

1 Low Carbon Readiness Index: A short measure to predict private low carbon behaviour

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23 RUNNING HEAD: Low Carbon Readiness Index

1 **Abstract**

2 This paper presents a theoretical argument that low carbon strivings – personal goals to reduce
3 carbon footprint in the household – can predict a wide range of diverse behaviours to reduce
4 greenhouse gas emissions, and reports four studies to validate Low Carbon Readiness Index
5 (LCRI), a short, three-item measure of low carbon strivings. It is a simple and easy-to-use
6 indicator of the general public’s readiness to transition to a fully low carbon lifestyle. LCRI is
7 associated with validated measures predicting environmentally significant reported behaviour
8 (Study 1), multiple low carbon behavioural clusters (Study 2 & 3), and predicts reduction in
9 actual energy use, arguably an aggregate measure of actual low carbon behaviours (Study 4).
10 LCRI can be used to develop low carbon policies and monitor their implementation.

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12 **Key words:** Environmental behaviour; low carbon; behavioural cluster; goal

1. Introduction

Human-caused greenhouse gas (GHG) emissions are a major driver of climate change (IPCC, 2014) and the private sphere currently makes up about a third of total emissions (Wright, Osman, & Ashworth, 2009). For private citizens, the immediate means to reduce GHG emissions is to modify their behaviours in the domain of household and personal travel (DEFRA., 2008; Gardner & Stern, 2008; Pears, 2011). Reductions can be achieved by using infrastructure that is energy efficient (e.g. efficient appliances, insulation) and that makes renewable energy available (e.g. solar panels), and by adopting routines that conserve energy (e.g. temperature curtailment) and minimise waste (e.g. composting). While it may be difficult to implement all possible measures to reduce GHG emissions, most people could make at least some changes. However, although a recent survey found that climate change is globally seen as a major threat (Pew Research Center, 2017), transition to low carbon living in the private sphere remains slow.

In order to aid policy making and implementation that promotes the reduction of GHG emissions in the private sphere, we present a short and easy-to-use three-item measure called the Low Carbon Readiness Index (LCRI). Note that the name of the measure references carbon for ease of communication as discernible from the standard practice of converting GHGs to carbon equivalents. Nevertheless, the items for this measure are phrased in terms of “greenhouse gasses” to capture other types of GHGs (e.g., methane) as well, so as to be relevant for a broader set of household behaviours including waste reduction (i.e., those aimed at reducing methane). The LCRI is designed to measure personal motivation to transition to low carbon living, and to predict a wide range of diverse behaviours that can reduce household GHG emissions. We report four studies to validate the claim and close the paper by discussing how the LCRI can be used to support efforts to promote low carbon living.

1 1.1 Predicting transition to low carbon lifestyle

2 Although a number of approaches have been used to predict environmental behaviour
3 (e.g., Gifford, 2014, for a review), the Reasoned Action Approach (RAA: Ajzen, 1991; Fishbein
4 & Ajzen, 1975; Fishbein & Ajzen, 2010) has been one of the most widely used. Many of its
5 applications have focused on specific environmental behaviours, such as composting (Mannetti,
6 Pierro, & Livi, 2004; Taylor & Todd, 1995), use of energy-saving light bulbs, unbleached paper,
7 water and meat consumption (Harland, Staats, & Wilke, 1999), and mode of travel (Bamberg &
8 Schmidt, 2003; Harland et al., 1999; Heath & Gifford, 2002; Verplanken, Aarts, Knippenberg, &
9 Moonen, 1998), although there has been an effort to conceptualize a generalized use of the
10 Reasoned Action Approach (Kaiser & Gutscher, 2003). This focus on specific behaviour is
11 partly due to the RAA's *principle of compatibility*, which suggests that predictors of a behaviour
12 must be measured at the level of specificity compatible with the behaviour. For instance, to
13 predict a specific behaviour such as "installing solar panels for my house next month", its
14 predictor must also be specified in terms of its four elements, action (installing), target (solar
15 panels), context (my house), and time (next month).

16 Nevertheless, the same methodological principle suggests that a general category of
17 behaviours can be predicted by predictors if they have compatible levels of specificity (Ajzen &
18 Fishbein, 1977; Fishbein & Ajzen, 2010). Thus, "intentions to perform a range of behaviours that
19 can potentially reduce carbon emissions in the household" should be able to predict a diverse
20 array of low carbon behaviours. We suggest that such generalized intentions are conceptually
21 akin to personal goals (Carver, 2015). Indeed, Kashima, Paladino, and Margetts (2014) showed
22 that *environmental strivings*, personal goals to improve the natural environment – a construct
23 based on Emmons's (1986) personal strivings – predicted a wide range of pro-environmental

1 behaviours including green shopping, green talk, driving less, as well as willingness to pay a
2 “Sustainability Fee” at the university (Margetts & Kashima, 2016). Analogously, we suggest that
3 personal goals to reduce carbon emissions may be conceptualized as *low carbon strivings*, and
4 the Low Carbon Readiness Index (LCRI), a measure of this construct developed from the
5 environmental strivings measure, should be able to predict a wide range of low carbon behaviour
6 within the household.

7 *1.2 Why should low carbon strivings predict low carbon behaviours?*

8 Adoption of low carbon behaviours (e.g., turning off the light) typically requires an
9 abandonment of pre-existing routinized high carbon behaviours (i.e., keeping the light on), which
10 have been repeatedly practised in people’s everyday activities within their household. That these
11 pre-existing behaviours are difficult to change can be understood from at least two perspectives
12 (Kurz, Gardner, Verplanken, & Abraham, 2014). First, psychologically speaking, repeated acts
13 can form a habit (e.g., Verplanken, 2005; Wood & Neal, 2007), so that when a contextual cue is
14 present, the act is likely performed unreflectively (Neal, Wood, & Quinn, 2006). Past behaviour,
15 therefore, is the dominant predictor of future behaviour in the same context (e.g. Danner, Aarts,
16 & Vries, 2008; Knussen, Yule, MacKenzie, & Wells, 2004) and Ouellette and Wood’s (1998)
17 meta-analysis provides evidence. Second, the pre-existing behaviours are embedded in socio-
18 cultural context. From a sociological perspective (e.g., Shove, Pantzar, & Watson, 2012), they
19 constitute *practices* – a set of routinized behaviours that accompany (i) the capacity to perform
20 physical actions or procedures (competence), (ii) things that are used to carry out the behaviour
21 (material), and (iii) knowledge, emotion and motivation (meaning). Cultural understandings
22 shared amongst people maintain a "community of practice" that structures multiple individuals’
23 behaviours (Shove, 2012; Shove, Pantzar, & Watson, 2012) and their relationships (Hargreaves,

1 2011). Any change to a system of practices tends to disrupt the status quo, and therefore tends to
 2 be resisted.

3 However, dual process perspectives (e.g., Borland, 2013; Kahneman, 2011; Sloman,
 4 1996; Triandis, 1977; see Evans, 2008, for a recent review) suggest that these habitual practices
 5 can be cognitively regulated under some circumstances. To use Kahneman’s (2011) well known
 6 nomenclature, *type 1 processes* are non-volitional mental processes (including habit) that are
 7 reactive to the immediate environment (Fazio, 1990; Kahneman, 2011). In contrast, *type 2*
 8 *processes* are deliberative and reflective. They can implicate higher order goals and aspirations
 9 that may be incongruent with the type 1 processes, and are effortful, difficult to sustain, and
 10 frequently unsuccessful (see Borland, 2013). To change pre-existing high carbon behaviours to
 11 low carbon alternatives requires an override of easy type 1 processes by more difficult type 2
 12 processes. Nonetheless, as Wood, Labrecque, Lin, and Runger (2014; also see Triandis, 1977)
 13 noted, the mental processes governing habit performance will typically occur in tandem with
 14 other, more intentional and goal-oriented, processes. This creates a possibility for type 2-guided
 15 behaviour changes to occur across different contexts over a period of time. Thus, *low carbon*
 16 *strivings may exert effects when there are opportunities for type 2 processes to regulate*
 17 *behaviour, thus cumulatively leading to a low carbon lifestyle over time.*

18 There are at least two classes of factors that may moderate a general tendency to engage
 19 in low carbon behaviour this way. One is the *perceived effectiveness* of a given behaviour in
 20 helping achieve the personal goal to reduce GHG emissions. Even if people are highly motivated
 21 to attain the personal goal of reducing GHG emissions, if they wrongly believe that a given
 22 behaviour is ineffective in doing so, they may not engage in type 2-guided self-regulation of the
 23 behaviour (Kashima et al., 2014). There is also considerable diversity in the way people perceive

1 the effectiveness of different behaviours in reducing energy consumption (Attari, DeKay,
 2 Davidson, & De Bruin, 2010). The other class of factors is the extent to which people have actual
 3 control over their behaviour (e.g. Fishbein & Ajzen, 2010); we may call this *actual difficulty*. As
 4 sociological perspectives highlight, behaviour change requires competences and materials
 5 (Shove et al., 2012). If people do not have control over a GHG reduction behaviour due to their
 6 lack of skills, resources, or opportunities (e.g. renters cannot install solar panels), or if the
 7 behaviour is actually very difficult (rather than perceived to be difficult) to perform, people may
 8 not be able to carry it out even if they have strong personal goals to reduce GHGs and they know
 9 its effectiveness. Variation introduced by these factors reduces the correspondence between
 10 general striving for GHG reductions and low carbon behaviour.

11 *1.3 What type of low carbon behaviours can low carbon strivings predict?*

12 The foregoing discussion provides a theoretical justification for the methodological
 13 principle of compatibility (e.g., Fishbein & Ajzen, 2010). A measure of a construct with a low
 14 level of specificity such as low carbon strivings can predict, not single-act criterion with a
 15 specified act, target, context, and time, but multiple-act criteria which capture a wide range of
 16 diverse behaviours with different configurations of act, target, context, and time. Nonetheless,
 17 creating a meaningful measure of diverse low carbon behaviours is difficult because low carbon
 18 behaviours in the household are highly heterogeneous, including daily curtailment behaviours
 19 (e.g. regulating heater use), occasional compensatory behaviours (e.g. carbon offsetting), and
 20 long-term investment in efficient infrastructure (e.g. energy efficient fridge).

21 Nonetheless, we can rely on behavioural clustering to construct meaningful behavioural
 22 criteria. Behavioural clustering is a phenomenon in which diverse behaviours tend to co-occur in
 23 a population, such that if a person engages in one behaviour in a cluster, he or she is also likely

1 to engage in other behaviours in the cluster. Behaviour clusters are empirically identified using
2 methods such as factor analysis, cluster analysis, and latent class analysis, and have been
3 documented in environmental psychology. For example, in Norway, Bratt (1999) identified three
4 behavioural clusters: recycling and information-based behaviours, transport behaviour, and
5 residential energy consumption. In the UK, Gilg, Barr, and Ford (2005) found three clusters:
6 shopping, composting, and reuse; domestic water and energy conservation; and recycling. In
7 Germany, Mills and Schleich (2010) found that the likelihood of purchasing energy efficient
8 household appliances and whitegoods was higher in homes that already had one or more energy
9 efficient appliances. This effect was strong and consistent across appliance type, implying the
10 existence of a “household appliance installation” cluster.

11 There is also evidence of higher order associations between different behavioural
12 clusters. For example, Berger (1997) identified six clusters of pro-environmental household
13 reported behaviour using principal components analysis in Canada: recycling, transportation,
14 energy use, lawn chemicals, water use, and “other” consumer behaviours. She also found that the
15 recycling cluster was associated with substantially increased levels of many other pro-
16 environmental behaviours, including those that were not related to waste management. For
17 example, she found that nearly twice as many recyclers used a programmable thermostat,
18 composted, and used their own shopping bags (Thøgersen & Ölander, 2006). Behaviour
19 clustering is conceptually related to spillover effects in which the performance of one
20 environmental behaviour increases the likelihood of performing another (e.g., Lanzini &
21 Thøgersen, 2014; Lauren, Fielding, Smith, & Louis, 2016; Margetts & Kashima, 2017;
22 Thøgersen, 1999; Thøgersen & Noblet, 2012; Thøgersen & Ölander, 2003).

1 Thus, behavioural clusters identify naturally co-occurring actions across target, context,
2 and time. Measures that capture a person’s engagement with behavioural clusters amount to
3 measuring broad and heterogeneous behaviours. We expect, therefore, that level of engagement
4 with a low carbon behaviour cluster will depend on the perceived effectiveness and actual
5 control that people have. However, we also expect that people who have a strong personal goal
6 to reduce GHG emissions will be more likely to engage in the comprising behaviours of the
7 cluster. We therefore hypothesise that low carbon strivings should be able to predict the extent to
8 which people engage with low carbon behavioural clusters. This line of reasoning is consistent
9 with Thøgersen and Ölander's (2003) finding that environmental values and environmental
10 concern predicted participation in clusters focussed on recycling, food purchasing and transport.
11 Similarly, when Truelove, Carrico, Weber, Raimi, and Vandenberg (2014, p. 132) reviewed the
12 literature on spillover from performing one low carbon behaviour to performing others within a
13 cluster they concluded that this process occurs when there is “[s]ocial and internal pressure to
14 live up to an assumed role”. We suggest that low carbon strivings can represent such higher
15 order concerns, values, and standards.

16 *1.4 Validating the LCRI*

17 Here, we present four studies that support the construct validity of the Low Carbon
18 Readiness Index (LCRI) as an indicator of low carbon strivings, namely, personal goals to reduce
19 carbon emissions in the household. First, to show convergent validity, we test whether LCRI is
20 associated with other measures of pro-environmental orientations. Second, to show construct
21 validity, we conduct two studies to test the coherence of the LCRI measure and whether LCRI is
22 associated with self-reported behaviours and greater intentions to perform behaviours in low

1 carbon behavioural clusters. Finally, we test whether LCRI can predict actual energy
2 consumption, arguably an aggregate measure of actual household low carbon behaviours.

3 **2. Study 1**

4 We constructed LCRI and investigated its relationships with three measures of pro-
5 environmental orientations: New Ecological Paradigm (Dunlap, Van Liere, Mertig, & Jones,
6 2000) as a benchmark of generalised environmental attitudes, environmental identity (Whitmarsh
7 & O'Neill, 2010), and environmental striving (Kashima et al., 2014). We also included a measure
8 of climate change beliefs because the most salient reason for reducing carbon emissions is likely
9 to be climate change mitigation (Hulme, 2009).

10 *2.1 Method*

11 One-hundred-and-two Australians (51 female) aged 21 to 80 years ($M_{age}=45.18$,
12 $SD_{age}=13.34$) were recruited by Qualtrics Panels and completed a 20-minute survey. (For more
13 detail on recruitment and sample size see Supplementary materials).

14 *2.1.1 Low Carbon Readiness Index (LCRI)*

15 LCRI items were developed by modifying Kashima et al.'s (2014) environmental
16 strivings measure: (1) I work hard to reduce my greenhouse gas emissions whenever possible;
17 (2) I feel very good when I am successful in reducing my greenhouse gases; (3) I would feel very
18 bad if I did not reduce my greenhouse gas emissions (Strongly disagree; Disagree; Neither agree
19 nor disagree; Agree; Strongly agree).

20 *2.1.2 Comparison measures for convergent validity*

21 We used three measures to check convergence with LCRI: Dunlap et al.'s (2000) New
22 Ecological Paradigm (Cronbach's $\alpha =.91$; $M=3.65$, $SD=.66$), Whitmarsh and O'Neill's (2010)

1 environmental identity (Cronbach’s $\alpha = .69$; $M=3.84$, $SD=.68$), and Kashima et al.’s
 2 environmental strivings (Cronbach’s $\alpha = .87$; $M=3.52$, $SD=.76$).
 3 Leviston, Walker, and Morwinski’s (2012) item was used to gauge climate change beliefs
 4 (see Supplementary materials) and an uneven distribution of responses (63.73% endorsed
 5 human-caused climate change), meant this measure was dichotomized: belief in anthropogenic
 6 climate change was coded as 1, and all others as 0.

7 *2.2 Results*

8 *2.2.1 Constructing LCRI*

9 We averaged the three items to compute LCRI (Cronbach’s $\alpha = .90$; $M=3.55$, $SD=.88$; see
 10 Supplementary analyses for results of principal components analyses across studies).

11 *2.2.2 LCRI association with comparison measures*

12 LCRI significantly correlated with each comparison measure (NEP, Environmental
 13 Identity and Striving, and belief in human-caused climate change; see Table 1).
 14

15 *Table 1.* LCRI association with comparison measures in studies 1 and 2

		LCRI	NEP	Belief in human- caused climate change	Environ- mental identity
Study 1	NEP	.48 ^{***}			
	Belief in human-caused climate change	.39 ^{***}	.50 ^{***}		
	Environmental identity	.55 ^{***}	.61 ^{***}	.45 ^{***}	
	Environmental striving	.65 ^{***}	.50 ^{***}	.31 ^{**}	.61 ^{**}
Study 2	NEP	.52 ^{***}			
	Belief in human-caused climate change	.42 ^{***}	.45 ^{***}		
	CC knowledge	.38 ^{***}	.37 ^{***}	.36 ^{***}	
	Social desirability	.10	.07	-.09	

1 ***p <.001, **p<.01.
2
3

4 **3. Study 2**

5 To further demonstrate LCRI's validity, its correlations with low carbon behavioural
6 clusters and related intentions were examined. Reported behaviours included the installation of
7 infrastructure and the performance of routine actions, initially selected from the description of a
8 'green' Australian household provided by Pears (2011) and the CSIRO Home Energy Saving
9 Handbook (Wright et al., 2009). A pilot test (N=50) confirmed that a community sample of
10 Australians also listed the chosen behaviours as examples of low carbon behaviour.

11 We also compared LCRI's ability to predict clusters of reported behaviour and intentions
12 relative to a standard measure (i.e., NEP). As in Study 1, we examined whether belief in human-
13 caused climate change and climate change knowledge were associated with LCRI. Finally, to
14 account for social desirability, we included a modified social desirability scale based on
15 Reynolds (1982).

16 *3.1 Method*

17 *3.1.1 Participants & procedure*

18 Two hundred and twenty-seven Australians (109 female; 59.5% homeowners) aged 21 to
19 81 years ($M_{age}=51.12$; $SD_{age}= 4.38$) were recruited by Qualtrics Panels and completed an online
20 survey approximately 30 minutes in length. (For more detail on recruitment, sample size and
21 sample characteristics see Supplementary materials).

22 *3.1.2 LCRI*

23 LCRI (Cronbach's $\alpha =.87$; $M=4.74$, $SD=1.15$) was the same as in Study 1 but used a 7-
24 point scale (Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree;
25 Somewhat agree; Agree; Strongly agree).

1 *3.1.3 Current infrastructure and routine low carbon behaviour*

2 Participants were asked, “Do you have this feature in the place you live at the moment?”
3 for the infrastructure items listed in Table 2. The distribution of raw responses is provided in the
4 Supplementary materials. For analysis, dichotomous measures were made where all “Yes”
5 responses were collapsed into a single category, coded 1, and the remainders were coded 0.
6 Preliminary analysis indicated this simplification did not obfuscate a pattern of differences for
7 the different yes responses. While the people who acquired low carbon infrastructure by moving
8 into a residence did not purchase the infrastructure directly, they may have chosen their
9 residence on the basis of its low carbon infrastructure.

10 Participants were then asked, “How often have you typically done these behaviours in the
11 past?” for the routine behaviour items listed in Table 2.

12 *3.1.4 Intentions*

13 Participants were first asked about their intentions to buy or install the pieces of
14 infrastructure they reported not having. The questions were phrased “In the next twelve months, I
15 intend to buy and/or install...” Participants were then asked about their intentions to engage in
16 the routine behaviours they had been previously asked about. The questions were phrased “In the
17 next month, I intend to...”. In both cases, responses were recorded on a 7-point Likert scale
18 (Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree;
19 Agree; Strongly agree).

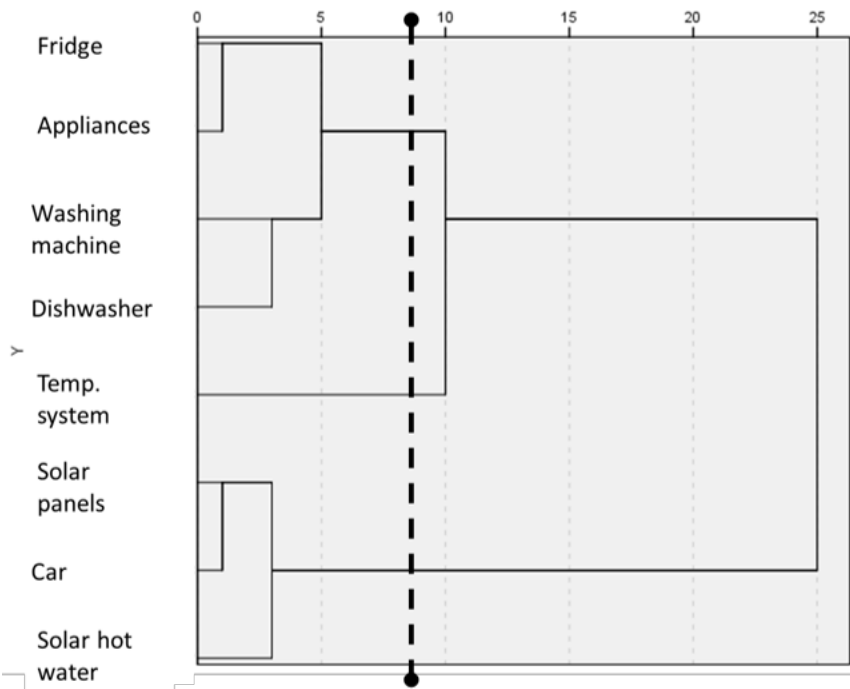
20 *3.2 Constructing behavioural clusters of low carbon behaviours*

21 *3.2.1 Summary measures for clustered infrastructure*

22 To identify clusters of reported infrastructure installation behaviours, dichotomous
23 measures were submitted to hierarchical clustering using Ward’s method and Squared Euclidian

1 Distances. As shown in the dendrogram in Figure 1, two clusters were identified: solar (solar
 2 panels, solar hot water) and appliances (washing machine, dishwasher, fridge and small
 3 appliances). Summary measures were calculated for these infrastructure clusters by summing the
 4 comprising dichotomous measures. Corresponding summary measures for cluster intentions were
 5 also calculated by averaging intention responses for each identified cluster (appliances
 6 Cronbach's $\alpha = .81$; solar Cronbach's $\alpha = .84$). Temperature system did not cluster closely with
 7 the other measures; it was used as a single item for past practice and intention. Similarly, while
 8 efficient car clustered with solar technology, this relationship was not supported by inter-item
 9 correlations, so efficient car was also examined as a single item.

10



11

12 *Figure. 1. Study 2: Hierarchical clustering of infrastructure with Ward's method*

13

14 *3.2.2 Behavioural clusters for routine behaviour*

1 A principal component analysis with oblimin rotation was conducted using the past
2 routine reported behaviour items. Two components were extracted (Kaiser-Meyer-Olkin
3 Measure =.75, Bartlett's Test of Sphericity $\chi^2(28) = 458.71$, $p < .001$). The first factor comprised
4 the temperature curtailment practices (eigenvalue = 2.66, 33.24% variance explained), while the
5 second comprised green payments and travel practices (eigenvalue = 2.00, 24.95% variance
6 explained). Summary measures were calculated for these clusters by averaging the past reported
7 behaviour measures. Corresponding summary measures were computed by averaging intentions
8 for each identified cluster (temperature curtailment Cronbach's $\alpha = .70$; green payments and
9 travel Cronbach's $\alpha = .67$).

10

1 **Table 2. Survey items used to construct behavioural cluster measures in Studies 2 and 3**

Cluster name	Comprising survey item	Present		Response options			
		S2	S3	S2	S3		
Infrastructure	Solar	• Photovoltaic solar panels	x	x	• I don't know • No • Yes, it was there when I moved in • Yes, I installed it	• I don't know • No • Yes	
	Temperature system	• High performance solar hot water system	x	x			
		• Reverse cycle heating/cooling system or energy efficient systems with 5-6-star energy ratings for all temperature control devices	x				
		• Reverse cycle heating/cooling system		x			
	Appliances	• Heater or with a 5-6 star energy rating ^a		x			
• Cooler a 5-6 star energy rating ^a			x				
• Efficient washing machine (5-6 star energy rating)		x	x				
Car	• Efficient fridge (5-6 star energy rating)	x	x	• I don't know • No • Yes, it was there when I moved in • Yes, I installed it • No, I do not have a dishwasher	• I don't know • No • Yes, some are energy efficient • Yes, all are energy efficient • No, I do not have a car		
	• High proportion of your small appliances are energy efficient (e.g., your toaster, kettle and blender are 5-6 star energy rated)	x					
Routine behaviour	Temperature curtailment	• Efficient dishwasher (5-6 star energy rating)	x		• I don't know • No • Yes, some are energy efficient • Yes, all are energy efficient • No, I do not have a car	• Never • Rarely • Sometimes • Often • Very often • Always	
		• Energy-efficient car ¹	x	x			
		Green travel & payments	• Only heated/cooled the rooms of your home that were used	x			
			• Used curtains, awnings, shutters, blinds and/or vegetation for shade	x			
	• Worn seasonal clothing to keep warm/cool		x				
	Green travel & payments	• Opened doors and windows to cool home when the weather is going to get hot later	x				
		• Minimize how much heating or cooling is used		x			
• Used the GreenPower option (i.e. paid a premium to support contribution of renewable energy to the grid) for some or all of the electricity bill ^b		x	x				
• Avoided driving a car for most travel (e.g. public transport, small motorbike, bike or walk)		x	x				
	• Carbon off-set air trips ^b	x	x				
	• When driving, carpooled with others	x					

2 ^aOnly asked if response to 'Reverse cycle heating/cooling system' question was not 'Yes'.

3 ^bAdditional option for GreenPower was 'I don't use energy from the grid' and for Carbon off-set was 'I don't use air travel'. These responses were not analysed.

4

¹ 'Energy-efficient' for cars in the Australian context includes small fuel-efficient cars and those of electric or hybrid design (Wright, Osman, & Ashworth, 2009). Multiple 'Yes' response options checked how commonly people with energy-efficient cars (15.9%) had a second car that was not energy-efficient (10.6%).

1 3.3 *Comparison measures*

2 We included NEP (Cronbach's $\alpha = .89$, $M=4.84$, $SD=.90$) and the climate change belief
3 measure as in Study 1. In addition, climate change knowledge was measured using a Climate
4 Change Quiz, developed by Berry and Raupach (2014; e.g. Greenhouse gases strongly influence
5 climate) in collaboration with the Australian Academy of Science. Finally, social desirability was
6 measured using a scale comprising six statements from Reynolds (1982; e.g. I am always
7 courteous even to people who are disagreeable, Cronbach's $\alpha = .70$). For more detail see
8 Supplementary materials.

9 3.4 *Results*

10 3.4.1 *LCRI association with comparison measures*

11 The LCRI measure showed significant positive correlations with the comparison
12 measures (NEP, belief in human-caused climate change, and climate change knowledge; Table
13 1). None of the measures were associated with social desirability.

14 3.4.2 *Infrastructure*

15 A series of analyses were conducted to examine whether LCRI and comparison measures
16 could predict past acquisition of low carbon infrastructure clusters: multinomial logistic
17 regression for the solar cluster, linear regression for the appliances cluster, and binary logistic
18 regression for the efficient temperature system and efficient car measures. Intentions to install
19 infrastructure for each cluster was also examined using linear regression. All analyses controlled
20 for social desirability. Summary results are presented in Table 3.

21 Across these analyses, higher LCRI was associated with both possession of low carbon
22 infrastructure and intentions to acquire it; the lack of relationship between LCRI and possession
23 of an energy-efficient car was the only exception. In contrast, neither NEP nor belief in human-

1 caused climate change was associated with infrastructure possession or intentions. Climate
2 change knowledge predicted solar intentions, possession of an efficient car and greater
3 possession of efficient appliances.

4 *3.4.4 Daily routine*

5 Linear regression analysis was used to examine whether LCRI and comparison measures
6 could predict low carbon daily routines and intentions. Again, all analyses controlled for social
7 desirability; summary results are in Table 3. Higher LCRI was significantly and consistently
8 associated with both past and intended performance of low carbon daily routines. The same
9 results were found for NEP and climate knowledge measure; however, belief in human-caused
10 climate change was unrelated to both past and intended practice **within the temperature**
11 **curtailment cluster**.

Table 3. Study 2: Low carbon practice and intention predicted by LCRI and comparison measures

	LCRI				NEP				CC knowledge				CC belief			
	Behaviour		Intention		Behaviour		Intention		Behaviour		Intention		Behaviour		Intention	
	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Solar ^a (1 element)	0.35*	0.16	0.31**	0.10	0.07	0.15	0.08	0.10	0.23	0.15	0.24*	0.10	0.24	0.32	0.36	0.22
Solar ^a (2 elements)	0.74**	0.28			0.09	0.15			0.36	0.27			0.48	0.55		
Appliances	0.30**	0.09	0.39***	0.09	0.11	0.10	0.01	0.10	0.23*	0.09	0.14	0.10	0.03	0.20	0.20	0.21
Temp. system	0.14**	0.14	0.32**	0.11	-0.25	0.14	-0.05	0.11	0.01	0.14	0.11	0.12	-0.25	0.29	0.47	0.26
Car	0.14	0.19	0.30**	0.11	-0.02	0.18	-0.08	0.11	0.48*	0.21	0.14	0.11	0.52	0.42	0.21	0.23
Temp. Curtailment	0.28***	0.06	0.35***	0.06	0.23***	0.06	0.16**	0.06	0.17**	0.06	0.24***	0.06	0.12	0.13	0.22	0.13
Green travel & pay.	0.47***	0.06	0.62**	0.07	0.17*	0.07	0.31***	0.08	0.25***	0.07	0.27**	0.08	0.56***	0.14	0.69***	0.16

^aSolar multinomial regression reference category = 0 elements.

*p<.05, **p<.01, ***p<.001

1 3.5 Discussion

2 Across Studies 1 and 2, LCRI showed good convergent validity with comparison
3 measures, and in Study 2 it was uncorrelated with social desirability. LCRI was also shown to be
4 a significant predictor of reported low carbon behaviour and intention, both in terms of
5 infrastructure possession and daily routines. It was noticeable that NEP and climate knowledge
6 were less predictive than LCRI, only predicting daily routines. It may be that the more general
7 beliefs tapped by these measures were sufficient for predicting easier behaviours like
8 temperature curtailment while the personal striving of a low carbon goal, as captured by the
9 LCRI, is needed to motivate investment in infrastructure.

10 LCRI failed to predict one reported low carbon behaviour; possession of an energy-
11 efficient car. This is unsurprising because it is a specific behaviour and is therefore not measured
12 at the same level of specificity as LCRI and this type of incompatibility in level of specificity
13 between predictor and outcome can be expected to reduce the correlation. As Stradling,
14 Meadows, and Beatty (2000) found, there are many different motivations and relevant factors
15 affecting different people's driving decisions (e.g. income). However, we did find that around
16 two thirds of people with an energy efficient car have at least one other car that is not energy
17 efficient, suggesting that further research focussed on cars could potentially examine the
18 transition from one to all cars in a household being energy efficient.

19 Together, Studies 1 and 2 showed initial evidence for the construct validity of LCRI as a
20 predictor of reported low carbon behaviour. However, replication in a large and diverse sample is
21 desirable to confirm the robustness of these findings. In particular, the people sampled in Studies
22 1 and 2 included both homeowners and renters on the rationale that, although renters could not
23 directly modify all forms of home infrastructure the way that homeowners could, renters were

1 able to select accommodation on the basis of existing low carbon infrastructure in the home
2 (including efficient heating, solar panels and solar hot water). However, because homeowners
3 have a much greater ability to modify major household infrastructure, we decided to control for
4 this factor in Study 3.

5 **4. Study 3**

6 Study 3 tested associations between LCRI and clusters of reported low carbon behaviours
7 using a large representative sample of the Australian population. To begin to account for the
8 practical factors and competing priorities that limit the successful pursuit of a low carbon goal,
9 we examined the LCRI-behaviour relationship while controlling for potential confounds
10 including demographic factors, perceived resources and importance of household comfort. We
11 also conducted a latent class analysis to explore the possibility that there may be different classes
12 of respondents who engage with different behavioural clusters and examined LCRI's relations
13 with the classes.

14 *4.1 Method*

15 *4.1.1 Participants & procedure*

16 Seven-hundred-seventeen Australians aged 18 years and over participated. They were
17 contacted by telephone by the Swinburne University of Technology's telephone interviewing
18 facility; 716 participants completed the survey immediately, while one completed an online
19 version at a later date. Note that some questions were panelled; panel 1 (n=239) included
20 questions about temperature systems and temperature curtailment, and panel 2 (n=237) included
21 all reported routine behaviours and efficient car intentions. (For more detail on recruitment,
22 study design and sample characteristics see Supplementary materials).

23 *4.1.4 Demographic characteristics*

1 Participants reported their household size, age, gender, place of birth, language spoken
 2 other than English, whether in paid work, and household income. Participants were also asked
 3 whether they resided in a house and whether they owned their own home (coded as 1 for own
 4 house, else 0). Again, we included the climate change belief measure.

5 4.1.5 LCRI and quality of life goal

6 LCRI (Cronbach's $\alpha = .84$; $M=3.81$, $SD=0.91$) was measured and calculated as Study 1,
 7 as discussed in the Supplementary materials, this was then deemed the preferred method of
 8 calculation for the LCRI. We also gauged the quality of life goal: "living in a comfortable and
 9 attractive home" on a scale of 1 (Not at all important) to 5 (Extremely important).

10 4.1.6 Resources

11 To measure participants' perceptions of having surplus time, and finances, they were
 12 asked how often they had 'Time left over to just relax after meeting your responsibilities', with
 13 six response options (Never; Rarely; Sometimes; Often; Very Often; Always) and whether they
 14 agreed with the statement, 'Our household income is high enough to satisfy nearly all our
 15 important desires' (Strongly disagree; Disagree; Neutral; Agree; Strongly agree).

16 4.1.7 Current infrastructure and routine low carbon behaviour

17 Participants were asked to report their current infrastructure and routine low carbon
 18 behaviour with the same question stems as in Study 2, using the items and response options
 19 listed in Table 2. The distribution of raw responses is provided in the Supplementary materials.
 20 For infrastructure items, typically only a small proportion of participants selected the 'don't
 21 know' option and it was collapsed with the 'no' responses for analysis (coded 0) because the
 22 LCRI was designed to predict the purposeful acquisition of low carbon infrastructure (i.e. 'yes'
 23 responses, coded 1).

1 4.1.8 Intentions

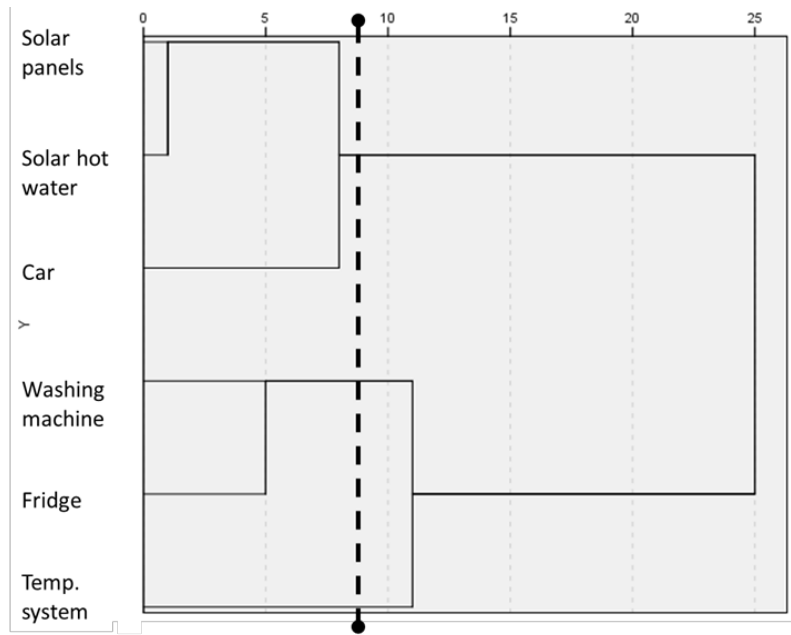
2 Intentions were measured in the same way as in Study 2, except that responses were
3 recorded on a 5-point Likert scale (Definitely do not intend; Probably do not intend; Undecided;
4 Probably do intend; Definitely do intend).

5 4.1.9 Constructing behavioural clusters

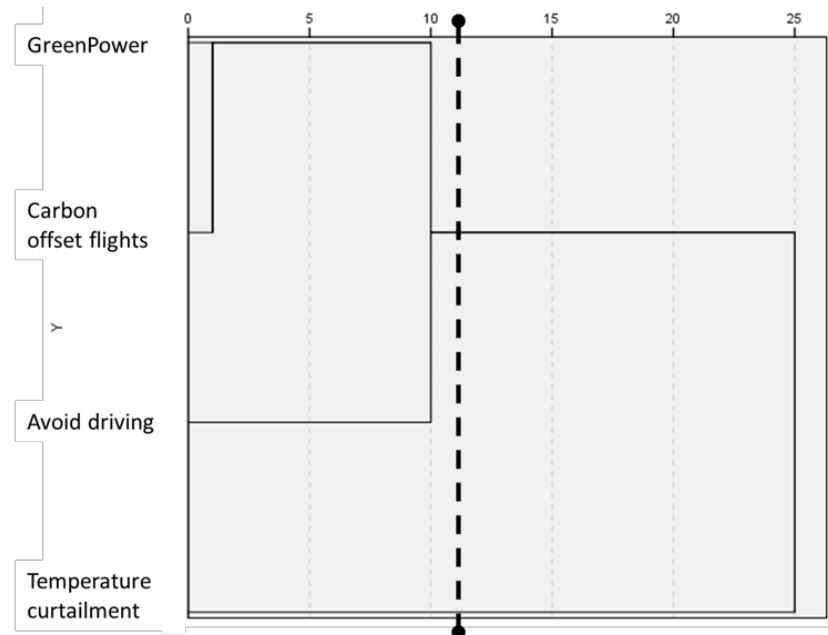
6 Dichotomous infrastructure measures were submitted to clustering as in Study 2 (see
7 Figure 2 (a)). Two clusters were identified: solar and appliances. Summary measures were
8 calculated as in Study 2. Temperature system did not cluster as closely with the other measures
9 so it was examined by a single item. Efficient car was also examined by a single item (for
10 comparability with Study 2 and due to low correlations with the solar items; $r=.09$, $p < .05$ with
11 hot water and $r=.19$, $p < .001$ with solar panels).

12 To minimise the length of the survey, a single item was used as a summary measure of
13 the past temperature curtailment cluster identified in the previous study. To capture the green
14 payments and travel practices cluster, three routine measures were averaged (GreenPower, avoid
15 driving a car, carbon off-set air trips; Cronbach's $\alpha = .54$). Although the Cronbach's α was low,
16 the cluster summary measure was made because the division between the temperature
17 curtailment cluster and the travel and payments cluster was supported by hierarchical clustering
18 of the routine measures, dichotomised at their mid-point (see Figure 2 (b)).
19 Summary measures of intention were calculated by averaging the intention items that paralleled
20 the behaviour items for each cluster (Cronbach's α for solar = .72; appliances = .70; green
21 payments and travel = .55).

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(a) Infrastructure



(b) Routine behaviour

Figure. 2. Study 3: Hierarchical clustering of reported infrastructure and routine behaviour with Ward's Method

1 *4.1.10 Classes of respondents with different infrastructure possessions*

2 Finally, we looked for classes of respondents who possess different types of
 3 infrastructure. Mplus was used to conduct a latent class analysis of the infrastructure measures.
 4 The best solution extracted three latent classes (three classes BIC= 4841.35; two classes BIC=
 5 4863.39; four classes BIC= 4874.89). As shown in Table 4, the three classes possessed advanced,
 6 intermediate or beginner levels of low carbon infrastructure (more discussion of classes is
 7 provided in the Supplementary materials).

8
 9 *Table 4. Study 3: Latent class analysis probability estimates for possession of different types of*
 10 *infrastructure*

	Class		
	Advanced	Intermediate	Beginner
Percentage	26.08	39.05	34.87
N	187	280	250
Probability of element			
Solar panels	.72	0	.27
Solar hot water	.58	.15	.33
Car	.70	.38	.21
Fridge	.68	.71	.19
Washing machine	.71	1	.15
Temp. system	.91	.73	.42

11
 12 **4.2 Results**

13 *4.2.2 LCRI prediction of clustered low carbon behaviour and intention*

14 A series of regression analyses were conducted to assess the association of LCRI with
 15 behavioural clusters and intentions. Tables 5 and 6 summarise effects for behaviours and
 16 intentions respectively; for more detail see the Supplementary materials.

17 Within the solar cluster, the LCRI significantly predicted having two elements of solar
 18 technology compared to none; however, it did not differentiate having one element versus no

1 element of solar technology. LCRI also predicted the possession of efficient appliances (one or
2 two elements compared to none), efficient car, practising temperature curtailment and making
3 green travel and payments. It did not predict possession of an efficient temperature system. In
4 addition, LCRI predicted intention to acquire both solar technology and efficient appliances, and
5 intention to establish low carbon routines within the temperature curtailment cluster. It did not
6 predict intention to acquire an efficient temperature system or car, nor to establish routines in the
7 green travel and payments cluster.

8 *4.2.3 LCRI prediction of the different classes of infrastructure possession*

9 Multinomial logistic regression was used to assess the association between LCRI and
10 infrastructure class membership (see Table 5). The advanced class was found to have
11 significantly higher LCRI than both the beginner and intermediate classes. However, LCRI did
12 not differentiate the beginner and intermediate groups.

13 *4.2.4 Effects for covariates predicting clusters and classes*

14 The comfortable and attractive home goal significantly and positively predicted both in
15 the practice of and the intention to use an efficient temperature system. The only other effects for
16 this predictor was that it negatively predicted past temperature curtailment. House ownership
17 predicted both practice and intention for the solar and temperature system clusters. Age and
18 household size also had a number of significant effects, although not consistently across practice
19 and intention.

20 In terms of the infrastructure classes, the advanced class were more likely to be
21 homeowners compared to both intermediate and beginner classes. Compared to the beginner
22 class, they were also more likely to work, be older, have spare time, have spare money and be

- 1 female. Similarly, when people in the intermediate group were compared to people in the
- 2 beginner group they were older, more likely to work and lived in small households.
- 3

Table 5. Summary of effects for regressions predicting low carbon behaviours

	Relative risk ratio (Multinomial)		Odds ratio (Logistic)		Semi-partial <i>r</i> (Linear)		Relative risk ratio (Multinomial)				
	Solar		Appliances		Temp. system	Car	Temp. curtail ment	Green travel & paym.	Infrastructure class		
	<i>ref:0</i>				<i>ref:0</i>				<i>ref: Beginner</i>	<i>ref: Inter.</i>	
	<i>1</i>	<i>2</i>	<i>1</i>	<i>2</i>			<i>Advan ced</i>	<i>Inter mediate</i>	<i>Advan ced</i>		
LCRI	1.16	1.37*	1.46***	1.63***	.85	1.30***	.33***	.35***	.85*	.71	.84**
Comf. & attractive home goal	.95	.96	.85	1.06	1.75**	1.02	-.09*	-.05	1.10	.96	.87
Surplus time	1.09	1.12	.95	1.23**	.81	.92	–	–	.95*	.85	.90
Surplus finances	1.00	1.30*	1.10	1.12	1.48	1.13	-.05	.06	.90*	.81	.90
Own house	2.57***	5.13***	.88	.88	1.84*	1.21	-.06	.05	.30***	.38	1.24***
Household size	1.04	1.14	.95	.81**	1.16	.98	.03	-.11	.74	.97*	1.31
Age	1.06	1.24	1.15	1.48***	1.02	1.47***	-.04*	-.01	.79*	.64*	.81
Female	.89	.77	1.00	1.57*	1.07	.98	-.01	-.01	1.24*	.79*	.64
Immigrant	1.35*	1.18	1.21	1.07	1.47	1.14	.02	.03	.66	.73	1.11*
Multi-lingual	.75	.91	1.58	1.54	.94	.80	-.02	-.05	1.03	1.04	1.01
Paid work	.62*	1.06	1.61	2.49***	1.74	1.37	-.07	.12*	.84**	.38*	.45
Income	.98	.92	1.07	1.22	1.24	.99	.04	.06	1.12	1.03	.91
Climate change belief	.51***	.84	.88	.87	1.07	1.11	.01	-.07	1.32	1.17	.88
Constant	.67	.08***	1.12	.70	.92	.49**			3.52***	6.44	1.83***
R ²	.07		.06		.12	.05	.14	.25	.07		

*p<.05, **p<.01, ***p<.001.

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Table 6. Semi-partial r values from linear regressions predicting low carbon intentions

	Solar	Appliances	Temp. system	Car	Temp. curtailment	Green travel & payments
LCRI	.15*	.18*	.07	.07	.21***	.10
Comf. & attractive home goal	.04	.06	.16**	.07	.06	.03
Past practice ^a	.04	.10*	-	-	.31***	.49***
Surplus time	.02	-.03	-.18**	.13	-.02	.02
Surplus finances	.01	-.04	-.22*	.04	-.05	.05
Own house	.18***	.01	.12	-.05	.00	.01
Household size	.02	-.01	-.02	-.01*	-.03	-.09*
Age	-.10*	-.12	-.19	-.10	.00	-.15*
Female	-.03	.00	-.23	-.15	.02	.06
Immigrant	-.06	.04	-.11	-.04	.03	.04
Multi-lingual	-.01	-.04	-.03	-.03	-.05	.01
Paid work	.06	-.01	-.07	.16	.03	.06
Income	-.01	-.04	.03	-.10	.07	.03
Climate change belief	.02	-.03	-.11*	-.01	.05	.06
R ²	.09	.08	.26	.14	.24	.44

*p<.05, **p<.01, ***p<.001.

^aPast practice refers to each intention's behavioural measure, included as a covariate.

1 4.3 Discussion

2 Study 3 again showed that the LCRI can predict activity within clusters of low carbon
3 behaviours and intentions, both in terms of infrastructure possession and daily routines. The
4 exceptions to this pattern of results again concerned narrow measures of reported behaviour
5 (temperature system and car). However, LCRI differentiated the infrastructure classes, which
6 incorporated all types of infrastructure possession into a single measure.

7 Study 3 replicated the core results of Study 2 with a larger national sample, while
8 adjusting for a range of contextual factors, including financial resources and income. Future
9 research examining LCRI's prediction of low carbon behaviour will seek to identify any patterns
10 of spillover between different types of low carbon activity.

11 While the predictive power of LCRI was robust in Study 3, some contextual factors also
12 stood out as important, especially house ownership. Those who do not own a house cannot
13 modify it at will, and therefore personal strivings cannot guide the behaviours that are not under
14 the control of type 2 processes. There were also indications, particularly for the infrastructure
15 classes, that people are more likely to engage in low carbon living in later stages of life. The
16 results confirmed our expectation that LCRI can predict generalized measures of reported low
17 carbon behaviours and intentions. However, measurement constraints meant that the studies thus
18 far concerned reported rather than actual behaviour. We now turn to actual behaviour in Study 4.

19 5. Study 4

20 Study 4 examined LCRI's capacity to predict an aggregate measure of a large number of
21 actual low carbon behaviours, namely, average daily energy use.

22 5.1 Method

23 5.1.1 Participants & procedure

1 Ninety-six adults (47 female) aged 29 to 85 years ($M_{\text{age}} = 51.12$; $SD_{\text{age}} = 11.54$)
2 participated. These people were members of a pre-existing study called the ‘Residential
3 Buildings Study’(RB study: Ambrose, James, Law, Osman, & White, 2013), which monitors
4 actual household energy consumption, conducted by the Commonwealth Science and Industrial
5 Research Organisation (CSIRO), an Australian Government agency. In September 2015, we
6 recruited participants of the RB study who agreed to complete a survey either over the telephone
7 (n=93) or online (n=3). Survey responses had 0-2% missing data except for income (6.59%). To
8 avoid loss of power, missing data were imputed using Expectation Maximisation (Enders, 2001)
9 in SPSS 22.

10 *5.1.3 LCRI and demographic characteristics*

11 LCRI was administered as in Study 1 (Cronbach’s $\alpha = .83$; $M=3.82$, $SD=0.78$).
12 Participants also reported their household size, gender, age and income level (Under \$31,200;
13 \$31,200 to just under \$52,000; \$52,000 to just under \$78, 000; \$78,000 to just under \$130,000;
14 \$130,000 or more). The conditioned floor area of the home was measured by CSIRO researchers.

15 *5.1.4 Energy use measures*

16 Regardless of behavioural patterns of energy use, the size of the home and the number of
17 people the home will inflate the amount of energy consumed. Preliminary analysis indicated that
18 there were three home types: (1) Less than 4 people, area less than 152.20 sqm; (2) Less than 4
19 people, area 152.20 sqm or more; (3) 4 or more people. Electricity consumption (kW) was
20 measured using a logger connected to the house mains switch board and hourly data were
21 aggregated into average daily consumption for (a) week days, and (b) weekend for two time
22 periods: time 1 and time 2, three months (June, July, August) before and three months
23 (December, January, February) after the survey (September, 2015), respectively. To preserve

1 degrees of freedom in the analyses, the energy measures were then normalized by home type (see
 2 Supplementary materials for more detail).

3 *5.2 Results*

4 **To examine the association between the LCRI and actual energy consumption we**
 5 **conducted three linear regressions.** As shown in Table 7, time 2 general power consumption was
 6 strongly predicted by time 1 energy consumption. However, even controlling for time 1 general
 7 power consumption, there was a significant association between LCRI and time 2 general power
 8 consumption for both weekday and weekend consumption. Those with a higher LCRI tended to
 9 consume less energy. The demographic characteristics controlled for were not significantly
 10 related to time 2 general power consumption.

11

12 **Table 7. Study 4: Beta coefficients for linear regressions predicting time 2 energy consumption**
 13 **with the LCRI**

Model	Predictors	General consumption	
		Week day	Weekend
1	LCRI	-.24*	-.21*
2	Time 1 energy consumption	.75***	.79***
3	Time 1 energy consumption	.74***	.78***
	LCRI	-.14*	-.15*
	Age in years	-.07	-.04
	Female	.03	.03
	Income	.02	.05

14 *p<.05, **p<.01, ***p<.001

15

16 *5.3 Discussion*

17 Study 4 found that higher LCRI predicted lower general energy consumption. This
 18 finding dovetails with the previous studies to suggest that having a stronger low carbon goal will

1 inform behaviour across a range of different low carbon behaviours, resulting in real reductions
2 in energy consumption. Future research examining the LCRI and actual energy consumption will
3 examine the relative impact of different low carbon behaviours and also employ longitudinal
4 modelling to confirm the robustness of the associations found here.

5 **6. General discussion**

6 Transformation to low carbon living requires a change in lifestyle. Four studies provided
7 evidence for the construct validity of Low Carbon Readiness Index (LCRI), a short
8 psychological measure that predicts a wide range of diverse low carbon behaviours in the
9 household, and that can index general willingness to transition to low carbon lifestyle.

10 When LCRI items were subjected to principal component analysis, they consistently
11 loaded on a single component with high levels of high internal consistency across samples. Study
12 1 provided evidence of convergent validity, showing that LCRI is associated with established
13 predictors of environmentally significant behaviour (NEP, environmental identity and
14 environmental striving), and belief in human-caused climate change. Although they could not
15 speak to causality, both Studies 2 and 3 supported LCRI's construct validity by showing that
16 personal goals to reduce carbon emissions predict greater reported engagement with low carbon
17 behavioural clusters. Finally, in Study 4, LCRI was shown to predict general energy use after it
18 was measured, even while controlling for the general energy use before its administration. We
19 believe LCRI can be used to monitor population-level willingness to transition to low carbon
20 lifestyle and to evaluate programs and policies to facilitate such cultural transformation.

21 However, both LCRI and the research so far have limitations. First, across all studies,
22 participants consented to participate knowing that the study concerned low carbon behaviours.
23 There is therefore a risk that the results are affected by participant self-selection into the studies.

1 However, in each study around a third of participants did not believe in human caused climate
2 change and this is a similar proportion found by other surveys measuring climate change beliefs
3 in the Australian population (Leviston, Greenhill, & Walker, 2015; The Climate Institute, 2016).
4 Further, Study 3 found that the relationships between the LCRI and low carbon practice were
5 robust even when adjusting for belief in human caused climate change. Consequently, we can be
6 reasonably confident in the results reported.

7 Second, LCRI measures general personal goals to reduce carbon emissions, and therefore
8 is expected to be associated with the engagement with clusters of low carbon behaviours rather
9 than the adoption of specific low carbon behaviours. As the RAA suggests, not all low carbon-
10 motivated people take the same low carbon actions, so a general measure is not well-suited to
11 predicting a specific low carbon behaviour. Consistent with this principle, in our results specific
12 reported behaviours (concerning temperature system and car) were not consistently predicted in
13 the way that behavioural clusters were. It is likely that broader clusters of multiple behaviours
14 would be needed to show the relationship between the LCRI and temperature and travel related
15 behaviours.

16 Third, although the behavioural clusters examined here covered a wide range of
17 infrastructure and daily routine activities, many other potential low carbon behaviours such as
18 shopping and waste management are yet to be examined. Scales summarising the green
19 payments and travel cluster may have had relatively poor reliabilities because the comprising
20 behaviours more closely cluster with behaviours like green purchasing and waste management
21 that were not examined in these studies. Furthermore, geographical and cultural factors may
22 affect the structure of any behavioural cluster. The low carbon behavioural clusters and classes
23 found here were similar to those found in other Western and European countries, with the solar,

1 appliances and temperature curtailment clusters seeming particularly cross-nationally relevant.
 2 However, these behavioural clusters are empirically derived, and sensitive to unknown
 3 contextual factors. Given the consistent results found across diverse behaviours in this paper, we
 4 expect that the relationship between LCRI and low carbon behavioural clusters will replicate
 5 across countries regardless of local variations in the clustering structure. However, identifying
 6 local variation in clustering should be a part of future research using LCRI to predict low carbon
 7 behaviour.

8 Finally, the brevity of the LCRI means that it does not give insight into the dynamics
 9 between the practical constraints and competing priorities that affect the successful performance
 10 of low carbon behaviour. For example, in Study 3 we controlled for several potentially relevant
 11 factors and found that home-ownership was associated with the installation of solar technology,
 12 highlighting the importance of actual control based on competence and resource considerations
 13 when promoting a low carbon lifestyle. In Study 3 we also found that a comfortable and
 14 attractive home was positively associated with the installation of efficient temperature systems
 15 but negatively associated with temperature curtailment. Such findings point to the diverse ways
 16 that other personal strivings may variously complement or compete with different low carbon
 17 behaviours and are worthy of further investigation (Axon, 2017).

18 Keeping these caveats in mind, the LCRI is a useful tool for researchers and practitioners
 19 seeking to promote low carbon living. While many psychological measures have some
 20 association with low carbon behaviour (e.g. climate change concern, environmental identity or
 21 environmental values) the LCRI is valuable for its direct relevance for GHG emission reduction,
 22 as well as its brevity and simplicity. Most existing scales are broadly concerned with the
 23 preservation of the natural environment, and not specifically with reducing GHG emissions.

1 Given that not all pro-environmental behaviours can reduce GHG emissions (e.g., saving a
2 beached whale), and that not all GHG reducing behaviours may be necessarily seen to be pro-
3 environmental (e.g., support for geo-engineering the atmosphere), we believe it is useful to have
4 a scale specifically designed to measure personal goal strengths for reducing GHG emissions.
5 This permits a more targeted measurement of public engagement with the climate change issue
6 and its mitigation.

7 The LCRI can be easily included in any investigation if researchers wish to explore the
8 relevance of their research for climate change mitigation and can be used at a minimum cost in
9 designing, implementing, evaluating, and revising the diverse range of climate change policies
10 available. In terms of public engagement, the three-item LCRI places a negligible burden on the
11 general public and can predict a wide range of their low carbon behaviours. It is consequently a
12 valuable tool for gauging public engagement. First, when designing a policy for climate change
13 mitigation, the LCRI can be used to determine the specific policy objective (Peters, Fudge, &
14 Sinclair, 2010). If the target community is not currently engaged with low carbon living (i.e., low
15 LCRI), a policy may need to be designed to persuade the public for the importance of GHG
16 emissions reduction; if it is already engaged (i.e., high LCRI), campaigns may be best designed
17 to show the public *how to perform the behaviours* that can reduce GHGs, to inform *how*
18 *effectively they can reduce GHG emissions*, and to provide *material and other resources for*
19 *performing them* to reduce their difficulty, i.e., to reduce the barriers for engaging with low
20 carbon behaviour clusters (Axon, 2017). In the implementation phase, the LCRI may be used to
21 decide on the communication strategies for the policy. If the community is highly engaged with
22 low carbon living (high LCRI), the policy may be best framed as a climate change mitigation
23 measure; however, if it is not (low LCRI), the policy may be better framed as something else,

1 e.g., an energy saving initiative. Finally, LCRI can be deployed inexpensively to monitor
2 whether and how much the campaigns and policies are having, or have had, an effect on the
3 public engagement by taking measurements before, during and after implementation of any
4 policy. This information may be used to continue, revise, or terminate those campaigns and
5 policies. Thus, the LCRI can be used to gauge a population's general willingness to transition to
6 low carbon lifestyle, and it can aid monitoring, policy making, and policy implementation in the
7 context of climate change and energy consumption.

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