Characterisation of Water-Related Energy in Households

Summary of Outcomes for Household 2, Melbourne

Project: Water-Energy-Carbon Links in Households and Cities: A New Paradigm (ARC LP120200745)

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DOCUMENT CONTROL

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This document has been prepared as a sub-task of a project funded by the Smart Water Fund and the Australian Research Council. This particular work is focussed on understanding water-related energy in a particular period of time, and as a component of total household energy use. The document may not be suitable for other purposes.

1. INTRODUCTION

This summary document outlines results of modelling undertaken as part of the Water-Energy-Carbon Links in Households study. The intention of this document is to convey results of modelling outcomes for your information, as a participating household. If you have any queries regarding the results presented or would like to request further information, please feel welcome to contact the research team by email to a.binks@uq.edu.au.

2. ABOUT THE STUDY

2.1. What did we do with your data?

- Using the information we collected during the household audit conducted in early 2013, we calculated and/or estimated a number of water and energy use characteristics for your household. These included parameters describing average values and standard deviations relating to:
  - appliances (e.g. water use per cycle, energy use per cycle, cycle duration, cycle temperatures, standby energy use)
  - fixtures and fittings (e.g. flow rates, temperatures)
  - structural aspects (e.g. pipe materials, sizes, distance from hot water systems)
  - behaviours (e.g. frequency, duration, temperature)
  - environmental aspects (e.g. cold water temperature)
- These parameters (132 in total) were used as inputs to a mathematical material flow analysis (MMFA) model. Based on these inputs (average daily values and statistical distributions), the model estimates water-related energy use for an average day in your household.
- We are using your data, to test the MMFA model under a wider range of circumstances. If you notice something strange in the results or this report, we would be pleased if you let us know.
- Using the water, electricity and gas records that you provided, we calculated average daily usage values for your household. We then compared this average value to the estimates from our model, to check for accuracy.

2.2. How confident are we in these results?

Input data for the model was of mixed quality, and can be summarised as follows:

- Higher confidence:
  - **Appliance data** – where possible detailed information was collected about your appliances, and accurate information for each specific model was collected from user manuals and technical documents. This data is reasonably accurate.
  - **Environmental data** – detailed information was collected from the Australian Bureau of Statistics for air temperature, and from Yarra Valley Water for cold water temperature in the distribution networks. This data is reasonably accurate.
  - **Fixtures, fittings and structural data** – flow rates, distances of fittings and appliances from hot water systems, and hot water temperatures were measured during the household audit. This data is reasonably accurate.
- Lesser confidence:
  - **Behavioural estimates** – parameters describing behaviours (such as frequency and duration of showers, frequency of use of appliances) were based on your estimates of your own and other householders' behaviour. The accuracy of these estimates can vary substantially.
  - **Heating and cooling** – energy use of heaters and air conditioners varies according to a number of factors, such as air temperatures, insulation, security of sealing of doors/windows, and household behaviours such

as opening and closing doors and windows. As the primary focus on this study was on water-related energy use, it was beyond the scope of our modelling to attempt to model heating and cooling with accuracy. Average rates of gas and electricity use for these appliances were obtained from Sustainable Living Victoria. The accuracy of these estimates can vary substantially.

2.3. What will we do next with this information?

Going forward with our research, we will be doing the following with these results:

- **Improving accuracy of input data**
  - With your permission, we have obtained detailed water logger data for each of your households from Yarra Valley Water. Once available, we will be processing this data to identify specific end uses and this will be used to improve our knowledge of frequency, duration, and volume of water use behaviours. In particular, it is expected that this will significantly increase the accuracy of a number of parameters including behavioural estimates.
  - In some households, we were able to install an Amphiro meter, which collects detailed information on flow rate and duration for each shower event. This data is expected to increase the accuracy of parameters relating to shower use.
  - Where available and with your permission, we will also be using smart energy meter data to improve our knowledge of electricity use behaviours and improve our confidence in the outputs of the model including possible analysis of specific time periods (eg summer, winter etc).
- **Scenario testing** – a key component of this research is the testing of a number of policy scenarios to investigate their impacts upon water-related energy use in households and cities. We will be using the model of your household and others from Melbourne and Brisbane to investigate these scenarios.
- **How this work will input to the study**. The results from this first group of households (including your household) is being used to help understand water and energy linkages at city scale. Information on the key sensitivities in particular, are informing the study of factors which have the largest influence on water-related energy. Consequently our city-scale study is starting to focus on those factors.

2.4. How am I involved in the study from now on?

You have provided us with all the information we need for this phase of our research. We would like to sincerely thank you for your assistance with our work and particularly for your patient cooperation throughout some of the more complicated data collection tasks.

The data that you have provided to us represents a significant advancement in knowledge of the relationships between water and energy use in households. This will inform exciting further research and we anticipate will be published (as comparisons against the other households) anonymously in research articles as well as a report for the Smart Water Fund. Ultimately, the outcomes of this research will build a better understanding of city-scale water-related energy use and greenhouse gas emissions, through the application of your detailed household data and other city-scale information.

If you wish to remain involved in the study, there may be aspects of our continuing research in which it would be extremely valuable for us to follow up with further questions regarding some of your data. Your continued involvement would be warmly welcomed. However, we recognise that your input to date has represented a significant time investment, and there is no expectation for you to remain involved if you have no further interest.

Finally, if you would like to be kept up to date with the outcomes of this research project over the next two years, we are more than happy to share as progress is made. Please let us know by email to a.binks@uq.edu.au if you would like to receive updates.

3. RESULTS FOR YOUR HOUSEHOLD

The sections of this report summarise the outcomes of modelling for your household, based on data collected from you during the household audit and calculated statistics for an average day in the study period (April 2012 – March 2013).

3.1. Total daily water use, energy use, costs and emissions estimates

Figure 1 presents estimated daily: water use (Figure 1a); water-related energy use (Figure 1b); greenhouse gas emissions for water-related energy use (Figure 1c); combined water and energy costs (Figure 1d); and greenhouse gas emissions (Figure 1e) and combined water and energy costs (Figure 1f) for other energy uses.

Greenhouse gas emissions were calculated using 100 year IPCC values from the National Greenhouse Account Factors (Australian Government Department of Industry, Innovation, Climate Change, Research and Tertiary Education, July 2013), as follows:

- Natural Gas emissions factor: 0.18342 kg CO_2-e per kWh (from Table 2)
- Electricity emissions factor (Victoria): 1.17 kg CO_2-e per kWh (from Table 5).

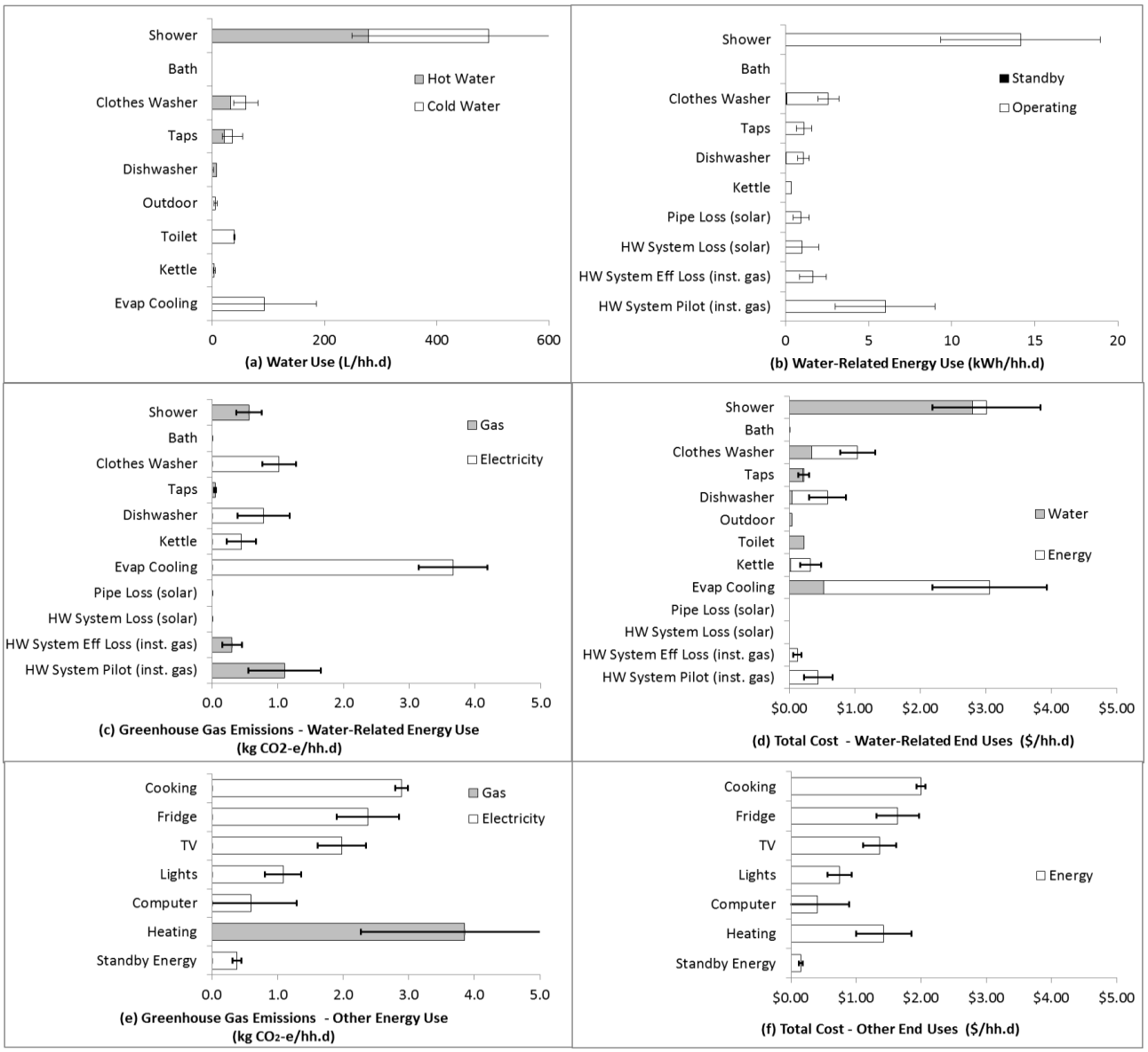

Figure 1: Results of Household WRE Model

Total daily estimates for water and energy use in your household are summarised in Table below. Column 'Comparison' highlights a comparison of model performance against utility record average recorded usage for the study period. Water use is compared against indoor totals only (rainwater tank used for outdoor purposes). Please note that improvement in the comparison is expected as more detailed data (water logger data, smart energy meter data, Amphiro data) becomes available to refine input parameter estimates.

Table 1: Summary of Model Results

KEY STATISTICS FOR PERIOD 1 April 2012 to 30 March 2013 HH2

Component	Units	Source		Mean	Comparison
Water Use Components					
Indoor Water Use	L/hh.d	Model	-	731	
Outdoor Water Use	L/hh.d	Model	-	6	
Total Water Use	L/hh.d	**Model**	**-**	**737**	**120%**
	L/hh.d	Utility record		613	
Total Electricity Use	kWh/hh.d	**Model**	**-**	**11.5**	**57%**
	kWh/hh.d	Utility record		20.3	
Gas Use Components					
Gas End Uses	kWh/hh.d	Model	-	22.5	
Gas HW System Heat Losses (from pipes and storage)	kWh/hh.d	Model	-	0.0	
Gas HW System Energy Losses (efficiency and pilot)	kWh/hh.d	Model		3.3	
Total Gas use	kWh/hh.d	**Model**	**-**	**25.8**	**20%**
	kWh/hh.d	Utility record		129	
Total Solar Energy Use		**Model**		**16.1**	
		Utility record		NA	
Total Household Energy Use (incl. solar)	kWh/hh.d	**Model**	**-**	**53.4**	
Total Water-Related Energy Use	kWh/hh.d	**Model**		**24.3**	
Water Related Energy as % of total model	% (Model/Model)			**46%**	

3.2. Sensitivity of water use, energy use, costs and emissions to household changes

The following tables highlight the most influential factors in your household water and energy use, and associated costs and GHG emissions. These were identified by testing the sensitivity of model results to a 10% increase in each input parameter. The parameters with the greatest influence on water, energy, cost and greenhouse gas emissions are listed at the left hand of each table. For each of these parameters, the 10% increase value and the corresponding change in total household usage has been listed in the right-hand columns of the table.

3.2.1. Water use

Table 2: Total Water Use – Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE TO 10% CHANGE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total HH water use**	
				(L/hh.d)	**(%)**
P1 Number of adults per household	3.04	*adults/hh.day*	0.30*	56	8%
P23 Number of showers per adult per day	1.80	*showers/day*	0.18	49	7%
P22 Flowrate per shower for adults	9	*Litres/min*	0.90	49	7%
P21 Flow duration per shower for adults	10	*min/shower*	1.00	49	7%
P106 Water use by evaporative cooler	0.5	*L/min*	0.05	9	1%
P107 Duration of evaporative cooler use	185	*min/day*	18.5	9	1%

** Change in average occupancy over whole year. For example, an increase in household occupancy of 0.3 adults/day is equivalent to an additional adult occupant for approximately 2 whole days per week.*

Table 3: Total Water-Related Energy Use (including solar hot water) – Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total HH water-related energy use**	
				(kWh/hh.d)	**(%)**
P24 Temperature of showers for adults	41	*°C*	4.1	2.4	11%
P1 Number of adults per household	3.04	*adults/hh.day*	0.3	1.5	7%
P21 Flow duration per shower for adults	10	*mins/shower*	1.0	1.4	7%
P23 Number of showers per adult per day	1.8	*showers/day*	0.2	1.4	7%
P22 Flow rate per shower for adults	9	*Litres/min*	0.9	1.4	7%
P3 Temperature of cold water	16.3	*°C*	1.6	- 1.1	-5%

3.2.2. Costs

Table 4: Total Water-Costs – Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total water costs**	
				($/hh.d)	***(%)***
P1 Number of adults per household	3.04	*adults/hh.day*	0.3	$0.23	5%
P23 Number of showers per adults per day	1.8	*showers/day*	0.2	$0.20	5%
P22 Flow rate per shower for adults	9	*Litres/min*	0.9	$0.20	5%

P23 Flow duration per shower for adults	10	*min/shower*	1.0	$0.20	5%
P107 Duration of use aircon evap	185	*min/day*	18.5	$0.04	1%

Table 5: Water-Related Energy-Costs (Gas) – Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total water-related energy costs**	
				($/hh.d)	**(%)**
P24 Temperature of showers for adults	41	*°C*	4.1	$0.03	15%
P1 Number of adults per household	3.04	*adults/hh.day*	0.3	$0.02	9%
P22 Flow rate per shower for adults	9	*Litres/min*	0.9	$0.02	9%
P23 Number of shower per adults per day	1.8	*showers/day*	0.2	$0.02	9%
P21 Flow duration per shower for adults	10	*min/shower*	1.0	$0.02	9%
P3 Temperature of cold water	16.3	*°C*	1.6	- $0.01	-6%

Table 6: Water-Related Energy-Costs (Electricity) – Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total water-related energy costs**	
				($/hh.d)	**(%)**
P44 Number of cycles hot front per day	1	*cycles/day*	0.1	$0.06	1%
P91 Number of cycles dishwasher per day	0.34	*cycles/day*	0.03	$0.02	0.5%

3.2.3. Greenhouse Gas Emissions

Table 7: Water-Related Emissions (Gas)– Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total greenhouse gas emissions**	
				(kgCO2-e/hh.d)	**(%)**
P24 Temperature of showers for adults	41	*°C*	4.1	0.09	15%
P1 Number of adults per household	3.04	*adults/hh.day*	0.3	0.05	9%
P22 Flow rate per shower for adults	9	*Litres/min*	0.9	0.05	9%
P23 Number of shower per adults per day	1.8	*showers/day*	0.2	0.05	9%
P21 Flow duration per shower for adults	10	*min/shower*	1.0	0.05	9%
P3 Temperature of cold water	16.3	*°C*	1.6	- 0.04	- 6%

Table 8: Water-Related Emissions (Electricity)– Model Sensitivity to Input Parameters

MODEL INPUTS				MODEL RESPONSE	
Parameter	**Input value (average day)**		**10% increase**	**Change in total greenhouse gas emissions**	
				(kgCO2-e/hh.d)	**(%)**
P44 Number of cycles hot front per day	1	*cycles/day*	0.1	0.28	2%
P91 Number of cycles dishwasher per day	0.34	*cycles/day*	0.03	0.11	1%

APPENDICES

A. Summary of Key Household Characteristics

Household ID	HH2
Number of Adults	4
Number of Children	0
House Type	Large brick, 2 storey
House Age	2+ years
Hot Water System Type	Solar + Gas Instantaneous
Clothes Washer Type	Front loader
Heating System Type	Gas (central ducted)
Cooling System Type	Evaporative Cooler (central ducted)
Cooking Type	Electric stove and oven
Rain Water Tank	No
Outdoor Irrigation	Yes (drip irrigation)
Electricity Retailer	Red Energy
Electricity Distributor	SP Ausnet
Gas Retailer	Red Energy
Gas Distributor	Envestra
Water Retailer	Yarra Valley Water

B. Summary of Water, Electricity and Gas Tariffs

Water Tariffs	***Fixed Rate***		***Variable Tier 1***		***Variable Tier 2***		***Variable Tier 3***	
Dec 2011 - Jun 2013	$ 1.21	$/day	$ 3.7302	per kL up to 0.44 kL/d	$ 4.0378	per kL next 0.44 kL/d	$ 5.0324	per kL balance
Electricity Tariffs	***Fixed Rate***		***Variable Tier 1***		***Variable Tier 2***		***Variable Tier 3***	
Dec 2011 - Jun 2013	$ 0.86	$/day	$ 0.2431	per kWh (all)				
Gas Tariffs	***Fixed Rate***		***Variable Tier 1***		***Variable Tier 2***		***Variable Tier 3***	
Dec 2011 - Jun 2013	$ 0.52	$/day	$ 0.0594	per kWh up to 14.7 kWh/d	$ 0.0501	per kWh balance		

C. Summary of Model Input Parameters (Annual average day model)

No (P)	Unit	Description	Probability Distribution	Mean	STDV-average day
Parameters for the household					
P1	[-]	Number of adults per household	tnormal	3.04	0.05
P2	[-]	Number of children per household	tnormal	0	0
P3	[°C]	Temperature cold water	tnormal	16.3	0.24
P4	[°C]	Temperature hot water at HWS	tnormal	60	5
P5	[°C]	Average indoor temperature	normal	14.9	0.34
P6	[°C]	Ambient air temperature at HWS storage	normal	15.10	0.50
P7	[m]	Ave. length of wastewater pipes	tnormal	10	3
P8	[m/s]	Velocity of wastewater	tnormal	0.1	0.05
P9	[m]	Radius of wastewater pipe	tnormal	0.1	0
P10	[W/(m^2	Heat coefficient of wastewater pipe	tnormal	2	1
P11	[m]	Average length of hot-water pipes (storage to	tnormal	12	2
P12	[m/s]	Velocity of hot water	tnormal	2.3	0.5
P13	[m]	Radius of hot-water pipe	tnormal	0.01	0.002
P14	[W/(m^2	Heat coefficient of hot-water pipe	tnormal	2	1
P15	[W/(m^2	Heat coefficient of hot-water storage	tnormal	0.5	0.5
P16	[m^2]	Surface of hot water storage	tnormal	1.82	0.200
P17	[-]	Split of hot water system: share of gas use	uniform	0	0
P18	[-]	Number of stand times in hot water pipes	uniform	3	1
P19	[m]	Thickness of hot-water pipe	tnormal	0.001	0.0001
P20	[-]	Switch: hws standard (0) / solar heat (1)	uniform	1	0
Parameters for showers					
P21	[min]	Flow duration per shower for adults	tnormal	10.0	2.00
P22	[L/min]	Flowrate per showers for adults	tnormal	9.0	2.25
P23	[-]	Number of showers per adult per day	tnormal	1.8	0.14
P24	[°C]	Temperature of showers for adults	tnormal	41	2
P25	[min]	Flow duration per shower for child	tnormal	0	0
P26	[L/min]	Flowrate per showers for child	tnormal	0	0
P27	[-]	Number of showers per child per day	tnormal	0	0
P28	[°C]	Temperature of showers for child	tnormal	0	0
P29	[-]	Fraction of instantaneous shower heating	uniform	0.2	0
P30	[-]	Split of instant. Shower: share of gas use	uniform	1	0
Parameters for bath					
P31	[L]	Volume per bath per adult	tnormal	0	0
P32	[-]	Number of baths per adult per day	tnormal	0	0
P33	[°C]	Temperature of baths for adults	tnormal	0	0
P34	[L]	Volume per bath per child	tnormal	0	0

No (P)	Unit	Description	Probability Distribution	Mean	STDV-average day
P35	[-]	Number of baths per child per day	tnormal	0	0
P36	[°C]	Temperature of baths for child	tnormal	0	0
P37	[-]	Fraction of instantaneous bath heating	uniform	0	0
P38	[-]	Split of instant. Bath share of gas use	uniform	0	0
Parameters for clothes wash					
P39	[-]	Number of cycles cold top per day	tnormal	0	0
P40	[-]	Number of cycles warm top per day	uniform	0	0
P41	[-]	Number of cycles hot top per day	uniform	0	0
P42	[-]	Number of cycles cold front per day	uniform	0	0
P43	[-]	Number of cycles warm front per day	uniform	0	0
P44	[-]	Number of cycles hot front per day	uniform	1.00	0.05
P45	[L]	Volume per cycle cold top	tnormal	0	0
P46	[L]	Volume per cycle warm top	uniform	0	0
P47	[L]	Volume per cycle hot top	uniform	0	0
P48	[L]	Volume per cycle cold front	uniform	0	0
P49	[L]	Volume per cycle warm front	uniform	0	0
P50	[L]	Volume per cycle hot front	uniform	60.00	15
P51	[kWh]	Energy per cycle cold top (excl. water heating)	tnormal	0	0
P52	[kWh]	Energy per cycle warm top (excl. water	uniform	0	0
P53	[kWh]	Energy per cycle hot top (excl. water heating)	uniform	0	0
P54	[kWh]	Energy per cycle cold front (excl. water	uniform	0	0
P55	[kWh]	Energy per cycle warm front (excl. water	uniform	0	0
P56	[kWh]	Energy per cycle hot front (excl. water heating)	uniform	0.77	0.19
P57	[°C]	Temperature cold cycle top	normal	0	0
P58	[°C]	Temperature warm cycle top	uniform	0	0
P59	[°C]	Temperature hot cycle top	uniform	0	0
P60	[°C]	Temperature cold cycle front	uniform	0	0
P61	[°C]	Temperature warm cycle front	uniform	0	0
P62	[°C]	Temperature hot cycle front	uniform	40	5
P63	[min]	Duration average cycle top	uniform	0	0
P64	[min]	Duration average cycle front	uniform	114	28.5
P65	[W]	Standby energy top	tnormal	0	0
P66	[W]	Standby energy front	uniform	3.50	1.8
P67	[-]	Connected to hot+cold (0) or only cold (1)	uniform	0	0
Parameters for taps					
P68	[-]	Number hand wash per person per day	tnormal	3.1	1.5
P69	[L]	Volume per hand wash	tnormal	1.40	0.70
P70	[°C]	Temperature hand wash	tnormal	16.3	0.24

No (P)	Unit	Description	Probability Distribution	Mean	STDV-average day
P71	[-]	Number teeth brush per person per day	tnormal	2.00	1.00
P72	[L]	Volume teeth brush	tlognormal	1.5	0.750
P73	[°C]	Temperature teeth brush	tnormal	16.3	0.24
P74	[-]	Number shave per adult per day	tnormal	0	0
P75	[L]	Volume per shave	tnormal	0	0
P76	[°C]	Temperature shave	tnormal	0	0
P77	[-]	Number dish wash (by hand) per hh per day	tnormal	0.67	0.01
P78	[L]	Volume dish wash (by hand)	tnormal	20	10.2
P79	[°C]	Temperature dish wash (by hand)	tnormal	56	2
P80	[-]	Number clothes wash (by hand) per hh per day	tnormal	0.00	0.00
P81	[L]	Volume per clothes wash (by hand)	tlognormal	10	5
P82	[°C]	Temperature clothes wash (by hand)	tnormal	55	1
P83	[-]	Number cleaning per hh per day	lognormal	0.09	0.02
P84	[L]	Volume per cleaning	lognormal	5	2.50
P85	[°C]	Temperature of cleaning	tnormal	40	1
P86	[-]	Number other use per person per day	lognormal	0	0
P87	[L]	Volume other use	lognormal	0	0
P88	[°C]	Temperature other use	lognormal	0	0
P89	[-]	Fraction of instantaneous tap water heating	uniform	0.2	0
P90	[-]	Split of instant. Taps share of gas use	uniform	1	0
Parameters for dishwasher					
P91	[-]	Number of cycles dishwasher per day	tnormal	0.34	0.02
P92	[L]	Volume per cycle dishwasher	tnormal	20	5
P93	[kWh]	Energy per cycle dishwasher (excl. water	tlognormal	1.75	0.875
P94	[°C]	Temperature dishwasher cycle	tnormal	65	5
P95	[min]	Duration average cycle dishwasher	tnormal	100	25
P96	[W]	Standby energy dishwasher	tnormal	2	0.5
P97	[-]	Connected to hot+cold (0) or only cold (1)	uniform	0	0
Parameters for outdoor use					
P98	[L]	Pool volume per day	uniform	0	0
P99	[L]	Irrigation per day	tnormal	6.00	3.00
P100	[min]	Duration pool filtration per day	uniform	0	0
P101	[kW]	Power of pool filter	uniform	0	0
Parameters for toilet flush					
P102	[-]	Number of toilet flushes per person per day	tlognormal	3.1	0.03
P103	[L]	Volume per toilet flush	tnormal	4.17	0.03
Parameters per kettle boil					
P104	[-]	Number of kettle boils per person per day	tnormal	1.41	0.07

No (P)	Unit	Description	Probability Distribution	Mean	STDV-average day
P105	[L]	Volume per boil	tnormal	0.8	0.4
Parameters for aircon					
P106	[L/min]	Water use aircon evap.	tlognormal	0.5	0.5
P107	[min]	Duration use aircon evap.	uniform	185	16
P108	[W]	Energy used aircon evap.	lognormal	900	100
P109	[W]	Standby energy aircon evap.	uniform	0	0
P110	[min]	Duration use aircon rest	tnormal	0	0
P111	[W]	Energy used aircon rest	tnormal	0	0
P112	[W]	Standby energy aircon rest	tnormal	0	0
Parameters for other energy use					
P113	[min]	Duration use cooking	lognormal	44	1.4
P114	[W]	Energy used cooking	tnormal	2965	6
P115	[W]	Standby energy cooking	tnormal	0	0
P116	[min]	Duration use fridge	uniform	1440	0
P117	[W]	Energy used fridge	tnormal	75	15
P118	[W]	Standby energy fridge	uniform	0	0
P119	[min]	Duration use TV	tnormal	334	2.8
P120	[W]	Energy used TV	lognormal	269	50
P121	[W]	Standby energy TV	lognormal	3.0	0.00
P122	[min]	Duration use light	tnormal	1070	250
P123	[W]	Energy used light	lognormal	46.1	4.5
P124	[W]	Standby energy light	uniform	0	0
P125	[min]	Duration use PC	lognormal	800	18.92
P126	[W]	Energy used PC	lognormal	33.5	40
P127	[W]	Standby energy PC	lognormal	10	3
P128	[min]	Duration use heating	lognormal	236	12.58
P129	[W]	Energy used heating	lognormal	4920	2000
P130	[W]	Standby energy heating	uniform	0	0
P131	[-]	Split of cooking energy: share of gas use	tnormal	0	0
P132	[-]	Split of heating energy: share of gas use	tnormal	1	0

D. Summary of Model Results for System Sub-Components (Annual average day model)

C.1 Water use sub-components

Model Output Sub-Component	Estimated Mean Value for Average Day
X1 W shower: cw+hw total[l/hh day]	492.5
X20 W bath : cw+hw total[l/hh day]	0.0
X39 W cloth : cw+hw total[l/hh day]	60.0
X83 W taps : cw+hw total[l/hh day]	36.2
X122 W dishes: cw+hw total[l/hh day]	6.8
X132 W outd. : cw+hw total[l/hh day]	6.0
X146 W toilet: cw+hw total[l/hh day]	39.3
X153 W kettle: cw+hw total[l/hh day]	3.4
X159 W aircon: w air.ev.[l/hh day]	92.7
TOTAL	**737**

C.2 Gas use sub-components

Model Output Sub-Component	Estimated Mean Value for Average Day
X19 E shower: inst. gas[kWh/hh day]	3
X38 E bath : inst. gas[kWh/hh day]	0
X121 E taps : inst. gas[kWh/hh day]	0
X186 E other :cook. gas[kWh/hh day]	0
X188 E other : heat. gas[kWh/hh day]	19.4
Y201 Instantaneous Gas System Efficiency Losses [kWh/hh.d]	1.6
Y202 Instantaneous Gas System Pilot Light Losses [kWh/hh.d]	1.7
TOTAL	**25.8**

C.3 Electricity use sub components

Model Output Sub-Component	Estimated Mean Value for Average Day
X18 E shower: inst. el [kWh/hh day]	0
X37 E bath : inst. el [kWh/hh day]	0
X120 E taps : inst. el [kWh/hh day]	0
X129 E dishes: operation[kWh/hh day]	0.6
X158 E kettle: all energ[kWh/hh day]	0.3
X170 E aircon: all energ[kWh/hh day]	2.8
X79 E cloth : oper.fro [kWh/hh day]	0.8
X175 E other : op fridge[kWh/hh day]	1.8
X177 E other : op TV [kWh/hh day]	1.5
X179 E other : op light [kWh/hh day]	0.8
X181 E other : op PC+ [kWh/hh day]	0.4
X185 E other :cook. el [kWh/hh day]	2.2
X187 E other :heat. el [kWh/hh day]	0.0
X201 E HH use: st.tot. [kWh/hh day]	0.3
TOTAL	**11.5**

C.4 Solar hot water system energy use sub-components

Model Output Sub-Component	Estimated Mean Value for Average Day
X17 E shower: hw store [kWh/hh day]	11
X36 E bath : hw store [kWh/hh day]	0
X71 E cloth : hw front [kWh/hh day]	2
X119 E taps : hw store [kWh/hh day]	0.9
X128 E dishes: hw total [kWh/hh day]	0.4
X202 E HH use: hw p.loss[kWh/hh day]	0.9
X203 E HH use: hwsy.loss[kWh/hh day]	1.0
TOTAL	**16.1**

C.5 Standby energy use sub-components

Model Output Sub-Component	Estimated Mean Value for Average Day
X81 E cloth : fro stand[kWh/hh day]	0.08
X130 E dishes: standby [kWh/hh day]	0.05
X164 E aircon: st.by tot[kWh/hh day]	0.00
X172 E other : st.by tot[kWh/hh day]	0.16
TOTAL	**0.29**

C.6 Energy use sub-components

Model Output Sub-Component	Estimated Mean Value for Average Day
X13 E shower: hw total [kWh/hh day]	14.1
X32 E bath : hw total [kWh/hh day]	0.0
X82 E cloth : all energ[kWh/hh day]	2.5
X110 E taps : hw total [kWh/hh day]	1.1
X131 E dishes: all energ[kWh/hh day]	1.0
X158 E kettle: all energ[kWh/hh day]	0.3
X202 E HH use: hw p.loss[kWh/hh day]	0.9
X203 E HH use: hwsy.loss[kWh/hh day]	1.0
Y201 Instantaneous Gas System Efficiency Losses [kWh/hh.d]	1.6
Y202 Instantaneous Gas System Pilot Light Losses [kWh/hh.d]	6.0
X170 E aircon: all energ[kWh/hh day]	2.8
X173 E other : op cook [kWh/hh day]	2.2
X175 E other : op fridge[kWh/hh day]	1.8
X177 E other : op TV [kWh/hh day]	1.5
X179 E other : op light [kWh/hh day]	0.8
X181 E other : op PC+ [kWh/hh day]	0.4
X183 E other : op heat. [kWh/hh day]	19.4
X172 E other : st.by tot[kWh/hh day]	0.2
TOTAL	**57.8**

C.7 Cost components of the system

Model Output Sub-Component	**Estimated Mean Value for Average Day**
Total Water Use ($/hh day)	$4.20
Total Electricity Use ($/hh day)	$3.16
Total Gas Use ($/hh day)	$1.64
Total Energy Losses ($/hh day)	$0.24
TOTAL	**$9.24**

C.8 CO2 performance

Model Output Sub-Component	**Estimated Mean Value for Average Day**
Total Energy Use (kg CO_2-e/hh day)	**21.1**
Total Electricity Use (kg CO_2-e/hh day)	*15.2*
Total Gas Use (including energy losses) (kg CO_2-e/hh day)	*5.9*
Total Water-Related Energy Use (kg CO_2-e/hh day)	**7.9**
Water-Related Electricity Use (kg CO_2-e/hh day)	*5.9*
Water-Related Gas Use (kg CO_2-e/hh day)	*2.0*
Water Related CO_2–e as a percentage of total household	**37%**