

Applying Nearest Neighbor Matching in Impact Evaluation – A Case Study at BC Hydro

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Introduction



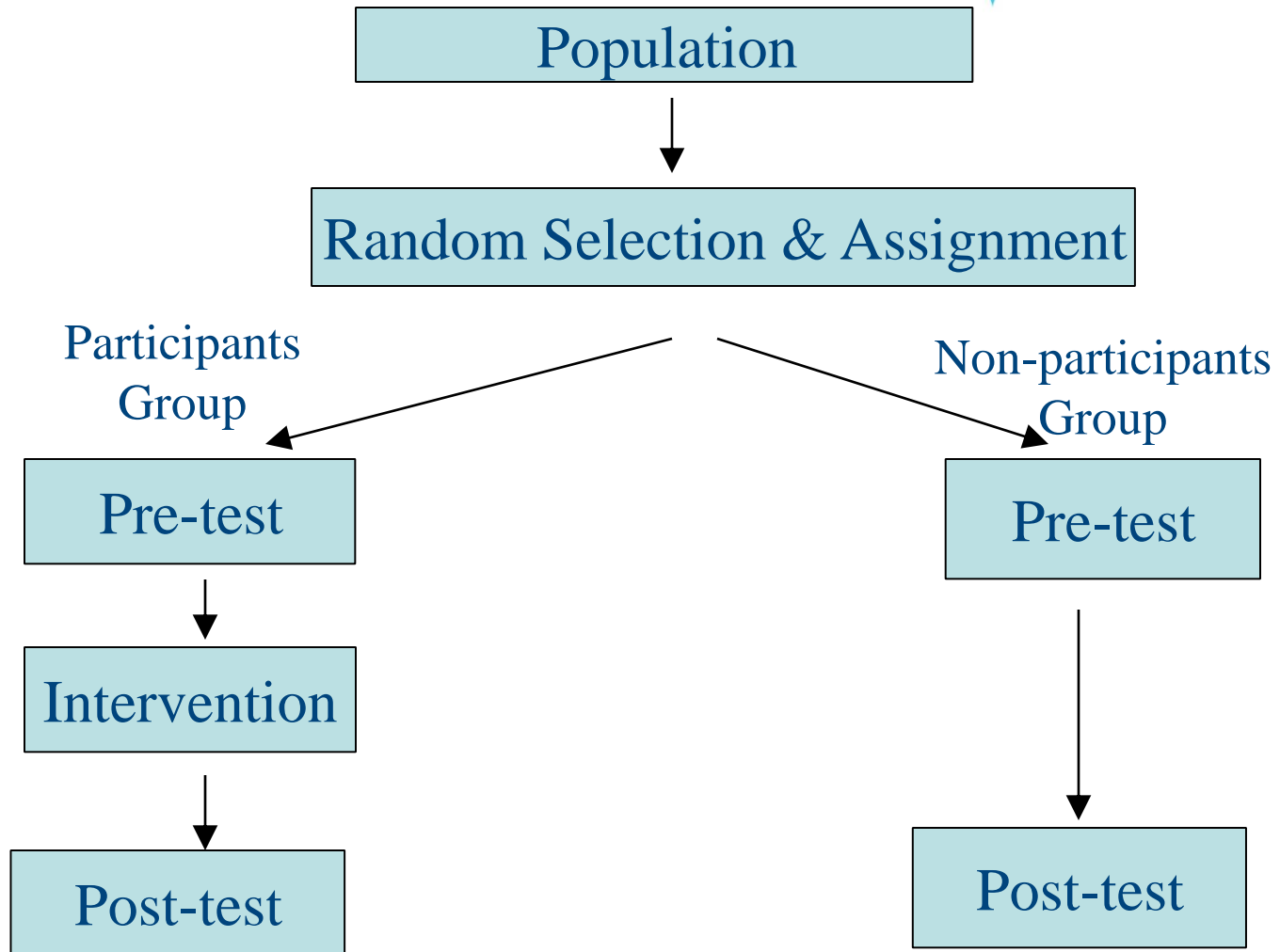
- Objective & Standard Approaches of Impact Evaluation
- Experimental Research
 - True Experimental Design
 - Quasi-Experimental Design with Matching
- Steps of Matching
- Case Study of Nearest Neighbor Matching (BC Hydro's Team Power Smart Behavioral Program)
- Resources

Impact Evaluation Objective & Standard Approaches



- Objective: estimate energy savings and co-benefits attributable to an energy conservation program
- Standard Approaches
 - Sampling analysis based on **measurement and verification (M&V)** savings collected from a sample of projects.
 - **Deemed savings** measures based on historical and verified data.
 - **Statistical analyses** of large volumes of billing/metered energy usage and survey data (baseline comparison).
 - ❖ One group pre-test/post-test.
 - ❖ Two groups pre-test/post-test (treatment vs. control experimental research).

True Experimental Design



Quasi-Experimental Design with Matching

PARTICIPANTS



NON-PARTICIPANTS



Steps of Matching

- Selection of Respondents
- Control of Extraneous Variables
- Defining Distance Measurement
- Implementing a Matching Method
- Diagnose of Matching
- Impact Estimation

Case Study – Introduction of Team Power Smart (TPS) Program



JOIN TEAM POWER SMART

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**MAKE A DIFFERENCE
AND CONSERVE TODAY.
SET YOUR GOAL AND
WE'LL HELP YOU SUCCEED.**



1 JOIN THE TEAM

Help reduce B.C.'s energy use and move toward self-sufficiency by 2016

Learn how to save energy and money with online tips & tools

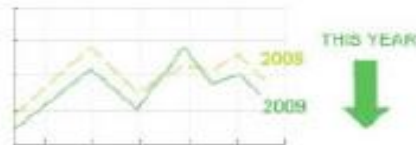
Receive a members-only version of our popular [Connected e-newsletter](#)

Get in on exclusive contests, including a [chance to win prizes](#) in conjunction with select Team Power Smart leaders

Qualify for members-only offers that can save you money

[Learn how to join the team](#)

2 ADD ACCOUNT



View your bill online, track savings and go paperless



Compare your energy usage to homes like yours

[Learn how to add your account](#)

3 TRACK PROGRESS



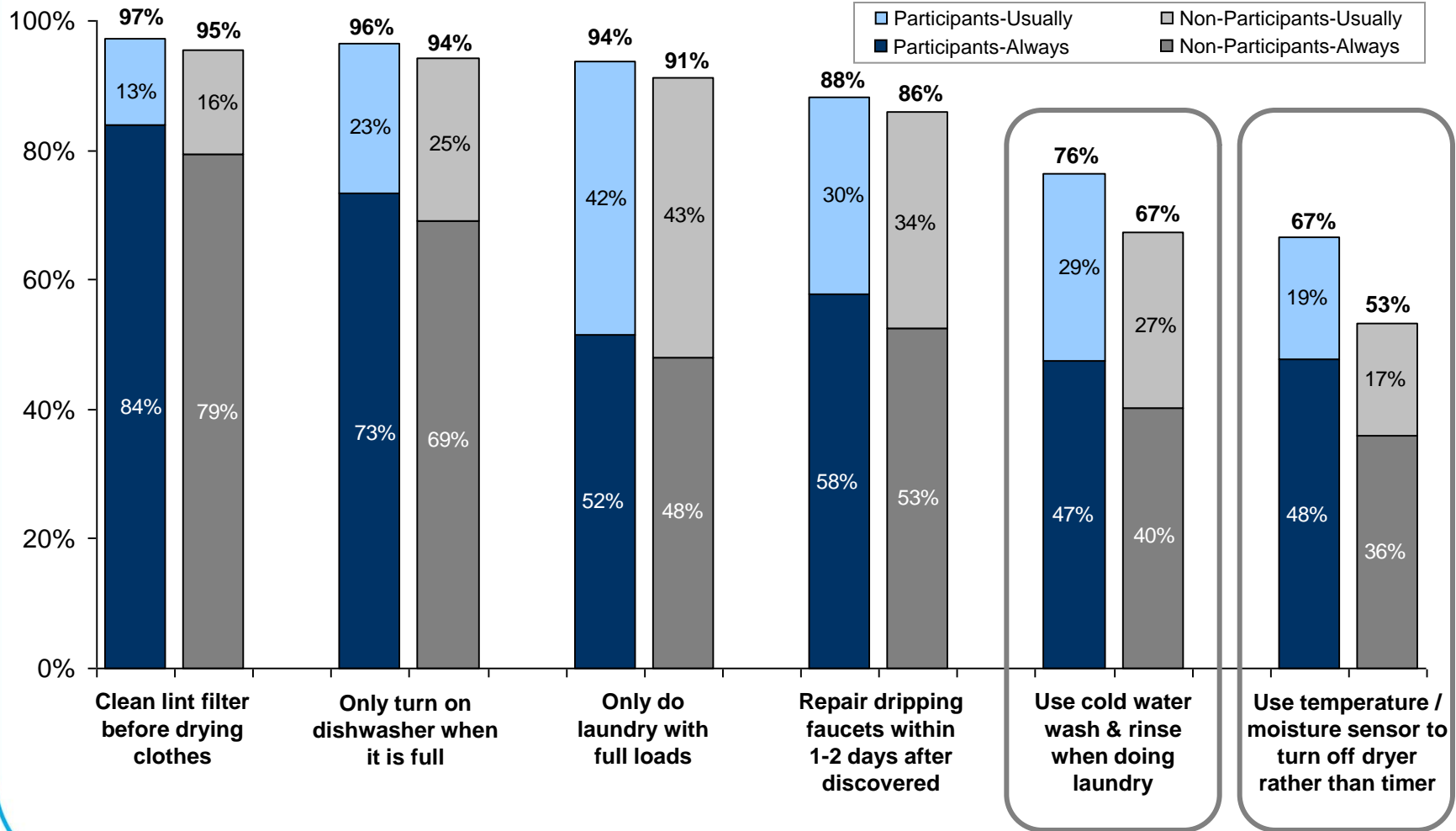
Compare your year-over-year energy consumption

Win exclusive rewards

Learn how to conserve with easy-to-use conservation tools

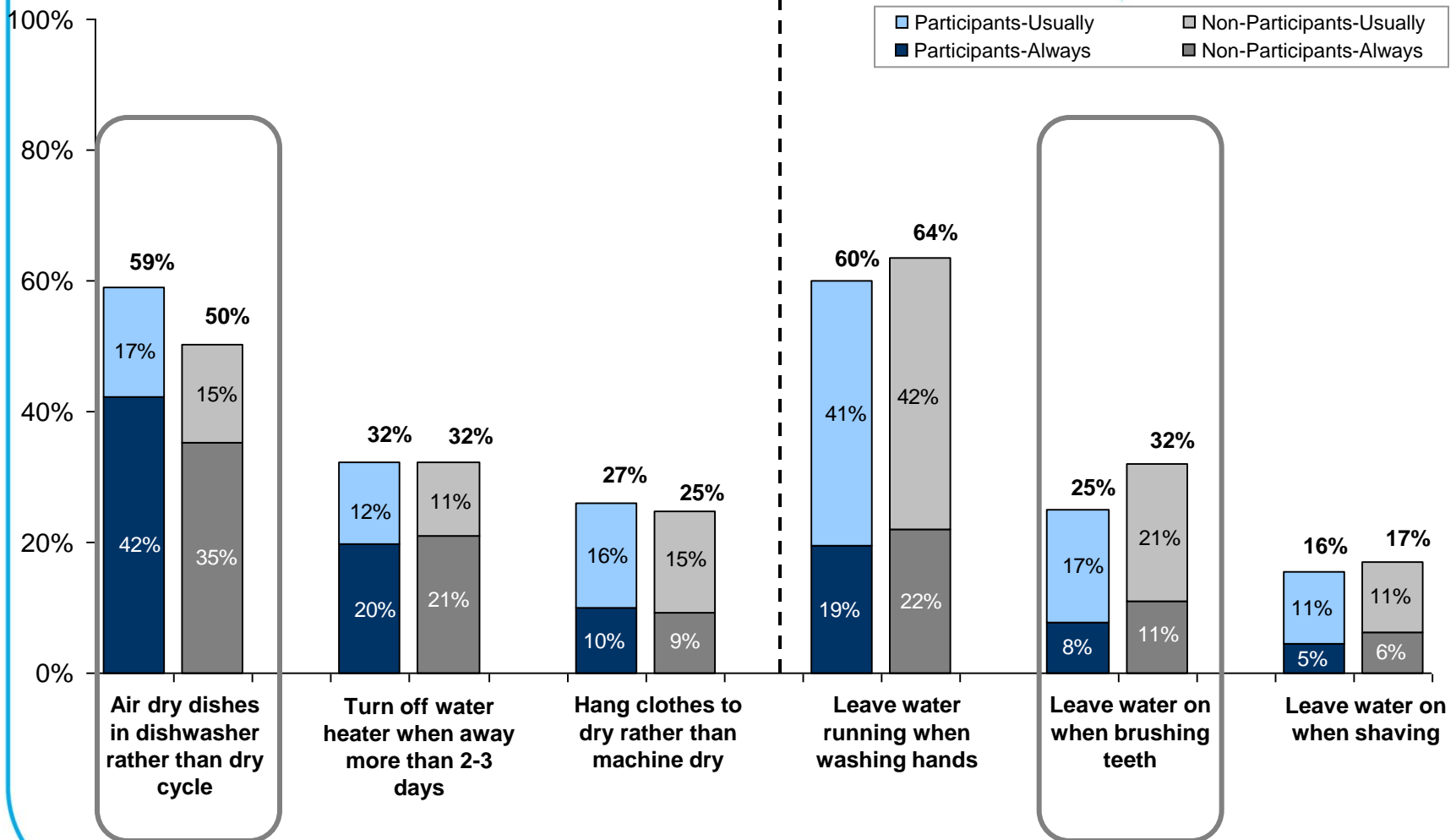
[Get more info about tracking your progress](#)

Case Study – Behavioral Comparison (Water Use, Washers & Dryers)



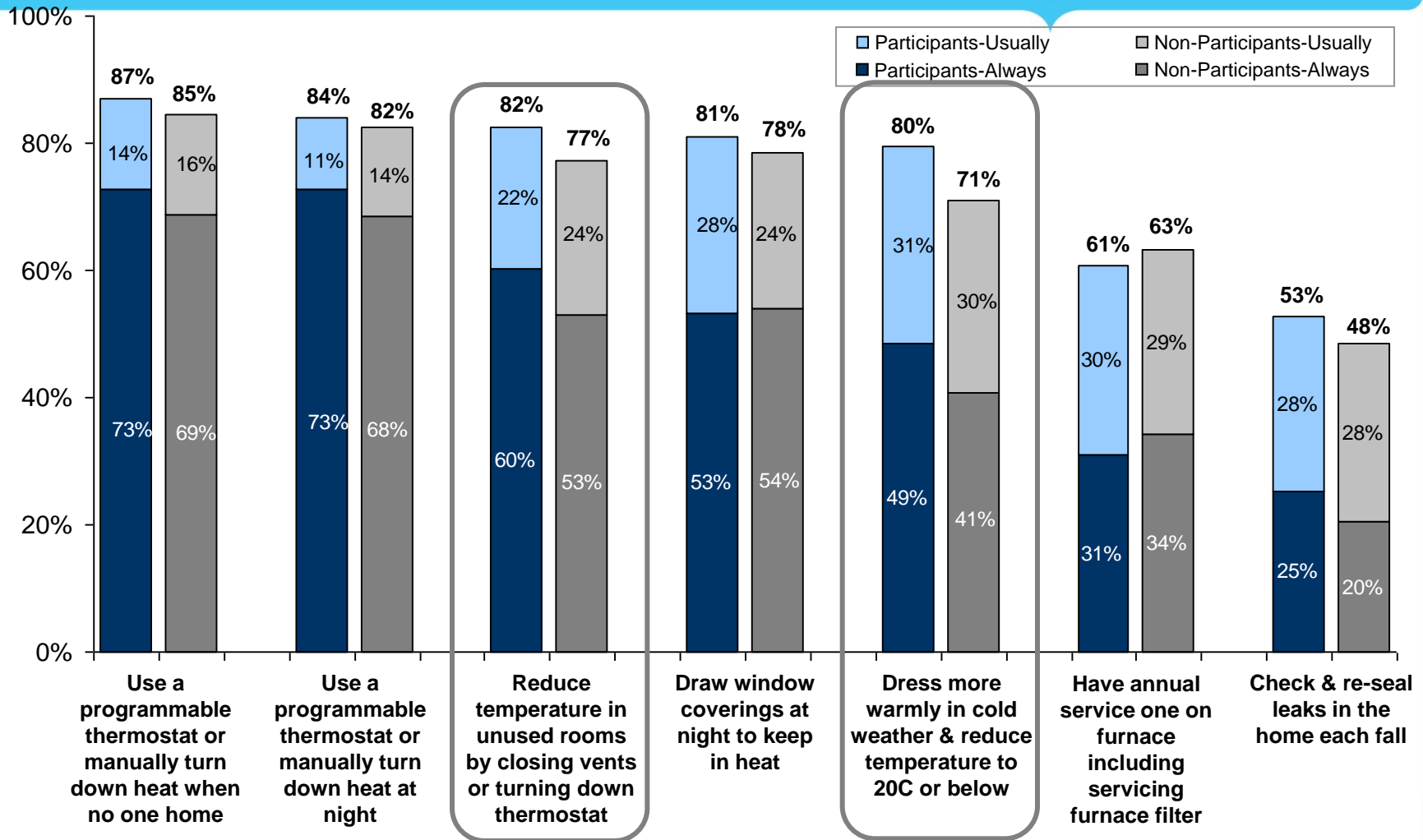
Source: Pedersen (TPS Customer Survey Study, 2010)

Case Study –Behavioral Comparison (Water Use, Washers & Dryers)-Cont'd.



Source: Pedersen (TPS Customer Survey Study, 2010)

Case Study - Behavioral Comparison (Home Heating)



Source: Pedersen (TPS Customer Survey Study, 2010)

Case Study – Matching Design



- Selection of Respondents : annual kWh
- Pre and Post Periods
- Control of Extraneous Variables (Regions, Building Types and Space Heating Types)
- Defining Distance Measurement (Absolute Distance)
- Implementing a Matching Method (1:1 Nearest Neighbor & Greedy Algorithm)

Case Study – Diagnose of Matching

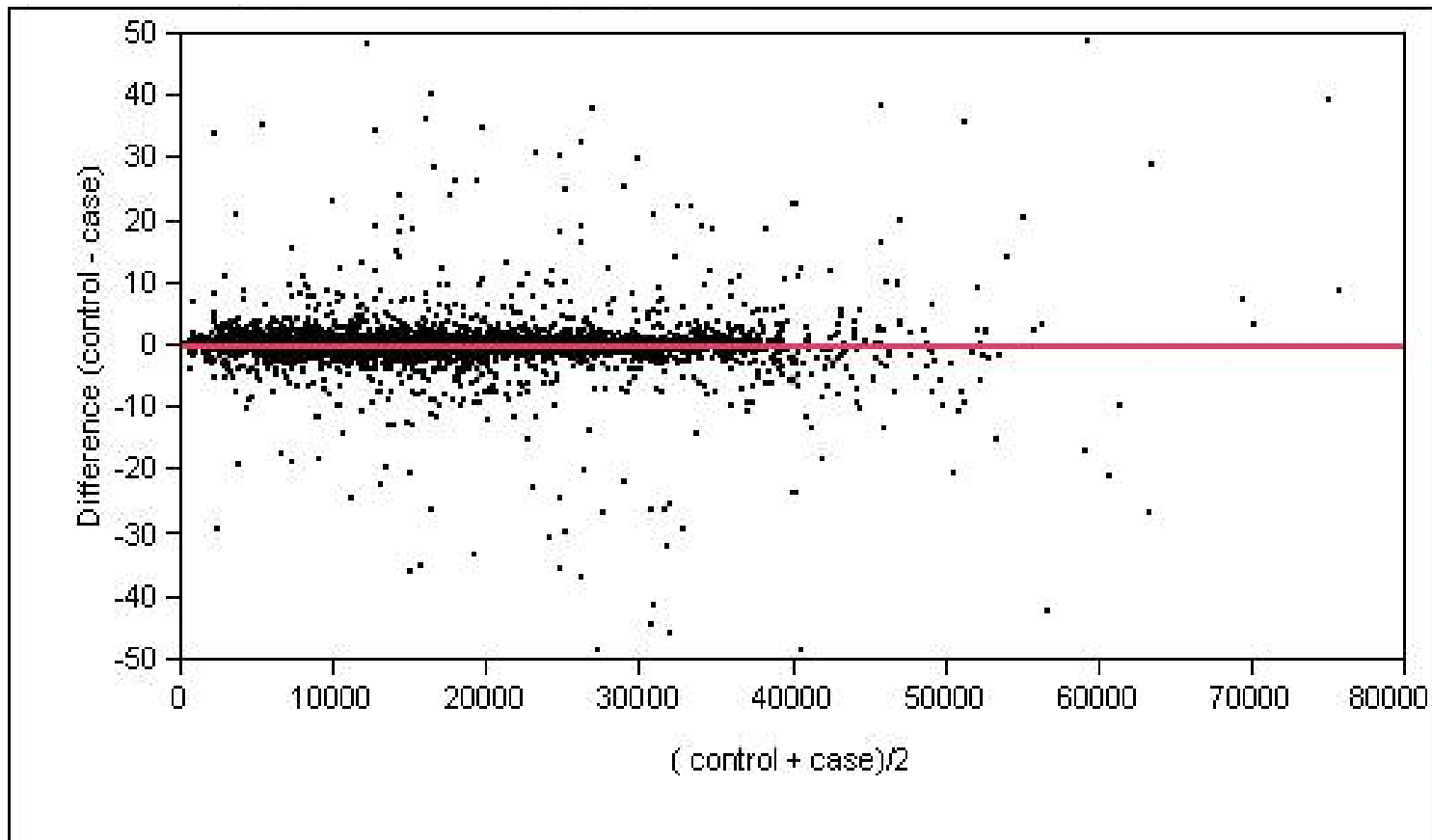


Example of Five Pairs of Matched Homes

Group	Region	Building Type	Primary Space Heating	Account	Baseline Consumption (kWh)
Participant	LM	SFD/Duplex	Non-Electric	A1	11,025.43
Comparison	LM	SFD/Duplex	Non-Electric	B1	11,025.45
Participant	South	SFD/Duplex	Electric	A2	53,405.66
Comparison	South	SFD/Duplex	Electric	B2	53,390.83
Participant	VI	SFD/Duplex	Electric	A3	16,280.99
Comparison	VI	SFD/Duplex	Electric	B3	16,280.88
Participant	VI	SFD/Duplex	Electric	A4	27,658.06
Comparison	VI	SFD/Duplex	Electric	B4	27,658.71
Participant	VI	SFD/Duplex	Electric	A5	12,498.74
Comparison	VI	SFD/Duplex	Electric	B5	12,498.63

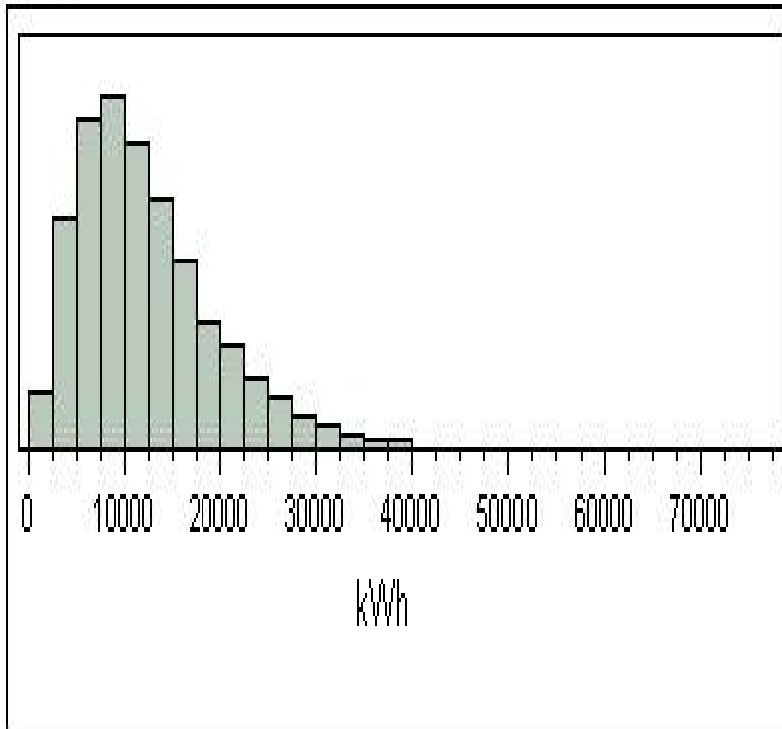
Case Study – Diagnose of Matching

Difference versus Average kWh of Each Pair of Matched Homes in Pre-Period

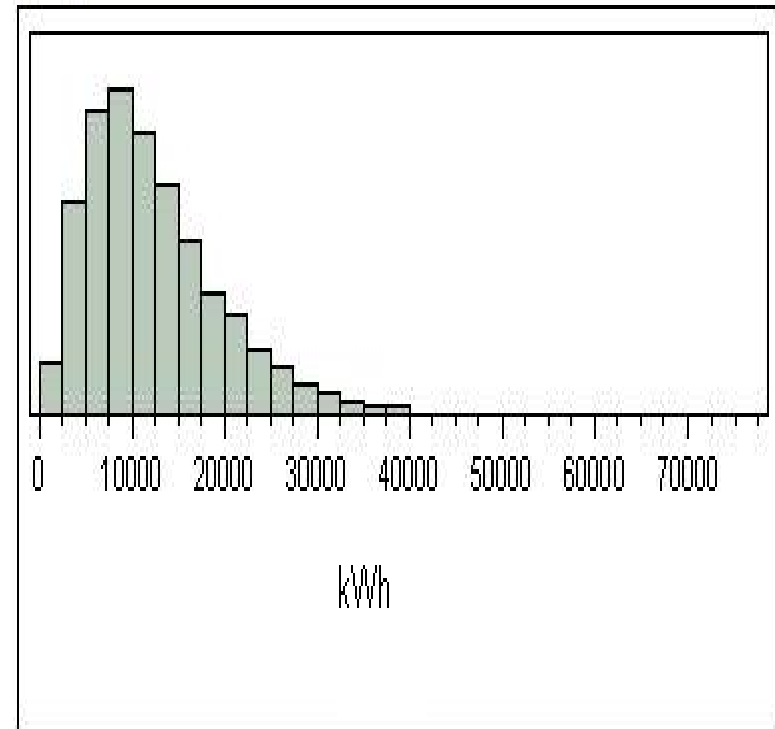


Case Study – Diagnose of Matching

Distribution of Pre-Program Annual Consumption for Participants



Distribution of Pre-Program Annual Consumption for the Matched Non-Participants



Case Study – Impact Estimation



Group	Number of Accounts	Average Pre-Program kWh	Average Post – Program kWh (Standard Error)	Total Post-Program GWh
TPS Participants	24,774	12,781.56	12,144.03 (60.20)	300.86
TPS Non-Participants	24,774	12,781.56	12,351.72 (62.53)	306.01
Difference/ Evaluated Savings		0.00	-207.69*	-5.15

*: Statistically significant at 95% confidence level.

Resources

- Lechner, M. (2002). Some practical issues in the evaluation of heterogeneous labour market programmes by matching methods. *Journal of Royal Statistical Society*, **165**, 59-82.
- Morgan, S. L. & Harding, D. J. (2006). Matching estimators of causal effects: Prospects and pitfalls in theory and practice. *Sociological Methods & Research*, **35(1)**, 3-60.
- Porro, G. & Iacus, S. M. (2009). Random recursive partitioning: a matching method for the estimation of the average treatment effect. *Journal of Applied Econometrics*, **24**, 163-185.
- Quick, S. A. (2005). *An Assessment of Propensity Score Matching as a Non-experimental Impact Estimator: Evidence From Mexico's PROGRESA Program*. Office of Evaluation and Oversight, Chapel Hill, NC.
- Rosenbaum, P. R. & Rubin, D. B. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, **70**, 41-55.
- Rubin, D. B. (1973). Matching to remove bias in observational studies. *Biometrics*, **29**, 159-184.
- Stuart, E. A., Marcus, S. M., Horvitz-Lennon, M. V., Gibbons, R. D., & Normand, S-L. T. (2009). Using non-experimental data to estimate treatment effects. *Psychiatric Annals*, **39(7)**, 719-728.

Questions?

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