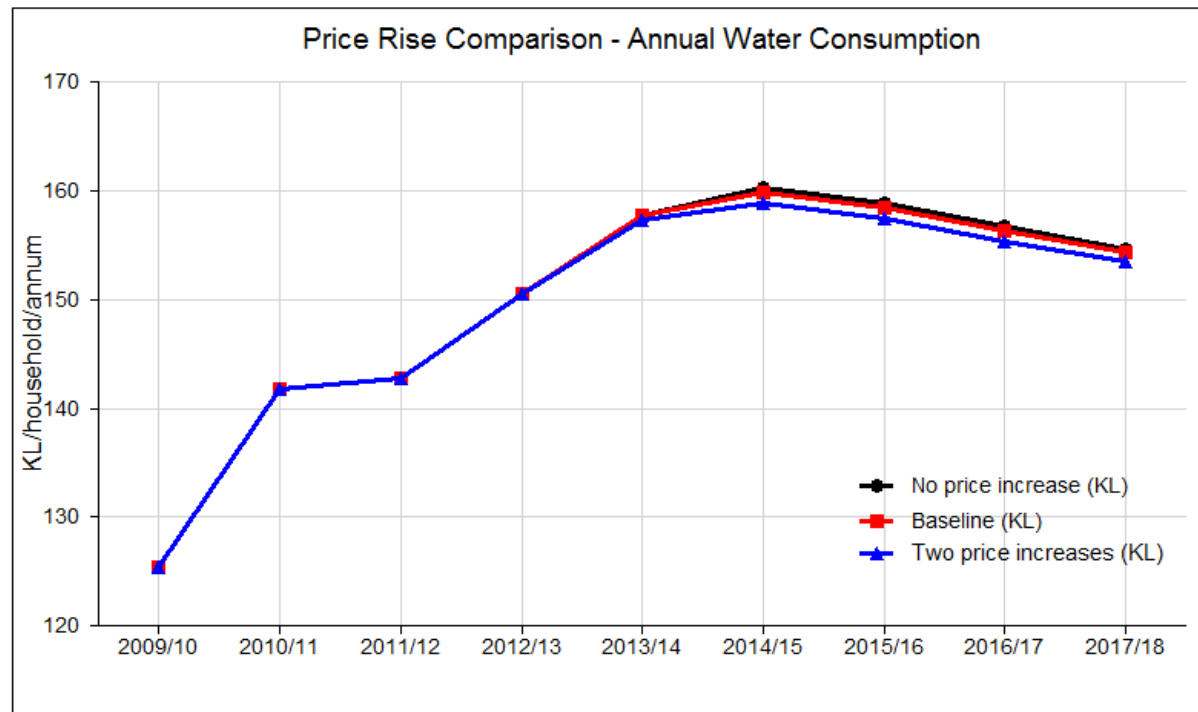
Theoretical maximum demand

Reduction in demand from behaviour change (behaviour maintenance)

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# Price rises

- Forecasts show that two 10% price increases from 2013 results in a 1.5kL (0.9%) reduction in household water consumption per annum
- Economic analysis shows a 6.3 kL (4.2%) drop in water consumption
- SimulAI results show the current high level of behaviour change in the Ballarat community provides little opportunity to reduce water consumption from price rises



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# SimulAI Online

- Access SimulAI via your web browser
  - includes hosting, maintenance and support
- You can:
  - Access your validated model online
  - Add many users
  - Create multiple scenarios – test assumptions and what-if analysis
  - Share scenarios (models), results, notes and descriptions
  - Refresh data and configure assumptions, parameters, etc...
  - Run simulations
  - Download results – disaggregated via region, and time or appliance
- Benefits
  - On-demand access to your models
  - Control, Visibility, Ease of Use
  - Facilitates collaboration: share scenarios and results
  - Maximise ROI: execute many scenarios when required
  - Hosted solution: no installation of software or hardware required to run large scale simulations



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A large, light gray watermark of a stylized logo is centered on the page. The logo consists of two overlapping, rounded shapes that form a central vertical opening, resembling a stylized 'Q' or 'D'.

**Questions?**

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# Technology theory – ants...

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# SimulAI Technology

- Consumer behaviour can be described by rules which are driven by a consumer's demographic characteristics, situation, and preferences
- Agent-based modelling provides a practical bottom-up approach to model mass-consumer behaviour where you *start* with the consumer
- Agents represent consumers and their prescribed rules to simulate decisions and behaviours of different consumers
- Millions of consumers can be simulated using SimulAI, allowing you to predict and explore options to influence mass-consumer behaviour



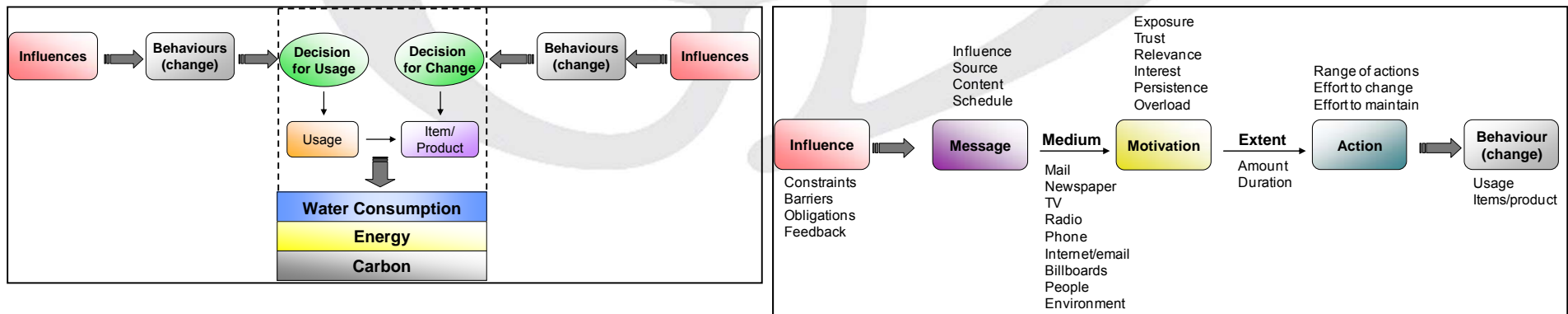
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# Water Forecasting Model

**SimulAIt is used to create a detailed simulation of your water customers**

- Simulated how consumers use water and make decisions in the garden, kitchen, bathroom, laundry, etc.
  - What products they use, how they use the products, how this changes over time
- Simulate how consumers' decisions are influenced by different policies and communication signals, such as media communications

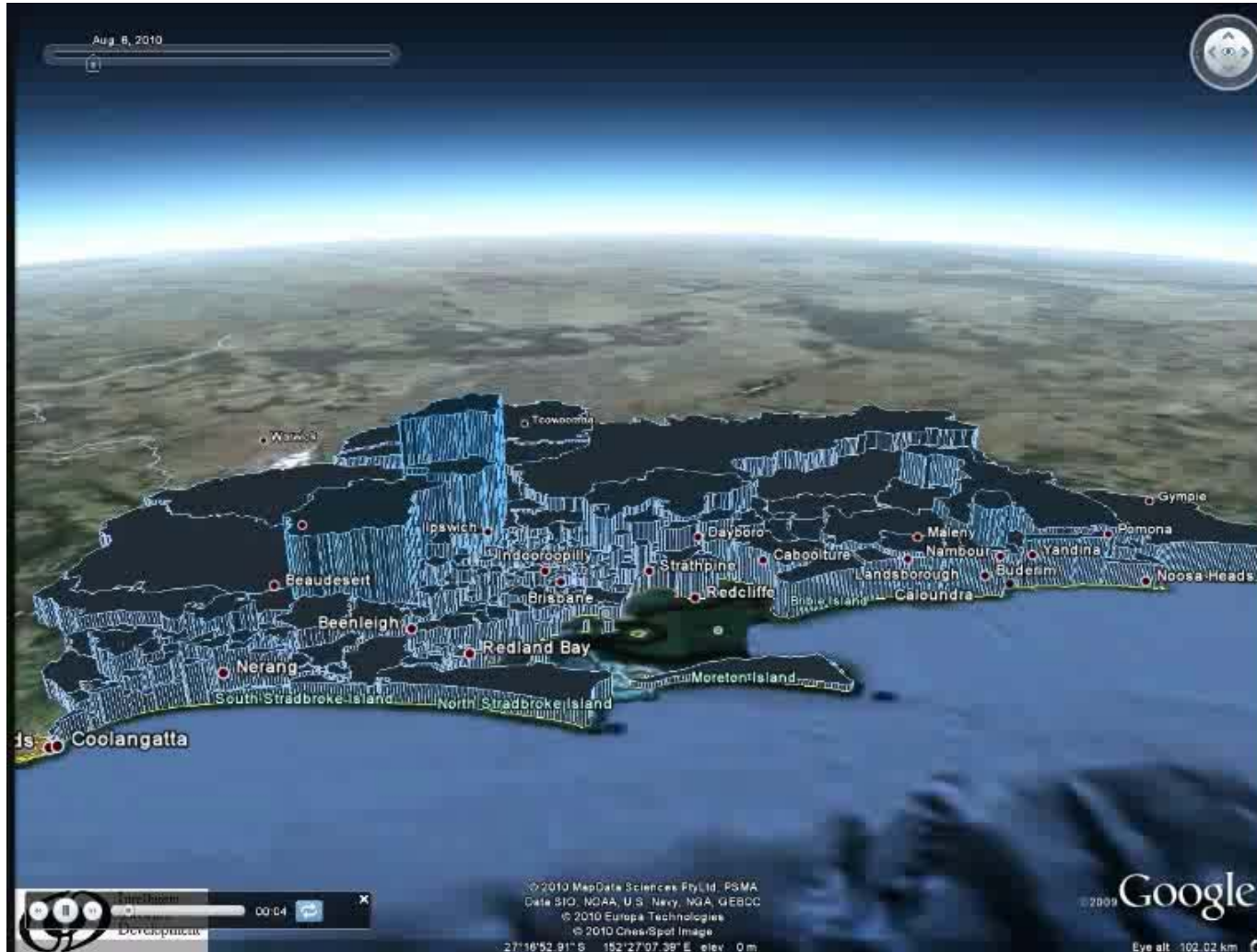
## Behavioural Model



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# SimulAI Simulation



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# QWC

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## Objective

- Inform future water conservation measures to maintain demand in order to delay billions of dollars in infrastructure costs
- Evaluate past water conservation and demand management measures

## Key outcomes and benefits

- Informed future water conservation options/programs to increase the likelihood that strategic objectives and financial savings are met
- Quantified water, energy, carbon and financial savings from past programs and policies



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# SimulAIIt Online (SOL)



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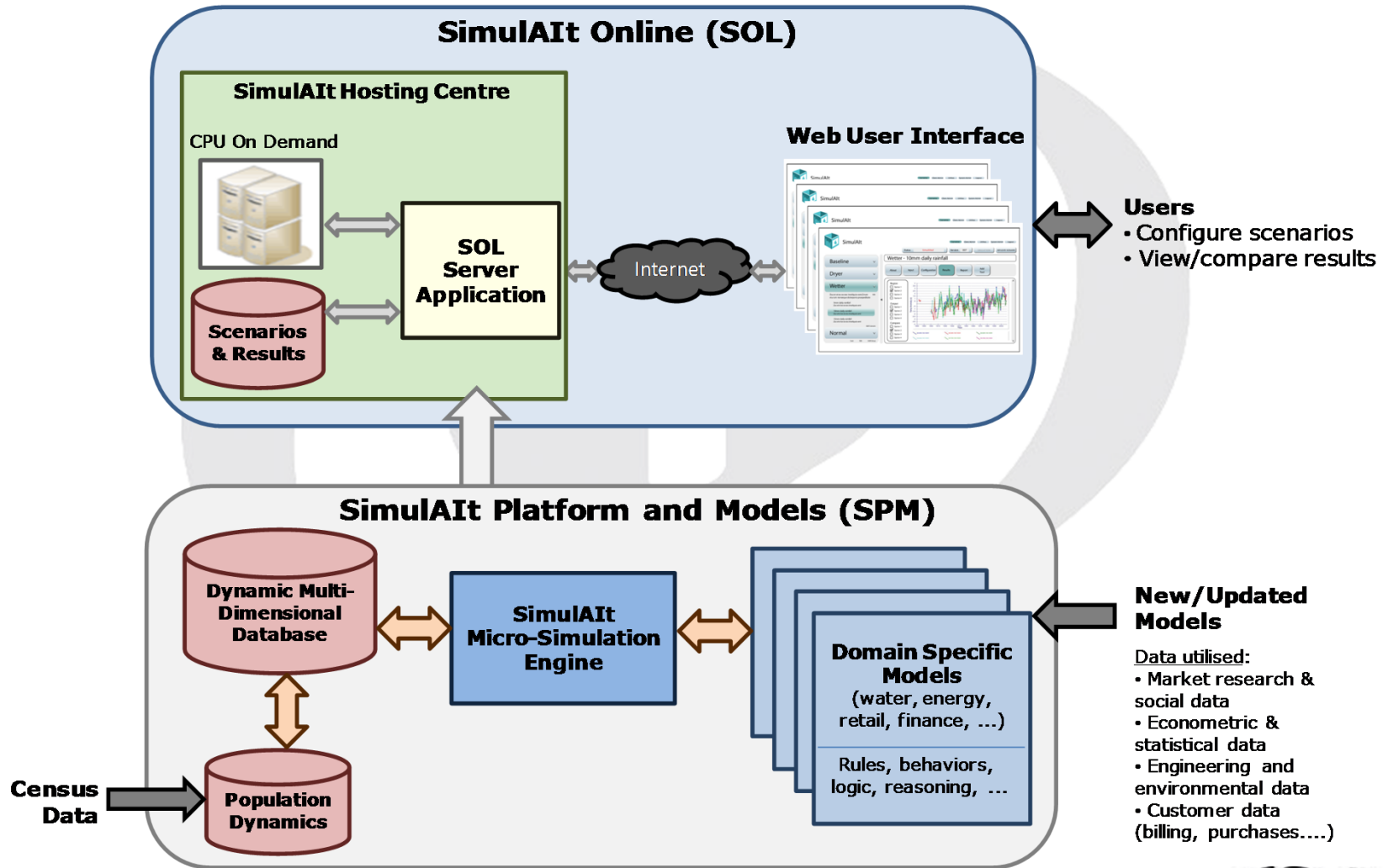
# Self Service – SimulAIIt Online

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- SimulAIIt Online (SOL)
  - Web portal into SimulAIIt
- Package includes
  - License, maintenance, and support
  - Hosting
- Clients can:-
  - Create multiple scenarios
  - Refresh data and configure the assumptions, parameters, etc...
  - View the results

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# SimulAIIt Technical Overview



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# Benefits of SOL

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- Control, Visibility, Ease of Use
- Facilitates collaboration
  - Share models
- Timeliness
  - Ability to respond quickly, rapid turn around
- Maximise ROI
  - Execute many scenarios when required
- Minimise cost of ownership/operating
  - Hosted solution
  - No infrastructure required
  - No IT support required
- Scalability
  - Cost-effective capacity on demand hosting

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# Main SOL screen

The screenshot shows the main interface of SimuAIIt Online. The browser address bar shows 'simulaitonline.com'. The page header includes the SimuAIIt Online logo and 'WATER' text. A navigation menu at the top contains 'Scenario', 'Client Admin', 'Event Log', and 'Event Definitions'. A 'Logout' button is visible next to the user name 'donper...'. The main content area is titled 'Default' and contains a 'Scenario Description' form with fields for 'Client', 'Model Type' (set to 'Water'), and 'Description' (set to 'Default scenario for the Water model type'). A 'Working pane' is visible at the bottom of the main content area. On the left side, there is a sidebar with 'Scenario groups' (Default, Test sc group) and 'Scenarios' (Add scenario group). Annotations with arrows point to various elements: 'Scenario menu items' points to the top navigation menu; 'Session messages' points to the top right area; 'Admin menu items' points to the 'Client Admin' and 'Event Log' buttons; 'User & logout' points to the 'Logout' button; 'Session message log' points to the 'Event Log' button; 'Model type' points to the 'WATER' text; 'Scenario groups' points to the sidebar list; 'Scenarios' points to the 'Add scenario group' button; 'Active scenario' points to the 'Default' scenario in the sidebar; and 'Working pane' points to the bottom of the main content area.

Scenario menu items

Session messages

Admin menu items

Model type

Scenario groups

Scenarios

Active scenario

Working pane

User & logout

Session message log

Intelligent Software Development

# Client admin – user information

The screenshot shows the SimulAIT Client Administration interface. The browser address bar displays `www.simulaitonline.com/Selector.html`. The user is logged in as 'isd'. The interface includes a navigation menu with 'Scenario', 'Client Admin', 'View Log', and 'Event Definitions'. The main content area is titled 'Client Administration' and shows 'Showing users for XYZ Company'. A green plus icon and the text 'Add new user' are highlighted with an arrow pointing to the text 'Add new user'. Below this is a table of active users with the following data:

Login ID	Last Name	Other Names	Email	Phone	Mobile Phone
wsmith@chw.com.au	Smith	William	wsmith@chw.com.au	03 90001234	0412999999
pablo	Dharwiyanti				
isd	Demo	ISD	isddemo@example.com	1234	1234

An arrow points from the text 'Active users: user details' to the table.

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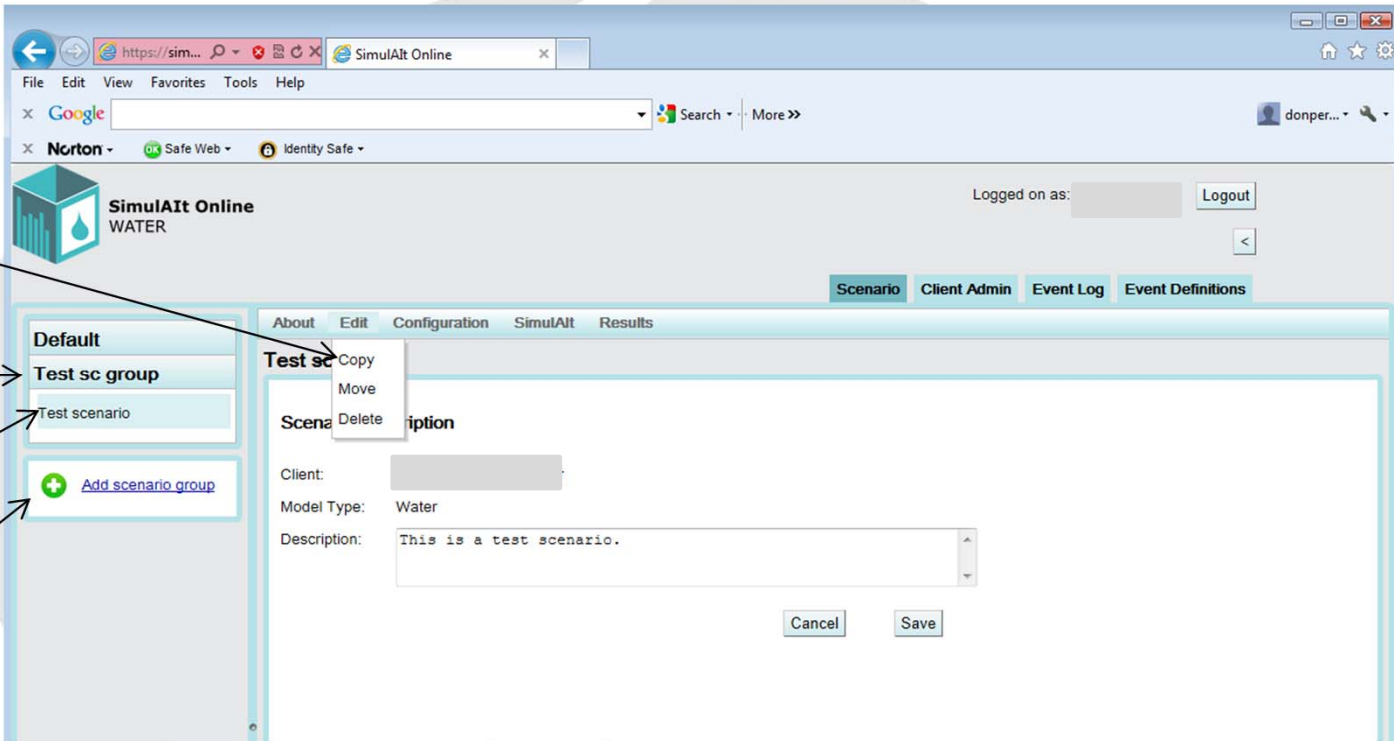
# Scenario: Edit scenario

Scenario edit menu

Scenario groups

Scenarios

Add scenario group



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# Scenario: About - Notes

Add note

Ordered list of notes

The screenshot shows a web browser window with the URL 'https://sim...'. The page title is 'SimuAIt Online WATER'. The user is logged in as 'donper...'. The main navigation menu includes 'Scenario', 'Client Admin', 'Event Log', and 'Event Definitions'. The 'Scenario' sub-menu is open, showing 'About', 'Edit', 'Configuration', 'SimuAIt', and 'Results'. The 'Test scenario' page is active, displaying a table of notes. The table has columns for 'Note', 'Date Created', 'Created by', 'Date Modified', and 'Modified by'. There are two notes listed, both created by 'Brendon' on 'January 04, 2012 12:25 PM'. The first note is 'Scenario created to test our new pricing strategy - 10% price increase.' and the second is 'Reduced the price increase from 10% to 8%.'.

Note	Date Created	Created by	Date Modified	Modified by
Scenario created to test our new pricing strategy - 10% price increase.	January 04, 2012 12:25 PM	Brendon	January 04, 2012 12:25 PM	Brendon
Reduced the price increase from 10% to 8%.	January 04, 2012 12:25 PM	Brendon	January 04, 2012 12:25 PM	Brendon

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# Scenario: Configuration

Time associated with parameter values

Config input type

Parameters tree: hierarchical to reduce complexity

Slide to increase working pane

Time explicit parameter values (cells)

Scroll cells through time

	Start	2000 Jan	2000 Feb	2000 Mar	2000 Apr	2000 May	2000 Jun	2000 Jul
Base percentage of households	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
Energy use per load - kWh	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
Litres per load - full load	75	75	75	75	75	75	75	75
Litres per load - full load - economy	60	60	60	60	60	60	60	60
Litres per load - half load	71	71	71	71	71	71	71	71
Litres per load - half load - economy	56.8	56.8	56.8	56.8	56.8	56.8	56.8	56.8

# Run scenario – SimuAIIt!

Start simulating the scenario

Set the scenario start and end times

Region tree

Selected regions

Save the selected regions for the scenario

The screenshot shows the SimuAIIt Online interface. At the top, there's a browser window with the URL 'https://sim...'. Below the browser, the SimuAIIt Online logo and 'WATER' text are visible. A navigation bar includes 'Scenario', 'Client Admin', 'Event Log', and 'Event Definitions'. The main content area is titled 'Test scenario' and shows 'Scenario status: Successfully run'. A 'Start Simulation' button is present. Below it, there are two date pickers: 'Simulation start time' (July 2007) and 'Simulation end time' (June 2010). A 'Region tree' is shown with a list of regions and their postcodes. The 'Vic' region is expanded, showing postcodes 3000 through 3008. The 'Save' button is highlighted.

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# Scenario: Results

**Range of results to download:**

Water, energy, carbon, revenue, etc.

Monthly, yearly

Disaggregated into different regions, appliances

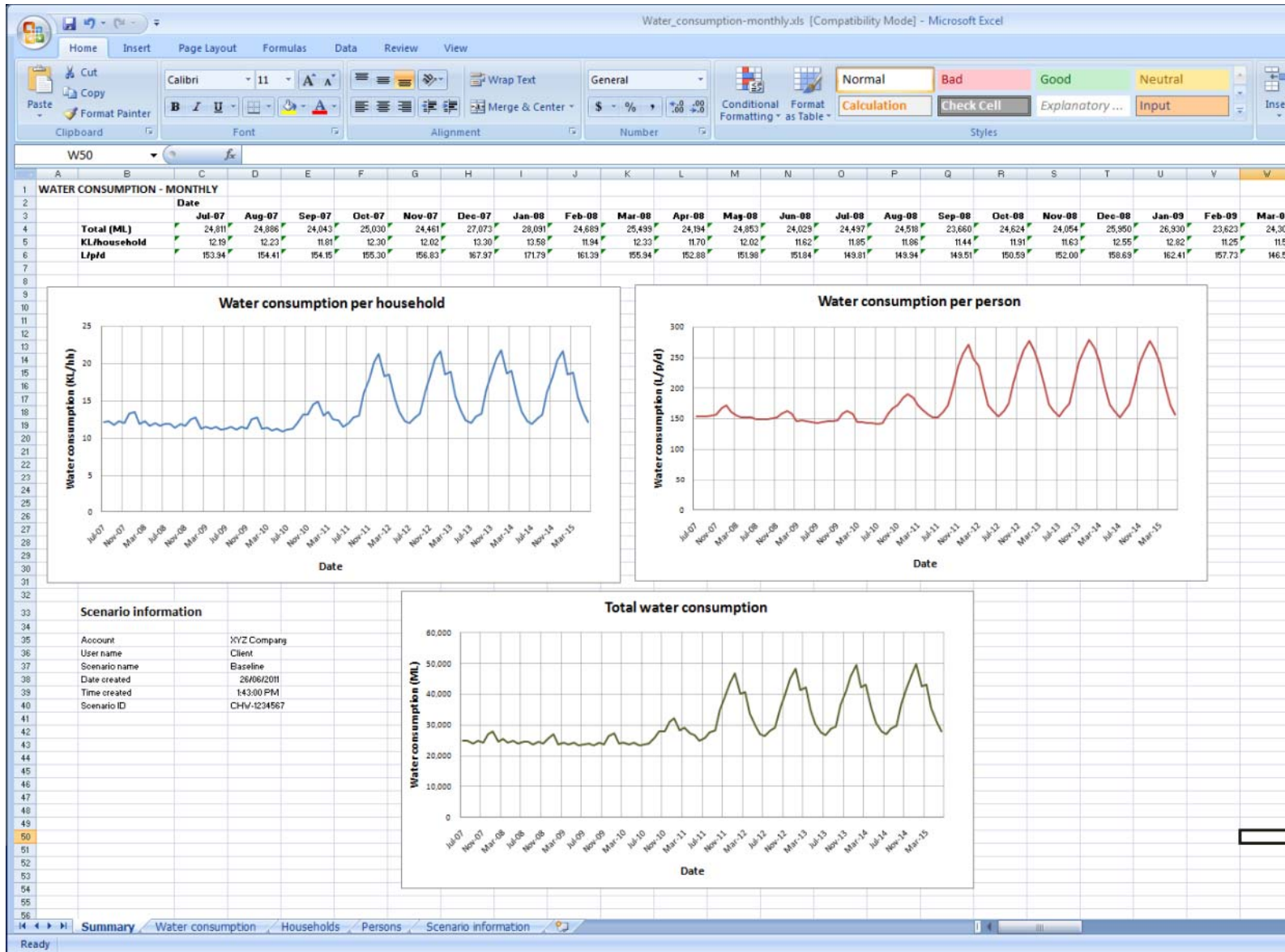
The screenshot shows the SimulAIT web application interface. The browser address bar displays 'www.simulaitonline.com/Selector.html#'. The user is logged in as 'isd'. The main navigation menu includes 'Scenario', 'Client Admin', 'View Log', and 'Event Definitions'. The 'Results' sub-menu is active, showing a table of reports for the 'Above 90% Water Supply' scenario.

Report Name	Description	Downloads
Summary Results	Printable Summary Results	
Appliance	PivotExample	
Appliance Indoor Outdoor	yearly 2007 08	
Appliance Indoor Outdoor	yearly 2012 13	
Carbon emissions	monthly	
Carbon emissions	yearly	
Energy consumption	monthly	
Energy consumption	yearly	
Energy consumption	yearly JL pivot updates	
Households and persons	monthly	
Revenue	yearly	
Washing machine Rebates Retail	monthly	
Washing machine Rebates Retail	yearly	
Water consumption	monthly	
Water consumption	yearly	
Consumption forecast	Dynamic Consumption Map Forecast	
Summary Results	Summary Results	

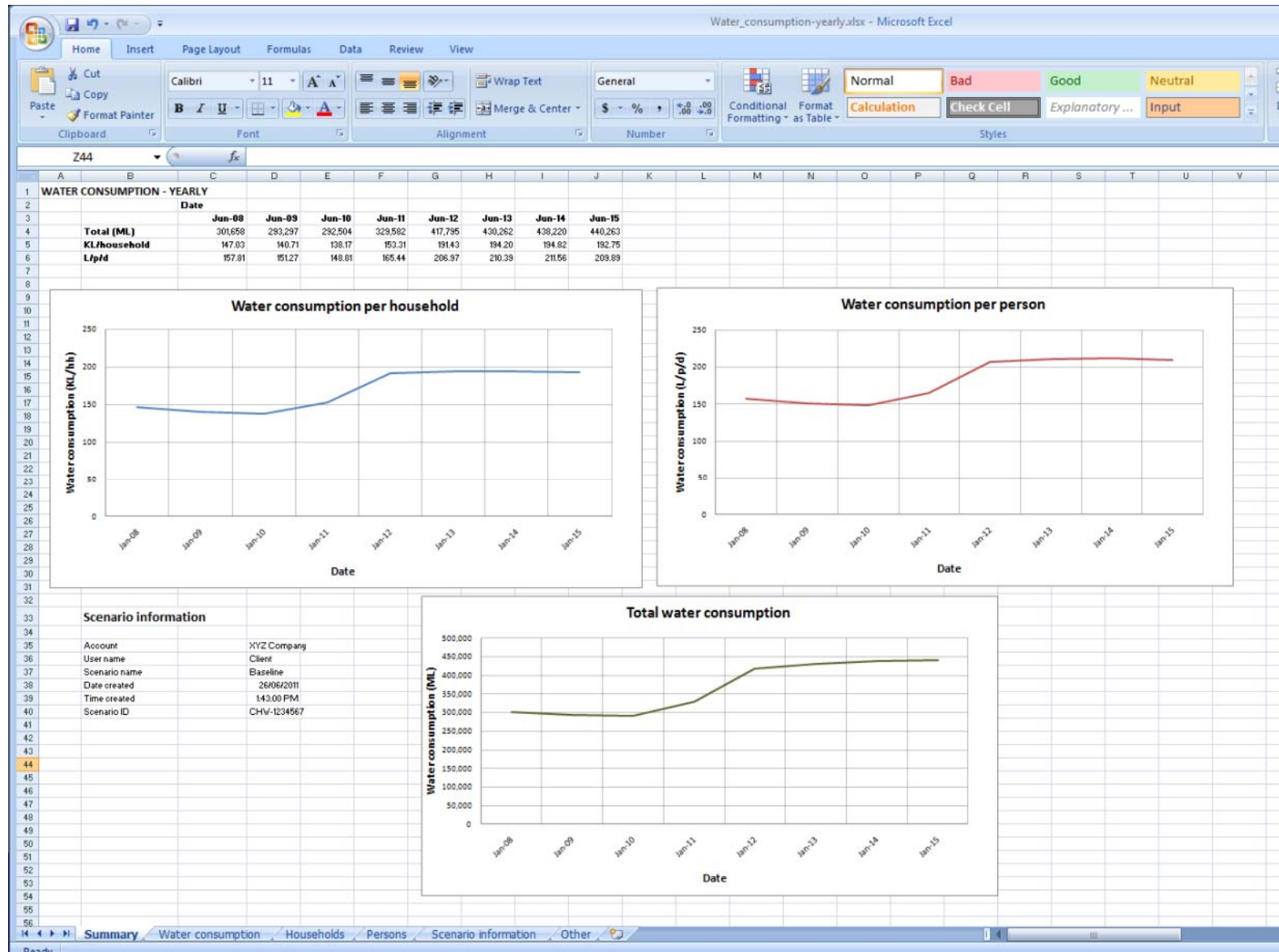
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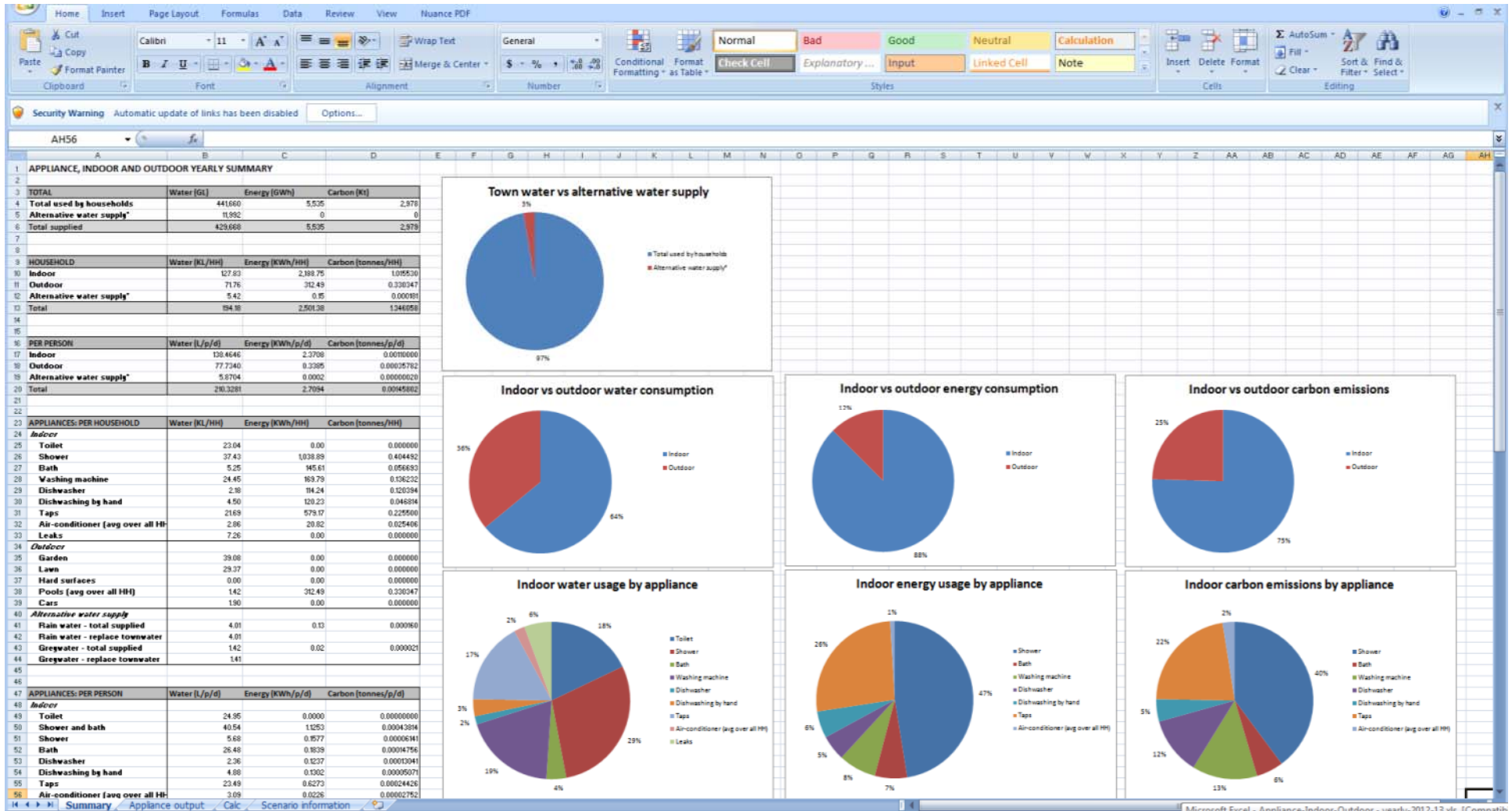
# Outputs: Monthly Demand



# Outputs: Yearly Demand



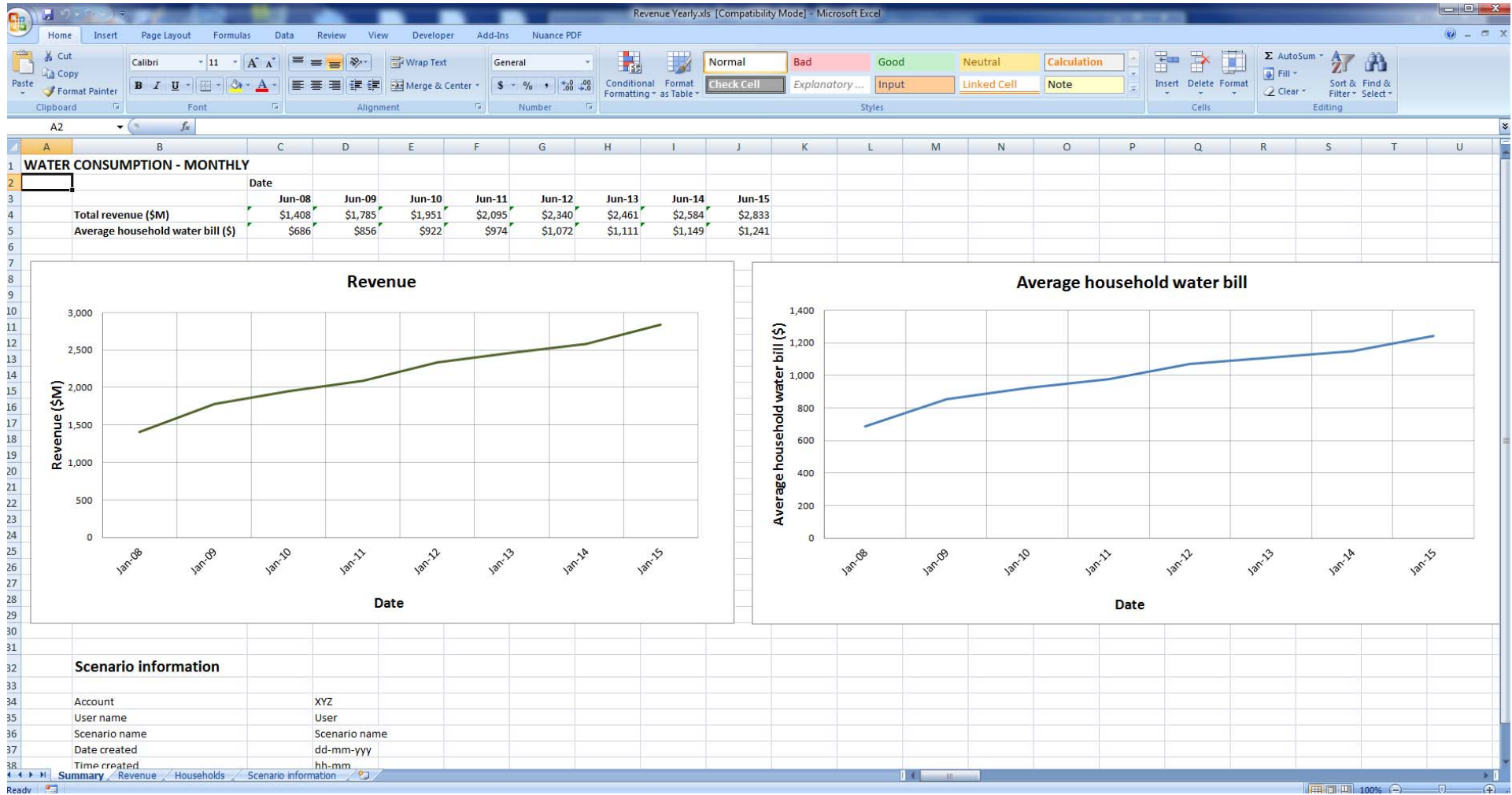
# Outputs: Household Usage



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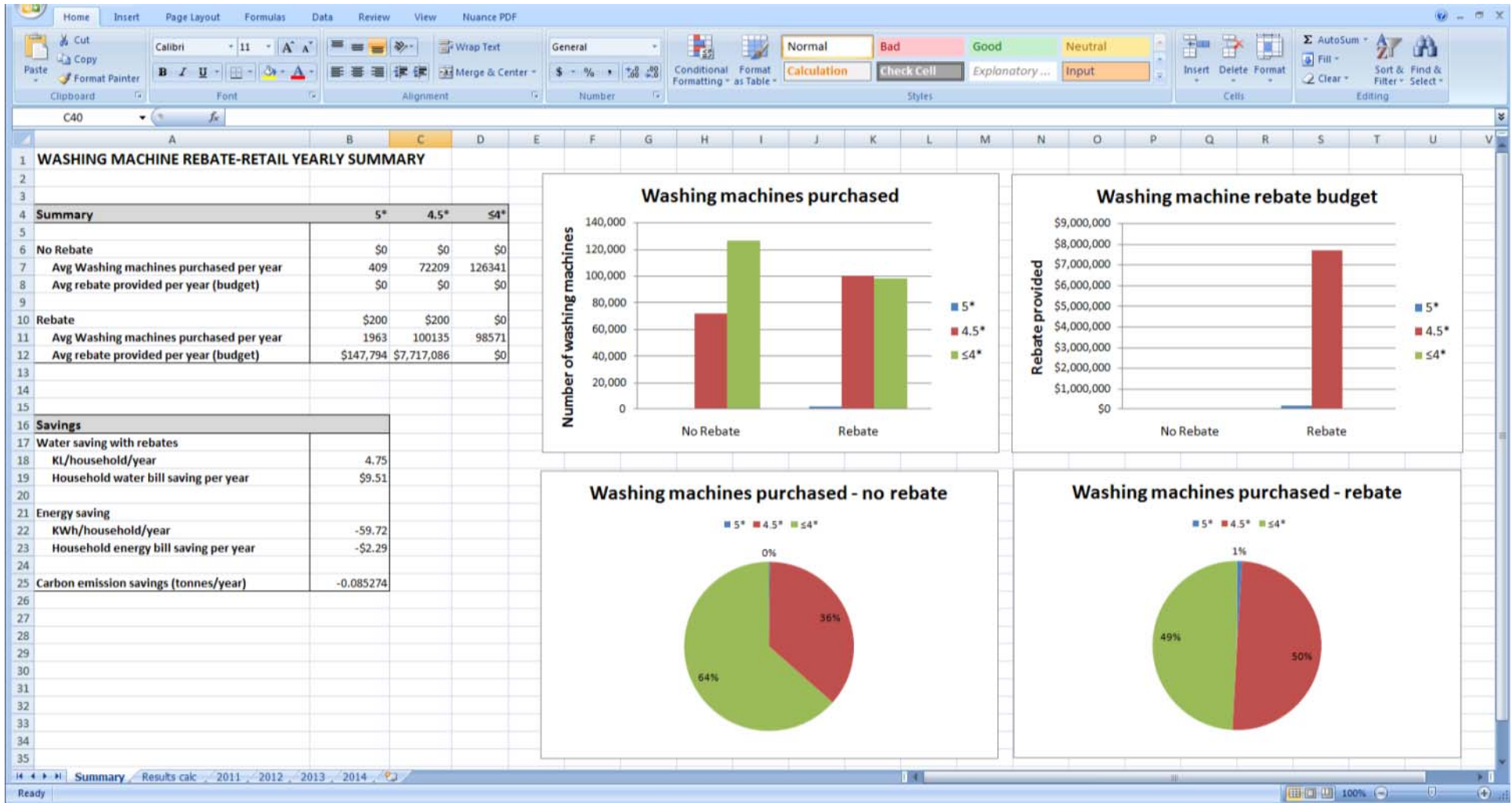
# Outputs: Revenue, Water Bills



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# Outputs: Rebate uptake/efficiency



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# Technology



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# Traditional approaches: Stats

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## Linear regression

- Uses historical data and selected variables
- Algorithm estimates the level of impact of variables on the forecasts
- The model extrapolates historical data to produce forecasts

## Limitations for a complex human-centric environment

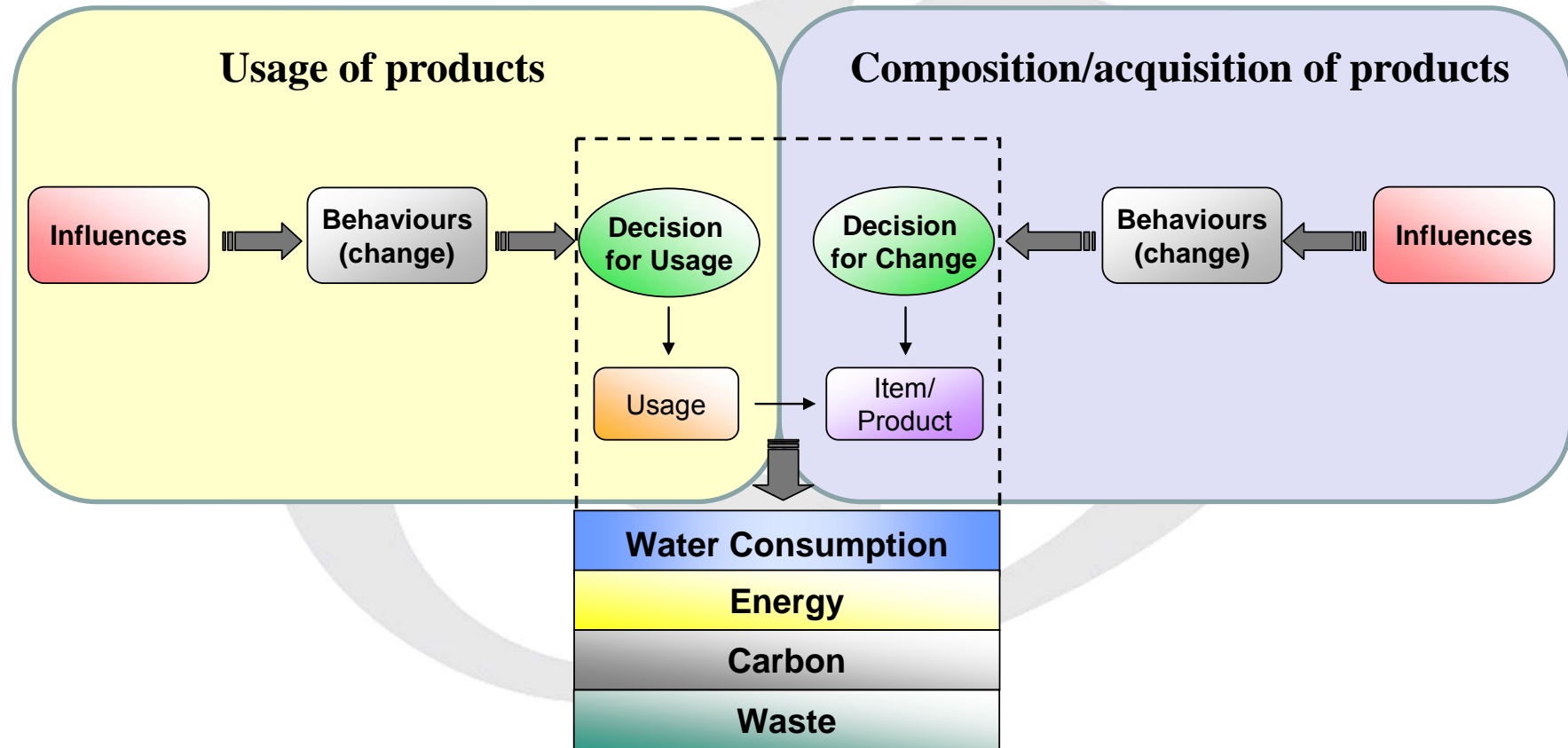
- A top down approach where aggregated variables are used to create the model, without considering how individual consumer behaviours affect the forecasts
- Unable to incorporate dynamic & non-linear human decision making factors
- The past is not always a good predictor of the future
- Unable to test new strategies or disruptive events not seen in the past
- Limited ability to validate models, as historical data is used in the models

## Typically single-purpose: forecasting

- Unable to address a range of business or policy questions

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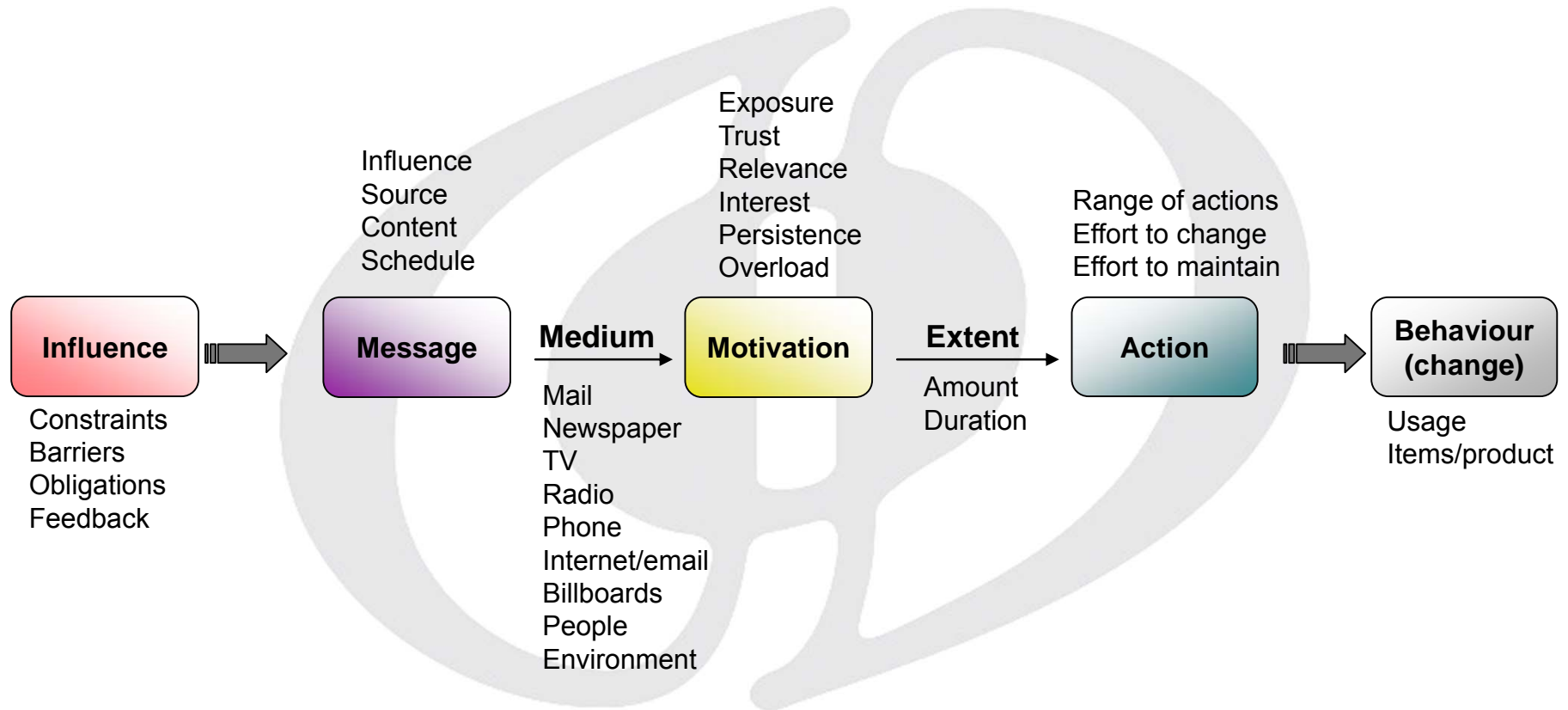
# SimulAIt behavioural model



Model: Influence ➤ Behaviours ➤ Decisions ➤ Water Consumption

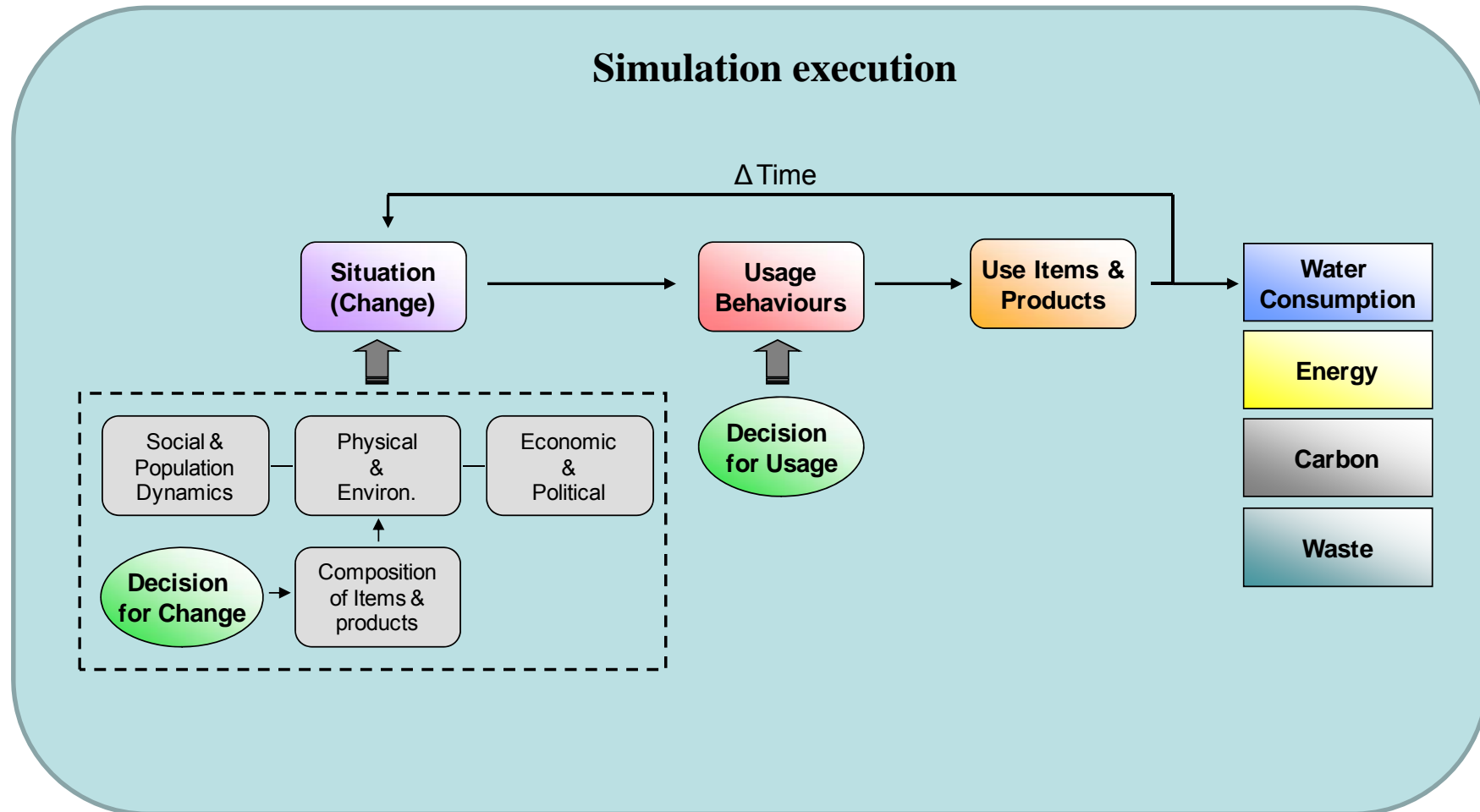
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# Influence-Behaviour model



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# SimulAI Execution

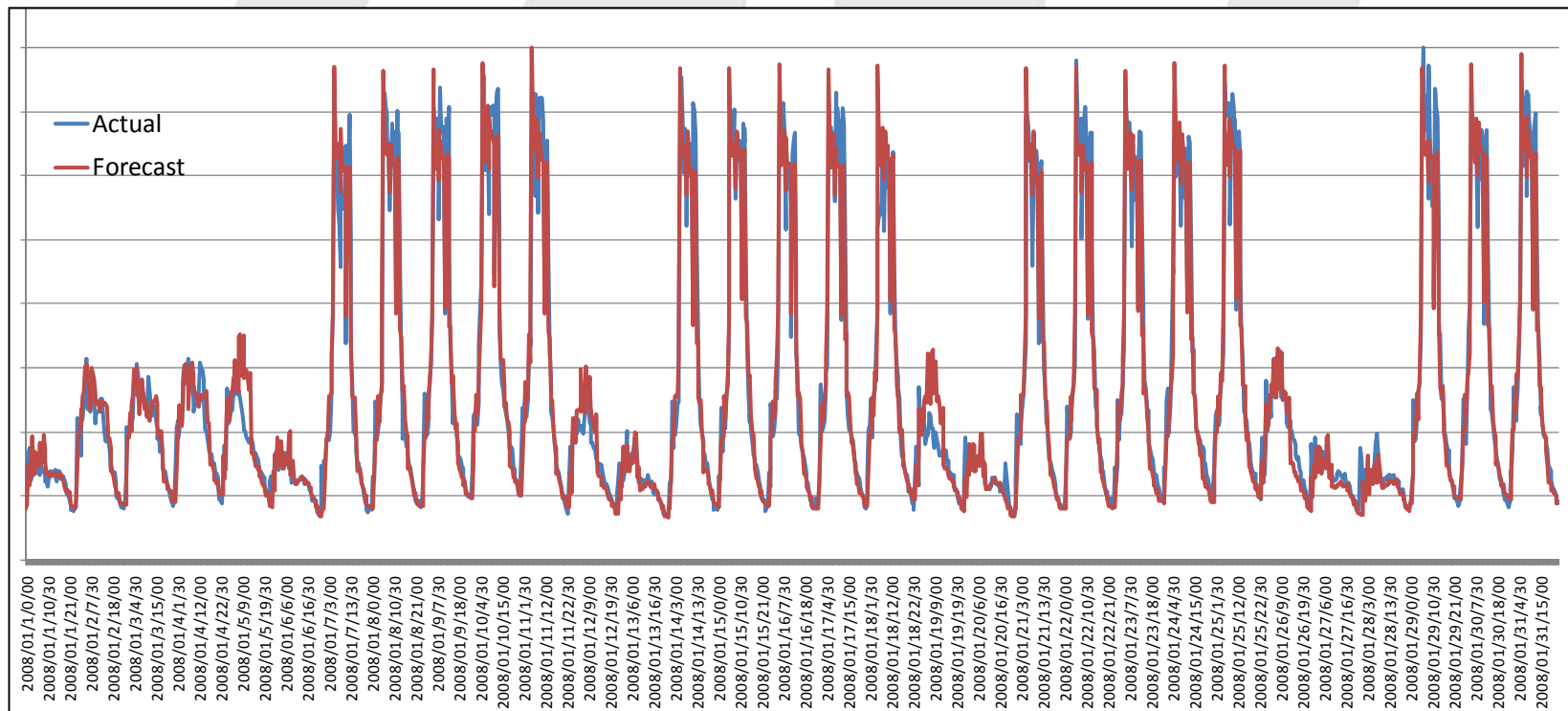


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# Energy Forecasting: Non-Res, 30mins

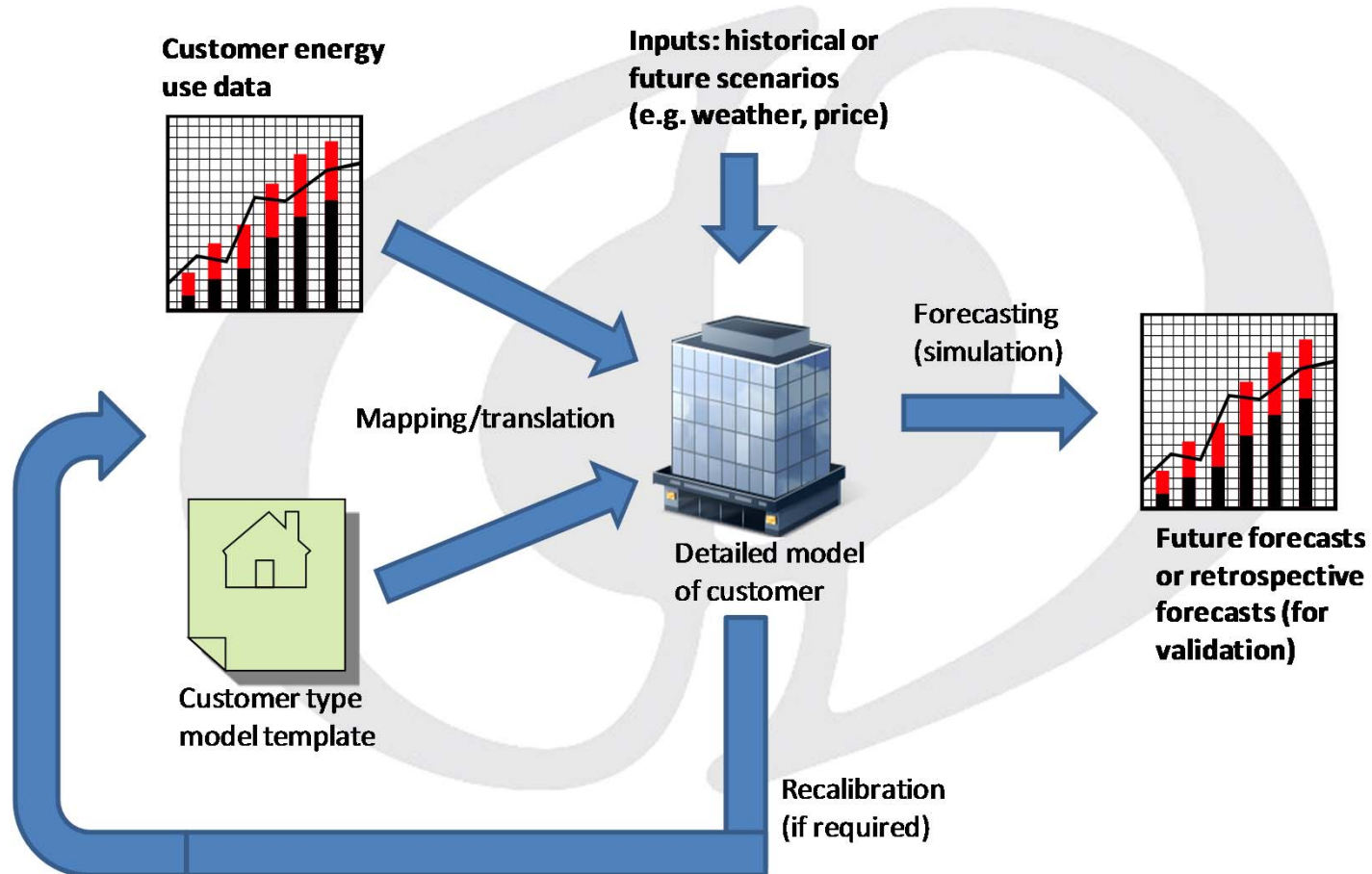
Energy load forecasting accuracy

	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>2008</b>	<b>99.0%</b>	99.2%	97.9%	98.8%	98.0%	95.0%	98.5%	99.6%	97.0%	99.6%	98.7%	96.5%	85.0%
<b>2009</b>	<b>99.8%</b>	96.7%	99.3%	99.3%	99.0%	98.9%	98.4%	98.8%	95.1%	97.3%	93.1%	98.6%	98.3%
<b>2010</b>	<b>98.3%</b>	91.9%	97.9%	97.1%	97.6%	98.6%	98.1%	99.1%	97.1%	87.8%			





# The non-res model



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# Why do this?

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## **Raw data with no/little context/understanding provides little value**

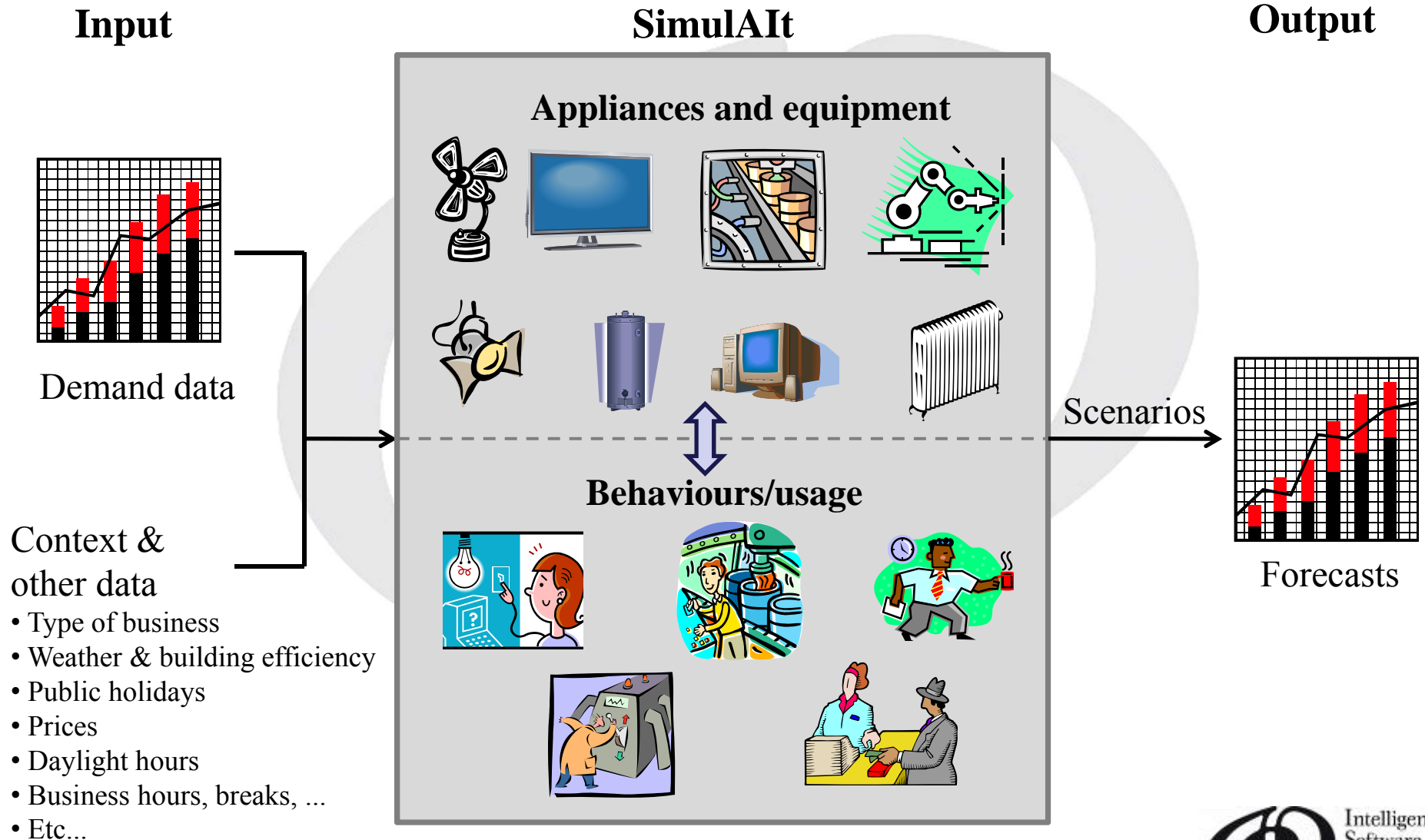
- The past may not be a predictor of the future – e.g. water and energy
- If you don't know what is contributing to the peaks and troughs, how can you:
  - Accurately forecast what will happen next week/month/year
  - Understand the impact on forecasts with changing factors or disruptive events (prices, uptake of efficient appliances, business expansion/growth, etc...)

## **Simulation and SimulAIIt provides a methodology and tool that can drill down into data, add context, represent complicating factors, and deal with the problem's complexity**

- Data + Context + SimulAIIt → Accurate and functional forecasting model

*"Predict a better future"*

# The process



*"Predict a better future"*

# SimulAI Features

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- Scalable simulation engine
  - 2 million households, > 4.5 million consumers
- Handles multiple data sources
  - Consider all factors than impact on consumer decision making
- Extensible
  - Scriptable architecture caters for complex environments
- Supports the creation and rapid turn-around of multiple scenarios and very large simulations
  - Comparisons, what if analysis
  - Ability to refresh/update data sources
- Provides visibility
  - Assumptions and parameters that drive the business rules and logic



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