Influence of the Central Victoria Solar City program on Household Energy Behaviour

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Energy Efficiency Policy

- **Encouraging households and industry to be more energy efficient has been a major challenge for policy makers.**

- **Paramount that energy efficiency policies are based on reliable research about not only *if* policies work, but extends to *how* they work and under what conditions.**

- *Energy Efficiency Gap*

  - *difference between optimal and actual levels of investment in energy efficiency (Hirst & Brown, 1990).*

  - *proponents suggest that market failure and barriers are major contributors to this underinvestment in energy efficiency (Dietz, 2010; Jaffe & Stavins, 1994).*

Energy Efficiency Gap
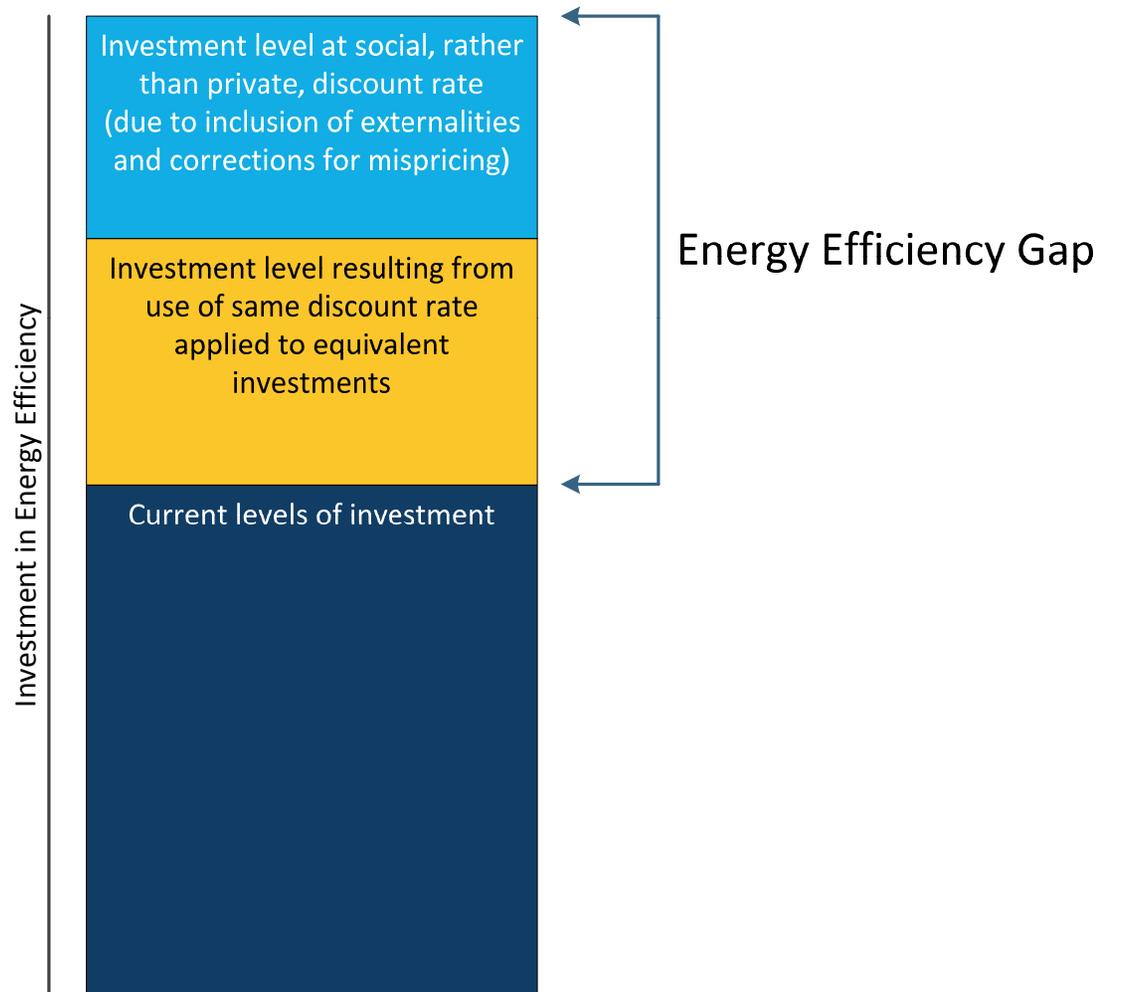
Refer Jaffe & Stavins (1994) for further detail.

Energy Efficiency Policy

- **Central economic question:**
  - Can government intervention correct investment inefficiencies?
- **Common policy alternatives:**
  - a Pigouvian tax
  - a cap and trade system (e.g. ETS)
  - energy efficiency subsidies and standards
  - energy efficiency programs
- **Although such measures are well recognised, a lack of credible empirical research makes it difficult to assess the potential influence of both independent & complementary government policy measures (Allcott & Greenstone, 2012).**

Solar Cities Program

- **Research trial designed to gain a better understanding of consumer response to the adoption of energy efficiency technologies and services.**

- **Australia's 7 Solar Cities are: Townsville, Adelaide, Alice Springs, Blacktown, Central Victoria, Moreland and Perth.**

Source: Department of Climate Change and Energy Efficiency (2011)
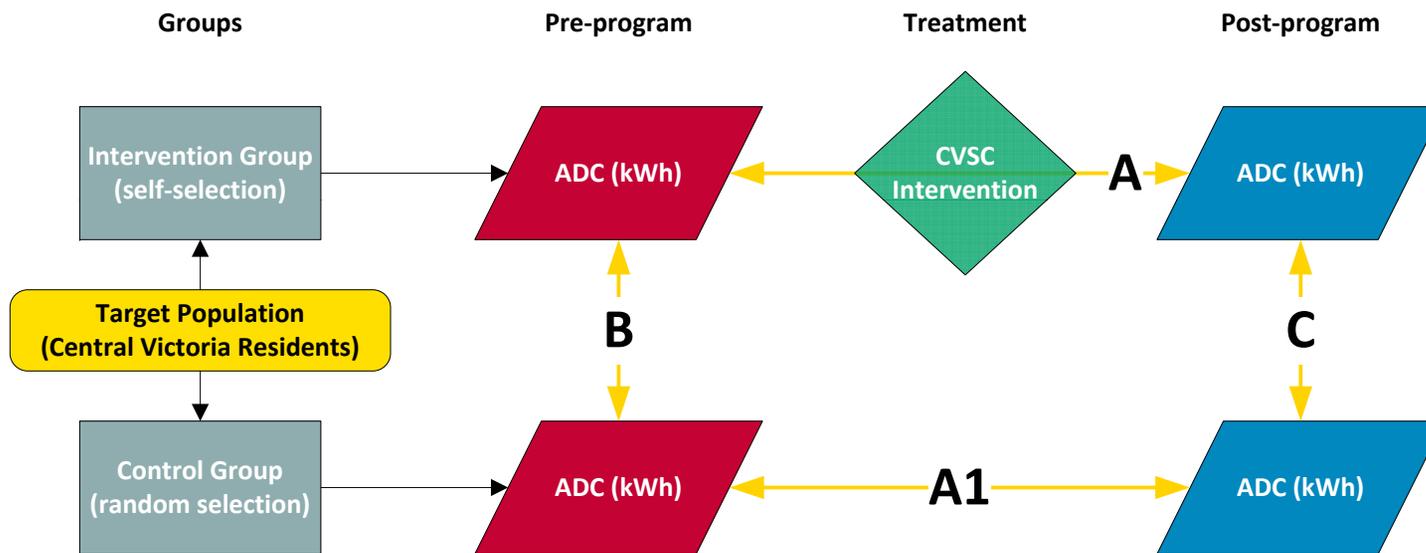
Overview of CVSC Program: Residential Trial

- **Administered by Sustainable Regional Australia**

- **Program involved the recruitment of 1,873 household research participants (intervention group) and a control group of 715.**

- **Each household in the intervention group received a free Home Energy Assessment (HEA)**

- **Eligible to take part in one or more additional program package:**

  – **Retrofit rebate package ($500 rebate on $2,000+ energy efficiency investments)**

  – **Solar Hot Water**

  – **Household Solar Photovoltaics (1.5 Kw system)**

  – **In Home Energy Displays (IHDs)**

Evaluation Objectives

- **Examine how energy efficiency programs influence participant behaviour.**
  1. To examine changes in electricity use attributable to the program
  2. To test how attitudes and beliefs influence participant intentions to reduce energy use and actual behavioural changes
  3. To test if program participation strengthens the influence of attitudes and beliefs on intentions to reduce energy use and actual behavioural changes

The Evaluation Design

- **Non-equivalent groups design**

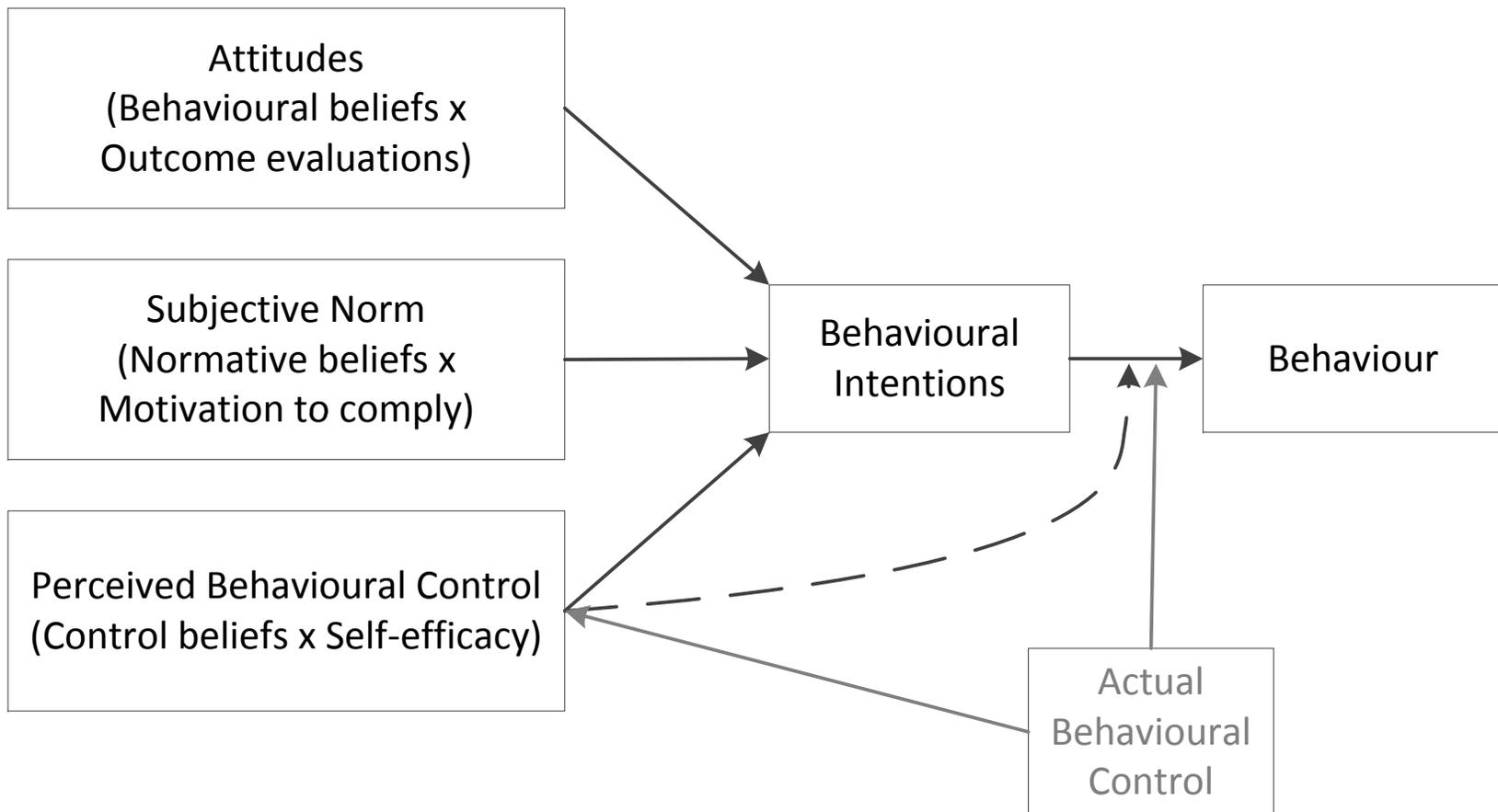| Groups	Pre-program	Treatment	Post-program
Intervention Group (self-selection)	ADC (kWh)	CVSC Intervention — A →	ADC (kWh)
Target Population (Central Victoria Residents)	B		C
Control Group (random selection)	ADC (kWh)	A1	ADC (kWh)

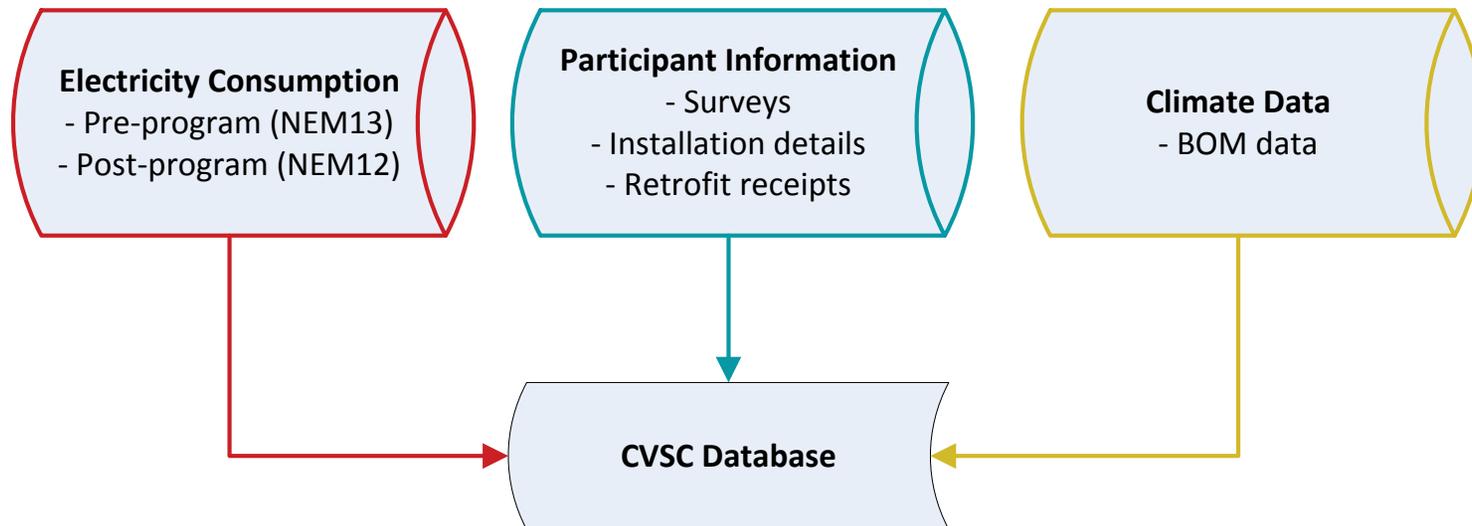A and A1: Comparison of changes to both groups since the intervention

B: Comparison between the two groups before the intervention (matched to control for biases)

C: Comparison between the two groups after the intervention

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Conceptual Framework: Theory of Planned Behaviour

Attitudes
(Behavioural beliefs x Outcome evaluations)

Subjective Norm
(Normative beliefs x Motivation to comply)

Perceived Behavioural Control
(Control beliefs x Self-efficacy)

Behavioural Intentions

Behaviour

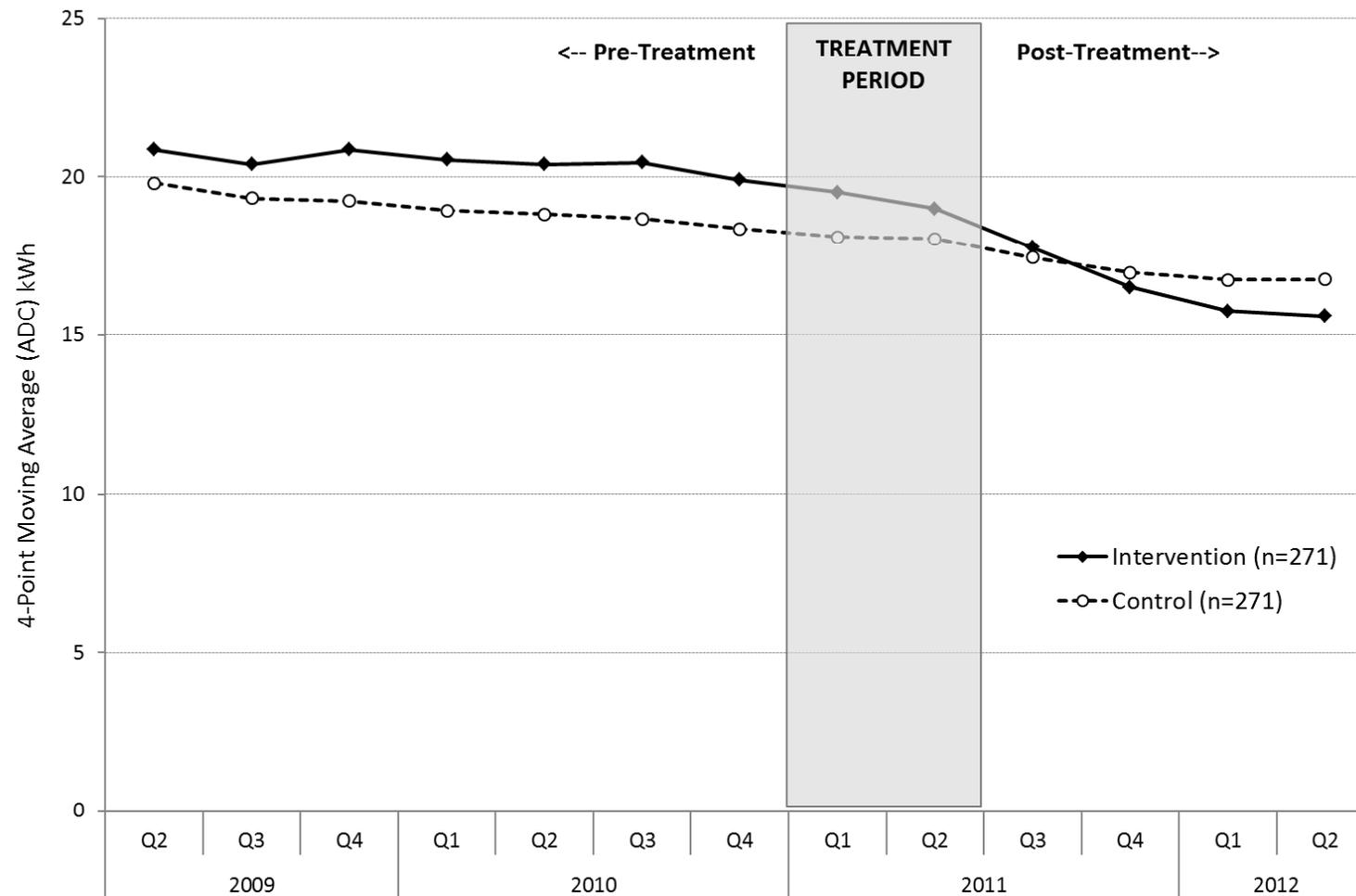Actual Behavioural Control

Data Collection

Matched Pairs

- **To increase comparability between the intervention and control groups a matched pairs design was used.**

- **Propensity score matching based on a composite of background variables.**
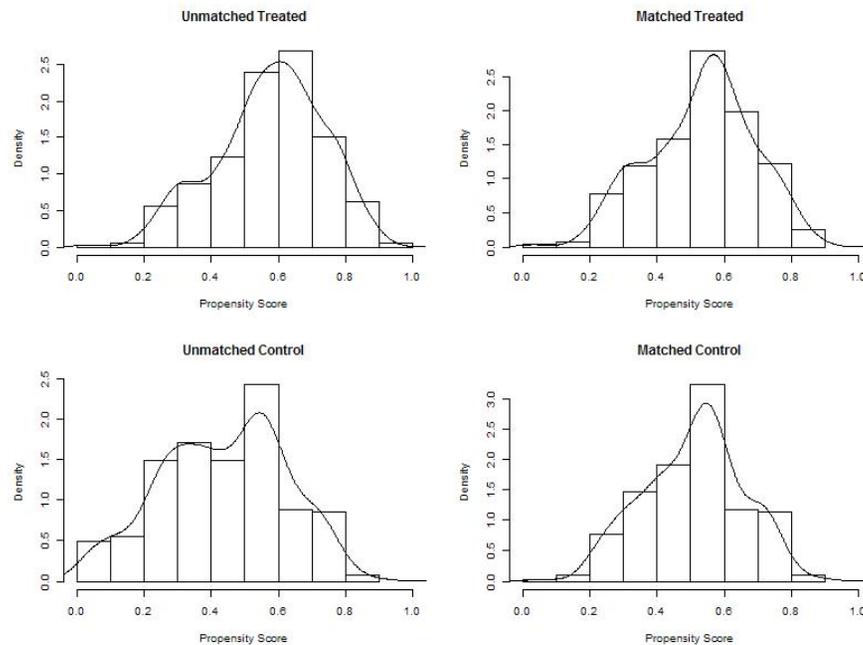
ADC: Pre- Post Intervention

Changes in Energy Use

- **A repeated measures ANOVA (rANOVA) was conducted to assess whether there were differences in changes to energy use between the intervention and control groups.**
  - There was no significant difference between the two groups' pre-intervention energy use.

- **This analysis found that the overall decrease in energy decrease for the intervention group was 5.8% more than that for the control group.**

- **This finding suggest that program participants, on average, achieved a greater reduction in electricity use than the control group.**

Pre-post Changes
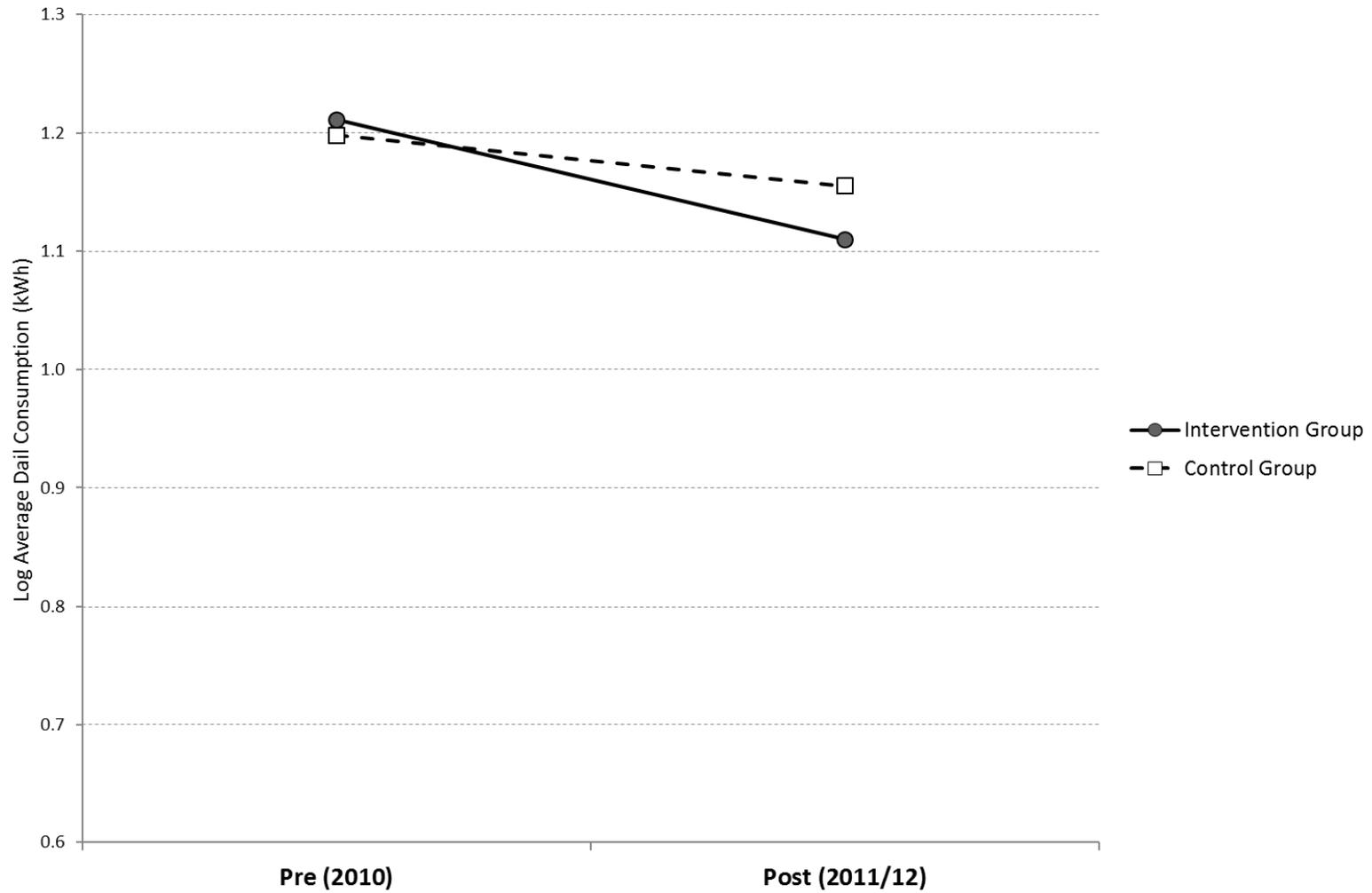
Explaining Energy Use, Intentions & Behaviour

- **A path analysis tested the fit between the TPB model and the data collected for the study. The combination of TPB variables provided a plausible explanation of behavioural intentions and behaviour**
  - attitudes (environmental & financial) and perceived behavioural control significantly contribute to the predication of behavioural intentions.
  - The subjective norm variable was not found to have a significant influence on intentions.
  - Intentions to reduce energy use were found to be a significant predictor of changes in electricity use, while perceived behavioural control did not have a significant influence.

Path Analysis

Attitudes (Environmental & Financial)

Subjective Norm

Behavioural Intentions

Behaviour

Perceived Behavioural Control

Actual Behavioural Control
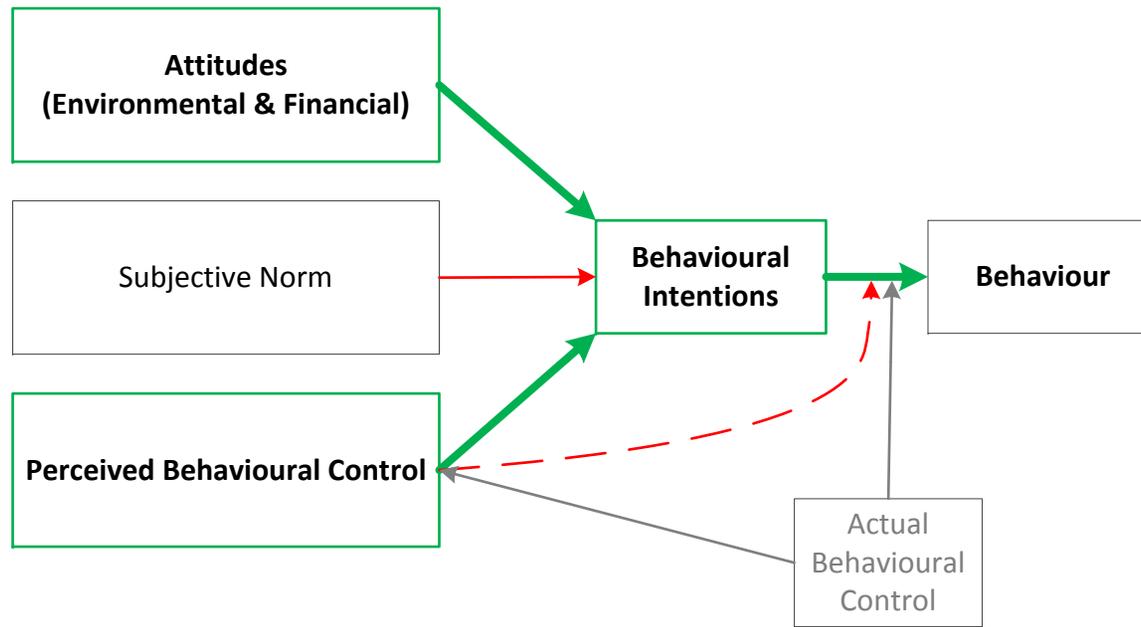
Green line = significant relationship (p<0.05)
Red line = not significant relationship (p>0.05)

	Intentions		Change in ADC (%)		
	Total Effect	Direct Effect	Total Effect	Direct Effect	Indirect Effect
Attitudes (environment)	0.21	0.21	-0.05	na	-0.05
Attitudes (financial)*	0.21	0.21	-0.05	na	-0.05
Subjective Norm	ns	ns	ns	na	-0.01
PBC	0.27	0.27	ns	ns	-0.06
Intention	na	na	-0.22	-0.22	0.00

Note: Figures are β coefficients; ns=not signficant; na=not applicable

Change in Energy Use & TPB

- **This finding suggests that only a trivial amount of change in electricity use is explained by the intentions and perceived behavioural control variables**

- **The strong fit between the TPB model and the study's data suggest that intentions completely mediate the influence of attitudes and perceived behavioural control on change in electricity use (i.e. actual behaviour).**

- **This finding suggests that although these constructs do not influence behaviour directly, they do so indirectly through their influence on intentions, which in turn has a direct effect on behaviour.**

Change in Energy Use & TPB

- **A multi-group path analysis suggests that participation in the program does not affect the direction and/or strength of the relationship between the model's independent and response variables.**

  - Therefore, there is no evidence that program participation moderates the TPB model in this study.

- **The only significant difference between the two groups related to the intercept for behavioural intentions, which suggests that average intentions for the intervention group are higher than the control group, even after controlling for attitudes, subjective norm and perceived behavioural control.**

Conclusions

- **Provides a framework for evaluating energy efficiency programs (*if* and *how* they work)**

- **5.8% of the electricity use reductions can be attributed to participation in the CVSC program. This finding suggests that the program was successful in encouraging participants to change their energy use behaviour.**

- **TPB is a plausible model to explain household energy use intentions and behaviour**

- **Intentions to reduce energy use were influenced by environmental and financial attitudes towards reducing consumption and perceived control over such behaviour.**

Conclusions

- **Social pressure does appear to be an important determinant of energy use intentions & behaviour in the context of other attitudes and beliefs**

- **Changes in intentions and behaviour may be driven by programs fostering more favourable attitudes and beliefs towards energy use rather than by strengthening the relationships between these constructs.**

- **Is reducing energy use harder than people think?**
  - **Possibly due to cognitive difficulties in considering peripheral internal and external factors (barriers/enablers) likely to influence such behaviour.**

Future Research

- **Participant outcomes may have varied depending on participant characteristics and adoption of the program's additional packages: retrofit rebate; household solar electricity; solar hot water; and in home energy displays**

- **Determinants of attitudes and perceived barriers towards reducing energy use**

- **Developments in behavioural economics concerning biases in decision-making may provide a useful theoretical framework to explain discrepancies between perceived and actual control over energy consumption**

- **To test the generalisability of this study, it is recommended that these findings are tested in other regions and for different types of energy efficiency programs or policies.**