This presentation premiered at WaterSmart Innovations

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INNOVATIONS

Micro-simulation approach for modeling customer behavior for demand forecasting and demand management

Intelligent Software Development (ISD)

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Common problems

- How can we more accurately forecast demand in a complex and changing consumer environment?
  - Bounce-back in demand following drought and water restrictions
  - Building business cases: capital planning, corporate plans, regulators & pricing
- How can we determine why household water consumption is decreasing?
  - What is contributing to the decrease?
  - When will the decrease slow down or stop?
- How can we design more effective demand management programs?
  - Restrictions, rebates, retro-fit, behavior change programs, pricing

The answers are dependent on the decisions of millions of *different* individual consumers/people

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Factors that impact water demand

- 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 behavior
  - Consumers usage of appliances – range of *possible and rational* behaviors
  - Frequency and duration of use, per household or per person
  - Interdependencies: seasonal factors, demographic factors (e.g. age & bath use)
- Behavior 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 behaviors – e.g. income level, preferences for different demographics, duration persisting with behavior, etc.

Need to consider all of these factors

Data Analytics & Decision Process

Observe
Descriptive Analytics

Business Questions:
What happened?
Why did it happen?
What is happening?
Why is it happening?

Solutions:
Data mining & forensics
Real-time analytics & mining
Market segmentation
Reporting & dashboards
Ad-hoc database queries

Predict
Predictive Analytics

Business Questions:
What is likely to happen?

Solutions:
Simulation
Statistics & linear regression
Predictive data-mining
Forecasting & trend reporting

Influence
Prescriptive Analytics

Business Questions:
What should I do about it?
How do I influence the future?
What are the consequences?

Solutions:
Simulation
Optimisation

Less data, greater insight, greater value

* Based on Gartner's model of analytics

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Current Approaches

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 behavior, and the impact individual behavior has on aggregated results
- Single purpose (forecasting) – difficult to address other business problems

Past demand may not be a good predictor of the future

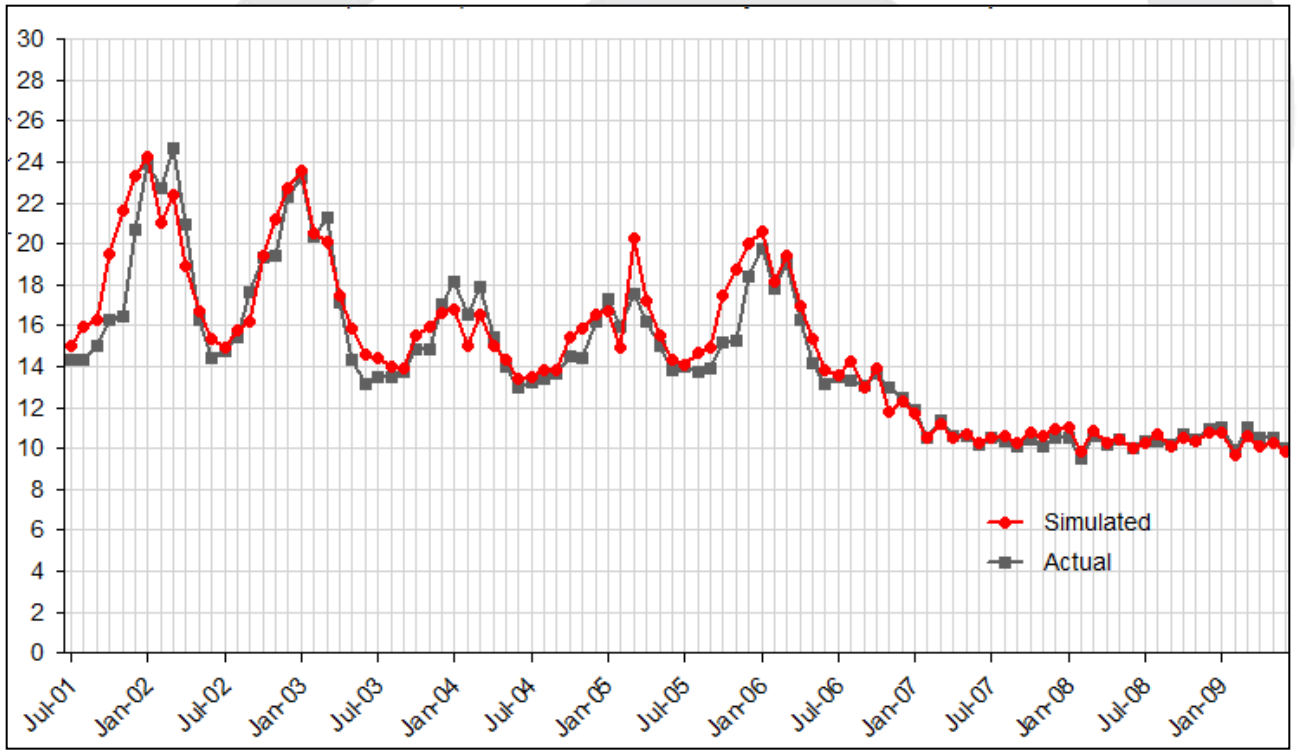
What is SimulAIt?

Agent-based micro-simulation platform that can accurately *predict* and explore options to *influence* mass-consumer behavior and decision making

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

Rigorous Validation

- **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



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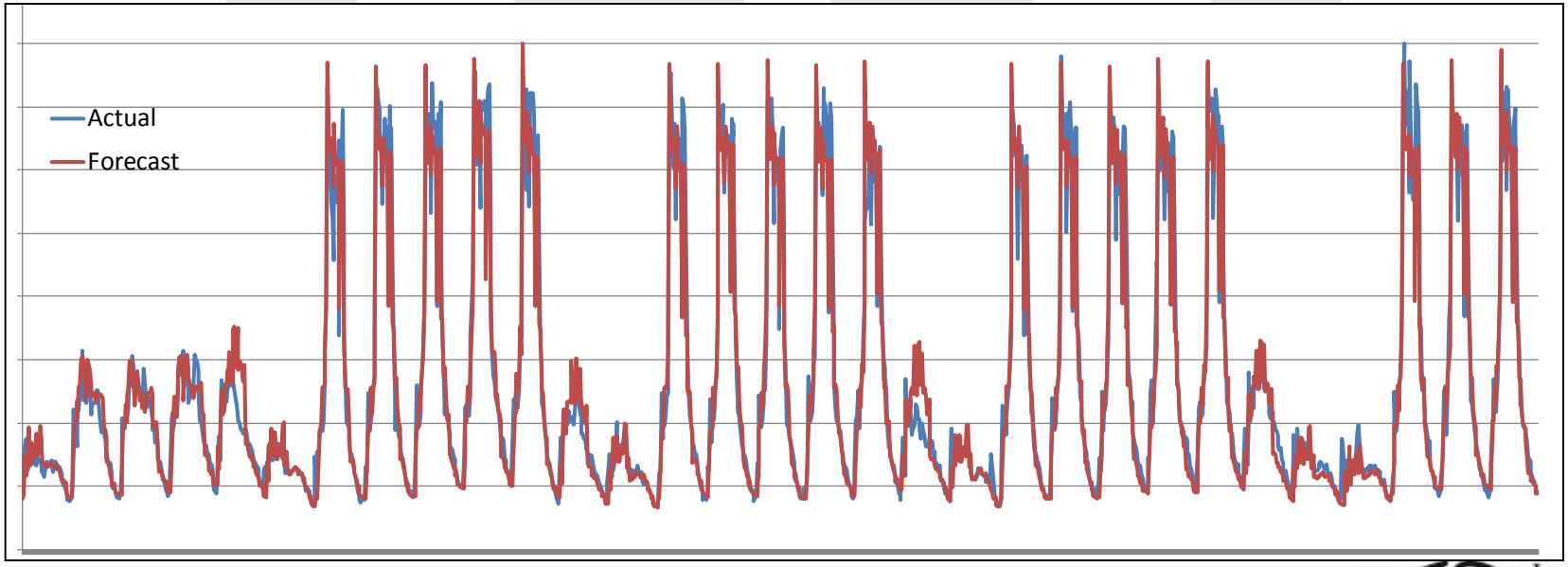
Energy: Businesses, 30mins

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



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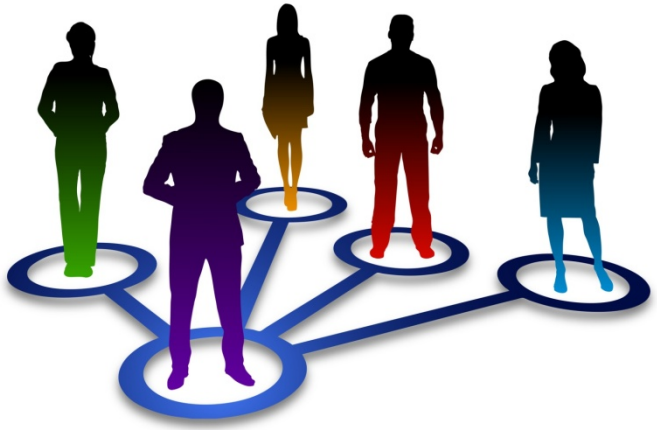
SimulAIt Technology

Different consumers

SimulAIt



Agent-Based Modeling: software agents represent different consumers in the virtual simulation environment

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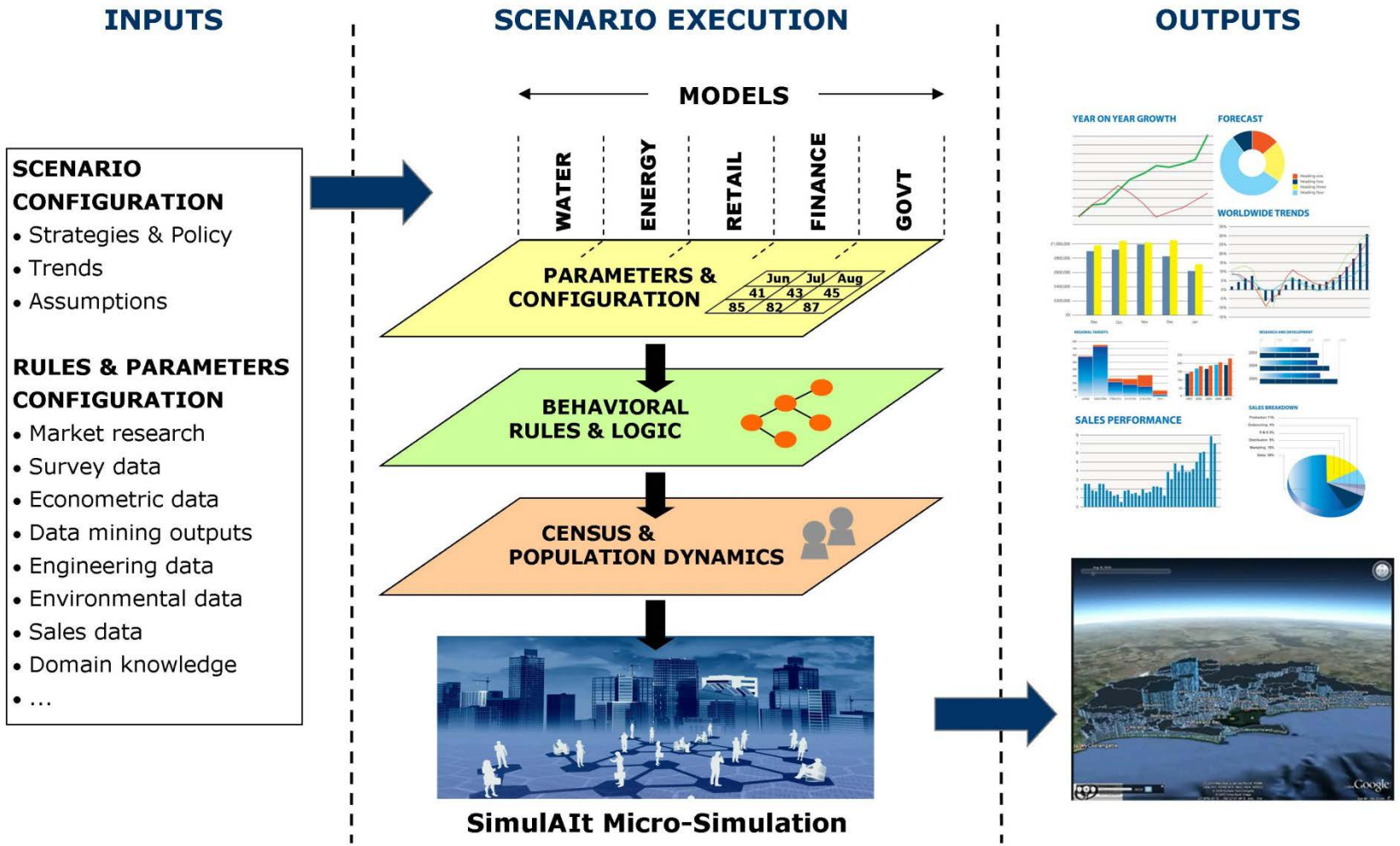
SimulAIt Architecture



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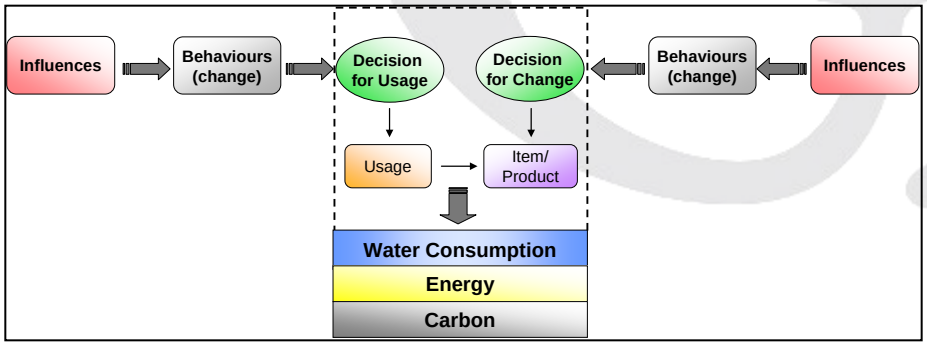
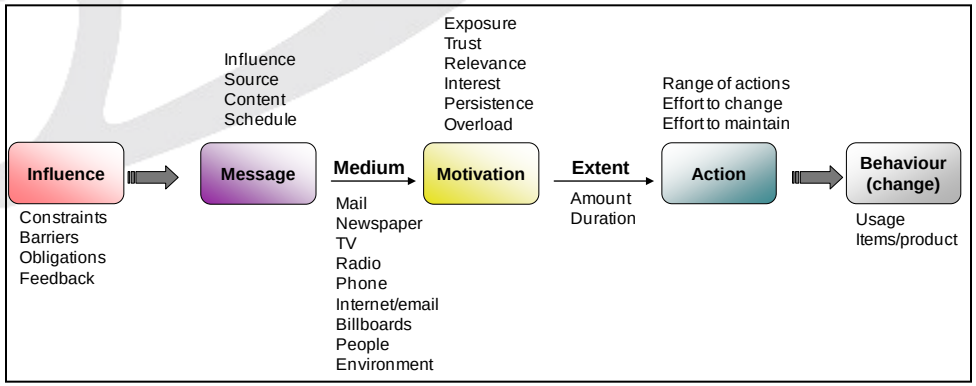
Water Forecasting Model

SimulAIt is used to create a detailed simulation of 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

Behavioral Model





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Credentials

Users

Melbourne Water

Yarra Valley Water

City West Water

South East Water

Central Highlands Water

momentum The power of natural thinking

Hydro Tasmania The power of natural thinking

Department of Sustainability and Environment

Government of South Australia — Department of Water, Land and Biodiversity Conservation

Queensland Water Commission — Securing our water, together.

Veolia

Essential Services Commission

Sustainability Victoria

EPA Victoria

department of human services

Australian Government — Department of Defence

Awards

South Australia's Top 20 Innovation Awards — Since the New Millennium

Water Industry Alliance — Awards Winner 2008

Innovators to Watch Awards 2008 — Finalist CleverGreen™

The 2009 iAWARDS — South Australia State Award Winner

The 2008 iAWARDS

KPMG — Cleantech Excellence Award 2009

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Case Study 1: Melbourne Water Utilities

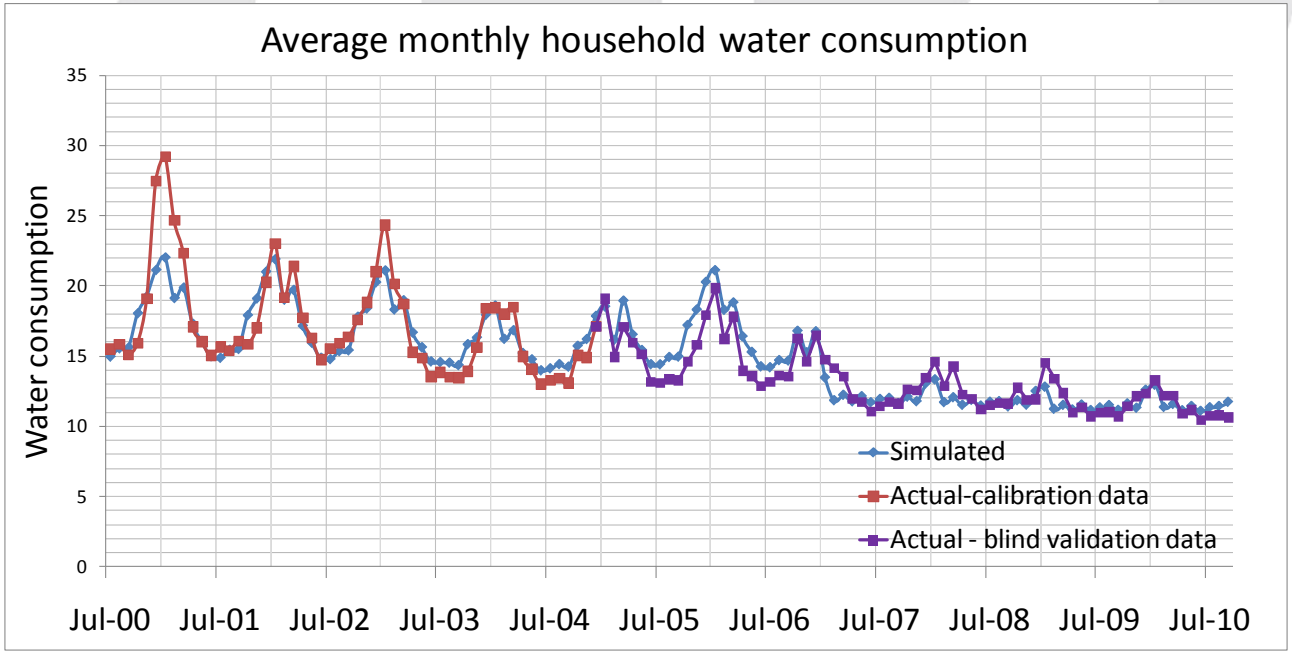
Objectives

- 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 Yarra Valley Water, City West Water and South East Water and participation from Melbourne Water
- Forecast bounce-back in demand from easing restrictions & price increases
- Flexibility to investigate customer water use behaviors and uptake of efficient appliances

Case Study 1: Melbourne Water Utilities

Key outcomes and benefits

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



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Case Study 2: Central Highlands Water

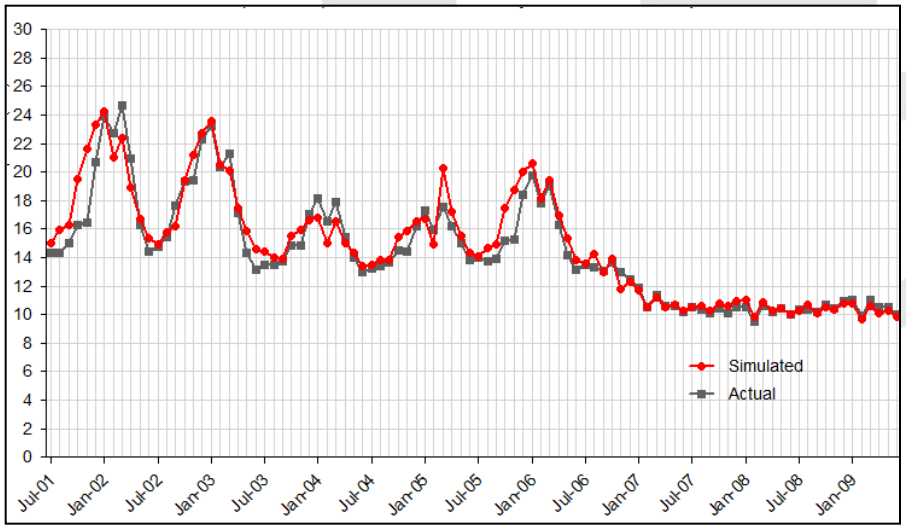
Objectives

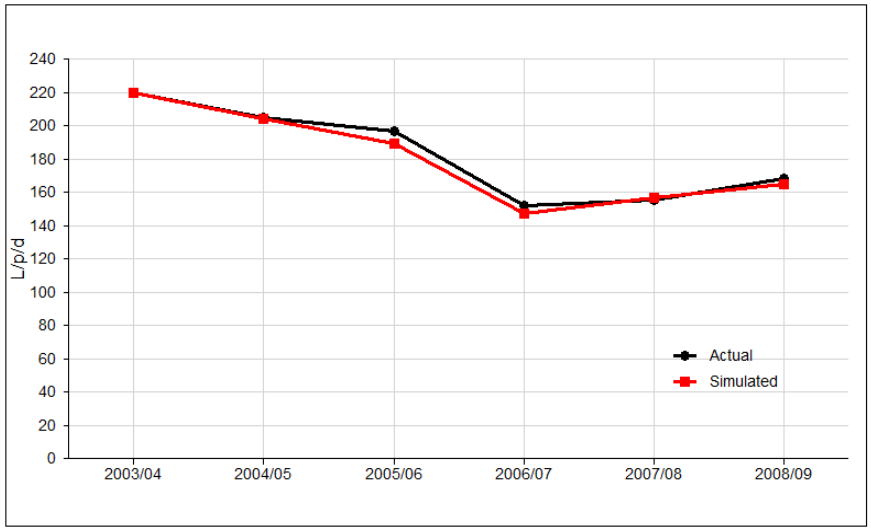
- Evaluate past strategies, and forecast bounce-back in demand from easing water restrictions
- Assess impact of price rises on water demand
- Assess impact of product uptake on revenue
- Build a business case to industry regulators
- Build demographic demand profiles

Case Study 2: Central Highlands Water

Key outcomes and benefits

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





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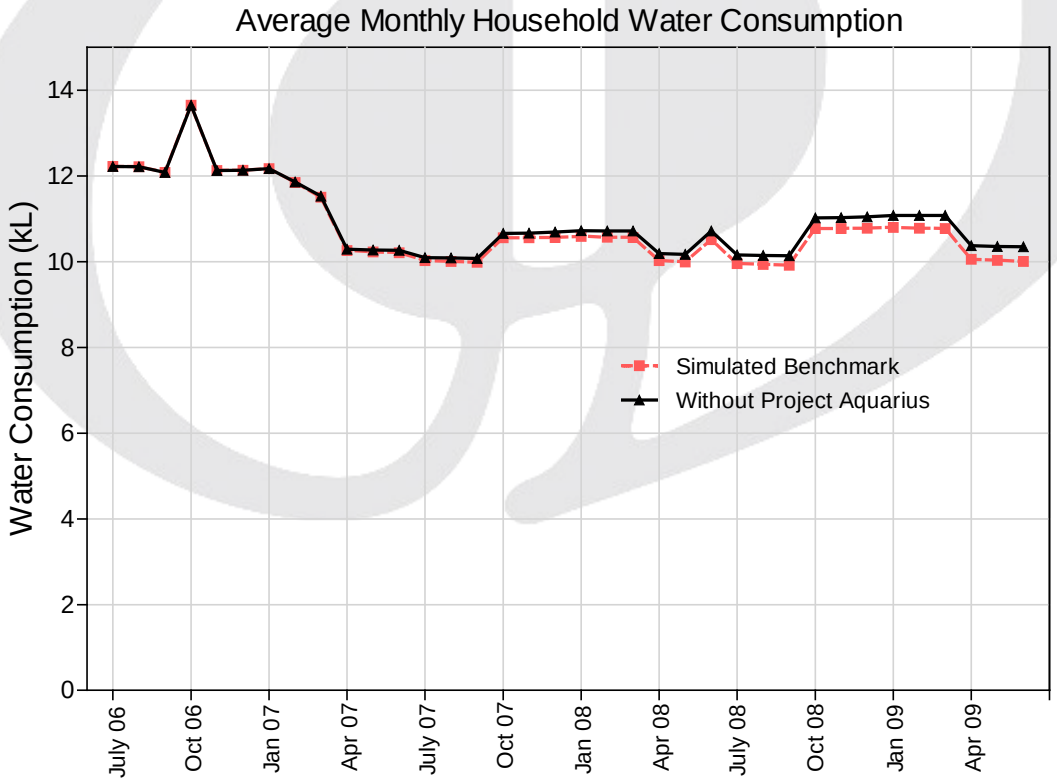
Retro-fit Programs: Project Aquarius

SAVINGS	Water	Energy	Carbon
Total	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
Per HH	37.4 KL/yr	815 KWh/yr	0.32 tonnes/yr
$	$52.36/yr	$58.72/yr	



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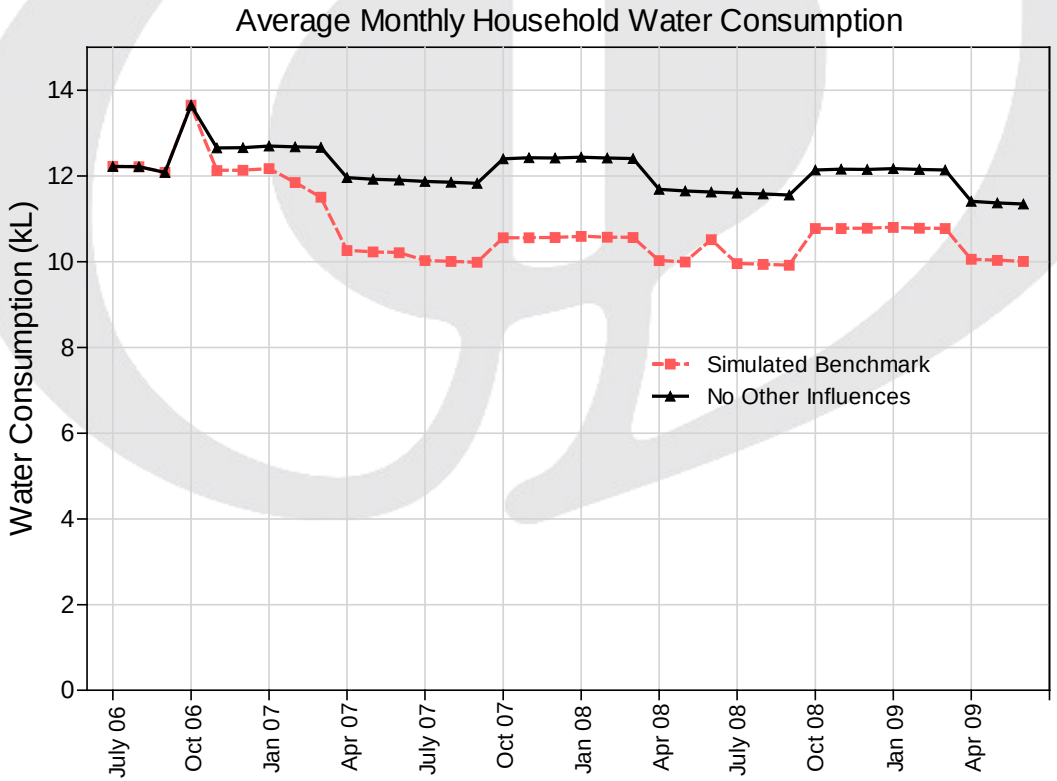
Voluntary Behavior Change

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



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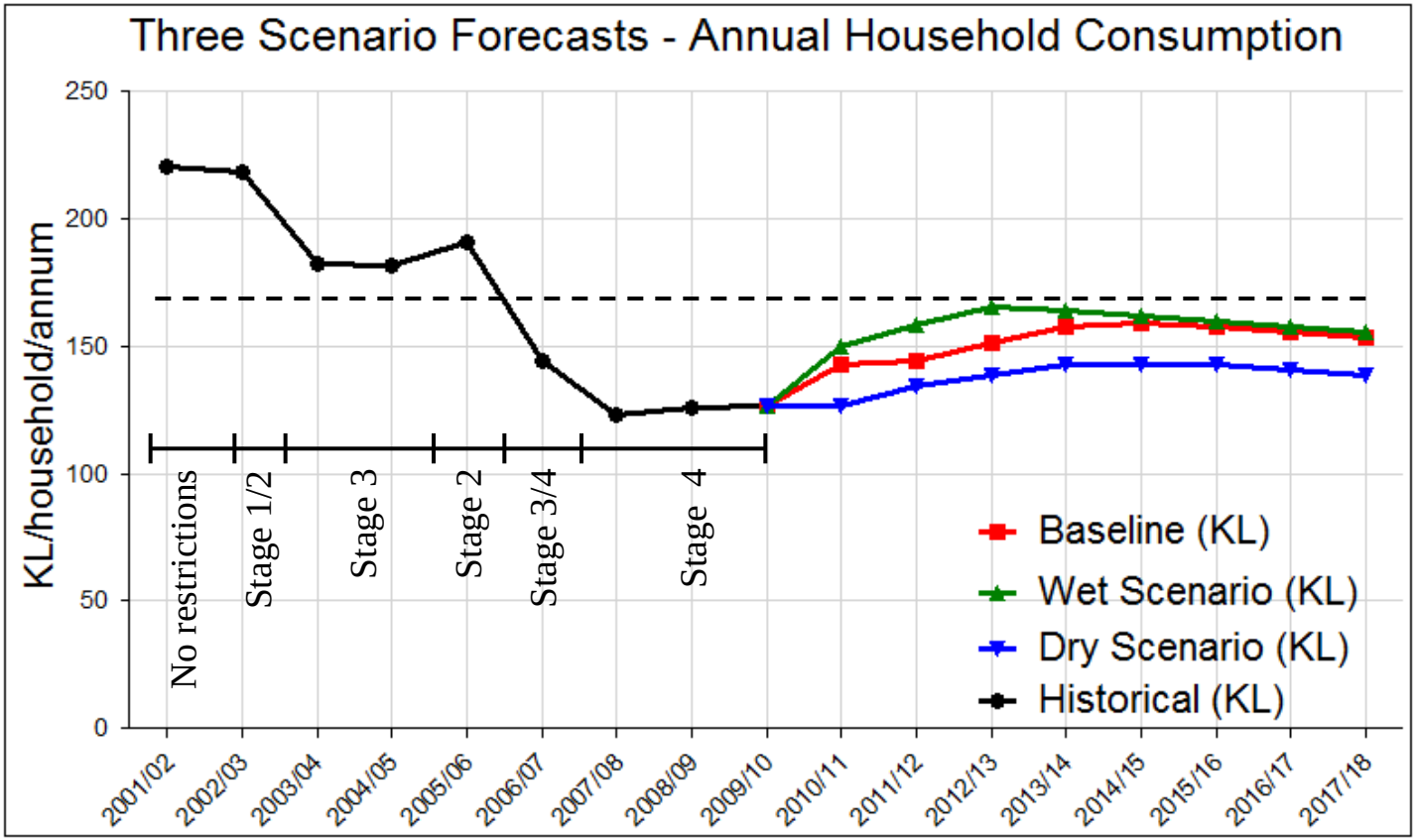
Future Forecasts

Comparison of scenarios (KL/HH/yr)



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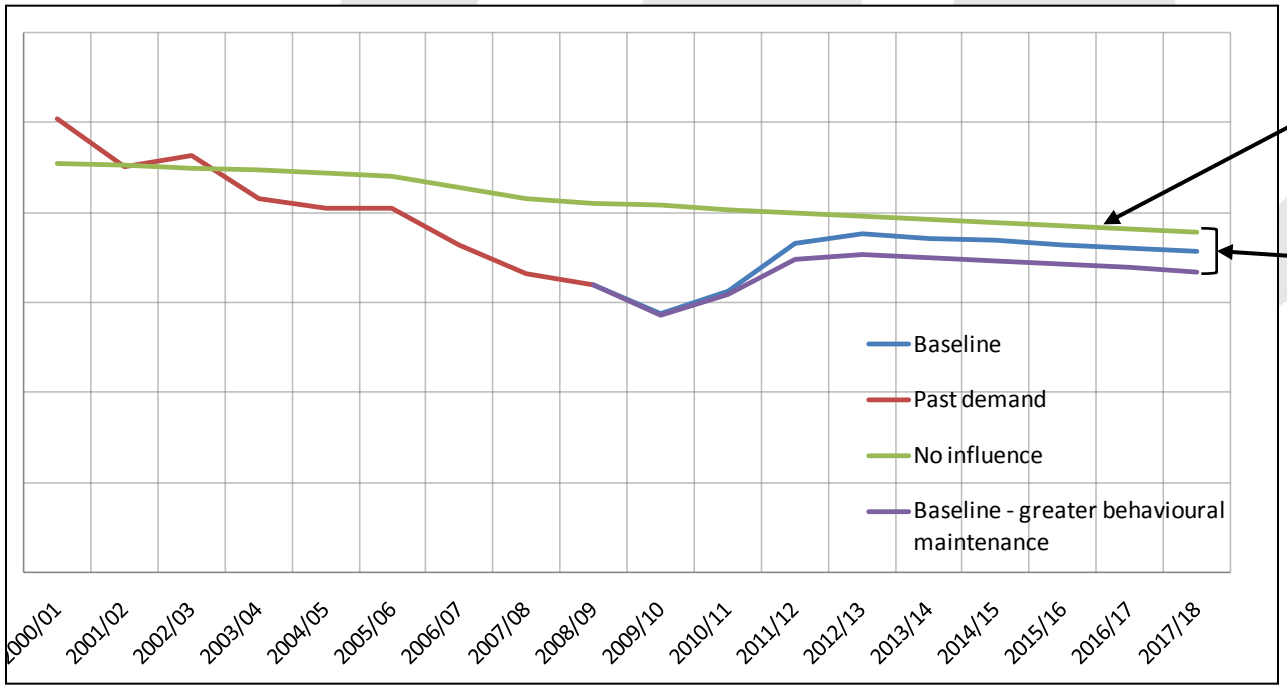
Demand Bounce Back

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

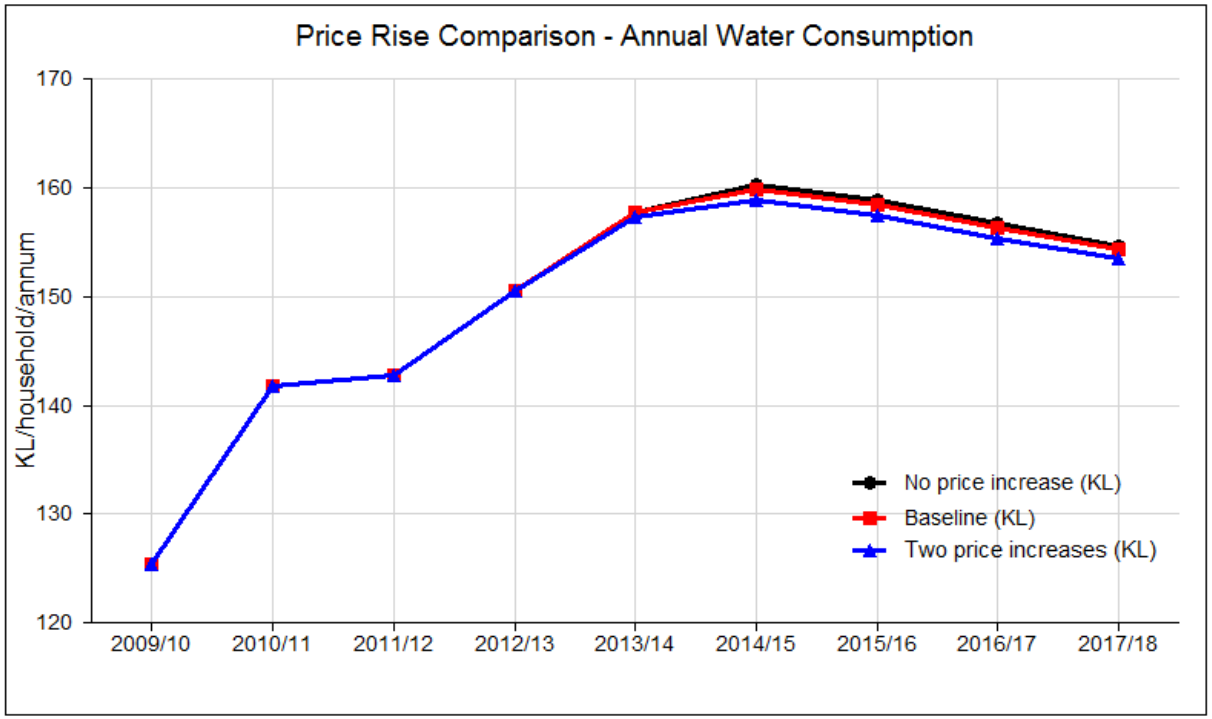


Theoretical maximum demand

Reduction in demand from behavior change (behavior maintenance)

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
- SimulAIt results show the current high level of behavior change in the Ballarat community provides little opportunity to reduce water consumption from price rises



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Case Study 3: Rebates

Objective

- Identify a mix of products and prices for the water rebates program that maximises efficiency and keeps within the program budget
- Three projects, and now a 3 year license to 2015

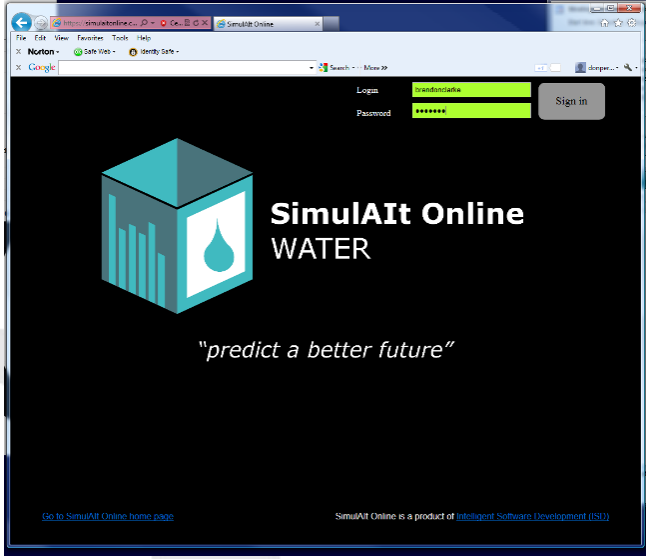
Approach

- Simulated 2 million households, 4.5 million consumers
- Incorporated consumer preference and affordability, and product age, failure and price
- Simulated product uptake and efficiency with different prices

Key outcomes and benefits

- Accurate predictions of product up-take and budget spend
- Prevented budgets blow-outs
- Cost/benefit (triple bottom line) analysis of different strategies
- Forecast the ROI of different demographics and regions, and to assist with targeted (micro)-marketing of the rebate program

SimulAIt Online (SOL)



- Access SimulAIt via a web browser
- SimulAIt Online allows:
  - 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 models, for technical and *non-technical* users
  - Control, visibility, ease of use
  - Facilitates collaboration and consistency: 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

Case Study 4: SOL

Challenge

- Limited availability of suitable data and forecasting models presents a challenge for regional water retailers to produce accurate forecasts for their pricing review

Approach

- Team members collaboratively used SOL to create validated models with minimal data
- Data used: Census regions, weather, schedule of restrictions and prices, and one year (pre-restriction) historical demand data to calibrate some outdoor watering parameters

Key outcomes and benefits

- SOL enabled team members to access, configure, validate, and share models and forecast results
- Demand forecasts used to support their pricing review

Conclusions

- New emerging micro-simulation approaches such as agent-based modeling provide a suitable model to represent complex consumer environments
- Case studies presented show practical application of SimulAIt micro-simulation to forecast water demand:
  - Bounce-back in demand
  - Effectiveness of water efficiency programs
  - Rebates and incentives
  - Pricing
- Models can be validated as minimal historical demand data is used to create the model
  - High-level of accuracy has been achieved
- Minimal data needed to create detailed models
  - Consumer logic/behavior and detailed Census data already built into the model
- SOL can facilitate on-demand access to the water model
  - Provides a collaborative tool for technical and non-technical users to create, validate, update and share scenarios and forecasts

Questions?

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27 Chesser Street,
Adelaide, South Australia, 5000

Phone: +61 8 8343 8455
Fax: +61 8 8260 8100
info@IntelligentSoftware.com.au
www.IntelligentSoftware.com.au

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Sub Decks of Slides……

SimulAIt Online (SOL)

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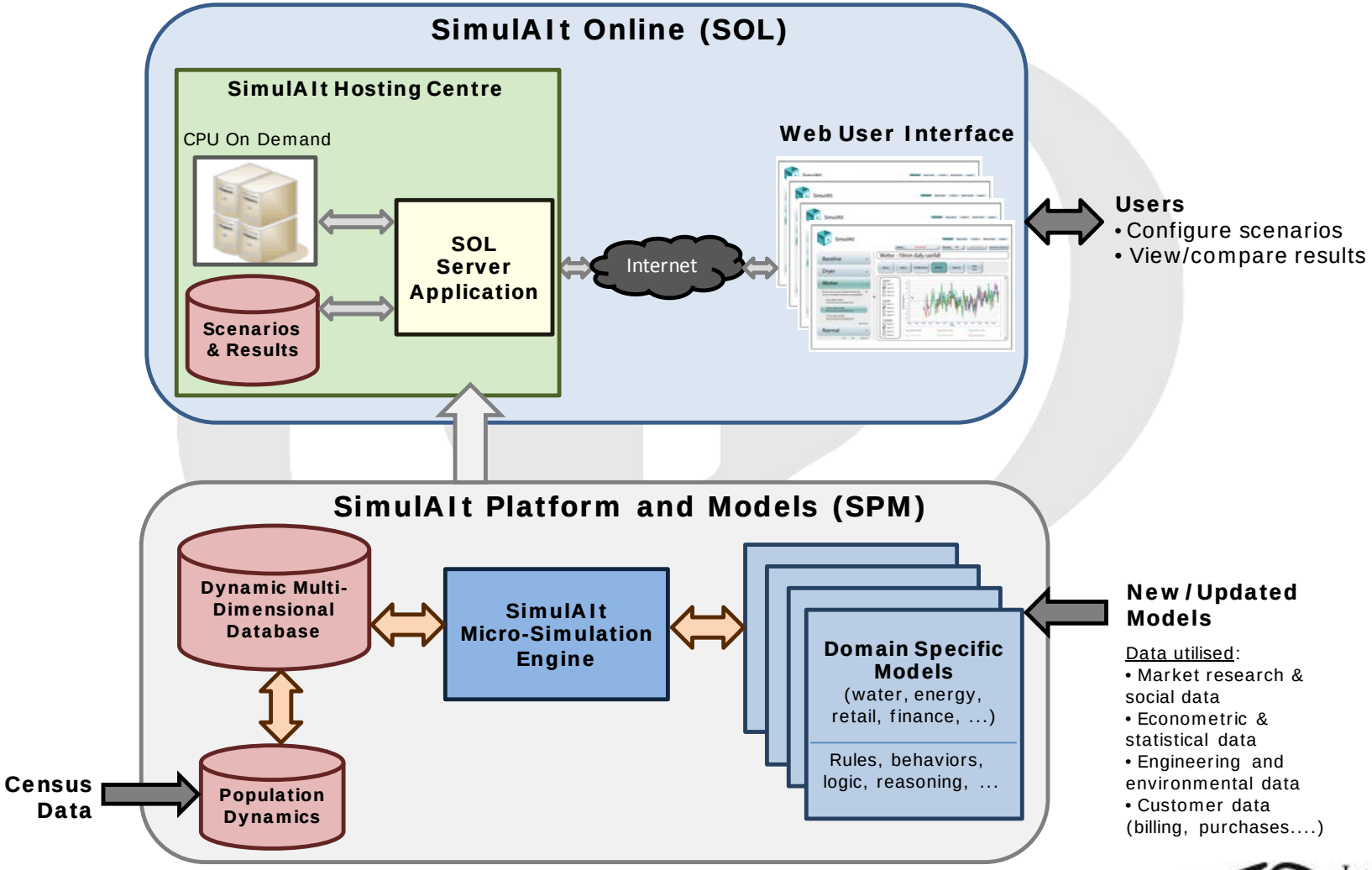
SOL Technical Overview



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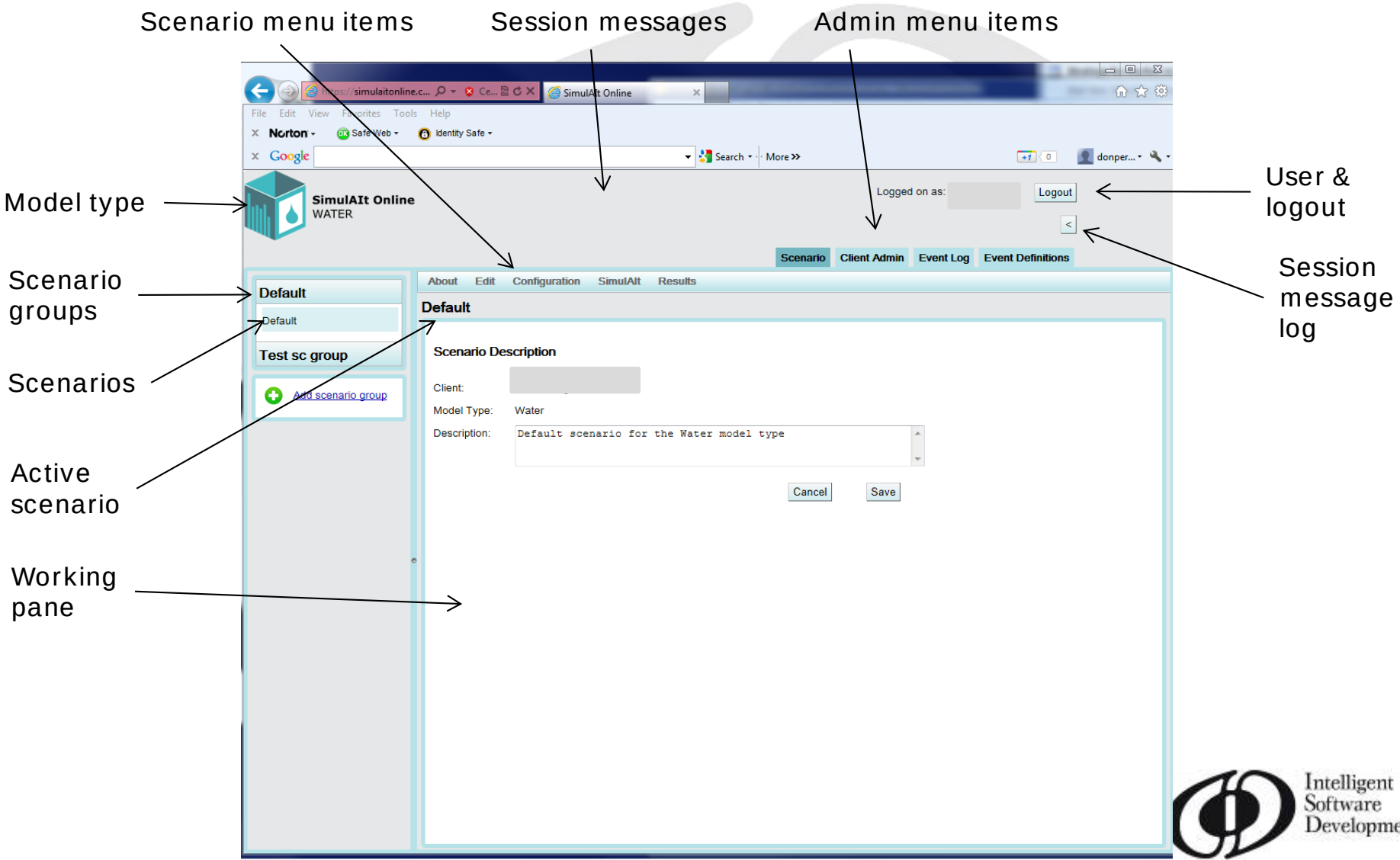
Main SOL screen



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Scenario: Configuration

Time associated with parameter values

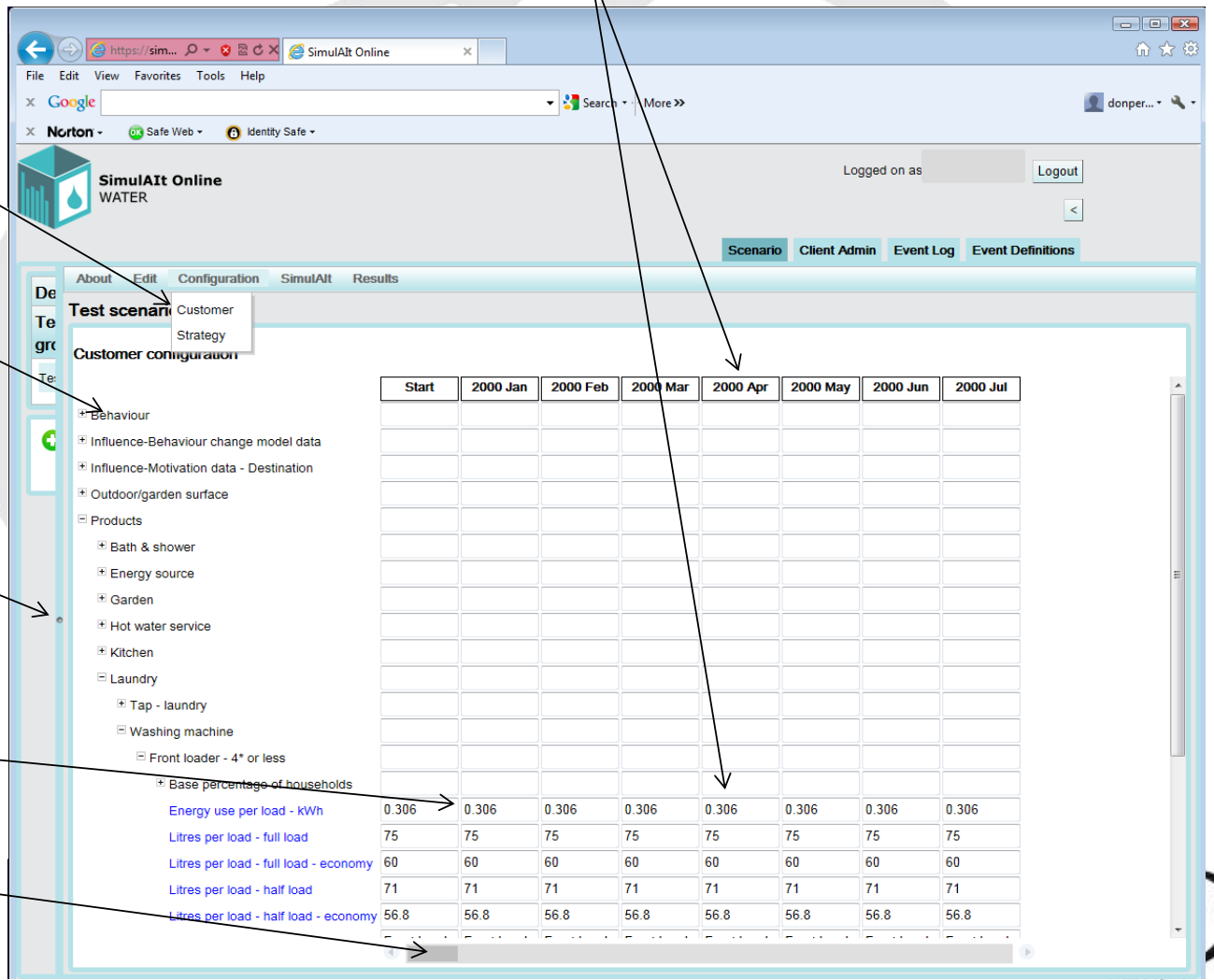
Config input type

Parameters tree: hierarchical to reduce complexity

Slide to increase working pane

Time explicit parameter values (cells)

Scroll cells through time



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Run scenario – SimulAIt!

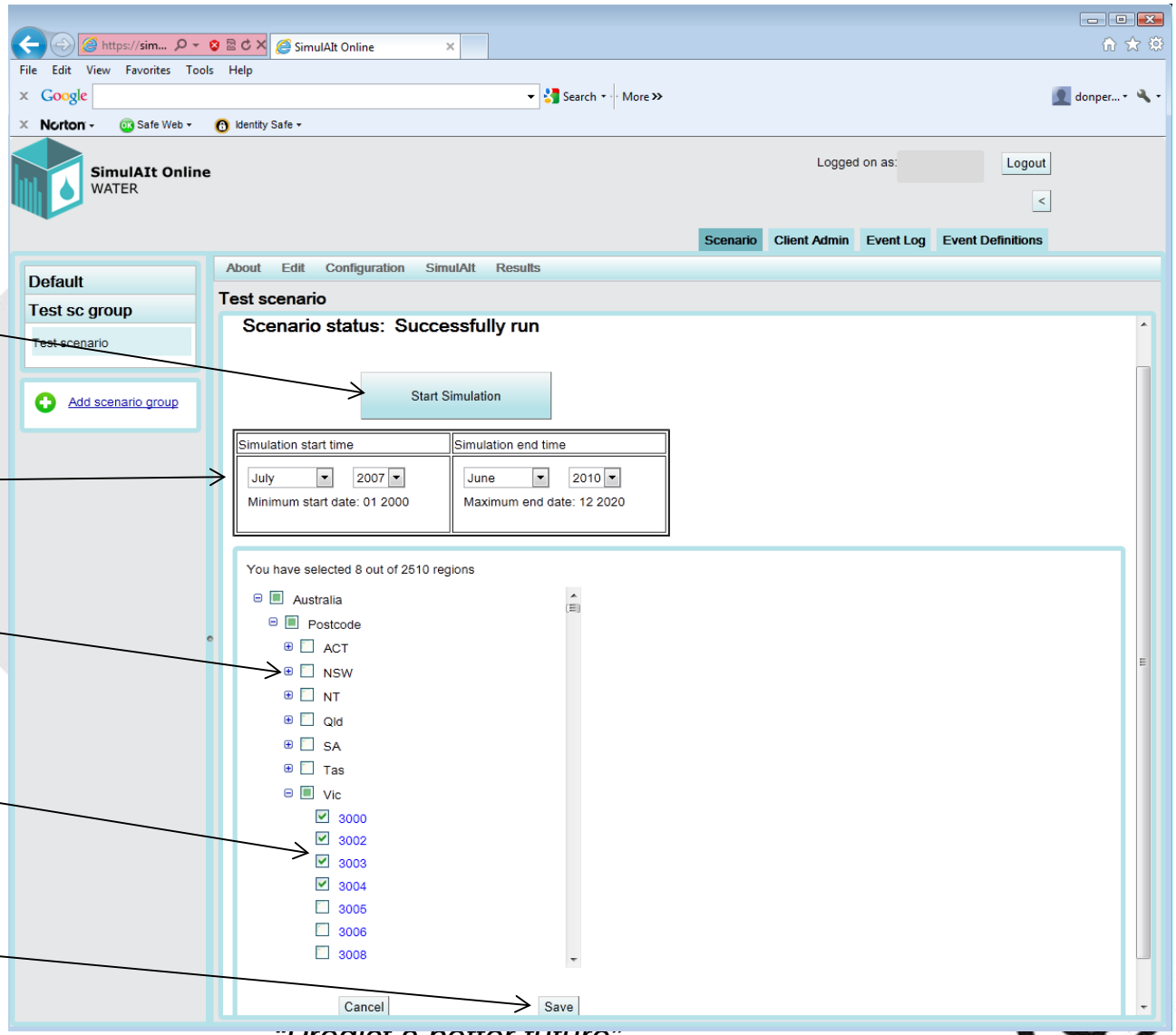
Start simulating the scenario

Set the scenario start and end times

Region tree

Selected regions

Save the selected regions for the scenario



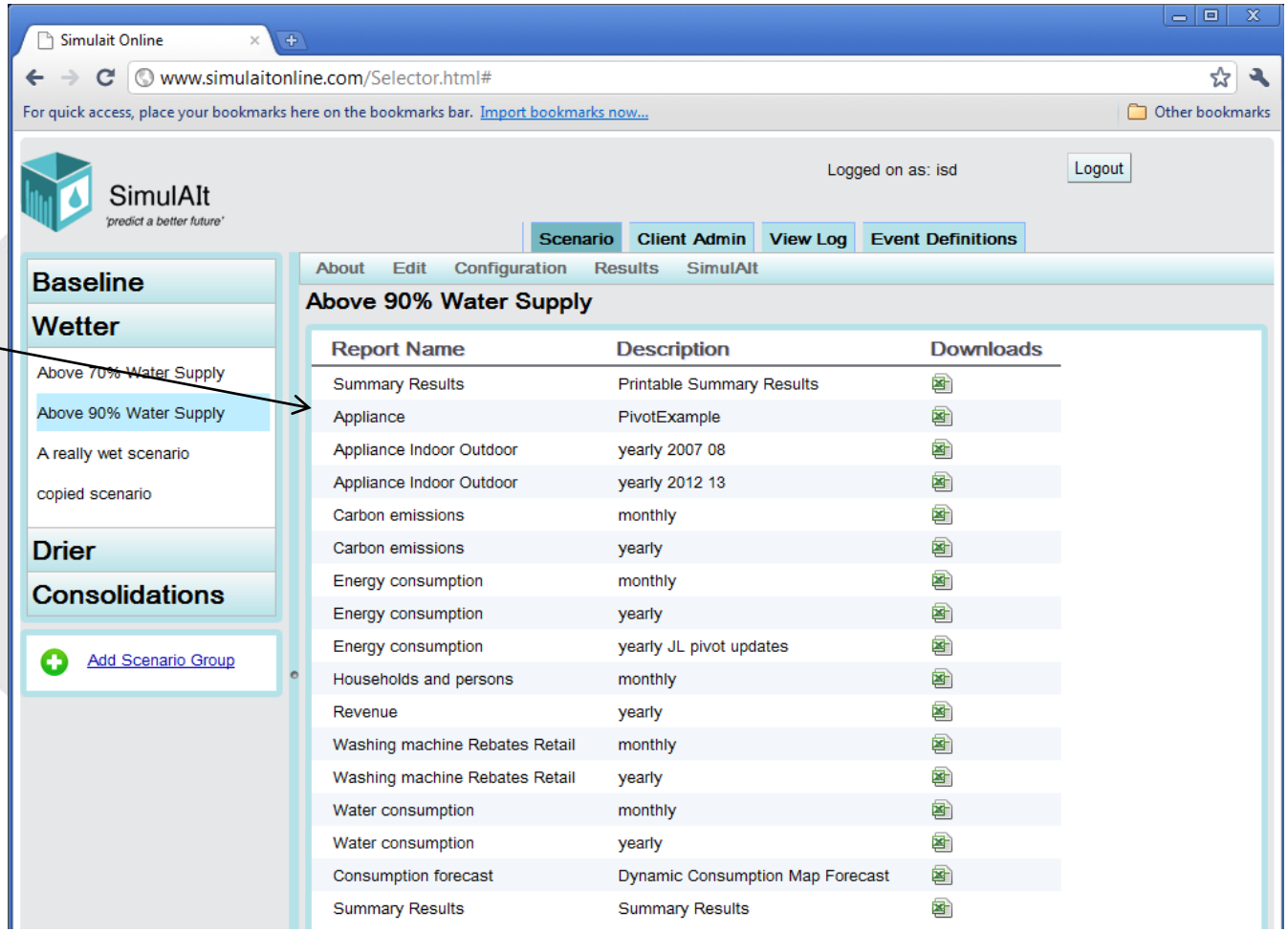
Scenario: Results

Range of results to download:

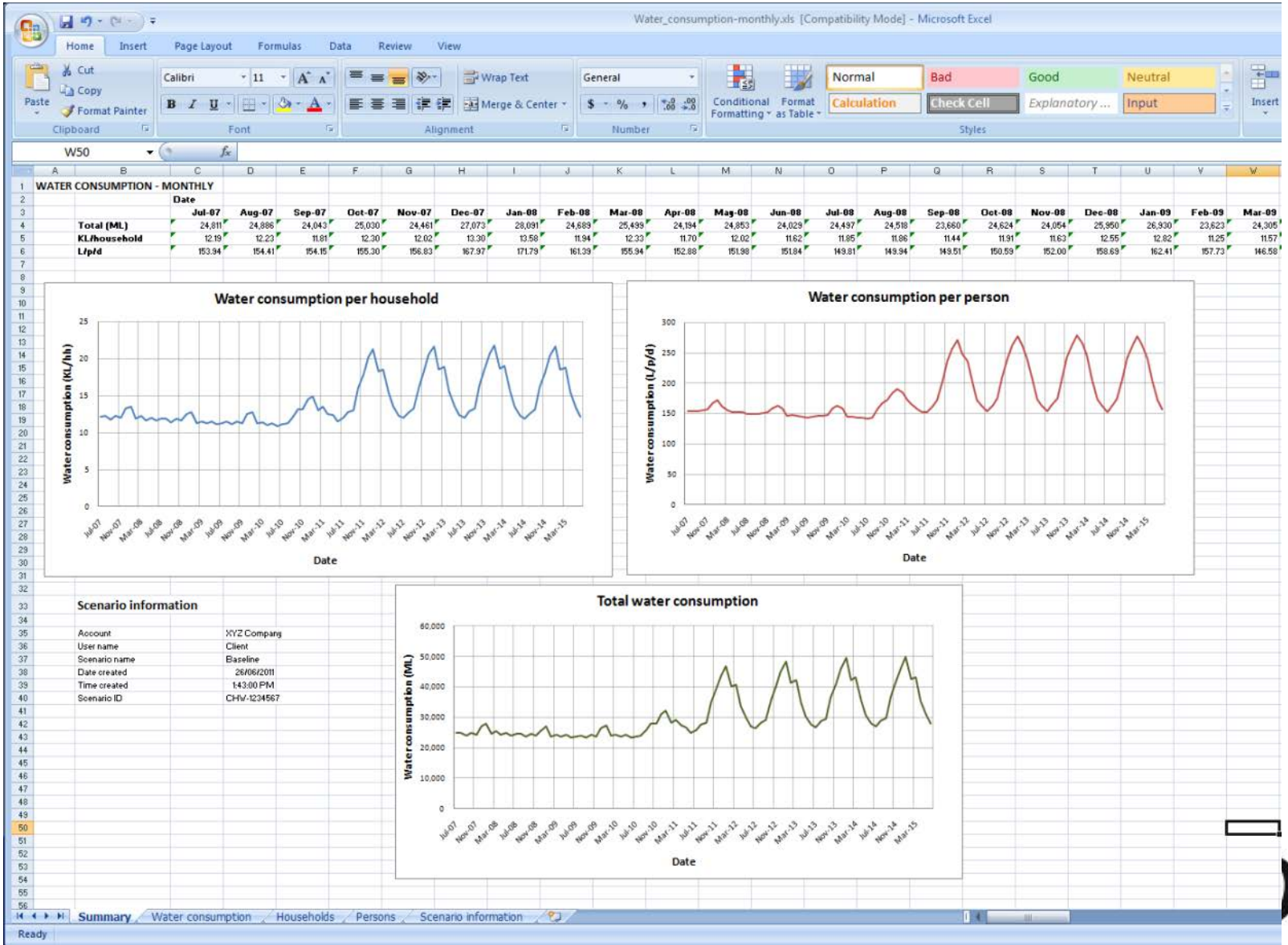
Water, energy, carbon, revenue, etc.

Monthly, yearly

Disaggregated into different regions, appliances



Outputs: Monthly Demand



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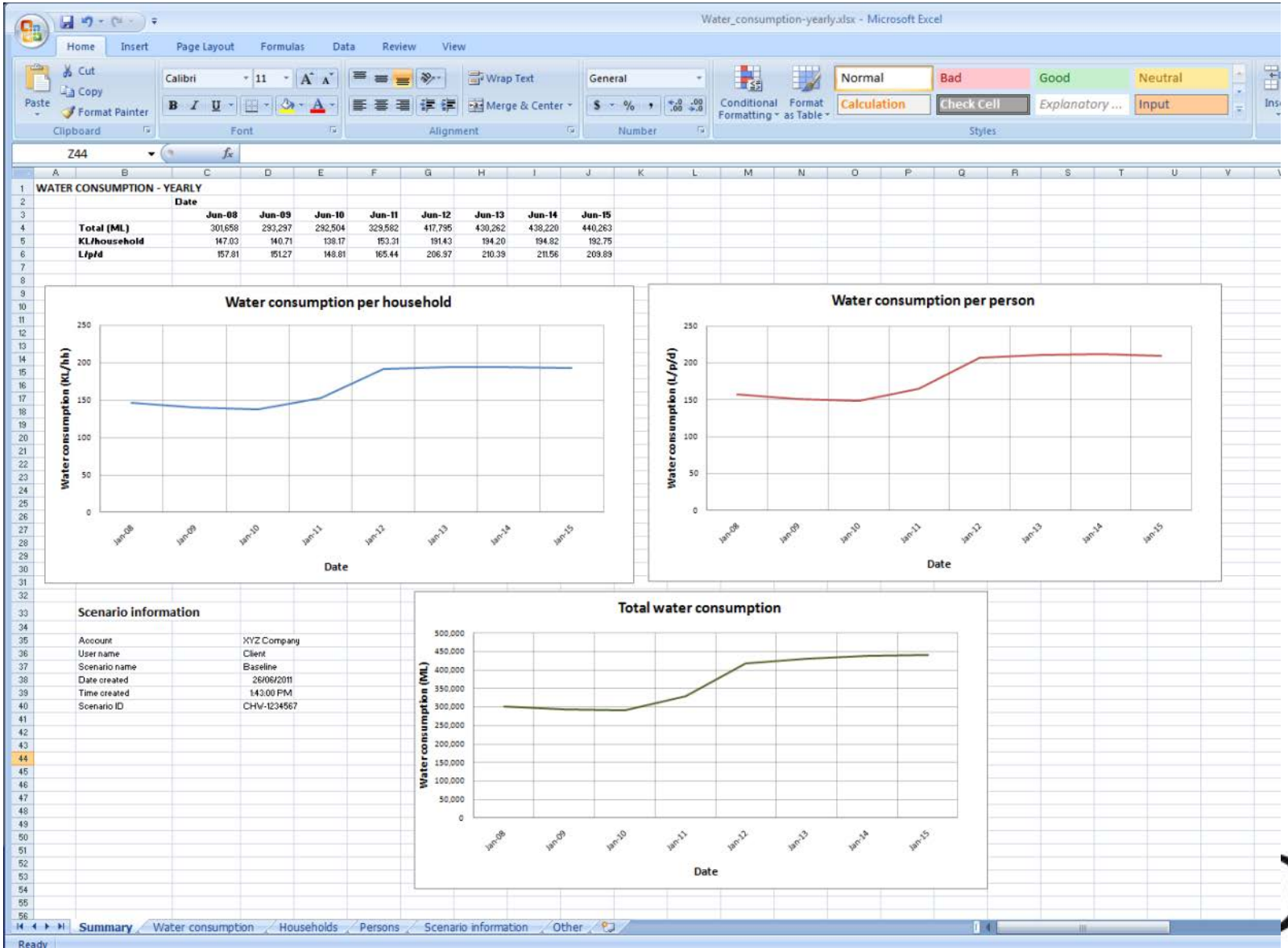
Outputs: Yearly Demand



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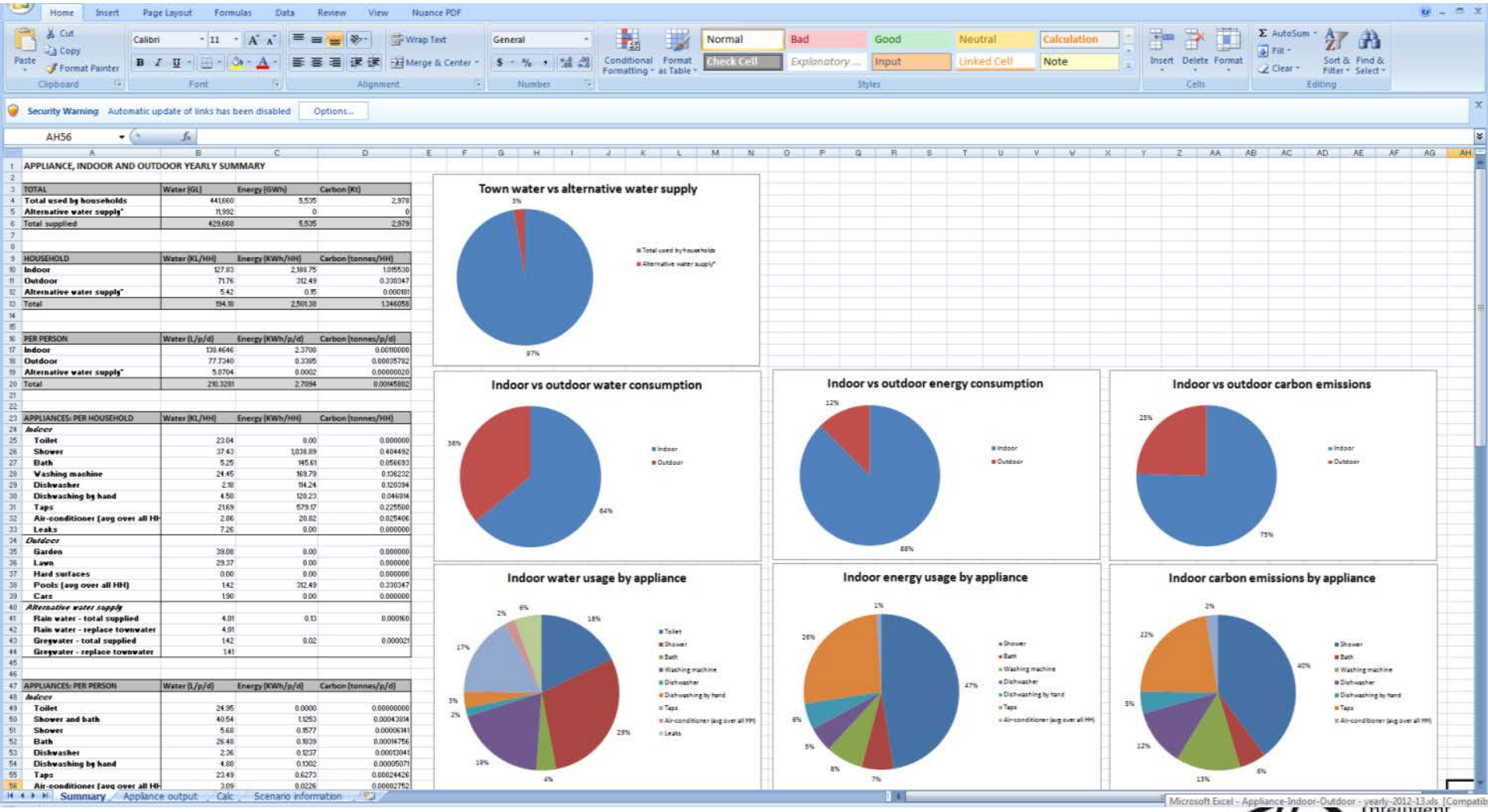
Outputs: Household Usage



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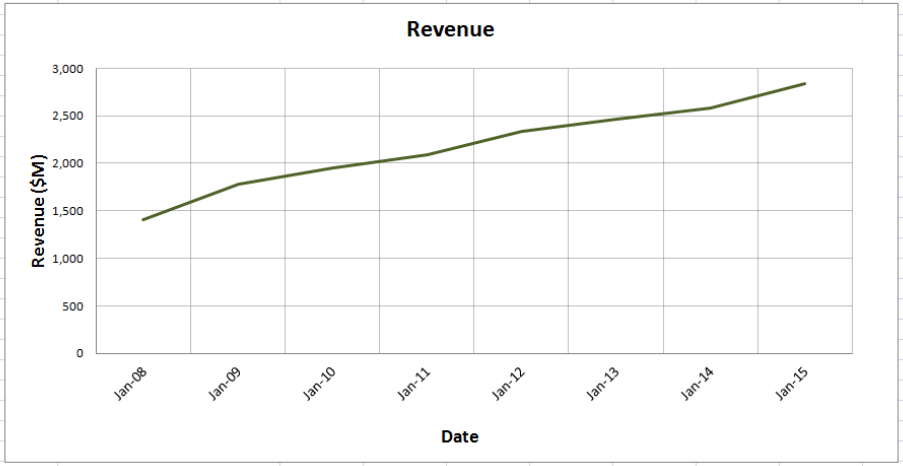
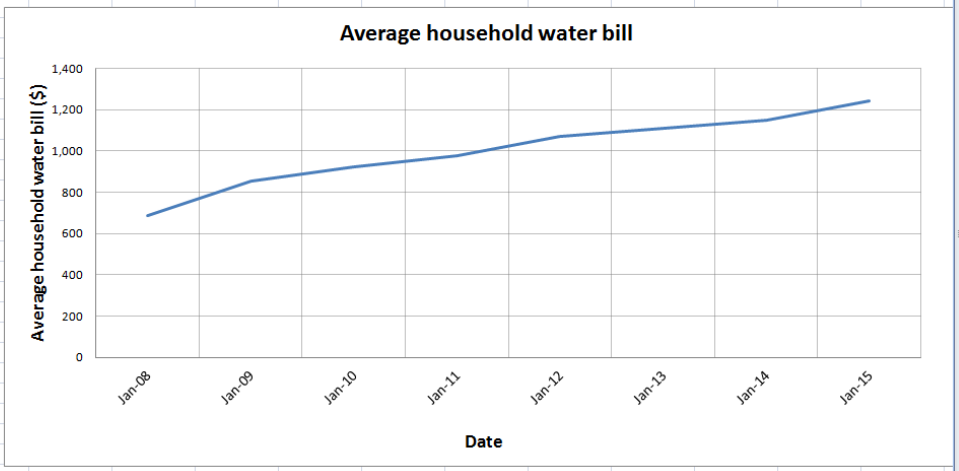
Outputs: Revenue, Water Bills

Revenue Yearly.xls [Compatibility Mode] - Microsoft Excel

WATER CONSUMPTION - MONTHLY								
	Date							
	Jun-08	Jun-09	Jun-10	Jun-11	Jun-12	Jun-13	Jun-14	Jun-15
Total revenue ($M)	$1,408	$1,785	$1,951	$2,095	$2,340	$2,461	$2,584	$2,833
Average household water bill ($)	$686	$856	$922	$974	$1,072	$1,111	$1,149	$1,241





Scenario information

Account	XYZ
User name	User
Scenario name	Scenario name
Date created	dd-mm-yyy
Time created	hh-mm

Summary | Revenue | Households | Scenario information

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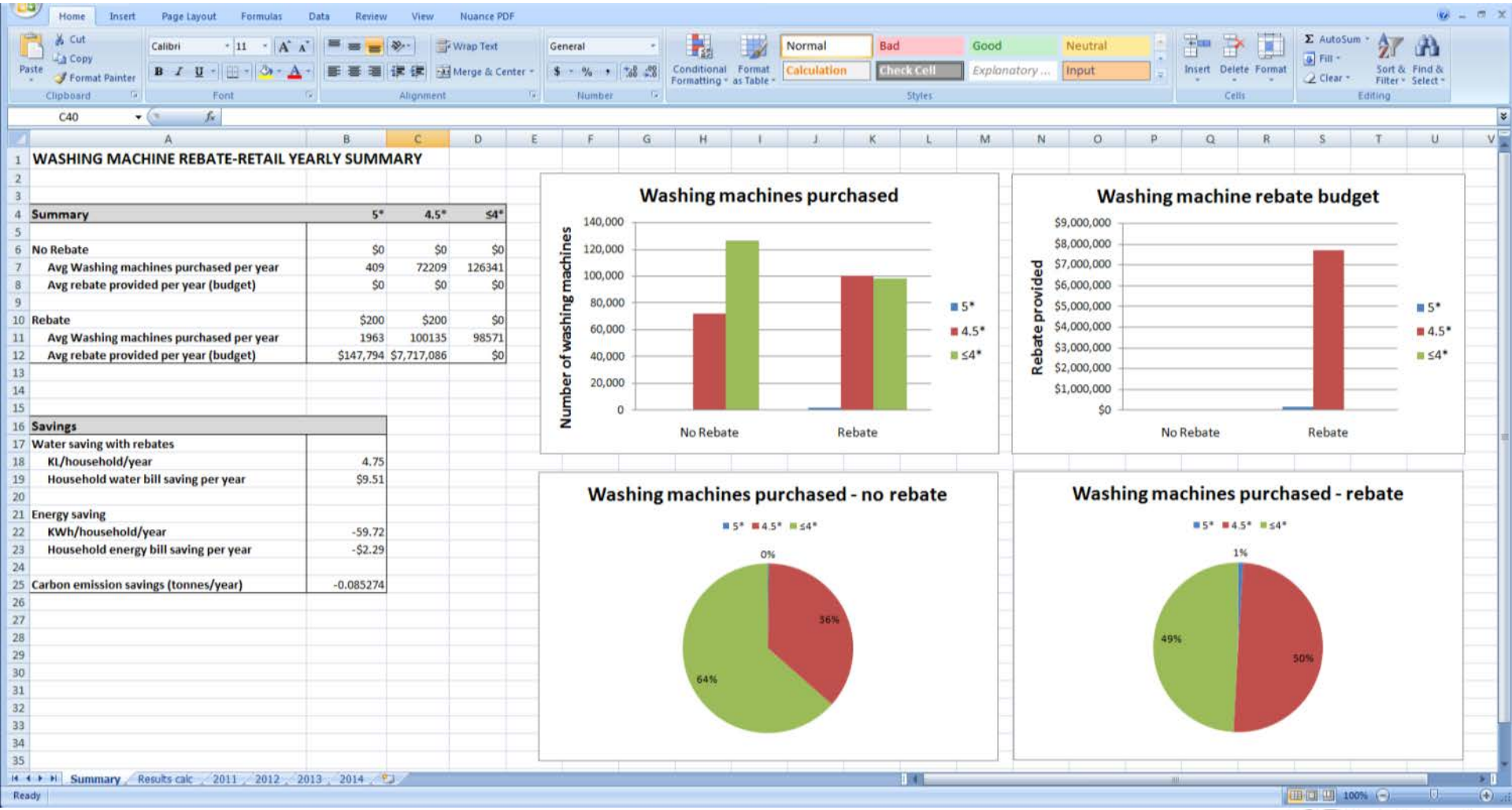
Outputs: Rebate uptake/efficiency



WASHING MACHINE REBATE-RETAIL YEARLY SUMMARY

Summary	5*	4.5*	≤4*
No Rebate	$0	$0	$0
Avg Washing machines purchased per year	409	72209	126341
Avg rebate provided per year (budget)	$0	$0	$0
Rebate	$200	$200	$0
Avg Washing machines purchased per year	1963	100135	98571
Avg rebate provided per year (budget)	$147,794	$7,717,086	$0

Savings	
Water saving with rebates	
Kl/household/year	4.75
Household water bill saving per year	$9.51
Energy saving	
KWh/household/year	-59.72
Household energy bill saving per year	-$2.29
Carbon emission savings (tonnes/year)	-0.085274

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