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All Party Parliamentary Group on Peak Oil
& The Lean Economy Connection

TEQs

Tradable Energy Quotas

A Policy Framework for Peak Oil and Climate Change

David Fleming and Shaun Chamberlin

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TEQs (Tradable Energy Quotas): A Policy Framework for Peak Oil and Climate Change

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The All Party Parliamentary Group on Peak Oil was set up in July 2007 to review estimates of future oil production and consider the consequences of declining world oil production for the UK and world economy.

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The Lean Economy Connection

The Lean Economy Connection is an independent research centre founded by Dr David Fleming in 1994 to develop the application of lean thinking to environment policy. Dr Fleming first described the model of TEQs (Tradable Energy Quotas) in 1996. His guide to TEQs, *Energy and the Common Purpose*, was first published in 2005 (third edition, 2007). His book, *Lean Logic*, is forthcoming in 2011.

Shaun Chamberlin joined The Lean Economy Connection as TEQs Development Director in 2006. His book, *The Transition Timeline*, was published in March 2009 (Green Books). His wider work is detailed at: www.darkoptimism.org

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Foreword

Since the first APPGOPO report was published in July 2008, the number and urgency of warnings about oil depletion has grown. In its eye-opening 2008 *World Energy Outlook*, the International Energy Agency (IEA) forecast that 64 million barrels a day of extra oil production will need to come on stream by 2030 if projected demand is to be met. That means that by 2030 we will need to be producing the equivalent of six new Saudi Arabias on top of existing production. This is almost certainly impossible.

The IEA effectively recognised this when it stated in the report that 'current global trends in energy supply and consumption are patently unsustainable – environmentally, economically and socially'.

While the UK Government failed to take the initiative on peak oil, in October 2008 a group of major companies in the UK including Virgin and Scottish and Southern Energy expressed their concern that peak oil is imminent and that post-peak production decline rates could cause serious energy supply problems for Britain. In their report 'The Oil Crunch', the Industry Taskforce on Peak Oil and Energy Security concluded that it is very unlikely that global oil production will be able to continue to grow beyond 2013.

A year later, the UK Energy Research Centre concluded that more than two thirds of current global crude oil production capacity may need to be replaced by 2030 and the energy regulator OFGEM warned of the prospect of shortages and breaks in the supply of gas and electricity before 2020. In February 2010 the Industry Taskforce's second report announced that 'we must plan for a world in which oil prices are likely to be higher and more volatile and where price shocks have the potential to destabilise economic, political and social activity... Our message to government and businesses is clear. 'Act now'.'

And in June 2010 Lloyds of London and Chatham House produced their 'Sustainable Energy Security' report, warning that businesses which fail to prepare could face 'catastrophic consequences'.

I share the concern of these groups, and have raised the issue with the government many times. Regrettably, the government is still unable to grasp how serious the threat of peak oil is, and so the UK remains inadequately prepared to cope with this looming crisis.

We urgently need to have a system in place to mitigate the economic and social consequences of peak oil. I believe TEQs provide the fairest and most productive way to deal with the oil crisis and to simultaneously guarantee reductions in fossil fuel use to meet climate change targets. The challenge is urgent and TEQs are among the best tools we have at our disposal to meet it.

John Hemming MP
Chairman of the All Party Parliamentary Group on Peak Oil (APPGOPO)

Executive Summary

TEQs (Tradable Energy Quotas) were designed from the outset as a response to the two sides of the energy problem: climate change and the depletion of fossil fuels.

Any framework designed to address either side of the problem must deliver in two ways. It must achieve a steep, but managed reduction in the use of fossil fuels. And it must forestall fuel poverty by guaranteeing fair entitlements to the energy that is available at the time. TEQs is designed for both these tasks.

No need to measure emissions

The design of TEQs is based on the insight that all emissions from energy-use within a national economy can be measured simply and efficiently by assigning a rating to fuels and electricity, based on the quantity of carbon dioxide and other greenhouse gases generated by their production and use. The emissions attributable to them thus become implicit in the quantities listed as usual on invoices, utility bills and till receipts. The TEQs system simply uses this information, making it unnecessary to measure carbon emissions directly.

Effective motivation

It is usually taken to be self-evident in the field of energy/climate policy that the key to persuading energy users to take action to reduce their dependency on fossil fuels is to offer a set of financial rewards and penalties. But outside this field, that simple carrot-and-stick assumption is now recognised to be flawed.

What motivates people to carry out a difficult task – one requiring thought and inventiveness – is, above all, confidence that the task is an interesting and worthwhile one. There must be a sense that it is in their own direct interests to participate, a belief that they can rely on the

cooperation of others, and an assurance that those managing the scheme are accountable to the participants, and are themselves required to participate.

The TEQs model fulfils these criteria. It provides a framework in which it is clearly in energy users' own interest to invent and develop ways of reducing their consumption of fossil fuels in line with the agreed national Budget.

The Government study

In 2008, prompted by the work of other research centres, the UK Government undertook a pre-feasibility study into TEQs, but this considered only emissions reductions, and not TEQs' role as a system guaranteeing energy entitlements. It also limited its economic appraisal to a vaguely-defined scheme for individuals only; and it did not provide the detailed systems-audit of TEQs which could be the basis of a decision on whether to take the scheme forward to implementation.

Common Purpose

Nations around the world are experiencing deepening energy scarcity. There is no doubt that the needed steep reduction in reliance on fossil fuels will not be achieved unless there is a sense of common purpose within nations, with citizens and communities fully involved and strongly motivated to invent their own solutions. We need a revolution in the way we use energy. TEQs provide the culture and framework for the common purpose and inspiration which could draw us together to that end.

Introduction

This report was commissioned by the All Party Parliamentary Group on Peak Oil, which invited The Lean Economy Connection to write a review of TEQs (Tradable Energy Quotas), giving particular attention to two questions:

1. What contribution could TEQs make to ensuring fair access to energy at a time of shortages of oil and gas?

2. How would TEQs work alongside models of carbon reduction at the international level?

The report summarises the key features of TEQs. It shows that they are a flexible instrument, suited to the task of *both* phasing-down carbon emissions *and* guaranteeing access to fuel as scarcities develop. And it shows that national and international instruments are complementary, provided there are clearly-defined boundaries between them. While national schemes can deliver deep reductions in energy use and carbon emissions inside national boundaries, international agreements commit governments to well-defined reduction targets in concert with all other participating nations. The existence of effective national schemes makes it possible for governments negotiating on the international stage to commit their nations to reduction targets on the ambitious scale that is needed.

The structure of the report is as follows:

Part 1: A Plan for All Seasons

1. *TEQs: Guaranteeing Emissions Reductions*
The defining features of TEQs are summarised. The Rating System gives all fuels and electricity a rating defined in terms of the carbon dioxide they will produce. The Entitlement guarantees individuals' access to fossil fuels, measured in carbon units. The Carbon Budget sets the rate of reduction in carbon emissions and in the use of fossil fuels. A market enables carbon units to be bought and sold within the limits set by the Budget.

2. *TEQs: Assuring an Entitlement to Energy*
If fuel scarcity, rather than emissions reduction, is the tighter constraint on the economy, a rationing system will be required to sustain a fair entitlement of the available fuels. Without this, fuel poverty would quickly turn into actual fuel deprivation. This use of TEQs as a rationing instrument requires only a switchover to new settings in the software which governs the system.

3. *Motivation: Climate Policy's Missing Link*
This chapter argues that a steep reduction in the demand for energy will require an effective and proven motivation structure. It must be built around (1) an intrinsic incentive – as distinct from an extrinsic regime of financial rewards and punishments; (2) "pull" – the principle by which participants respond to local conditions rather than merely complying with instructions from the authorities; (3) a framework for the full participation of all energy users; and (4) a setting for cooperation between all actors in the common task of achieving the energy descent.

4. *How do TEQs fit with the EU ETS?*

The scale on which an effective TEQs scheme would operate is examined. The two formats in current debate are (1) the Layered Format, calling for the creation of two (or more) schemes within a single economy, one for individuals and at least one other for all other users (e.g. the EU ETS); and (2) the Integrated Format, bringing all energy-users in a national economy within a single frame of reference (TEQs). This chapter examines both options and concludes that only the Integrated Format would be capable of the dual purpose of ensuring fair entitlements of fuel and reducing emissions.

Part 2: The Science and Policy Context

5. *The Two Sides of the Energy Problem*

This chapter summarises the latest evidence on peak oil and climate change, and argues that when the interactions between them are properly understood and combined with our UK energy outlook, our only realistic option is a steep reduction, leading to a phase-out, in the demand for fossil fuels.

6. *Policy Update*

Although the model of TEQs was first described in 1996, and first presented at the House of Commons in the following year, the rate of diffusion into political thinking has been slow. This chapter outlines the sequence of events, and analyses the Government's research into the scheme in the light of the work of other research centres, concluding that the Government's own criteria for a full feasibility study have now clearly been met.

Conclusions

The report concludes that we require a policy framework that guarantees emissions reductions while sustaining fair entitlements to fuel in conditions of scarcity. To do this, it must engage with and motivate the whole of society in the task of phasing-out our dependence on fossil fuels. TEQs is the only instrument available to achieve this ambitious, but essential, aim.

Part 1

A Plan for All Seasons

1. TEQs: Guaranteeing Emissions Reductions

Climate policy is not, at present, reducing carbon emissions on a scale which has any relevance to the real task of maintaining a stable climate. There are many reasons for this. One is that policy is conceived as a top-down process, allowing little or no participation by energy users outside the small circle of professional debate and expertise. The citizen is on the receiving end of instructions about energy use, but has no active part to play in thinking about it. He or she is not invited to develop means of achieving the deep reductions that are required, radically changing lifestyles and fossil fuel dependency, and working with local communities in achieving this.

One reason for this lack of engagement is that there is no framework in place for it. This report describes such a framework. TEQs (Tradable Energy Quotas) is an electronic system which guarantees reductions in a nation's use of fossil fuels, and involves energy users and communities in the task of working out how to achieve this in the light of local conditions and opportunities. At the same time it ensures that, as the use of fossil fuels is reduced – either by design or by shortfalls in supply – there is a system in place to assure fair access for every energy user.

If citizens were (a) invited to participate in working out for themselves how to live within a steeply-declining carbon budget, and (b) given a guarantee of fair and equal access to scarce energy, climate and fuel policy alike would move into the real world where deep reductions in fossil-fuel dependency would become realistic.

Figure 1: The Budget - A 20-Year Planning Horizon

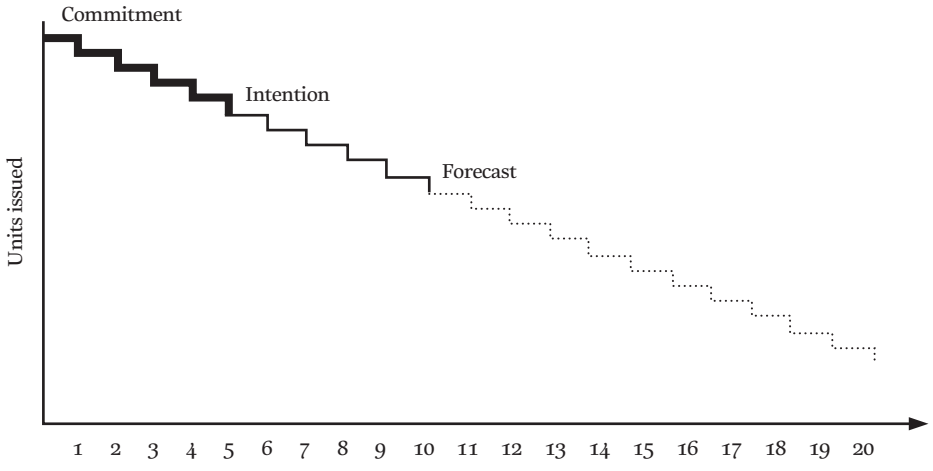
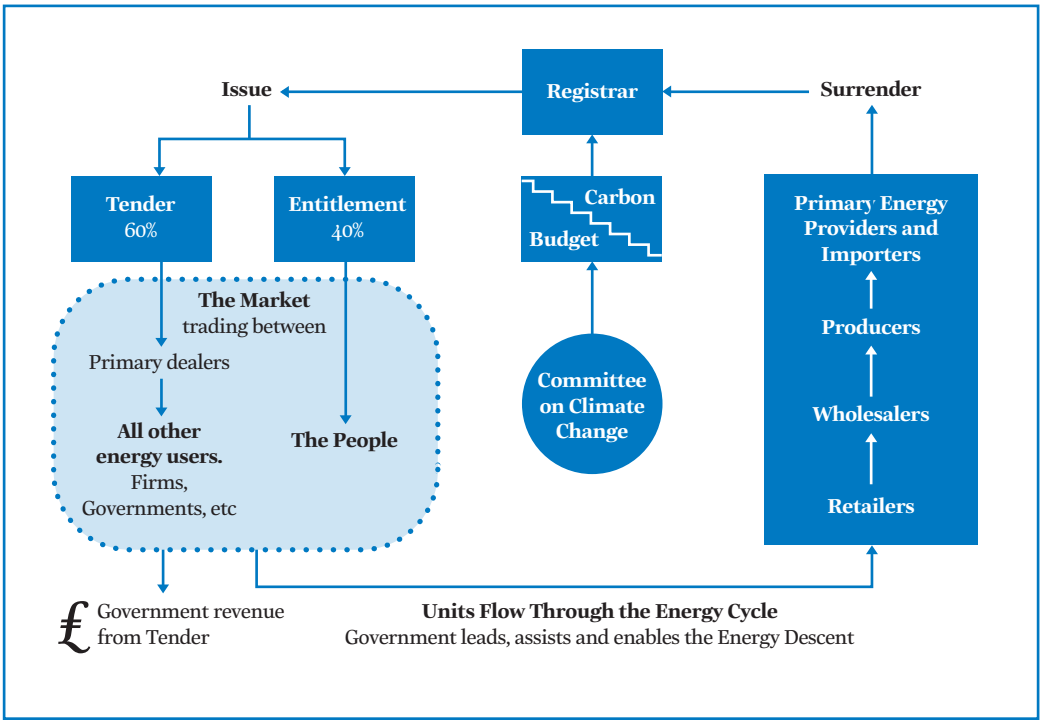


Figure 2: The Market for Tradable Energy Quotas



How TEQs Work

At the heart of the TEQs model is the national Carbon Budget (set, in the UK, by the Committee on Climate Change). The Budget states the volume of carbon emissions that will be permitted each year. The TEQs system then shares out this quantity, by the **Issue** of units to individuals and into the market. On the first day of the scheme, one year's supply is issued; it is then topped-up each week, so that there is always a rolling year's supply of units in participants' accounts. Accounts are maintained by the Registrar.

Part of the Issue is an unconditional and equal **Entitlement** to all adults, issued directly into their TEQs accounts (around 40% of the units are issued in this way, in line with the proportion of UK emissions that come from individuals and households). The remainder is sold by **Tender**, as part of the weekly auction that already takes place for the sale of Treasury Bills and Government debt. Banks and brokers obtain a supply of units on instructions from their clients, and distribute them to all non-household energy-users in the economy – to industry and services of all kinds, and to the Government itself. The Tender provides revenue, which the Government uses to facilitate, in every way it can, the process of reducing dependence on fossil fuels.

When fuel or electrical energy is purchased, buyers pay for it as usual using money, but must also surrender units corresponding to the carbon content of their purchase. Individuals who use less than their Entitlement of units can sell the surplus; those who need more can buy them on the market. The units are electronic.

The number of occasions on which individuals actually purchase energy is

quite limited – perhaps eight times a year for utilities, although it could rise to some thirty times a year for individuals with cars – and most TEQs transactions are done by card and direct debit. Moreover, on each of these occasions, the surrender of TEQs units takes place along with the money payment, as part of the same transaction. This is a system with low levels of noise and administration, leaving people to concentrate on the challenge of living within the steep descent in the availability of fossil fuels.

The **Rating System** evaluates fuels and electricity in terms of the carbon they contain and release. One TEQs unit is equivalent to one "carbon unit" – corresponding to the quantity of fuel or electrical energy that produces one kilogram of carbon dioxide over its lifecycle (not only from its final combustion, but also from the combustion of the other fuels used in bringing that fuel to market). The system ensures that all electricity and fuel carries a carbon rating, e.g. 0.2 units per kWh, or 2.3 units per litre.

The TEQs units received by the energy retailer for the sale of fuel or electricity are then surrendered when the retailer buys energy from the wholesaler who, in turn, surrenders them to the primary provider. Finally, the primary provider surrenders units back to the Registrar when it pumps, mines or imports the fuel. This closes the loop (see Figure 2, The Market for Tradable Energy Quotas). The flow of units round the loop is routinely accounted-for in companies' existing stock-control systems, so the system is self-monitoring, requiring no routine public sector intervention.

The fact that the carbon content is known when energy or fuel is sold avoids the need for direct measurement of emissions from exhaust pipes or houses. It also means that the carbon labelling of individual products within the economy becomes unnecessary.

Key Benefits of TEQs

1. *Guaranteed emissions reductions.*
TEQs are a guarantee that the trajectory of reductions set by the Budget will actually be achieved. The quantity of fuel is determined by the Budget; the price adjusts around it. Price in the TEQs model is the free variable, the expansion joint which adjusts to circumstances; it is the degree of freedom which enables the market to keep the Budget's promises.

It is in the interests of the market as a whole that the price of TEQs units should be low – as low as possible. What is more, price takes the temperature of the scheme: the lower it is, the more successfully are energy users adjusting to the tough demands of the energy descent. As the scheme advances, with next year's average energy consumption below this year's average, the difficulty of coping without having to buy additional units in the market will increase, so the desire for unit prices to be low will become ever stronger.

TEQs are a guarantee that the reduction set by the Carbon Budget will actually be achieved.

Success in keeping unit prices low will depend on the extent to which energy-users are able to reduce their energy demand. The features detailed below are designed to facilitate this, and thereby mitigate the price pressures imposed on us by energy depletion. So long as the scheme is in operation, the guarantee holds: carbon emissions / fuel usage will descend at the rate determined by the Budget.

2. *Equity.*
Although the per capita entitlement is equal, that does not necessarily make it adequate for the individual's needs, but it brings into each individual's own life a direct encounter with the reality of diminishing access to energy. Where there are households and individuals whose energy needs are very high (because, for instance, their house is poorly insulated or because they have to drive a long way to work), the equal entitlement draws focus to the problem and provides a powerful incentive to deal with it. The TEQs entitlement engages with the inherently unjust consequences of climate change and fuel depletion, prompting urgent action where it is most intensely needed, in advance of the undiscriminating reductions in energy rations which will soon be imposed by nature.

3. *Time to plan ahead.*
The guaranteed TEQs Budget gives a clear long-term warning of the scale of reduction in energy use which has to be achieved over a rolling 20-year time horizon: the trajectory of energy descent set by the Budget is held constant; that constancy is made possible because prices can adjust round it.

The long-term perspective is essential. Decisions will have to be made now, and action taken now, which will take twenty years or more to get the intended results. The long-term view must be present as a defining property of any scheme designed to reduce – and, ultimately, to end – our dependency on fossil fuels.

4. *Leaves the money with the consumer.*
The cost of achieving the energy descent will be high, requiring profound changes in lives and expectations, in the use of land and technology, and in the pattern of industry and transport. Moreover, the economy may be in deep recession due to the combined effects of peak oil and climate change. Individuals and households will therefore need as much money as they can get in order to pay for the transformation. The free distribution of TEQs units to individuals ensures that the money stays where it is most needed. The revenue received by the Government from the Tender will also be used to create a fund to support the communication and training, expert guidance and capital costs required by a decisive and steep energy descent.

If the energy descent were seen by consumers as, in essence, a money problem, it would be just one more charge on the household budget.

Consumers' budgeting is also assisted by the price-balancing effect of TEQs. TEQs will tend to stabilise the price of energy in two ways. First, they prevent fuel (e.g. oil) being, in effect, distributed on the basis of an auction, with access being limited to the highest bidders (or the fastest movers). Secondly, the price of energy and the price of units will tend to move in opposite directions. If, or when, world oil prices reach very high levels, this will reduce the demand for oil, therefore reducing the demand for units and thus their price, so that the net price paid by consumers (oil+units) is more stable than the price of either oil or units alone.

5. *Government there to help.*
The Government's role is to enable everyone (including the Government itself, because it too is bound by the scheme) to achieve the reduction set by the Carbon Budget. It is a priority of Government policy to do everything in its

power to enable the economy to achieve the energy descent with the least possible disruption. It will do so on the basis of call-and-response, providing services such as training, infrastructures, loans, and changes or relaxations in regulation which open the way to comprehensive transformation in the energy and material structures of the economy.

The Government, in a TEQs scheme, is in the same boat as everyone else. It is integral to the success of the scheme. It is not spending its time issuing instructions and regulations; it is working out how to cope intelligently with the transformation that is facing us all.

6. *Specified in terms of energy.*
The problem is an energy problem, and it will call for imaginative and highly-motivated energy solutions. If the energy descent were seen by consumers as, in essence, a money problem, it would be just one more charge on the household budget. Although the most successful energy-savers will be able to sell excess units, financial incentives are peripheral to the scheme, and TEQs avoid the demotivating effect of a system based on extrinsic rewards (see Chapter 3).

7. *Ownership.*
The scheme belongs to the people who use it – that is, to all energy-users. The price of units is a signal of the progress being made by energy-users in reducing their reliance on fossil-fuels as required by the Carbon Budget.

8. *An assured entitlement.*
At times of scarcity, consumers will need to be sure that they can obtain their entitlement of fuel and energy. Without such an entitlement, or ration, those who are unsuccessful in bidding for the energy they need, or who are not quick enough to get hold of whatever fuel is available, will be left with none. This absolute requirement for a ration/entitlement applies whether the aim is to reduce carbon emissions, or to cope with fuel shortages, or both.

TEQs guarantee to individuals the right to buy fuel in at least the quantity specified by the entitlement. That is not quite the same as a straight rationing scheme – which stops people buying more than a given amount – since in the case of TEQs, you can buy more units on the market (just as long as others are willing to sell them). TEQs rationing does not set an upper limit for individual energy users, but it does protect essential and fair access to energy.

TEQs rationing does not set an upper limit for individuals' energy use, but it does protect essential and fair access to energy for all.

9. *Both for fuel scarcity and the climate.*
Even in the unlikely event that the scheme were being used exclusively to reduce carbon emissions, without there being any need to ration fuel itself, there would still be a scarcity problem which would make an entitlement scheme essential. As the Carbon Budget declines, units will become scarcer, and if the distribution were left entirely to an auction, it would exclude all but the highest bidders. That is, the imposed scarcity of carbon units and the actual scarcity of fuel would have the same effect, requiring the same guarantees. Since both climate change and fuel scarcity are upon us, any fuel-related scheme must be equipped to deal with either or both. TEQs are designed to do this.

TEQs bring an intense focus to the aspects of energy-use where action can be most effective.

10. *International advantage.*
The first-mover nation will quickly develop the advantage of reduced energy-costs and ahead-of-the-field technology. A nation with a TEQs scheme will be able to commit itself with confidence to deep reductions, breaking the inertia in international negotiations by showing the way for other nations to do the same.

11. *Pull.*
TEQs are based on pull (Chapter 3). "Pull" sets up a clear commitment to, and framework for, the energy descent, by whatever means energy users can devise. Rather than dictating changes from the top down, TEQs are a framework for change to be pulled along by energy-users themselves. Households, neighbourhoods, communities, local authorities and industry will have a common frame of reference in which to cooperate in the ambitious reductions which are beyond the reach of individual consumers. The significance of pull is central: TEQs bring a sharp, intense focus to the aspects of energy-use where action can be most effective; they provide the incentive to call on Government and other sources for assistance on a call-and-response basis; they motivate action; they encourage people to work out what action to take if it is not immediately clear. They stimulate creative intelligence.

12. *Common Purpose.*
If the energy descent becomes a shared goal, then action taken by the individual in his or her own interest is the same as the action needed in the collective interest. The TEQs framework helps to achieve this common purpose. Confronting all participants will be major tasks such as developing the proximity principle (shorter travel and transport distances – goods and services being produced in proximity to the people who will be using them) and building local competence to meet local needs. The only way in which an individual can achieve major changes such as these is by cooperating with others at the level of households, streets, towns, the nation; TEQs clearly specify the task as one of cooperating to achieve an energy revolution.

Why a Carbon Tax Would Be Less Effective Than TEQs

None of these desirable characteristics apply to a carbon tax. In fact, the unsuitability of taxation for the task of reducing carbon emissions needs to be frankly recognised:

1. If taxation were high enough to influence the behaviour of the better-off, it would price the poor out of the market.

2. The focus of the scheme must be on the long-term energy-descent, sustained over many years. There needs to be a framework to guide this, but this is not a job which taxation can do. It is impossible for tax to give a long-term steady signal: if it remains constant, it will be inappropriate at certain periods of the economic cycle; if it fluctuates, it does not provide the steady signal.

None of these desirable characteristics apply to a carbon tax.

3. Taxation would take money from people just at the time they need it most: to achieve the needed reductions, they

will need to spend substantially on a whole range of structural changes and technologies, and it is essential that they should have as much discretionary income as possible to enable them to do this.

4. Taxation is based on the assumptions that the authorities know what people need to do, and that they won't do it unless pushed – in effect fined for not getting on with it. The energy descent, by contrast, requires a clearly-defined framework whose difficulties can only be solved by the application of local ingenuity. Tax may, at best, establish an *extrinsic* incentive to achieve compliance with a stated goal; effective motivation can establish a far stronger *intrinsic* incentive to achieve well beyond such a goal, and to cooperate with others to do the same.

5. Tax has no role in the distribution of fair entitlements to energy at a time of scarcity. If a tax regime did exist to phase down carbon emissions, it would still be necessary to have in place a rationing scheme specified in terms of entitlements to energy.

In short, taxation ought naturally to be aligned with recognised values – being set at higher rates for bad things than for good things – but its usefulness as a motivator is limited. It should concentrate on what it is good at – raising money.

2. TEQs: Assuring an Entitlement to Energy

The depletion of oil and gas, and the scarcities and outages that will follow, will make it necessary for the UK Government, in common with governments around the world, to install a rationing system. Its purpose will be to provide every energy-user with fair access to energy, and to pre-empt the intense competition for energy that would otherwise develop. Such a system needs to be installed and tested well in advance of the start of energy shortages. If substantial shortages were to develop before a rationing system were in place, a breakdown in the orderly distribution of energy would follow.

TEQs are designed to be capable of switching from carbon entitlements to energy entitlements at short notice. All accounts and systems will already be in place, and the changeover from reducing carbon emissions to sustaining fair access to the scarce fuel, while continuing the reduction in carbon emissions from fuels unaffected by the scarcity, will require only the activation of prepared settings to the system's programming. Specifically, the following changes will be needed in the settings of the programme that governs the system.

The Rating System

At a time of fuel scarcity – and assuming that a TEQs infrastructure is in place – the first step will be to estimate the available quantity of the fuel. That quantity is measured in units. If the scarce fuel is oil, petrol could be taken as the standard unit, with 1 unit equal to 1 litre. Other fuels derived from crude oil require more (or less) energy to produce than does petrol, and their unit ratings would be adjusted to allow for this – so that highly-refined kerosene might have a rating of (say) 1.1 units, and other fuels might have a rating of less than 1. This allows the energy market the flexibility it needs to keep its production of fuels in balance with demand.

TEQs are designed to be capable of switching from carbon entitlements to energy entitlements at short notice.

When an energy-user purchases petrol, he or she (or it – it may be a company) surrenders units corresponding to the amount purchased, so that, for a purchase of 10 units of petrol, he or she surrenders 10 units. Those units (in the same way as an ordinary money payment for the fuel) are then pulled along the chain of supply, back to the refiner, the primary producer/importer, and the Registrar. Each stage in the production and distribution uses energy, and those energy-purchases, too, are covered by the surrender of units, which also find their way back to the primary producers and the Registrar.

This mechanism is identical to that used for controlling carbon emissions, with the single exception that fuels are rated in terms of the actual quantity of fuel they represent, rather than in terms of their carbon content. No procedures would

have to change. When the system switches from a Carbon Budget to a Budget (or Budgets) covering specific fuel(s), a new Issue of units will be made, with a new Entitlement and Tender and a switchover to different settings in the software.

In the case where a second fuel, such as gas, is in short supply, rations (e.g. Tradable Gas Units – one unit per kWh) would be issued in addition to the Tradable Oil Units and the carbon units already in circulation.

The Entitlement

The distribution of Tradable Oil Units, or Tradable Gas Units, to individuals will be the same in terms of design and implementation as the distribution of tradable carbon units. They will be issued by weekly top-ups into individuals' accounts. A likely scenario is that one fuel (say, oil) is in short supply, while the consumption of other fuels (say, gas and coal) has to be reduced as part of the continuing descent in carbon emissions. That is to say, concurrent budgets will be needed for, respectively, fuel and carbon emissions. The TEQs model is explicitly designed to sustain two (or more) budgets in this way.

It is possible that, in the case of shortages that are expected to be volatile or short-lived, the rolling period of issue will be shorter than the one-year's supply in the case of carbon units. It could, for instance, be as short as two months, backed by good information on the circumstances of the shortage and its expected duration.

If a TEQs system were in place, adaptations to respond to energy scarcities could be made with great speed.

The Tender

When TEQs are used for rationing carbon, the distribution of units to organisations is based on the auction of units at the Tender, where bidding organisations receive their units in accordance with the settlement price – the price at which supply and demand are in balance.

However, at a time of actual – and perhaps profound – fuel shortage, the terms of the Tender may need to be revised. In this situation, the settlement price may prove to be so high that some participants do not succeed in obtaining any units – or not enough to enable them to continue services which are essential to the economy – so that some intervention may be needed to guarantee users minimum access to energy. For example, food producers could make a case for such a guarantee.

In these circumstances, the terms of the Tender will be modified to deliver rations guaranteeing a minimum entitlement for participants with a valid claim, while the remainder would be auctioned as usual. The hybrid Tender would have the benefits of meeting unconditional needs – insofar as the total quantity of available energy allows – and sustaining the market for units. The existence of the market is essential. Some rationed assets (e.g. food) do not need a market in entitlements, because differences between individual needs are relatively minor or at least predictable. But in the case of the distribution of energy entitlements, the very wide diversity of energy needs makes the market a central asset as the only available means of sustaining an efficient allocation.

The use of the hybrid Tender may also be required in the context of a market designed purely for carbon emissions. As noted in Chapter 1, a steeply-declining Carbon Budget would in some circumstances make carbon units unavailable to some service-providers in

the quantity needed to function. The use of guaranteed minimum allocations should be avoided wherever possible, because it impairs the efficient distribution of units, which is contrary to the interests of all participants in the economy, but it is a means of fine-tuning the market, requiring no modification to the scheme beyond adjustments to programme settings in the light of current circumstances. It may be necessary as a means of sustaining supplies of the energy needed by essential services.

If energy scarcity were to develop before tried and tested rationing systems were in place, profound hardship would follow.

Such adjustments to the functioning of TEQs fall easily within the range of the settings available to any flexible system. The key condition for them to be feasible is preparation time, but once a TEQs system is in place, the adaptations needed to respond to energy scarcities could be made promptly.

If energy scarcity were to develop before tried and tested rationing systems were in place, profound hardship would follow – that is, actual energy famine for the losers in the competition for fuel. All too clearly, this would be unjust. Indeed, the distribution of scarce fuel would involve some form of auction or contest which, in the case of severe scarcity, could be violent. TEQs are designed to sustain orderly access to energy in these conditions. And the instrument is designed, too, to prevent an even greater injustice, in that it represents a realistic response to climate change. Any system which falls short of being an effective instrument to reduce carbon emissions on the required scale would lead to populations being exposed to the full impact of climate change, whose consequences would be unjust by any standards.

In summary, it is reasonable to conclude that we are running into danger. Energy shortages will occur. We do not know when, but the event is undoubted and it is not far distant (Chapter 5). There is a real possibility that this will happen before a rationing system is in place. The combination of energy scarcity and the absence of rationing provision has lethal potential and it needs to be corrected without delay.

3. Motivation: Climate Policy's Missing Link

What is needed is a transformation in energy use for the low carbon economy and for a world after peak oil. [1]

How is this to be done? To answer this, we need to look beyond the usual economic and technical analysis, and turn to the question of what drives behavioural change. The incentives that motivate people to get results need to be no less well understood than the relevant science and technologies. At the heart of this is *common purpose*, where there is an alignment of individual and collective purpose, so that actions and aims which the individual recognises as in his or her own interests are the same as those of the community as a whole.

Here are four guidelines:

An Intrinsic Incentive

To be effective, incentives need to be *intrinsic* to the task. That is, the motivation needs to be based on the actual benefits of doing the task, rather than on a set of rewards for doing it, or penalties for not doing it. In the case of extrinsic rewards, the authorities offer inducements for actions which, in a living, participative system, would be done for their own sake. Studies have consistently shown that such extrinsic rewards have a detrimental effect on performance at challenging tasks, especially those requiring insight or creativity, or long-term behaviour change.

The research suggests that rewarding people for engaging in a task tends to undermine their intrinsic motivation for doing it. This evidence might seem counterintuitive, but we can recognise that people tend to recoil from situations where their autonomy is diminished, where they feel controlled or manipulated. An extrinsic reward or penalty offers an artificial inducement to carry out a task which is worth doing for its own sake, and/or which has its own intrinsic benefits. Since the inducement is irrelevant to the task, the result is that the task itself comes to be perceived as a tedious prerequisite for getting a reward or avoiding a penalty, and not as something at which we are inclined to excel by applying our ingenuity and creativity. [2]

At present, we have a policy-response shaped by sophisticated climate science, brilliant technology and pop behaviourism, based on simple assumptions about carrot-and-stick incentives.

Nonetheless, it is usually taken to be self-evident in the field of energy/climate policy that some form of financial incentive or disincentive is needed to achieve the policy goals required for the energy transition. Otherwise (it is argued) why would people bother to take any action at all?

As a result, we have at present a policy-response shaped by a mixture of sophisticated climate science, brilliant technology and pop behaviourism, based on simple assumptions about carrot-and-stick incentives. And yet, as the social psychologist Alfie Kohn emphasises,

> Not a single controlled study has ever found that the use of rewards produces a long-term improvement in the quality of work. [3]

> Rewards usually improve performance only at extremely simple – indeed, mindless – tasks, and even then they improve only quantitative performance. [4]

In other words, people need to feel motivated by the task itself; pay-for-performance is an inherently flawed concept. There is an irony here, because the financial incentives embodied in taxation are being increasingly taken up by the public services and as a fundamental principle of environmental management, just at the time at which this simplistic behaviourist ploy is being abandoned by industry, which has gone through some forty years of pain and puzzlement in discovering its flaws.

Tradable Energy Quotas, then, are a system based on *intrinsic* incentives. They provide reasons to want to reduce dependency on fossil fuels, to plan ahead, to cooperate with others, to apply ingenuity, to take the risk of inventive solutions which will achieve the rate of energy descent defined by the Budget.

The Budget is set in terms of the scarce goods themselves – carbon, energy, and specific, named, fuels. Those assets have money values, of course – all assets do – but TEQs units are not defined in terms of money: they are energy units, not money units. The Budget provides a clearly defined incentive for all energy-users, collectively and individually, to get by on a diminishing supply of energy. Motivations are aligned. The people – all energy-users – are involved. And they are not there for the money, but because they know that even less energy will be available in the future, that we all have to live with this, and that we must work out together how to build solutions with the stunning speed that both climate change and peak oil demand.

Pull

The concept of "pull" is based on principles of lean thinking developed in Japan in the post-war period. It is now applied by companies around the world, but it is not widely recognised in public policy. Pull recognises that the people best placed to understand and cope with a complex local task are those who are doing it – who know the practical detail. In the case of TEQs, since the common purpose is defined, participants do not need forever to rely on instructions; they can respond to actual local circumstance. The Government is freed from having to micromanage the energy transition with regulations; instead it can call on the greatest intellectual energy source available to our society: the creative intelligence of the people.

The Government is freed from having to micromanage the energy transition.

Where there is an alignment of aims, so that people know what they are collectively trying to do, actions can be pulled along by the actual detail of the time and place, rather than *pushed* by a regulatory agency that cannot know the detail. Pull means that people can respond to a challenge on its own terms, building on local knowledge – being allowed to switch on their brains.

In a pull-system, people do not simply apply the rules they have been given; they *pull* answers out of the situation; they *invent* solutions; they *discover* ways forward which the management does not have to work out for itself. In this context aims can be defined without any reliable knowledge of how they are to be achieved, or even whether they are achievable. Pull opens the way to the creative discovery of means which are at present unknown or out of sight, and which, when they are invented or revealed, will surprise. [5]

Participation

Participation by citizens in the decisions and institutions affecting their lives has declined. One of the defining changes has been the transfer of public policy from citizens to experts, with the result that citizenship has been substantially drained of its meaning. If this is to be repaired, it will require, first of all, that citizens recover a sense of legitimacy when participating in, and acting on, decisions affecting their own community. [6]

Deliberation confers ownership of the task on local people, and enables them to take responsibility for initiatives.

Legitimacy exists when there is a sense of ownership of an initiative by the people who are affected by it. There is an understanding of the task; there is an intention to achieve consensus about it; there is a sense that they have the right to take action with respect to the community they belong to and the place that they know, and this right is confirmed by the fact of getting together to deliberate on it. [7]

And deliberation, in turn, is the chance to talk about options before they have been settled, with the confidence that the conversation matters – that its conclusions can have an effect on what happens. It confers ownership of the task on local people, and enables them to take responsibility for local initiatives.

During the era of cheap energy and confident growth, the participation of individuals in deliberation about how to serve the community, and how to build the institutions they wanted, was not seen to be necessary: experts were there to decide; consumers were there to consume. But in the new era of the energy transition, it will be needed again. In case there are doubts as to whether citizens have the knowledge needed to play a useful part in the complex decisions of our time, the sociologist Benjamin Barber offers a useful reminder that, when people feel there is something useful they can do with the knowledge, they will acquire it:

> Give people some significant power and they will quickly appreciate the need of knowledge, but foist knowledge upon them without giving them responsibility, and they will display only indifference. [8]

TEQs are designed to develop participation, and the legitimacy and deliberation on which it depends. The Budget presents communities with a clear task: how to transform their material and energy economies to cope with the remorseless decline in the availability of energy. To meet that challenge, it may be necessary to call on outside expertise – but it is expertise which is invited, not imposed: the community affirms the responsibility for its own energy problem.

Participation in these senses has, to a large degree, drained away from citizenship during the years of energy-led affluence. TEQs bring the indispensable asset of a participative citizenship back to life.

Cooperation

Action to reduce demand for fossil fuels – to achieve the energy transition – will require substantial and sustained cooperation between energy users. From this distance, it is hard to describe its nature in any detail, but opportunities for cooperation in general terms are sketched in Figure 3 below.

Figure 3: TEQs Cooperation

Households	Households cooperate in conservation, renewables systems, repairs and local food.			
Communities	Communities and households cooperate in skills, cultivation, schools, services, materials recovery and jobs.	There is cooperation between communities in developing the potential for local self-reliance and resilience.		
Companies	Households and companies cooperate in closed-systems (zero waste) and household production.	Communities and companies cooperate in local sourcing, and the supply of specialist skills in the building of local energy systems.	Companies cooperate to sustain a flow of goods and services and promote best standards even if at the cost of competitive advantage.	
Loc/Nat Gov	Government assists households with training, funds and regulatory support for the energy descent.	Government provides assistance of all kinds on a "call-and-response" basis. Communities develop self-regulation.	Companies cooperate with Government in technical innovation, building local infrastructures and reducing transport needs.	Local Governments sustain joint training courses, energy descent solutions and shared information.
	Households	Communities	Companies	Local/National Gov

4. How do TEQs fit with the EU ETS?

TEQs are designed to include all energy-users in a national economy. Since the model was published in 1996, several variants have been devised and debated under the general heading of "personal carbon trading" (PCT). In some of these variants the scope of the scheme is limited to individual consumers, leaving out other energy users such as business and the public sector which would be covered by some other scheme, such as the European Union Emissions Trading Scheme (EU ETS). In support of this format, it is argued that the EU ETS already exists and is immoveable, so that an economy-wide scheme is out of the question:

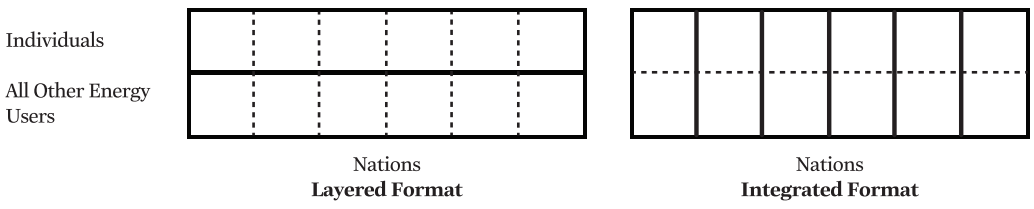
> The core economic instruments for managing emissions for the foreseeable future are the EU Emissions Trading Scheme (EU ETS) [and the domestic supplier obligations]. Analysis of any PCT system that does not operate in tandem with these instruments will be purely academic: this suggests that TEQs and similar designs of personal carbon trading schemes that assume organisations and individuals operating together in an economy-wide scheme are non-starters. 9

In the integrated format, all participants in the energy market operate in the same scheme.

But there are two ways of seeing the scale and format of a carbon/energy rationing scheme. First, there is the Layered Format, in which different participants in the same national economy belong to different schemes, so that businesses would belong to one scheme, operating in its own market and governed by its own Carbon Budget, and individuals would belong in a different scheme, working to a different Carbon Budget, in a different market, and at different prices. The presumption is that the Layered Format would cross national boundaries, as does the EU ETS, which includes some thirty nations; other national groupings, such as the North American Free Trade Area (NAFTA), or a global scheme, would use the same format.

Secondly, there is the Integrated Format. It is *integrated* in that all participants in the energy market – companies, public sector bodies and individuals – operate in

Figure 4



the same scheme. The scale of this market is critical – and it is sufficiently small and self-contained to enable a strongly-developed sense of common purpose and shared ownership. There is acceptance of the Budget as a just representation of national circumstances, and of the authorities responsible for it as qualified to represent the collective interest. Each nation designs and manages the scheme in response to consultation, and to the particular circumstances and energy usage that exist within its national boundaries.

Under the Integrated Format, TEQs would be the means by which nations implement the targets they have agreed at the international level. Wider multinational (e.g. EU) targets would become realistic as each nation committed itself to one Carbon Budget and market corresponding to its own situation and endorsed by consultation with its energy-using public. In the case of small nations, there would be the option of joining forces in a "national" group on a scale equivalent to the larger nations.

It is useful to compare the merits of these two models against three criteria:
(1) The Carbon Budget
(2) Fuel Pricing
(3) Rationing

The Carbon Budget

The Carbon Budget, setting the quantity of permitted emissions and their rate of decline, is the defining property of the scheme. If the Budget were too steep, then the geographical area in which it belonged would find itself plunged directly into an energy problem: with too many buyers of units and too few sellers, the price would rise sharply, so that, for some participants, there would be no price at which they could meet their needs for energy. Conversely, if the Budget were set too high, there would be no incentive to reduce energy demand, the price of units would decline towards zero, and the scheme would in effect cease to operate.

Even within a nation, of course, there are wide divergences of energy use, so that some users will find it harder than others to stay within the Budget or to buy the additional units they need – but it is for such adjustments that the market exists. The problem would arise where one whole nation within a multinational TEQs scheme comprising a large group of nations had energy needs substantially above or below the average for the others. This would lead to large-scale transfers of units from the nation with the lower demand to the nation with the higher demand, together with a transfer of funds the other way, which would reduce the scheme to simple money-politics, an unproductive mix of opportunism and resentments. The nation that received the windfall revenue would have little incentive to reduce its energy demand yet further, and the nation that bore the cost would pay less attention to driving down its energy demand than to challenging the scheme. If the imbalance were severe, the scheme would be short-lived.

A central condition of success is that the Carbon Budget should be pitched at a level which is seen to be just, and towards which participants have a sense of ownership.

A central condition of success, therefore, is that the Budget should be pitched at a level which is seen to be just and realistic, and towards which the participants in the scheme can feel a sense of ownership.

The implication is that the scheme should be based on relatively small areas, with which participants feel they can identify – roughly on the scale of the nation – as specified in the Integrated Format.

It follows that any TEQs scheme must include all energy-users.

Fuel Pricing

In the case of the Integrated Format (the TEQs model) a central principle is that the *numéraire* – the unit in which carbon emissions are measured and traded – is expressed in terms of energy, not in terms of emissions themselves. As explained in Chapter 1, carbon emissions are translated into energy units – that is, the amount of any given fuel needed to produce a kilogram of carbon dioxide. All fuels and electricity supplies are therefore "carbon rated", and TEQs units measure quantities of fuel and electricity (litres, kilowatt hours). This use of easily measured units is a necessary condition of a feasible carbon-rationing scheme involving individuals. There is no need to measure the carbon-emissions of your car or house: they are already accounted-for in the fuel you buy. The significance of this is not merely that it keeps things simple; it is the only realistic design for a scheme: people buy fuel exactly as they did before, except that they automatically surrender units at the time of purchase in accordance with its published carbon-rating.

But it follows that any TEQs scheme must include all energy-users. If it included only some energy-users, then fuel would carry two (or more) different prices, depending on who the buyer was: if you were to turn up at a garage in your car to buy petrol, you would be paying a different price for it than someone who showed up in a commercial vehicle, and whose energy-consumption was covered by another scheme. Different prices for the same fuel would immediately lead to black market brokerage, and the scheme would break down.

It would be possible, no doubt, to remain aloof from such detail and to devise a very highly-regulated scheme in which people were required at the time of purchase to show the seller evidence of whether they were purchasing fuel for business or private use; people who used their cars (or homes) for both private and work-related purposes could perhaps pay two different prices for their energy (filling their tanks with, say, 13 litres at one price and 21 litres at another). Enforcement and anti-fraud measures could be established to regulate the application of the scheme at every level. The scheme would have to do without the self-monitoring "pull" feature in which units were brought within the standard accounting systems of companies and then pulled through to the primary suppliers and the Registrar; without this, costs would be high: routine carbon-accounting from oil-well to petrol-pump would not work if some of the final product (the petrol) were exempt from the process. [10]

And yet, the theoretical possibility that a mis-specified scheme can be made to work if enough money and regulation is thrown at it invariably disappoints when it is put into practice. The TEQs scheme is self-monitoring, requiring no enforcement costs apart from the routine auditing needed for any significant initiative, but this property depends on it being a coherent, economy-wide model.

TEQs is self-monitoring, requiring no enforcement costs apart from routine auditing.

Rationing

The use of the Layered Format as a means of rationing fuel is highly problematic. In the case where a TEQs scheme is used to sustain entitlements to fuel at a time of scarcity, the existence of a separate – multinational – scheme, with businesses' energy-use being governed by the EU ETS, violates fundamental principles of the design of a rationing scheme.

A rationing scheme has to be a fair distribution of a scarce resource, including *all* the users of that resource, distributing the limited quantity according to a single set of criteria which is transparent and widely understood, and for which the Government is accountable. To deal with the distribution of fuel rations to business on different criteria, yielding two availabilities and two sets of prices, covering differently-defined and overlapping geographical areas, and for which the national Government has no accountability, would forfeit any confidence in the equity and transparency of the scheme. And it would sharply reduce any prospects for the trust and alignment of interests that are required for joint, cooperative effort to flourish. [11]

Furthermore, in the real world of rationing under conditions of scarcity, it cannot be predicted how nations will obtain their supplies of the scarce oil and/or gas. It seems probable that nations that are well-placed – which, for instance, own large reserves – will feel justified in taking full advantage of this, rather than sharing out fuel stocks equally to other nations which lack that advantage. And governments will undoubtedly negotiate for supplies of fuel in order to get the best deal they can for their populations. In these circumstances, an EU ETS which provided an EU-wide budget without regard to the differences in energy stocks and sources available to the participating nations would be hard to reconcile with a feasible system of rationing.

There is at present intense concern to develop a system:
- With a global reach;
- Capable of, and committed to, an ambitious phase-down of carbon emissions;
- Able to guarantee fair access to energy for all energy-users.

These three requirements can be provided by economy-wide national systems within an overarching coordinating framework. That framework derives its effectiveness from the commitments made by governments acting on behalf of their national economies. The actual delivery of those commitments is achieved by national systems on the model of TEQs.

International and national schemes are complementary if, and only if, there is a well-defined and explicit distinction between their respective areas of activity.

In the real world of rationing under conditions of scarcity, it cannot be predicted how nations will obtain their supplies of oil and/or gas.

Solutions to the energy problem will not be delivered by up-stream systems, nor by down-stream systems. It will be delivered by full-stream integration of all participants in a system explicitly designed for cooperative, complementary programmes. If suppliers, consumers and public bodies have reason to trust each other and to talk to each other – if they are all in the same scheme and they realise they will not solve the problem without each others' cooperation – then there will be a chance of achieving a fast, fair and effective energy transition.

Part 2

Science and Policy Context

5. The Two Sides of the Energy Problem

Our climate challenge is now widely discussed, and the peak oil problem is also rapidly moving up the agenda, but insightful consideration of the relationship between the two remains rare. We will examine this here, but a quick examination of the two aspects will provide a useful grounding.

Climate Change Summary [12]

The pre-industrial atmospheric CO2 concentration was 278 parts per million (ppm) and did not vary by more than 7ppm between the years 1000 and 1800 CE. Yet by late 2010 CO2 concentrations in our atmosphere were at roughly 390ppm, and are currently rising by between 1.5 and 3 ppm each year. [13]

The Intergovernmental Panel on Climate Change (IPCC)'s latest assessment report, in 2007, predicted 2.0-2.4 degrees of ultimate warming even if atmospheric CO2 concentrations were stabilised at current levels. It also found that even keeping to this dangerous level of temperature increase would involve a peak in CO2 emissions by 2015 and 50-85% reductions in global emissions by 2050, relative to 2000 levels. [14]

The science is clear that the decisions made in the next few years will determine the future of our planet's climate for millennia to come.

In September 2007 the IPCC announced that:

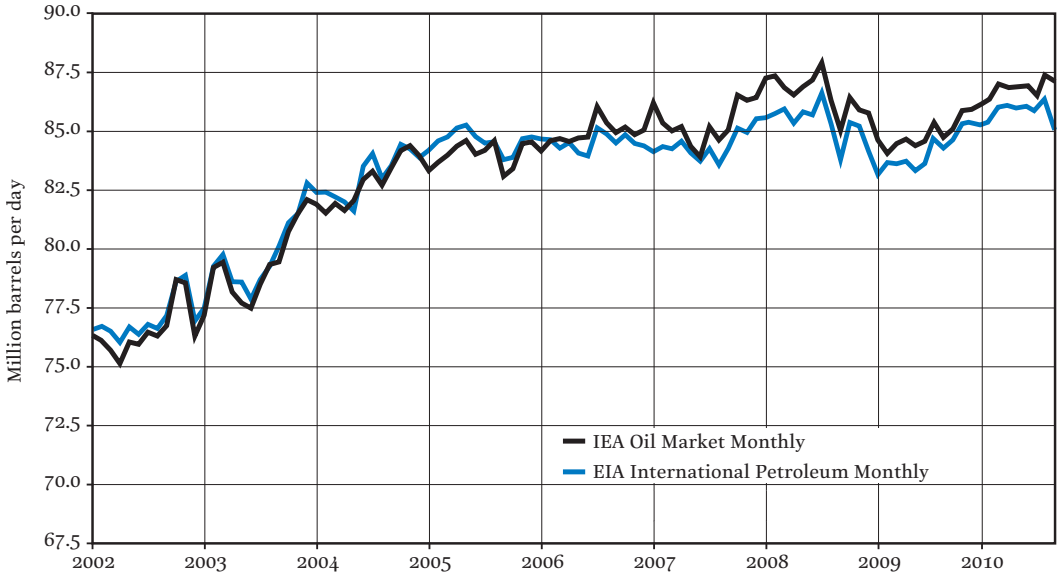
> It is probably too late to avoid some impacts, including major ones in developing countries... Moreover, if warming is not kept below 2 degrees C, which will require the strongest of mitigation efforts, and currently looks very unlikely to be achieved, then substantial global impacts will occur, such as: species extinctions and millions of people at risk from drought, hunger and flooding, etc. [15]

Furthermore, there are various significant aspects to the IPCC approach which indicate that they may be *understating* the severity and urgency of the problem, with certain climate feedback mechanisms not yet included in their modelling, and with observed changes already outstripping their most pessimistic predictions.

Here in the UK we have already seen heatwaves becoming more frequent in summer, rainfall more focused into days of heavy precipitation and more severe windstorms, while the average sea level around the UK (after adjusting for natural land movements) is about 10cm higher than it was in 1900, with the rate of rise increasing substantially. Yet of course the deeper concern is the future national and global impacts that our current decisions and actions commit us to. [16]

Drs James Hansen and Makiko Sato of NASA have found that the threshold for runaway global warming is likely to be a 1.7°C rise above pre-industrial levels, yet

Figure 5: World Liquids Production



we have already seen a rise of 0.8°C, with at least an additional 0.6°C rise still due just from emissions to date. They and other leading scientists – including the Chair of the IPCC – now hold that we need to return atmospheric CO2 concentrations to 300-350 ppm in order to avoid catastrophic impacts. In other words, we must draw carbon out of our atmosphere before temperatures increase too far and trigger feedback mechanisms – *drastically slowing the rate at which we continue to emit carbon is entirely necessary, but no longer sufficient*. [17]

Maintaining a benign climate can probably still be achieved, but to grasp this chance it will be necessary to radically and rapidly restructure our society. The science is clear that the decisions made in the next few years will determine the future of our planet's climate for millennia to come.

Peak Oil Summary [18]

It is a fact well-established by experience that the rate of oil production (extraction) from a typical oilfield increases to a maximum point and then gradually declines. This point of maximum flow is known as the production peak. Because the same is true of the total oil production from a collection of oilfields the peaking concept is also applied to regions, to countries and to the entire world. This global production peak is what is generally referred to by the term 'peak oil'. [19]

As shown in Figure 5 above (which includes conventional oil, unconventional oil and biofuels), global production has broadly levelled off at around 85-88 million barrels per day (m b/d) since mid-2005, despite the incentive to increase production caused by the massive increase in oil prices in that period (from a $13/barrel average in 1998, to a $55/barrel average in 2005, to a peak at over $140/barrel in July 2008 and a $70-90/barrel price throughout 2010). This means that the many new oil wells and unconventional sources that came on stream during this period have only just managed to offset the accelerating depletion of existing fields. [20]

Global recession led to a sharp fall in both the oil price and oil production in mid-2008, with a recovery since. However, with

oilfield depletion continuing inexorably, and global oil *discoveries* having peaked forty-five years ago, it is questionable whether production will ever significantly exceed former levels, even in the event of an economic recovery.

Meanwhile, mainstream projections of global demand for oil touch nearly 104m b/d by 2030, and over 110m b/d by 2035. Unless production follows, against all reasonable expectation, substantial scarcities are inevitable. [21]

It is now questionable whether production will ever significantly exceed former levels.

Here in the UK around three quarters of our primary energy consumption is derived from oil and gas, yet our domestic production of these fuels peaked in 1999 and has been in steep decline since, forcing the UK to become a net importer of oil since 2005. Looking to the future, Government forecasts see oil and gas production on the UK continental shelf plummeting to around a tenth of 1999 levels by 2030, and the May 2007 Energy White Paper projects that with existing policies, by 2020 we could be looking to import around 80% of our natural gas needs (and 75% of our coal). In a world facing severe fossil fuel depletion problems, this dependency on reliable supplies from abroad leaves us extremely vulnerable to energy shortages. [22]

Experts also highlight that, with oil-exporting countries using more of their oil domestically, global 'peak oil exports' likely passed some years ago, with one credible report concluding that the current top five oil exporters – Saudi Arabia, Iran, Russia, Norway and the United Arab Emirates – are likely to provide *zero* net oil exports by about 2030. [23]

It is clear that UK energy policy faces huge challenges as it comes to terms with the energy resource depletion we face over the coming decades (see Figure 6 opposite). [24]

Climate Change and Peak Oil - Joined-Up Thinking

Figure 7 illustrates the overwhelming urgency with which we need to act in response to climate change. In light of this, it might be tempting to call for an immediate ban on fossil fuel extraction, yet our society depends heavily on these energy sources. Without them, our infrastructure for food supply, transportation, heating, electricity and so forth would fail catastrophically.

So we can clearly see what is often overlooked – within current political thinking, there is a tension between addressing climate change and addressing the challenges of peak oil. This has been seen in the US Congress, where Climate Change Bills (to limit emissions) vie for attention with Energy Independence Bills (to subsidise emissions-heavy tar sands and coal-to-liquids plants). In short, slowing the decline in fossil fuel supply worsens the climate challenge, while speeding it worsens the 'peak oil' adaptation problems.

The UK's domestic production of oil and gas has been in steep decline since 1999.

The free market approach to the problem of peak oil is to rebalance declining supply and burgeoning demand through an

Figure 6: Conventional Fossil Fuels: estimates of maximum global production potential [25]

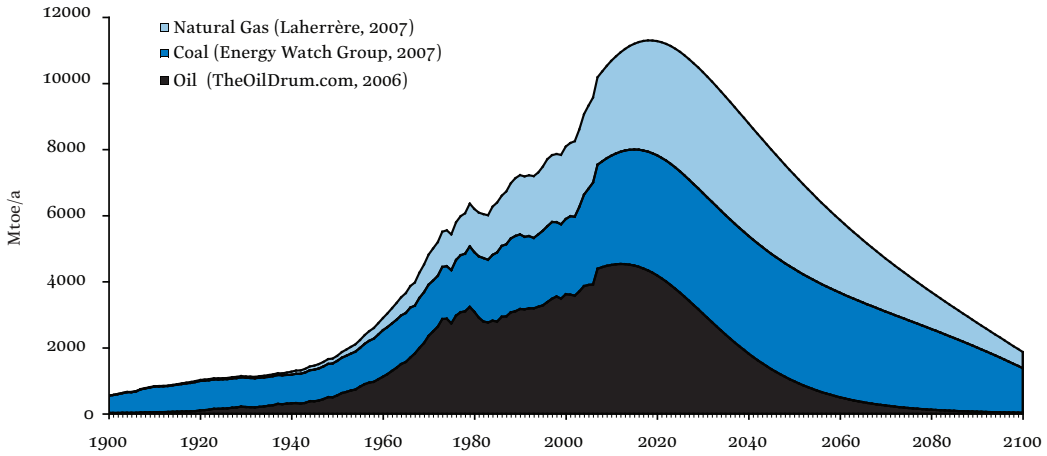


Figure 7: Global emissions descent needed to stabilise at 450 ppm CO2e [26]

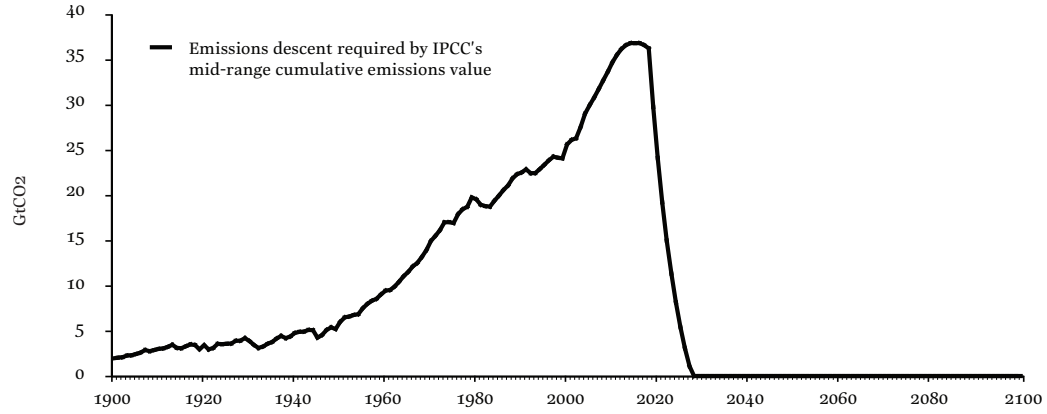


Figure 7 shows the conclusions of Tyndall Centre research into the reduction in emissions from energy use and industrial processes that would be needed to stabilise global CO2e concentrations at 450ppm, according to IPCC figures (see endnote 26). The IPCC's Fourth Assessment Report estimated that stabilising concentrations at 450ppm CO2e would give us a 50:50 chance of exceeding 2°C warming above pre-industrial levels, although other studies suggest that 450ppm would bring a higher risk of exceeding 2°C. [27]

increase in the oil price, simply pricing some consumers out of the bidding – what is known as "demand destruction". Yet markets do not distinguish between more and less essential uses of oil – if the global rich are willing and able to pay more to fuel cars and jets than people elsewhere are able to pay to heat their homes or power their hospitals, then the limited supply of oil will flow to the highest bidder. Demand destruction can be cruel or even fatal for those who can no longer afford energy supplies, and the international oil price is effectively a rough measure of how much of it is going on.

In early 2007, with oil prices having risen to just $60/barrel, the UN highlighted the extent to which the less developed countries are exposed to a rise in the price of oil:

> Recent oil price increases have had devastating effects on many of the world's poor countries, some of which now spend as much as six times as much on fuel as they do on health. Others spend twice the money on fuel as they do on poverty alleviation. And in still others, the foreign exchange drain from higher oil prices is five times the gain from recent debt relief.
>
> Of the world's 50 poorest countries, 38 are net importers of oil, and 25 import all of their oil requirements. 28

The question of whether we should leave some of the available fossil fuels in the ground, then, becomes a question of whether the suffering caused by higher oil prices is more or less tolerable than the effects of increased emissions and the resultant climate change. This is the *supply side dilemma* we find ourselves in.

Thankfully though, there is a course of action which ameliorates both climate change and peak oil simultaneously. If we begin to wean ourselves off our fossil fuel addiction, finding ways to reduce our energy demand relatively painlessly, we reduce the need for the more merciless varieties of demand destruction. By lessening the desperation for increased energy supplies we also make it politically feasible to consider the necessary step of leaving some of the fossil fuels where they are, in response to climate change. 29

The more we can reduce the UK's energy demand, the better off we will be.

The more we can reduce UK energy *demand*, the better off we will be (financially, as well as in terms of energy security), and the less difficult the global supply side dilemma becomes.

The extent to which our energy demand must be reduced will depend partly upon how much of this demand can be met through low-carbon generation, so we must examine the UK energy context in more detail.

The UK Energy Picture

Around 90% of the UK's energy (including 78% of our electricity) is currently supplied by oil, gas and coal, and as we have seen above, our ability to produce or import these fossil fuels is likely to become significantly constrained over the coming years and decades.

Nuclear energy contributed 15% of our electricity in 2007, but has been declining for the last decade and will inevitably continue to do so over the next decade or two, no matter what decisions are taken on its future in the coming years. Indeed, around 30% (22.5 GW) of the UK's current total electricity generation capacity is scheduled to close by 2020, as nuclear and coal plants either reach the end of their

planned lifetimes or are shut down to comply with EU environmental legislation. 30

In addition, it is becoming clear that nuclear energy faces depletion issues of its own. As the world's reserves of high-quality uranium ore dwindle, it has become an open question whether new nuclear power stations would use up more useful energy over their full life-cycle (in mining, transporting, milling and processing the fuel, building and decommissioning the power stations and managing the waste) than is generated over the power station's lifetime.

It may be that nuclear is actually becoming an *energy sink*, rather than an energy source, and thereby worsening our climate and energy challenge, in addition to providing its own unique difficulties – the risk of nuclear accidents (or deliberate sabotage), the commitment to millennia of high-tech nuclear waste management, and the increased risk of nuclear weapons proliferation. 31

With current policies the proportion of UK energy from renewables will reach only 6% by 2020.

Naturally, we might wish to fill our 'energy gap' with renewables, but in 2007 they contributed only 3.3% of our energy supply (including 5% of our electricity). The UK Renewables Advisory Board – in common with other studies – estimates that with current policies the proportion of energy from renewables will reach only 6% by 2020, and that even with radical policy changes and great effort they can only foresee it providing 14% of projected demand by 2020. 32

Meanwhile, talk of 'clean coal' is rather irrelevant, as its development exists on a very different timescale to our immediate challenges. Tony Blair and Jan Peter Balkenende, then UK and Dutch Prime Ministers, declared in 2006 that,

> The science of climate change has never been clearer. Without further action, scientists now estimate we may be heading for temperature rises of at least three to four degrees above pre-industrial levels... We have a window of only 10 to 15 years to avoid crossing catastrophic tipping points. 33

And Intergovernmental Panel on Climate Change chairman Rajendra Pachauri announced in 2007 that,

> If there's no action before 2012, that's too late. What we do in the next two to three years will determine our future. This is the defining moment. 34

With bodies as diverse as the World Business Council for Sustainable Development, Shell, the United Nations, the Massachusetts Institute of Technology and the Intergovernmental Panel on Climate Change accepting that carbon capture and storage can't deliver on a big commercial scale until at least 2030, it is clear that so-called "capture ready" coal power stations are not a sensible option. We cannot solve today's energy problems with tomorrow's new technologies. 35

So if neither renewables nor nuclear can make up the shortfall in our energy supply, oil and gas are in steep decline, and our climate obligations rule out coal, what can we do?

There is a simple answer – cut our cloth accordingly and learn to reduce our energy dependency in line with the reducing supply. When we talk of demand and supply as two separate and unrelated

factors we are led back towards the insoluble supply-side dilemma, but the reality is that the amount of energy we need is governed in part by the amount of energy we have, and how we choose to use it. If we are to meet the climate challenge, managing energy demand is not just the only sensible option, it is the only option.

It is this reality that is recognised by the rapidly-increasing number of Transition Towns, who are exploring practical, positive solutions for changing lifestyles and local infrastructure in response to these collective challenges. 36

The reality is that the amount of energy we need is governed in part by the amount of energy we have.

Local initiatives like these are an essential part of creating a thriving society through this period of energy descent, and their potential would truly be unleashed if supported by a national policy framework designed to encourage and empower their small-scale solutions. TEQs would achieve this, while simultaneously ensuring that these solutions are collectively sufficient to meet our national carbon reduction targets.

6. Policy Update

We will begin by looking briefly at the history of the TEQs model, before moving on to examine where it would sit within the current policy landscape, how the political debate on the scheme is developing and why it may be an idea whose time has come.

A Brief History of TEQs

The model for TEQs (Tradable Energy Quotas) was first published in June 1996 in "Stopping the Traffic", an article by David Fleming in *Country Life*. This was followed by a discussion paper, *Tradable Energy Quotas: Setting Limits to Carbon Emissions*, and then by a journal publication, and a series of presentations to Governmental organisations and NGOs. These included the following: [37]

16 February 1998
Presentation to the United Nations Association at the House of Commons.

14 May 1998
Presentation to Globe International at the House of Commons.

11 June 1998
Presentation at the Department of Trade and Industry.

1-2 July 1998
Workshop, Brussels, sponsored by the European Commission, DG XII RTD Programme, "Environment and Climate" Unit on Human Dimensions of Climate Change. Proceedings: David Fleming (ed).

13 January 1999
Presentation and publication of report on Tradable Energy Quotas at House of Commons, sponsored by Tim Yeo, MP.

Two research funding applications to the European Union (Fifth Framework) followed, in partnership with twelve research centres in Europe, whose participation was secured by detailed personal briefings. The applications, which were prepared in collaboration with Richard Starkey, University of Huddersfield, were submitted on 13 June 1999 and 14 February 2000. Both were rejected.

However, briefings on the model continued, and it became more widely recognised. This was assisted when Starkey joined the Tyndall Centre, and was able to use the publicity resources available to the University of Manchester. That, in turn, was followed by wider recognition, leading in due course to oral evidence on Personal Carbon Trading being heard by the House of Lords Select Committee on Science and Technology, and by a Ten Minute Rule Bill on Personal Carbon Trading presented by Colin Challen MP, on 7 July 2004.

Tradable Energy Quotas (aka Personal Carbon Trading / Personal Carbon Allowances / Domestic Tradable Quotas) then became widely studied by research centres, extending internationally. This brief survey of research activity is far from exhaustive, but leading UK participants included the Environmental Change Institute (Oxford), the National Economic Research Council, the Royal Society of Arts, the Institute of Public Policy Research, and various university departments. Numerous papers followed, including Richard Starkey and Kevin Anderson's *Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use*. Mayer Hillman's popular book on personal carbon allowances, *How We Can Save the Planet*, was published by Penguin Books in 2004. [38]

The Lean Economy Connection (director, David Fleming) resumed its campaign for TEQs in December 2004, launching a website for TEQs, followed by an upgrade in May 2007 (www.teqs.net). In October 2005, the first edition of *Energy and the Common Purpose*, which explains the model in depth, was published, with second and third editions published in January 2007 and September 2007. A Dutch edition followed in September 2008, with a second, expanded edition in March 2009.

Promotion of TEQs has been sustained by The Lean Economy Connection (David Fleming and Shaun Chamberlin) with a series of lectures and/or presentations to conferences, professional associations, amenity groups, university courses, the Environmental Audit Committee and a joint meeting of the All Party Parliamentary Groups on Peak Oil and Climate Change (10 June, 2008).

TEQs have been discussed on a number of popular shows, including BBC Radio 4's *You and Yours* and BBC1's *Newsnight*, and endorsed in many books and reports on climate change and fuel prospects. These include: David Boyle (2002), *The Money Changers*; George Monbiot (2006), *Heat*; David Strahan (2007), *The Last Oil Shock*; the Centre for Alternative Technology (2007), *Zero Carbon Britain*; Rob Hopkins (2008), *The Transition Handbook* and Shaun Chamberlin (2009), *The Transition Timeline*.

The UK Government has funded the following research into personal carbon allowances, which we discuss in more detail below:

1. Centre for Sustainable Energy: Simon Roberts and Joshua Thumim (2006), *A Rough Guide to Individual Carbon Trading*.

2. DEFRA Pre-Feasibility Study: *Personal Carbon Trading* (2008).

The Policy Context - Why We Need TEQs

A great deal has changed in the policy world since TEQs were designed back in 1996, as the climate and energy problems the scheme was designed to address have gained a vastly higher profile.

The Climate Change Act now mandates 80% emissions cuts by 2050, and cuts of 34% by 2020, but while there are over one hundred UK policies designed to impact on emissions, there is as yet no coherent structure in place to ensure that this emissions cap is respected. The Government's track record is not good, and hoping to achieve our 2020 goal with current policies is politely described by one study as "very optimistic". 39

While it is tempting to think of a tightening cap on emissions as a solution in itself, the true challenge is to transform our society so that it can thrive within this limit.

As the House of Commons Environmental Audit Committee commented in October 2007,

> The organic process by which leadership and responsibility have evolved appears to have created a confusing framework that cannot be said to promote effective action on climate change. 40

We must recognise that while it is tempting to think of a tightening cap on emissions as a solution in itself, the true challenge is to transform our society so that it can thrive within this limit. If

we fail in this, the political pressure to loosen or abandon any cap will become irresistible: "*enough talk of future generations, my children are hungry today*".

Now that the cap for UK emissions is in place, the focus must be on two things – continually checking to ensure that this cap (within the context of the international response) is adequate to address the latest findings of climate science, and enabling and stimulating the necessary reductions in energy demand to allow the UK to thrive under the cap. And as Lord Smith of Finsbury, Chairman of the Environment Agency, argued in November 2009, the fairest and most effective way of meeting the UK's emissions targets is rationing. [41]

It must also be recognised that around 90% of the UK's energy needs are met from carbon-intensive sources, so a declining carbon budget means a declining energy budget. In other words, even if we did not live in a world of energy resource depletion (as outlined in Chapter 5), the Climate Change Act itself means that a method for ensuring entitlements to the available energy is essential. [42]

The free market ('rationing by price') is not well-suited to this task. We need a simple, coherent framework which deals with both sides of our energy dilemma, and helps to make low-carbon living both feasible and fair.

DEFRA's Pre-Feasibility Study into TEQs

In November 2006, the UK Government's Department for Environment, Food and Rural Affairs (DEFRA) published an initial scoping study which concluded that a personal carbon allowance and trading system has the potential to achieve emissions savings in a fairer way than carbon taxes, and would reward people for leading low-carbon lifestyles. Accordingly, DEFRA went on to fund a number of research projects as part of a pre-feasibility study into the implementation of TEQs, which concluded in May 2008. [43]

The headline finding of DEFRA's second study was that "personal carbon trading has potential to engage individuals in taking action to combat climate change, but is essentially ahead of its time and expected costs for implementation are high". DEFRA decided not to continue its research programme at that time on the basis of the study's cost-benefit analysis, and in personal communication we have been told that DEFRA (or now DECC, which has taken on the climate change brief) feels it has "thrown down the gauntlet" to the research community to show that costs would be lower, or benefits higher, than found in the pre-feasibility study.

As stated on the DEFRA website,

> The Government remains interested in the concept of personal carbon trading and, although it will not be continuing its research programme at this stage, it will monitor the wealth of research focusing on this area and may introduce personal carbon trading if the value of carbon savings and cost implications change. [44]

We aim to show here that there is now ample evidence that this criterion has been met, and that the continuing absence of a full, grounded and careful evaluation of possible frameworks for reducing emissions and rationing fuel leaves the UK unprepared and extremely vulnerable to the consequences of both energy shortages and climate change.

The DEFRA study consisted of four reports, each commissioned from a different body and focusing on a different area – technical feasibility and potential cost, effectiveness and strategic fit, public acceptability and distributional impacts. All these reports have now been moved to the DECC website,

and can be accessed at:
http://tinyurl.com/DeccPCT

This work represented a useful addition to the body of research in the field, with positive findings on technical feasibility, public acceptability and distributional impacts, but as the DEFRA decision was based on the cost-benefit analysis, it is here that we will focus, looking at the additional benefits of TEQs which were not factored into the calculation, at the likely overstatement of the costs of the scheme and at the shortcomings of the cost-benefit methodology used.

Shortly after the release of DEFRA's study, The Lean Economy Connection released a detailed response to all four reports, which will be referred to below. This can be accessed at: http://tinyurl.com/TLECDefra

Additional Benefits of TEQs

It must first be made clear that the Effectiveness and Strategic Fit report (which contained the decisive cost-benefit analysis) did not actually examine the TEQs scheme. With regard to the four reports that made up their pre-feasibility study, DEFRA stated that,

> To ensure the research areas were as compatible as possible and could be brought together...it was necessary to provide a baseline description of a personal carbon trading scheme, and set some key assumptions around scheme design... For the purposes of this project, a Domestic Tradable Quotas (AKA Tradable Energy Quotas) model was assumed. [45]

Nonetheless, this one report explicitly addressed Mayer Hillman's substantially different PCA scheme, which has a more limited scope. The report states that,

> In this report, an assessment is made of the economic efficiency of creating a downstream cap and trade scheme that covers the following sectors; domestic primary fuel, domestic electricity use, leisure use of road transport fuel and leisure aviation, as proposed by Hillman (2004). Alternative designs have been proposed, including more ambitious economy wide schemes, however considering the net benefit of introducing trading to the above sectors provides an insight into the added value of personal carbon trading generally. [46]

For reasons that should be clear from Part One of the present report, and as discussed in detail in our full response to the DEFRA study, we strongly challenge this assumption that the effect of a limited PCA scheme on the emissions of individuals would be the same as the effect of an economy-wide scheme on those same emissions.

We strongly challenge the assumption that the effect of a limited PCA scheme on the emissions of individuals would be identical to the effect of an economy-wide scheme.

This also leads to another notable oversight. DEFRA's work focused purely on the benefit of guaranteeing emissions reductions, and not on TEQs' additional role as a rationing system ready to ensure fair access to energy. Means of guaranteeing entitlements will be required in the case of *any* effective scheme, whether its aim is to reduce carbon emissions or to sustain an orderly distribution of energy at a time of scarcity. The PCA scheme considered in DEFRA's cost-benefit analysis would not have this dual function, and this would make it necessary to devise a separate electronic energy

rationing scheme to deal with fuel scarcity. For a full assessment of the benefits of TEQs, an investigation would need to examine the likely impacts of an energy shortage without an effective rationing system in place.

And within its limited scope of investigating only carbon reductions, the DEFRA report focuses exclusively on the potential impact of "increased visibility" of individuals' carbon emissions, thus ignoring many of the key features of TEQs designed to facilitate the reduction of emissions. These are discussed in more detail in Chapter 3, but they include the shift in perceived norms in acceptable behaviour, the sense of common purpose, the spur to innovation created by a predictable demand for low-carbon solutions and the increased willingness to cooperate within a system in which all are clearly understood to be participating.

The report also proposes 'softening' the hard cap on national emissions, by allowing emissions permits to be purchased from overseas if this is deemed cheaper than reducing domestic emissions. This would remove the central guarantee that the national Carbon budget is actually achieved, and it is fundamentally in conflict with a core purpose of the TEQs system. It also draws into question the report's underlying assumption that the Government's emissions targets will be met, and that the only outstanding question is how to achieve this at the lowest cost. With a soft cap, the validity of this assumption becomes dependent on the robustness of international carbon trading schemes, which is currently dubious at best. [47]

We would agree that implementing the scheme examined in DEFRA's cost-benefit analysis would be a mistake, as it fails both to address our climate challenge and to help with energy shortages. Yet to apply the conclusions from that report to the very different TEQs scheme is inappropriate and misleading.

Questionable Costs

It must first be noted that while DEFRA's cost-benefit analysis was based on the *benefits* of a limited PCA scheme which would apply to individuals only, its estimate of *costs* was taken from Accenture's report on the implementation of an economy-wide TEQs scheme. [48]

This report estimated total set-up costs of between £700 million and £2 billion, and running costs of £1–2 billion per year, although stressing that these estimates were not based on a detailed costing exercise. Our reasons for believing Accenture's costings to be considerably overstated can be found in our detailed response (and the Institute for Public Policy Research have since produced an alternative estimate which halves the cost), but it must also be remembered that the costs of addressing climate change and peak oil are non-negotiable. We can search for the same range of benefits for a lower price, but action on these massive challenges can no longer be postponed, lest the payment be taken in consequences. [49]

Annex C of the Effectiveness and Strategic Fit report counts a full 94 present or planned policies that impact on the level of personal carbon emissions, before even considering other emissions. As the Treasury heard in 2008,

> PricewaterhouseCoopers considered that... in the context of a growing number of initiatives, programmes and associations which have been set up in recent years: "there is now perhaps a perception that the setting of Government policy needs to be more focused". [50]

Because TEQs would bring this clarity and focus to the area, it could also free up much of the spending currently allocated

The Influence of Uncertainty

The DEFRA cost-benefit analysis assumes a Shadow Price of Carbon of £29/tonne of CO2 in 2013, a requirement for 50m individual accounts, an annual cost per account of £52.07 and an average reduction in individual emissions of 2.5% brought about by the scheme.

All of these variables are subject to significant uncertainties – the number of accounts required depends on the criteria applied (e.g. at what age accounts are provided), estimates for the cost of administering accounts vary from £5-£50 per account per annum, and the Shadow Price of Carbon (SPC) is a deeply controversial figure, with one Government study suggesting that under the methodology used it could range from £0/tCO2 to more than £3,000/tCO2. [51]

Most importantly, setting the benefit derived from the implementation of a TEQs scheme at just 2.5% of individual emissions is highly questionable. This figure is based on the assumption that the only way in which a scheme would affect emissions is through increased visibility of emissions. While this may or may not apply to the scheme design considered in the cost-benefit analysis, it is clearly inapplicable to TEQs, as outlined in Chapter 3 above.

Nonetheless, using this assumption, the 2.5% figure used in the cost-benefit analysis was reached on the basis of a report which found that *improved metering and energy displays* caused a reduction in emissions of 0-10%, through increased visibility of emissions. An average of 5% was taken from this range, and then this figure was halved on the basis that not all of this visibility benefit would be attributable to the scheme under consideration, with other policies like smart metering likely to be introduced alongside it. It is clear that this is far from a detailed audit of the likely benefits of a TEQs scheme. [52]

Joshua Thumim's work looks at the different variables used and points out that, for example, even an assumed benefit of a 10% reduction just in personal emissions, coupled with a Shadow Price of Carbon of £35/tCO2, leads to the conclusion that the benefits of the scheme examined by DEFRA outweigh the costs. [53]

Considering that the Government has since revised its central Shadow Price of Carbon for the relevant sector to £60/tCO2 (double the figure used in DEFRA's cost-benefit analysis in 2008), it is clear that the Government's decision to delay a full feasibility study into TEQs rests on an analysis that is, at best, deeply uncertain. [54]

to these various policies, as many of them would no longer be required, and the Government would be able to shift the focus from educating the country on the need for emissions reductions, to helping the country to achieve them.

Limitations of Methodology

Even if we were to accept the approach taken by DEFRA's study, there are problems with the cost-benefit analysis behind its conclusions. As Joshua Thumim at the Centre for Sustainable Energy points out, slight changes to certain variables transform the result, and those same variables are subject to large uncertainties, as outlined in the box opposite.

The fundamental point is that, given the large uncertainty surrounding all of these figures, the outcome of a cost-benefit analysis is largely arbitrary, depending entirely on the assumptions made. There is a pressing need to establish grounds for thorough, well-supported assumptions.

In Conclusion

A month after the release of DEFRA's pre-feasibility study, the then-Chair of the All Party Parliamentary Climate Change Group, Colin Challen MP, wrote that,

> The only rational response is to recognise that we cannot manage climate change with the old tools of government... most urgently we need to recognise that early carbon reductions are the most important step, and that will only happen with rapid behavioural change, which means some form of carbon rationing.
>
> In this respect, for any minister or potential minister to say the time for personal carbon allowances has not yet come illustrates either deep cynicism, defeatism or complacency, or perhaps a combination of all three. 55

The House of Commons Environmental Audit Committee's response to DEFRA's study also urged a far more proactive approach:

> If the Government is to stand the slightest chance of meeting its 2050 carbon emissions target it cannot afford to neglect the domestic and personal sector. Reductions in carbon emissions from business and industry will be meaningless unless accompanied by significant and equal reductions from households and individuals.
>
> Personal carbon trading could be essential in helping to reduce our national carbon footprint. Further work is needed before personal carbon trading can be a viable policy option and this must be started urgently, and in earnest. In the meantime there is no barrier to the Government developing and deploying the policies that will not only prepare the ground for personal carbon trading, but which will ensure its effectiveness and acceptance once implemented... Although we commend the Government for its intention to maintain engagement in academic work on the topic, we urge it to undertake a stronger role, leading and shaping debate and coordinating research. 56

DEFRA's work to date does not constitute the detailed systems-audit of TEQs which could be the basis of a decision on whether to take the scheme forward. In the absence of such a properly grounded evaluation, the development of ways of including the personal and the commercial sector both in the reduction of carbon emission and in the rationing of fuel has stalled. This leaves the United Kingdom and other economies unprepared and vulnerable to the consequences of energy shortages and unmitigated climate change. It is to be hoped that a full, grounded and careful feasibility evaluation will be commissioned in Britain or elsewhere in the near future. This is now a priority.

Conclusions

Let us return to the two questions the All-Party Parliamentary Group asked this report to address:

1. What contribution could TEQs make to ensuring fair access to energy at a time of shortages of oil and gas?

2. How would TEQs work alongside models of carbon reduction at the international level?

The report's answers to these questions can be summarised as follows:

1. TEQs are an instrument designed to ensure the fair distribution of entitlements to fuels and energy under conditions of scarcity, while simultaneously delivering a steep reduction in carbon emissions.

2. There is no incompatibility between national schemes such as TEQs and international schemes, *provided* there is a clear distinction between the respective scope (national or international) of the two kinds of scheme, each with their own defined tasks and spheres of activity.

As the survey by Shaun Chamberlin (Chapter 5) shows, the physical realities of both climate change and peak oil are now far advanced, and substantial consequences will shortly be upon us. We cannot know when oil and gas shortages will start, but when they do, we are unlikely to be given much notice. If we are unprepared, we will be in energy-shock within days.

Two kinds of preparation are possible. The first is psychological preparation, where the population is made aware of the nature of the energy problem, its reasons, and the ways in which it can be expected to mature. People will need to be informed about the long-term practical progress that can be made in reducing dependency on fossil fuels. It is reasonable to believe that long-term solutions are possible; the danger is that the shortages that occur between now and then could reduce the chances of getting there.

The second kind of preparation is practical. A proven rationing system must be in place before shortages begin. The system needs to be installed, tested and familiar to all – and if in the meantime it is used as a means of reducing carbon emissions and starting the phase-out of oil and/or gas, that is a clear advantage.

The first essential for success is a prompt decision on the choice of system. Any feasible energy rationing system will require (amongst others) these features:

1. All energy users must be included in the system, which guarantees fair access to fuel/energy supplies.

2. It must be capable – at short notice, and in the light of current availability – of adjusting rations for each form of fuel/energy for which shortages are in prospect.

3. Rations must be tradable to allow the flexibility needed to accommodate widely differing levels of energy dependency.

4. A national-level scheme is needed, owned by energy users, and with a fully accountable government.

Tradable Energy Quotas meet these criteria.

Once the principle of electronic rationing has been understood, a range of options

opens up. It could be designed for carbon emissions, or for oil and/or gas and/or electricity. It could be adapted to the short-term or long-term; the Tender could be issued by auction or by allocation, or by a combination of the two. This is a generic instrument, permitting a high degree of flexibility. But there is clarity, too: there is no doubt that a form of rationing, using the established electronic technology of the day, is needed, and that it should be of a kind which can be tailored to the needs of place and time.

This adaptability is vital, because expectations of what will happen to the world's economy and society in the mid-term (25 years) enjoy little consensus. For instance, the case has been strongly argued that a Green New Deal, led by investment in renewable energy sources, could be a new engine of growth, providing millions of jobs, and that green technology could be the biggest economic opportunity of the 21st Century. 57

Other critics argue that growth expectations are unrealistic, and that the priority is to develop a different kind of macro-economic structure which delivers prosperity without growth. 58 And there is the darker critique which argues that the costs of growth will be paid in terms of the multiple problems of fuel depletion, climate change, deforestation, over-fishing, extinctions, species loss and overpopulation, and that, as these problems converge, economic growth will go into reverse, threatening our political economy in fundamental ways. 59

The case for TEQs does not depend on decision or agreement on which of these futures is the closest to reality. Whatever prospects we face, it is clear that fossil fuel consumption is going to be quickly reduced, either voluntarily or involuntarily, and that a reduction over which we are able to maintain a degree of voluntary control will require the full engagement not just of governments but of citizens. A determined, consensual descent in the demand for fossil fuels is needed.

National schemes enable a sense of ownership by all energy users within the nation; they clearly affirm national governments' responsibility for their operation and effectiveness; they underwrite a straightforward pricing structure, with fuels being priced on a single set of criteria for all purchasers within the national economy; and they set the budget at a level whose starting-point is relevant to each participating nation's current level of energy usage.

International schemes, by which governments commit their nations to specific targets, provide a framework for a global response to the connected problems of carbon emissions and fuel depletion. However, the current struggles of the UN process working towards such an agreement are instructive, with leaders playing "you first", and understandably reluctant to promise emissions cuts which they have no way to deliver without causing real hardship and resentment.

TEQs could be the game-changer, both allowing national leaders to promise substantial reductions in fossil-fuel dependency with confidence that they will actually happen, and emboldening them to throw down the powerful challenge: "we are acting, so must you".

It is now intensely urgent that nations should have an instrument, available and proven, which is capable of both reducing carbon emissions and rationing scarce fuel. The system capable of delivering that is TEQs.

Endnotes

1. See Chapter 5. For the concept of a phase-out of fossil fuels – as distinct from the less ambitious aim of a reduction, see Centre for Alternative Technology (2007), *Zero Carbon Britain*, Machynlleth: Centre for Alternative Technology, and Public Interest Research Centre (2008), *Climate Safety*, Machynlleth: Public Interest Research Centre.

2. See Alfie Kohn (1999), *Punished by Rewards*, Houghton Mifflin; Daniel H. Pink (2010), *Drive: The Surprising Truth About What Motivates Us*, Canongate.

The significance of intrinsic incentives is also recognised implicitly by the UK Environmental Audit Committee: "A carbon allowance could be more effective at incentivising behavioural change and engaging individuals in reducing their emissions than the price signals resulting from green taxation." (*Personal Carbon Trading*, Fifth Report of Session 2007-2008, http://tinyurl.com/ychjjza)

For accessible video presentations summarising this research see Daniel Pink's 2010 presentations at the RSA (http://tinyurl.com/2ga47re) and for TED (http://tinyurl.com/nfxme9)

3. Kohn (1999), p 265

4. Kohn (1999), p 46

5. The key source on pull is James P. Womack and Daniel T. Jones (2003), *Lean Thinking*, Free Press

6. Frank Fischer (2000), *Citizens, Experts and the Environment*, Duke University Press, especially Chapter 1

7. Fischer (2000), Chapter 10

8. Benjamin Barber (1984), *Strong Democracy*, University of California Press, in Fischer (2000), p 29

9. RSA Projects, Carbon Limited: Andy Kerr and William Battye (2008), *Personal Carbon Trading: Economic Efficiency and Interaction with Other Policies*, RSA, pp 5, 46-47

10. For example, the DEFRA report commissioned from Accenture (2008), *An Analysis of the Technical Feasibility and Potential Costs of a Personal Carbon Trading Scheme* produced estimated running costs of between £1 and £2 billion per annum, p 6. For a commentary on this report see Chapter 6 of this report, or The Lean Economy Connection (2008), *DEFRA's Pre-Feasibility Study into Personal Carbon Trading – A Missed Opportunity*, at http://www.teqs.net/DEFRAPFSresponse.pdf

11. For lessons learnt from historical rationing and applied to tradable carbon rationing, see: Mark Roodhouse (2007), "Rationing returns: A solution to global warming?", *History and Policy*, http://tinyurl.com/Roodhouse

12. This section is a revised and updated summary of the climate change information in the book by the lead author of Part 2 of this report. See Shaun Chamberlin (2009), *The Transition Timeline*, Green Books, pp 127-166

13. It should be noted that despite widespread misunderstanding of its meaning, the total CO2e (equivalent CO2) figure is currently estimated to be slightly lower than that for simple CO2. This is because total CO2e accounts for all the factors that affect global temperature

change, some of which are cooling factors. For a full explanation of the different meanings of CO2e see: Shaun Chamberlin, "The Climate Science Translation Guide", *Dark Optimism* (blog), 3rd Sept 2008, http://tinyurl.com/whatisCO2e

Up-to-date measurements of atmospheric CO2 concentrations are always subject to revisions, pending recalibrations of reference gases and other quality control checks. Trends and 2010 figures taken from: http://www.esrl.noaa.gov/gmd/ccgg/trends/ (site accessed October 2010)

14. Source: *IPCC AR4 Working Group 3 Summary for Policymakers*, http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-spm.pdf , Table SPM.5, p15

15. From IPCC Press Release, 18th Sept 2007, http://tinyurl.com/2chmu. Full report: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, 7-22. http://www.ipcc-wg2.org/index.html.

Note: The IPCC strictly define "very unlikely" as meaning a likelihood of less than 10%

16. 'The Climate of the UK and Recent Trends', Geoff Jenkins *et al*., UK Climate Impacts Programme, Dec 2007, http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=469&Itemid=477

More information on current UK climate trends, and projections out to 2099, are available in the *UK Climate Projections 09*, http://ukcp09.defra.gov.uk/

17. 'Target atmospheric CO2: Where should humanity aim?', James Hansen et al. (2008), http://arxiv.org/abs/0804.1126, p1

For support for the 350ppm target from the IPCC Chairman, see: http://tinyurl.com/Rajendra350

18. This section is a revised and updated summary of the peak oil information in the book by the lead author of Part 2 of this report. See Shaun Chamberlin (2009), *The Transition Timeline*, Green Books, pp. 116-129 and pp.156-161.

19. For a clearly written exploration of the science of peak oil, building up from the basics, see 'The Science of Oil and Peak Oil', Gail Tverberg, http://tinyurl/colwr8

20. This graph includes conventional and unconventional oil, as well as biofuels. Graph data from International Energy Agency (IEA) and Energy Information Administration (EIA), with assistance from Rembrandt Koppelaar gratefully acknowledged.

21. Figures from the U.S. Dept. of Energy/Energy Information Administration (EIA) *International Energy Outlook 2010*: http://www.eia.doe.gov/oiaf/ieo/index.html

These are revised down from the figures in their 2008 report: 96 mb/d by 2015, 113 mb/d by 2030.

22. *UK Energy In Brief*, Department for Business Enterprise and Regulatory Reform, July 2008, http://tinyurl.com/ydvp2ss

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Also see: 'Cost of energy imports to UK trade balance', Euan Mearns, The Oil Drum:Europe, October 21 2010, http://europe.theoildrum.com/node/7057

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The Oil Crunch: A wake-up call for the UK economy, UK Industry Taskforce on Peak Oil & Energy Security (ITPOES), February 2010, http://tinyurl.com/y92k5pr, pp.24-26

Sustainable Energy Security: Strategic Risks and Opportunities for Business, Chatham House-Lloyds 360° Risk Insight White Paper, June 2010, http://tinyurl.com/2ejzqun

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25. Figure 6 shows research on the maximum feasible global production of oil, natural gas and coal, quantified in Million Ton Oil Equivalents per annum (MToe/a). For comparison with Figure 5, a million barrels of oil per day is approximately 53MToe/a and one barrel of oil = 0.146 tons of oil.

Graph taken from: "Olduvai revisited 2008", Luis De Sousa, The Oil Drum: Europe, February 28th 2008, http://europe.theoildrum.com/node/3565

Data sources:

Gas: "Fossil fuels: what future?", Jean Laherrère, ASPO and ASPO France, 2007, http://hubbertpeak.com/laherrere/Beijing20061009.pdf

Coal: *Coal: Resources and Future Production*, Zittel and Schindler, Energy Watch Group, July 2007, http:energywatchgroup.org/Oil-report.32+M5d637b1e38d.0.html

Oil: "The Loglet Analysis", Sam Foucher, The Oil Drum, September 2006, http://europe.theoildrum.com/node/3565

26. Pre-2000 data taken from Boden, T.A., G. Marland, and R.J. Andres. 2009. "Global, Regional, and National Fossil-Fuel CO2 Emissions". *Carbon Dioxide Information Analysis Center*, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001

Post-2000 data taken from research by Alice Bows and Kevin Anderson of the Tyndall Centre for Climate Change Research, for Anderson, K. and Bows, A., 2008, "Reframing the climate change challenge in light of post-2000 emission trends", *Philosophical Transactions of the Royal Society A*, 366, 3863-3882.

The curve is based on the mid-range estimates of allowable cumulative emission budgets (to come in at 450ppm) from the IPCC's Fourth Assessment Report (AR4). Curve assumes:
- stringent curtailment of deforestation such that that 80% of world's forest carbon stock remains intact by 2100 (taking 1060GtCO2 total forest carbon stock in 2000 as baseline).
- approximate halving of the emission intensity of current food production.

Original paper also included curves based on the AR4's highest estimates of allowable

cumulative emissions budgets, but more recent climate science suggests that these are unrealistic, given better understanding of:

- the radiative forcing impacts of aerosols and non-CO2 aviation emissions, such as emissions of NOx in the upper troposphere, vapour trails and cirrus formation (see e.g. Andreae et al., 2005, "Strong present-day aerosol cooling implies a hot future". *Nature* 435,1187–1190);
- the degradation of carbon sinks (see e.g. Canadell et al., 2007, "Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks". *PNAS*, 104)
- previously underestimated emission sources (see e.g. Eyring et al., 2005, "Emissions from international shipping:1. The last 50 years". *J.Geophys.Res*. 110, D17305); and
- the implications of early emission peaks for 'overshooting' stabilization concentrations and the attendant risks of additional feedbacks.

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28. Sustainable Bioenergy: *A Framework for Decision Makers*, UN-Energy, http://www.fao.org/docrep/010/a1094e/a1094e00.htm , p 39

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We urgently need to have a system in place to mitigate the economic and social consequences of peak oil. I believe TEQs provide the fairest and most productive way to deal with the oil crisis and to simultaneously guarantee reductions in fossil fuel use to meet climate change targets.
John Hemming MP, Chairman, All Party Parliamentary Group on Peak Oil

Whilst I am less convinced than some people about the imminence of peak oil I firmly believe, regardless of this, that tradable personal carbon allowances could make a big contribution to reducing energy consumption and therefore carbon emissions in Britain. I also believe that it is extremely urgent for Britain, and all developed countries, to move away from a fossil fuel-based economy as quickly as possible.
Tim Yeo MP, Chairman, House of Commons Energy and Climate Change Select Committee

A concept of brilliant simplicity, offering a predictable and orderly reduction of greenhouse gas emissions year-on-year, with flexibility in an enclosed system, independent of taxation and providing complete transparency between goals and delivery.
Colin Challen, Founder Chairman, All Party Parliamentary Group on Climate Change

TEQs have long been Green Party policy, as we believe that we need a fair and transparent system to reduce energy demand and give each person a direct connection to the carbon emissions associated with their lifestyle. The TEQs scheme would guarantee that the UK's targeted carbon reductions are actually achieved, while ensuring fair shares of available energy.
Caroline Lucas MP, Leader, Green Party of England and Wales

This eloquently presented proposal merits very serious consideration by all political parties. There remains an undeniable gap between the current policy mix and what we actually need to do urgently both to reduce emissions of greenhouse gases and to avoid the potentially devastating consequences of declining fossil fuels. Tradable Energy Quotas offer significant policy advantages in addressing both those pressing imperatives.
Jonathon Porritt, Founder Director, Forum for the Future

A watertight proposal that deserves to be spread as widely as possible, as it is an idea of its time. Take the time to read and understand this mechanism thoroughly. New situations require fresh thinking.
Rob Hopkins, Founder of the Transition Towns movement

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