

Supplementary Materials Part S1

FACTOR QUESTIONS

POLITICAL CRITERIA

- i) How does it fit with existing policy?
- ii) Feasibility of implementation
- iii) Burden on government – would it require new governing bodies established
- iv) Popularity with public – would political parties be hesitant to enact policy due to implications for electability
- v) Would it require government funding?

ECONOMIC CRITERIA

- i) Is the model regressive or progressive (if applicable)?
- ii) Would it incur costs on industry or public?
- iii) Would it impact natural capital?
- iv) Would it impact growth/ GDP?
- v) Would it generate jobs?

SOCIAL CRITERIA

- i) Social justice implications
- ii) Potential changes to lifestyle

TECHNOLOGICAL CRITERIA

- i) Would new technology/ software need to be developed to facilitate this policy?
- ii) Would this policy encourage the development of 'green' technology?
- iii) Would this policy hinder technological development?

LEGAL CRITERIA

- i) How would this policy be enforced?
- ii) Mandatory or voluntary
- iii) Potential penalties
- iv) Implications for changes to law

ENVIRONMENTAL CRITERIA

- I) Emissions cap or no cap?
- II) Carbon footprinting requirement/ scope
- III) Would this policy encourage environmental awareness?

Table S1. PESTLE analysis of a PCT model according to criteria defined in Supplementary Materials

Political	<ul style="list-style-type: none"> - Could fit in with existing ETS schemes - Would require significant money and manpower to implement - Would require governing body to oversee - May be unpopular due to limitations on public - Funded by government, projected to potentially cost between £700 million - £2 billion to set up (according to 2008 projection) and require running costs from government (Lane et al., 2008)
Economic	<ul style="list-style-type: none"> - Incurs costs on businesses etc to have carbon footprints for goods/ services conducted and maintained - Job generation – within government body and carbon footprinting organisations - Limits amount of goods and services public will purchase due to limits on carbon they can ‘spend’ - Progressive policy - [1]
Social	<ul style="list-style-type: none"> - Trading allows wealthy individuals to pay to keep their current lifestyle, poorer individuals may feel pressure to sell credits to gain additional income - Trading would allow for flexibility of lifestyle - Educates the public on their carbon spending and carbon cost of lifestyle - Individuals may try to ‘cheat’ the system to gain more credits/ incentives [2]
Technological	<ul style="list-style-type: none"> - Could require adaptation of existing banking systems or require new systems to be created to track carbon credits [3] - Would need the creation of online credit marketplace or brokers - Carbon credit cards would require contactless machines to spend credits - Items may need barcodes or tags that have carbon credit cost - May encourage development of ‘greener’ technology - Unlikely to hinder technological development
Legal	<ul style="list-style-type: none"> - Mandatory - New regulations on carbon emitting and carbon spending - Regulation and definition of carbon footprint must be set and adhered to for parity across all goods and services - Some form of penalty for non-compliance
Environmental	<ul style="list-style-type: none"> - Hard cap on emissions possible so emission reduction can be controlled - Requires carbon footprinting (or similar) for goods and services, method of CF will impact reductions - Scope of included goods and services flexible – some models only include household heating/ energy and transport [4] - Trading would allow all yearly surplus to be used – therefore cap would always be met rather than aiming to not meet the cap

Table S2 PESTLE analysis of PCA model according to criteria defined in Supplementary Materials Part S1

Political	<ul style="list-style-type: none"> - Could fit in with existing ETS schemes - Government funded - Would require governing body to oversee - May be unpopular due to limitations on public – even more limitations than PCT - Funded by government, projected to potentially cost similar to predicted PCT models between £700 million - £2 billion to set up (according to 2008 projection) and require running costs from government
Economic	<ul style="list-style-type: none"> - Incurs costs on businesses etc to have carbon footprints for goods/ services conducted and maintained - Job generation – within governmental body and carbon footprinting organisations - Limits amount of goods and services public will purchase due to limits on carbon they can ‘spend’ - Limits amount of goods and services public will purchase due to limits on carbon they can ‘spend’ this could have some impact on GDP
Social	<ul style="list-style-type: none"> - Public’s activity heavily limited by carbon budget, cannot buy credits to continue existing lifestyle if carbon intensive. - People with higher income cannot buy further credits to maintain current lifestyle - No trading means lower income/ vulnerable peoples cannot be exploited by those with greater wealth to gain carbon credits. - Progressive policy - [1]
Technological	<ul style="list-style-type: none"> - Could require adaptation of existing banking systems or require new systems to be created to track carbon credits [3] - Carbon credit cards would require contactless machines to spend credits - Items may need barcodes or tags that have carbon credit cost - May encourage development of ‘greener’ technology - Unlikely to hinder technological development
Legal	<ul style="list-style-type: none"> - Mandatory - New regulations on carbon emitting and carbon spending - Regulation and definition of carbon footprint must be set and adhered to for parity across all goods and services - Some form of penalty for non-compliance

Environmental

- Hard cap on emissions possible so emission reduction can be controlled
 - Requires carbon footprinting (or similar) for goods and services, method of CF will impact reductions
 - Scope of included goods and services flexible – some models only include household heating/ energy and transport [4]
 - Surplus not used each year – could roll over but more likely any surplus would be unused and therefore possibility emissions could stay below cap
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Table S3 PESTLE analysis of carbon labelling model according to criteria defined in Supplementary Materials Part S1

Political	<ul style="list-style-type: none"> - Does not require a new government body in order to regulate it - Burden to carbon footprint can be on producers rather than government - 'Nudge' rather than policy
Economic	<ul style="list-style-type: none"> - Low cost to government - Incurs costs on businesses etc to have carbon footprints for goods/ services conducted and maintained - Job generation –within carbon footprinting organisations
Social	<ul style="list-style-type: none"> - Reliant on public changing own behaviour due to raised awareness - Nudge principles - Allows people to make their own choices - Raises awareness of carbon emission costs of products and services
Technological	<ul style="list-style-type: none"> - Carbon labelling would not require additional technology in terms of additional barcodes/ accounts for goods and services - Unlikely to hinder technological development
Legal	<ul style="list-style-type: none"> - Voluntary for the public not for businesses – still enforcement needed - Regulation and definition of carbon footprint must be set and adhered to for parity across all goods and services
Environmental	<ul style="list-style-type: none"> - Does not have hard cap, only can encourage public to be more environmentally aware rather than clear cuts in emissions - Minimal changes in behaviour so likely minimal changes in emissions [5] - Requires carbon footprinting (or similar) for goods and services, method of CF will impact reductions

Table S4 PESTLE analysis of carbon tax model according to criteria defined in Supplementary

Political	<ul style="list-style-type: none"> - Fits in with existing policies – due to being tax - Technically easy to implement - Has direct impact on public which may be unpopular - Would not require a specific new governing body to oversee it - Would generate revenue may be some implementation and monitoring costs
Economic	<ul style="list-style-type: none"> - Regressive tax – lower income households would spend proportionally more of their income on tax than higher income households [6] - Costs on industry and public - Unlikely to significantly impact growth as no cap - Unlikely to generate jobs
Social	<ul style="list-style-type: none"> - Consumers would likely carry on ‘as usual’ and absorb the cost to an extent as they have with heavily taxed products like alcohol [7] - May widen social income divide due to nature of regressive taxes - Often an upstream tax so public would have little awareness of carbon weight per good or service
Technological	<ul style="list-style-type: none"> - Does not require massive technological changes to current systems or ways of life - May encourage businesses to use more efficient technology that does not incur carbon taxation - May inspire technological development of less polluting technology
Legal	<ul style="list-style-type: none"> - Mandatory - Could incur legal penalties if avoided - Could be vulnerable to fraud and therefore legal pursuit - Change in taxation policy
Environmental	<ul style="list-style-type: none"> - Could encourage reduction of carbon emissions - No hard cap on emissions so level of emissions reduced cannot be controlled - Often upstream so would be applied on fuels for goods and services - May not raise environmental awareness – people may just carry on as usual

Supplementary Materials References

- [1] Al-Guthmy FMO, Yan W. Mind the gap: personal carbon trading for road transport in Kenya. *Climate Policy* 2020;20:1141–60.
- [2] Uusitalo V, Huttunen A. *Motivating Citizens To Reduce Their Mobility Emissions Through Personal Carbon Trading*. Lahti: 2021.
- [3] Lane C, Harris R, Roberts S. An analysis of the technical feasibility and potential cost of a personal carbon trading scheme. Department for Environment, Food and Rural Affairs. Department for Environment, Food and Rural Affairs 2008:47.
- [4] Fleming D, Chamberlin S. *TEQs Tradable Energy Quotas A Policy Framework for Peak Oil and Climate Change*. London: 2011.
- [5] Vanclay JK, Shortiss J, Aulsebrook S, Gillespie AM, Howell BC, Johanni R, et al. Customer Response to Carbon Labelling of Groceries. *Journal of Consumer Policy* 2011;34:153–60.
- [6] Elkins P, Baker T. Carbon Taxes and Carbon Emissions Trading. *Journal of Economic Surveys* 2002;15:325–76.
- [7] Sumner J, Bird L, Dobos H. Carbon taxes: A review of experience and policy design considerations. *Climate Policy* 2011;11:922–43.