UNIVERSITÀ
DI PAVIA

DIPARTIMENTO DI SCIENZE POLITICHE E SOCIALI

CORSO DI LAUREA IN SVILUPPO ECONOMICO E RELAZIONI INTERNAZIONALI

PERSONAL CARBON TRADING: DRIVING BEHAVIOURAL CHANGE TOWARDS PLANETARY BOUNDARIES

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ANNO ACCADEMICO 2021/22

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Abstract

Personal carbon trading (PCT) is the term used to describe a group of radical, innovative public policies that, because of the imperative to act to achieve national greenhouse gas emission reduction targets, aim to limit personal carbon emissions by instigating profound behavioural change. This thesis will first define these policies by describing their origin and rationale. The second objective is to understand the mechanisms these policies adopt to provoke behavioural change, their effectiveness, and the critical issues with respect to the parameters of economic, political, and social feasibility. The final object of interest of this analysis is the compatibility of personal carbon trading systems and the European Union's existing emissions trading scheme, the EU ETS, in light of developments arising from the Fit for 55 package. Overall, this analysis illustrates how technological progress, the policies adopted due to the COVID-19 pandemic and the energy crisis triggered by the war in Ukraine in 2022, constitute pre-conditions that may have made the implementation of personal carbon trading policies less complex, and argues that PCT as a policy tool could help to steer the debate in the field of environmental mitigation policies towards an increasing involvement of citizens.

Personal Carbon Trading (PCT) è il termine utilizzato per descrivere un gruppo di politiche pubbliche radicali e innovative che, a causa dell'imperativo di agire per raggiungere gli obiettivi nazionali di riduzione delle emissioni di gas serra, mirano a limitare le emissioni personali di anidride carbonica istigando un profondo cambiamento comportamentale. Questa tesi intende innanzitutto definire queste politiche descrivendone l'origine e le motivazioni. Il secondo obiettivo è comprendere i meccanismi che queste politiche adottano per provocare un cambiamento comportamentale, la loro efficacia e le criticità rispetto ai parametri di fattibilità economica, politica e sociale. L'ultimo oggetto di interesse di questa analisi è la compatibilità tra i sistemi di scambio di quote di carbonio personali e l'attuale sistema di scambio di quote di emissioni dell'Unione Europea, l'EU ETS, alla luce degli sviluppi derivanti dal pacchetto Fit for 55. Nel complesso, questa analisi illustra come il progresso tecnologico, le politiche adottate a causa della pandemia COVID-19 e la crisi energetica innescata dalla guerra in Ucraina nel 2022, costituiscano delle precondizioni che potrebbero aver reso meno complessa l'implementazione di politiche di personal carbon trading, le quali potrebbero contribuire a orientare il dibattito nel campo delle politiche di mitigazione ambientale verso un crescente coinvolgimento dei cittadini.

Acronyms

PCT: personal carbon trading

TEQs : Tradable Energy quotas

C&S: Cap and share

EU ETS : Emission Trading System of the European Union

GHGs: Greenhouse gases

IPCC: International Panel on Climate Change

UNFCCC: United Nations Convention on Climate Change

COP: Conference of Parties

Introduction

Climate change is a "truly complex and diabolical policy problem".[1] This is due to some features of climate change: its dynamics are intricate, therefore to be understood it requires the cooperation of several scientific disciplines such as chemistry, physics, and biology, but also social sciences including economics, sociology, etc. It is also a multilevel problem in geographical terms: some regions are more affected than others by extreme weather phenomena (floods, droughts, heat waves, etc.). At the same time, some local phenomena have major global repercussions, e.g. the thawing of permafrost. These local phenomena are called "tipping points". Tipping points or elements are:

"regional-scale features of the climate that could exhibit threshold type behaviour in response to human-driven climate change [...] the consequences of such shifts in the tipping element for societies and ecosystems are likely to be severe".[2]

The abrupt and irreversible change of a certain feature of the system, the "tipping element", can be triggered by a change in a forcing variable, for example, the rise

[1] Steffen, W., extract of.Dryzek, J.S., Norgaard, R.B., & Schlosberg, D., *A truly complex and diabolical policy problem* , "Climate Change and Society", Oxford University Press, 2011
[2] Ibidem.

of the concentration of CO_2 in the atmosphere.[3] Examples of tipping elements are the Amazon rainforest, the South Asian monsoon system and large polar ice sheets.[4] For instance, Greenland and the West Antarctic are large polar ice sheets that could melt if the global average temperature rose by 2 or 3°C above the pre-industrial level. [5] Although this could take millennia, if Greenland and the West Antarctic disappeared completely they would cause an increase in global sea levels of 13 metres.[6] A local issue could become a global and irreversible problem, that was triggered by a variable exceeding a certain threshold. Thus, the climate system is characterised by "threshold/abrupt change behaviour".[7] Additionally, some aspects of climate change dynamics are not predictable. For example, climate scientists are not sure about how much the global average temperature will rise even if the GHG concentration is stabilised: there is only a 50:50 chance that limiting GHG concentration to 450 ppm CO_2eq will limit the temperature rise to 2°.[8] Hence, for global, national and local governance, climate change is a truly diabolical political problem.

Despite some uncertainties, one fact is undeniable: the cause of temperature rise is the anthropogenic emissions of greenhouse gases. The correlation between GHG emissions and temperature rise has been shown by all climate scientific models since 1980, first among them the Intergovernmental Panel on Climate Change (IPCC) reports. The figure below shows how "cumulative carbon determines warming".[9]

[3] Ibidem.
[4] Ibidem.
[5] Ibidem.
[6] Ibidem.
[7] Ivi, 24.
[8] Ivi, 26.
[9] IPCC, 2013: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

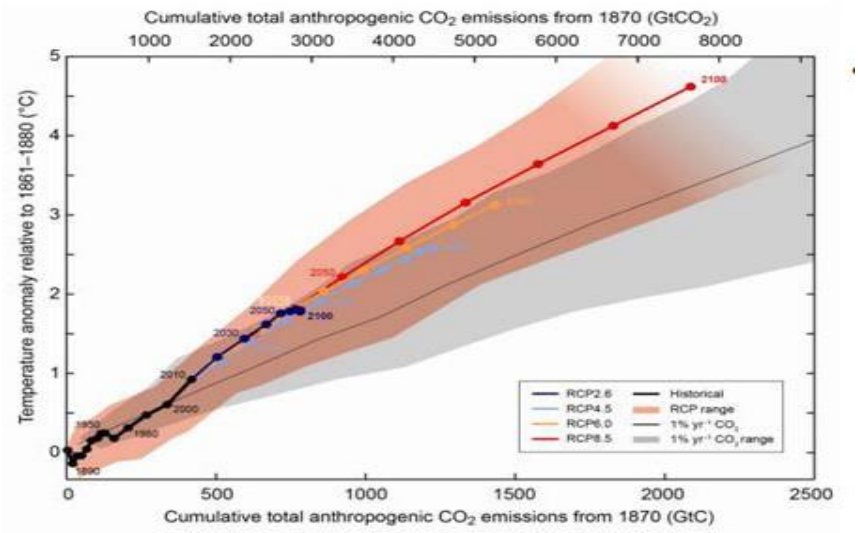

Figure 1 Graph showing the positive correlation between cumulative total anthropogenic emissions from 1870 and temperature anomaly for 1861-1880 levels (pre-industrial average global temperature). Source: IPCC, 2013.[10]

Climate change, though, is only one of the pieces composing the puzzle depicting the environmental crisis. The concept of "planetary boundaries" helps better grasp the entirety of this picture. The planetary boundaries framework was formulated in 2009 by a group of scientists led by Jon Johan Rockström,[11] who quantitatively identified nine "processes that regulate the stability and resilience of the Earth system".[12] These limits represent the "safe operating space" on a planet that is not subjected to large-scale irreversible changes where humanity can live.[13] The figure below depicts the nine planetary boundaries which are: Stratospheric ozone depletion, Loss of biosphere integrity (biodiversity loss and

[10] Knutti, R., Relationship between global emissions and global temperature rise, CLA chapter 12, : *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* , 2013, IPCC AR 5 Working Group I, Climate Change 2013: the Physical Science Basis, https://unfccc.int/sites/default/files/7_knutti.reto.3sed2.pdf

[11] Rockström, J., Steffen, W., Noone, K.., Persson, Å., Chapin, F. S., III, Lambin, E.,. Lenton, T. M., M. Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., De Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., and Foley. J, Planetary boundaries:exploring the safe operating space for humanity. *Ecology and Society* 14(2): 32. [online] URL: http://www.ecologyandsociety.org/vol14/iss2/art32/, 2009

[12] Planetary boundaries, Stockholm Resilience Centre, Stockholm University, https://www.stockholmresilience.org/research/planetary-boundaries.html, last accessed 13/04/2023

[13] Ibidem.

extinctions), Chemical pollution and the release of novel entities, Climate Change, Ocean acidification, Freshwater consumption and the global hydrological cycle, Land system change, Nitrogen and phosphorus flows to the biosphere and oceans, Atmospheric aerosol loading.[14] Research found in 2015 that the boundaries of climate change, biodiversity loss, shifts in nutrient cycles (nitrogen and phosphorus), and land use, were pushed beyond the limit by human activities; in January 2022 new research found that the boundaries of environmental pollutants and other "novel entities", that is to say, plastics pollution, were also exceeded.[15]

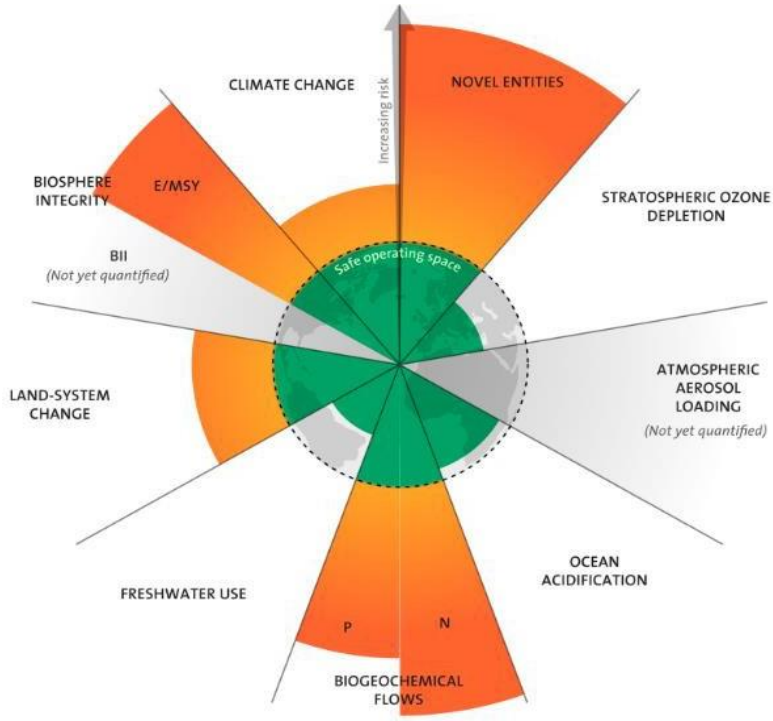

Figure 2 The most recent graph (January 2022) showing planetary boundaries and the ones that have been exceeded. Source: Azote for Stockholm Resilience Centre, based on analysis in Persson et al 2022 and Steffen et al 2015.[16]

The concept of planetary boundaries is a representation of the finite dimension of planet Earth, and the impact humankind had on it through the depletion of natural resources. The latter is so unprecedented that Paul Crutzen, a Nobel laureate on

[14] Ibidem.
[15] Ibidem.
[16] Ibidem.

the committee of the International Geosphere-Biosphere Programme,[17] thought of creating a new geological era: the Anthropocene. The Anthropocene describes the new geological epoch that corresponds to our days, where the impact of human beings on the planet has become as strong as the geological forces that have shaped the planet, and the main driver of change in the Earth system.[18] The Anthropocene follows the Holocene, the era that has categorised the past 11,700 years, characterised by a stable climate and environmental conditions that have allowed human civilisations to grow and prosper.[19] The Anthropocene represents the era "where human activities start to have a significant – and negative – global impact on Earth's ecosystems"[20], this impact is a historical exception in the 4,5 billion years of the life of our planet.[21]

The numerous scientific models and reports elaborated since the 1980s have contributed to bringing the problem of climate change into the political agenda of the international community. Following the UNFCCC official timeline we can retrace a brief story of the international community's efforts to face climate change.[22] In December 1990, the United Nations established a negotiating committee to elaborate a Framework Convention on Climate Change which was formally adopted in 1992: the "UNFCCC United Nations Framework Convention on Climate Change"(UNFCCC). This convention stands out for introducing the concept of emission targets involving the various parties. At the 1992 Rio Earth Summit the UNFCCC was open for signatures and in 1994 was signed by 196 countries. On this occasion, it was established that "conferences of parties"

[17] Dixson-Decleve S., Gaffney, O., Ghosh. J, Randers, J., Rockstrom, J., Stoknes, P. E., *Earth for All: A Survival Guide for Humanity*, New Society Publishers, 20 set 2022, p. 13
[18] Ivi, 14
[19] Gough, I., *Heat, Greed and Human Need Climate Change, Capitalism and Sustainable Wellbeing*, Visiting Professor, Centre for the Analysis of Social Exclusion, London School of Economics, UK, 2017 ISBN: 978 1 78536 510 2, p. 19
[20] Ibidem.
[21] Dixson-Decleve S., Gaffney, O., Ghosh. J, Randers, J., Rockstrom, J., Stoknes, P. E., op. cit, p, 14
[22] UNFCCC -- 25 Years of Effort and Achievement Key Milestones in the Evolution of International Climate Policy, United Nations Framework Convention on Climate Change, https://unfccc.int/timeline/, last accessed 13/04/2023

(COP) would meet annually or every few years to negotiate climate change policies. The main results achieved by the soon 28 COPs are the Kyoto Protocol (1997), the first treaty discussing reducing GHG, which came into force in 2005, and the Paris Agreement discussed during COP21 in 2015 and entered into force in 2016. Article 2 of the Paris Agreement sets the goal of:

"Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change"[23].

The IPCC identified the 2° threshold as the limit to respect to avoid a dangerous and irreversible change in the climate system.[24] To maintain temperature rise within the 1.5° C threshold, which is deemed to be safer than the 2°, the scenarios assessed by the recent 6th IPCC assessment report showed that global greenhouse gas emissions would "have to peak before 2025 at the latest, and be reduced by 43% by 2030"[25]; methane emission would have to be reduced by one third at the same time. Stabilising the global temperature means reaching net zero emissions, which according to the report should be reached globally in the early 2050s.[26] The COPs following COP21 have been organised to detail the commitments of the Paris Agreement and to substantiate the commitment of signatory parties; this is evaluated through the domestic measures they have adopted to reach the 1.5° objective, which is reported to the UNFCCC through the National Determined Contributions (NDCs) reports every five years.

[23] United Nations, Paris Agreement, 12 December 2015, https://unfccc.int/sites/default/files/english_paris_agreement.pdf, last accessed 13/04/2023
[24] Rousseaux, S., *Etat des lieux international des programmes de carte carbone individuelle*, hal-00521330, 2010, p. 7
[25] IPCC, The evidence is clear: the time for action is now. We can halve emissions by 2030, Press Release, https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/, last accessed 13/04/2023
[26] Ibidem.

The information on climate science and international climate negotiations shared above leads to two main conclusions. First, the concept of planetary boundaries implies the limited nature of planet Earth. Second, if humankind wants to preserve its well-being on this same planet, it needs to act as soon as possible and change its current course of action to reach the emission reduction targets set by the various COPs on time. Quoting the IPCC Chair Hoesung Lee: "We are at a crossroads. The decisions we make now can secure a liveable future. We have the tools and know-how required to limit warming".[27]

Priyadarshi Shukla Co-Chair of the IPCC Working Group III claimed that "having the right policies, infrastructure and technology in place to enable changes to our lifestyles and behaviour can result in a 40-70% reduction in greenhouse gas emissions by 2050. This offers significant untapped potential".[28] Among the existing climate mitigation policies, personal carbon trading (PCT), operationalises the concept of planetary boundaries by creating a personal cap on emissions, trying at the same time to address economic inequalities. It is a cap-and-trade policy similar to an emission trading system, defined by the Eurostat glossary as:

"a market mechanism that allows those bodies (such as countries, companies or manufacturing plants) which emit (release) greenhouse gases into the atmosphere, to buy and sell these emissions (as permits or allowances) amongst themselves."[29]

PCT is similar to an ETS trading in its market mechanism, the main difference is the target bodies: the ETS is directed to companies and manufacturing plants, PCT is directed to individuals.

[27] Ibidem.
[28] IPCC, The evidence is clear: the time for action is now. We can halve emissions by 2030, op. cit.
[29] Eurostat statistics explained, Glossary: Emissions trading system (ETS), https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=Glossary:Emissions_trading_system_(ETS), last accessed 13/04/2023

The first object of analysis of this thesis will be answering to the following question: is PCT the "right policy" that can stimulate this paramount change in our lifestyles and behaviour? This will be explored considering the political context of 2022-2023, characterised by the consequences of the COVID-19 pandemic and the war in Ukraine. Another aspect which will be central to this thesis is the relationship between PCT and the European Emission Trading System (EU ETS). The EU ETS system is the "world's first international emission trading system"[30], the leading EU climate policy adopted at the beginning of the 2000s to reduce the European Unions' industrial emissions. The EU ETS includes a limited number of sectors and will, as soon as 2027 or 2028, include emissions deriving from the residential sector (except for electricity), and transport (other than aviation). A complete description of the EU ETS, its functioning and the sectors involved, especially after the political developments related to the EU Green Deal, will be detailed in the fourth chapter of this thesis. We will therefore try to answer to a second question: Could PCT be implemented in the European Union and coexist with the European Emission Trading System (EU ETS) scheme?

To answer these questions, the thesis will be structured into four chapters. The first chapter will introduce PCT, providing a definition of the policy, describing the variety of PCT options that exist, the history of the policy, and stressing the importance of reducing individual emissions to reach the emission reduction targets. The second chapter will then describe in detail the mechanisms that PCT would put in place to drive behavioural change to reduce individual emissions through an overview of the existing academic literature, and the results of a recent case of PCT trial, the Norfolk Island experiment. This chapter will then focus on a comparison between existing alternative policy initiatives and ideas

[30]European Commission, Development of EU ETS (2005-2020), Climate Action, https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/development-eu-ets-2005-2020_en, last accessed 19/04/2023

aimed at stimulating individual behavioural change to reduce personal contribution to GHG emissions, in particular it will compare PCT and the carbon tax. The third chapter will subsequently depict the challenges posed by PCT, the costs of implementation and operation, the social and political acceptability through a comparison with other policies, such as the carbon tax, as well as other challenges. The fourth and final chapter will focus on the possible implementation of PCT in the European Union. It will first, address the issues derived by the choice of a certain geographical area of implementation for PCT, then it will set the framework of the European Union's climate policy and the EU Emission Trading System, its history and recent political developments. It will highlight the issues deriving from the hypothetical coexistence of PCT and the EU ETS system, to finally discuss the possibility of implementing PCT schemes at a sub-national level through the case study of the CitiCAP PCT scheme developed in the Finnish city of Lathi.

This thesis is based on a literature review, complemented by the insights deriving from the conversations I had with Mathilde Szuba, professor of Political Science at Sciences Po Lille, Joseph Dellatte, Resident Fellow - Climate, Energy and Environmet in Institut Montaigne, Michele Stua, professional affiliate of the Management Institute of Scuola Superiore Sant'Anna di Pisa, Christian Gollier, Executive Director of the Toulouse School of Economics and the interviews organised with Tina Fawcett, senior researcher in the Energy Programme at Oxford's Environmental Change Institute, and Joseph D'Halluin, former parliamentary assistant of the member of the French Parliament François Ruffin. The idea of this thesis derives from the stimulating conversations that I had with professor Szuba, who introduced me to personal carbon trading. I would like to thank all of them for the time they dedicated to me and the invaluable advice they have put forward, which has been fundamental for writing this thesis. I would also like to thank my mentor, ecologist, and creator of the NGO Cambiamo, Gabriele Porrati, who helped me build my expertise on the dynamics of climate

change and who pushed me to never stop learning. Finally, I would like to express my gratitude to my parents, my family, my partner and my friends who fundamentally supported me throughout these years.

Chapter 1: Personal Carbon Trading an overview of a policy invention

1.1 Definition of PCT and varieties of schemes

"Personal carbon trading is an umbrella term for various downstream cap-and-trade policies, all of which aim to limit carbon emissions within a society by engaging individuals in the process".[31] This is the definition of PCT adopted by Tina Fawcett and Yael Parag.[32] Three main features of PCT emerge from this definition:

- It aims at reducing a given society's emissions;
- It is not a policy in itself but a name for a group of policies sharing the same objective;
- It acts on the individuals living in that society to reach its objective.

This first chapter will explore these features characterising PCT. First, personal carbon trading was created as a "mitigation policy proposal"[33] to link personal action with global carbon reduction goals[34]. PCT policies entail the creation of tradable carbon allowances to be distributed equally to all adults in a given

[31] Parag, Y., Fawcett, T., *Personal carbon trading: a review of research evidence and real-world experience of a radical idea*, "Energy and Emission Control Technologies*"*, Dove Medical Press Limited, 2014, p. 23
[32] Ibidem.
[33] Fawcett, T., Parag, Y., Nerini, F., Ekins, P., *Personal carbon allowances revisited*, "nature sustainability", vol 4, 2021, p. 1025
[34] Ibidem.

society : every adult would be entitled to a personal carbon budget that should be "spent" whenever a payment is made for purchasing transport fuel and/or home heating and electricity bills,[35] the allowances would be reduced over time according to the national emission reduction targets.[36] The letter T in PCT stands for "trading" and refers to the fact that the carbon allowances can be traded through a personal carbon market or enabling market.[37] Thus, individuals with higher housing and transport energy-related consumption, should buy additional allowances to cover their demand from the individuals who have lower consumption patterns and therefore can save unused carbon allowances. PCT establishes a form of financial reward for the avoided emissions and a price for the exceeding emissions.[38] PCT is therefore a *downstream cap-and-trade* policy, because allowances are distributed to consumers and traded among them, contrary to an *upstream cap-and-trade* scheme, such as the EU ETS, which, instead, distributes allowances to fossil fuel suppliers.[39]

Thus, every PCT scheme shares the following features:

- "individuals periodically receive a carbon quota for free"[40];
- "the scheme is mandatory, with no opt-outs"[41];
- "for every activity that involves carbon use within the scope of the scheme, allowances are surrendered"[42];
- "the allowances are tradable, enabling a market in allowances to deal with the different surrender requirements of above-average and below-average carbon consumers"[43];

[35] Ibidem.
[36] Ibidem.
[37] Ibidem.
[38] Rousseaux, S. op.cit, p. 11
[39] Woerdman, E. & Bolderdijk, J. W., *Emissions trading for households? A behavioral law and economics perspective*, "European Journal of Law and Economics", 44, 553-578, 2017, p. 558
[40] Parag, Y., Eyre, N., *Barriers to Personal Carbon Trading in the Policy Arena*, "Climate Policy", Environmental Change Institute, University of Oxford, Centre for the Environment, 2010, p. 354
[41] Fawcett, T., Parag, Y., *An introduction to personal carbon trading*, "Climate Policy", Environmental Change Institute, University of Oxford, 2010, p. 332
[42] Parag, Y., Eyre, N., op. cit., p. 354
[43] Fawcett, T., Parag, Y., *An introduction to personal carbon trading*, op. cit, p. 332

- "allowances are reduced over time in line with national carbon reduction commitments"[44].

The second feature of PCT is that it is a general term to describe a group of policies. Over the years, starting from the 1990s, various PCT schemes have been created especially in the UK by researchers including David Fleming (The Lean Economy Connection), Aubrey Meyer (Global Commons Institute), Mayer Hillman et Tina Fawcett (Policy Studies Institute), Richard Starkey et Kevin Anderson (Tyndall Centre for Climate Change Research).[45] We will focus here on presenting some schemes to illustrate the existing diversity; the history of PCT will be discussed in the following paragraph.

Different PCT schemes give different names to the same concept of the carbon budget, which can be referred to as personal "carbon rations, allowances, quotas, tradable permits and cap and share"[46]. These schemes are designed with different levels of definition, some are thoroughly detailed policies, others are only a project or ideas.[47] Nonetheless, none of them is a "fully developed policy instrument"[48], hence, PCT can be referred to as a "policy invention".[49] Moreover, PCT schemes vary in "inclusiveness, the scope of emissions involved, the level of individual engagement, and rules for allocating, surrendering and trading carbon units".[50] These features bring about some issues such as whether children should be involved in PCT and what sectors should be included. Some examples among the existing PCT schemes to this date include, among others, Tradable energy quotas (TEQs), Tradable consumption quotas, and Personal Carbon Allowances (PCA), Household carbon trading, and Tradable transport carbon permits.[51] Cap and Share is another scheme adopting the methodology of carbon capping to reduce emissions, but contrary to the options above, it is an upstream

[44] Ibidem.
[45] Rousseaux, S., op. cit., p. 10
[46] Parag, Y., Fawcett, T., *Personal carbon trading: a review.*. , op. cit., p. 24
[47] Ivi, p. 25
[48] Ibidem.
[49] Parag, Y., Eyre, N., op. cit.
[50] Fawcett, T., Parag, Y., *An introduction to personal carbon trading,* op. cit., p. 331
[51] Parag, Y., Fawcett, T., *Personal carbon trading: a review.*. , op. cit., p. 26

system. [52] The majority of these schemes have been developed in the UK for the UK economy, apart from Cap and Share, designed in Ireland for the Irish economy, and Household carbon trading, designed for California. Among those, TEQs and PCAs were inspired by the concept of Contraction and Convergence (C&C) elaborated by the Global Commons Institute.[53] Some of the most complete schemes that have been developed so far: Tradable energy quotas and Personal Carbon Allowances, and Cap and Share.

Domestic tradable quotas, later named Tradable energy quotas (TEQs), were designed in the UK in 1996 by the policy analyst Dr David Fleming.[54] The implementation of this scheme would cover the whole economy[55] and the scope of TEQs would include household energy consumption and personal travel, but it would be excluding air travel. Under TEQs carbon units or emission rights are allocated to all adult individuals and to organisations on an equal per capita basis: 40% of emission rights would be given for free to adults, whereas organisations receiving the remaining 60% of emission rights would have to buy their units through an auction on a national market for carbon units.[56] This market would also allow individuals to buy and sell their carbon units. The market transactions would be carried out electronically,[57] through a card similar to a real credit card used for storing citizens' carbon credit measured in points; the credit would be used by citizens to access products deriving from fossil fuels which, once

[52] Matthews, L., *Upstream, downstream: the importance of psychological framing for carbon emission reduction policies*, "Climate Policy", 10 (2010) 477–480
[53] Rousseaux, S., op. cit., p. 10
[54] Starkey, R., and Anderson, K., *Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use,* Technical Report 39, Tyndall Centre for Climate Change Research, University of Manchester (section 5-6), 2005
[55] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, "Energy Policy" 38, 6868-6876, Environmental Change Institute, University of Oxford, 2010, p. 6869
[56] Fawcett, T., Yael Parag, Y., *An introduction to personal carbon trading,* op. cit., p. 331
[57] Ivi. 330

purchased, would reduce the points accumulated on the card.[58] TEQs would replace the European Union Emission Trading system (EU ETS).[59]

Personal Carbon Allowances (PCA) were developed by Mayer Hillman in 1998 and later in 2005, by Hillman and Tina Fawcett.[60] Contrary to TEQs, the PCA scheme does not cover the whole economy but only household energy and personal transport, including air travel.[61] This scheme would work in parallel with the EU ETS, moreover, children would also be entitled to allowances, which would be managed by their parents.[62] In spite of these differences, PCA is similar to TEQs in its cap and trade mechanism: all adults (and children) would receive an equal carbon allowance for free that would be set according to a national cap for carbon emissions and that would be reduced over time. Allowances could be traded in the personal carbon market, where transactions would be carried out electronically.[63]

Cap and Share policy was developed by the Foundation for the Economics of Sustainability (FEASTA) in 2008 in Ireland for the Irish economy.[64] This system, as TEQs, includes the whole economy, but unlike TEQs, it does not distribute certificates to purchase energy products to individuals. Under C&S scheme, a national authority would set a cap on national emissions, a certificate equivalent to an equal share of these national emissions would then be given to all adults of the country for free. The allowance holders would consequently be able to sell their certificates to fossil fuel suppliers through banks or post offices.[65] Fossil fuel suppliers would need to buy the certificates and surrender them to authorities

[58]Szuba, M., *Gouverner dans un monde fini : des limites globales au rationnement individuel, sociologie environnementale du projet britannique de politique de Carte carbone*, (1996-2010). Sociologie. Université Panthéon-Sorbonne - Paris I, 2014. Français. NNT : 2014PA010540. Tel-01794527, p. 22
[59] Ibidem.
[60] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6869
[61] Fawcett, T., Parag, Y., *An introduction to personal carbon trading,* op. cit. p. 330
[62] Ibidem.
[63] Ibidem.
[64] Feasta, *Cap and share: A fair way to cut greenhouse gas emissions,* The Foundation for the Economics of Sustainability. Available on <http://www. feasta.org/documents/energy/Cap-and-Share-May08.pdf), 2008
[65] Fawcett, T., Parag, Y., *An introduction to personal carbon trading,* op. cit., p. 330

to pay for the equivalent amount of emissions that they have introduced into the market by selling their products.[66] Since fossil fuel suppliers would most likely increase the price of their products as a result of the introduction of the obligation to surrender carbon allowances, the additional income that individuals will get access to by selling their certificates will compensate for the additional cost of goods and services they will have to face.[67]

TEQs, PCA and C&S have been examined respectively by the British and Irish governments, a more detailed history of TEQs will be provided in the following paragraph. The table elaborated by Fawcett and Parag giving a brief overview of the above-mentioned PCT variations can be found in Appendix I.

1.2 The history of PCT: the institutionalisation of planetary boundaries and the case of the United Kingdom

TEQs described in the previous section are not just an example of PCT, they are, together with Personal Carbon Allowances (PCA), the first PCT projects ever conceived and discussed by political institutions. These two policies, which can be referred to as "carbon card", were designed in the 1990s in the United Kingdom, the former by David Fleming and the latter by Mayer Hillman and later Tina Fawcett. In this section, we will analyse the intention of the authors in translating the concept of planetary boundaries into public policy and the political debate that emerged in the UK government and Parliament around these policies between 2006-2008. The interest of this analysis can be well explained through the words of Mathilde Szuba:

"[the carbon card] is one of the public policy projects that has gone furthest in attempting to institutionalise the consideration of global environmental limits. An isolated and exceptional attempt, this borderline case offers the opportunity to

[66] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6869
[67] Ibidem.

formulate initial hypotheses on the forms that public action could take in a finite world."[68]

The idea of a carbon card derives from the concern for the environmental limits posed by peak oil[69] and climate change to human societies, which led Fleming and Hillman to think about the necessity to introduce a form of carbon rationing. The two scholars conceived the carbon card as an instrument for anticipating the scarcity of energy resources, as argued by Mathilde Szuba "it was an instrument for a society to organise its self-limitation in order to live within the climate and energy limits".[70] The policy was almost included in the UK political agenda in 2004-2005 through the private member's bill put forward by the Labour Member of Parliament Colin Channel. The bill, called "The Domestic Tradable Quotas Act" and inspired by the research of the Tyndall Centre for Climate Change Research[71], was debated but was not adopted as legislation.[72] The carbon card was eventually included in the political agenda in 2006 and remained part of the political debate until 2008/2009 when the project was abandoned.[73] The 2006-2008 period witnessed a mobilisation of interest in favour of PCT especially in the UK through think tanks, universities, civil society, voluntary groups, and the UK government itself. The interest of the UK government at the time can be explained through various factors: first, David Miliband, Secretary of State for Environment, Food and Rural Affairs (May 2005-June 2007) was a strong advocate for the policy and contributed to raising the government's interest in the idea.[74] Then, the Labour government of Tony Blair (May 2005 - June 2007) and subsequently Gordon Brown (June 2007 – May 2010), seemed to have found in the carbon card an alternative environmental policy to the Fuel Duty escalator

[68] Szuba, M., op. cit., p. 27
[69] Peak oil is a theory developed by Marion King Hubbert describing how: "the conventional sources of crude oil, as of the early 21st century, either have already reached or are about to reach their maximum production capacity worldwide and will diminish significantly in volume by the middle of the century." Source: Encyclopaedia Britannica, peak oil, https://www.britannica.com/topic/peak-oil-theory
[70] Ivi, p. 24
[71] Rousseaux, S., op. cit., p. 12
[72] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6868
[73] Szuba, M., op. cit., p. 23
[74] Ivi p. 24

project,[75] a tax which was removed in 2000. The third reason motivating the government's interest is that the carbon card was a tool for demonstrating their commitment to strong emission reductions and their readiness to make bold technological choices.[76]

In 2007, the UK Treasury and the Ministry of Commerce and Industry, the Environmental Audit Committee of the UK Parliament and the Department for Environment, Food and Rural Affairs[77] were requested to conduct some pre-feasibility studies to analyse the potential effectiveness of PCT, the policy framework, public acceptability, technical feasibility and the potential costs.[78] In 2008, Defra published one of the four studies and a synthesis report; in the latter, it summarised the four pieces of analysis and brought about its conclusions, which resulted in the carbon card project being removed from the political agenda.[79] In fact, according to the synthesis report, if the carbon card was considered interesting as a potential tool to raise consumers' awareness of their energy consumption and their impact on the planet, there were some areas of concern regarding its social acceptability and the high costs it entailed. The policy was therefore described as "an idea currently ahead of time".[80] A month after the publication of Defra's synthesis report, the House of Commons Environmental audit Committee (EAC) published its report,[81] which instead depicted PCT as an essential instrument to reduce the UK's national carbon footprint, and tried to counter the previous report to prevent the government from abandoning the project.[82] In 2009, the House of Commons debated the EAC's report, and the Liberal Democrats launched an internal consultation. Simon

[75] The Fuel Duty Escalator, introduced by the UK government in the 1990s, created a tax raising the fuel price by a certain percentage as an instrument to cut carbon emissions. Brown's government increased the tax up to 6% above inflation, this resulted in social unrest and strikes that led the government to withdraw the policy. Source: https://researchbriefings.files.parliament.uk/documents/SN03015/SN03015.pdf
[76] Ibidem.
[77] Ivi p. 25
[78] Rousseaux, S.,op. cit., p. 13
[79] Ibidem.
[80] Ivi p. 26
[81] Environmental Audit Committee, *Personal Carbon Trading*, The Stationery Office, London, 2008
[82] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6869

Huges, the president of the party, seemed to show interest in PCT, and Lord Smith, the head of the Environment Agency, stated that a policy involving individuals should have been developed in the following twenty years from then.[83] In spite of these efforts, PCT was eventually taken off the political agenda in the United Kingdom.

Despite the short permanence of PCT in the political agenda, the intellectual impact that this policy idea generated in the UK remains visible. Think tanks, among which the New Economics Foundation and the Fleming Policy Centre[84] (created after Fleming's death and named after him); citizens' groups and voluntary initiatives, among which Transition towns, and Carbon Rationing Action Groups (CRAGs), political parties such as the Scottish Greens,[85] and the All-Party Parliamentary Group on Peak Oil continue to study and promote the idea of PCT.[86] What is more, the debate on PCT spread from the UK to other European countries and other continents. Indeed, the green political party Ecolo in Belgium, some members of the French Parliament and candidates for the presidential election in 2007 (Corine Lepage and François Bayrou) have included this policy in their political programme.[87] Moreover, the Chinese government and some political representatives from the US and Australia have discussed PCT as a valid policy.[88] Some international organisations also discussed the possibility of adopting PCT as a mitigation policy: the United Nations Environment Programme, the ASEAN and the International Energy Agency.[89] The European Union was also part of this discussion, especially since it adopted in 2003 the directive setting its system of emission cap-and-trade, the EU ETS, which led to

[83] Rousseaux, S., op. cit., p. 14
[84] Fleming Policy Centre, TEQs, at glance, https://www.flemingpolicycentre.org.uk/teqs/, last accessed 29/03/2023
[85] Scottish Greens, 2007 Manifesto A Manifesto for Green Government, https://greens.scot/sites/default/files/Manifestos/2007-Holyrood-Manifesto.pdf, last accessed 30/03/2023
[86] Szuba, M., op. cit.
[87] Rousseaux, S., op. cit., p. 14-15
[88] Ibidem.
[89] Ibidem.

some considerations on the compatibility of PCT with this scheme. These will be addressed in the fourth chapter of this thesis.

If a great interest was placed in PCT by scholars, policymakers, and citizens from 2005 to 2010 and during the 2010s, the amount of research on the topic seems to have decreased since then, mainly because of the challenges that the policy poses in terms of costs, social and political acceptability and the hardship faced by researchers because of the lack of data and in putting in place trials to test the policy. The literature analysing the challenges concerning PCT will be discussed in the third chapter.

1.3 The importance of mobilising individuals to reach the emission reduction targets

Why is mobilising individuals important for meeting emission reduction targets? How much are individuals contributing to carbon emissions? The answers to these questions will ultimately explain the rationale behind PCT policies.

The carbon footprint is one of the existing most popular and user friendly methods to quantify the impact of individuals on the planet and make it visible. There are various online personal carbon footprint calculators and existing methodologies, such as the Global Footprint Network,[90] and carbonfootprint.com.[91] WWF also developed country-based calculators for among others, the UK, Switzerland and Italy. [92] These calculators are based on an online questionnaire that investigates almost all the aspects of an individual's lifestyle involving consumption that leads to direct and embodied carbon emissions ("the indirect emissions embodied in the goods and services that

[90]Global Footprint Network, Footprint calculator, https://www.footprintcalculator.org/home/en, last accessed 01/04/2023
[91] Carbonfootprint.com, https://www.carbonfootprint.com/calculator.aspx, last accessed 01/04/2023
[92] WWF Italia, http://www.improntawwf.it/main.php, last accessed 01/04/2023

individuals buy")[93]. Some calculators are more complex than others, but the majority investigate food and travel choices, housing conditions (dimension of the house and household, energy efficiency, energy mix, conditions and materials of the house etc..). They often also include questions on consumption habits such as the frequency with which individuals purchases clothes, electronic devices and paper-based objects (books, newspapers, journals etc..) that relate to embodied emissions. According to the calculator developed by WWF, the average world carbon footprint is 6,4 tonnes of CO_2eq per year and the average carbon footprint of a Swiss person is 13,51 tonnes;[94] to carbonfootprint.com, the Italian average carbon footprint is 5,38 tonnes whereas the EU average corresponds to 6,8 tonnes.[95]

Another method that researchers have used to understand individual responsibilities to climate change is calculating the consumption-based emissions and production based emissions. Production-based emissions, the technique recommended by the IPCC to collect data for national CO_2 emissions inventories and the one that is currently mostly used, estimates "the greenhouse gas emissions from all the oil, coal, and gas consumed in a country by private households, industrial production of goods and services, and electricity production".[96] This technique does not account for emissions deriving from international air and sea transportation, and most of all, it does not account for carbon leakage.[97] Carbon leakage describes the phenomenon of delocalisation of industries' production plants from a country with strict environmental and emission regulations, to countries with less stringent environmental regulations.[98] The production-based emissions methodology does not detect this phenomenon,

[93] Parag, Y., Fawcett, T., *Personal carbon trading: a review.., op. cit.*, p. 24
[94]WWF.org.uk, Footprint calculator methodology, https://footprint.wwf.org.uk/methodology, last accessed 01/04/2023
[95] Carbonfootprint.com, https://www.carbonfootprint.com/calculator.aspx, last accessed 01/04/2023
[96] Franzen, A., Mader, S., *Consumption-based versus production-based accounting of CO2 emissions: Is there evidence for carbon leakage*?, "Environmental Science and Policy", 84 Institute of Sociology, University of Bern, Fabrikstrasse 8, 3012, Bern, Switzerland, p. 34–40
[97] Ibidem.
[98] Ibidem.

as it only accounts for the emissions deriving from industries that are present on a certain territory, without considering the emissions deriving from industries of such territory having moved their production sites in other countries. On the contrary, the consumption-based emissions methodology "subtracts from countries all emissions that are contained in exported products, including transportation emissions, and includes the embodied emissions in the inventories of the importing countries".[99] The stronger the phenomenon of carbon leakage, the greater will be the ratio between consumption-based emissions and production-based emissions.[100] Chancel and Piketty, investigated emission inequalities and argued that "to better represent individual responsibilities to climate change [...] it is important to move from production-based emissions to consumption-based emissions".[101]

	tCO_2e per person per year	% change with production	ratio to world average
World average	6.2	0	1
N. Americans	22.5	13	3.6
West. Europeans	13.1	41	2.1
Middle East	7.4	-8	1.2
Chinese	6	-25	1
Latino Americans	4.4	-15	0.7
S. Asians	2.2	-8	0.4
Africans	1.9	-21	0.3
Sustainable level	1.3	0	0.2

Table 1 Table showing Piketty and Chancel calculations of current per capita CO_2eq emissions with the consumption-based methodology. Source: Piketty, Chancel, 2015.[102]

[99] Ibidem.
[100] Ibidem.
[101] Piketty, T., Chancel,L., *Carbon and inequality: from Kyoto to Paris Trends in the global inequality of carbon emissions (1998-2013) & prospects for an equitable adaptation fund,* Iddri & Paris School of Economics, Paris School of Economics, 2015, p.28
[102] Ibidem.

The authors elaborated CO_2eq emissions data attributed to individuals with the consumption-based methodology, these correspond to: 22 tonnes of CO_2 per year for a North American, to 13 tonnes for a Western European, 6 tonnes for a Chinese and South Asian and 2 tonnes for an African.[103] From this table we can deduct two facts: first, the percentage change between consumption-based emissions and production-based emissions is significant. For instance, West Europeans consumption-based emissions are 41% higher than production based emissions, whereas Chinese consumption-based emissions are 25% lower than production-based emissions. This methodology reallocates emissions between Western Europe and North America on one side, and Asian and African countries on the other side.[104] Therefore, these figures reveal a second fact: the inequality of carbon emission patterns, that is to say, how the responsibility for emissions varies significantly among different countries of the world.

The IPCC has estimated that to keep the temperature rise below 2° with a 50:50 chance[105], we should limit CO_2 emissions to 1000 gigatonnes (Gt) CO_2eq from the present day to 2100.[106] From this information it is possible to derive the ideal individual carbon budget "the amount of CO_2e emissions each individual is entitled to emit, between now and 2100"[107]: in 2010 S. Rousseaux reported it corresponded to around 2,2 tonnes of CO_2eq per person per year, [108] in 2015 Piketty and Chancel calculated a level of approximately 1.2tCO_2e7.[109] Hence, whether we use the carbon footprint or the consumption-based emissions methodology, it is clear that individual carbon emissions of high-income countries are significantly higher than the recommended sustainable level shown here above. Furthermore, the more time passes without a significant reduction in GHG emissions, the stringent the personal carbon budget will be. Thus, a greater involvement of

[103] Ibidem.
[104] Ibidem.
[105] Gough, I., op.cit, p. 29
[106] Piketty, T., Chancel,L., op. cit., p. 15
[107] Ibidem.
[108] Rousseaux, S., op. cit., p. 8
[109] Piketty, T., Chancel,L., op. cit., p. 15

individuals in climate mitigation is paramount to reaching the emission reduction targets and the net-zero objective by 2050.[110]

What is more, the importance of involving individuals to reach these objectives was underlined by the 6th assessment report published by the Intergovernmental Panel on Climate Change (IPCC). The third section (Working Group III) of the Sixth Assessment Report (AR6), published in April 2022, stressed the importance of demand-side solutions for emission reductions by dedicating a chapter to "Demand, services and social aspect of mitigation".[111] If the IPCC had already stressed the importance of individual behaviour and lifestyle change to meet the climate targets in its 2007 report,[112] the 2022 report, instead, dedicated for the first time a full chapter to this topic,[113] underlining that:

"The indicative potential of demand-side strategies to reduce emissions of direct and indirect CO_2 and non-CO_2 GHG emissions in three end-use sectors (buildings, land transport, and food) is 40–70% globally by 2050 (high confidence)."[114]

Mobilising individuals is relevant not only because they contribute to climate change through their consumption patterns, but also because they "can encourage innovation and a change in production through demanding low-carbon products and services."[115] "Socio-cultural and lifestyle changes can accelerate climate

[110] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') PE/27/2021/REV/1, *OJ L 243, 9.7.2021, p. 1–17 (BG, ES, CS, DA, DE, ET, EL, EN, FR, GA, HR, IT, LV, LT, HU, MT, NL, PL, PT, RO, SK, SL, FI, SV)*

[111] *Action on demand*, « Nature Climate Change », 12, 409, 2022, https://doi.org/10.1038/s41558-022-01369-7

[112] Rousseaux, S., op. cit, , p. 8

[113] *Action on demand*., op. cit.

[114] Creutzig, F., J. Roy, P. Devine-Wright, J. Díaz-José, F.W. Geels, A. Grubler, N. Maïzi, E. Masanet, Y. Mulugetta, C.D. Onyige, P.E. Perkins, A. Sanches-Pereira, E.U. Weber, 2022: *Demand, services and social aspects of mitigation.* In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.00, p. 505

[115] Rousseaux, S., op. cit., p. 8

change mitigation (medium confidence)"[116], the objective of PCT is to be a key driver for this change. Further details of PCT, its advantages, its flaws and the levers it is supposed to use to stimulate behavioural change will be outlined in the following chapters. In this section, we will clarify the rationale behind the definition of personal carbon emissions adopted by the designers of PCT.

Although the carbon footprint and consumption-based emissions are useful methodologies to understand the impact of our lifestyle on the planet, PCT designers adopted a different approach to measure the carbon emissions that can be attributed to individuals. PCT evaluates the impact of individuals through "personal carbon emissions", that is to say, the emissions arising from direct energy use in the household and transport use.[117] The reason behind PCT including only these two sectors is that, first, they represent individuals' choices and therefore they are an expression of individual's role of "householders and transport users".[118] Another reason is that they are easier to calculate than embedded emissions deriving from consumption of goods, which would be more complicated to attribute to individuals.[119] It could be argued that direct personal carbon emissions patterns vary between countries and within the same country, because of diverse energy efficiency of housing, access to energy sources and to lower-carbon transport options, climate, cultural norms about comfort and other factors that could contribute to higher or lower individual energy use.[120] For example, if the average energy use doesn't vary significantly between the northern and southern regions of the United Kingdom, in the United States instead, energy use is 40% lower than the national average in Florida and 17% higher in the state of New York.[121] These differences could perhaps influence the relevance of PCT perceived by policymakers in certain countries, as personal

[116] Ibidem.
[117] Parag, Y., Fawcett, T., *Personal carbon trading: a review.., op. cit.,* p. 24
[118] Ibidem.
[119] Ibidem.
[120] Fawcett, T., *Personal carbon trading in different national contexts*, "Climate Policy", 10, Environmental Change Institute, University of Oxford, 2010, p. 344
[121] Ibidem.

carbon emissions' contribution to global warming could be lower or higher depending on the above-mentioned factors and it could vary among regions within the same country.[122] Despite this issue, an analysis published by the International Energy Agency in 2007, showed that although personal carbon emissions could vary as it has just been illustrated, in developed countries they correspond to around 42% of the total national emission level (for example the UK, Ireland and Denmark share similar figures, the US figure is around 38%).[123] The IEA's study was, though, limited to 14 member countries and it did not include international aviation, thus a more comprehensive data set on average national direct personal carbon emissions for a wider range of countries would be necessary to further develop PCT as a policy option. Overall, according to IEA's assessment a PCT scheme could cover "an average of 45% of national emissions of CO_2 from energy use in major developed countries."[124]

The interest in PCT lies as a whole in the following statement: "delivering emission reductions by altering millions of individual's energy-use choices and behaviour remains an unmet policy challenge".[125]

1.4 Conclusions

Some expressions used to describe PCT have been: "a policy invention", "a radical policy", and "a policy ahead of its time". The first section of this chapter has introduced PCT, outlining its key features: its objective is reducing emissions in a given society, the fact it is an umbrella term that describes a group of policies, and the fact it focuses on personal carbon emissions. The history of the PCT project designed in the United Kingdom and discussed by the UK government was presented as the first and only occasion in which a PCT policy

[122] Ibidem.
[123] Parag, Y., Fawcett, T., *Personal carbon trading: a review..*, op. cit., p. 24
[124] Fawcett, T., Parag, Y., *An introduction to personal carbon trading,* op. cit. p. 331
[125] Ibidem.

entered the policy agenda and as an example of a policy aiming at bringing concern for planetary boundaries in the policy landscape. Finally, this chapter also presented the rationale behind acting on personal carbon emissions deriving from consumption choices related to household energy use and transport. PCTs' interest in acting on individual emission reductions is supported by data on the individual contribution to carbon emissions and recent literature on climate change provided by the IPCC, which underlines the importance of involving demand-focused initiatives as a mitigation strategy to meet the emission reduction targets.

Chapter 2: Fostering individual action and behavioural change to meet the emission reduction challenge, the case of PCT

2.1 Can PCT drive behavioural change? The theory behind the policy

According to Bobbio, Pomatto and Ravazzi,[126] every public policy is based on a cause-effect theory:

if the measure x is implemented at time t_1, the effect y will happen at time t_2.

The cause-effect theory is based on two underlying hypotheses: 1) the intervention hypothesis and 2) the causal hypothesis.[127] The former supposes that through policy *x* the recipients will modify their behaviour, the latter, that if the expected behavioural change happens, then the effect *y* will happen as a consequence.[128] PCT aims at reducing personal carbon emissions, and ultimately collective GHG emissions, through the creation and distribution of carbon allowances that, by engaging individuals, should cause a behavioural change in

[126] Bobbio L., Pomatto G., Ravazzi S., *Le politiche pubbliche, problemi, soluzioni, incertezze, conflitti*, Mondadori Università, Milano, 2017, p. 9
[127] Bobbio L., Pomatto G., Ravazzi S., op. cit., p 11
[128] Ibidem.

their consumption patterns.[129] We could argue that PCT is a public policy based on the following cause-effect theory:

If PCT (x) is implemented at time t_1, the effect of GHG emission reduction (y) will happen at time t_2.

Thus, the underlying hypotheses would be: 1) if PCT is implemented at time t_1, the consumers involved in the scheme will modify their behaviour and reduce their transport and housing energy-related demand, 2) if the consumers involved in the scheme will modify their behaviour, a general emission reduction will happen at time t_2. Considering this framework, to understand if PCT could deliver the desired effect, GHG emission reduction, it would be necessary to evaluate hypotheses 1 and 2, that is to say, if PCT can drive the desired behavioural change. This paragraph will try to answer this question through a literature review.

Parag et al. argue that PCT would implement three mechanisms that would cause the desired behavioural change: economic, cognitive and social.[130] The scheme below was elaborated by the authors and displays the cause-effect theory underlying PCT and the three mechanisms, which will be thoroughly explained below.

[129] Capstick, S., Lewis, A., *Personal Carbon Trading: Perspectives from Psychology and Behavioural Economics*, Institute for Public Policy Research, London, UK, 2008, p. 370
[130] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit., p.1025

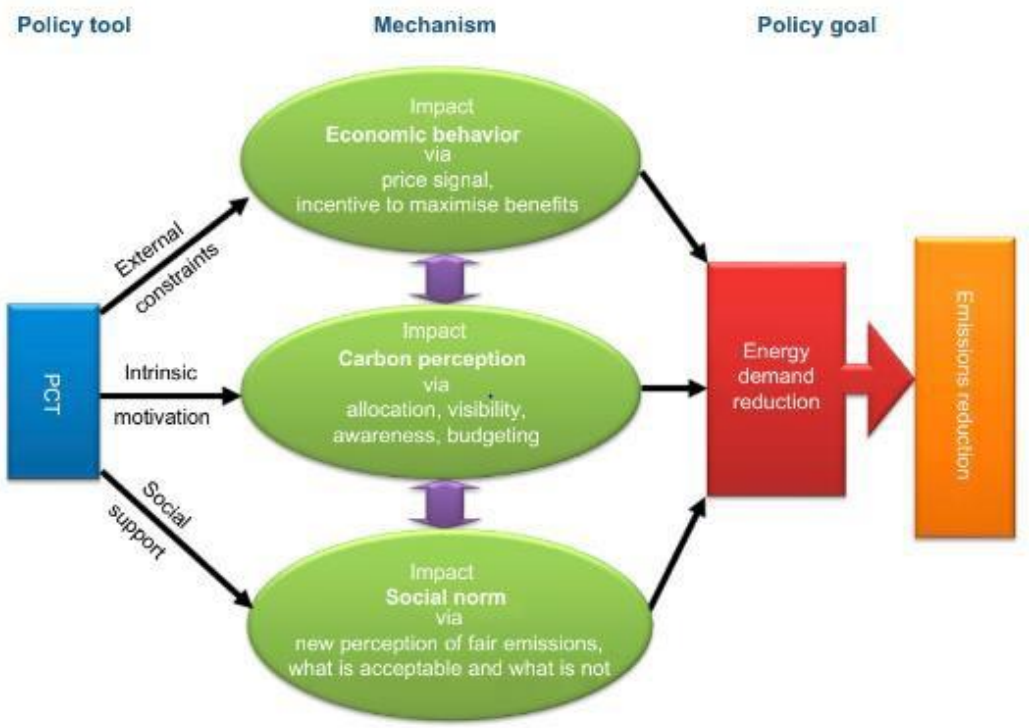

Figure 3 PCT mechanism. Source: Fawcett, Parag, 2009.[131]

PCT is a form of carbon pricing because it places a price on fossil-fuel-based energy.[132] This creates an economic incentive for PCT recipients to lower their energy consumption level, therefore it represents the economic mechanism.[133] The price of carbon would be determined by the market, through the intersection between the offer and the demand of carbon allowances, but also by the market quality and possible shocks.[134] As an example of a possible allowance market dynamic a surplus of allowances on the market would cause the price to shrink; the EU Emission Trading System offers a good example to show how this effect could happen. During its initial phase of implementation, too many allowances were given out for free, therefore the price of allowances distributed under the

[131] Environmental Change Institute, University of Oxford. Adapted from Parag Y, Strickland D., *Personal Carbon Budgeting: What people need to know, learn and have in order to manage and live within a carbon budget, and the policies that could support them*, UKERC Research Report, Demand Reduction Theme, 2009
[132] Ibidem.
[133] Parag, Y., Fawcett, T., *Personal carbon trading: a review... op. cit.,* p. 25
[134] Ibidem.

EU ETS was initially close to zero, the low price level was also brought down by an external unforeseen shock, the 2008 economic recession.

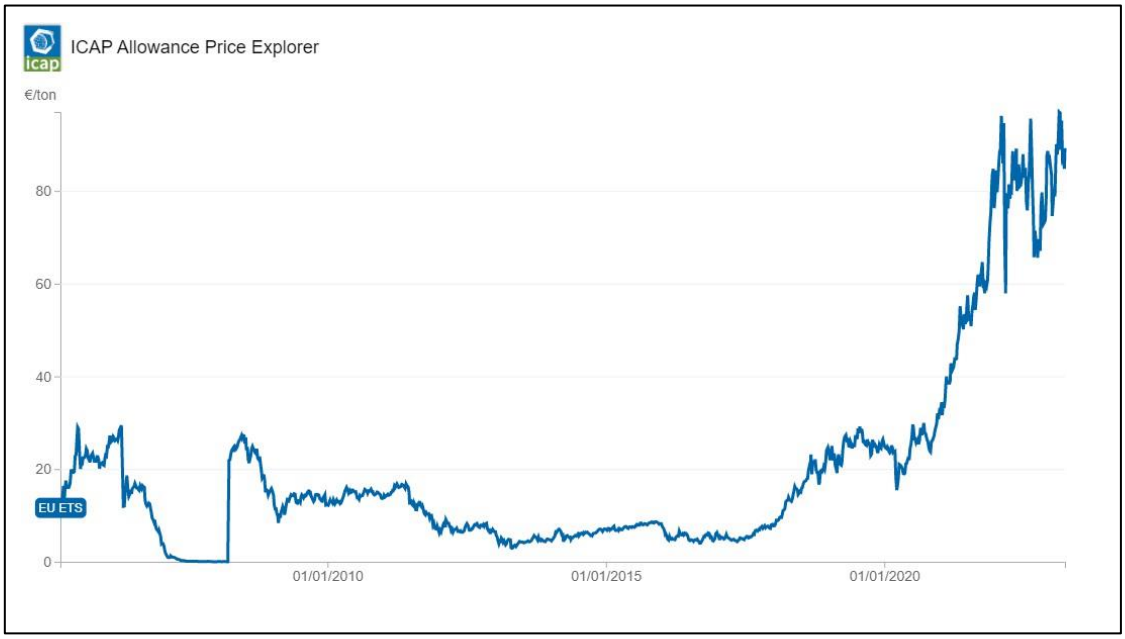

Figure 4 Graph showing the trend of the EU ETS carbon allowance price from its creation to the present day (2023). Credit: International Carbon Action Partnership. Source: ICAP, 2023.[135]

The reforms of the EU ETS in the 2010s reduced the number of free allowances, moreover, the third reform of the EU ETS introduced a Market Stability Reserve to control the number of allowances on the market. These reforms allowed the price to grow and to become more effective (eventhough it is deemed to be still too low): the price of carbon, represented in the market by the benchmark EU Allowance (EUA), touched in February 2023 almost 100€/tonne (99,99€/tonne).[136] This is an example to show how the market-based price of carbon allowances can fluctuate and what factors could contribute to these

[135]International Carbon Action Partnership, ICAP Allowance Price Explorer, https://icapcarbonaction.com/en/ets-prices, last accessed 14/04/2023
[136]Twidale, S., EU carbon price hits record high nearing 100 euros/tonne, Reuters, 20 February 2023, https://www.reuters.com/markets/carbon/eu-carbon-price-hits-record-high-nearing-100-eurostonne-2023-02-20/, last accessed 14/04/2023

variations, in this case an economic recession and the free distribution of allowances. A detailed overview of the EU ETS history will be elaborated in the fourth chapter of this thesis.

The cognitive or psychological mechanism is due to the visibility of carbon that derives from the fact of assigning a price to it. This would stimulate the awareness of consumers regarding their carbon footprint and their long-term impact on global emissions.[137] It would also "encourage carbon budgeting"[138], that is to say, consumers would base their choices on the available personal carbon budget created through the PCT scheme. The allowance scheme would also produce a form of reward and penalty as "noticeable implications" that should encourage the energy-saving behaviour.[139] In fact, consumers with lower energy consumption patterns could earn a financial reward by selling their allowances to other consumers with higher consumption patterns who, instead, will have to purchase more allowances to sustain their lifestyle.[140] Additionally, the individual's credit or debt situation would represent another lever for the cognitive mechanism.[141] The social mechanism implies that PCT would contribute to creating a new social norm of "low-carbon-behaviour",[142] by setting an acceptable and fair level of carbon emissions corresponding to the level of capped emissions set by the allowances distributed to individuals.[143] Hence, the implementation of an equally allocated allowance scheme should introduce a new normative concept that should push individuals to consider high consumption patterns as unfair.[144]

[137] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit., p.1025
[138] Ibidem.
[139] Woerdman, E. & Bolderdijk, J. W., op.cit., p.567
[140] Ibidem.
[141] Parag, Y., Fawcett, T., *Personal carbon trading: a review... op. cit.,* p. 25
[142] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit., p.1025
[143] Parag, Y., Fawcett, T., *Personal carbon trading: a review... op. cit.,* p. 26
[144] Woerdman, E. & Bolderdijk, J. W., op. cit., p.570

The capacity of a PCT scheme to change energy end-users' consumption choices, corresponds to its success and its "behavioural effectiveness".[145] If the system is successful because enough consumers reduce their consumption patterns, its success should be self-sustaining. The lower energy demand would reduce the demand for allowances, which would cause the price of allowances on the market to shrink, making the allowance trading system more acceptable because of the lower price of energy.[146] To ensure the effectiveness of PCT schemes, though, it is necessary to consider that some obstacles or negative side-effects could incur. Woerdman and Bolderdijk, for instance, point out that the visibility of the carbon price created by the scheme could impact its acceptability because, for instance, climate sceptic consumers could show some form of opposition to its implementation.[147] Moreover, they argue that energy consumption, like other behaviours, is shaped by habits and that it is often complex to transform an intention to change a certain behaviour into action.[148] Other behavioural barriers that hamper energy-saving behaviours are the capacity of individuals of processing information, forgetfulness (the fact of leaving the lights on), and costly information acquisition (if information is not provided to consumers they will likely not search it on their own).[149] The creators of PCT argue that the three mechanisms the policy is based on, could provide an effective incentive to overcome these barriers created by habits and change consumers' behaviour.[150]The OECD recommended in 2022 some solutions to overcome these barriers to face the energy crisis, among these, it outlined the behavioural effectiveness of information campaigns setting clear guidelines, social comparison (comparison of people's energy savings with their neighbours'

[145] Woerdman, E. & Bolderdijk, J. W., op. cit., p.567
[146] Ibidem.
[147] Ibidem.
[148] Woerdman, E. & Bolderdijk, J. W., op. cit., p.569
[149] OECD, *Confronting the energy crisis: changing behaviours to reduce energy consumption*, 2022, https://www.oecd.org/ukraine-hub/policy-responses/confronting-the-energy-crisis-changing-behaviours-to-reduce-energy-consumption-5664e8a9/, p. 7
[150] Capstick, S., Lewis, A., op. cit. , p. 372

savings) and default options (such as setting the thermostat 1° below by default).[151] These could perhaps inspire further research on PCT.

2.2 Can PCT drive behavioural change? Experimental Simulations and case studies

Research on PCT has questioned its various dimensions, its social and political acceptability and consumers' behavioural response to the scheme. The paragraph above has illustrated the theoretical framework and arguments supporting the behavioural effectiveness of PCT, in this paragraph we will share the results of some simulations and experiments to try to respond to the following question: can PCT drive behavioural change?

Researchers tried to provide an answer to this question through various methodologies. Some analysed the behavioural response of citizens involved in Carbon Reduction Action Groups (CRAGs). CRAGs are schemes based mainly in the UK where participants voluntarily adopt a personal carbon allowance scheme.[152] These groups only adopt a limited number of features with respect to a complete PCT scheme, excluding for instance the trading element and the presence of penalties, moreover, participants are characterised for being highly motivated and self-selecting.[153] If research has shown that CRAGs can significantly cut the emissions of a portion of the population (the participants), these results are based on a unrepresentative sample of the broader population, hence, these results cannot be attributed to the general population.[154] Other researchers, Wallace, Bristow and Zanni, utilised quantitative and qualitative methods, such as questionnaire-based data and participants interviews.[155] According to results collected by Wallace, the participants stated that if a PCT

[151] Ivi, p. 5
[152] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6871
[153] Capstick, S., Lewis, A., op. cit. , p. 372
[154] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6871
[155] Capstick, S., Lewis, A., op. cit. , p. 372

scheme was implemented they would adopt a series of choices, such as "improving home energy efficiency, changing their car or using public transport, taking holidays closer to home, changing job or home location and, for some, increasing working at home".[156]

Field trials have also been explored as a research option which could allow to collect important data for PCT feasibility. Fawcett, contributed to drafting a report on the approach to adopt while investigating PCT in an empirical fashion through field trials. Nonetheless, other researchers, such as Capstick and Lewis, argue that field trials risk being expensive and time-consuming,[157] and Fawcett argues that it would be complicated to conduct a pilot study because the participants could get around the system by purchasing energy intensive goods outside the geographical area that is being tested.[158] Capstick and Lewis therefore designed a computer based experimental simulation, which had the advantage of being less expensive and time consuming than a field trial.[159] They designed their simulation to understand if the introduction of personal carbon allowances would have caused a behavioural change, and if this change was correlated with the participants' environmental attitude, their support for PCT and their carbon footprint, which was calculated before the simulation.[160] The simulation created a virtual framework of implementation of PCT, participants were attributed a certain amount of carbon allowances in figurative year 1, which would have diminished in figurative year 2. This procedure was adopted to observe if the diminishing allowances in year 2 would have led to a behavioural change. The results of this study, published in 2010, are threefold. First, the visibility of the declining allowance stimulated a carbon-conserving behaviour.[161] The authors argue that this finding suggests that PCT, by introducing a carbon allowance declining over time, has a higher behavioural effectiveness than price signals

[156] Ibidem.
[157] Ibidem.
[158] Ibidem.
[159] Ibidem.
[160] Capstick, S., Lewis, A., op. cit. , p. 373
[161] Capstick, S., Lewis, A., op. cit. , p. 381

alone.[162] The second finding is that participants with a lower carbon footprint and a higher environmental awareness were more prone to support PCT than participants with a higher footprint.[163] The last finding is that experimental simulations do not necessarily have a real world applicability, because participants' intentions regarding their carbon budgeting behaviour may not actually coincide with action in case of the introduction of a real PCT scheme; the same could be argued for questionnaires or interviews.[164] The authors of this research also point out the need to organise more trials, and the existence of several research gaps that need to be investigated to further prove the feasibility and the interest of PCT as a policy that aims at reducing personal emissions, these include testing the psychological and social response to the introduction of a PCT scheme, an idea that Fawcett shares too.[165]

Among the research focusing on PCT, one is particularly interesting as it is the first and only real experiment of PCT in the world: Norfolk Island Carbon and Health Evaluation (NICHE). The NICHE programme, which run between 2011-2014 on Norfolk Island, Australia, was funded by the Australian Research Council and was led by Garry Egger, Professor of Lifestyle Medicine and Applied Health Promotion at Southern Cross University. The experiment aims at testing the impact of a PCT system on reducing personal emissions and obesity-related behaviours.[166] The authors of the test hypothesised that personal carbon emissions and obesity share common drivers.[167] The island was chosen, because it is a small territory of 8 x 5 km and ~1800 residents, 1500 km from the east coast of Australia and 1200 km from the north of New Zealand, thus, it is an isolated community where the transactions of goods and services with external

[162] Ibidem.
[163] Ibidem.
[164] Ibidem.
[165] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6875
[166] Southern Cross University, Norfolk Island to trial world first Personal Carbon Trading program, 27 October 2010, https://www.scu.edu.au/engage/news/latest-news/2010/norfolk-island-to-trial-world-first-personal-carbon-trading-program.php, last accessed 17/04/2023

[167] Ibidem.

partners can easily be traced.[168] Additionally, the community, which along with the local administration showed interest in the project, is relatively wealthy and it has a similar lifestyle to the population of mainland Australia.[169] Hence, the findings of this study could, in theory, be more easily generalised to the Australian population.

The NICHE scheme was presented to the inhabitants (the idea was also to involve the tourists visiting the island), who were offered to adopt a voluntary scheme where they would have received a fixed amount of carbon units for free, stored on a personal carbon card similar to a credit card. These units were reduced every time participants purchased energy-intensive products, such as fuel and energy for housing, and from the second year of the implementation of the scheme, every time they purchased food as well.[170] As a classic PCT, this scheme allowed the participants who consumed less carbon-intensive products to win a financial reward by handing in the unused credits to a carbon bank, participants with a more carbon-intensive lifestyle, instead, had to purchase more carbon units to sustain their transport, housing and dietary choices.[171] The final turn up of volunteers counted up to 218 participants, 27% of the total households, however, because of technical difficulties of creating a carbon bank and collecting data, the PCT scheme that should have been implemented was substituted by an alternative called Personal Carbon Goals (PCG).[172]

Some PhD dissertations from the University of the Southern Cross analysed the data extracted by pre and post-implementation research and offered an evaluation

[168] Webb, G., Hendry, A., Armstrong, B., McDermott, R., Swinburn, B., Egger, G., *Exploring the Effects of Personal Carbon Trading (PCT) System on Carbon Emission and Health Issues: A Preliminary Study on the Norfolk Island*, "The International Technology Management Review", Vol. 4 (2014), No. 1, 1-11
[169] Norfolk Island to trial world first Personal Carbon Trading program, Southern Cross University, op. cit.
[170] Ibidem.
[171] Ibidem.
[172] Webb, G. J., *Assessment of personal carbon goals for reducing obesity-related behaviour and carbon emissions in a remote island community: the Norfolk Island carbon and health evaluation study*, Southern Cross University, 2018, https://researchportal.scu.edu.au/discovery/fulldisplay/alma991012820348802368/61SCU_INST:ResearchRepository

of the impacts of the NICHE experiment. A pre-implementation survey conducted on a sample of individuals of the local population identified a link between environmental awareness and attitudes towards personal health issues.[173] For this reason, researchers suggest that insisting on the personal aspect of behaviours linked to obesity and climate change could help promote the use of PCT.[174] Furthermore, a PhD dissertation reported the results of the ex-post evaluation of the impact of the scheme: if the health-related results were not significant, the emission reduction results provide some arguments in favour of PCT. There was a reduction in both average household fuel and household electricity consumption, the first of 25,1%, the second of 12,3%, resulting in a reduction in total household carbon emissions of 18%.[175] Almost half of the participants (45%) confirmed through a follow-up questionnaire that PCG had an impact on their consumption habits.[176]

Despite these encouraging results, some flaws need to be outlined. First, the absence of a control group does not allow to determine with certainty the degree of carbon emission reduction; then, this experience confirms that the implementation of a PCT system is complex, because of "the lack of infrastructure and financial social support systems".[177] As mentioned above, the initial PCT scheme was turned into the PCG scheme because of the difficulties encountered in involving banks to create the carbon bank, and poor Internet connectivity on the island, which limited the capacity of data storage and the transactions through a credit-card-like system.[178] Another issue was the fact that the scheme proved to be disadvantageous to a number of smaller households, a factor that was not compensated because of the absence of a dedicated financial or taxation social system.[179] Finally, during an interview in March 2023,[180] Tina

[173] Ibidem.
[174] Webb, G., Hendry, A., Armstrong, B., McDermott, R., Swinburn, B., Egger, G., op. cit., 8
[175] Webb, G. J., op. cit., 116
[176] Ibidem.
[177] Ibidem.
[178] Ibidem.
[179] Webb, G. J., op. cit., 138

Fawcett argued that, despite the interesting results of the Norfolk island experiment, these are only displayed in PhD dissertations and that, to her knowledge and the knowledge of the author of this thesis, none of these results are published on peer reviewed articles yet.

2.3 Policy initiatives aimed at driving behavioural change for climate mitigation: a comparison between the carbon tax and PCT

The tools that policies can implement to modify the recipients' behaviour can be categorised in the following areas: incentive or disincentive, regulation, public management, communication, nudging, and laissez-faire.[181]

More precisely, regarding climate mitigation policies, the OECD and International Energy Agency (IEA) issued in 2002 an insightful research gathering the policies and measures adopted by IEA Member Countries to deal with climate change.[182] This framework (a table illustrating the classification of policies can be found below) was used by Richard Starkey and Kevin Anderson to present the project of Tradable energy quotas (TEQs) to the Science and Technology Committee of the House of Lords of the United Kingdom in 2005.[183] The researchers described TEQs as fiscal policies because, according to the functioning of this scheme, their impact on consumers can be assimilated to a carbon tax.[184] Apart from some variations, such as TEQs, PCT can be categorised through the OECD classification as Tradable permits, therefore as a trading instrument.

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[180] The interview with Tina Fawcett, senior researcher in the Energy Programme at Oxford's Environmental Change Institute, was held on the 17th of March 2023 by the author of this thesis.
[181] Bobbio, L., Pomatto, G., Ravazzi, S., op. cit., p. 92
[182] OECD, IEA, *Dealing with Climate Change Policies and Measures in IEA Member Countries* 2002 Edition, IEA PUBLICATIONS, 9, rue de la Fédération, 75739 PARIS Cedex 15 Pre-press by Linéale Production. Printed in France by Sagim (61 01 32 1 P) ISBN 92-64-19518-1 2001
[183] Memorandum by Richard Starkey and Dr Kevin Anderson, domestic tradable quotas(DTQs), minutes of evidence, science and technology committee, -house of Lords, https://publications.parliament.uk/pa/ld200506/ldselect/ldsctech/21/4120102.htm, last accessed 24/03/23
[184] Ibidem.

Policy Type	*Classification*
Fiscal	Taxes (tax, tax exemption, tax reduction, tax credit)Fees/charges, refund systemsSubsidies (transfers, grants, preferential loans)
Tradable permits	Emissions tradingGreen certificatesProject-based programmes (including CDM and JI)
Regulatory instruments	Mandates/standardsRegulatory reform
Voluntary agreements	"Strong""Weak"
Research, developmentand demonstration (RD&D)	Research programmesTechnology developmentDemonstration projectsTechnology information dissemination
Policy process and outreach	Advice/aid in implementationConsultationOutreach/information disseminationStrategic planningInstitutional development

Figure 5 OECD Climate change policy measures adopted by IEA Member countries, 2002 Edition. Source: OECD, IEA, 2002.[185]

Among the policy instruments illustrated above, the carbon tax is often presented as a valid non-trading alternative to PCT. The carbon tax and PCT can both be defined as market-based instruments,[186] which aim at achieving emission reductions through price-based signals creating an economic incentive to reduce consumers' carbon emissions.[187] A carbon tax "is a charge placed on energy sources that emit carbon dioxide by the government; it reflects the carbon intensity of the fuels used".[188] It is a price-signal based on the polluter-pays principle that is sent to economic agents, the fuel suppliers, (who will then pass it on to consumers as higher prices for heating, fuel and electricity), the consumers directly, or both.[189] The tax creates a price that represents or approximates the externalities deriving from fossil fuels consumption decisions, incentivising a behavioural change to reduce personal carbon emissions.[190] If the objective is the

[185] OECD, IEA, *Dealing with Climate Change Policies and Measures in IEA Member Countries* 2002 Edition, op. cit.
[186] Johnson, M., Harfoot, M., Musser, C., Wiley, T., *Cap and Share: Phase 1; policy options for reducing greenhouse gas emissions*, Interim Final Report Report to Comhar Sustainable Development Council, Ireland, Cambridge Econometrics, ED43215, Issue Number 4, 28th May 2008, p. 34
[187] Ibidem.
[188] Ibidem.
[189] iD4D,Carbon tax is the most effective solution for mitigating climate change, interview with Christian Gollier, 20 August 2019, https://ideas4development.org/en/https-ideas4development-org-carbon-tax-mitigating-climate-change/, last accessed 18/04/2023
[190] Ibidem

same as a PCT scheme, the carbon tax is purely based on an economic incentive as it does not include the psychological and social mechanism put in place by PCT described in the precedent paragraphs. The price of carbon needs to reach a certain level to be effective in causing the necessary behavioural change to reduce emissions. Christian Gollier, director of the Toulouse School of Economics, argues that a 50€/tonne carbon tax would adequately reflect "the impact of CO_2 on future generations"; [191] Ian Parry, the principal environmental fiscal policy expert in the IMF's Fiscal Affairs Department, argues instead that if for some countries a 35$/tonne tax would be sufficient, others such as Australia and Canada, would need a 70$ tax to reach the emission reduction targets set by the Paris Agreement.[192]

The carbon tax is considered simple to implement for governments because it could be collected together with the fuel taxes, already collected by the majority of countries, or it could be added on royalties paid by drilling industries.[193] Furthermore, the revenues deriving from the scheme could be invested in research and development, and public services based on low carbon alternatives.[194] Another main advantage is that a carbon tax could give industries a clear price signal, which is deemed to be more stable than the price set by an emission trading scheme, the fluctuation of which was shown in the previous paragraph.[195] The carbon tax, though, does not necessarily guarantee that the emission reduction targets will be met, because it would need to be adjusted over time towards the emission reduction targets, a complex process that requires a significant amount of information.[196] In addition, carbon taxation causes some social and political acceptability issues, which represent a challenge for PCT as well. The social and political acceptability aspects regarding the carbon tax and

[191] Ibidem.
[192] Parry, I., Putting a price on pollution, finance and development, International Monetary Fund, December 2019, https://www.imf.org/en/Publications/fandd/issues/2019/12/the-case-for-carbon-taxation-and-putting-a-price-on-pollution-parry, last accessed 18/04/2023
[193] Ibidem.
[194] Johnson, M., Harfoot, M., Musser, C., Wiley, T., op. cit., p. 34
[195] Ibidem.
[196] Ibidem.

PCT will be discussed in the following chapter, we will focus here on the behavioural effectiveness of the two policies.

First, Fawcett and Parag argue that PCT will stimulate a behavioural change not only through an economic incentive, but also through a psychological and social mechanism, whereas the carbon tax is based only on the first.[197] Moreover, according to the House of Commons Environmental Audit Committee's report on PCT elaborated in 2008, PCT schemes are more likely to bring about the necessary behavioural change than existing schemes such as the carbon tax, because they would enhance the personal responsibility of emissions and connect it with a broader challenge, the emission reduction challenge.[198]PCT would induct a moral and normative change that would not be possible with price signals alone.[199] Another argument in favour of PCT is that "despite the variation in methods and sample types, the results are remarkably similar: when PCT is compared with carbon taxation (or other policies) it is usually preferred [...]For those who prefer PCT, its key benefits are seen as fairness and effectiveness".[200]

[197] Parag, Y., Fawcett, T., *Personal carbon trading: a review... op. cit.,* p. 27
[198] Capstick, S., Lewis, A., op. cit., p. 370
[199] Ibidem.
[200] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6873

Scheme	Cost Effectiveness	Public Engagement	Environmental Outcome	Equity	Simplicity
Personal carbon allocation schemes					
Cap and Share					
DTQs/TEQs					
PCR					
RAPS					
Ayres					
Sky Trust					
Non-trading options					
Carbon Tax					
Regulation					
Voluntary Schemes					
Fuel Excise Duty					

Table 2 Table confronting Personal Carbon Trading schemes with non-trading options according to the criteria of cost-effectiveness, public engagement, environmental outcome, equity, and simplicity. Source: Cambridge Econometrics, 2008.[201]

An evaluation of Cambridge Econometrics, commissioned by the Comhar Sustainable Development Council in Ireland to evaluate the Cap and share policy,[202] summarises the arguments mentioned above and shows that when compared with other non-trading options, the environmental outcome and the public engagement criteria are stronger for PCT variations. These seem to be a weak point for the other non-trading options, which instead seem to be stronger with respect to the cost effectiveness and the simplicity criteria.[203]

Environmental citizenship is another policy that aims at changing individual behaviour to reach emission reduction targets, which stands out for its innovative approach. Environmental citizenship was first introduced by Andrew Dobson,

[201] Johnson, M., Harfoot, M., Musser, C., Wiley, T., op. cit., p. 51
[202] Ibidem.
[203] Ibidem.

Professor of Environmental Political Theory at Keele University, UK, who presents it as a valid alternative to other instruments used by environmental policies aimed at stimulating behavioural change, such as economic incentives and nudging.[204] The policy differs from nudging and economic incentives because it derives from two assumptions: that human beings are other-regarding and that they consider the collective interest more than their self-interest.[205] Dobson theorised that the motivations that move human behaviour, more than just the idea of reaching some form of personal gain and personal interest, are also based on altruism and the understanding of an idea of collective good.[206] An example to translate this policy idea into a concrete option is explained by Dobson in an interview with Mathilde Szuba and Luc Sémal.[207] While discussing methods to influence fish consumption patterns in the UK, Dobson explained that to change consumers' behaviour, an alternative to creating economic incentives would be appealing to their sense of environmental citizenship by discussing with citizens that: "if we are going to kill fish, we should eat them all rather than just throw them overboard… That we should be thinking in the long term about fish stocks".[208] Hence, environmental citizenship is a long-term approach that aims at involving people through democratic mechanisms in the ecological transition, as explained by Dobson: "my feeling is that you have to take people with you, because without them you can't have any long-term settlement or long-term behaviour change".[209]

More than being an interesting and innovative policy approach, environmental citizenship and the arguments used by Dobson, could also be used to support personal carbon trading. As illustrated above, PCT's main objective is to bring about a behavioural change so that citizens are made responsible for their

[204] Dobson, A., et al., *Andrew Dobson: trajectories of green political theory. Interview by Luc Semal, Mathilde Szuba and Olivier Petit*, "Natures Sciences Sociétés", vol. 22, no. 2, 2014, pp. 132-141.
[205] Ibidem.
[206] Ibidem.
[207] Ibidem.
[208] Ibidem.
[209] Ibidem.

emissions and will possibly become more aware of their impact on the planet. It could be argued that PCT could stimulate the emergence of a sense of environmental citizenship. On the one hand, the creation of an individual cap on emissions could push citizens to acknowledge the existence of a collective interest, the "emerging norm of carbon neutrality".[210] On the other hand, the existence of the personal cap could make citizens perceive the atmosphere as a common good, through the idea implied by PCT of "keeping one's carbon footprint within one's fair share of atmosphere",[211] therefore to think outside of their sole personal interest.

To Dobson, economic incentives and regulations could be the solution for a problem that requires a quick intervention such as climate change.[212] However, they would cause a behavioural change that relies solely on self-interest and an individualistic cost-benefit analysis, without the long-term learning outcome sought by environmental citizenship. Although the latter requires a longer time for its implementation to bring about concrete results, it goes beyond just providing an economic reason for citizens to make more sustainable choices. "If you hurry in the wrong direction, you won't get to the right place. You may actually end up in the wrong place – quicker, but in the wrong place."[213] These same arguments could perhaps be used to support PCT.

2.4 Conclusions

Personal carbon trading is an innovative policy that aims to generate a significant behavioural change: reduce personal carbon emissions. After a brief introduction to the public policy theory of social change, the first section of this chapter explained the mechanisms that PCT would implement to foster this change:

[210] Ibidem.
[211] Woerdman, E. & Bolderdijk, J. W., op. cit. 570
[212] Dobson, A., op. cit.
[213] Ibidem.

economic, psychological and social. The idea of its creators is that the behavioural effectiveness of the policy lies in the multiple levers it utilises, which go beyond the sole economic incentive rationale, for instance by creating a new social norm of carbon neutrality. The second paragraph of this chapter tried to answer the following question: can PCT drive behavioural change? Going beyond the theoretical assumptions, the results of various simulations were reported and commented on: globally it seems that PCT could drive behavioural change. Nonetheless, it is not possible to know if the claims made by the participants of virtual simulations and questionnaires would match the real choices they would make in case a real PCT was implemented. The Norfolk island experiment is the only case of a real experiment of a PCT system, which helped support the claims made by the participants of PCT virtual simulations: the PCG scheme implemented in the experiment, despite the difficulties encountered, seemed to cause a significant reduction of total emissions of the participants (18%). Broadly, more data and similar research projects would be necessary to further develop and support personal carbon trading. Furthermore, since the carbon tax is deemed to be the most valid market-based instrument alternative to PCT, the last paragraph illustrated the main differences between the two policies in achieving behavioural change. If the carbon tax is preferred for its simplicity, research seems to show that PCT is preferred to it. Finally, Andrew Dobson's environmental citizenship was described as a policy that, as PCT, wishes to provoke a deep and long-term behavioural change in emission patterns. The arguments supporting environmental citizenship, mainly its long-term behavioural impact, could also be utilised to support PCT.
The IPCC 6th assessment report states that: "the lockdowns implemented in many countries in response to the COVID-19 pandemic demonstrated that behavioural change at a massive scale and in a short time is possible (high confidence)",[214] another argument that supports the feasibility of the large-scale change implied by PCT and its potential behavioural effectiveness.

[214] Creutzig, F., et al., op. cit. p. 505

Chapter 3: "A radical policy": the challenges posed by PCT

3.1 Costs of Implementation and Operation

PCT was described in the early 2000s as "a radical policy outside the mainstream of policy making"[215], and "a policy ahead of its time". One reason for these labels is PCT's innovative approach of involving individuals in reducing their emissions patterns through a form of cap-and-trade scheme, another is the costs of implementation and operation PCT entails. Some of the most comprehensive pre-feasibility studies on this policy, the reports commissioned by the British government to the Department for Environment Food and Rural Affairs and the Economic Audit Committee in 2007, assessed the costs, among other aspects, of the possible implementation of a PCT scheme in the UK. Defra published its analysis in 2008. This pre-feasibility study suggested that personal carbon trading entails broadly two types of costs: setting-up costs, due to the creation of a data database system to manage the carbon card accounts and of a banking system, and the annual running costs.[216] The estimated set-up costs ranged between £700 million and £2 billion, the running cost was £1-2 billion per year,[217] that is to say, for a population of 50 million such as the UK population £20-£40 per individual

[215] Fawcett, T., Parag, Y., *An introduction to personal carbon trading,* op. cit. p. 332
[216] Ibidem.
[217] Defra, *Synthesis Report on the Findings from Defra's Pre-feasibility Study into Personal Carbon Trading,* Department for Environment, Food and Rural Affairs, London, 2008, p. 3

per year.[218] If confronted with an upstream cap-and-trade system, PCT is significantly more expensive to run as the former would cost £50 million-£100 million to be introduced and £50 million to run.[219]

The Defra was not the only body that elaborated a cost and benefit pre-feasibility study. Some other researchers, such as Bird and Lockwood, have questioned the methodology it used and argued that the costs might be half of those it suggested, around £0.5-£1 billion per year.[220] Additionally, the costs outlined by Defra were evaluated at an early stage (2008), therefore they could be subject to change.[221]

PCT implementation and running costs are likely to depend on the type of PCT scheme implemented,[222] the institutions that need to be set up for its implementation and the administrative functions it requires. For example, the PCT version created by the University of Groningen foresees allocations based on the average fuel use per adult person in a reference year instead of the exact individual consumption; this, according to the developers of this variant, should reduce administrative costs.[223]

A pre-feasibility evaluation on the Cap and Share scheme elaborated for Ireland by Cambridge Econometrics, analysed not only the set-up and running costs but also the administrative functions and the actors needed for the creation and implementation of a C&S scheme. According to this study, the set up of the C&S scheme would be attributed to a government body which would have to set the cap of allowances, such as the existing Department for Environment or a new independent body.[224] The authors of the report then argued that the administrative functions could be managed by an administrative body, such as, in the case of Ireland, the Environmental Protection Agency as it already manages the EU ETS

[218] Defra, *Synthesis Report*… op. cit.,p.3
[219] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6871
[220] Parag, Y., Fawcett, T., *Personal carbon trading: a review..*, op. cit., p. 29
[221] Ibidem.
[222] Ibidem.
[223] Woerdman, E. & Bolderdijk, J. W., op. cit., p.557
[224] Johnson, M., Harfoot, M., Musser, C., Wiley, T., op. cit. p. 70-71

system and is responsible for the National Emissions Inventory.[225] Some administrative functions needed for the C&S system include market regulation; maintaining the register of fuel suppliers; participating individuals and the trading registry; issuing guidance about the standards on how to report and verify emissions, and issuing the certificates.[226] This scheme would also involve some intermediaries that would manage the transactions of allowances between the fuel suppliers, the allowance holders, and the central authority, these would be banks and post offices.[227] If the example of Norfolk Island has demonstrated that their involvement in a carbon trading scheme might not be straightforward, the Cambridge Econometrics' analysis argued that the fact of involving them in the scheme should provide them with a larger client base, which should constitute a form of incentive.[228] Moreover, these intermediaries already work with similar trading systems, thus the functions attributed by a PCT scheme should not cause a significant additional burden to them.[229]

Furthermore, researchers added to the above-mentioned costs, which would be financed through the national budget, some transaction costs deriving from psychological mechanisms that the household involved in the scheme would be confronted with. Woerdman and Bolderdijk argue that the households involved in the allowance market would bear "the time cost of extra allowance action".[230] This would occur when they purchase the goods involved in the scheme (transport and housing-related expenses) and they would have to add the action of handing in the carbon credits to the action of purchasing the goods.[231] Another psychological cost derives from the additional time needed for participants to gather information on their emissions, their level of credits and the allowance prices. This would sum up to the cognitive cost already implied by the PCT

[225] Ibidem.
[226] Ibidem.
[227] Ibdem.
[228] Ibidem.
[229] Ibidem.
[230] Woerdman, E. & Bolderdijk, J. W., op. cit., p.559-560
[231] Ibidem.

system: the action of deciding to buy or sell allowances, that is to say, the management of their carbon credits over time.[232]

Another factor that influences the costs of setting up a PCT scheme is the technical feasibility or the existence of the necessary technologies to implement it. The report elaborated by Defra in 2008, already stated that "no insurmountable technical barriers were identified to the introduction of a personal carbon trading scheme";[233] in the 2010s there was consensus among researchers on this statement.[234] The main enabling technology that could have allowed to set up of a PCT scheme in the 2010s was the existing widely used credit and debit card infrastructure, which, allowing electronic transactions, could have facilitated the carbon credit transactions.[235] In an updated version of her research published in 2021, Fawcett argues that the advancement of Artificial Intelligence, digitalisation, and the high ownership of smartphones could help lower implementation costs even further and could lead to the creation of even more effective Apps.[236] The App could collect information on the users' emission patterns and their habits related to energy consumption, to then elaborate data into personalised estimates of their carbon emissions and into feedback and advice on how to reduce them.[237] Woerdman and Bolderdijk suggest that this could help consumers follow their emission patterns and therefore increase their awareness of their energy consumption, which could further enhance the effectiveness of a PCT scheme.[238] This could perhaps help reduce not only the administrative but also the cognitive costs described here above.

[232] Ibidem.
[233] Defra, *Synthesis Report*… op. cit.,p.3
[234] Fawcett, T., *Personal Carbon Trading: A policy ahead of its time?*, op. cit., p. 6871
[235] Ibidem.
[236] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited,* op. cit., p. 1028
[237] Ibidem.
[238] Woerdman, E. & Bolderdijk, J. W., op. cit., p.569

If it is true that: "PCT would be a relatively expensive policy to introduce and maintain",[239] the ongoing technological progress should facilitate setting it up and running it.

3.2 Social acceptability

The Defra referred to personal carbon trading as "a policy ahead of its time", not only because of the results of its cost analysis illustrated here above, but also because it was concerned about the social acceptability of the policy.[240] Many researchers have concentrated their efforts on this issue regarding PCT, analysing aspects such as the philosophical definition of fairness chosen by PCT, the distributional impacts of the policy, and its social acceptability compared to other policies. These three aspects will be analysed here below.

PCT schemes vary according to the interpretation of the concept of fairness adopted by their creators, which is reflected in the allocation principle of allowances and contributes to the social acceptability of the scheme.[241] For instance, the standard PCT scheme is based on the equal per capita allocation principle, which derives from an interpretation of fairness as "rights": all adults are entitled to a certain amount of carbon allowances for free (the distribution of allowances for free is called grandfathering).[242] This allocation system derives from the principle of equity and is based on the idea that every human being is entitled to an "equal right to emit carbon", which as a consequence would make the PCT scheme fair.[243] The equal allocation principle has been questioned in multiple ways, a question that remains unanswered is for instance if children should receive allowances at all or if they should receive a partial allowance, or if "capabilities" (the capacity to reduce emissions) would be instead what should be

[239] Fawcet, T., *Personal carbon trading a policy ahead of its time?,* op. cit. 6871
[240] Ibidem.
[241] Ibidem.
[242] Ibidem.
[243] Ivi, p. 6870

referred to as fair.[244] Some researchers also questioned the very same idea of distributing equal personal carbon allowances. Starkey argued that "brute luck" factors, factors that cannot be controlled by individuals, such as the geographical area where people live and the local climate, influence personal carbon emission levels.[245] Therefore, Starkey challenged the concept of initial equal allocations with the idea of introducing an initial unequal allowance distribution: for example, individuals living in a colder area should receive a higher number of allowances because of their higher energy demand, which does not derive from their choices but from an external variable, climate.[246] This distributive style is deemed to be fairer as it would reflect the brute luck factors and compensate for higher costs that the PCT would generate for these individuals.[247]

The second aspect that influences the social acceptability of PCT is the distributional effects of PCT, i.e. if it would be regressive or progressive. Researchers such as Ekins and Dresner, and Thumim and White have analysed the emission patterns according to housing composition, geographical location and income variables in the United Kingdom.[248]

	Losers			Winners		
Equivalised income deciles	1000s of HHs	% of decile group	% of all HHs	1000s of HHs	% of decile group	% of all HHs
1-3	2,141	29%	9%	5,246	71%	21%
4-7	3,946	40%	16%	5,908	60%	24%
8-10	4,067	55%	17%	3,323	45%	13%

Table 3 Table elaborated by Thumim and White illustrates the results of their evaluation of the distributional effects of PCT in the United Kingdom out of a sample of 24,632 million people. Source: Defra, 2008.[249]

[244] Parag, Y., Fawcett, T., *Personal carbon trading: a review..,* op. cit., p. 29
[245] Lockwood, M., *The economics of personal carbon trading,* "Climate Policy", 10 (2010) 447–461, 2010, p. 456
[246] Ibidem.
[247] Ibidem.
[248] Ibidem.
[249] Thumim, J.,White, V., *Distributional Impacts of Personal Carbon Trading: A report to the Department for Environment, Food and Rural Affairs, Defra,* Centre for Sustainable Energy, London, 2008, p. 43

The table above, extracted from Thumim and White's research, shows the winners (those having a surplus of allowances) and losers (those having to buy additional allowances) resulting from the adoption of a PCT scheme. Among the winners, those having a surplus of allowances are 71% of the 1st to 3rd deciles, against 45% of the richest deciles.[250] Among the richest deciles, 55% are classified as losers, as they would have to purchase additional allowances to maintain their lifestyle.[251] Two factors influence the credit or debit situation of individuals under a PCT scheme, their geographical location and the household dimension: rural households and larger households need more energy, therefore they would need more allowances.[252] For this reason, PCT can broadly be deemed to be progressive, though, it involves some low-income losers: from the analysis here above 2,1 million households (from a sample of 24,6 million households) would be worse off as a result of a PCT scheme introduction.[253] This is due to their higher consumption of energy deriving from the type of housing (larger than average) and the geographical location (rural areas).[254] Fawcett argues that aviation was not included in this analysis, and that including it could prove PCT to be more progressive, as low-income households fly significantly less than high-income households.[255]

Other researchers conducted various forms of empirical tests to study the social acceptability of the policy, among them focus groups, questionnaires, interviews, and online opinion polls involving between 30 and 1000 +participants.[256] Some of these studies have shown that the factors influencing the participants' opinion on PCT were "the role of the state and the rights of the individual, their opinions on the equity, the practicality, environmental effectiveness and negative aspects

[250] Ibidem.
[251] Ibidem.
[252] Fawcet, T., *Personal carbon trading a policy ahead of its time?,* op. cit. 6870
[253] Ibidem.
[254] Ibidem.
[255] Ibidem.
[256] Ivi, p. 6872

of the PCT scheme".[257] For example, in an opinion poll conducted in 2008, participants seemed "less opposed" to PCT than carbon taxation, 31% said they supported/strongly supported PCT, against 19% supporting a carbon tax.[258] Fawcett argues that "despite the variation in methods and sample types, the results are remarkably similar: when PCT is compared with carbon taxation (or other policies) it is usually preferred [...]For those who prefer PCT, its key benefits are seen as fairness and effectiveness".[259]

In 2010 Fawcett suggested that the methodologies used to collect social acceptability data should be reassessed and that data should be verified because of possible flaws in methods such as opinion polls.[260] Furthermore, the author highlights the need for a definition of acceptability (should it correspond to 50%/70%/90% of preference in a sample?), which has not been established yet.[261] To the question "Has there been a significant evolution in the debate and research on PCT since the 2010s?" asked during an interview in March 2023, Tina Fawcett described the current lack of data and the need for further research on key aspects of the policy.[262] The author mentioned some interesting new research projects, first, a research project testing the acceptability of PCT in Germany with the established methodology, which led to results similar to the ones obtained for the UK: "quite a lot of people think it's a good idea, some people don't, it has mostly to do with whether people think it is effective or fair [...] you get the same sort of people with higher carbon footprints slightly less keen on it".[263] The similarity between the results found for the two countries could be due to cultural similarities, therefore Fawcett suggested that similar research should be performed in other countries. Additionally, the author mentioned an innovative research project running from January 2023 up to

[257] Ibidem.
[258] Ibidem.
[259] Ivi, p. 6873
[260] Ibidem.
[261] Ibidem.
[262] Interview with Tina Fawcett, senior researcher in the Energy Programme at Oxford's Environmental Change Institute, was held on the 17th of March 2023 by the author of this thesis.
[263] Ibidem.

November 2027, the "Energy Demand Observatory & Laboratory". This project, joined by T. Fawcett, will collect data about household energy use in the UK through a 2000 households representative sample.[264] This database will constitute an important source of data for evaluating policies such as personal carbon trading.

In addition, the policies implemented in Europe and the rest of the world as a result of the COVID-19 pandemic between 2020-2023 represent a natural experiment of the social acceptability of measures restricting individual choice, which could be of use for PCT. The measures implemented by governments during the pandemic, such as travel restrictions, curfews, social distancing, compulsory vaccinations and mask use etc... led to a restriction of individual freedom motivated by public health concerns. Apart from some cases of people openly contesting them and violating them, the majority of citizens complied with these new rules they had never experienced before in their lifetime.[265] During the pandemic the values of public health and safety challenged and outweighed the value of individual freedom, making new forms of control more acceptable. The policies implemented around the world, such as the measures listed before, the compulsory digital vaccination pass, and the use of contact-tracing Apps (although they were voluntary in some cases such as in the case of Italy), could constitute a natural experiment for the implementation of PCT. A lesson that can be drawn from this experience is that if a strong communication campaign is structured to mobilise public opinion and the purpose is explained thoroughly, in the case of COVID restrictions public health in the case of PCT climate change, big-scale behavioural change is possible with a relatively high rate of compliance.[266] Another lesson derives from the use of contact-tracing Apps.[267] Although these caused privacy concerns regarding the use of the data

[264] Ibidem.
[265] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit., p.1027
[266] Ibidem.
[267] Ibidem.

they collected, especially in Asia, if these issues are taken into consideration and users are guaranteed privacy protection, the technology used for creating them could constitute an interesting precedent for emission-tracing Apps for PCT.[268]

3.3 Political feasibility

PCT was defined as "a radical approach for mitigation", "a policy invention", and "innovative policy".[269] The political obstacles that this policy has to face in the policy arena are a consequence of these characteristics. PCT is radical to the extent it challenges the approach adopted by mitigation policies so far, moreover, it is considered as an innovative policy because it was never implemented before.[270] Thus, it constitutes a political risk and policymakers will be cautious in adopting it and they will probably oppose some resistance to the concept of limiting individual personal carbon emissions because of the novelty of the approach, the effectiveness of which has not been proven yet.[271] This also partly explains the events that occurred in 2008 when the project was slowly abandoned after Defra's report described PCT as radical, ahead of its time, and complex in terms of administrative costs and social acceptability.

An additional obstacle for PCT is the fact that it is not yet a fully developed policy option. Parag and Eyre argue that even for one of the most detailed schemes, such as Tradable Energy Quotas, its compatibility with the existing policy landscape, or the enforcement of the allocation of allowances are not clear yet.[272] This lack of definition of the policy and the uncertainty associated with it are part of what blocks it from being considered in the political agenda.[273]

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[268] Ibidem.
[269] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit., p.1026
[270] Ibidem.
[271] Ibidem.
[272] Yael Parag, Nick Eyre, *Barriers to Personal Carbon Trading in the Policy Arena*, op. cit., p. 357.
[273] Ivi, 356.

Furthermore, "PCT has no strong lobby in the policy arena".[274] If in the early 2000s Hillman and Fleming, the creators of TEQs, participated in the political debate investing time and energy in promoting personal carbon trading as a policy option[275] and acting as policy entrepreneurs in the sense given by Kingdon,[276] currently, despite the presence of think tanks and researchers studying PCT, there is no policy entrepreneur or advocacy group actively promoting it.[277] When asked about whether currently, any groups are promoting PCT, Tina Fawcett confirmed the findings of Yael Parag and Nick Eyre in the 2010s: "You get enthusiastic individuals"[278], but no group or strong coalition is advocating for PCT, and coalitions are usually what help policy proposals and ideas to be brought forward in the policy arena.[279]

Another issue regarding PCT in the policy arena is the so-called "framing". Framing is the cognitive process of identifying: the reason why a problem is a public policy problem, the actors causing it, the victims and who should solve it.[280] It is a chosen narrative, an interpretative lens, which helps policymakers and citizens understand the problem in its multifaceted dimension,[281] but most importantly, which contributes to the probability that the problem will attract the attention of citizens.[282]

The way climate change is framed as a public policy problem could influence the capacity of PCT to attract the attention of policymakers and the general public as a mitigation policy. Parag and Eyre highlight that climate change is currently represented by the predominant framing as a "remote problem".[283] The

[274] Ivi, 358.
[275] Szuba, M., op. cit., p. 22
[276] Kingdon, J.W., *Agendas, Alternatives and Public Policies,* Harper Collins, New York (NY),1995 (1984).
[277] Parag, Y., Eyre, N., *Barriers to Personal Carbon Trading in the Policy Arena*, op. cit., p. 358
[278] Interview with Tina Fawcett, senior researcher in the Energy Programme at Oxford's Environmental Change Institute, was held on the 17th of March 2023 by the author of this thesis.
[279] Ibidem.
[280] Bobbio L., Pomatto G., Ravazzi S., op. cit., p 57
[281] Ivi, p. 58
[282] Ivi, p. 62
[283] Parag, Y., Eyre, N., *Barriers to Personal Carbon Trading in the Policy Arena*, op. cit., p. 360

remoteness of climate change derives from the fact that it is presented as a "global environment problem, distant from ordinary people and one over which they have no control".[284] As a result, currently, climate mitigation policies put the responsibility on energy suppliers without directly involving individuals. PCT instead, is based on a different framing for climate change, a vision where individuals play a fundamental role in driving the emission reduction challenge; this vision could clash against the predominant framework.[285] It could be argued that the energy crisis hitting especially Europe following the Russian invasion of Ukraine in February 2022, has contributed to putting this framework into question. In fact, as a result of this major global crisis, European policymakers and Member states' governments started to increasingly engage with individual responsibility of households and companies to reduce energy consumption to enhance their energy security. Many European countries adopted policies aimed at guaranteeing the energy security of the continent, mainly to decouple their dependence on Russian gas. These policies focused on reducing energy consumption, increasing the percentage of renewable energy in the energy mix and finding new partners to import gas. Some of the adopted policies include making new gas and raw materials agreements with partners other than Russia (such as the United Arab Emirates, the United States etc..)[286], increasing investments, public spending in renewable energies, and increasing the renewable energy targets (the Council of the EU and the Parliament reached a provisional agreement to raise the 2030 target of renewable energy from the current 32% to at least 42.5%, aiming for 45%).[287] An additional type of policy adopted by Member states that could pave the way for PCT is energy demand reduction policies. A large number of Member states adopted policies such as

[284] Ibidem.
[285] Ibidem.
[286] European Council on Foreign Relations, *EU Energy Deals Tracker*, https://ecfr.eu/special/energy-deals-tracker/, last accessed 27/04/2023
[287] European Commission, Renewable Energy Directive, https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en#:~:text=After%20being%20considered%20by%20the,adopted%20and%20enter%20into%20force, last accessed 27/04/2023

"calls on commercial operators to turn off lights at night-time, as well as awareness raising campaigns to encourage citizens to lower thermostat temperatures, take shorter hot showers, switch off lights, reduce car use and turn off appliances".[288] Among others, the French government published in October 2022 a plan for energy sobriety (sobriété énergétique) which aims at cutting energy consumption by 10% by 2024 and 40% by 2050.[289]The adopted measures aimed at public administration, economic actors and households include tools such as, financial incentives, for example, bonuses for installing heat pumps, and communication campaigns aimed at incentivising household energy savings.[290] The Ministry of Environment and Energy Security (MiTE) of Italy, instead, enacted in October 2022 a decree to limit the energy used for buildings' heating, which reduced the heating season by 15 days and heating of 1°.[291] "The objective is to promote conscious and intelligent behaviour in gas and electricity consumption, which will not only have an impact on the containment of gas demand and users' billing costs themselves but also on decarbonisation policies."[292] Another example is the "Playing my part" programme launched in April 2022 by the European Commission and the International Energy Agency, which consisted in a campaign providing tips and suggestions to reduce individuals' and companies' energy consumption.[293] "If the government were prepared to consider individuals as the primary agents of their behavioural change, and implicitly to frame personal emissions as a problem of personal behaviour, the likelihood of PCT being in the policy option basket would

[288]OECD, 2022, op. cit

[289] Direction de l'information légale et administrative (Première Ministre), Que prévoit le plan de sobriété énergétique pour les ménages ?, 07/10/2022, https://www.service-public.fr/particuliers/actualites/A16012#:~:text=Le%20plan%20de%20sobri%C3%A9t%C3%A9%20%C3%A9nerg%C3%A9tique%20a%20%C3%A9t%C3%A9%20annonc%C3%A9%20le%206,%2C%20entreprises%2C%20collectivit%C3%A9s%20et%20citoyens., last accessed 26/04/2023

[290] Ibidem.

[291] Ministero dell'Ambiente e della Sicurezza Energetica, Energia. MiTE, firmato il Decreto che stabilisce nuovi limiti e orari per i riscaldamenti, https://www.mase.gov.it/comunicati/energia-mite-firmato-il-decreto-che-stabilisce-nuovi-limiti-e-orari-i-riscaldamenti, last accessed 27/04/2023

[292] Il Sole 24 Ore, Al via il piano del governo: riscaldamenti a 19 gradi e 15 giorni in meno. Come funzionerà dai condomini agli ospedali, 06/10/2022, https://www.ilsole24ore.com/art/al-via-piano-governo-riscaldamenti-19-gradi-e-15-giorni-meno-come-funzionera-condomini-ospedali-AEbhR7xB, last accessed 27/04/2023

[293] OECD, 2022, op. cit.

increase".[294] It could be argued that the energy crisis has increased the likelihood of this shift, and the political acceptability of PCT as a solution to further help the necessary behavioural change to happen.

Another factor contributing to the perception of PCT is its framing as "personal carbon ration"[295], implying that the implementation of PCT would entail the introduction of some form of rationing. The idea of rationing is explicitly mentioned by the creators of TEQs, who aimed to bring the concept of planetary boundaries to the individual level through the creation of personal carbon quotas.[296] To some researchers, the use of the term "rationing" would not be beneficial to the aim of attracting public interest on PCT. They argue that the comparison between PCT and food rationing during World War II could make PCT be perceived as some form of external constraint associated with austerity.[297] Moreover, the idea of scarcity PCT entails goes against the commitment to consumerist lifestyles, strong after more than 50 years of "extraordinary material abundance".[298] Parag and Eyre highlighted in 2010 how in those years, considering the context of economic contraction, a form of rationing would not have been welcomed by public opinion.[299] This could still be true for the 2020s considering the economic context caused by the pandemic and the war in Ukraine. In times of economic strain such as these, policymakers tend to prefer policies promoting consumption to stimulate growth.[300]

Hillman and Fleming, instead, openly refer to rationing when describing their idea of Tradable Energy Quotas, comparing it to food rationing during WWII in the United Kingdom. According to the researchers, food rationing involved an egalitarian dimension: "Rationing, coupled with subsidies and price controls,

[294] Parag, Y., Eyre, N., *Barriers to Personal Carbon Trading in the Policy Arena*, op. cit., p. 361
[295] Ivi, p. 357
[296] Szuba, M., op. cit., p. 21
[297] Parag, Y., Eyre, N., *Barriers to Personal Carbon Trading in the Policy Arena*, op. cit., p. 357
[298] Cohen, M., J., Is the UK preparing for "war"? *Military metaphors, personal carbon allowances, and consumption rationing in historical perspective* ,"Climatic Change", Springer Science+Business Media 2011, 104:199–222 DOI 10.1007/s10584-009-9785-x, p. 216
[299] Ibidem.
[300] Ibidem.

promoted social equality, and consumption became more equal in contrast with the intense inequalities that had existed previously."[301]

It is this same idea of equality deriving from rationing that pushed Delphine Batho and François Ruffin, Members of the French National Assembly of Génération écologie and La France Insoumise, to put forward a draft law in the French Parliament aiming to introduce individual quotas for aviation. The draft law filed in June 2020 ("draft law n°3164 aiming at introducing an individual carbon quota to limit the use of aeroplanes"),[302] aims to create a personal carbon quota for the use of aviation, the quota would be reduced every five years to reach the goal of carbon neutrality by 2050.[303] The quota would be cumulative and would only be valid for air travel motivated by leisure, therefore, it would not apply for cases of air travel for business, travel related to the respect of fundamental human rights, such as travel motivated by family reasons, and, since the draft law was designed to be enforced in France, travel motivated by the continuity of the French territory.[304] [305] Joseph D'Halluin, parliamentary assistant of François Ruffin during the drafting phase of this law, argued during an interview held in May 2022[306] that the aviation quota, partly inspired by Mathilde Szuba's Doctoral thesis, tries to find a way to cap consumption while safeguarding a balance between the respect of social rights, the principle of

[301] Szuba, M., op. cit., p. 21

[302] Proposition de loi n°3164 visant à instaurer un quota carbone individuel pour limiter l'usage de l'avion, presented by M. François Ruffin et Mme Delphine Batho, registered in the Presidency of the French National Assembly the 30th of June 2020, https://www.assemblee-nationale.fr/dyn/15/textes/l15b3164_propositionloi#:~:text=Notre%20proposition%20de%20loi%20fixe,moins%20plusieurs%20fois%20par%20an., last accessed 26/04/2023

[303] Batho, D., Un quota carbone individuel pour organiser la diminution du trafic aérien, Planète, L'Observateur, 3 July 2020, https://www.nouvelobs.com/planete/20200703.OBS30863/delphine-batho-un-quota-carbone-individuel-pour-organiser-la-diminution-du-trafic-aerien.html, last accessed 26/04/2023

[304] The continuity of the French territory refers to the fact that in the French "Code des Transports", the continuity between the mainland France and its overseas territories has to be ensured through transport to avoid isolation of communities and citizens living in territories and islands, such as La Réunion, Mayotte etc...,https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000023086525/LEGISCTA000023070046/, last accessed 26/04/2023

[305] Batho, D., op. cit.

[306] The interview with Joseph D'Halluin, parliamentary assistant of the Member of Parliament François Ruffin in 2020, was held in May 2023 by the author of this thesis.

equality and the aim of not exceeding the planetary boundaries.[307] This draft law is an example of policy similar to PCT in its principle and in its idea of creating a form of rationing, the main difference between the two policies derives from the fact that the aviation quota does not include any form of trading, to its creators this design reflects more strongly the concept of planetary boundaries.[308] Another interesting aspect is the rationale of adopting a quota instead of a tax: Batho and Ruffin wanted to avoid putting forward a measure that had proven to be unpopular. Indeed, in 2019 the French government discussed the adoption of a fuel tax, a discussion that, because of its distributive or redistributive effects, was followed by an intense period of strikes organised by the Yellow Vests movement (Gilets Jaunes).[309] The quota was designed to limit air travel for various reasons, first, to start introducing and implementing the concept of planetary boundaries in a sector that is less sensitive than fuel, [310] indeed if car users often use the purchased fuel to reach their workplace, half of the flights are motivated by leisure.[311] Then, because of the strong inequalities characterising this sector: only a minority of people fly regularly, whereas an important part of the population has never flown (roughly 80% of the world population, in the case of France 15% of its population).[312]

The arguments formulated in favour and against this draft law also offer an interesting lesson for PCT's social and political feasibility. Both PCT and the aviation quota aim at restricting consumption, a factor that, as explained above, would not be easily welcomed by a public opinion used to abundance and comfort. After the draft law was filed in June 2020, many newspapers and TV programmes discussed the pros and cons of their proposal. The main arguments brought forward against the draft law insisted on the idea that the introduction of

[307] Ibidem.
[308] Ibidem.
[309] Ibidem.
[310] The interview with Joseph D'Halluin, parliamentary assistant of the French Member of Parliament François Ruffin in 2020, was held in May 2023 by the author of this thesis.
[311] Reporterre, Des députés proposent des quotas individuels de carbone pour limiter les trajets en avion, 30 June 2020 , https://reporterre.net/Des-deputes-proposent-des-quotas-individuels-de-carbone-pour-limiter-les-trajets-en-avion, last accessed 26/04/2023
[312] Reporterre, op. cit.

such quota would limit individual freedom as a form of "punitive ecology"; it would kill the already fragile aviation industry and cause a negative social impact because of possible job losses, and, by only introducing it France, it would create an incentive for consumers to fly from other countries sharing a border with France, undermining the national industry even further.[313] When asked if the general public is ready to receive a proposal that "reduces individual freedoms", D'Halluin argued that, freedom is a complex theoretical question and that in any case the idea of planetary boundaries must be given political credibility, that it is important to talk about this proposal, to create a narrative so that it is seen as an egalitarian project uniting the nation at the service of social justice.[314] Furthermore, the invasion of Ukraine has created political-emotional momentum that could facilitate the introduction of the idea of rationing, this indeed, is an extension of the concept of energy sobriety promoted by the French government as a solution to the energy crisis in 2022.[315]

Although the aviation quota is an interesting example of a policy that could make a strong case for PCT, to this day, the project was referred to the Committee on Sustainable Development and Territorial Planning of the French National Assembly on the 30th of June 2020, and in 2023 it still hasn't been discussed.

3.4 Other challenges and questions to answer

The administrative cost and the social and political feasibility are some of the challenges faced by PCT, however, other questions need to be answered to make PCT a real policy option.

Some of these questions are related to the market design. For an emission trading system to be functioning correctly several features need to be clarified: first, should allowances be distributed for free (grandfathering), by a division of the

[313] Dor, F., Pour ou contre le « quota carbone individuel » pour limiter nos trajets en avion ?, Les Echos Start, 9 July 2020, https://start.lesechos.fr/societe/environnement/pour-ou-contre-le-quota-carbone-individuel-pour-limiter-nos-trajets-en-avion-1222554, last accessed 26/04/2023

[314] Interview with Joseph D'Halluin, May 2023.

[315] Ibidem.

total cap per capita, or should they be distributed through auctions? The first option creates a political process of allocation, which often causes over allocation and is influenced by lobbies, as shown by the case of the EU ETS. [316] Instead, the second option adds a cognitive and material cost for the participants of the scheme deriving from the fact that they would have to participate in auctions.[317] Then, a verification authority needs to be nominated for monitoring, reporting, regulation, and for sanctions to be enforced in case of non-compliance (what sanctions should be enforced?). This authority needs to ensure in the geographical area involved by the scheme: the consistency of the price, the standardisation of the method used to measure a tonne of CO_2, and the enforcement of sanctions in order for the cap-and-trade system to be credible and effective.[318] Another issue is a clear definition of the extension of the scope of the scheme. As presented in the first chapter of this thesis, PCT schemes have initially been developed including only "delivered energy use (heating, indirect emissions from electricity use, personal transport)"[319], however, the debate is still open on the idea of including aviation and public transport.[320] The issue of the extension of the scope is connected to the issue of giving a clear definition to "personal carbon emissions" to distinguish them from professional emissions. To Brohé an unclear definition of the two could cause carbon leakage or even PCT to be regressive, as an important part of the emissions, especially of high-income quintiles of population, can derive from their professional life.[321] Indeed, businesses often pay for travel expenses and accommodation of their employees; this would allow them to avoid tracing these emissions as "personal carbon emissions", but rather as emissions motivated by professional commitments. Finally, the price of allowances needs to be high enough to create an economic incentive but not too high to provoke social issues and to have a negative impact

[316] Brohé, A., *Personal carbon trading in the context of the EU Emissions Trading Scheme*, "Climate Policy", 2010, p. 465
[317] Ibidem.
[318] Ibidem.
[319] Ivi, p. 467
[320] Ibidem.
[321] Ivi, p. 473

on fuel poverty.[322] These questions need to be answered for the market to be structured and functioning. Other questions that need to be answered are:

- What is the ideal geographical area /scale of implementation of PCT (local, national, European, international)?
- Is PCT compatible with the existing policy landscape?

These will be discussed in the following chapter considering in particular the case of the European Union and the coexistence of a possible PCT scheme and the EU ETS**.**

3.5 Conclusions

This chapter presented the main challenges faced by PCT: the costs, the social and political acceptability and others which will be detailed in the following chapter. The first pre-feasibility analysis published by Defra showed the high cost of PCT as a policy comparing it to other policy options such as a carbon tax. Another type of costs, more than the set-up and running costs would be borne by the participants of the scheme. Indeed, they would have to face psychological costs deriving from the additional time required by the decision-making involved in the allocation of personal allowances, which is time and energy-consuming. These costs depend on the variant of the PCT scheme adopted, the administrative functions required by this variant and the existing technologies that need to be implemented for the scheme to be functioning. Pre-feasibility studies and the academic literature had already proved that there are no major technical obstacles to the adoption of a PCT scheme. This argument is even stronger more than ten years after, because of the technological advances, such as the development of Artificial Intelligence and the wide use of smartphones, which could help develop tools such as Apps that could facilitate the users' control of their carbon

[322] Ivi, p. 479

credits. In the second paragraph, we focused on the social acceptability of PCT. Social acceptability depends on whether people see PCT as fair, and the definition of fairness can vary according to the variation of PCT adopted. For instance, the original PCT designers thought of allocating allowances to users on an equal basis, however, other researchers commented that an unequal allowance would better reflect factors that contribute to energy use that go beyond the control of individuals (brute luck factors). Other researchers have analysed the possible distributional impact of PCT and have found that, if it is broadly progressive, some low-income citizens would be classified as "losers" as a result of the introduction of the scheme. Questionnaires, opinion polls and interviews instead show that broadly, when compared to other instruments, PCT is preferred or less disliked. Fawcett suggested that these results should be revised as well as the methodology adopted, and that it would be useful to find a definition of what is deemed to be socially acceptable. Furthermore, political acceptability was discussed, illustrating a list of possible factors that could hamper PCT in the policy arena. The first factor is that PCT is an innovative and radical policy, therefore its effectiveness has never been tested before. This, and the fact that it challenges the current methodology and framing of climate change as a public policy problem and of the role of personal carbon emissions, could create an obstacle in the agenda-setting phase of policymaking, as politicians could perceive PCT as a risky option. The policies adopted because of the energy crisis hitting Europe from the beginning of 2022 could have contributed to starting shifting the responsibility partly on consumers, and therefore might have created a more favourable context for PCT's political acceptability. The lack of strong advocacy action in PCT's favour also contributes to the low chances of it entering the policy agenda. Rationing was also discussed concerning whether PCT should be referred to as such. Some researchers argue this would not benefit its public acceptability because it would restrain consumption in a society that is not used to limits and where policymakers prefer tools to stimulate economic growth. Other researchers insist on the egalitarian dimension of rationing,

deriving from the fact that it implies the equal distribution of the same good that was previously unevenly distributed. As an example of a policy based on rationing and the rationale here above, we discussed the draft law introducing an aviation quota filed in the French National Assembly in 2020. PCT could be confronted with the same remarks made against this draft law, of limiting freedom and hampering industry. The questions regarding other challenges that remained unanswered will be dealt with in the fourth chapter.

Chapter 4: Interaction of PCT with the existing policy landscape in the European Union: Is PCT compatible with the EU Emission Trading System?

4.1 The question of the appropriate level of governance for the implementation of PCT in the European Union

This fourth and last chapter will be structured around two questions:

- What is the ideal level of governance to implement PCT in Europe?
- How does PCT interact with the existing policy landscape, mainly with the EU ETS?

Before discussing these two questions, it is fundamental to clarify the interest in the European Union as the potential geographical area for the implementation of PCT. On the one hand, the majority of literature was produced in Europe, especially in the UK, apart from some examples from the United States, Canada and China. The literature produced on PCT so far focuses geographically on high-income countries with high emission patterns, the administrative infrastructure and means to implement a policy considered administratively costly and complex. Finally, it is in the author's intellectual interest to focus on

the European Union especially because of the EU ETS system, to understand if and how PCT and the former could coexist.

Starting with the first question, PCT has mainly been proposed as a policy to be implemented at the national level.[323] The advantage of implementing PCT at the national level is that this would allow designing a scheme adapted to the needs of a given country, its population and its climate. For example, a country with a high internal variation of climates, such as Spain, might prefer to implement a system with an unequal distribution of allowances to take into account the fact that some citizens might consume more energy for heating or cooling than others.[324] The distributional effects of PCT are also likely to vary from country to country. Each country might be characterised by a certain type of housing (dimensions, materials used, etc...), a certain energy mix (the share of low-carbon energy vary among EU Member states) and the availability of low-carbon transport solutions.[325] These factors all influence the capability of citizens to modify their lifestyle and reduce their emissions to fit into a PCT scheme, and would be better addressed if a PCT scheme was implemented at the national level.

Nonetheless, the implementation of PCT in European countries at the national level leads to two issues. First, apart from insular countries, such as Iceland and the UK, the majority of countries in the European continent have one or more international borders, which could lead to the phenomenon of cross-border transport emissions. This phenomenon describes the fact that citizens could avoid paying for additional allowances for their transport consumption by purchasing fuel or flying from bordering countries with cheaper allowances or with no PCT system in place.[326] The probability of this phenomenon happening is quite high: consumers who live close to international borders in Europe sometimes chose to

[323] Fawcett, T., *Personal carbon trading in different national contexts*, "Climate Policy", 2010, p. 347
[324] Ivi, p. 342
[325] Ivi, p. 344
[326] Ivi, p. 345

purchase fuel in bordering countries because of the variations in tax levels, for instance, between France and Luxemburg.

The second problem generated by introducing a PCT scheme at the national level in the EU is expressed by the second question posed at the beginning of this paragraph: how does PCT interact with the existing policy landscape? First of all, PCT was and still is thought to be an enabling policy, which could push individuals "to make the most of existing schemes, such as product and building standards, energy labels, taxation and financial incentives, as well as low carbon transport modes".[327] It is necessary to stress that if PCT puts the responsibility on individuals, trying to push for the untapped potential of demand reduction stressed by the IPCC, this behavioural change could be limited by the existing policy landscape, especially by the absence of policies enabling low-carbon choices. For example, if the infrastructure allowing low-carbon mobility, such as cycle paths and public transport, is not sufficiently developed, and the building sector does not provide for efficient/low-consuming housing, consumers will be physically limited in the range of low-carbon choices they have access to. Thus, if the behavioural change towards a low-carbon lifestyle is possible, probable and desirable to convey the transition to the net-zero objective, it must be accompanied by a massive investment in infrastructures (transport, building etc..), a systemic change, in which consequently individuals can make low-carbon lifestyle choices.

Another issue that we will thoroughly discuss in the following paragraph is the overlap between PCT and the existing EU ETS.[328] We will illustrate the functioning of the EU ETS, its history, its recent advancements and the issue of compatibility with PCT.

[327] Parag, Y., Fawcett, T., *Personal carbon trading: a review..*, op. cit., p. 27
[328] Fawcett, T., *Personal carbon trading: a policy ahead of its time?*, op. cit., p. 6870

4.2 The EU ETS history, membership, sectors covered and recent developments

The Emission Trading system of the European Union, also known as EU ETS, is based on the idea that putting a price on carbon is the most cost-effective way to limit national carbon emissions and reach international climate engagement targets, as it is deemed to promote investment in innovation for low-carbon technologies. The EU ETS currently covers around 10.000 installations producing the following GHG emissions: carbon dioxide (CO_2), nitrous oxide (N_2O) (from production of nitric, adipic and glyoxylic acids and glyoxal) and perfluorocarbons (PFCs) (from the production of aluminium).[329] In addition to these, the sectors involved are "electricity and heat generation, energy-intensive industry sectors, including oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals, and civil aviation".[330] The EU ETS is the world's first international trading system for CO_2 emissions covering 40% of the EU's greenhouse gases emissions.[331] It includes not only members of the European Union but also members of the European Economic Area such as Norway, Liechtenstein and Iceland, and it is linked to the Swiss emission trading system since an agreement was signed between the parties in 2017.[332] The system, as PCT, is based on the principle of cap-and-trade, which means that the emissions of installations covered by the EU ETS are capped and the cap is reduced over time (cap). The involved installations purchase through auctions the allowances they have to submit every year to cover their emissions, or they receive them for free (grandfathering) depending on the sector they are part of (the Fit for 55 package approved by the EU in 2023 though, is contributing to phase out free

[329]European Commission, Sectors & gases covered, EU Emission Trading System (EU ETS), https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en#sectors--gases-covered, last accessed 02/05/2023
[330] Ibidem.
[331] Ibidem.
[332] Ibidem.

allocation from almost all the sectors involved to limit companies' windfall profits deriving from it). Non-compliance entails financial sanctions, however, if the installations' level of emissions is lower compared to the amount of allowances they possess, these can be sold to other installations (trade).

The history of the EU ETS system can be tracked according to 4 phases of development or trading periods. It was initially set up in 2003 by *Directive 2003/87/EC*[333] of the European Parliament and the Council establishing a scheme for greenhouse gas emission allowance trading, and it came into force in 2005. The Commission's proposal to establish such a system was based on the results of the Kyoto Protocol of 1997, and the *Green Paper on greenhouse gas emissions trading within the European Union* published in 2000.[334] The first phase (2005-2007) contributed to creating the prototype that would have been put in place in phase 2. Phase 1 established a price for carbon, free trade in emission allowances across the EU, alongside the monitoring mechanisms for businesses covered by the system (at the time the system only covered CO_2 emissions from power generators and energy-intensive industries).[335] Since in this starting phase allowances were mainly attributed for free and the penalty for non-compliance was €40 per tonne, the total amount of allowances offered to business exceeded emissions therefore in 2007 the price of allowances fell to zero.[336] The 2008-12 phase coincided with the definition of exact national caps on greenhouse emissions within the Kyoto Protocol framework, allowing the EU ETS second phase to align with them.[337] The caps on national emissions were adjusted

[333] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/*EC*, OJ L 275, 25.10.2003, p. 32–46

[334] European Commission, Green Paper on greenhouse gas emissions trading within the European Union, COM/2000/0087, 08/03/2000, Brussels

[335]European Commission, Development of the EU ETS (2005-2020), Climate Action, https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/development-eu-ets-2005-2020_en, last accessed 02/05/2023

[336] Ibidem.

[337]European Commission, Kyoto 1st commitment period (2008-2012), Climate Action, https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-made-cutting-emissions/kyoto-1st-commitment-period-2008-12_en, last accessed 02/05/2023

according to each country's wealth and were expressed as emissions in a chosen base year. The other main features of phase two are the entry of Iceland, Liechtenstein and Norway as new members, a lower cap on allowances elaborated according to emission data collected in phase 1 (6.5% compared to phase 1), the reduction of free allocation to 90% of the total, the introduction in the system of Nitrous oxide emissions and of auctions by several countries, the increase to €100/tonne of the penalty for non-compliance and the introduction of the aviation sector on 1 January 2012.[338] Similarly to the first phase, during the second, the price of carbon was low because of the 2008 economic crisis where emissions were cut because of the recession, creating a surplus of allowances and as a consequence, a lower price of carbon.

Phase 3 (2013-2021), instead, reshaped the system. An EU-wide cap on emissions was introduced to substitute national caps, auctions substituted free allocation of allowances, more sectors and greenhouse gases were included, and allocation rules applying to the allowances given away for free were harmonised.[339] Finally, the "New Entrants Reserve", a fund of 300 million to deploy innovative, renewable energy technologies and carbon capture and storage allowances was introduced alongside the Market Stability Reserve, the mechanism to control the number of allowances on the market set in 2019.[340]

During phase 3, the legislative framework was revised to set phase 4 (2021-2030). This fourth revision is based on a new EU ETS directive that was adopted and entered into force in spring 2018 (*Directive (EU) 2018/410*).[341] The 2018 directive aims at lowering the cap with an annual pace of 2.2% from 2021; allowing free allocations to sectors at risk of carbon leakage according to technological innovation, and installing new funds (the Innovation Fund and the

[338] European Commission, Development of the EU ETS (2005-2020), Climate Action, op. cit.
[339] Ibidem.
[340] Ibidem.
[341] Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814, Official Journal of the European Union.

Modernisation Fund) to help the power sector industry's transition into low carbon economy.[342]

In 2023 the EU ETS was reformed again, this time to align with the European Green Deal, one of the six priorities for the Ursula von Der Leyen European Commission (2019-2024) aiming to drive the ecological transition of the European Union.[343] Within this context, the Commission approved the *Climate target plan* which sets the EU-wide objective of becoming climate neutral by 2050 and a new 2030 net emission reduction target: the European Union emissions will have to be cut from 40% to at least 55% compared to 1990 levels.[344] The 2050 and 2030 objectives were then made legally binding by the *European Climate Law* (*Regulation (EU) 2021/1119*) entered into force on 29 July 2021.[345] The Commission subsequently adopted a series of legislative proposals to set the path for meeting the new goals: the *Fit for 55* package (55 stands for 55% reduction of emissions by 2030).[346] Since the EU emission reduction targets are implemented through the EU ETS, the Effort Sharing Regulation, the Land use, Land use change and forestry Regulation, these climate policies had to be adapted to the 55% target. To increase the ambition of the EU ETS the Fit for 55 package adopted the following objectives: reduce the emissions from the EU ETS sectors by 62 % by 2030 compared to 2005 levels;[347]

[342]European Commission, Revision for phase 4 (2021-2030), Climate Action, https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/revision-phase-4-2021-2030_en, last accessed 02/05/2023

[343] European Commission, The European Commission's priorities, 6 Commission priorities 2019-2024, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024_en, last accessed 02/05/2023

[344]European Commission, 2030 Climate & Energy frame work, Climate Action, https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-energy-framework_en, last accessed 02/05/2023

[345] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), Official Journal of the European Union.

[346] Council of the European Union, Fit for 55, https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/, last accessed 02/05/2023

[347] European Parliament, Fit for 55: Parliament adopts key laws to reach 2030 climate target, press release, https://www.europarl.europa.eu/news/en/press-room/20230414IPR80120/fit-for-55-parliament-adopts-key-laws-to-reach-2030-climate-target, last accessed 02/05/2023

phase out free allowances to companies from 2026 until 2034;[348] gradually extend the EU ETS to the maritime sector and extra-European flights through the CORSIA scheme; create a self-standing ETS (ETS II) for emissions from fuels used in buildings and road transport; expand and adjust the Market Stability Reserve, and to introduce a "Carbon Border Adjustment Mechanism" CBAM, which should function in parallel to the EU ETS.[349] Other objectives of the *Fit for 55* are increasing Member States' emission reduction targets, introducing EU fleet-wide CO_2 emission targets for new cars and vans from 2030 onwards, reforming the Regulation on Land Use, Land Use Change and Forestry (LULUCF), protecting and expanding Europe's forests, creating a Social Climate Fund, and adopting a series of other measures related to energy efficiency and taxation.[350] The package was adopted by the European Commission the 14th of July of 2021 and it was submitted to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions following the ordinary legislative procedure. The agreement between the co-legislators, the European Parliament and the Council of the European Union, concerning the Fit for 55 EU ETS related pieces of legislation (the Revision of the ETS Directive, Amendment of the MRV shipping Regulation, Revision of the ETS Aviation Directive) was adopted by the 18th of April 2023 European Parliament Plenary session, and on the 28th of April 2023 by the Council of the European Union.[351][352]These revisions will enter into force following the signature by the two institutions and the publication in the EU's Official Journal.

More precisely, with the recent Fit for 55 revision, the EU ETS will also include emissions arising from the maritime sector, including vessels beyond 5000

[348] Ibidem.
[349] Ibidem.
[350] Ibidem.
[351] Ibidem.
[352] Council of the EU, Fit for 55': Council adopts key pieces of legislation delivering on 2030 climate targets, Press release, , 25 April 2023, https://www.consilium.europa.eu/en/press/press-releases/2023/04/25/fit-for-55-council-adopts-key-pieces-of-legislation-delivering-on-2030-climate-targets/, last accessed 03/05/2023

tonnes from 2024; emissions deriving from aviation, not only for flights within the European Economic Area but also flights to third countries as it will incorporate the CORSIA agreement[353] (from 2027 it will include flights to third countries not applying CORSIA); emissions deriving from burning waste will be included in 2028. Additionally, the EU ETS II will add the emissions deriving from fuel distribution for road transport and buildings in 2027 (2028 if energy prices are too high).[354]

4.3 Can PCT and the EU ETS coexist?

To understand how and if PCT and the EU ETS could coexist it is first necessary to make a comparison of the sectors involved in the two systems, to do so we will first focus on the historical phase preceding the adoption of the Fit for 55 package.

Before the introduction of the Green Deal, the EU ETS did not cover emissions from agriculture, waste, "the residential sector (except for electricity), and transport (other than aviation)"; "as a result, emissions from all energy sources, other than electricity, in the residential sector [were] not covered by a cap and trade scheme." [355] This was used as an argument in favour of PCT, as this aims to reduce personal carbon emissions deriving from housing and transport sectors, not yet covered by the EU ETS system. The main issue that was addressed at the time was the compatibility of the two systems deriving from possible overlaps. An example of overlap derived from the fact that the EU ETS already included household electricity. Therefore, setting up a PCT scheme would have generated

[353] CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) is a global scheme for offsetting CO2 emissions from international aviation to stabilise them at their pre COVID levels adopted by the International Civil Aviation Organisation (ICAO) in 2018; EU member states committed to participate from its pilot phase, which began in January 2021; from 2024 CORSIA will count 119 participants. Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), ICAO Environment, https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx, last accessed 02/05/2023

[354] European Parliament, Fit for 55: Parliament adopts key laws to reach 2030 climate target, press release, op. cit.

[355] Ivi, p. 24

a double-counting and double-regulation problem.[356] If a parallel PCT scheme was implemented, end-users, who already paid for a mark-up price for carbon enshrined in the price electricity because of the EU ETS, would have had to pay an additional carbon price (double regulation), and, at the same time, two different allowances should have been sold for the same good (double counting).[357] This could have led to inconsistent carbon prices for different fuel types and consequently to inefficient abatement choices made by individuals: if electricity is double taxed (by the PCT and EU ETS), gas price will be lower because it is not included in the EU ETS but only by the PCT scheme, individuals would therefore utilise more gas.[358] Similarly, countries adopting a PCT scheme would have experienced higher emission abatement cost than countries without a PCT scheme.[359] The hypothetical overlap of the two schemes would also create two different carbon prices: one deriving from the EU ETS, and another from the PCT scheme.[360] If these two differed significantly, which is possible because the price of PCT if not managed correctly would be volatile and could rise unlimitedly, PCT would face social discontent because individuals would pay a higher price than what businesses would be paying through the EU ETS,[361] a price that would also differ among EU Member states.[362]

Thus, the coexistence of the EU ETS and a PCT scheme seemed overly complex. For this reason, some researchers suggested that the PCT scheme should substitute completely the EU ETS (the TEQs scheme), while others argued that allowances under the EU ETS should be reallocated to individuals,[363] or that the two schemes should be linked or harmonised. One option could be to link national PCT schemes to one another at the European level, this, though, would

[356] Brohé, A., op. cit., p. 473
[357] Fawcett, T., *Personal carbon trading: a policy ahead of its time?,* op. cit., p. 6871
[358] Brohé, A., op., cit., p. 473
[359] Ibidem.
[360] Ibidem.
[361] Ibidem.
[362] Woerdman, E. & Bolderdijk, J. W., op. cit., p.561
[363] Ibidem.

not eliminate the issues deriving from the fact that there would be differences in sectors covered, allowance allocation, and registration.[364] Therefore, a form of harmonisation at the EU level could be introduced. Creating a PCT scheme at the EU level could be beneficial as ideally it could overcome the problems raised above, and also, it could contribute to the image of the European Union being a "frontrunner in the battle against climate change", the policies of which, as it happened for the EU ETS in the past, could inspire other countries in the international arena.[365] Additionally, it is interesting to note that, before creating the EU ETS, the European Commission had evaluated the possibility of introducing a cap-and-trade scheme for "small mobile emitters"[366], though, it argued that monitoring emissions and enforcing compliance on them would have been complex and would have entailed high administrative costs.[367] The Commission also argued that "if the community wishes to follow a prudent step-by-step approach in the development of emission trading, it should initially confine itself to large fixed point sources of carbon dioxide, where monitoring and supervision of the system is more feasible".[368] [369] As a result, Woerdman and Bolderdijk asked in their paper if the time is right for the European Union to take the next step and extend the European cap-and-trade system to small emitters.[370] Nonetheless, this option too would generate some issues. First, creating an equal per capita scheme of carbon allowances in the EU would cause a transfer of wealth/allowances from countries with a carbon-intensive energy mix to countries with a low-carbon energy mix such as France.[371] The first would indeed have to pay for more allowances to cover the emissions deriving from their energy mix, whereas the second could sell the additional allowances deriving

[364] Ibidem.
[365]Dijkshoorn, P., *Personal Carbon Trading: The Holy Grail for Severe Emission Reductions?*, "Carbon and Cimate Law review", Vol. 13, No. 3, 2019, p. 208-216, p.213
[366] Woerdman, E. & Bolderdijk, J. W., op. cit., p.556
[367] Ibidem.
[368] Ibidem.
[369]COM. Green Paper on Greenhouse Gas Emission Trading within the European Union. Green Paper presented by the Commission (8.3.2000), COM(2000) 87 final. Brussels: European Commission, (2000)
[370] Woerdman, E. & Bolderdijk, J. W., op. cit., p.556
[371] Brohé, A., op., cit., p. 467

from their cleaner energy mix. Similarly, since income varies significantly among the 27 Member states, finding the balance between setting the right price of carbon to stimulate the desired behavioural change, while making sure it is affordable for the population of all of them (to avoid the distributional impacts which seem to already characterise PCT), could be complex.[372] Another issue raised by the idea of harmonising PCT at the EU level is the probability of it passing the decision-making process. To do so it would have to be endorsed and adopted by a majority of Members of the European Parliament, and a majority of Member states in the Council of the European Union: 15 out of 27 countries (representing at least 65% of the population of the European Union) would have to vote in favour of it. According to Woerdman and Bolderijk, this may be complicated to achieve especially in the Council.[373]

The arguments above were provided before the adoption of the Fit for 55 package and the revision of the EU ETS directive described in the previous paragraph. Therefore, we will analyse what issues could arise from the parallel existence of the updated version of the EU ETS and a PCT scheme, to verify if they are compatible and if any form of coexistence or harmonisation would be possible.

First, the revision of the EU ETS directive enlarged the scope of the policy to more sectors, including shipping, aviation including towards countries signatory of the CORSIA agreement and third countries, and most importantly including fuel distributors, building and road transport through the creation of the parallel EU ETS II. Hence, the assumption that transport and the residential sector (apart from aviation and electricity) constituted an area untouched by the EU ETS is now being challenged by the new EU ETS II. The EU ETS II will be an upstream

[372] Dijkshoorn, P., op. cit., p. 467
[373] Woerdman, E. & Bolderdijk, J. W., op. cit., p.562

system regulating fuel suppliers rather than car drivers and households:[374] the former will have to monitor and report "the quantity of fuels they place on the market for surrendering emission allowances each calendar year depending on the carbon intensity of the fuels."[375] This mechanism is thought to stimulate innovation, the decarbonisation of the fuel suppliers' products and an increase in the available revenue to finance the energy transition.[376] [377]The system puts in place a first phase of data collection where fuel distributors will need to report the quantity of fuel they have sold, whereas the official start of the cap-and-trade phase will be in 2027, or 2028 if energy prices are too high.[378] Under the EU ETS II allowances will exclusively be auctioned and the market balance will be guaranteed by a Market Stability Reserve.[379] The EU ETS II would therefore bring the emissions covered by the EU ETS system to 75%.[380] Other important features of the EU ETS II are that, first, Member states can adopt an exemption for their fuels distributors if they have already put in place a "national carbon price scheme with a price level equivalent or higher than the EU system",[381] such as Germany where an EU ETS II-like system was introduced at the national level.[382] Then, the price of carbon will be capped at 45 €/tonne until 2030, a price

[374] European Commission,Questions and Answers – Emission Trading – Putting a price on carbon, Press corner, 14 July 2021, https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3542 , last accessed 04/05/2023
[375] Ibidem.
[376] Ibidem.
[377] Dimitrisina, R., Can the proposal for the ETS 2 survive the political storm?, Friedrich Erbert Stiftung, Brussels, 01/03/2022, https://justclimate.fes.de/e/reform-ets-housing-transport-energy, last accessed 04/05/2023
[378] Ibidem.
[379]International Carbon Action Partnership, EU Emissions Trading System for buildings and road transport ("EU ETS 2"), https://icapcarbonaction.com/en/ets/eu-emissions-trading-system-buildings-and-road-transport-eu-ets-2, last accessed 09/05/2023
[380] Göss, S., Understanding the new EU ETS (Part 2): Buildings, Road Transport, Fuels. And how the revenues will be spent, 06/02/2023, energypostes.eu, https://energypost.eu/understanding-the-new-eu-ets-part-2-buildings-road-transport-fuels-and-how-the-revenues-will-be-spent/, last accessed 04/05/2023
[381] Göss, S., op. cit.
[382] Wettengel, J., Germany's carbon pricing system for transport and buildings, Clean Energy Wire, 28 October 2022, https://www.cleanenergywire.org/factsheets/germanys-planned-carbon-pricing-system-transport-and-buildings, last accessed 04/05/2023

that is deemed to be too low to have a real impact on pushing to adopt low-carbon alternatives.[383]

Two main arguments were brought forward against this new scheme. On the one hand, as a result of the way it is structured, which is arguably similar to the Cap and Share idea developed in Ireland, fuel distributors will be bearing the cost of the new EU ETS II and will consequently pass it on to consumers as a price mark-up, similar to what was predicted for the Cap and Share scheme. As a result, this would cause rising prices for road transport and heating fuels that, summed up to the energy crisis, could disproportionately impact low-income households.[384] On the other hand, the differences in energy mixes among Member states could create an imbalance in the distribution of the cost of the system.[385] As argued for a harmonised PCT expanded at the EU level, the risk is that countries using more coal and fossil-fuels in their energy mix, such as Eastern European countries, would pay more for additional allowances. This concern is confirmed by the behaviour of Hungary and Poland, who were the only two countries in the Council of the European Union to vote against the revision of the ETS directive, apart from Belgium and Bulgaria abstaining.[386] To counter these adverse social effects the Commission put forward the idea of creating a Social Climate Fund within the Fit for 55 package. This fund is aimed to provide Member states with the necessary means to financially support transport users, vulnerable households and micro-enterprises, as well as to invest in the decarbonisation of the transport and housing sectors.[387] The fund will provide €72.2 billion through the EU budget and the revenues collected through the EU ETS II between 2025 and 2032.[388]

[383] Ibidem.
[384] Ibidem.
[385] Ibidem.
[386] Council of the European Union, Agriculture and Fisheries Council Public session, press, Council live, 25 April 2023, https://video.consilium.europa.eu/event/en/26808, last accessed 04/05/2023

[387] European Commission, Questions and Answers – Emission Trading – Putting a price on carbon, Press corner, op. cit.
[388] Ibidem.

The main difference between the EU ETS II and a PCT scheme is that the former is an upstream cap-and-trade system: as explained in the first chapter of this analysis this means that the energy end-users do not manage the allowances but that they pay a higher price for carbon emissions. A PCT system instead would entail an allocation of allowances to citizens, which "while placing them under an obligation to share the responsibility of emissions reduction, would mark a major shift in the political economy of the environment".[389] Despite this difference, the sectors covered by the EU ETS II and PCT coincide, hence, it could be argued that if the two systems had to coexist, the double-counting issues raised before the introduction of the Fit for 55 package for the electricity production would also happen for the housing and transport sector. Additionally, if the political interest in PCT depends on the emission reductions needed by a certain country and the emission reductions that PCT can bring about,[390] the presence of the new EU ETS II, which should increase the emissions covered by carbon pricing in the EU to 75%, might reduce the appeal for PCT as a policy option. Despite this, since many details of the EU ETS II have yet to be finalised before it becomes operational, its effectiveness cannot be presumed yet and the possible areas of overlap with PCT should be further investigated. The table below summarises the data discussed above.

[389] Brohé, op. cit., 468
[390] Fawcett, T., *Personal carbon trading in different national contexts*, op. cit. P. 341

	EU ETS I	EU ETS II	PCT
Geographical scope:	EU	EU	National level, EU level, local level?
Sectors involved:	Electricity and heat generation; energy-intensive industry sectors (oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals); civil aviation; maritime transport	Energy from buildings road transport and fuels	Energy from households and private transport (aviation in some PCT variations)
GHG covered:	CO2, N2O, PFCs	CO2	CO2
% emissions covered:	40%	EU ETS I + EU ETS II = 75%	40-50%
Allowances surrendered by:	The sectors involved : around 10 000 installations	Fuel distributors who operate in the sectors involved	Energy end-users
Allocation of rights:	Increased auctioning over time and grandfathering	Auctioning	Grandfathering

Table 4 Main characteristics of the EU ETS I, and EU ETS II after the approval of the Fit for 55 package, compared to the characteristics of PCT schemes. Source: author's elaboration inspired by the model of Kevin Anderson, 2005.[391]

4.4 PCT at the sub-national level: the case of the city of Lathi, Finland

The sub-national level of implementation of PCT could represent a starting point for, first, testing PCT application in real life, and then transitioning or scaling it up at the national and European level: a "voluntary, community-scale initiative"[392] could be a first step for the introduction of PCT.[393] Additionally, doing so within the European Union, which can be pictured as a hub for innovative policies investing in and publicising good practices and exemplar cases among its Member states, would allow PCT projects to get the necessary media, public, and policymakers' attention to allow the emergence of positive data and experience sharing mechanisms among the 27. Another reason to start implementing a PCT scheme at the sub-national level is that the Paris Agreement

[391] Starkey, R., Anderson, K., *Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use*, TECHNICAL REPORT – PROJECT T3:22, Tyndall Centre for Climate Change Research, University of Manchester, 2005, p. 39
[392] Fawcett, T., *Personal carbon trading: A policy ahead of its time?*, op. cit. P. 6871
[393] Ibidem.

"urges cities, sub-national authorities, civil society and the private sector" to intensify their climate action.[394]

CitiCAP (Citizens' Cap and Trade Co-created) is a PCT project implemented in the city of Lathi in Finland that can be considered as one of the innovative good practices mentioned before: "Lahti has become the first city in the world to launch a personal carbon trading scheme to reduce emissions from transport."[395] This project was implemented between late 2019 and the end of 2020 in the city of Lathi, a 120 000 inhabitants city nominated as the European Green Capital for 2021.[396] The scheme was designed through the cooperation of various actors from the public sector, such as the European Union, through the European Union's Urban Innovative Actions initiative, academia, the Lappeenranta-Lahti University of Technology (LUT), the Lahti University of Applied Sciences (LUAS), Lahti Region Development LADEC, and the private sector, five tech companies that helped develop the App CitiCAP used to run the scheme, such as MOPRIM.[397] To contextualise the pilot project, the Finnish population travels on average 40km per day, the majority of people using cars (76%); in Lathi, despite 80% of people live in a pedestrian area, 60% of the residents prefer using their personal vehicle for journeys of under 5km.[398] Lathi's PCT scheme was structured as follows: the CitiCAP App was the main tool for citizens to participate in the scheme;[399] [400]the scheme only regulated the citizens' emissions

[394] Sihvonen, M., Uusitalo, V., Huttunen, A., Ronkainen, T., Kahiluoto, H., Kuokkanen, A., *A proposal for a novel urban mobility policy: Personal carbon trade experiment in Lahti city*, "Utilities Policy" 92, LUT-yliopisto, Finland, 2020, p. 1

[395] Turner, P., Expert, U., CitiCAP Zoom-in 3: An interview about Personal Carbon Trading scheme, Urban Innovative Actions 02/03/2021, https://uia-initiative.eu/en/news/citicap-zoomin-3-interview-about-personal-carbon-trading-scheme, last accessed 10/05/2023

[396] Green Lathi, The 360-degree sustainability transformation of Lahti, https://greenlahti.fi/en/story, last accessed 09/05/2023

[397] Ripa, F., Lahti launches EU-first Personal Carbon Trading (PCT) scheme for mobility, Eltis The Urban Mobility Observatory,23 Sep 2019, https://www.eltis.org/discover/news/lahti-launches-eu-first-personal-carbon-trading-pct-scheme-mobility, last accessed 09/05/2023

[398] Sihvonen, M., Uusitalo, V., Huttunen, A., Ronkainen, T., Kahiluoto, H., Kuokkanen, A., *A proposal for a novel urban mobility policy: Personal carbon trade experiment in Lahti city*, op. cit., p. 3

[399] Participation is voluntary, the authors aimed to reach 1% of the population, including additional 50-100 volunteers to form a control group.

[400] Ivi, p. 4

deriving from transport; the emission cap was set according to the city's carbon neutrality objective set to 2025 and it declined over time (the cap was initially set at -20% of the current emission line, therefore at 17kg CO_2 eq per week); the chosen allowances distribution principle, set through public engagement to increase public acceptability, was even distribution, however families could access +30% of allowances to compensate for personal issues (children, area of residency, disability affecting transport).[401]

The CitiCAP App used the acceleration sensor technologies included in smartphones, internet of things, and a newly developed AI technology to automatically detect users' chosen way of transport, the length of the journey and the duration of the journey; the participants then only had to report how many people were travelling with them by car for example to report for carpooling (considered as more ecological than the individual use of a car).[402] The allowances were automatically deducted when participants moved and the balance was calculated every week.[403] If they used more allowances than what they had, they had to purchase more credits from the market at the current market price, instead, if they used less allowances than their total amount by, for instance, choosing to cycle instead of driving, they earned virtual euros (a virtual complementary currency) according to the market carbon price, which they could use to access on the App discounts on city and consumer services and products, such as "tickets for local busses or swimming halls, bags and pedestrian reflectors."[404]

On the one hand, the App with its user-friendly interface allowed citizens to have a clear and up to date picture of their carbon footprint, their carbon allowances balance, the transport mode breakdown and the products they could access with

[401] Ibidem.
[402] Ibidem.
[403] Ibidem.
[404] Urban Innovative Actions, City of Lahti Launches a Personal Carbon Trading Scheme for Citizens, https://www.uia-initiative.eu/en/news/city-lahti-launches-personal-carbon-trading-scheme-citizens, last accessed 10/05/2023

the cumulated virtual currency.[405] On the other hand, mobility data was stored on the PCT platform built in a cloud, this is used by the city to update or develop new services, urban planning and businesses for its citizens. [406] For instance, the App allowed to detect an 80% reduction in public transport use during 2020 because of the COVID-19 pandemic.[407] As a result of this pilot scheme: 3000 citizens downloaded the App, which registered 350 active users per week, one in three users declared that they reduced their mobility emissions because of the scheme, half of participants thought it was an interesting policy, 70% of them said it made them think about the impact of their transport choices on the climate, and some said they would be interested in including more sectors in the scheme such as food.[408][409]

The interest generated on the project went beyond Lathi and Finland and makes this pilot scheme a unique learning opportunity for other communities around Europe. The interest in these schemes is even greater considering the impact cities have on the planet and the role they could play in reducing individual emissions. The increasing urbanisation concentrates more people, resources and power, therefore, it generates more emissions, at the same time, cities and urban planning determine citizens' consumption of food, production of waste, and energy use for transport and heating.[410] Hence, PCT voluntary urban schemes similar to Lathi's CitiCAP could "empower and mobilise citizens in a way that can create political pressure from the bottom up, particularly if such schemes are

[405] Sihvonen, M., Uusitalo, V., Huttunen, A., Ronkainen, T., Kahiluoto, H., Kuokkanen, A., *A proposal for a novel urban mobility policy: Personal carbon trade experiment in Lahti city*, op. cit., p. 4
[406] Urban Innovative Actions, City of Lahti Launches a Personal Carbon Trading Scheme for Citizens, op. cit.
[407] Ibidem.
[408] Turner, P., Expert, U., op. cit.
[409] Lathi, Personal carbon trading scheme made Lahti-people question their mobility choices – and reduce their emissions, 11/03/2021, https://www.lahti.fi/en/news/personal-carbon-trading-scheme-made-lahti-people-question-their-mobility-choices-and-reduce-their-emissions%E2%80%AF/, last accessed 10/05/2023
[410] Sihvonen, M., Uusitalo, V., Huttunen, A., Ronkainen, T., Kahiluoto, H., Kuokkanen, A., *A proposal for a novel urban mobility policy: Personal carbon trade experiment in Lahti city*, op. cit., p. 1

expanded cross-scale",[411] allowing to set a possible first step to introduce the needed limitation of personal consumption and reduce individual emissions.

4.5 Conclusions

The ideal level of governance for implementing PCT is one of the multiple complex questions that need to be discussed when doing research on PCT. This is mainly thought to be implemented at the national level, however, some researchers also put forward the idea of linking PCT systems at the European level or harmonising PCT at the European level. All three options present issues, such as for the case of national implementation, the phenomenon of cross-border transport emissions, and, for the harmonisation at the EU level, the risk of redistribution of wealth/allowances from Member states with a high-carbon energy mix to the ones with more renewable energy mixes. The fundamental question though, is if PCT and the EU ETS can coexist or if they should be merged. This chapter illustrated the history of the EU ETS system and compared the sectors covered by this policy and by PCT. Before the revision of the EU ETS, introduced by the Fit for 55 package, researchers argued that there was enough room in the policy arena for PCT, because the former did not cover travel and housing emissions. With the introduction of the EU ETS II system approved in 2023, the policy space might be more crowded as this scheme also involves the sectors not covered before, bringing the emission coverage of the overall EU ETS to 75% of EU emissions. Thus, there is no clear answer about if the EU ETS and parallel PCT schemes could coexist or if they should be harmonised at the European level, as the details of the EU ETS II still need to be elaborated and the system still has not been implemented. Further research should focus on this topic. Nevertheless, below the European and the national level, local administration plays an important role in introducing possible PCT voluntary schemes, which could represent a fundamental step forward for research about

[411] Ibidem.

PCT implementation, its possibilities to be scaled up, as well as a first step towards the involvement of individual responsibility in the emission reduction challenge. The example of the CitiCAP PCT pilot scheme that was set up in the city of Lathi in Finland shows that local urban voluntary PCT schemes can be implemented and that they can become a leading model for other cities in Europe and potentially the world. This experience also confirms that technological progress can play a fundamental role in the development of PCT tracing Apps, as argued by Tina Fawcett, Fuso Nerini, Yael Parag and Paul Ekins.[412]

[412] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit., p. 1028

Conclusion

Personal carbon trading is an innovative and radical policy invention developed at the end of the 1990s, which to this day still has not been implemented. This thesis analysed PCT trying to answer two questions:

- Is PCT the "right policy" that can stimulate the paramount change in our lifestyles and behaviour?
- Could PCT be implemented in the European Union and coexist with the European Emission Trading System (EU ETS)?

Through an analysis of the history of the policy, its brief political career in the UK, the theoretical and empirical studies on its behavioural effectiveness, as well as the main issues regarding its implementation, we tried to answer the first question. The theoretical arguments provided by the creators of the policy, the idea that PCT could drive a behavioural change because of three mechanisms (economic, social, psychological), are supported by the results of an empirical test, the Norfolk Island trial, and two natural experiments, the COVID-19 pandemic and the energy crisis of 2020 and 2022. These cases show that PCT can drive behavioural change and that people can accept to limit their freedom (limiting their mobility and consumption choices) to respond to challenges for the collective well-being.

Despite these encouraging results, PCT still has to be developed into a complete policy option and some issues need to be confronted; one of the main issues is the distributional effects caused by the policy. PCT is promoted by its supporters as a powerful idea, respecting the principle of fairness to stimulate behavioural change and limit personal carbon emissions. Indeed, the trading mechanism allows the redistribution of emission allowances and wealth from wealthy and more energy-consuming households to energy sober households, who tend to be lower-income households. However, it also seems to negatively affect some low-income households living in rural areas in houses bigger-than-average with less access to low-carbon transport options. This issue is paramount to drive an ecological transition which is just, and should be addressed by for instance developing forms of support and compensation to protect these households and help them transition to a low-carbon lifestyle, to increase the social acceptability of the policy.[413]

Additionally, PCT cannot be "the right policy" as it was not conceived to be implemented on its own. PCT is rather an enabling policy existing in a regulatory environment where other policies aim to reduce personal emissions, such as bonuses for households for installing solar panels or heat pumps. In this regulatory environment PCT is deemed to increase the use of low carbon options. This policy landscape must offer individuals the choice to reduce their emissions for PCT to be successful and allow individual lifestyle change. Indeed, if PCT places responsibility on individuals, this should not be interpreted as a way of shifting responsibility away from the public and private sector. These indeed, play the fundamental role of designing the policies, providing services, and influencing consumption choices, such as transport and housing, that are determinants of individual lifestyles. For example, if more cycle paths are not built, citizens will not feel safe enough to choose their bicycle instead of their car

[413] Fawcett, T., Parag, Y., Fuso Nerini, F., Ekins, P., *Personal carbon allowances revisited*, op. cit. P. 1029

to bring their children to school or to commute to work, if houses are not renovated to increase their energy efficiency, their energy consumption will be higher, if massive investments are still injected in the fossil fuels sector, consumers will still be dependent on gas for their household heating. However, this is not citizens' responsibility. Thus, PCT can be considered as a possible good option to incentivise the necessary behavioural shift and limit personal carbon emissions when compared for example to a carbon tax, but for it to be successful it needs to be accompanied by a systemic change that goes beyond the individual.

There are various levels of governance at which PCT could be implemented: sub-national, national, and European. The national and European level of implementation is what has been investigated the most and the levels that cause the most issues. On the one hand, the national level of implementation would lead to the coexistence of PCT and the EU ETS, which could cause possible overlaps, especially with the new EU ETS II introducing an upstream ETS for fuel distributors, private transport and buildings. On the other hand, the harmonisation at the EU level of a PCT scheme or the idea of taking the EU ETS to the next step by also including small-emitters is an interesting idea that would need to be further analysed considering the possible distributional effects it could generate among Member states.

This analysis leads to two directions that research on PCT should take. First, more data on personal carbon emissions deriving from people's lifestyles is needed. Building large datasets collecting this sort of data will be fundamental to better understanding the impact that PCT could have, the variations in carbon footprints among individuals, and designing updated pre-feasibility studies. Technological progress is an advantage that certainly plays a central role in this data collection phase. Then, the second direction is setting up more trials or urban voluntary PCT schemes. These, as shown by the case of the city of Lathi, can be insightful experiences that can test the idea of PCT and issues such as

social acceptability and distributional effects, while presenting personal carbon trading to citizens and collecting more data on personal carbon emissions.

In conclusion, as observed by Tina Fawcett during our interview, PCT is a powerful idea that still attracts attention and which, whether it will be implemented or will remain just an idea, brings about a constructive discussion on what is the role of individuals and what they can do for the emission reduction challenge. As argued by Anna Kuokkanen et al.:

"So far, the topic of setting a boundary or limiting consumption has been a proverbial elephant in the room in most developed countries. Until this topic is fully explored in broader society and policy, climate change will persist."[414]

[414] Sihvonen, M., Uusitalo, V., Huttunen, A., Ronkainen, T., Kahiluoto, H., Kuokkanen, A., *A proposal for a novel urban mobility policy: Personal carbon trade experiment in Lahti city*, op. cit. 4

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Appendix I

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Scheme	**Summary**
Tradable Energy Quotas (TEQs)	Previously known as 'DTQs' (domestic tradable quotas). TEQs is one of the more detailed and developed proposals. It was proposed and developed in the UK for the UK economy. It aims to tackle climate change and peak oil. The scope of scheme covers the whole economy. How it works: a TEQ budget sets a limit on annual carbon emissions over the next 20 years, which then rolls forward week by week. 40% of the allowances are distributed free to individuals on an equal per capita basis. Personal emissions allocations cover household energy use and personal travel, but not air travel. The remaining 60% are sold by tender to all other energy users. All fuels have a carbon rating and purchasers must surrender carbon units to cover related emissions. Transactions are carried out electronically and all carbon units are tradable. TEQs scheme has been examined by the UK government in a 'pre-feasibility' study.
Cap and Share (C&S)	C&S is one of the more detailed and developed proposals. It was proposed and developed in Ireland for the Irish economy. The scope of the scheme covers the whole economy. How it works: an independent committee sets a national carbon cap. All adults periodically receive certificates entitling them to an equal share of national emissions. Certificates are sold by individuals via banks or post offices to companies that import or extract fossil fuels. These suppliers require surrendering certificates equal to emissions from the use of the fossil fuels that they introduce into the economy. The price of emissions flows through the economy. C&S has been examined by the Irish government.

Tradable consumption quotas	The details of this scheme are not particularly well developed. The scope of the scheme covers the whole economy. How it works: a national cap is set on carbon emissions. All national emissions are allocated for free to individuals on equal per capita basis. All products would be carbon labelled. Quotas are surrendered by individuals to cover the emissions related to the non-manufacturing-related carbon content of purchased goods and their own direct use of energy. Manufacturing organizations buy emissions quotas from individuals in a carbon market to cover their carbon emissions related to the process of manufacturing.
Personal carbon allowances (PCA)	PCA was proposed and developed in the UK. It is one of the more detailed and developed proposals. The scope of the scheme covers household energy and personal travel. How it works: a national cap is set for emissions from household energy use, including air travel. Allowances and personal are allocated periodically on an equal per capita basis to individuals for free to cover these emissions. For every transport purchase of electricity, gas, transport fuels and services, allowances are surrendered. Transactions (PCA) are carried out electronically and allowances are tradable in the personal carbon market.PCA has been examined by the UK government in a 'pre-feasibility' study.
Household carbon trading	Household carbon trading was proposed in California and examined against its emission targets. The details of this scheme are not particularly well developed. The scope of the scheme covers household energy. How it works: a yearly carbon emissions cap is set for residential energy use based on emissions reduction targets. Allowances are allocated to each household on an equal per household allocation basis via utility service providers who place the allowances in each user's account. These are deducted periodically by the utility according to energy use, and additional allowances must be purchased if the account is in deficit. The carbon allowances are fully tradable. At the end of a compliance period, the state collects the permits from the utilities and determines compliance with the cap.

Tradable transport carbon permits	Tradable transport carbon permits were originally suggested in France and the scheme was examined for emissions generated by French private transport. It has also been applied to the UK.38The scope of the scheme covers private road transport. How it works: a cap is set for emissions from private transport. Allowances are allocated to all individuals for free (not necessarily on an equal basis). For every purchase of fuel, allowances are transferred to the regulating authority to cover the CO_2 equivalent of a liter of fuel and cancelled. Transactions and trading are carried out electronically. Participants buy and sell permits through intermediates like banks or buy them at the petrol pump.