# REMOVING BARRIERS TO ENVIRONMENTAL ACTION: THE IMPACT OF PERSONAL CAP-AND-TRADE SYSTEMS ON INDIVIDUALS' SENSE OF EFFICACY AND PERSONAL RESPONSIBILITY FOR CLIMATE CHANGE

by

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B.Sc., University of British Columbia, 2016

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
IN
NATURAL RESOURCES AND ENVIRONMENTAL STUDIES

UNIVERSITY OF NORTHERN BRITISH COLUMBIA

April 2020

## ABSTRACT

In complex industrialized societies, it is virtually impossible for individuals to know the environmental impact of their consumption. A personal cap and trade system, which assigns citizens limited, tradable allocations of pollution (e.g., carbon pollution), can link individuals directly to their environmental impact and enable them to chart a path to sustainable living. To explore public reactions to this system, an *Amazon Mechanical Turk* sample of individuals residing in Canada viewed a video describing either a carbon tax system or a personal cap and trade system. A personal cap and trade system based on allocations of kilograms of carbon dioxide equivalents ($kgCO_{2e)}$ was viewed as significantly more likely than carbon taxes to enable Canadians to reduce their carbon consumption and to live more sustainably. A range of public concerns that might limit support for carbon pricing systems were identified with qualitative analysis of participant comments about the systems.

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## ACKNOWLEDGEMENTS

First, I would like to thank Dr. Loraine Lavallee for being an exceptional mentor throughout my graduate student experience and for using her expertise to guide me through this research. I am very grateful for the support and encouragement she provided me with, and for the opportunities she sought out and helped happen. My graduate experience would not have been the same without her.

To my committee members, thank you for refining this research by offering your valuable expertise.

To UNBC and to UNBC's Office of Graduate Programs, thank you for providing me with the financial support to purse my Master's degree, to carry-out this research, and to attend an international conference. This funding truly allowed me to get the most out of my Master's experience. I would also like to thank the Social Sciences and Humanities Research Council of Canada (SSHRC) for supporting this research and providing me with the funding required to focus on my studies.

To my lab mates, thank you for offering helpful feedback on this research and for encouraging me to achieve my goals.

To Demi Quickfall, thank you for aiding in the creation of the experimental stimulus videos and for helping me throughout this thesis.

To my friends and family, thank you for helping me find balance throughout my studies.

# Chapter 1: Introduction and Present Study

## The Problem: A Climate Emergency

Humanity is consuming natural resources 1.7 times faster than can be regenerated by ecosystems resulting in deforestation, fresh-water scarcity, soil erosion, biodiversity loss, and greenhouse gas (GHGs) build-up in the atmosphere (Global Footprint Network, 2018). These changes to the environment are contributing to more severe natural disasters (such as droughts, wildfires, and hurricanes) that are having devastating impacts on communities.

In an effort to address this global emergency, in December 2015, 195 countries signed the Paris Agreement (Coad, Gibbard, Macdonald & Stewart, 2017). This agreement set emission reduction targets to keep global temperature rise below 2°C compared to pre-industrial levels, with efforts to avoid exceeding 1.5°C (United Nations Framework Convention on Climate Change, 2015). As a part of this agreement, the Canadian government pledged to, by 2030, reduce Canada's carbon dioxide equivalent ($CO_{2eq}$) emissions by 30% compared to 2005 levels (Coad et al., 2017). Canada is still far from that target; in 2016, emissions were reduced by only 4%. In 2018 the target itself was deemed insufficient by the Intergovernmental Panel on Climate Change [IPCC] special report on global warming which stated that global fossil fuel usage should be reduced by 50% in less than 15 years, and eliminated almost entirely in 30 years. On July 17, 2019 the Canadian House of Commons declared a national climate emergency (Global News, 2019). The Canadian government will need to adopt significant measures to achieve the IPCC targets.

## The Impact of Individual Consumption

Private individual and household activities account for a large portion of the total negative environmental impacts of human activity (European Environmental Agency, 2010). Specifically, the greatest areas of impact for individual consumption are energy use, transportation, housing, and food (O'Rourke & Lollo, 2015). Within those areas, eating red meat, driving a car, and heating/cooling homes are the activities that account for the most environmental degradation (Dietz, Gardner, Gilligan, Stern & Vandenbergh, 2009). The United Kingdom (UK) government attributes 42% of UK carbon emissions to individuals through household energy use and personal transport (Department of Trade and Industry, 2007). In major developed countries, personal emissions account for almost half of all emissions (International Energy Agency, 2013). Focusing solely on regulating industry will be insufficient to reach the ambitious global target of restricting warming to 1.5°C. In order to achieve climate targets, policy that targets individual lifestyle change (e.g., moving closer to work to avoid travel; eating less meat) and behaviour change (e.g., cycling or transiting to work rather than driving; picking a local as opposed to exotic vacation destination), is required in addition to the adoption of low carbon technology (e.g., electric cars) (Creutzig, Fernandez, Haberl, Khosla, Mulugetta & Seto, 2016). Lifestyle and behaviour must adjust alongside efficiency upgrades in order to achieve desired outcomes.

## The Case for Down-Stream Policy Initiatives

Individuals can be nudged toward sustainable living by altering individual behaviours (e.g., increasing the selection of vegetarian food options, creating bike lanes, creating incentives for purchasing electric cars) or the economic systems they are a part of can organize their lives around achieving sustainability targets. The present research investigates

the ability of well-known market mechanisms that put a price on environmental pollution (carbon taxes and cap and trade systems applied to individuals) to change individuals' psychological responses towards environmental issues, such that a stronger culture of environmental protection is built.

Collective initiatives designed to reduce humanity's environmental harm can be divided into upstream (supply-side) programs versus down-stream (demand-side) programs. Upstream programs are initiatives focused on governments, the producers of products (e.g., energy-efficiency requirements) and on changes to infrastructure (e.g., installing bike lanes). Downstream programs act more explicitly on citizens (e.g., carbon taxes, incentives for purchasing electric vehicles and for making home energy-efficient renovations, congestion tolls on roads entering city centres). Down-stream solutions targeting technology choices, consumption, behaviour, lifestyles, service provision and associated socio-technical transitions have fewer environmental risks than many supply-side technologies (von Stechow, Minx, Riahi, Jewell, McCollum, Callaghan, Bertram, Luderer & Baiocchi 2016). However, down-stream approaches that are mandatory and involve direct and immediate costs to citizens (versus incentives), such as carbon taxes and road tolls, can be unpopular among the public (Rhodes, Axsen & Jaccard, 2017), and tend to elicit public criticism before implementation (Treuer, Weber, Appelt, Goll, & Crookes, 2012). Therefore, downstream approaches have not received as much attention as upstream approaches that work around the individual (Creutzig, Roy, Lamb, Azevedo, Bruine de Bruin, Dalkmann, …Weber, 2018).

Up-stream initiatives on their own have had limited success in moving Canadians toward sustainable lifestyles. Despite improvements in energy efficiency (amount of emissions produced per unit of energy output), energy consumption continues to rise (Creutzig et al. 2016). In Canada, from 1990 to 2013 there was an estimated 25%

improvement in energy efficiency, nevertheless, greenhouse gas emissions grew by 21% in total and by 31% excluding emissions from the electricity sector (Natural Resources Canada, 2016). Modern houses might be more energy efficient; however, if they are larger, energy savings can be reduced, if not lost altogether. Consequently, some analysts suggest that environmental policies must act directly on individuals' total resource consumption (Creutzig et al., 2018; de Coninck, Revi, Babiker, Bertoldi, Buckeridge, Cartwright…Waterfield, 2018) by setting clear limits on absolute consumption per person per year (Harris, Diamond, Iyer, Payne, Blumstein & Siderius, 2008) (e.g., annual fossil fuel caps applied to everyone), rather than focus on efficiency requirements (e.g., building requirements of $CO_{2e}$ per square meter per year).

Another problem with up-stream initiatives is that, since they do not involve the individual directly, they do not necessarily increase citizens' knowledge about environmental problems and the individual's role in these problems. Citizen knowledge and prioritization of environmental conservation is valuable for achieving significant environmental goals. Växjö Sweden, the 'greenest' city in Europe (Dale, 2011), has widespread support among citizens from all political parties to prioritize environmental issues. The public is highly educated on environmental problems and on the opportunities associated with building an economy around environmental conservation (Dale, 2011; Emelianoff, 2014). This public knowledge reduces misunderstandings surrounding economic initiatives that are environmentally sustainable, and increases support for these initiatives even when they have high capital start-up costs (Dale, 2011). The present research explores whether down-stream initiatives might increase citizens' sense of efficacy in achieving significant environmental targets and sense of personal responsibility for climate action. If an individual has a sense of efficacy and personal responsibility, these beliefs are expected to increase the individual's interest in

environmental issues and in turn, increase environmental awareness and support for environmental initiatives.

**Obstacles to a culture of sustainability: insufficient sense of efficacy and personal responsibility**

When people are faced with a very serious and potentially life-threatening situation, either personal (e.g. cancer) or collective (e.g. climate change), but cannot solve the problem, they lack efficacy to influence the outcome. Under these circumstances, it is functional for people to adopt emotion-focused coping responses, such as denial or distraction, to direct attention away from the situation and avert the persistent emotional distress (see Gardner & Stern, 1996 for a review; Norgaard, 2011). With global environmental problems, coping responses such as avoiding thinking about climate change, minimizing its importance, or outright denial will enable individuals to continue to function in the face of a looming global crisis, but will clearly reduce the individual's attention toward, knowledge about and political action on the problem (Roser-Renouf, Maibach, Leiserowitz, & Zhao, 2014). Indeed, Roser-Renouf et al. (2014) found that beliefs that climate change is real, human-caused, dangerous, *and solvable,* were significant predictors of the individual's involvement with climate change issues, and the individual's beliefs that society (including government, corporations, industry, and citizens) should be doing more to reduce global warming. Roser-Renouf et al. (2014) further suggest that to mobilize political participation and climate change activism, the risks associated with climate change should continue to be communicated. However, the *effectiveness* of actions individuals can take (e.g., writing letters to government officials, volunteering with organisations working to reduce global climate change, and attending a rally) must also be clearly communicated. Feelings of personal efficacy for having an

influence on climate change are related to increased support for government climate change policies and increased pro-environmental behaviour (Lubell, Zahran, & Vedlitx, 2007). Individuals will not be motivated to take action unless they perceive their actions (either personal behaviour change or civic actions) will be effective in reducing climate change, or influencing political action on climate change.

There are many barriers to individuals developing a sense of efficacy and sense of responsibility for addressing global problems. In complex industrialized societies that are embedded in globalized economies, it is virtually impossible for individuals to chart a path to sustainable living (O'Rourke & Lollo, 2015). In trying to select environmentally-sustainable food, for example, consumers use features such as the transportation distance of the food and whether or not the food is organic; however, these features can conflict with the environmental life-cycle analyses of the product (Poore & Nemecek, 2018; Tobler, Visschers, & Siegrist, 2011). Even if the environmental impact of particular products was readily apparent, it is also very difficult for individuals to know how close or distant their total resource use is to a goal of being environmentally-sustainable. To achieve a sustainable lifestyle, does the individual need to give up meat and international travel if they already live in a small, energy-efficient multi-unit building and do not own a car? Currently, asking individuals to live sustainably is similar to telling them to live within their income: without telling them what their income is, without telling them the cost of the products and services they use, and without enabling them to keep track of the money in their bank account.

The individual citizen's motivation to take personal responsibility for reducing environmental harm is also undermined by the fact that environmental problems are collective rather than individual problems. It is difficult to make large personal sacrifices such as giving up meat or international air travel when you know it will not make any

difference to solving a global problem. If the majority of citizens are not working to achieve collective sustainability goals, the motivation for any one individual to do so is vastly reduced (Dawes, 1980; Ostrom, 1990; Ostrom, Burger, Field, Norgaard & Policansky, 1999) as the individual effort will not solve the problem. This can only be overcome with initiatives directed at coordinated collective action.

**Summary**

Humanity is using natural resources 1.7 times faster than can be regenerated by ecosystems (Global Footprint Network, 2018). To reduce per capita impact on the environment, up-stream initiatives that avoid directly involving citizens are often preferred by policy makers because solutions that immediately and negatively impact individual citizens often elicit public criticism before implementation (Treuer et al., 2012). However, up-stream initiatives on their own have had limited success in moving Canadians toward sustainable lifestyles. Despite improvements in energy efficiency (amount of emissions produced per unit of energy output), energy consumption continues to rise (Creutzig et al., 2016; Natural Resources Canada, 2016). Down-stream initiatives that act more directly on the individual by setting clear limits on absolute consumption per person per year, have been argued as necessary to achieve sustainability goals (Creutzig et al., 2018; Harris, et al., 2008). Additionally, initiatives that involve individuals more directly might be able to increase citizens feelings of personal responsibility and collective efficacy, enabling them to direct more attention to environmental problems.

**Increasing a culture of sustainability using market mechanisms that put a price on environmental damage**

The present study will explore the question: Can down-stream market mechanisms, specifically, carbon taxes and personal cap and trade systems (cap and trade systems applied to individuals), foster in Canadians a sense of personal responsibility and a sense of efficacy for reducing environmental impact, and achieving significant environmental goals?

Self-efficacy is a person's belief about how capable they are to deal with a specific problem (e.g., climate change) or to accomplish a desired outcome (e.g., live sustainably) (Bandura, 1982). In the present study, citizens' beliefs about whether market mechanisms can enable them to achieve significant environmental goals either as an individual (personal efficacy) or as a collective (collective efficacy) are investigated. **Personal efficacy** refers specifically to beliefs that the market-mechanism can enable individuals to reduce their impact on climate change and to live sustainably. With global environmental problems such as climate change, individuals on their own are unable to bring about significant environmental outcomes. As such, collective action is needed to solve the problem. Therefore, **collective efficacy** beliefs are also investigated: the individual's belief that the market mechanisms will enable Canada to achieve significant environmental sustainability goals.

**Features of market mechanisms: carbon taxes and personal cap and trade systems**

Below is an analysis of the features of carbon taxes and personal cap and trade systems and their predicted impact on human psychological and motivational responses. Market mechanisms that put a price on environmental damage, such as pollution taxes and cap and trade systems, are collective approaches for achieving sustainability targets.

Therefore, both have the potential to generate a sense of collective efficacy in the population. However, these two systems vary in the type of feedback provided to citizens about the impact of their consumption on the environment (Parag & Strickland, 2011). Economists promote carbon taxes because they are very efficient to administer (Harrison, 2010, 2012; Jaccard, 2012a; Rhodes & Jaccard, 2013). However, how paying a tax can solve climate change is not clear to all citizens, especially to those who distrust government and oppose taxes (Drews & van den Bergh, 2016, Jaccard, 2012b). Furthermore, with a hidden carbon tax, such as the tax in place in British Columbia, no useable feedback is given to the individual about their personal contribution to the problem. In contrast, personal cap and trade systems provide individuals with useful information by assigning clear individual pollution targets, and enabling individuals to monitor their own cumulative impact relative to their assigned targets (Parag & Strickland, 2011).

**Pollution (e.g., Carbon) Tax**

In 2008, British Columbia (BC) was the first jurisdiction in North America to implement a tax on carbon collected at the individual level (Hsu, 2011). The current tax is hidden in the price of fossil fuels and therefore it does not educate or inform consumers about their level of carbon pollution. A carbon tax operates by making fossil fuels more expensive, which aims to decrease consumption, and signals to the marketplace that over time, there will be increasing demand for products that produce less carbon pollution.

GHG emissions have decreased since the introduction of the BC carbon tax, but emission targets are still far from being met. By 2020, BC's GHG emissions were to be reduced by at least 33% compared to 2007 levels (Greenhouse Gas Reduction Targets Act, 2007); as of 2017, emissions have been reduced by 2.0% (Government of British Columbia,

2019). In 2019, the Federal Government of Canada enacted a mandatory carbon tax that is to reach $50/tonne by 2022 in all provinces and territories that did not already have their own form of carbon pricing (Environment and Climate Change Canada, 2019). The Conference Board of Canada reported that the carbon tax will help reduce emissions, but alone, even a tax reaching $200/tonne would be insufficient to make the reductions required (Coad et al., 2017).

A pollution tax that is applied to everyone has three features that can potentially influence human motivation and beliefs: it is mandatory, it has an associated provincial or national target, and it punishes behaviour that causes pollution (see Figure 1).

**(1) Mandatory versus voluntary program.** A mandatory program communicates that action on climate change is important to society. When the full weight of government is behind an environmental initiative, this endorsement could legitimize environmental action and could help to strengthen a social norm that GHG pollution is not socially acceptable.

**(2) A provincial or national environmental target**. A provincial or national environmental target provides a collective goal toward which citizens' individual contributions will help to achieve.

**(3) Punishment for polluting**. The use of punishment is the third feature of carbon taxes relevant to motivation. Through operant conditioning, behaviour can be either strengthened with positive reinforcement (rewards) or can be weakened through punishment (Schacter et al., 2011; Skinner, 1938; Skinner, 1953).

The above three features on their own are limited in their ability to generate a sense of efficacy and personal responsibility among the public, and risk creating negative attitudes toward carbon taxes. An interview study demonstrated that experts including civil servants, sustainability consultants, accountants, health care executives, entrepreneurs and researchers

generally believed that public awareness surrounding the operation of the BC carbon tax is insufficient. Members of the public may know that they are paying a carbon tax, but do not have a clear idea of why they are paying it (Guzman & Clapp, 2017). Given the strong opposition to carbon taxes among conservative premiers in Canada, the information distributed to the public about the effectiveness of the carbon tax in achieving environmental targets is often partisan and confusing (Wells, 2018).

Furthermore, the level of financial punishment with a carbon tax is relatively small and therefore is not expected to have a strong, immediate impact on the resource-consumption behaviour of individuals. The response of energy demand to fluctuations in price is very low, and as such, a carbon tax would have to be very high to have a significant impact on energy consumption behaviour (House of Commons Environmental Audit Committee [HCEAC], 2008; Coad et al., 2017). Individuals are accustomed to absorbing price fluctuations resulting from taxation and likely need additional provocation to make changes to their lifestyle (HCEAC, 2008).

When punishing polluting behaviour (e.g., paying a tax on pollution) is perceived to be ineffective, and there are few options for avoiding the tax, negative attitudes toward the program may arise, especially among people who are not strongly in favour of taxation (Rhodes et al., 2017).

**Personal Cap and Trade (e.g., Personal Carbon Trading)**

Personal cap and trade systems have the potential to increase citizen awareness about the environmental impact of consumption, and to involve citizens directly in achieving environmental targets. In the UK, a personal cap and trade system for carbon emissions called Personal Carbon Trading (PCT) was considered by the HCEAC (2008), and received

considerable public attention (Fawcett, 2010, 2012; Fawcett & Parag, 2010; HCEAC, 2008). PCT systems have also recently received media attention in Canada (Boyle, 2019; Slaughter, 2019). The system proposed in the UK involved setting a national cap on total carbon emissions, and dividing the cap up amongst the population, with each individual receiving their own allocation of the emissions. Initially the cap is high to give people and the market-place time to adjust before facing more stringent caps. Each adult receives a full allowance and in most variations of the system, children under 18 receive half or one third of an allowance. The scope of the system includes consumption of gas, electricity, coal, road fuels and personal aviation (not public transportation) (HCEAC, 2008). Individuals have carbon accounts, receive carbon statements and have a carbon card from which carbon units are debited at the time of purchase. Additionally, individuals can buy and sell unused carbon credits on the market (Hillman & Fawcett 2004). After conducting a pre-feasibility study in 2008, the UK Department for Environment, Food and Rural Affairs (DEFRA) concluded that PCT was "an idea that was ahead of its time" (Fawcett, 2010). The main policy concerns were public acceptability and high administrative costs (DEFRA, 2008). However, most research shows that PCT is likely to be at least as socially acceptable as alternative taxation policies (see Parag & Fawcett, 2014 for a review; Howell, 2007). While there is an increased administrative cost, individual cap and trade could be more effective than simple taxation at creating behaviour change and reducing carbon emissions (HCEAC, 2008). Importantly, PCT also has the potential to create broader culture change surrounding environmental sustainability.

**The effectiveness of cap and trade systems on reducing environmental pollution.** While a cap and trade policy has not yet been implemented at the individual level, it has been used at the industrial level. The largest success was the US sulfur dioxide ($SO_2$) emissions

allowance trading program that was a part of the Acid Rain Program (ARP). The ARP was implemented in 1995 under Title IV of the 1990 Clean Air Act Amendments (United States Environmental Protection Agency, 2018). A $SO_2$ emissions cap was placed on the coal-fired power plant industry, with each plant being allocated their respective share of emission permits that could be used, banked, or traded with other plants. The ARP proved to be successful, achieving a 67% emissions reduction in 2010 compared to 1990 levels (United States Environmental Protection Agency, 2011). The most recent available data indicates that by 2016, plants under the ARP experienced a 91% emission reduction from 1990 (United States Environmental Protection Agency, n.d.).

**The features of PCT systems and individual motivation and beliefs.** Relative to carbon taxes, PCT has many more features for enhancing individuals' knowledge about their environmental impact, and for generating a sense of personal responsibility and efficacy for achieving environmental targets (see Figure 1). In addition to being a mandatory program associated with a provincial/national target that includes punishment for excessive resource use (features 1-3), PCT includes the following features that can enhance individual motivation.

**(4) Incentives for conservation as well as punishment for excessive resource use**. With PCT, carbon pollution is punished only if an individual's cap has been surpassed. If a person remains below the cap, they would be able to sell their remaining credits and be rewarded for their conservation. Self-determination theory suggests that rewarding individuals for a behaviour will be particularly helpful in changing behaviour if the person is not intrinsically motivated to engage in the behaviour (Ryan & Deci, 2017). In other words, individuals who are not in favour of mandatory environmental initiatives are likely to feel

more favourable toward a system that creates opportunity for personal financial gain rather than simply punishing behaviour.

**(5) Individuals can compare the environmental impact of their choices**. Insufficient knowledge about personal contributions to climate change and effective ways to reduce $CO_{2e}$ emissions prevents individuals from taking action against climate change (Whitmarsh, Seyfang & O'Neill, 2011; Tobler, Visschers & Siegrist, 2012; de Coninck et al., 2018). PCT would help raise the individuals' awareness about the environmental impact of their activities by providing a carbon label. This would increase the understanding of the relative differences in emissions resulting from personal decisions such as choosing a travel destination that requires a few hours' drive, compared to one that requires a long plane ride; or the difference between driving to work and cycling to work. This is supported with evidence from interviewing participants of Carbon Rationing Action Groups, the closest operating system to PCT; most interviewees said that they now have a greater understanding of where their emissions come from and the relative impact of different activities (Howell, 2012).

**(6) Clear individual environmental goal.** Individuals regulate behaviour around goals (Carver & Scheier, 1990). People achieve more substantial goals when they have specific goals (e.g., 3 tonnes of carbon per year; 100 carbon credits) rather than vague goals (e.g., reduce carbon emissions) (Locke & Latham, 2002, 2006). A PCT system provides individuals with a very specific individual goal.

**(7) Individuals can easily monitor their progress toward their environmental goal**. For individuals to regulate their own behaviour around achieving specific goals, they must receive feedback on how they are doing relative to the goal (Carver & Scheier, 1990; McCalley & Midden, 2002; McCalley, 2006; Thaler, 1999). PCT monitors individuals use of resources in an account, and can therefore provide feedback about progress relative to

individual caps. Indeed, when placed in a personal carbon-trading simulation study, individuals' energy-use decreased over time as they received feedback about their resource use relative to their diminishing cap (Capstick & Lewis, 2010).

When all of the above features (1 through 7) are included in one system, they are expected to significantly increase individuals' sense of efficacy in creating environmental change. Features 5 through 7 provide individuals with information about their environmental impact and are expected to increase individuals' sense of responsibility. Together, an increased sense of efficacy and personal responsibility are expected to encourage individuals to direct more attention to environmental issues (see Figure 2). This in turn is expected to increase environmental knowledge, risk perception, and the prioritization of environmental issues (both personally and politically). These outcomes are important as a sense of efficacy along with perceived risk and environmental knowledge are associated with support for government climate change policies (Drews & Van den Bergh, 2016; Lam, 2014; Lubell et al., 2007; Tobler et al., 2012), which will be important in leading society toward a low carbon future.

For individuals who are not generally in favour of collective action on environmental issues, a PCT system is expected to increase their support for environmental initiatives through the communication of social norms for conservation, the direct feedback about personal impact on the environment, and through incentives for conservation in the form of credit trading. In this group of people, an increased sense of personal responsibility for environmental action combined with incentives for conservation are expected to be equally as important as an increased sense of efficacy.

**The effectiveness of PCT systems at reducing environmental pollution**

**Carbon Rationing Action Groups**. Currently, the closest operating system to PCT is *Carbon Rationing Action Groups* (CRAGs). CRAGs are grassroots voluntary groups in the UK made up of citizens who are looking to reduce their direct carbon emissions from household energy use and personal transport. Each year, members agree to a fixed, equal-per-capita ration of carbon emissions (Howell, 2012). Howell (2012) found that CRAG members reduced their average per capita carbon footprint by 32% in their first year with their respective group. When interviewed, most members also reported that they now have a greater understanding of where their emissions come from and the relative impact of different activities. Many mentioned monitoring their energy use more closely and as a result, they reported becoming more aware of their consumption (Howell, 2012).

**Personal Carbon Goals trial.** A 15-month Personal Carbon Goals trial conducted on Norfolk Island (a small community 1,600 kms from the east coast of New South Wales, Australia) also found promising results for the reduction of personal carbon emissions (Webb, 2018). The trial, called the Norfolk Island Carbon Health Evaluation (NICHE) Project, was supposed to be a PCT trial; however, due to a lack of support from banks to use their existing infrastructure, a simplified version of PCT called Personal Carbon Goals was run. In total, 218 households volunteered to participate, representing 27% of all households on the island. The Personal Carbon Goals system assigned each participating household a carbon card account that could be accessed online; each individual within the household received their own carbon card to use at the petrol station and were incentivised to use it with a fuel discount.

Annual household carbon emissions (from fuel for homes, electricity and petrol/diesel) were calculated during a baseline period, and then each household received a

unique carbon emission goal 10% below their baseline level. Households received feedback on how they were doing relative to their goal with quarterly statements; statements included a breakdown of carbon emissions by energy type, and a comparison to the 'NICHE average' of comparable households (Webb, 2018). Both Personal Carbon Goals and PCT provide a carbon consumption goal and feedback on how a household or individual is doing relative to that goal; the primary difference is that with Personal Carbon Goals there is no option to trade emissions. Therefore, there was no incentive for going under your assigned goal beyond saving money on utility bills/fuel for your vehicle.

Post intervention, there was a 25.1% reduction in carbon emissions associated with household fuel consumption (e.g., for heating), and a 12.3% reduction associated with electricity usage. No significant changes in petrol/diesel consumption (or active transport) were found. Webb (2018) suggested that future research examine if PCT would be more successful at encouraging active transport in a location with more supportive infrastructure (e.g., access to public transport, cycle ways etc.). Another important finding is that participation in Personal Carbon Goals developed positive attitudes towards a mandatory PCT system 'as a tool to improve the environment'. Post-trial survey results indicated that 68.1% of participants agreed that PCT would be an acceptable mandatory tool to improve the environment. This represents a 19.2% increase compared to baseline results (48.9%). Attitudes of those who live in Norfolk but did not participate in the trial remained unchanged at around 45.0% (Webb, 2018).

There is limited research on the impact of PCT on the behaviour of citizens who are not motivated to participate in a carbon pricing system (CRAG participation and NICHE participation was voluntary). Parag, Capstick and Poortinga (2011) conducted a survey with a nationally representative British sample ($n$ = 1,096) and found that citizens reported a

somewhat greater willingness to reduce their energy use under a PCT system compared to an energy tax system (participants reported a greater willingness to reduce their mileage, thermostat temperature, and dairy consumption, but there was no difference in willingness to reduce washing machine water temperature under a PCT system compared to an energy tax). Capstick and Lewis (2010) conducted an online PCT simulation study and also found that individuals were willing to reduce their energy consumption under a PCT system. In the computer simulation, as their carbon allowance diminished and became more restrictive participants made more energy-conserving decisions. However, both these studies are limited in that indicating you are willing to partake in an action does not necessarily mean you would take that action when faced with that situation in the real-world.

**Positive Spillover.** Positive spillover refers to the phenomena that engaging in one pro-environmental behaviour increases the motivation to partake in other related pro-environmental behaviours (Thøgersen & Crompton, 2009). Research suggests that the framing of PCT could lead to behaviour change beyond the scope of the policy due to an increased awareness and understanding of personal emissions across activities. In a study that evaluated behaviour change intentions, PCT framing significantly increased participants' intentions to reduce dairy consumption (a product outside the scope of a proposed PCT/carbon tax system), whereas a carbon tax did not (Parag et al., 2011).

Interviews with individuals who partake in CRAGs also found evidence for spillover effects under a PCT policy (Howell, 2012). While the scope of CRAGs involve only direct emissions, interviewees illustrated increased knowledge of indirect emissions as well,

> being a part of [the CRAG] has raised our awareness of all those other things that involve energy (Dave). I realised that consumption of meat and overseas goods was a

much bigger deal from a carbon creating point of view than I realised before (Calum). (Howell, 2012, p. 254).

In addition to CRAG members reducing their average per capita carbon footprint by 32% in their first year with the group, interviews also indicated additional behaviour change beyond what is captured in the scope of the project. "We don't use supermarkets anymore. I use local food shops. […] I don't buy cosmetics that aren't organic […] I don't buy new clothes (Lara)" (Howell, 2012, p. 255).

**The Present Research**

Implementing a provincial or nation-wide personal cap and trade policy such as PCT will be substantially more expensive than implementing a carbon tax (DEFRA, 2008). Therefore, a PCT system would need to yield very clear environmental conservation benefits beyond those achieved by a carbon tax to rationalize its implementation. A PCT system offers a way to connect citizens to their environmental impact and enables them to see a path to sustainable living; this is expected to increase citizens' sense of personal responsibility and efficacy for achieving meaningful environmental targets. The main goal of the present study was to examine whether PCT systems have a larger impact than carbon tax systems on key beliefs that can give rise to broader environmental awareness: (1) a sense of collective efficacy for significantly reducing environmental impact, (2) a sense of personal efficacy for living sustainably, and (3) a sense of personal responsibility for achieving environmental goals.

The perceived efficacy of climate policy is an important feature in generating public support for the policy (Lam, 2014; Joireman, Van Lange, Wood, Leest & Lambert, 2001; Kallbekken & Saelen, 2011). Citizens are more likely to support a policy that they believe

will have clear climate benefits (Brouwer, Brander & Van Beukering, 2008; Tobler et al., 2012; Drews & Van den Bergh, 2016). For example, Norwegians who believed that a fuel tax would reduce citizens' driving were more likely to support the tax (Kallbekken & Saelen, 2011). Therefore, if PCT elicits a greater sense of efficacy in citizens than carbon taxes, it is expected to receive stronger public support.

**Hypothesis 1:** Compared to carbon taxes, PCT will create

- a greater sense of efficacy for individuals to reduce their environmental impact (personal efficacy)
- a greater sense of efficacy for the collective to achieve significant environmental targets (collective efficacy)
- a greater sense of personal responsibility for partaking in actions to reduce climate change
- stronger support for the carbon pricing system

To test for differences in the psychological impact of carbon tax and PCT systems, a series of videos were developed. The first video, which all participants watched, provided basic climate change information. A control group watched only the climate-change video and then completed the following belief measures: personal responsibility for climate change, climate change risk perceptions, prioritization of environmental protection relative to economic growth, and interest in additional environmental information. Participants in an experimental condition watched a second video explaining either a carbon tax system or a PCT system. These videos described the system, and then provided a very systematic example of the information that an individual living in Canada would receive when purchasing gasoline, natural gas or electricity (e.g. Gasoline at the pump: $50.48 + 1 carbon

credit, 7 *carbon credits remaining*). After viewing the second video, individuals in the experimental conditions completed the following belief measures: collective efficacy (as a whole, can we reach our sustainability goals), personal efficacy (as an individual, can I achieve my sustainability goals), sense of personal responsibility for climate change, climate change risk perceptions, prioritization of environmental protection relative to economic growth, knowledge acquisition, and interest in additional environmental information. The study was completed online using *Amazon Mechanical Turk* (MTurk) with a sample of individuals living in Canada.

**Additional belief changes**

A market mechanism that is seen to be effective at reducing carbon pollution and that also increases a person's sense of responsibility for environmental action is expected to reduce individuals' psychological need to defensively avoid thinking about climate change. Consequently, if participating in a market system such as PCT is able to increase individuals' sense of efficacy and personal responsibility, this should increase the individual's interest in environmental issues and, over time, lead to increased environmental awareness and knowledge, risk perception and prioritization (see Figure *2*). Objectively assessed knowledge about climate change is one of the most robust predictors of favourable attitudes toward climate action and involvement with climate change issues (Drews & Van den Bergh, 2016; Roser-Renouf et al. 2014), while public risk perceptions have been found to drive policy as much as scientific risk assessment (Correia, Fordham, Saraiva & Bernardo, 1998; Slaymaker, 1999; Tierney, Lindell & Perry, 2001).

**Hypothesis 2:** Compared to carbon taxes, considerations of PCT systems will create:

- an increased interest in environmental information

- an increased sense of climate change risk perceptions
- increased prioritization of environmental protection relative to economic growth

**Knowledge Acquisition**

Even if citizens are motivated to act on climate change, actions can be prevented due to a lack of knowledge surrounding the causes of climate change and effective ways to reduce emissions (Whitmarsh et al., 2011; Tobler et al., 2012; de Coninck et al., 2018). The information provided with PCT systems could help raise the individuals' awareness about the environmental impact of their activities, enabling them to effectively reduce emissions. Evidence from CRAGs suggests that in addition to the reduction of direct personal emissions, this awareness can lead to the reduction of indirect emissions outside the scope of PCT (Howell, 2012).

**Hypothesis 3:** Compared to a carbon tax, PCT systems will better educate individuals on the relative amount of carbon emissions resulting from different personal activities (knowledge acquisition).

**Variations of Carbon Tax and PCT Systems**

In addition to the main goal of examining differences between carbon tax systems and PCT systems as broad approaches, variations of these systems were investigated. The different variations altered the environmental information provided or altered the way the information was provided. It was predicted that altering the information (or the framing of the information) provided to individuals on the environmental impact of their consumption,

may affect their sense of efficacy for achieving environmental targets and their sense of personal responsibility for climate change.

**Carbon Tax Systems.** Two different types of carbon tax systems were described: (1) a low visibility carbon tax where the tax is embedded in the cost of the product, and no carbon pollution information is provided, and (2) a high visibility carbon tax where the tax is still embedded in the cost of the product, but individuals are also provided with a carbon label indicating the amount of carbon emissions associated with the purchased product. The low visibility carbon tax is similar to the tax that is currently in place in British Columbia. It does not provide the individual with any information about their environmental impact and is not designed to transform individuals' awareness about their environmental impact.

A high visibility carbon tax, in contrast, might be an efficient method for increasing environmental awareness about individuals' environmental impact. Alongside the cost of a product, the high visibility carbon tax, designed for this study, presented the amount of carbon pollution resulting from the product in $kgCO_{2e}$ and in percent of total monthly recommended carbon consumption (e.g., Gasoline at the pump: \$54, 101 $kgCO_{2e}$, 13% of total monthly recommended carbon pollution). This includes two features of PCT: carbon labeling that makes it easy for individuals to compare the actual environmental impact of their choices, and a clear individual environmental goal. However, individuals' overall consumption over time is not tracked.

Research regarding product labeling revealed that the effects of a product being labeled as "not sustainable", has a greater impact on decision making than seeing that a product is labeled as sustainable (Choi & Ng, 2011). Therefore, the labels used in this scenario (as well as those used in the PCT scenarios) that expose the negative impacts of consumption on the environment are likely to be more effective in increasing the use of

environmentally friendly products compared to eco labeling. Without clear explicit knowledge regarding the harmful environmental impact of an action, individuals will not have a negative attitude towards it (Fransson & Gärling, 1999). The more individuals learn about the negative climate impact their behaviour is causing, the more they feel responsible for climate change, and the more they think that their actions can make a difference (de Coninck et al., 2018; Steg & de Groot, 2010; Jakovcevic & Steg, 2013; Chen, 2015; Ray, Hughes, Konisky & Kaylor, 2017; Woods, Nielsen, Pedersen & Kristofersson, 2017).

**Hypothesis 4:** Compared to a low visibility carbon tax, a carbon tax with carbon labeling will produce significantly higher levels of personal efficacy, collective efficacy, personal responsibility for climate change, climate change risk perceptions, prioritization of environmental protection relative to economic growth, knowledge acquisition, and interest in additional environmental information.

**PCT Systems.** Three different types of PCT systems were described: (1) a PCT system based on carbon credits as proposed by the UK government, (2) a PCT system based on $kgCO_{2e}$ where carbon allocations are assigned in kilograms rather than being converted to credits, and (3) Personal Ecosystem Impact Trading (PET) where a cap in placed on total ecological impact rather than carbon emissions alone. All three systems provide individuals with a monthly allocation of pollution, an account to track cumulative pollution, labels that provide the ability to compare the environmental impact of personal choices, and the ability to buy and sell pollution units.

Most of the literature on personal cap and trade systems has focused on the pollutant carbon and has assigned quotas in the form of carbon credits (e.g., PCT with credits). For this study, the condition PCT with $kgCO_{2e}$, was developed since it was expected that actual units of pollution would be easier for individuals to understand compared to credits. Additionally,

the term *credits* may generate misconceptions surrounding PCT. Receiving an allocation of $kgCO_{2e}$ rather than an allocation of credits keeps the policy focus on carbon pollution.

**Hypothesis 5**: Among PCT mechanisms, compared to providing people with feedback based on carbon credits, providing people with feedback based on $kgCO_{2e}$ will produce significantly higher levels of personal efficacy, collective efficacy, personal responsibility for climate change, climate change risk perceptions, prioritization of environmental protection relative to economic growth, knowledge acquisition, and interest in additional environmental information.

While most of the literature on personal cap and trade has focused on carbon emissions, a personal cap and trade system could be applied to the individual's broader environmental impact using a measure such as the *Ecological Footprint* (Global Footprint Network, 2018). An *Ecological Footprint* is a measure of how much area of productive land and water (in global hectares) is required to support and absorb the waste from the consumption of an individual or a population. Biologically productive land is split into six categories: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land. In addition to climate change, the *Ecological Footprint* includes the individual's impact on biodiversity, water quality and soil quality. Carbon emissions currently account for 60% of people's total *Ecological Footprint* and represent the fastest growing component of the *Ecological Footprint*; reducing our carbon footprint is the most urgent and necessary step we can take to reduce the demand we are placing on Earth's resources (Global Footprint Network, 2018).While a PCT system with carbon credits or with $kgCO_{2e}$ would target the most essential component of *Ecological Footprint*, it would be insufficient at addressing climate change in a holistic manner in relation to other environmental issues (e.g., deforestation, overgrazing, fisheries collapse, food insecurities,

rapid species extinctions etc.) (Global Footprint Network, 2018). PET would address total *Ecological Footprint*.

**Hypothesis 6**: Compared to PCT with credits, PET with credits will produce significantly higher levels of personal efficacy, collective efficacy, personal responsibility for climate change, climate change risk perceptions, prioritization of environmental protection relative to economic growth, knowledge acquisition, and interest in additional environmental information.

**Summary of the experimental conditions**

Below is the summary of the six different conditions in the experiment.

(1) **Control Condition** – Participants watched a brief introduction to climate change video, but were not provided any information on a carbon pricing system.

(2) **Low Visibility Carbon Tax (Current BC Carbon Tax)** – First, participants watched the climate change video. Next, participants watched a second video where they received information about the carbon tax, including that the tax is intended to increase every year. Then, participants received feedback about the cost of products within the scope of the carbon tax policy (e.g., Gasoline at the pump: $54).

(3) **Carbon Labeling Policy (with embedded tax)** – First, participants watched the climate change video. Next, participants watched a second video where they received the same information as condition 2 about the carbon tax. The amount of carbon pollution resulting from a product was presented beside the product cost, along with a measure of percent monthly recommended carbon pollution (e.g., Gasoline at the pump: $54, 101 kg$CO_{2e}$, 13% of total monthly carbon pollution). Individuals' overall consumption was not tracked.

(4) **Personal Carbon Trading (PCT with credits)**. First participants watched the climate change video. Next, participants watched a second video where they received information about PCT, including information about individual caps and how caps are intended to decrease every year. The condition description was based on the PCT policy proposed by the UK government. Participants received feedback about the carbon credit cost of products. Carbon credits represent the amount of $CO_{2e}$ emissions resulting from purchased products (**e.g., Gasoline at the pump: $50.48 + 1 carbon credit, 7** ***carbon credits remaining****)*.

(5) **Personal Carbon Trading (PCT with kg$CO_{2e}$)**. First participants watched the climate change video. Next, participants watched a second video where they received information equivalent to that in condition 4, the only difference being that carbon credit allocations were given in the unit $kgCO_{2e}$. Therefore, carbon consumption was labeled with $kgCO_{2e}$ (**e.g., Gasoline at the pump: $50.48 + 100 kg$CO_{2e}$,** ***700 kg$CO_{2e}$ remaining****)*.

(6) **Personal Ecosystem Impact Trading (PET)**. First participants watched the climate change video. Next, participants watched a second video where they received the same information as condition 4, however, the cap was on total *Ecological Footprint* instead of carbon emissions. *Ecological Footprint* was explained to participants. Ecosystem impact credits were presented alongside the product price (**e.g., Gasoline at the pump: $50.48 + 1 ecosystem impact credit,** ***7 ecosystem impact credits remaining****)*.

**Political Orientation, Environmental Values and Trust in Government**

Citizens who identify as conservative tend to deprioritize environmental issues and show weaker support for environmental policy than those with a liberal ideology (Campbell & Kay, 2014; McCright & Dunlap, 2011). Furthermore, liberals are more likely to view climate change as risky and are more likely to support costly risk mitigation public policies (Zahran, Brody, Grover & Vedlitz, 2006). Participants' political orientation is assessed in the study to examine whether it moderates any of the above predicted relations.

Environmental values and trust in government can also influence support for environmental initiatives and therefore were included as control variables (Lubell et al., 2007, Torgler & Garcia-Valinas, 2007; Jagers, Lofgren & Stripple, 2009).

# Chapter 2: Methods

## Participants

A total of 1027 people residing in Canada signed up for the study on Amazon Mechanical Turk (Mturk), but 580 were excluded from analysis for the following reasons: 214 decided not to participate after reading the consent form, 67 did not complete the experiment, and 299 failed the attention check tests embedded in the experiment.

The final sample included $N = 447$; 190 females; 250 males; 7 preferred not to answer. Ages ranged from 18 to 68 ($M = 31.79$, $SD = 10.50$). The sample was 65.1% Caucasian, 11.0% East Asian, 10.7% South Asian, 4.7% Black, 3.8% Hispanic/Latino, 3.8% Indigenous Canadian, 3.1% Middle Eastern, 0.6% Southeast Asian, 0.6% Métis, and 2.0 % other. The majority of the sample considered themselves to be liberal or left of centre in political orientation: 26.0% identified as left of center (e.g., NDP), 35.6% identified as in the center (e.g., Liberal), 12.5% as right of center (e.g., Conservative), and 25.9 % as other or did not know. The majority lived in Ontario (45.0%), followed by British Columbia (17.7%), Quebec (12.3%), Alberta (12.1%), Manitoba (3.6%), Nova Scotia (3.6%), New Brunswick (2.5%), Saskatchewan (1.8%), Prince Edward Island (0.9%), and finally Newfoundland (0.7%). There were no participants from the Yukon, Nunavut or Northwest Territories.

## Measures

### Dependent Variables.

***Efficacy.*** Collective and personal efficacy were each assessed using the average score of two questions, answered on 4-point scales (1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree). **Collective efficacy items:** *this system would reduce global climate change*, and *this system would enable Canada to achieve significant environmental*

*sustainability goals*, $r$ (385) = .75, $p < .001$. Scores ranged from 1 to 4; $M = 2.89$, $SD = 0.75$ (see Table 1). These items were based on the following measure of perceived policy effectiveness, *What effect do you think it* [the policy described] *would have on climate change?*; participants answered using a 7-point scale, 1 = Reduce or stop climate change, 4 = Neither reduce nor increase, 7 = Increase climate change (Bostrom, O'Connor, Bodid, Ekstrome, Halderf, Jeschkeg…Saelensindee, 2012). **Personal efficacy:** *this system would enable Canadians to significantly reduce their impact on climate change*, and *this system would enable me to live sustainably*, $r$ (385) = .67, $p < .001$. Scores ranged from 1 to 4; $M = 2.80$, $SD = 0.79$ (see Table 1). Note: participants in the control condition did not complete these questions.

*Validity*. The correlation between the measures of personal and collective efficacy, $r$ (385) = .83, $p < .001$, provides some evidence that the two scales have conceptual content in common (convergent validity). The correlations between the measures of personal and collective efficacy with personal responsibility, system support, and risk perception are consistent with previous research, and with the study prediction (predictive validity). Finally, personal efficacy differed significantly between experimental conditions, whereas other measures (personal responsibility, system support, risk perception, environmental values etc.) did not. This provides evidence that personal efficacy is measuring something different than the other variables (discriminant validity).

***System support.*** Two items developed by Lam (2014) were used to assess participants' support for the market mechanism they viewed in the second video. Participants answered the following questions using a 5-point scale (1 = definitely would not, 2 = would not, 3 = neither would or would not, 4 = would, and 5 = would definitely): *Would you support the implementation of this system in Canada?* and, *Would you be willing to make*

*adjustments to your behaviour under this system?, r* (385) = .72, $p < .001$. Participant scores ranged from 1 to 5; $M = 3.68$, $SD = 1.09$ (see Table 1). Note: participants in the control condition did not complete these questions.

***Knowledge acquisition.*** Knowledge acquisition was measured with a task that included three items. Participants were asked: *Please indicate the activity that results in the most $CO_{2e}$ emissions…* Question 1: *Heating a home in Northern British Columbia with natural gas during the month of January; Driving 466km in a medium sized gasoline car (approximately one tank of gas); Result in roughly the same amount of emissions; Unsure.* Question 2: *Providing a home in Northern British Columbia with electricity during the month of January; Driving 466km in a medium sized gasoline car (approximately one tank of gas); Result in roughly the same amount of emissions; Unsure.* Question 3: *Heating a home in Northern British Columbia with natural gas during the month of January; Providing a home in Northern British Columbia with electricity during the month of January; Result in roughly the same amount of emissions; Unsure.* The number of correct responses was recorded and summed to create a single score. Scores ranged from 0 to 3; $M = 1.61$, $SD = 1.09$ (see Table 1).

***Personal responsibility.*** Five items were selected from a 7-item Likert scale of personal climate change norms developed by Jansson and Dorrepaal (2015); their sample received a Cronbach's alpha of 0.91. Participants indicated their level of agreement on a 5-point scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) with the following statements: *I think it is important to have my climate impact in mind in my everyday behaviours*, *I have a moral responsibility to take climate change into consideration*, *I have a moral obligation to buy climate friendly products when shopping, I feel a personal responsibility for global warming*, and *Not only governments and*

*industry are responsible for climate change, I am as well*. Cronbach's alpha for the five items was 0.87; scores across the five items were averaged. Scores ranged from 1.6 to 5.0; $M$ = 4.00, $SD$ = 0.76 (see Table 1).

***Risk perceptions.*** Climate change risk perceptions were measured using a six-item scale developed by Kellstedt et al. (2008). For the first three items, participants indicated their agreement on a 4-point scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree) with the statement *Global warming and climate change will have a noticeably negative impact on…*the following 3 things… *in the next 25 years* (personal health, financial situation, and environmental welfare). For the next three items, participants indicated the degree of risk, on a 4-point scale (1 = no risk, 2 = low risk, 3 = medium risk, 4 = high risk)*, of global warming and climate change exerting a significant impact on…*the following 3 things… *in the next 25 years* (public health, economic development, and environmental integrity). The six items had a Cronbach's alpha of 0.85, which is similar to the Cronbach's alpha of the sample used by Kellstedt et al. (2008) (Cronbach's alpha = 0.87). Scores across the six items were averaged; scores ranged from 1 to 4; $M$ = 3.19, $SD$ = 0.56 (see Table 1).

***Prioritization of environmental protection relative to economic growth.*** Participants were asked, *Please rate the importance of the following issues to you* on a 7-point scale (7 = extremely important, 6 = very important, 5 = important, 4 = neutral, 3 = not important, 2 = not very important, and 1 = not important at all): *Economic growth*; *Reducing poverty*; *Environmental protection*; *Improving education*; and *Mitigating injustice to indigenous people's in Canada*. First, centered scores were calculated for economic growth and environmental protection, and then the difference between the two centered scores was calculated. Scores ranged from -6 to 6; $M$ = 0.64, $SD$ = 1.52 (see Table 1). A negative score

indicates that economic growth was ranked above environmental protection; a positive score indicates that environmental protection was ranked above economic growth; a score of zero indicates that they were ranked as equal.

***Interest in environmental Information.*** To measure interest in environmental information, participants were asked (*yes*/*no*) if they would like to learn more about climate change. If they clicked *yes*, a link to additional information was provided and their response was recorded. Overall, 57% of participants responded *yes*.

***Environmental Values.*** Participants completed the shortened Schwartz Value Survey (Schwartz, 1992), which included 26 items (each followed by a short definition in parentheses); e.g., *loyal (faithful to my friends, group)*). Participants indicated on a 9-point scale (-1 = opposed to my principles, 0 = not important, 4 = important, 7 = of supreme importance) how *important as a guiding principle* each value is to them. Two of the 26 items assess environmental values: (1) unity with nature (fitting into nature) and (2) protecting the environment (preserving nature). These two items were centred by subtracting the individual item score from the average score across all 26 items. The two centered scores are significantly correlated, $r(477) = .52$, $p < .001$, and were combined to provide an index of environmental values. Scores ranged from -3.6 to 4.0; $M = 0.61$, $SD = 1.33$.

***Trust Index.*** Trust in government was measured by taking the average of two items on a 5-point scale (1 = never, 2 = once in a while, 3 = about half the time, 4 = most of the time, 5 = always): (1) *how much of the time do you think you can trust the federal government in Canada to do what is best for the country,* and (2) *how much of the time do you think you can trust the federal government in Canada to make decisions in a fair way* (Gershtenson & Plane, 2007). The two measures of trust are significantly correlated, $r$ (477)

= .85, $p < .001$, and were combined to form an index of trust in government. Scores ranged from 1 to 5; $M = 3.02$, $SD = 0.95$.

***Attention check items.*** The purpose of the three attention check items were to ensure that participants watched their assigned video (the experimental stimulus) in its entirety before completing the outcome measures. The items were as follows: (1) Did participants select the letter in SurveyMonkey that was displayed at the end of their YouTube Video (yes/no); $n = 723$ participants selected the correct letter. (2) A two-item recall test in the Carbon Tax condition; a four-item recall test in the other conditions (question example: *What happens if an individual goes over their monthly allocation of carbon credits?* (a) *Nothing* (b) *They must pay a set fine* (c) *They must pay for additional carbon credits at the market value*). Participants who received a score of < 50% were removed. Of the participants who passed the first attention check, $n = 694$ passed the recall test. (3) The amount of time it took participants to complete the survey was evaluated. Participants were removed if the time it took them to complete the survey was less than the length of their assigned video(s) plus 8 minutes; $n = 447$ passed all three attention checks.

**Procedure**

Participants signed up for the study online using Mturk, where they were linked to an online survey on the platform SurveyMonkey. When data is screened and attention checks are embedded in the experiment, Mturk samples have been shown to provide quality data (Chmielewski & Kucker, 2019). Moreover, data quality of Mturk samples has been shown to be comparable to university student samples (Necka, Cacioppo, Norman & Cacioppo, 2016;

Kees, Berry, Burton & Sheehan, 2017). Three items were used in the present study to assess participants' attention.

Participants received US $2 for participating in university-based research. SurveyMonkey randomly assigned participants to one of the six conditions: control ($n$ = 62); Carbon tax ($n$ = 79); Carbon labeling ($n$ = 82); PCT with credits ($n$ = 87); PCT with $kgCO_{2e}$ ($n$ =71); PET ($n$ = 66); see Table 2 for sex, age, political orientation and province of residence of participants by condition.

**Introduction video**. All participants watched a brief, 2 minute (min) 45 second (sec), informational video on global climate change (see Appendix A for the video link). The informational video explained greenhouses gases and their importance in making the Earth habitable; explained anthropogenic emissions and how they are driving global climate change; and described global and Canadian climate change targets. The video concluded by informing participants of the Federal Government's decision to make carbon pricing mandatory in Canada. Participants in the control condition then completed the following outcome measures: personal responsibility for climate change, climate change risk perceptions, and prioritization of environmental protection relative to economic growth.

**Experimental treatment videos.** Participants who were assigned to one of the five experimental conditions watched an additional video describing an environmental pricing system. Videos ranged in length from 3 min 45 sec to 7 min 45 sec (Carbon tax: 3 min 56 sec, Carbon tax with labeling: 6 min 14 sec, PCT with credits: 6 min 36 sec, PCT with $kgCO_{2e}$: 6 min 43 sec, PET: 8 min 03 sec). All videos provided a description of the system, followed by examples of the information one would receive when purchasing gasoline, natural gas, or electricity (see Appendix A for links to the videos). Some examples of the information received are: carbon tax condition, *cost of gas: $55.50*; PCT with carbon credits,

*cost of gas: $50.50, 1 carbon credit (7 credits remaining)* etc. The videos and scripts followed a highly similar structure (see Appendix B for video transcripts); they differed in length only because more complex systems required additional explanation. For example: the carbon labeling video needed to communicate all the information present in the carbon tax video in addition to information about carbon labeling, the PCT systems need to show participants a mock carbon/ecosystem impact statement, and the PET video needed to provide an explanation of *Ecological Footprint*. As attention check 1, a letter was displayed at the end of the YouTube video, participants had to select this same letter in SurveyMonkey.

After watching their respective experimental treatment video on YouTube, participants returned to SurveyMonkey and completed the second attention check (a two-item recall test in the carbon tax condition; a four-item recall test in all other conditions). Next, participants completed the outcome measures: personal efficacy, collective efficacy, system support, personal responsibility, risk perceptions, prioritization of environmental protection relative to economic growth, and knowledge acquisition. They were also asked whether they had any comments about the policy; $n$ = 211 participants (55 % of those in an experimental condition) provided comments.

Finally, all participants completed demographic, environmental value, and trust in government questions. Their interest in additional environmental information was also assessed.

For the final attention check, the amount of time it took participants to complete the survey was evaluated.

**Debriefing.** At the end of the experiment participants were given more information about the purpose of the study and were given references to the research that framed the research questions.

## Data Analysis

**Quantitative**. It was planned to test the impact of environmental pricing system (Carbon Tax, Carbon Labeling, PCT with credits, PCT with $kgCO_{2e}$, PET) and political orientation (Conservative: yes/no) on the dependent variables (with the exception of interest in environmental information) using a series of two-way MANOVAs and ANOVAs. However, since an insufficient number of Conservatives completed the study[1] one-way analyses were run instead to investigate the effect of pricing system. Since interest in environmental information was a binary measure, it was analyzed using a logistic regression.

To ensure that there were no significant differences in environmental values and trust between groups, separate one-way ANOVAs were run. No significant differences were found between groups[2].

***Grouping dependant variables into MANOVAs and ANOVAs***. The specific groupings of MANOVAs and ANOVAs were determined based on how the dependent variables were correlated (Tabachnick & Fidell, 2013, p. 270). To ensure the dependant variables were not too highly correlated for MANOVA, multicollinearity and singularity were assessed by generating bivariate Pearson correlations among the dependent variables. No variables were correlated greater than $r$ =.90, therefore, none were combined or deleted (Tabachnick & Fidell, 2013, p. 88). Two dependent variables, knowledge acquisition and prioritization of environmental issues, were not sufficiently correlated with the other dependent variables; therefore, they were run in separate one-way ANOVAs (Tabachnick & Fidell, 2013, p. 270). Collective efficacy, personal efficacy, system support, personal

[1] Number of Conservatives who completed the study: control: $n$ = 11, Carbon Tax: $n$ = 7, Carbon Labeling: $n$ = 14, PCT with credits: $n$ = 8, PCT with $kgCO_{2e}$: $n$ = 6, PET: $n$ = 10

[2] Environmental Values: $F$ (5, 441) = 0.79, $MSE$ = 1.41, $p$ = .559; Trust in Government: $F$ (5, 441) = 0.74, $MSE$ = 0.66, $p$ = .597.

responsibility, and climate risk perceptions all had sufficient correlation. However, based on the bivariate scatterplots, these variables as a group were not adequately linearly related to include in one MANOVA. Collective efficacy, personal efficacy, and system support had a sufficient linear relationship and were included in one MANOVA. Personal responsibility and risk perceptions also had a sufficient linear relationship, and were included in a second MANOVA.

In total, five analyses were run (see Table 3). A Holm-Bonferroni correction was applied to an alpha of .05 to adjust for multiple comparisons. The *p*-values obtained from the five analyses were ordered from lowest to highest, and compared to the following corrected alpha levels: .01, .0125, 0.0167, .025, and .05.

***Efficacy and System Support***. To test whether the different pricing systems affected participants' sense of personal efficacy, collective efficacy, and support for the system, a one-way between-persons MANOVA was used. Since participants in the control condition did not view a pricing system, they were not given the efficacy and system support survey questions. Therefore, the independent variable had five levels: Carbon Tax, Carbon Labeling, PCT with credits, PCT with $kgCO_{2e}$, and PET. One case was a multivariate within-cell outlier[3] and was removed, therefore the final *N* for this analysis was 384. Evaluation of the assumptions of normality, homogeneity of variance-covariance matrices, linearity, and multicollinearity were satisfactory.

Wilks' criterion was used to determine if there were group differences between the combined dependent variables (personal efficacy, collective efficacy, system support). In order to determine group differences between the individual dependent variables, Roy-

[3] criterion of $p < .001$, critical $\chi^2 = 16.26$

Bargmann stepdown analysis was used. In order to maintain an error rate of 1% for the analysis, a Holm-Bonferroni correction was used to calculate the alpha for each step (shown in Table 3). Smithson's (2003) program (NoncF3.sps) was used to calculate effect sizes (Partial $\eta^2$) and the confidence limits for the effect sizes (Tabachnick & Fidell, 2013, p. 291).

All dependent variables were judged to be sufficiently reliable to warrant stepdown analysis. Priority was assigned based on univariate *F* scores (personal efficacy emerged as the highest priority, followed by collective efficacy, and finally system support). Therefore, for stepdown analysis, personal efficacy was analyzed in a univariate ANOVA; collective efficacy was analyzed in a one-way ANCOVA with personal efficacy as a covariate; and support was analyzed in a one-way ANCOVA with collective efficacy and personal efficacy as covariates[4]. While univariate *F*s are misleading, they were reported alongside stepdown *F*s to help with the interpretation of the stepdown analysis (Tabachnick & Fidell, 2013, p. 288). To determine which pairings of pricing systems were significantly different from one another, post-hoc least significant difference (LSD) tests were conducted with an alpha of .003 for each pairwise comparison.

***Knowledge Acquisition.*** To test if knowledge acquisition varied between groups, a one-way between-person ANOVA (System = 5 levels; $N = 385$) was performed. Knowledge acquisition scores could range from 0 to 3 and were based on the number of correct answers to three questions about the relative amount of $CO_{2e}$ emissions resulting from activities described in the experimental videos. The Carbon Tax acted as the control because it did not provide individuals with emissions quantification information, whereas all other systems did. Results from the evaluation of assumptions of normality and homogeneity of variance were

[4] Homogeneity of regression was achieved at $p > .01$ for all components of the stepdown analysis. A cut-off of $p > .01$ was used because robustness is expected (Tabachnick and Fidell, 2013, p. 282).

satisfactory. The ANOVA was followed up with post-hoc LSD tests; an alpha of .0125 was used for each pairwise comparison.

***Risk Perception & Personal Responsibility.*** To test whether being exposed to different pricing systems affected participants' risk perception and feeling of personal responsibility for climate change, a one-way between-persons MANOVA was used. Wilks' criterion was used to determine if there were group differences between the combined dependent variables (risk perception and personal responsibility). The independent variable had six levels: Control, Carbon Tax, Carbon Labeling, PCT with credits, PCT with $kgCO_{2e}$, and PET. There were five univariate within-cell outliers[5] which were adjusted to the most extreme score within condition that satisfied $|z| < 3.3$. One multivariate within-cell outlier[6] was deleted, therefore the final *N* for this analysis was 446. Results from the evaluation of assumptions of normality, homogeneity of variance-covariance matrices, linearity, and multicollinearity were satisfactory.

***Environmental Prioritization.*** To test if prioritization of environmental issues relative to economic development varied between groups, a one-way between-persons ANOVA (System = 6 levels; $N = 447$) was performed. Three within-cell outliers were adjusted to the most extreme score within conditions that satisfied $|z| < 3.3$. Results from the evaluation of assumptions of normality and homogeneity of variance were satisfactory.

***Interest in Environmental Information***. The impact of the five pricing systems on environmental interest (a binary *yes*/*no* variable) was tested using logistic regression. The assumptions of adequate ratio of cases to variables and linearity in the logit were met.

[5] criterion: $p < .001$, $|z| < 3.3$, criterion used by Tabachnick and Fidell, 2013, p.73
[6] criterion: $p < .001$, critical $\chi^2 = 13.816$

**Qualitative**. A substantial number of participants ($n$ = 211) provided comments about the pricing system they were exposed to. The participants who chose to provide comments did not differ from those who did not in terms of political orientation, environmental values, or trust in government[7].

Emergent themes were identified using an inductive coding approach (Miles, Huberman, & Saldaña, 2014). The coding process was divided into two major stages, First Cycle and Second Cycle coding, as described by Saldaña (2013). A combination of descriptive codes, In Vivo codes, value codes and evaluation codes (Saldaña, 2013) were used to summarize participants' responses during the First Cycle coding stage. Second Cycle coding synthesized the codes into categories to generate Pattern codes (Saldaña, 2013; Miles et al., 2014, p. 86). Analysis of the Pattern codes and the relationships between these codes led to the generation of subthemes. Finally, after exploring relationships between codes, and using a circular process of refining and revisiting categories, codes, and subthemes, emergent themes were identified (see Table 9).

[7] all $t(445) < .551$, $p > .582$

## Chapter 3: Results

The primary goal of the study was to examine whether, relative to carbon tax systems, PCT systems would be viewed as more effective at enabling the collective to reach environmental targets (collective efficacy) as well as at enabling individuals to reduce their personal environmental impact (personal efficacy). If a pricing system increases citizens' sense of efficacy and personal responsibility, these beliefs were expected to in turn increase interest in environmental issues, perceptions of environmental risk, and prioritization of environmental protection. The psychological impact of the different environmental pricing systems was tested. Correlations among the dependent and demographic variables are provided first, followed by results from the five quantitative analyses that were conducted (see Table 3). For a summary of how these results relate to the six hypotheses introduced in Chapter 1, please see Table 4. After the quantitative results are presented, thematic analysis of participants comments about the policy are provided.

First, when examining the bivariate correlations (see Table 5), it is apparent that collective and personal efficacy were highly correlated with each other, and they were each correlated similarly with the other dependent variables. When participants felt that the pricing system could attain significant global and national goals (collective efficacy) and that it could enable the individual to live more sustainably (personal efficacy), participants also tended to show more support for the pricing system, tended to pay more attention to environmental information (knowledge acquisition and environmental interest), viewed climate change as a more significant risk, and reported more personal responsibility for reducing their environmental impact.

Those who were politically conservative (compared to those who identified as elsewhere on the political spectrum) reported weaker environmental values, weaker feelings

of personal responsibility for action, weaker climate change risk perceptions, and placed lower priority on environmental protection relative to economic development; however, the groups did not differ on efficacy beliefs, knowledge acquisition or interest in environmental issues. Surprisingly, compared to liberals, political conservatives did not report less overall support for the environmental pricing systems they were exposed to.

In general, youth was associated with stronger environmental beliefs including: efficacy beliefs, support for environmental pricing systems, environmental risk perceptions and knowledge acquisition. Across all of the dependent variables, there were two sex differences: males performed better than females on the knowledge acquisition task, and women placed higher priority on environmental protection relative to economic development.

**Differences among Pricing Systems**

The impact of the two carbon tax systems (Carbon Tax, Carbon Labeling) and three PCT systems (PCT with credits, PCT with $kgCO_{2e}$, PET) on the dependent variables was examined using two one-way MANOVAs, two one-way ANOVAs, and one logistic regression. Sample sizes for each condition were as follows: control ($n$ = 62); Carbon Tax ($n$ = 79); Carbon Labeling ($n$ = 82); PCT with credits ($n$ = 87); PCT with $kgCO_{2e}$ ($n$ = 71); PET ($n$ = 66). An experiment-wise error rate of $\alpha = .05$ was used. The $p$-values obtained from the five analyses were ordered from lowest to highest, and compared to the following corrected alpha levels: .01, .0125, 0.0167, .025, and .05.

**Efficacy and System Support**

First it was tested if the five pricing systems (carbon tax, carbon labeling, PCT with credits, PCT with $kgCO_{2e}$, and PET) differentially affected participants' perceptions of personal efficacy, collective efficacy, and support for the system. The combined dependent variables did differ significantly among pricing system, $F$ (12, 998) = 3.40, $p < .001$, Wilk's $\Lambda = 0.899$, partial $\eta^2 = .04$, 99% CI [.01, .06], and had a small to medium effect size (Table 2.2 in Murphy & Myors, 2004).

Examining the dependent variables separately, a sense of personal efficacy, that is, participants' sense that the policy they viewed would enable them to decrease their carbon consumption and live sustainably, differed significantly between pricing systems, stepdown $F$ (4, 379) = 6.03, $p < .001$, partial $\eta^2 = .06$, 99.7% CI [0.005, 0.133], and had a medium effect size (Table 2.2 in Murphy & Myors, 2004). Table 7 provides the results of the pairwise comparisons. PCT with $kgCO_{2e}$ elicited the most personal efficacy ($M = 3.13$, $SD = .73$), followed by PCT with credits ($M = 2.91$, $SD = .75$). PCT with $kgCO_{2e}$ elicited significantly more personal efficacy than the following three systems: Carbon Tax ($M = 2.72$, $SD = .76$), Carbon Labeling ($M = 2.67$, $SD = .74$), and PET ($M = 2.57$, $SD = .86$) (see Figure 3).

Across the pricing systems, different levels of collective efficacy (beliefs that the pricing system could achieve significant global and National environmental targets) provided no additional variance beyond what is already captured with the measure of personal efficacy. The univariate $F$ (4, 379) = 3.32, $p = .011$, $MSE = 1.85$, partial $\eta^2 = .03$, for collective efficacy would have been significant if a more liberal alpha had been applied; the stepdown $F$ (4, 378) = 1.11, $p = .350$, partial $\eta^2 = .01$, 99% CI [.00, .04] was not significant.

In terms of participants' level of support for the different environmental systems, the majority of participants indicated that they supported the system they viewed: 73% indicated

they would either support or definitely support the system (selected 4 or 5 on the 5 point scale), 10% were neutral (selected 3), and 17% indicated they would not support their assigned system (selected 1 or 2 on the scale). Support did not, however, differ significantly as a function of the pricing systems: stepdown $F$ (4, 377) = 3.12, $p$ = .015, partial $\eta^2$ = .03, 99.5% CI[.00, .09].

**Knowledge Acquisition**

Next, it was tested if the pricing system that participants viewed affected the knowledge they acquired about the relative amount of carbon emissions resulting from different activities (e.g., personal vehicle use). Knowledge acquisition scores were based on the number of correct answers to three questions about the relative amount of $CO_{2e}$ emissions resulting from activities described in the experimental stimulus videos (scores could range from 0 to 3). Figure 4 illustrates that knowledge acquisition varied significantly across pricing systems, $F$ (4, 380) = 4.84, $MSE$ = 1.14 , $p$ = .001 partial $\eta^2$ = .049, 98.75% CI [.004, .103], with a medium effect size (Table 2.2 in Murphy & Myors, 2004).

Follow up pairwise comparisons indicated that relative to the Carbon Tax ($M$ = 1.29, $SD$ = 1.02), more knowledge was acquired with Carbon Labeling ($M$ = 1.94, $SD$ = 1.06), PCT with $kgCO_{2e}$ ($M$ = 1.89, $SD$ = 1.12) and PCT with credits ($M$ = 1.75, $SD$ = 1.11) (see Table 8 and Figure 4). Unlike the other cap and trade systems, people did not acquire more knowledge with PET ($M$ = 1.55, $SD$ = 1.03).

**Risk Perception & Personal Responsibility**

The different pricing systems did not have a significant impact on participants' climate change risk perception or their sense of personal responsibility for taking action on climate change: $F$ (10, 878) = 0.999, $p$ = .443, Wilk's $\Lambda$ = .978, partial $\eta^2$ = .01, 98.33% CI [.00, .02].

**Environmental Prioritization**

The type of pricing system participants viewed did not affect their prioritization of environmental issues relative to economic issues: $F$ (5, 441) = 0.78, $MSE$ = 2.16, $p$ = .562, partial $\eta^2$ = 0.01, 97.5% CI [.00, .03].

**Interest in Environmental Information**

After participants watched their videos and completed the questions about their assigned pricing system, they were asked (*yes*, *no*) if they were interested in receiving more information about global environmental issues. More than 50% of participants in each condition responded *yes*: PCT with $kgCO_{2e}$ (63.4%, $n$ = 71), Carbon Tax (59.5%, $n$ = 79), PET (57.6%, $n$ = 66), PCT with credits (57.5%, $n$ = 87), Carbon Labeling (53.7%, $n$ = 82), control (53.2%, $n$ = 62). However, there were no significant differences among conditions, $\chi^2$ (1, N = 447) = .518, $p$ = .472.

**Thematic Analysis**

A substantial number of participants (n = 211) provided comments about the policy they viewed. In terms of the general tenor of the comments provided, 44% were mostly

negative toward the pricing system they viewed, 18% were mostly positive, 11% offered both negative and positive reflections, and 27% provided neutral comments (e.g., asking for clarification about a specific aspect of the policy).

Emergent themes were identified using an inductive coding approach (Miles, Huberman, & Saldaña, 2014; Saldaña, 2013). During First Cycle coding, 122 codes were generated. In Second Cycle coding, these codes were synthesized into 19 Pattern codes. Analysis of the Pattern codes and the relationships between these codes led to the generation of subthemes, and finally, 10 emergent themes were identified (see Table 9).

The majority of themes/sub-themes were present across all environmental pricing systems, but some were specific to one system in particular (e.g., Carbon Tax with Carbon Labeling) or to a set of systems (e.g., PCT systems). When speaking about a specific system or set of systems, it will be explicitly specified.

**Government regulation restricts our freedom.** A few participants were against government regulation, one individual said they felt a bottom up approach from citizens is what is needed. A small number of participants felt that a PCT system would restrict their freedom, describing the system with the following adjectives, “Orwellian”, “fascist”, “socialist”, “insanity”, “onerous”, “communist”, “intrusive”, and comparing the system to “war rationing”. While there was negative emotion associated with the majority of respondents who spoke of the restriction of freedom, there were a few who acknowledged that PCT would resist freedom, but did not seem entirely opposed to it, “It feels a bit like war rationing, but I suppose that is unavoidable.”

**Targeting Canadian citizens with carbon pricing is both ineffective and unfair**. Many participants felt that since businesses and corporations produce the majority of environmental pollution, the onus should be the them to pay for the environmental damage,

“I don't understand why you are pretending like individuals are the problem, this is passing on a problem created by industries, they must be forced to fix it, not the people who are victims of it.” Carbon pricing at the individual level places the burden on citizens stuck in systems they did not create and cannot change, “Modern working families are just punished for a society we did not design”.

Targeting individuals was not only viewed as unfair, but also as ineffective, “How will this affect any real change in how energy is provided-- all the costs of CO2e are just loaded on to the backs of working families, instead pressuring the energy providers to change how they do business”. Commenting on how corporations account for such a large portion of emissions, participants felt that carbon pricing at the individual level “will hardly put a dent in the issue”.

Another major reason carbon pricing applied to individual citizens was viewed as unfair and ineffective was because many participants felt the poor would suffer while the rich would keep polluting, “This policy would put a big strain on poor people while allowing well off people to maintain their lifestyle with little change”. People feared that those who could afford to weatherproof their home, purchase an electric car etc. would not do so as they can easily pay the tax without adjusting their lifestyle. Meanwhile, (especially after being burdened by a tax) the poor (who already take the bus and walk when possible for transit), would not be able to afford to upgrade to more efficient furnaces/appliances, or renovate their homes with new windows and added insulation rendering the policy ineffective in decreasing carbon emissions. Many felt that in the end, carbon pricing just makes citizens pay more for fossil fuels, and does little to change behaviour and decrease pollution.

Some participants remarked that Canada accounts for an “insignificant” amount of carbon emissions globally. Some thought that carbon pricing may be effective if applied to

everyone in the world (particularly in countries such as China), but until then, it would just inconvenience Canadians while making no difference in reducing overall global climate change.

**Carbon pollution should not be monetized.** A small number of individuals expressed that, "handling carbon output shouldn't always involve monetization". Monetization of carbon was noted to be ineffective in reducing emissions as it can lead to the justification for polluting. One individual reflected that it is the monetization of carbon that can lead to serious equity issues,

> I believe the global north has for far too long been okay with paying for pollution, yes having to pay for [credits] acts as a deterrence, much like a carbon tax does, but it also somehow makes it easier to rationalize the quantity of pollution, so much to the fact that rich people will be easily able to buy credits to be able to pollute more and thereby exacerbate the polarization of the quality of lives led by people with disparate incomes and lifestyles. Makes me imagine a climate dystopia, where eventually the poor and marginalized have to trade their credits, just to survive.

**This policy is particularly unfair to vulnerable groups**. Many participants were particularly concerned for how the increased cost of a carbon pricing policy would affect vulnerable groups including, Indigenous populations, elderly citizens, medical patients, farmers, families with children, those who live in rural/remote communities, those who live in hostile/cold climates, and renters. Participants were worried this policy would push those who already struggling even further into poverty, decreasing their quality of life substantially.

The urban vs. rural dichotomy came up frequently, with individuals feeling that carbon pricing policies might be suitable for urban areas with mild winters and access to

public transit, but that it is unfair to apply that same tax (or assign the same amount of credits) to northern and rural communities, “Will the carbon tax be the same across the country? For instance, would those living in the North be unfairly taxed because they require more heating/transportation? What about rural communities who don't have a public transit option and must drive?” Some participants recommended that different areas in Canada should be assigned a different tax rate (or a different amount of credits) based on factors such as climate, distance from urban centers, and accessibility of public transit.

Another group that participants were concerned for were renters who do not have control over weatherproofing or upgrading to energy efficient appliances and already have expensive utility bills, “As someone living in an underprivileged community where landlords don't tend to do needed renovations (and there's a housing crisis), it already results in having a lot of people having ridiculously high hydro bills”. Participants felt that, “This plan doesn't seem to give landlords any incentive to go green and puts the onus on the renters which is not fair at all.”

**Government should focus on subsidies and supply side initiatives.** While this was not directly asked in the open-ended questions, alongside sharing their comments on their assigned carbon pricing policy, many participants also expressed what kind of initiatives they would like to see the Government do,

> [Instead of] complicate[ing] the lives of Canadians who as a whole account for an insignificant % of global emissions, I would rather government policy focus on the supply side (encourage manufacturers to produce electric vehicles by sharing R&D spending, shift sources of power generation).”

Many participants wanted government to encourage innovation and green technology. When speaking about a PCT system, one participant remarked, “I feel like it's a policy that forces

Canadians to be more mindful of their impact on the ecosystem, but at the same time does not really offer any ways to help Canadians be more mindful." Participants wanted the government to provide alternate energy sources to make it possible to transition away from fossil fuels (solar, wind, and electric were all suggested). Participants also wanted government policies to be coupled with municipal projects and incentives to help citizens adjust to new regulations and policies. Suggestions included providing free batteries and solar cells, providing subsides for energy efficient appliances and electric vehicles, and providing subsides for low-income citizens to weatherproof their homes. Individuals preferred rewarding good behaviour to punishing bad behaviour. Participants said it would be motivating and appreciated if they were rewarded for their efforts beyond simply paying less tax or having extra credits left over at the end of the month, "It would be nice if people could qualify for bonus carbon emission credits for actions like planting a tree, keeping a garden, installing solar panels on their roof, purchasing an electric car, etc.". Many participants also expressed that in order to transition away from driving, public transit needs to be affordable, and it needs to be made more available and reliable, especially in rural areas. Participants also wanted to see more options become available for long distance transit.

**Personal cap and trade is good in theory, but the details have not been thought out.** Some participants thought that personal cap and trade was a good system in theory, but that it might not be practically possible and required more thought. Many participants wanted more details on the policies. Practical issues that participants brought up included: do renters or landlords use their credits for bills, how are credits split between roommates, do you get extra credits for dependants, how are airplane emissions managed across boarders? These uncertainties caused many participants to be hesitant, but not opposed to the idea. Many sentences started with, "I agree with this policy…however…", "I'm not against it, but….".

Many described the policy as complex or complicated, and a few even stated that the carbon tax is much simpler implying it was preferred. Participants thought that a PCT system would be expensive to administer, difficult to enforce, and that the bureaucracy would be challenging to manage. Additional worries included privacy concerns, fears of the market value of credits rising exponentially over time, fears that the credits are too cheap to make a difference, fears of a fossil fuel black market emerging, and concerns of privatization of the credits market if adequate protections are not put in place.

**We need to take action on climate change & carbon pricing is effective**. The previously mentioned quote, "It feels a bit like war rationing, but I suppose that is unavoidable", not only captures the theme that government regulation can restrict our freedom, but it also suggests that the participant is acknowledging that more, perhaps even uncomfortable initiatives need to be taken to combat climate change. There were some participants (in both the Carbon Tax and PCT conditions) who felt that their assigned carbon pricing system was a "very good policy", stating, "More needs to be done about climate change and this would do a great deal to help". Many used the descriptor "great" and one participant in the PCT with $kgCO_{2e}$ condition even went as far as to say, "This is the best thing I have heard about in a long time regarding government policies". Some participants commented that they thought PCT provided effective incentives, "I strongly believe that this policy is a great incentive for people to pay close attention to their role in climate change and to reduce their carbon footprint". Others were not convinced that carbon pricing would do "a great deal to help" but agreed that "it's definitely a start…More needs to be done though to reduce our dependency on fossil fuels". Some participants expressed that, "We need to reduce our consumption drastically to achieve Paris Accord' goals", and they felt that more (beyond carbon pricing) also needed to be done.

**Quantification of carbon pollution is useful.** A number of participants in the PCT and carbon labeling systems saw a benefit in quantifying carbon emissions, "by tracking it [carbon emissions], it will be a big eye opener for many people", "It will help everyone to be more carbon emission conscious", "It really allows you to understand the impacts of your choices", "It would really increase accountability - seeing how much $CO_2$ emissions you generate and taking steps to reduce that". Quantifying carbon emissions and holding people accountable (in the case of PCT) contributed to the positive appraisal of participants who felt this was a great policy that would be effective. Participants who stated that they already try their best to reduce their carbon footprint were particularly fond of the measurement provided by the systems, "I already make an effort to reduce my carbon footprint, and I would appreciate something like this that actually measures how much of a difference it makes. It would also challenge me to reduce even more". Two participants voiced that they would like the scope of the system to be expanded to food and other products. Two individuals in the carbon labeling condition liked the monthly recommended carbon consumption information, they found it a familiar concept, comparing it to the recommended daily intake labels on food. However, one participant suggested that there be a system to view aggregated data (such as with PCT) so individuals do not have to amalgamate the data on their own**.** One concern presented with labeling emissions or credits is that some people simply will not pay attention to the label, rendering it useless.

**Support and effectiveness of pricing systems require policy transparency and education (specifically regarding what is being done with the money).** Education and transparency regarding how the carbon pricing policy is going to work to reduce environmental impact was also viewed as a necessity by participants. In particular, participants wanted to know how the government would use the money gained from the

carbon tax; many felt the effectiveness of a carbon pricing policy was dependant on this detail. Some participants described the carbon tax as a “money grab”. These comments among others indicate the necessity of communicating what is being done with the tax money,

> “Where exactly is that tax-payer money going? What are our alternatives, can we afford them?... Are we working towards that? I think a lot of people have these questions. There needs to be complete transparency on these issues, and it needs to be communicated properly and expansively to the general public.”

Frustrated participants wanted the tax money to be put towards research for green technology, or towards helping low income individuals weatherproof their homes and upgrade to high efficiency appliances.

# Chapter 4: Discussion

On their own, up-stream initiatives that avoid directly involving citizens have had limited success in moving Canadians towards sustainable lifestyles. Despite improvements in energy efficiency, energy consumption continues to rise (Creutzig et al. 2016; Natural Resources Canada, 2016). Focusing solely on regulating industry will be insufficient to reach the ambitious global target of restricting warming to 1.5°C. Down-stream initiatives that act more directly on the individual by setting clear limits on absolute consumption per person per year, have been argued as necessary to achieve sustainability goals (Creutzig et al., 2018; Harris, et al., 2008). Initiatives such as cap and trade systems that require citizens to live within an ecological budget (e.g., a carbon budget) are one method for achieving clear sustainability targets. Furthermore, a cap and trade system would reconnect citizens to the environmental impact of their consumption while enabling them to monitor and reduce this impact. An increased sense of personal responsibility and efficacy within the population might create the conditions for cultural change that demands more substantial environmental action.

## The Features of Personal Cap and Trade Systems Linked to a Sense of Efficacy

The present research is a preliminary study on the impact of a PCT system on individual citizens' beliefs and attitudes. Efficacy beliefs are particularly important for preventing distraction and denial, and for encouraging individuals to take environmental action. Therefore, the effect of PCT on efficacy beliefs is the primary focus of this research. PCT systems have numerous features that should enhance the individual's sense that they can contribute to achieving environmental goals effectively, and that collective environmental

goals are attainable. The features of PCT systems that seem to be most strongly linked to a sense of efficacy are the following:

**(1) Increased knowledge surrounding the environmental impact of activities.** Insufficient knowledge acts as a barrier for the individual to effectively reduce $CO_{2e}$ emissions (Whitmarsh et al., 2011; Tobler et al., 2012; de Coninck et al., 2018). CRAG members reported having a greater understanding of where their emissions come from and the relative environmental impact of different activities (Howell, 2012). It is expected that this increased awareness helped members reduce their carbon footprint by 32% during their first year with their respective CRAG.

In the present study, participants in the PCT with credits, PCT with $kgCO_{2e}$ and the Carbon Labeling condition performed significantly better on a knowledge acquisition task compared to those in the Carbon Tax condition (acting as the control). This supports the theory that PCT would increase the understanding of relative differences in emissions resulting from personal decisions such as choosing a travel destination that requires a few hours' drive, compared to one that requires a long plane ride; or the difference between driving to work and cycling to work. This knowledge should help citizens to reduce $CO_{2e}$ emissions effectively.

**(2) Clear individual targets.** PCT gives individuals a clear carbon consumption target that shows a path towards achieving national targets. Individuals regulate behaviour around goals (Carver & Scheier, 1990) and achieve more substantial goals when they are specific (e.g., reduce carbon consumption to 800 kg $CO_{2e}$ per month) rather than vague (e.g., reduce carbon consumption) (Locke & Latham, 2002, 2006). One participant in the PCT with $kgCO_{2e}$ condition stated, "I already make an effort to reduce my carbon footprint, and I would appreciate something like this that actually

measures how much of a difference it makes. It would also challenge me to reduce even more."

**(3) Individuals can monitor their progress towards their carbon cap.** To regulate behaviour around goals, individuals must receive feedback about their progress towards their goal (Carver & Scheier, 1990; McCalley & Midden, 2002; McCalley, 2006; Thaler, 1999). In a PCT computer simulation study, individuals decreased their carbon consumption over time as they received feedback relative to a decreasing carbon allowance (Capstick & Lewis, 2010). In the present study, one participant reflected, "it would really increase accountability - seeing how much $CO_2$ emissions you generate and taking steps to reduce that".

**(4) Mandatory.** A mandatory program communicates that action on climate change is important to society. When the full weight of government is behind an environmental initiative, this endorsement could legitimize environmental action and could help to strengthen a social norm that GHG pollution is not socially acceptable.

**(5) Incentives for carbon conservation.** The system rewards individuals financially for carbon conservation. One study participant in a PCT condition reflected, "I strongly believe that this policy is a great incentive for people to pay close attention to their role in climate change and to reduce their carbon footprint". When changing behaviour (e.g., switching from driving alone to carpooling, driving to cycling, turning down the thermostat etc.), rewarding the individual is particularly helpful if they lack intrinsic motivation to engage in the behaviour (self-determination theory, Ryan & Deci, 2017). Moreover, in general, individuals act more favourably towards policies that reward rather than punish individuals (Hsu, 2011).

On a sample of primarily liberal and politically left-leaning individuals living in Canada, personal cap and trade systems were not viewed, universally, as more efficacious than carbon tax systems at enabling Canada and citizens themselves to achieve sustainability targets. A personal cap and trade system using tradeable carbon credits (PCT with credits), and a personal cap and trade system based on full *Ecological Footprint* (PET) were viewed as similar to carbon tax systems in their ability to help Canadians to reduce their impact on climate change and to live sustainably. However, among Canadian residents, a personal cap and trade system based on $kgCO_{2e}$ (PCT with $kgCO_{2e}$) was viewed as more effective at enabling citizens to achieve significant sustainability goals compared to carbon tax systems, and PET.

## The Effectiveness of Personal Cap and Trade Variations

Although all personal cap and trade systems presented to participants contained the features listed above, only PCT with $kgCO_{2e}$ was viewed as significantly more effective than carbon taxes at enabling Canadians to reduce their environmental impact.

**Tradable Carbon Credits vs. Tradable units of $kgCO_{2e}$.** One possible explanation for the efficacy attributed to PCT with $kgCO_{2e}$, is that providing a numeric value that directly quantifies carbon pollution is more transparent to the individual than arbitrary, ambiguous credits. Credit trading could also be misconstrued as stock market transactions, which would take the focus away from carbon emissions. When citizens are given an allocation of $kgCO_{2e}$ rather than credits, it is easier for the public to understand what they are trading, and it does more to educate the population on carbon pollution. These themes are reflected in the

qualitative component of this study, where participants expressed that they want complete transparency and education surrounding how carbon pricing works.

Moreover, a credit may be viewed as a permission to pollute, whereas a $kgCO_{2e}$ label clearly represents pollution. Without labels that are clear and explicit about the negative impact of an action, individuals will not have a negative attitude towards it (Fransson & Gärling, 1999).

While credits may make sense for businesses, these findings suggest that a cap and trade policy applied to individuals could benefit from assigning carbon allocations in the form of pollution units (e.g., $kgCO_{2e}$) rather than credits. Further research on PCT should continue to investigate how carbon emissions allocations are framed.

**PCT vs. PET**. PCT with $kgCO_{2e}$ was viewed as significantly more effective than PET. A pricing system based on *Ecological Footprint* is completely novel. Policies that enforce a bold change in status quo often face public opposition until the policy is implemented, accepted, and becomes the new status quo (Treuer et al., 2012). PET would support broader environmental goals; however, since it is a new concept, participants either (1) might have been confused and not understood this, or (2) may have viewed this as unrealistic given the pushback some provinces are giving to much simpler carbon pricing policies (Ljunggren, 2019). Although there was a brief description of *Ecological Footprint* presented to participants assigned to the PET condition, *Ecological Footprint* is a difficult concept to understand. Therefore, the implementation of PET would first require educating the public on *Ecological Footprint*.

**Limitations.** Although personal carbon trading elicited somewhat stronger efficacy ratings, these rating might be suppressed by the methods used in this research. Using a video to convey an unfamiliar carbon pricing system, such as PCT, is very different to living with

the system. Many individuals expressed in the qualitative analysis that they believed the effectiveness of the system was dependent on the details (e.g., by how much individual carbon allocations would decrease each year, the cost of carbon credits, what support would be available for low income individuals etc.). These comments suggest that the absence of certain policy details limited the ability of participants to rate their perceived effectiveness of the system.

Based on the video presentation, individuals may not think that a carbon cap will adjust citizens' behaviour, when in reality it may. A trial such as the NICHE project that allows participation in a PCT system for a period of time would give participants direct experience with the system in day-to-day life. This would be expected to have a much stronger effect on psychological beliefs, particularly on the person's sense of personal responsibility.

Another point of caution is that multiple statistical tests were conducted as a part of this study, increasing the chance of getting a significant result when in fact there is no difference between conditions (statistical type I error). In order to control for this type I error, a Holm-Bonferroni correction was used to keep experiment-wise error within an alpha of .05. Moreover, given the design of the experiment, and the way the measures were phrased, it is reasonable to assume that efficacy would be a more sensitive measure compared to other dependent variables. To measure efficacy, participants were asked if they thought the policy *would* enable Canadians to reduce their carbon consumption etc., whereas with the other measures participants were asked about their *current* feelings of personal responsibility, risk perceptions etc. (this is much more difficult to influence with simple video exposure).

**Did increased efficacy translate into increased support for PCT with $kgCO_{2e}$?**

Overall, 72.9% of participants in this study supported the environmental pricing system that they were asked to evaluate. Previous research has demonstrated that public perceptions surrounding the efficacy of climate policies to achieve important collective objectives, is important in generating public support for the policy (Lam, 2014; Joireman et al., 2001; Kallbekken & Saelen, 2011). Since citizens are more likely to support a policy that they believe will have clear climate benefits (Brouwer et al., 2008; Tobler et al., 2012; Drews & Van den Bergh, 2016), it would be expected that PCT with $kgCO_{2e}$ would receive more public support than carbon tax systems. However, this study found no differences in support for the carbon pricing policies. An explanation for these findings is discussed below.

**Public Support.** Low public acceptability of PCT was a concern in DEFRA's pre-feasibility report and contributed to the decision of the UK Government to halt further government funded research on PCT (DEFRA, 2008). DEFRA conducted qualitative research to assess public acceptability of PCT alongside carbon taxes and upstream cap and trade, by running twelve focus groups with 92 participants from different regions in England with varying socio-economic backgrounds and varying environmental values and attitudes. The initial response to all pricing policies was negative. DEFRA's research found that compared to the carbon tax (or upstream cap and trade), responses to PCT were more polarized, receiving more 'very negative' reactions and more 'very positive' reactions (DEFRA, 2008). The qualitative portion of this study also found that a few individuals expressed strong polarizing views towards personal cap and trade systems in the open-ended response section, with views ranging from the "best thing I have ever heard" to "insanity".

Most research on the public acceptability of PCT has been conducted in the UK. Research conducted before the implementation of the UK carbon tax in 2013 shows that PCT

is likely to be at least as socially acceptable as alternative taxation policies, and in some cases even preferred (Howell, 2007; see Parag & Fawcett, 2014 for a review). One study ($n$ = 936) conducted outside of the UK, in Sweden, found that Swedes preferred their current carbon tax over the implementation of PCT (Jagers et al., 2011). This was not surprising as individuals resist change to the status quo (Treuer et al., 2012).

PCT systems have received recent media attention in Canada (Boyle, 2019; Slaughter, 2019). To the best of my knowledge, this is the first study to investigate levels of public support for PCT in Canada. This study supports findings from research conducted in the UK that public acceptability for PCT and carbon taxes are comparable. It is encouraging that PCT received equal support to carbon taxation given that carbon taxation represents the current state in many Canadian provinces, and a PCT system would disrupt status quo.

This study was limited in that participants did not engage with an operating PCT system for a substantial period of time. If a PCT policy were to be implemented, it is expected that support would increase over time. Pricing policies generally experience increased acceptability post implementation as citizens begin to experience positive effects from the policy (de Coninck et al., 2018) and as citizens realize anticipated negative outcomes will not happen (Schuitema, Steg, & Forward, 2010). Indeed, acceptance of the mandatory NICHE Carbon Card system on Norfolk Island as a tool for improving the environment increased by 19.2% after participation in the 15-month trial (baseline, 48.9%, follow-up, 68.1%). Attitudes of Norfolk Island citizens who did not partake in the trial remained unchanged (baseline, 45.0%, follow-up, 44.4%).

Qualitative analysis conducted in this study could help to identify the factors participants considered when evaluating support for their environmental pricing policy. The systems were described to participants as general approaches to reduce environmental

impact, rather than detailed policy proposals. It is predicted that more information surrounding some key system design elements could increase (or decrease) system support. Policy effectiveness (Kallbekken & Saelen, 2011), fairness (Fujii et al., 2004), and freedom (Eriksson et al., 2006) are all factors that influence policy support. Therefore, it is not surprising that these themes emerged during qualitative analysis. Attention given to these items could be used when developing detailed policy proposals to leverage policy support.

***Policy effectiveness.*** Participants who were in favour of carbon pricing (carbon taxes and PCT) thought it would help to reduce climate change or that at the very least, it would be a good start. Many expressed that they felt the effectiveness of their assigned policy (and therefore their support for the policy) ultimately came down to what was being done with the tax money (or any government money gained through the PCT credit market). Some participants expressed that they would like to see this money be invested in green technology or used to help vulnerable groups. In order for the policy to be effective, participants also felt that complete transparency and education on how the system would work to reduce environmental impact would be required. Focus groups conducted in BC also expressed a need for education surrounding how the tax works (Guzman & Clapp, 2017).

***Policy effectiveness & Fairness.*** Further discussion surrounding policy effectiveness will be talked about in conjunction with fairness; participants often talked about these two themes together.

*Industry is responsible for climate change*. Many participants felt that businesses and corporations cause the majority of environmental damage and therefore a policy that targets individuals would be both ineffective, “hardly put[ting] a dent in the issue” and unfair, “passing on a problem created by industry”. Therefore, in order to gain public support for policies applied to individuals, it is important that complementary policies and/or regulations

are applied to industry, and it is imperative that citizens are educated on how policies applied to individuals and industry can work together to achieve environmental targets.

*Unfair to low-income individuals*. Another reason that participants in this study (and in previous focus groups, see Parag & Fawcett, 2014 for a review) felt that their assigned carbon pricing policy would be ineffective and unfair is because they felt high income individuals would not respond to the price signal. Participants felt that they would pay the tax (or pay for extra carbon credits) and continue to live a high carbon lifestyle. Meanwhile, low income individuals would be unable to invest in efficiency upgrades (rendering the policy ineffective) and would experience financial burden from the tax/having to pay for additional carbon credits (rending the policy unfair).

This theme suggests that in order to gain the support of the population, there would need to be assistance provided to low-income households (e.g., through free household weatherproofing, installation of energy efficient appliances etc.). In addition to low-income individuals, other populations that participants worried about included Indigenous populations, elderly citizens, medical patients, farmers, families with children, those who live in rural/remote communities, those who live in hostile/cold climates, renters, and those who had a long commute. If participants felt that these groups were adequately supported, it is expected that policy support would increase.

*PCT as a progressive policy*. One theme that came up in previous studies, but was not present in this study, is that some people felt PCT was more progressive compared to a carbon tax. Some participants in previous research reflected that PCT might be more fair than a carbon tax since low income individuals who already take transit and generally have smaller carbon footprints could benefit financially from PCT. High income individuals who may travel frequently and have large homes would have to pay for their overconsumption

(see Parag & Fawcett, 2014 for a review). Indeed, DEFRA (2008) found that in the UK, 71% of low-income households would have more credits than required, and 55% of high-income households would have insufficient credits to meet their current needs. Of the low-income individuals who would have insufficient credits to meet their current carbon consumption, the majority lived in rural areas in larger-than-average homes, with their carbon credit deficit being driven from heating rather than transport needs. It is possible that participants in this study did not bring up this theme because they were exposed to a carbon tax *or* PCT system, whereas in the focus groups participants discussed and compared the two policies side by side.

*Fossil fuel alternatives must exist*. Another point regarding effectiveness and fairness that participants mentioned in this study (and that participants mentioned in other focus groups, see Parag & Fawcett, 2014 for a review) is that without alternatives to transition away from fossil fuels (e.g., access to public transit, safe bike lanes, affordable electric vehicles) a carbon pricing policy punishes citizens for something that they cannot change. This emphasizes that in order to gain support, municipal policies that work to offer fossil fuel alternatives, and policies that support green innovation must be in place to complement an overarching carbon pricing policy.

*Canadian emissions are negligible on a global scale*. Finally, some participants stated that any Canadian policy aimed at reducing carbon emissions would just inconvenience Canadians while being ineffective in reducing overall global climate change. The government would need to explain the importance of Canada being a global leader on the climate change front.

***Restriction of Individual Freedom.*** Most individuals who expressed strong negative sentiments towards PCT systems were opposed to the system due to a restriction of freedom,

comparing the system to war rationing, or describing the system as “communist” or “intrusive”. A very small number of participants expressed strong negative emotions towards PCT systems, however a vocal minority can be very powerful in policy-making procedures (Anne Wolf, 2019).

**Compared to a Carbon Tax, does PCT educate individuals on the relative impact of different activities?**

Currently, there is a lack of knowledge surrounding effective ways to reduce emissions; energy savings from low-energy activities such as lighting are often overestimated by individuals, and energy savings from high-energy activities such as in-home water heating are underestimated (Attari, DeKay, Davidson & de Bruin, 2010; Stern, 2014). The ability for citizens to quantify the impact of cycling to work rather than driving, taking fewer hot showers, or turning off the lights when leaving the room should allow individuals to reduce their personal $CO_{2e}$ emissions effectively. Evidence from CRAGs suggests that this awareness can lead to the reduction of direct personal emissions in addition to indirect emissions outside the scope of PCT (Howell, 2012).

Participants in the Carbon Labeling, PCT with credits, and PCT with $kgCO_{2e}$ conditions acquired more knowledge about the relative amount of carbon pollution produced from personal activities, compared to those in the Carbon Tax condition. This supports reflections from CRAGs groups that providing individuals with clear feedback about the carbon pollution associated with their consumption can increase carbon literacy (Howell, 2012, Parag et al., 2011).

**Do carbon tax or PCT systems increase individuals feeling of personal responsibility for climate change?**

Increased feelings of efficacy for reducing environmental impact generated by PCT are expected to alleviate the need for emotion-focused coping (e.g., distraction), allowing individuals to pay more attention toward, and become more knowledgeable on environmental problems. This, in conjunction with the features present in a PCT system (e.g., information on the environmental impact of personal consumption) was expected to increase citizens' sense of personal responsibility for environmental action. However, feelings of personal responsibility were not significantly affected by carbon pricing system. Although PCT with $kgCO_{2e}$ was viewed as more effective compared to carbon taxes in enabling citizens to live sustainably, individuals in that condition did not experience greater feelings of personal responsibility.

In this study participants were presented with the environmental impact associated with the consumption of a hypothetical person; this likely limited the ability of the systems to influence feelings of personal responsibility. It is expected that in order for PCT to influence individuals' sense of personal responsibility, they would have to receive feedback regarding *their* consumption relative to a cap. One example of a study that could influence feeling of personal responsibility is a PCT computer simulation experiment conducted by Capstick and Lewis (2010). First, participants were asked a range of questions used to calculate their personalized carbon footprint. Next, participants were asked a series of multiple-choice questions indicating which actions they would take under varying (diminishing) carbon budgets that were based on their personalized carbon footprint. Participants received information on the carbon impact of each decision they made, and on the cumulative impact of the decisions they made throughout the simulation, relative to their budget. The purpose of

this study was to examine changes in carbon-budgeting behaviour; however, a similar design could be used to test for changes in feelings of personal responsibility. Running a PCT field trial would be another suitable method for investigating changes in feelings of personal responsibility.

Although type of pricing system did not influence participants' sense of personal responsibility, participants in general agreed that it is important to have their climate impact in mind with everyday behaviours, felt a moral responsibly to take climate change into consideration, held a moral obligation to buy climate friendly products when shopping, felt personally responsible for global warming, and felt responsible for climate change alongside governments and industry. While the quantitative findings reflect a considerable degree of personal responsibility, the qualitative component of this study was able to shed light on some barriers that are still suppressing feelings of efficacy and personal responsibility for taking climate action.

Some individuals (in all conditions) expressed that they felt stuck in systems they did not create and cannot control. Some participants blamed industry for the over consumption of fossil fuels, and felt the responsibility lay on corporations to fix the problem, not individuals. In order to encourage these individuals to accept some personal responsibility for climate action, a complementary policy could be applied to industry. It would have to be made clear to citizens how under these policies, both industry *and* citizens would work together to achieve provincial, or national environmental goals.

Qualitative analysis also highlights that in order for participants to feel a sense of personal responsibility for climate action, fossil fuel alternatives must exist. Consider a very simplified scenario; an individual drives a gasoline vehicle to work everyday. A PCT policy is implemented and as a result, the individual realizes that this habit is responsible for their

overconsumption of carbon. The individual may look for alternatives, but if their town lacks public transit, has no bike lanes, and has unsafe slippery road conditions in the winter, the individual would lack a sense of efficacy for change, and accepting personal responsibility would simply be demoralizing.

**Do carbon tax or PCT systems increase the following outcomes: interest in environmental information, climate change risk perception, prioritization of environmental protection relative to economic growth?**

A sense of personal responsibility for environmental action combined with feelings of efficacy were expected to increase the individual's interest in environmental information, climate change risk perceptions, and prioritization of environmental protection relative to economic growth. Feelings of personal responsibility were not significantly different between groups; therefore, as expected, the outcomes listed above (interest in environmental information, climate change risk perceptions, prioritization of environmental protection relative to economic development) also showed no significant difference between groups.

The correlations between collective and personal efficacy and these other factors (interest in environmental information, climate change risk perceptions, prioritization of environmental protection relative to economic development) provides some support for the proposition that pricing systems that can increase the individuals' sense of personal responsibility and efficacy might in turn influence attention toward and attitudes about environmental risk and conservation. This potential relationship requires further investigation.

The design of this study was limited in its ability to detect these outcomes expected to follow from efficacy feelings. In this study, perceived efficacy of a hypothetical policy that was not currently in place was measured. Participants indicated that they felt they *would* be able to reduce their environmental impact *if* a PCT policy was in place, not that they currently feel they can reduce their environmental impact. In order to experience outcomes that follow from a sense of efficacy, (e.g., increased risk perceptions), the individual would need to experience a feeling of efficacy in their current situation over a period of time. Therefore, field trails such as the Norfolk NICHE project that could influence actual levels of efficacy are recommended to further investigate these hypothesized outcomes of an increased sense of efficacy and personal responsibility.

**Summary of Discussion of Thematic Findings**

The thematic findings propose that carbon pricing should be a policy that works in complement with other environmental policies. Qualitative findings suggest that multiple policies will be needed, and communication on how these policies interact and can work together to bring about climate targets must be communicated to the public clearly and effectively. Examples of policies that could complement carbon pricing applied to individuals are: policies that address emissions from industry, policies that ensure the provision of fossil fuel alternatives, and policies that ensure *everyone* is adequately supported in the transition to a low carbon future including (but not limited to) those living in rural areas, low-income individuals, and Indigenous populations.

As an example, carbon pricing provides incentives for individuals to increase the energy efficiency of their homes, but policies that support/enable low income households to

undergo efficiency upgrades would be required from an equity and effectiveness standpoint. Moreover, carbon pricing drives citizens towards public transportation, biking and walking, but policies that make those alternatives accessible must exist in order for carbon pricing to be effective. While the NICHE trial was successful in decreasing utility consumption, it was ineffective in decreasing emissions from transportation, likely because of the lack of infrastructure to support that transition (Webb, 2018).

The Conference Board of Canada reported that the carbon tax will help to reduce emissions, but carbon pricing alone will be insufficient to make the reductions required (Coad et al., 2017). While on its own it is insufficient, carbon pricing is one tool that can provide the necessary framework to engage complementary tools that can help in reaching a low carbon future.

**Measurement and Sample Issues**

The study relied heavily on self-report measures of beliefs, including efficacy beliefs, personal responsibility, risk perceptions, and prioritization of environmental issues. Several of these measures were developed for use in this study and have yet to be subjected to rigorous validation. Some of the null findings in this research might be due to psychometric issues with the scales. Future research should revisit these research questions with closer attention to measurement validity.

This study was not intended to provide a representative sample of Canadians' views of carbon pricing mechanisms. The primarily goal was to determine whether, by connecting individuals more directly to their environmental impact, PCT systems have the capacity to transform individuals' key beliefs. Therefore, issues of the representativeness of the sample

are not a primary concern. Nevertheless, it is important to have an understanding of the characteristics of the sample and ways in which it might be limited. As with many online studies (see Nestler, Thielsch, Vasilev & Back, 2015), this study had a substantial number of participants drop out prematurely (after getting paid, $n = 214$ failed to complete the consent form, and $n = 67$ left partway through the study). Research has found that those who complete online surveys in their entirety rank higher in the following personality traits: conscientiousness, openness and agreeableness (Nestler et al., 2015). Moreover, a large number of participants were excluded from the study based on failed attention checks. For example, many participants were excluded from analysis because based on the time it took them to complete the survey, it would not have been possible to watch the experimental video in its entirety. Since conscientiousness is related to higher levels of commitment (Nestler et al., 2015), it is expected that those who ranked higher on conscientiousness would be more likely to have watched the videos in their entirety, passed all attention checks, and remained in the sample.

In a laboratory setting participants are less likely to drop-out compared to in an online setting (Birnbaum, 2004; Reips, 2002a). It is predicted that bringing participants into a lab and having them watch the videos in person and fill out the survey in person, would lead to a more representative sample with regards to personality traits. Since personality traits, specifically agreeableness and openness and to a lesser extent conscientiousness, correlate with environmental concern (Hirsh, 2010), a representative sample of personality traits is important for understanding the broader public's support for PCT.

**Summary**

The present research is built on the idea that feelings of inefficacy for achieving environmental goals are directing Canadians' attention away from environmental issues. The goal of this research was to explore whether PCT, a mandatory pricing system that assigns individuals tradeable pollution allocations and provides information about the environmental damage resulting from consumption, will be seen as more effective than carbon tax systems (that simply put a price on carbon pollution) at achieving significant environmental sustainability targets. The present study found that a PCT system with $kgCO_{2e}$ was viewed as significantly more effective than carbon taxes at enabling Canadians to reduce their carbon consumption and to live more sustainably (see Figure 3).

An important future step will be to explore whether PCT systems enhance efficacy perceptions among a diverse spectrum of citizens in the Canadian population. Most importantly, future research should examine whether PCT can influence the efficacy perceptions and, subsequently, interest in environmental issues of members of the population who tend to obstruct environmental policy. In the present study, Conservative-party affiliation, trust in government and environmental values were not strongly associated with efficacy evaluations of the environmental pricing policies. These correlations suggest that efficacy perceptions might transcend group differences. In future research, it would be useful to examine whether a PCT system creates shifts in broader belief systems among high-income individuals who can hold considerable influence over the direction of the country.

Low income individuals are a group for whom PCT systems might not enhance personal efficacy to achieve environmental targets. Barriers facing low income families to live within an environmental cap needs to be carefully examined and addressed with policy design.

## Chapter 5: Conclusions and Further Directions

Personal cap and trade systems are one method for giving citizens clear information about the environmental harm associated with consumption. These systems are also a means for guiding the individual and the economy in a direction towards less environmental damage. Individuals cannot regulate their behaviour around environmental goals unless they have the proper information (e.g., a specific carbon target and carbon labeling of products) and tools (e.g., a carbon account to track progress) to do so.

In the present research, we learn that pricing systems that provide individuals with specific information about their carbon pollution (i.e., PCT with credits, PCT with $kgCO_{2e}$, and carbon taxes that include carbon labelling) increased people's knowledge about the relative amount of carbon emissions resulting from different personal activities. CRAGs members reported that they found this knowledge helped them to reduce their direct personal carbon emissions, as well as their indirect carbon emissions outside the scope of the program (Howell, 2012). On top of this beneficial education, participants in this study felt that PCT with $kgCO_{2e}$ would increase their ability to live sustainably and would help Canadians to significantly reduce their impact on climate change. Increasing the individual's sense of efficacy is important for reducing the use of denial and distraction techniques that decrease the individual's attention toward, knowledge about and political action on monumental problems such as climate change (Roser-Renouf, Maibach, Leiserowitz, & Zhao, 2014).

The other expected benefit of a PCT system is an increased sense of personal responsibility for environmental protection by connecting individuals directly with the environmental harm associated with consumption. Individuals with a sense of personal responsibility combined with a sense of efficacy are expected to direct more attention to environmental issues and, possibly, either apply more pressure on governments to ensure

environmental protection or to, at least, support political platforms that include environmental protection (as the population does in Växjö Sweden).

Exposure to a PCT system in the present study did not increase individuals' sense of personal responsibility or interest in environmental issues. These changes are expected only after individuals participate in a PCT system in which they experience a sense of collective efficacy, receive feedback (information) about the environmental harm associated with *their* consumption, and receive information about their cumulative environmental impact relative to their assigned limit. A laboratory experiment that simulates the feedback (information) provided by a PCT system (e.g., Capstick & Lewis, 2010) versus the information provided by a carbon tax system, would be one method for examining the individual's sense of personal responsibility.

Field studies of cap and trade systems would also be useful in examining the ways in which PCT systems might transform individuals' beliefs. Field studies with environmentally motivated volunteers have demonstrated the ability of these types of systems to reduce personal carbon emissions (Howell, 2012; Webb, 2018) and to increase the individual's awareness of their environmental impact (Howell, 2012). Field studies should be expanded (1) to include the attitude and beliefs measures discussed in this study and (2) to include individuals who are not already motivated by environmental concerns.

The problem with the two methods discussed (a computer simulation or a field study), is that they do not put people in a situation of *collective* action on the problem. Without placing individuals in a mandatory system, computer modelling would likely be one of the only ways to estimate the outcomes of a compulsory collective pricing system.

Environmental problems such as climate change can only be solved with coordinated collective action; individual efforts simply cannot bring about desired environmental

outcomes. Furthermore, it is difficult to take action and make sacrifices when you know it will not make a difference in solving a global problem. Citizens' sense of efficacy for solving climate change is a significant predictor of their involvement with climate change issues (Roser-Renouf et al., 2014). Results from this study suggest that PCT systems as a collective approach for solving climate change may be able to instill a sense of efficacy within the population, removing a significant barrier to climate action. Further research on the ability of this system to harness collective action and accelerate a culture that supports aggressive environmental initiatives is warranted.

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Table 1

*The number of questions making up each measure, the internal reliability of the questions, and descriptive statistics (M, SD, range) across all environmental pricing and control conditions.*

| Measure | *N* of questions for each measure | Pearson's *r*/ Cronbach's alpha | *M (SD)* | Range |
|---|---|---|---|---|
| Collective Efficacy | 2 | 0.75* | 2.89 (0.75) | 1 to 4 |
| Personal Efficacy | 2 | 0.67* | 2.80 (0.79) | 1 to 4 |
| System Support | 2 | 0.72* | 3.68 (1.09) | 1 to 5 |
| Knowledge Acquisition | 3 | - | 1.61 (1.09) | 0 to 3 |
| Personal Responsibility | 5 | 0.87 | 4.00 (0.76) | 1.6 to 5.0 |
| Risk Perception | 6 | 0.85 | 3.19 (0.56) | 1 to 4 |
| Environmental prioritization | - | - | 0.64 (1.52) | -6 to 6 |

*Note*. *N* = number, *M* = means, *SD* = standard deviation. Pearson's *r* is reported for *N* = 2 questions, Cronbach's alpha is reported for *N* > 2 questions.
*$n = 385$, $p < .001$

Table 2

*Sex, age, political orientation and province of residence of participants in each environmental pricing system condition.*

| | | Control | Carbon Tax | Carbon Tax with labeling | Personal Carbon Trading with Credits | Personal Carbon Trading with $kgCO_{2e}$ | Personal Ecosystem Impact Trading |
|---|---|---|---|---|---|---|---|
| ***n*** | | 62 | 79 | 82 | 87 | 71 | 66 |
| **Sex** | Female | 53.2% | 43.0% | 40.2% | 44.8% | 40.8% | 33.3% |
| | Male | 46.8% | 57.0% | 57.3% | 52.9% | 59.2% | 62.1% |
| | Prefer not to answer | 0.0% | 0.0% | 2.4% | 2.3% | 0.0% | 4.5% |
| **Age** | *M*(*SD*) | 33.5(11.5) | 31.6(10.6) | 31.5(10.7) | 31.9(9.9) | 30.1(8.6) | 33.2(10.8) |
| **Political orientation** | Left of center | 19.4% | 25.3% | 24.4% | 32.3% | 31% | 21.2% |
| | Center | 38.7% | 39.2% | 26.8% | 31.0% | 40.8% | 39.4% |
| | Right of center | 17.7% | 8.9% | 17.1% | 9.2% | 8.5% | 15.2% |
| | Other or do not know | 24.2% | 26.6% | 31.7% | 27.6% | 19.7% | 24.2% |
| **Province of residence** | Alberta | 11.3% | 13.9% | 12.2% | 10.3% | 11.3% | 13.6% |
| | BC | 12.9% | 15.2% | 12.2% | 31.0% | 12.7% | 19.7% |
| | Manitoba | 3.2% | 6.3% | 2.4% | 2.3% | 2.8% | 4.5% |
| | NB | 3.2% | 1.3% | 3.7% | 3.4% | 0.0% | 3.0% |
| | Newfoundland | 0.0% | 2.5% | 0.0% | 1.1% | 0.0% | 0.0% |
| | Nova Scotia | 4.8% | 2.5% | 3.7% | 3.4% | 4.2% | 3.0% |
| | Ontario | 40.3% | 39.2% | 52.4% | 33.3% | 62.0% | 43.9% |
| | PEI | 1.6% | 0.0% | 1.2% | 0.0% | 1.4% | 1.5% |
| | Quebec | 19.4% | 17.7% | 11.0% | 12.6% | 4.2% | 9.1% |
| | Saskatchewan | 3.2% | 1.3% | 1.2% | 2.3% | 1.4% | 1.5% |

*Note*. *n* = number, *M* = mean, *SD* = standard deviation, BC = British Columbia, NB = New Brunswick, PEI = Prince Edward Island

Table 3

*Analyses conducted to detect differences in participants' psychological responses to different environmental pricing systems.*

| Analysis | Independent Variables | Dependent Variables | Corrected alpha | p-value |
|---|---|---|---|---|
| One-way MANOVA | **5**: CT, Carbon Labeling, PCT (credits), PCT ($kgCO_{2e}$), PET | **3:** Collective and Personal Efficacy, Support | .01 | $p < .001$ |
| One-way ANOVA | **5:** CT, Carbon Labeling, PCT (credits), PCT ($kgCO_{2e}$), PET | **1**: Knowledge Acquisition | .0125 | $p = .001$ |
| One-way MANOVA | **6**: Control, CT, Carbon Labeling, PCT (credits), PCT ($kgCO_{2e}$), PET | **2:** Personal Responsibility, Risk Perception | .0167 | $p = .443$ |
| Logistic Regression | **6**: Control, CT, Carbon Labeling, PCT (credits), PCT ($kgCO_{2e}$), PET | **1:** Interest in environmental information | .025 | $p = .472$ |
| One-way ANOVA | **6**: Control, CT, Carbon Labeling, PCT (credits), PCT ($kgCO_{2e}$), PET | **1**: Prioritization of environmental issues | .05 | $p = .562$ |

*Note*. Dependent variables were measured with a survey after participants had watched a video on an environmental pricing system and/or a video on climate change.
CT = Carbon Tax, PCT = Personal Carbon Trading, PET = Personal Ecosystem Impact Trading.
Corrected alpha was obtained using a Holm-Bonferroni correction to maintain an experiment-wise error rate of $\alpha = .05$. Analyses are rank ordered from lowest to highest p-value.

Table 4

*Summary of hypotheses investigating participants' psychological responses to different environmental pricing systems.*

| | Hypothesis | Support | Explanation |
|---|---|---|---|
| 1 | Compared to CTs, PCT systems will create a greater sense of:<br>• Efficacy for individuals to reduce their environmental impact (**personal efficacy**)<br>• Efficacy for the collective to achieve significant environmental targets (**collective efficacy**)<br>• **Personal responsibility** for climate change action<br>• **Support** for the system | Partially supported | Only feeling of personal efficacy were significantly affected by the type of environmental pricing system.<br><br>PCT with $kgCO_{2e}$ created a greater sense of personal efficacy compared to both Carbon Tax Systems, and PET. |
| 2 | Compared to CTs, PCT systems will create an increased:<br>• **Interest in environmental information**<br>• Sense of **climate change risk perceptions**<br>• **Prioritization of environmental protection** relative to economic growth | Not supported | |
| 3 | Compared to CTs, PCT systems will better educate individuals on the relative amount of $CO_{2e}$ emissions resulting from different personal activities (knowledge acquisition). | Partially supported | Participants in the PCT ($kgCO_{2e}$), PCT (credits), and Carbon Labeling (with an embedded tax) conditions performed significantly better on the knowledge acquisition task compared to participants in the Carbon Tax and PET conditions. |
| 4 | Compared to a low visibility carbon tax, a carbon tax with carbon labeling will produce significantly higher levels of personal efficacy, collective efficacy, knowledge acquisition task etc. (see *note* for full list of variables of interest). | Partially supported | Only one variable was significant: Participants in the Carbon Labeling (with an embedded tax) condition performed significantly better on the knowledge acquisition task compared to participants in the Carbon Tax condition. |
| 5 | Among PCT mechanisms, compared to providing people with feedback based on carbon credits, providing people with feedback *based on kgs of carbon* will produce significantly higher levels of personal efficacy, collective efficacy etc. (see *note* for full list of variables of interest). | Partially supported | No significant difference between PCT ($kgCO_{2e}$) and PCT (credits); however, PCT with $kgCO_{2e}$ was significantly better than a tax at providing a sense of personal efficacy whereas PCT with credits was not. |
| 6 | Compared to PCT with credits, PET with credits will produce significantly higher levels of personal and collective efficacy, etc. (see *note* for full list of variables of interest). | Not supported | |

*Note*. Full list of variables of interest: personal efficacy, collective efficacy, personal responsibility for climate change action, support for the system, knowledge acquisition, interest in environmental information, sense of climate change risk perceptions, prioritization of environmental protection relative to economic growth. Environmental pricing systems investigated: CT, CT with labeling, PCT with credits, PCT with kgCO2e, PET. PCT = Personal Carbon Trading, PET = Personal Ecosystem Impact Trading.

Table 5

*Correlations among dependent variables and demographic variables across all environmental pricing and control conditions.*

| Measure | 1. Col. Eff. | 2. Pers. Eff. | 3. Pers Res. | 4. Sys. Sup. | 5. Risk Perc. | 6. Know. Aqui. | 7. Int.Envr. Info. | 8. Prior. Envr. | 9. Envr. Values | 10. Conservative | 11. Gov. Trust | 12.Age |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Collective Efficacy | - | | | | | | | | | | | |
| 2. Personal Efficacy | .83** | - | | | | | | | | | | |
| 3. Personal Responsibility | .55** | .57** | - | | | | | | | | | |
| 4. System Support | .74** | .75** | .70** | - | | | | | | | | |
| 5. Risk Perception | .33** | .28** | .46** | .42** | - | | | | | | | |
| 6. Knowledge Acquisition | .18** | .19** | .17** | .19** | .13** | - | | | | | | |
| 7. Interest in Envr. Info. | .27** | .27** | .27** | .27** | .16** | .17** | - | | | | | |
| 8. Prioritization Envr.Protection | .12* | .10* | .30** | .26** | .32** | .07 | .00 | - | | | | |
| 9. Envr. Values | .08 | .06 | .29** | .15** | .24** | .08 | .07 | .42** | - | | | |
| 10. Politically Conservative | .01 | -.05 | -.12* | -.06 | -.16** | -.04 | .06 | -.20* | -.13** | - | | |
| 11. Gov. Trust | -.09 | -.03 | -.08 | -.07 | -.03 | -.01 | -.06 | -.08 | .03 | .03 | - | |
| 12. Age | -.11* | -.11* | -.03 | -.15** | -.16** | -.10* | -.06 | -.07 | .09 | .05 | .04 | - |
| 13. Sex | .04 | -.02 | -.07 | -.02 | -.09 | .18** | .09 | -.12* | .09 | .04 | -.05 | -.01 |

*Note*. Dependent variables and demographics were measured with a survey after participants had watched a video on an environmental pricing system and/or a video on climate change.
**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 6

*Univariate ANOVA and Roy-Bargmann stepdown results with effect sizes (Partial $\eta^2$), indicating differences in participants sense of personal efficacy, collective efficacy, and support for five environmental pricing systems.*

| | | | | | | | | | CL around Partial $\eta^2$ per alpha | |
|---|---|---|---|---|---|---|---|---|---|---|
| **DV** | **alpha** | **Uni-variate *F*** | **df** | ***p*** | **Step-down *F*** | **df** | ***p*** | **Partial $\eta^2$** | ***Lower*** | ***Upper*** |
| Personal Efficacy | .003 | 6.03[a] | 4/379 | < .001 | *6.03 | 4/379 | *< .001 | .06 | .005 | .133 |
| Collective Efficacy | .010 | 3.32 | 4/379 | .011 | 1.11 | 4/378 | .350 | .01 | .000 | .044 |
| Support | .005 | 2.75 | 4/379 | .028 | 3.12 | 4/377 | .015 | .03 | .000 | .087 |

*Note*. Personal efficacy, collective efficacy, and support were measured with a survey which was completed after participants had been exposed to one of five environmental pricing systems (carbon tax, carbon tax with labeling, personal carbon trading with credits, personal carbon trading with $kgCO_{2e}$, personal ecosystem impact trading). Alpha for each step was calculated using a Holm-Bonferroni correction to maintain an alpha of .01 for the MANOVA.
Analyses were conducted to follow up a significant one-way MANOVA (3 levels: personal efficacy, collective efficacy, support).
DV = dependent variable, df = degrees of freedom, CL = confidence limits.
[a]Significance level cannot be evaluated but would reach p <. 003 in a univariate context.
*Significance is achieved at p < .003.

Table 7

*Pairwise comparisons of participants' perceived ability of different environmental pricing systems to enable individuals to live sustainably (generate a sense of personal efficacy).*

| (I) Condition Assigned | (J) Condition Assigned | *MD* (I - J) | *SE* | *p*-value | 99.7% Confidence Interval Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Carbon Tax | Carbon Label | 0.05 | 0.12 | .697 | -0.31 | 0.41 |
| | PCT with credits | -0.20 | 0.12 | .102 | -0.55 | 0.16 |
| | PCT with $kgCO_{2e}$ | -0.41* | 0.13 | .001 | -0.78 | -0.03 |
| | PET | 0.15 | 0.13 | .243 | -0.23 | 0.53 |
| Carbon Label | Carbon Tax | -0.05 | 0.12 | .697 | -0.41 | 0.31 |
| | PCT with credits | -0.24 | 0.12 | .040 | -0.60 | 0.11 |
| | PCT with $kgCO_{2e}$ | -0.46* | 0.12 | < .000 | -0.83 | -0.09 |
| | PET | 0.10 | 0.13 | .419 | -0.28 | 0.48 |
| PCT with credits | Carbon Tax | 0.20 | 0.12 | .102 | -0.16 | 0.55 |
| | Carbon Label | 0.24 | 0.12 | .040 | -0.11 | 0.60 |
| | PCT with $kgCO_{2e}$ | -0.21 | 0.12 | .083 | -0.58 | 0.15 |
| | PET | 0.35 | 0.13 | .006 | -0.03 | 0.72 |
| PCT with $kgCO_{2e}$ | Carbon Tax | 0.41* | 0.13 | .001 | 0.03 | 0.78 |
| | Carbon Label | 0.46* | 0.12 | < .000 | 0.09 | 0.83 |
| | PCT with credits | 0.21 | 0.12 | .083 | -0.15 | 0.58 |
| | PET | 0.56* | 0.13 | < .000 | 0.17 | 0.95 |
| PET | Carbon Tax | -0.15 | 0.13 | .243 | -0.53 | 0.23 |
| | Carbon Label | -0.10 | 0.13 | .419 | -0.48 | 0.28 |
| | PCT with credits | -0.35 | 0.13 | .006 | -0.72 | 0.09 |
| | PCT with $kgCO_{2e}$ | -0.56* | 0.13 | < .000 | -0.95 | -0.17 |

*Note*. A sense of personal efficacy was measured using survey data. Scores could range from 1 to 4 with higher values representing higher levels of efficacy.
PCT = Personal Carbon Trading, PET = Personal Ecosystem Impact Trading, MD = mean difference, SE = standard error.
*The mean difference is significant at $p \leq .003$ based on pairwise comparison Least Significant Difference post hoc tests. The error term is Mean Square (Error) = 1.171.

Table 8

*Pairwise comparisons of participant test scores (on a knowledge acquisition task) between groups who were exposed to different environmental pricing systems.*

| (I) Condition Assigned | (J) Condition Assigned | *MD* (I - J) | *SE* | *p*-value | 98.75% Confidence Interval Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Carbon tax | Carbon label | -0.65* | 0.19 | < .000 | -1.07 | -0.23 |
| | PCT with credits | -0.46* | 0.17 | .006 | -0.87 | -0.04 |
| | PCT with $kgCO_{2e}$ | -0.60* | 0.18 | .001 | -1.03 | -0.16 |
| | PET | -0.25 | 0.18 | .154 | -0.70 | 0.19 |
| Carbon label | Carbon tax | 0.65* | 0.17 | < .000 | 0.23 | 1.07 |
| | PCT with credits | 0.19 | 0.16 | .243 | -0.22 | 0.60 |
| | PCT with $kgCO_{2e}$ | 0.05 | 0.17 | .765 | -0.38 | 0.49 |
| | PET | 0.39 | 0.18 | .026 | -0.05 | 0.84 |
| PCT with credits | Carbon tax | 0.46* | 0.17 | .006 | 0.04 | 0.87 |
| | Carbon label | -0.19 | 0.16 | .243 | -0.60 | 0.22 |
| | PCT with $kgCO_{2e}$ | -0.14 | 0.17 | .412 | -0.57 | 0.29 |
| | PET | 0.20 | 0.17 | .248 | -0.24 | 0.64 |
| PCT with $kgCO_{2e}$ | Carbon tax | 0.60* | 0.18 | .001 | 0.16 | 1.03 |
| | Carbon label | -0.05 | 0.17 | .765 | -0.49 | 0.38 |
| | PCT with credits | 0.14 | 0.17 | .412 | -0.29 | 0.57 |
| | PET | 0.34 | 0.18 | .062 | -0.12 | 0.80 |
| PET | Carbon tax | 0.25 | 0.18 | .154 | -0.19 | 0.70 |
| | Carbon label | -0.39 | 0.18 | .026 | -0.84 | 0.05 |
| | PCT with credits | -0.20 | 0.17 | .248 | -0.64 | 0.24 |
| | PCT with $kgCO_{2e}$ | -0.34 | 0.18 | .062 | -0.80 | 0.12 |

*Note*. Knowledge acquisition task scores could range from 0 to 3 and were based on the number of correct answers to three questions about the relative amount of $CO_{2e}$ emissions resulting from activities described in environmental pricing videos.

PCT = Personal Carbon Trading, PET = Personal Ecosystem Impact Trading, MD = mean difference, SE = standard error.

*The mean difference is significant at $p \leq .0125$ based on pairwise comparison Least Significant Difference post hoc tests. The error term is Mean Square (Error) = 1.139.

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Table 9

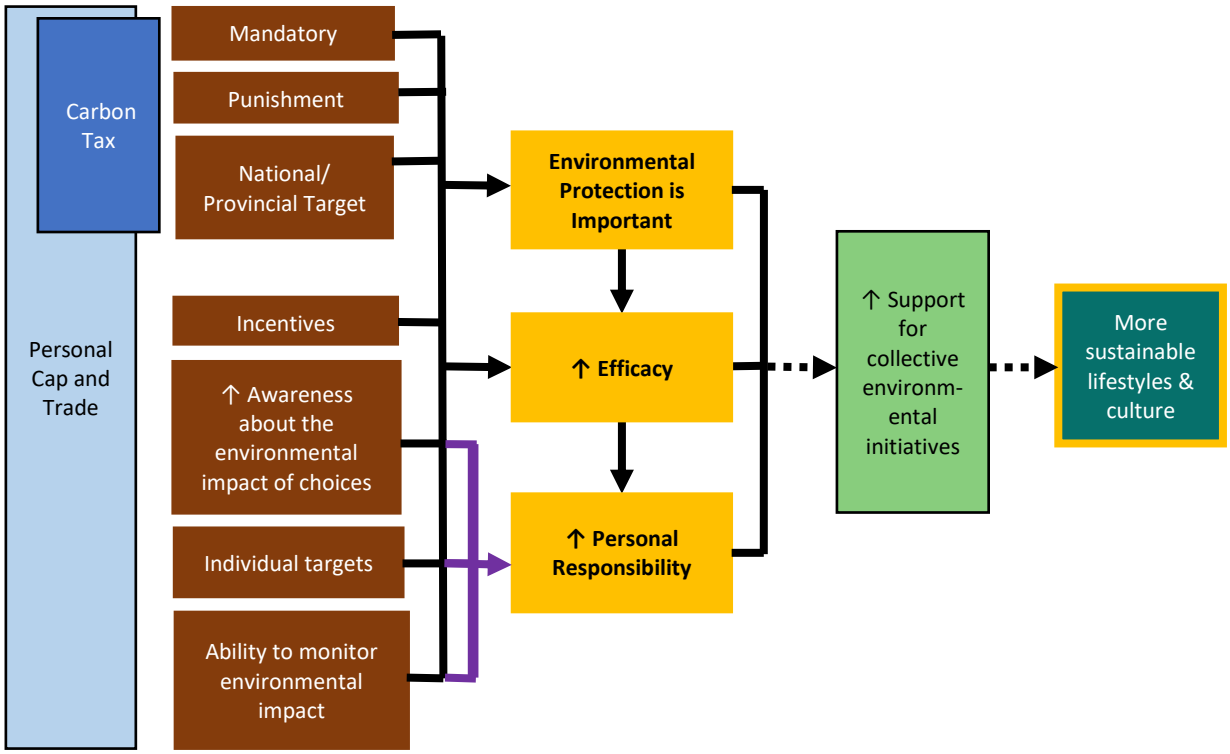
*Emergent categories and themes from qualitative analysis of individuals comments on environmental pricing systems (carbon tax, carbon tax with labeling, personal carbon trading (credits), personal carbon trading ($kgCO_{2e}$), personal ecosystem impact trading).*

| **Categories** | |
|---|---|
| Concerns about fairness | Preference of government action |
| Concerns about effectiveness | Alternatives |
| Upper Class vs Lower Class | Good start but not enough |
| Individual vs Corporation | Attitudes |
| Citizens are stuck in systems | Positive Emotions |
| Rural & Remote *vs* Urban needs | Negative Emotions |
| Vulnerable groups | Management concerns with personal cap and trade |
| Global issue | Practicality concerns with personal cap and trade |
| Where is the taxpayer money going? | Policy improvements/suggestions |
| Desire for transparency and education | |

| **Themes** |
|---|
| Targeting Canadian citizens with carbon pricing is both ineffective and unfair |
| Government should focus on subsides and supply side initiatives |
| This policy is particularly unfair to vulnerable groups. |
| Support and effectiveness of pricing systems require policy transparency and education |
| (specifically regarding what is being done with the money) |
| Quantification of carbon pollution is useful. |
| Personal cap and trade is good in theory, but the details have not been thought out. |
| Government regulation restricts our freedom. |
| We need to take action on climate change. |
| Carbon Pricing is effective. |
| Carbon pollution should not be monetized. |

Figure 1

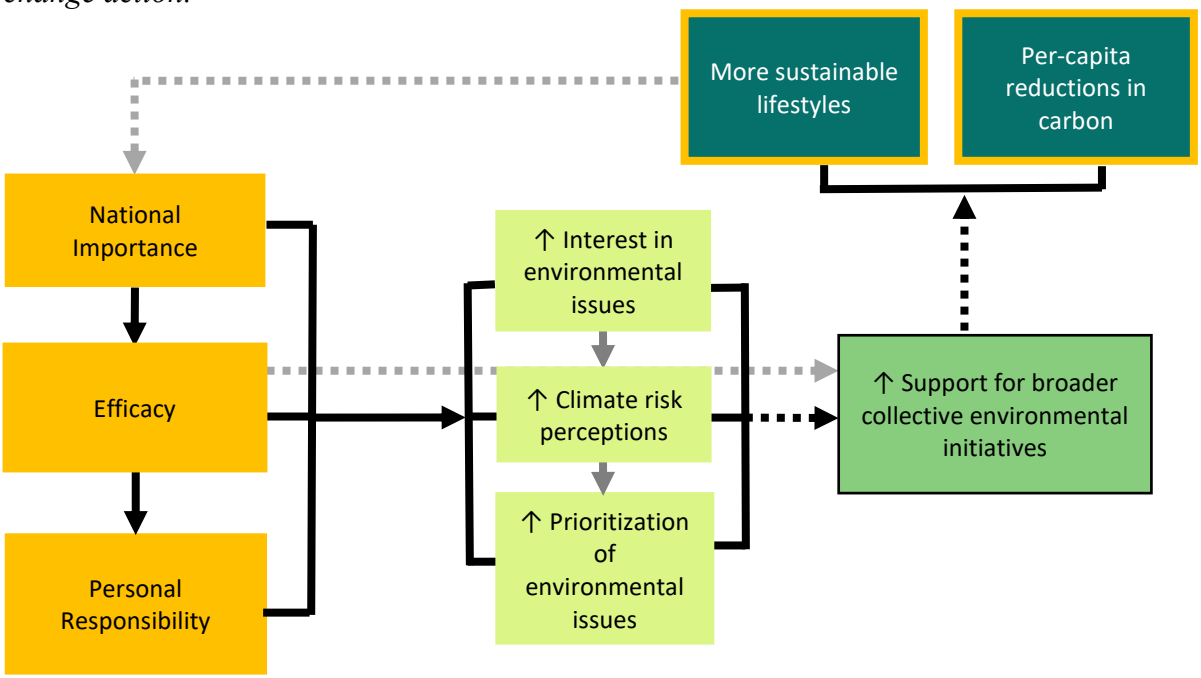
*The features of carbon pricing systems (taxes and personal cap and trade) that are expected to increase citizens belief that environmental protection is important, and genereate a sense of efficacy and personal responsiblitiy for climate action.*




*Note*. A sense of efficacy and personal responsiblitiy for climate action would be expected to increase support for collective environmental initaitves, these initiatives would be expected to allow individuals to lead more sustainable lifestyles.

Figure 2

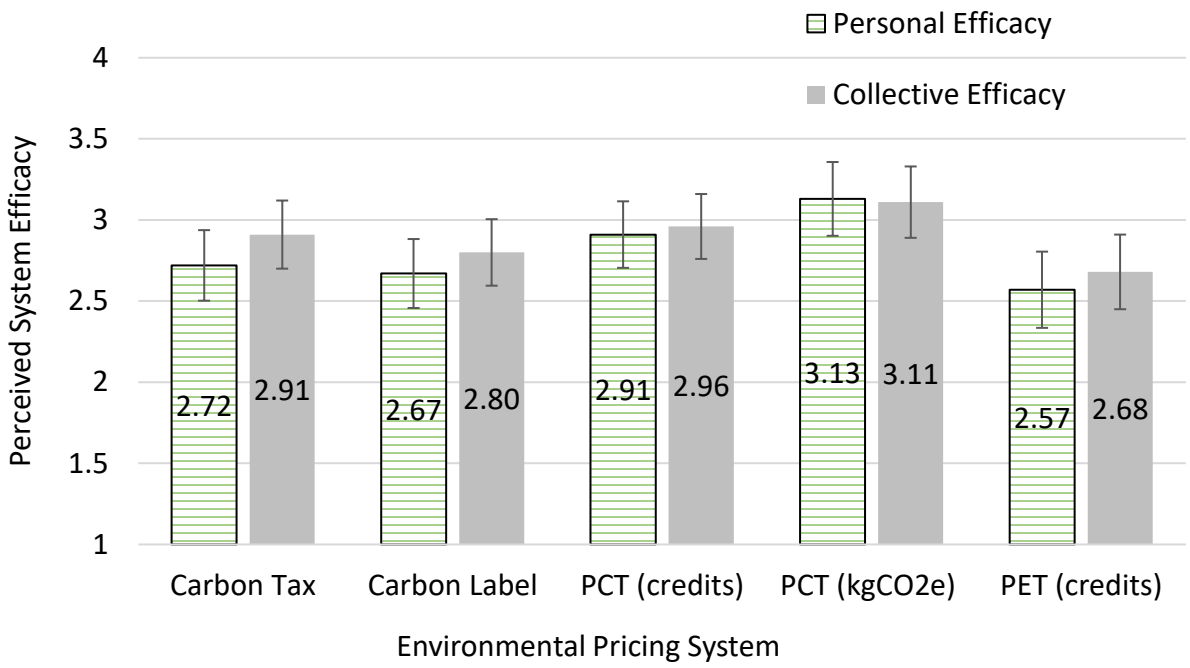
*Hypothesized outcomes following a sense of efficacy and personal responsibility for climate change action.*




*Note.* Personal Carbon Trading (a cap and trade system applied to individuals) is expected to increase citizens belief that environmental protection is important, and generate a sense of efficacy and personal responsibility for climate action within the population. These outcomes would be expected to increase citizens interest in environmental issues, increase climate change risk perceptions, and increase the prioritization of environmental issues. Together, this would be expected to increase citizen support for environmental initiatives.

Figure 3

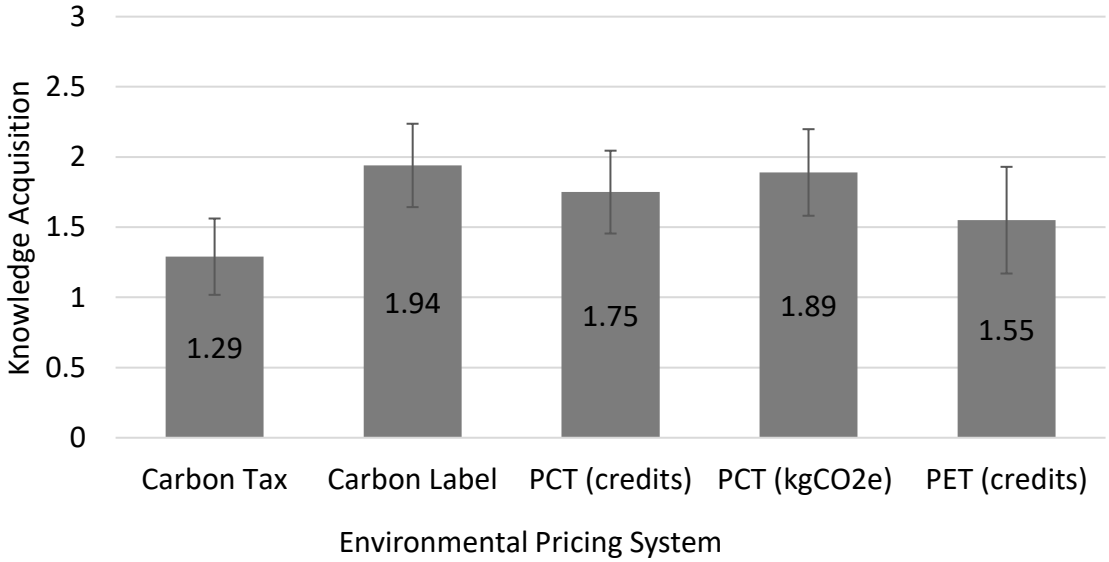
*Perceived personal and collective efficacy associated with different environmental pricing systems.*




*Note.* Carbon Label = Carbon Tax with Labeling, PCT = Personal Carbon Trading, PET = Personal Ecosystem Impact Trading.
Personal and collective efficacy beliefs: 1 = no efficacy, 2 = low efficacy, 3 = moderate efficacy, 4 = high efficacy.
Error bars represent 99% confidence intervals.

Figure 4

*Knowledge acquisition after watching a video on an environmental pricing system.*




*Note.* Knowledge acquisition task scores could range from 0 to 3 and were based on the number of correct answers to three questions about the relative amount of $CO_{2e}$ emissions resulting from activities described in environmental pricing videos.
Carbon Label = Carbon Tax with Labeling, PCT = Personal Carbon Trading, PET = Personal Ecosystem Impact Trading.
Error bars show 98.75% confidence intervals.

## Appendix A

*Links to videos used in the experiment:*

**Introduction video**: https://youtu.be/5LZ_WIMvA-g

**Carbon Tax video**: https://youtu.be/4X5XtXXUmJw

**Carbon Tax with Carbon Label video**: https://youtu.be/OWAOIuol5vk

**Personal Carbon Trading with Credits video**: https://youtu.be/FfOB8g4ezBs

**Personal Carbon Trading with kg$CO_{2e}$ video**: https://youtu.be/IW62NzDNpSU

**Personal Ecosystem Impact Trading video**: https://youtu.be/BtibLB-FDtc

## Appendix B

*Transcripts of videos used in the experiment*:

**Introduction Video**

The reason the Earth is warm enough to sustain life is because of Greenhouse gases. Greenhouse gases trap heat from the sun in the Earth's atmosphere.

There are a variety of greenhouse gases in the atmosphere including carbon dioxide, methane, nitrous oxide, ozone, and hydrofluorocarbons to name a few.

The warming effect of all greenhouse gases are communicated in a common unit called a carbon dioxide equivalent ($CO_{2e}$).

Since methane has a warming potential of 24 times that of carbon dioxide, 1 tonne of methane would be equal to 24 tonnes $CO_{2e}$.

The correct balance of Greenhouse Gases in the atmosphere is required for Earth to be habitable.

This balance is maintained through natural processes as greenhouse gases are both released into the atmosphere and are sequestered from the atmosphere.

In the 1700s humans started burning fossil fuel for energy, releasing greenhouse gases into the atmosphere. These are referred to as anthropogenic emissions.

The use of fossil fuels sparked the Industrial Revolution and is what has led to our current North American lifestyle.

However, the burning of fossil fuels has also upset the balance of greenhouse gases in the atmosphere.

The increase of greenhouse gases in the atmosphere resulting from human activity, is causing the increase in average global temperature, and is driving global climate change.

Global climate change causes more severe droughts, wildfires, and hurricanes.

In order to try and minimize these risks, in 2015, 195 countries including Canada signed the Paris Agreement; a climate agreement to keep global temperature rise below 2°C compared to pre-industrial levels, with efforts to avoid exceeding 1.5°C.

The Canadian government pledged to, by 2030, reduce Canada's $CO_{2eq}$ emissions by 30% compared to 2005 levels.

In order to help achieve this goal, the Canadian government has made Carbon Pricing mandatory in Canada.

**Carbon Tax Video**

One way to implement carbon pricing is with a carbon tax. A carbon tax is applied to products that citizens purchase which contribute to the greenhouse house gases in the atmosphere.

With a carbon tax, citizens are charged based on the greenhouse gas pollution they create through regular household heating, personal transportation, and emissions resulting from electricity usage.

A carbon tax increases each year, this helps to decrease greenhouse gas emissions by making fossil fuels more and more expensive.

Consider the following scenario:

You live with two roommates in a three-bedroom house in Northern British Columbia. You own a medium sized car.

You drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend $54 dollars on the gas.

Living in a cold northern climate, you heat your house in the winter using natural gas provided by Fortis BC. Your home is an older building; however, the doors and windows have been weatherproofed, and you have a high efficiency furnace. Your thermostat is set to 21°C. Natural gas is also used to heat water for showers, and from your tap.

For the month of January your Fortis BC bill is $125 dollars.

By setting the temperature back to 16°C overnight, the following savings could be made in one year $65.

In the summer months you don't need to use natural gas for heating, however, some is still used for your hot water tank. For the month of July, your Fortis BC bill is $32.

You have a washer and dryer in your home, and your house is lit using incandescent light bulbs. Both you and your roommate are conscious of turning off the lights as you leave the room. You also share a TV you enjoy watching in the evenings after work. All these items (among others such as the fridge, freezer, and kitchen appliances) use electricity provided by BC Hydro.

Over the course of one month, your BC Hydro bill is $105.

Upgrading all your lights to LED bulbs would result in the following savings on BC Hydro bills over one year $612.

Your friends in Vancouver live 780 kms away. You make a trip to visit them by car, enjoying the scenery along the way.

The cost of fuel associated with one round trip to Vancouver in your car is $182.

Here is a mock bank statement summarizing your spending over one month in January.

Here is a mock bank statement summarizing your spending over one month in July.

**Personal Carbon Trading (carbon credits)**

One way to implement carbon pricing is with a personal cap and trade system called Personal Carbon Trading.

In a Personal Carbon Trading system, the Canadian government would determine a cap on total yearly carbon emissions from personal car transportation, residential heating and electricity usage. This total amount would be converted into allowances, and would be distributed to all adult citizens in the form of carbon credits.

Each adult would have a carbon account, and carbon credits would be deposited (for free) into each person's carbon account on a monthly basis. Each person would receive the same number of carbon credits.

As a person causes carbon dioxide emissions, for example, by heating their home with natural gas, a corresponding number of carbon credits would be deducted from his or her carbon account for the activity producing the emissions.

Individuals who make an effort to reduce their emissions or who already cause very little emissions will be able to sell their unused carbon credits to those who need more than their allowance.

In practice, the system would work as follows. Imagine that you have just put gasoline in your car and then go inside to pay.

First you use your carbon credits to pay for the emissions, and then you pay for the gasoline. If you have already used up the allotted carbon credits for that month, you can easily buy extra credits at the gasoline station.

Rather than paying for pollution with an embedded tax such as with the carbon tax, you would be paying for pollution by using your carbon credits.

Initially, 1 carbon credit is equal to 0.1 tonnes $CO_2$ equivalent.

The market price is assumed to be $5.00 per carbon credit, and each individual is given 8 free carbon credits per month.

Over time, the monthly allocation of carbon credits would be decreased in order to lower total carbon emissions to achieve national targets.

Consider the following scenario:

You live with two roommates in a three-bedroom house in Northern British Columbia. You own a medium sized car.

First let's consider a month when you go over your monthly allocation of 8 carbon credits.

It is January. You drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$50.50 + 1 carbon credit** on the gas. You have 7 carbon credits remaining.

Your friends in Vancouver live 780 kms away. You make a trip to visit them by car, enjoying the scenery along the way.

The cost of fuel associated with one round trip to Vancouver in your car is **$171 + 3 carbon credits**. You have 4 carbon credits remaining.

Living in a cold northern climate, you heat your house using natural gas provided by Fortis BC.

Your home is an older building; however, the doors and windows have been weatherproofed, and you have a high efficiency furnace. Your thermostat is set to 21°C. Natural gas is also used to heat water for showers, and from your tap.

Your Fortis BC bill for the month is **$107 + 5 carbon credits**. You are out of carbon credits, and must pay $5 for 1 additional carbon credit.

You have a washer and dryer in your home, and your house is lit using incandescent light bulbs. Both you and your roommate are conscious of turning off the lights as you leave the room.

You also share a TV you enjoy watching in the evenings after work. All these items (among others such as the fridge, freezer, and kitchen appliances) use electricity provided by BC Hydro.

Over the course of the month, your BC Hydro bill is **$105+ 0.1carbon credit**.

Here is a mock bank statement summarizing your spending over the month of January.

Notice at the start of the month the government deposits 8 carbon credits into your account.

Note the carbon credit charges.

Notice you went over your carbon allocation and are being charged for additional carbon credits.

Now let's consider a month when you go under your monthly allocation of 8 carbon credits.

It is July. Again you drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$50.50 + 1 carbon credit** on the gas. You have 7 carbon credits remaining.

Since it is summer you don't need to use natural gas for heating, however, some is still used for your hot water tank. For the month of July, your Fortis BC bill is **$29 + 1 carbon credit**. You have 6 carbon credits remaining.

Over the course of the month, your BC Hydro bill is **$115 + 0.1 carbon credit.**

Here is a mock bank statement summarizing your spending over the month of July.

Notice that you went under your monthly carbon allocation. You could either carry over your credits to the next month, or sell them for the market value.

This policy would be mandatory for all Canadians, and carbon credit allocations would decrease over time.

### Personal Carbon Trading ($kgCO_{2e}$)

One way to implement carbon pricing is with a personal cap and trade system called Personal Carbon Trading.

In a Personal Carbon Trading system, the Canadian government would determine a cap on total yearly carbon emissions from personal car transportation, residential heating and electricity usage. This total amount would be converted into allowances, and would be distributed to all adult citizens in the unit of kg $CO_{2e}$.

Each adult would have a carbon account, and kilograms $CO_{2e}$ would be deposited (for free) into each person's carbon account on a monthly basis. Each person would receive the same number of carbon emission allowances.

As a person causes carbon dioxide emissions, for example by heating their home with natural gas, a corresponding amount would be deducted from his or her carbon account for the activity producing the emissions.

Individuals who make an effort to reduce their emissions or who already cause very little emissions will be able to sell their unused carbon emissions to those who need more than their allowance.

In practice, the system would work as follows. Imagine that you have just put gasoline in your car and then go inside to pay.

First you use your carbon card to pay for the emissions, and then you pay for the gasoline. If you have already used up the allotted carbon emissions for that month, you can easily buy extra emission allowances at the gasoline station.

Rather than paying for pollution with an embedded tax such as with the carbon tax, you would be paying for pollution by using your carbon emission allowances.

The market price is assumed to be \$5.00 per 100 kg $CO_{2e}$

Each individual is given 800 free carbon emission allowances per month.

Over time, the monthly allocation of carbon allowances would be decreased in order to lower total carbon emissions to achieve national targets.

Consider the following scenario:

You live with two roommates in a three-bedroom house in Northern British Columbia. You own a medium sized car.

First let's consider a month when you go over your monthly allocation of 800 kg of carbon emissions.

It is January. You drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **\$50.50 and 100 kg carbon emissions** on the gas. You have 700 kg of carbon emissions remaining.

Your friends in Vancouver live 780 kms away. You make a trip to visit them by car, enjoying the scenery along the way.

The cost of fuel associated with one round trip to Vancouver in your car is **\$171 and 300 kg$CO_{2e}$**. You have 400 kg carbon emissions remaining.

Living in a cold northern climate, you heat your house using natural gas provided by Fortis BC.

Your home is an older building; however, the doors and windows have been weatherproofed, and you have a high efficiency furnace. Your thermostat is set to 21°C. Natural gas is also used to heat water for showers, and from your tap.

Your Fortis BC bill for the month is **$107 + 500 kg$CO_{2e}$**. You are out of carbon emissions, and must pay for an additional 100 kgs of carbon emissions.

You have a washer and dryer in your home, and your house is lit using incandescent light bulbs. Both you and your roommate are conscious of turning off the lights as you leave the room.

You also share a TV you enjoy watching in the evenings after work. All these items electricity provided by BC Hydro.

Over the course of the month, your BC Hydro bill is **$105 and 10 kg$CO_{2e}$**.

Here is a mock bank statement summarizing your spending over the month of January

Notice, at the start of the month the government deposits 800kgs of $CO_2$ emissions into your account.

Note the carbon emission charges.

Notice you went over your carbon allocation and are being charged for additional carbon emissions.

Now let's consider a month when you go under your monthly allocation of 800 kg $CO_2$ emissions.

It is July. Again you drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$50.50 + 100 kg$CO_{2e}$** on the gas. You have 700 kgs of carbon emissions remaining.

Since it is summer you don't need to use natural gas for heating, however, some is still used for your hot water tank. For the month of July, your Fortis BC bill is $**29 + 100 kg$CO_{2e}$**. You have 600 kg$CO_{2e}$ of carbon emissions remaining.

Over the course of the month, your BC Hydro bill is **$115 + 10 kg$CO_{2e}$ emissions**.

Here is a mock bank statement summarizing your spending over the month of July.

Notice that you went under your monthly carbon allocation. You could either carry over your emissions to the next month, or sell them for the market value.

This policy would be mandatory for all Canadians, and carbon emission allowances would be reduced over time.

### Carbon Tax with Carbon Labeling

One way to implement carbon pricing is with a carbon tax.

A carbon tax is applied to products that citizens purchase which contribute to the greenhouse house gases in the atmosphere.

The tax is embedded in the cost of the product.

With a carbon tax, citizens are charged based on the greenhouse gas pollution they create through regular household heating, personal transportation, and emissions resulting from electricity usage.

A carbon tax increases each year, this helps to decrease greenhouse gas emissions, and meet national targets by making fossil fuels more and more expensive.

A carbon labelling policy could exist alongside a carbon tax policy to help educate the public on the environmental impact of their consumption.

With a carbon labeling policy, the amount of carbon emissions resulting from products within the scope of the carbon tax would be labelled (in kilograms or tonnes $CO_{2e}$) beside the cost of the product.

Additionally, the percent of individual monthly recommended carbon consumption would be calculated by the national government based on national emission targets.

Products would be labeled with their contribution, in percentage, to the amount of monthly recommended carbon emissions

For example, when filling your car up on gas at the pump, your receipt shows the price of the product, the amount of carbon dioxide emissions, and the percent of monthly recommended carbon dioxide emissions resulting from the gasoline.

Consider the following scenario:

You live with two roommates in a three-bedroom house in Northern British Columbia. You own a medium sized car.

First let's consider a month in the winter.

It is January. You drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$55.50** dollars on the gas, burning of the gasoline results in **100 kg$CO_{2e}$** of carbon emissions, this represents **13%** of individual monthly recommended carbon emissions. (slide says, **$55.50, 100 kg $CO_{2e}$, 13% monthly recommended $CO_{2e}$**)

Your friends in Vancouver live 780 kms away. You make a trip to visit them by car, enjoying the scenery along the way.

The cost of fuel associated with one round trip to Vancouver in your car is **$186, burning of the gasoline results in 300 kg$CO_{2e}$ this represents 38% of individual monthly recommended carbon emissions.**

Living in a cold northern climate, you heat your house using natural gas provided by Fortis BC.

Your home is an older building; however, the doors and windows have been weatherproofed, and you have a high efficiency furnace. Your thermostat is set to 21°C. Natural gas is also used to heat water for showers, and from your tap.

Your Fortis BC bill for the month is **$132**, burning of the natural gas results in **500 kg$CO_{2e}$, this represents 63% of individual monthly recommended carbon emissions**.

You have a washer and dryer in your home, and your house is lit using incandescent light bulbs. Both you and your roommate are conscious of turning off the lights as you leave the room.

You also share a TV you enjoy watching in the evenings after work. All these items (among others such as the fridge, freezer, and kitchen appliances) use electricity provided by BC Hydro.

Over the course of the month, your BC Hydro bill is **$105.50**. The use of electricity from BC Hydro results in **10kg $CO_{2e}$, this represents 6% of monthly carbon emissions**.

Now let's consider a month in the summer.

It is July. Again you drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$55.50** dollars on the gas. Burning of the gasoline results in **100 kg$CO_{2e}$, this represents 13% of monthly recommended $CO_{2e}$**. (slide says, "$55.50, 100 kgCO2e, 13% monthly recommended $CO_{2e}$)

Since it is summer you don't need to use natural gas for heating, however, some is still used for your hot water tank. For the month of July, your Fortis BC bill is $**34, the natural gas burned results in 100 kgCO2e this represents 13% of monthly $CO_{2e}$ emissions.**

Over the course of the month, your BC Hydro bill is **$115.50. which results in 10 kg $CO_{2e}$ and represents 1% of individual monthly recommended $CO_{2e}$ emissions**.

In summary, Carbon taxes increase each year making fossil fuels more and more expensive. The costs you have been shown include a carbon tax.

**Personal Ecosystem Impact Trading**

One way to implement pricing on environmental pollution is with a personal cap and trade system called Personal Ecosystem Impact Trading. This policy aims to reduce the ecological footprint of individuals.

An Ecological Footprint measure determines how much productive land and water (in global hectares) is required to support and absorb the waste from consumption. Biologically productive land is split into six categories: cropland, grazing land, fishing ground, built-up land, forest area, and carbon demand on land. An Ecological Footprint can act as an indicator of environmental issues such as biodiversity declines, water and soil conservation, in addition to global warming.

In a Personal Ecosystem Impact Trading system, the Canadian government would determine a cap on total yearly ecological impact (measured in global hectares) from personal car transportation, residential heating and electricity usage.

This cap on ecosystem impact would be converted into allowances, and would be distributed to all adult citizens in the form of ecosystem impact credits.

Each adult would have a ecosystem impact account, and ecosystem impact credits would be deposited (for free) into each person's ecosystem impact account on a monthly basis.

Each person would receive the same number of ecosystem impact credits.

As a person causes ecosystem impacts (e.g. by heating their home with natural gas), a corresponding number of ecosystem impact credits would be deducted from his or her ecosystem impact account for the activity producing the damage.

Individuals who make an effort to reduce their impact or who already cause very little impact will be able to sell their unused ecosystem impact credits to those who need more than their allowance.

In practice, the system would work as follows. Imagine that you have just put gasoline in your car and then go inside to pay.

First you use your ecosystem impact credits to pay for the emissions, and then you pay for the gasoline. If you have already used up the allotted ecosystem impact credits for that month, you can easily buy extra credits at the gasoline station.

Rather than paying for pollution with an embedded tax such as with the carbon tax, you would be paying for total environmental impact by using your ecosystem impact credits.

Initially, 1 ecosystem impact credit is equal to 0.1 global hectares.

The market price is assumed to be $5 per ecosystem impact credit.

Each individual is given 8 free ecosystem impact credits per month.

Over time, the monthly allocation of ecosystem impact credits would be decreased in order to lower total ecosystem impact to achieve national targets.

Consider the following scenario:

You live with two roommates in a three-bedroom house in Northern British Columbia. You own a medium sized car.

First let's consider a month when you go over your monthly allocation of 8 ecosystem impact credits.

It is January. You drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$50.50 + 1 ecosystem impact credit** on the gas. You have 7 ecosystem credits remaining.

Your friends in Vancouver live 780 kms away. You make a trip to visit them by car, enjoying the scenery along the way.

The cost of fuel associated with one round trip to Vancouver in your car is **$171 + 3 ecosystem impact credits**. You have 4 ecosystem impact credits remaining.

Living in a cold northern climate, you heat your house using natural gas provided by Fortis BC.

Your home is an older building; however, the doors and windows have been weatherproofed, and you have a high efficiency furnace. Your thermostat is set to 21°C. Natural gas is also used to heat water for showers, and from your tap.

Your Fortis BC bill for the month is **$107 + 5 ecosystem impact credits**. You are out of ecosystem impact credits and must pay for 1 additional ecosystem impact credit.

You have a washer and dryer in your home, and your house is lit using incandescent light bulbs. Both you and your roommate are conscious of turning off the lights as you leave the room.

You also share a TV you enjoy watching in the evenings after work. All these items (among others such as the fridge, freezer, and kitchen appliances) use electricity provided by BC Hydro.

Over the course of the month, your BC Hydro bill is **$105+ 0.1 ecosystem impact credit**.

Here is a mock bank statement summarizing your spending over the month of January.

Notice at the start of the month the government deposits 8 ecosystem impact credits into your account.

Note the ecosystem impact charges.

Notice you went over your ecosystem impact allocation and are being charged for additional ecosystem impact credits.

Now let's consider a month when you go under your monthly allocation of 8 ecosystem impact credits.

It is July. Again you drive your car to work, to get groceries, and to run errands. After driving 466kms you notice your gas tank is on empty so you go to fill up on gas.

You spend **$50.50 + 1 ecosystem impact credit** on the gas. have 7 ecosystem impact credits remaining. You have 7 ecosystem impact credits remaining.

Since it is summer you don't need to use natural gas for heating, however, some is still used for your hot water tank. For the month of July, your Fortis BC bill is $**29 + 1 ecosystem impact credit**. You have 6 carbon credits remaining.

Over the course of the month, your BC Hydro bill is **$115 + 0.1 ecosystem impact credit**.

Here is a mock bank statement summarizing your spending over the month of July.

Notice that you went under your monthly ecosystem impact allocation. You could either carry over your credits to the next month, or sell them for the market value.

This policy would be mandatory of all Canadians. Ecosystem impact credits would decrease over time.