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Reconciling scientific reality with realpolitik: moving beyond carbon pricing to TEQs – an integrated, economy-wide emissions cap

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This article considers why price-based frameworks may be inherently unsuitable for delivering unprecedented global emissions reductions while retaining the necessary public and political support, and argues that it is time to instead draw on quantity-based mechanisms such as TEQs (tradable energy quotas).

TEQs is a climate policy framework combining a hard cap on emissions with the use of market mechanisms to distribute quotas beneath that cap.

The significant international research into TEQs is summarized, including a 2008 UK government feasibility study, which concluded that the scheme was "ahead of its time." TEQs would cover all sectors within a national economy, including households, and findings suggest it could act as a catalyst for the socio-technical transitions required to maximize wellbeing under a tightening cap, while generating national common purpose toward innovative energy demand reductions.

Finally, there are reflections on the role that the carbon management community can play in further developing TEQs and reducing the rift between what climate science calls for and what politics is delivering.

The essential problem is easily stated: there is a rift in realism. Realism about the findings of climate science demands dramatic and immediate emissions reductions if we are to avoid catastrophic destabilization of the global climate [1,2]. Anderson and Bows argue that these reductions must be in the region of 10% per annum in industrialized (UNFCCC Annex 1) countries [3,201]. Yet present political reality in these countries says that such reductions are unthinkable [4]. While realists about climatology rightly argue that physical reality "bats last" and does not negotiate, realists within politics argue with equal validity that any approach that tries to radically transform society against society's wishes will be resented and, soon enough, rejected.

The failure to reconcile these viewpoints is perhaps the greatest obstacle facing the field of carbon management, since without clear agreement about where society is transitioning to, it becomes virtually impossible to effectively enable the socio-technical changes required, and to retain the necessary public backing. If we are seeking only to tweak the economy for marginal, politically palatable emissions reductions, then carbon pricing might be an appropriate framework. For example, it can serve to stimulate the incremental adoption of "low-hanging fruit" such as overdue efficiency improvements [5]. However, climatologists are ever clearer that we require dramatic and unprecedented emissions reductions in order to avoid the worst ravages of climate destabilization [6].

As Intergovernmental Panel on Climate Change lead author Josep G. Canadell recently stated in this journal, "The time has come to truly build carbon management into the deepest inner workings of society" [7]. Canadell goes on to state the common assumption that "no doubt" this should be achieved through carbon pricing. His recognition of the need for a coherent, overarching framework to harness the many facets of climate policy and action toward the goal of dramatic global emissions reductions is entirely justified. However, in this article, we raise significant doubts that carbon pricing is the most appropriate candidate to deliver the speed and depth of change

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Key terms

Carbon pricing: Umbrella term referring to policy frameworks – such as carbon taxation and conventional carbon trading – which use increases in the price of carbon as the core mechanism to restrain emissions. The term is distinguished from *quantity-based* carbon policy frameworks, which are built around a hard cap on emissions. On this definition, TEQs is not an example of "carbon pricing," since the scheme is built around a hard cap, with the price of TEQs units merely providing a highly visible indicator of how well society is adapting to the declining cap.

Social cost of carbon: The social cost of carbon measures the marginal cost to society of emitting one extra tonne of carbon today, incorporating the full economic cost of the climatic damage it will cause over its atmospheric lifetime. In theory, it signals what society should be willing to pay now in order to avoid the future damage caused by emissions.

Upstream: Refers to policy that engages with the limited numbers of fuel and energy companies that bring carbon into an economy. Upstream policy has the advantage of being cheaper to implement than downstream engagement (defined below).

Common purpose: Shared effort to reach a shared goal, with personal aims and collective aims aligned. Here applied to uniting a nation in the aim of radical reductions in energy demand.

Personal carbon trading (PCT): Umbrella term for frameworks that include an element of trading for individuals, including TEQs and personal carbon allowances (PCAs). PCAs would only cover individuals, and non-specialists can find the term PCT misleading when applied to the TEQs scheme, which covers all sectors of the economy, but it is the established umbrella term within the field.

Carbon rating: Under the TEQs scheme, each fuel or electricity source is subjected to a lifecycle emissions analysis in order to determine its "carbon rating." This rating determines the number of TEQs units that must be surrendered alongside a purchase of that energy – e.g. 0.1 units per kWh, or 2.1 units per liter. One TEQs unit permits the purchase of an amount of fuel of electricity that produces 1 kg of CO_2 over its lifecycle (i.e., not only from final combustion, but also from the combustion of all other energy consumed in bringing it to market).

Downstream: Refers to policy that engages with the many millions of individuals and households that consume energy in an economy. Downstream policy has the advantage of engaging directly with the source of energy demand.

Extrinsic motivation: Being motivated by the prospect of an external reward for undertaking a task, or penalty for not doing so

Intrinsic motivation: Being motivated by one's own desire for the direct consequences of a task undertaken, or by the inherent value seen in undertaking it.

required, regardless of whether prices are set via carbon trading (e.g., the European Union Emissions Trading Scheme) or carbon taxation. The dominance of the argument that price-based mechanisms are best able to deliver change in an efficient and cost-effective way [8,9] may be concealing other options from view, but alternatives are both available and much needed.

As is widely recognized in the field of socio-technical transition, in order to achieve deep societal change, the path-dependency and political and cultural lock-in that underpins current carbon usage must be addressed. This requires careful consideration of the multiple levels where change can be directed, and where pressure can be brought to bear [10], in order to nurture individual and organizational agency and develop alternative practices [11,12]. Smith *et al.* and others within the field note that marginal approaches that "treat regime transformation as monolithic and dominated by rational action" [11] may have been appropriate for addressing problems such as acid rain or water pollution, but are unlikely to succeed when applied to more challenging problems like climate change and resource depletion, which require a range of fundamental, complex and interrelated system changes [11,13]. A fresh approach is therefore needed.

As such, we, the carbon management community, have contributed to the widening rift between science and politics by attempting to respond to the imperatives of climatology with policy interventions that do not reflect the workings of society. As the literature on socio-technical transitions shows, a reconciliation will require action from us all: scientists, policy makers, campaigners and the public [11–14]. Within academia, we can begin by improving our cross-disciplinary communication, in particular by aligning the latest climate science more closely with findings in the fields of socio-technical transitions, social psychology and climate policy, and vice versa. One of the aims of this Perspectives article is to contribute to this process.

We begin by arguing for certain necessary features that any successful carbon management framework needs to display if it is to enable the scale and depth of changes required, both technically and socially. We consider several ways in which current policy frameworks fail to meet these, and then go on to assess an alternative with significant political and research history – TEQs (tradable energy quotas) – and whether it demonstrates the required features. Finally, we draw conclusions about appropriate pathways for future climate policy.

Essential features of an effective climate policy framework (and why carbon pricing is failing to deliver)

Ensuring emissions reductions

The fundamental shortcoming of the existing climate policy approach is its failure to curb emissions, with global CO_2 emissions from burning fossil fuels reaching a record high of 36 billion tonnes in 2013 (61% above 1990 levels, 2.1% above 2012) [15]. In the words of the International Energy Agency, addressing this requires "a far-reaching transformation of the global energy system" [16].

There are two approaches to achieving such radical change in a short timeframe; the essential difference between them being which of two variables is adjusted. Climate policy frameworks either act to influence *energy prices* (e.g., carbon taxation) in the belief that consequent emissions reductions will be sufficient to avoid climate catastrophe, or to place a cap on *emissions* (e.g., TEQs, explained below) in the belief that the price effects of this will not cause economic catastrophe. These are termed the *price-based* and *quantity-based* approaches, respectively.

The European Union Emissions Trading Scheme (EU ETS) is the largest emissions trading scheme in operation and perhaps the most prominent existing climate policy framework [17]. It caps emissions from the EU's power sector and heavy industry, and is notionally a quantity-based "cap and trade" scheme. However, in practice it has a ceiling on permit prices and is linked to non-EU nations through the Clean Development Mechanism and Joint Implementation framework, meaning that it has what is termed a "soft cap" – in other words, there is no absolute limit on emissions, as demonstrated by the hundreds of millions of tonnes of carbon that have been emitted above the level of its "cap" [18]. Neither the "global carbon market" established through the Kyoto Protocol and

subsequent international negotiations [19], nor a raft of national and regional carbon markets [20], has delivered emissions cuts of the speed and scale required.

Since they lack a hard cap, such frameworks are, in effect, price-based schemes, wherein an appropriate carbon price becomes necessary to achieving the intended emissions reductions (note that for the purposes of this article we do not distinguish between price-based schemes and hybrid schemes, since both open up the possibility of exceeding the cap, and it is the integrity of the cap that is our primary concern here) [21,22]. As such, they reduce the financial risk of high prices causing economic catastrophe at the expense of forgoing the benefits of quantity-based schemes that are explored below. It is perhaps unfortunate that the term "cap and trade" is widely applied to such effectively price-based schemes, as it can cause confusion and leaves us lacking a widely understood distinct term for "hard cap and trade" schemes. In this article, we refer to such alternative frameworks as "quantity-based" or "hard cap" schemes.

As both theory and present experience demonstrate [1,3,5,15,23], price-based mechanisms cannot deliver certainty of adequate emissions reductions. This is in part because energy demand has proven to be resilient (inelastic) in the face of price rises [24,25], but also because there will always be significant uncertainty as to whether the price is set at the right level to reflect the social cost of carbon. Arriving at a definite figure is rendered impossible by the need to incorporate unknowable factors, such as the exact economic impacts of present-day emissions on future generations (including non-marginal catastrophic scenarios) and forecasts of future atmospheric greenhouse gas concentrations [9,26,202]. As Rosen and Guenther argue,

> *"humanity would be wise to mitigate climate change as quickly as possible without being constrained by existing economic systems and institutions, or risk making the world uninhabitable…since we can never know what the cost of a hypothetical reference case would be, and since we must proceed with a robust mitigation scenario, we will never be able to determine the net economic benefits of mitigating climate change,* even in hindsight.*" (emphasis in original)* [27]

Consequently, given what is at stake, we argue that a quantity-based "hard cap" is the appropriate framework for our present situation, since this can guarantee achievement of a long-term emissions trajectory defined by climate science, *as long as the framework itself has the public/political support to survive the subsequent economic effects.*

We note that the rate of transition committed to by the UK government under its Climate Change Act (a 31% reduction in emissions from 2013 to 2025, representing a 50% reduction on 1990 levels) has already led to tension and a real threat to the political sustainability of the Act itself [4,203,204], despite the fact that current policies cannot deliver on such a carbon budget without "significant design improvements and increased ambition, extended further in time" [28].

It must also be remembered that the Climate Change Committee that recommended those commitments – tasked with representing physical reality in negotiation with the political reality of the day – stated at the time that "the level of ambition in this [carbon] budget should be regarded as an absolute minimum, and more may be both feasible and required" [29].

Meeting more ambitious targets, however, such as Anderson and Bows' annual 10% reductions, could be devastating for those in fuel poverty and politically damaging for those associated with such ambition, unless an appropriate policy framework can be found and implemented [3,205]. This is where the clash of physical reality (as revealed by climate science) and political reality becomes most apparent. Thus far, we have collectively ignored the rift between the two, telling ourselves that the problem is being addressed as emissions continue to rise. Moving to a quantity-based framework would call our bluff and prompt the necessary reconciliation; a painful one, no doubt, yet kinder than unmitigated climate change is liable to demand.

And as well as choosing an appropriate framework, we must also apply it widely and consistently. At present, even in countries that lead the way on carbon management, almost half of emissions – those generated by individuals and households – are not currently covered by any overarching, consistent policy framework. The UK, for example, has relatively ambitious, legally binding emissions targets [30] and 100+ present or planned policies that impact on the level of household carbon emissions: from taxation, tax rebates, feed-in tarrifs and grants to building regulations, information schemes, smart meters and appliance labelling [31]. However, these are collectively laboring under what Kern *et al.* characterize as UK energy policy's "complex and incoherent" governance framework [32], with the House of Commons Environmental Audit Committee concluding that "existing initiatives are unlikely to bring about behavioural change on the scale required, with many individuals choosing to disregard the connection between their own emissions and the larger challenge" [33]. Consequently, the potentially huge collective impact of individual and household decisions on energy use is not being fully realized, and will be essential to a successful climate mitigation effort [34,35].

Price-based frameworks could potentially be applied to this [36], but we will now consider certain inherent features of carbon pricing frameworks that have contributed to their becoming sufficiently unpopular that even climate activist groups oppose and demonstrate against

them [206]. In this context, any attempt to directly engage households in a pricing framework is perceived as a risky political move, and may even be perceived by some stakeholders as "letting government off the hook" by shifting away the responsibility for action [37].

Public acceptability

If a compulsory climate policy framework is to be applied to individuals, families and their homes, it is likely to receive far more scrutiny than present upstream approaches. In this context, the carbon pricing approach of treating all equal-sized emissions cuts as fungible can be expected to raise controversy. While it is true that the geographical location of cuts make little difference to the climatic impact, other differentiating features become highly significant when radical restructuring of the economy is necessary. For example, society may distinguish between what Shue broadly terms "subsistence emissions" – here, the emissions perceived as unavoidable when living within a household's current societal context – and "luxury emissions," that could reasonably be cut back [5,38].

These distinctions are culturally subjective and transitory – as society changes, the emissions required for "subsistence" will change, as may the modes of subsistence – but while emissions perceived as "luxury" may be called on for adaptation, any program that cuts back on perceived "subsistence emissions" is likely to experience a significant public backlash. Consequently, winning and retaining popular and political support requires carbon management frameworks that deliver emissions reductions while safeguarding entitlements to basic energy services [39].

Another reason underlying the unpopularity of the carbon pricing approach is that it embeds a contradiction at the heart of policy. The UK Department of Energy & Climate Change (DECC) describes its aims as being to "make sure the UK has secure, clean, affordable energy supplies and promote international action to mitigate climate change" [207]. Yet if decarbonization is pursued primarily by striving to raise carbon prices, then it pulls against affordability of energy supply. Over 80% of global energy still comes from fossil fuels [208], so aiming to raise carbon prices while keeping energy affordable is difficult – the prices of energy and carbon remain stubbornly linked. Accordingly, price-based approaches as currently designed tend to hurt the poorest, both globally and within nations, as the deliberate raising of the price of carbon makes energy unaffordable for many, effectively rationing energy by price.

To put this in context, household energy bills in the UK have increased by 75% over the past 10 years (as compared with 23% general price inflation, and despite a reduction in energy consumption). Although the Committee on Climate Change find that four fifths of this increase is unrelated to climate policy, the public have nonetheless come to identify the current suite of climate change mitigation policies with further increases to already-rising energy prices [40]. In these straitened times, this drains public and political support, especially when juxtaposed with the widely reported windfall profits reaped by corporate participants in the EU ETS [41].

Simpler, more radical price-based proposals like the "Fee & Dividend" revenue-neutral carbon tax [209] could, if implemented, mitigate the impact on the poorest and thus bolster the political sustainability of the policy, potentially making a higher carbon fee/tax feasible. However, such frameworks would still preserve the double agenda – the need for both higher carbon prices and lower energy prices – that leaves the "rift in realism" unresolved, and underpins the incoherence of our present policy suite.

As discussed in detail below, quantity-based frameworks offer the powerful possibility of a simple, shared, high-profile focus throughout society: keeping the price of energy as low as possible.

A longer term perspective

In addition to failing to recognize the distinction between "subsistence" and "luxury" emissions, carbon pricing also struggles to account for another way in which emissions cuts of the same size may differ. Consider a 1-tonne CO_2 cut resulting from a new renewable energy technology, or from a different way of organizing social life. This type of cut may unlock the possibility of dramatic future cuts. By contrast, consider a different 1-tonne cut resulting from an end-of-pipe technology added to inherently carbon-intensive infrastructure that must soon be closed down. Viewed from a long-term perspective, the impacts of these 1-tonne cuts differ significantly [5].

For a sustainable transformation in societal emissions, we need policy that places such sensitivity to wider transformational potential at the core of decision making. Decisions and investments which may take 20 years or more to achieve the intended results are required throughout society, and appropriate long-term planning will only happen under a widely supported policy framework combining clarity and longevity.

Price-based frameworks have tried to fulfil this overarching role, but since they inherently treat all emissions reductions as fungible, allow for uncertainty with regard to the expected overall rate of decarbonization and cannot provide a consistent long-term signal to the economy (a stable price will be inappropriate at certain points of the economic cycle, while a fluctuating price lacks the necessary consistency [17,39]), they instead often drive short-term, quick-fix approaches. These in turn can reinforce political and cultural lock-in, resulting in higher emissions over the longer term [23].

A truly effective framework would need to provide real clarity and confidence regarding the long-term trajectory toward a low-carbon future, allowing society

to focus on innovating toward that end, rather than on meeting the immediate requirements of patchwork policy [10,11].

■ Integration – cross-sector engagement, motivation and collaboration

Bringing individuals, households, business and all energy-users into climate policy in an engaged and integrated way would open up significant new possibilities for cross-sector co-operation. The "complex and incoherent" governance framework [32] under which climate policy currently operates may have obscured the possibilities here, but they are potentially huge.

As Peters, Fudge and Hoffman recently highlighted in this journal, there is both a need and a failure "to engage people individually and collectively in establishing more sustainable, low-carbon societies" [42], with the provision of a clear vision recognized as critical to such large-scale system change [11].

If a clear and effective method could be found to stimulate common purpose in carbon reductions throughout society, articulating the direction of travel visibly at a range of levels, then the practical and political challenges of achieving dramatic emissions cuts could quickly take on a very different appearance. From our current perspective, it may seem unlikely, even utopian, to imagine communities and households collaborating with each other to this end, alongside companies and local and national government. However, this is precisely the kind of radical change that climate policy must catalyze in order to enable citizens to maximize their wellbeing within adequate carbon constraints [39,43].

Having outlined some of the features of present practice that are contributing to the current rift between science and policy, we will now describe and consider an alternative framework that engages with these shortcomings, and thus may offer an effective way forward.

A candidate policy framework: TEQs (Tradable Energy Quotas)

The TEQs scheme is a quantity-based framework for emissions that integrates all sectors of the economy, including households. It would operate at the national scale [44], providing a means for a country to guarantee the achievement of its national carbon budget, and thus play its part in – even lead – the global climate change mitigation effort [39].

Several excellent expositions of the details of the scheme now exist [39,45,46], but in essence it can be thought of as similar to an electronic system for rationing energy use, only with legal trading of allowances. A variant named personal carbon allowances (PCAs), which would cover only household emissions, has also been proposed [47], with personal carbon trading (PCT) having become the established umbrella term for these related schemes.

PCT as a whole has been described as "an innovative, radical policy approach to climate mitigation" [34], with TEQs in particular described as "a simpler and fairer approach than either green taxation or the European Union Emissions Trading Scheme, [that] also provides people with a powerful incentive to demand low-carbon technologies" [48].

Under TEQs, every adult would receive an equal free entitlement of TEQs units each week. All other energy users – government, industry, etc. – would secure their TEQs units through a weekly tender (auction), either by directly participating, or via intermediaries such as high street banks or the post office (known in the literature as "market makers" or "primary dealers") [46].

The total number of TEQs units issued into the economy would be determined by the national carbon budget (in the UK, this is currently recommended to the Government by the Committee on Climate Change). The proportion of that total issued as free entitlements would reflect the proportion of national emissions produced by the direct fuel and electricity use of the household sector (currently around 40%), with the remainder issued to organizations via the weekly tender [49].

Whenever fuel or energy was purchased in the country, a number of units corresponding to the amount of energy bought would have to be surrendered to the retailer from the purchaser's TEQs account, in addition to their monetary payment. This number would be determined by the carbon rating carried by all fuels and electricity, which is calculated on the basis of the lifecycle emissions associated with their production and use (and thus provides a competitive advantage to low-carbon energy sources) [39,46].

TEQs units would only be required for direct purchases of fuel and energy (not for purchases of all products and services within the economy), and unit transactions would generally be automatic, integrated into existing credit-card and direct-debit systems [50].

Those households using less than their entitlement of TEQs units would be able to sell their surplus to the bank or post office at the prevailing national price (determined by the auction price at the start of the week and varying with national demand thereafter). Those who need more could buy these surplus units at the national price, with the process of buying and selling comparable with topping up a mobile phone or travel smart card (e.g., London's Oyster cards). Similarly, overseas visitors, or others without units, would simply pay a surcharge at the point of energy purchase, determined by the retailer buying the necessary units on their behalf and passing on the cost.

A full year's supply of TEQs units would be issued via both entitlement and tender on the first day of the scheme. From then on, the regular weekly issue of new units would commence. Hence, there would be a rolling year's supply of units in the economy at all times.

As illustrated in Figure 1, after TEQs units pass from consumers to energy retailers at the point of energy purchase, those same units would then pass from the retailers to wholesalers as the retailers purchased their own energy supplies. They would continue to flow up the energy supply chain until ultimately reaching the country's primary energy providers and importers. Finally, these organizations would surrender the units back to the original issuing body (registrar) in exchange for the right to produce or import energy into the economy, in line with the national carbon budget. In other words, at every point where energy moves through the economy, the units are exchanged for the energy and thus flow in the opposite direction.

Crucially, this allows downstream public engagement without the need for an extensive downstream compliance and enforcement process. Just as with cash, any supplier who sold fuel or energy without ensuring the receipt of the requisite number of TEQs units would quickly find themselves out of pocket when purchasing their own supplies. And, just as with cash, the government does not need to monitor every retailer to ensure that they are not giving away their stock. Nothing more than routine auditing would be called for [22,51].

TEQs also seeks to combine the best of upstream and downstream policy by covering all emissions from energy use within the economy, while requiring neither direct measurements of emissions at the point of combustion nor a lifecycle analysis of every possible product and service. Through the lifecycle carbon rating on fuels and electricity, the emissions attributable to them can be quantified upstream. And since energy is required for all economic activity, the emissions implicit in the production of all goods and services are thus covered. For example, no TEQs units are surrendered for the purchase of a chair, but the manufacturer of the chair will have needed to purchase units, as will the company who transported it to the shop, and they will pass the costs on to their customers (in the cash price that they charge). So, downstream, consumers simply find that the cheaper option tends to be the lower carbon option, while retailers who are able to offer a lower carbon supply chain receive a clear competitive advantage.

With regard to goods imported from abroad (and on the assumption that there is not a TEQs system or

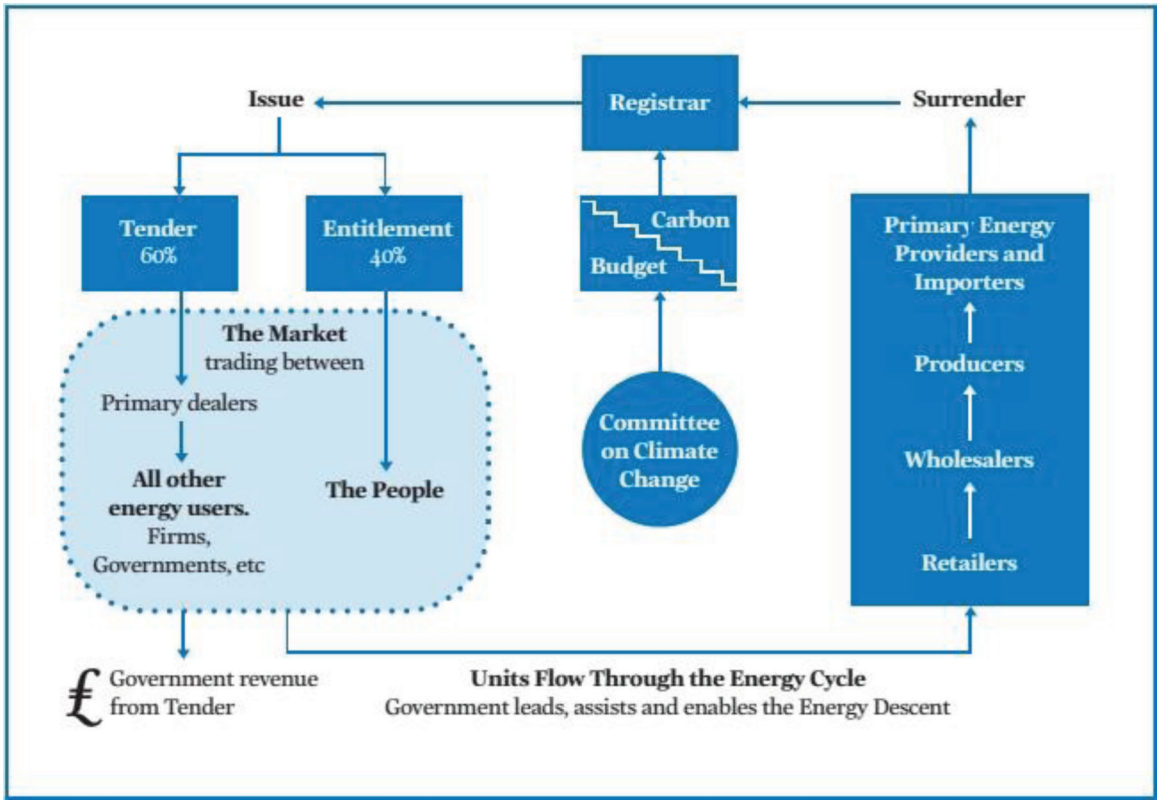

Figure 1. How TEQs units flow through the economy [39].

equivalent operating in the origin country), import tariffs will likely be necessary to protect domestic producers. Until recently, such tariffs were deemed politically unrealistic, but the World Trade Organization have now admitted that their rules do not prohibit such tariffs [210], and there is growing political recognition that in the absence of a robust global agreement on climate change, tariffs are the only option to defend countries that take their emissions responsibilities seriously [52,211].

Importantly, just as with carbon pricing, TEQs is not intended as a stand-alone policy, but rather as "the umbrella mechanism within which a wide range of other policies would operate" [45]. Indeed, it has the potential to create a far more receptive national environment for the many vital carbon management tools covered in this journal and elsewhere, from green taxation and sweeping standards-based regulation [205] to the creation of low-carbon precincts [53] and atmospheric carbon removal technologies such as agroecological soil carbon sequestration [54] or industrial direct air capture [55]. The key is that by ensuring the overall carbon budget is respected, TEQs provides the overarching framework to shift such policies from worthwhile (yet sometimes resented) drops in the ocean to essential and much-welcomed initiatives helping society to thrive as it moves through a difficult energy transition.

We will examine the political climate around TEQs presently, but first let us consider the ways in which it may outperform price-based mechanisms with regard to the criteria outlined above.

Ensuring emissions reductions

As discussed above, quantity-based systems such as TEQs can guarantee achievement of the national carbon budget over its full term in a way that carbon pricing cannot, as long as the TEQs framework itself remains in place.

It should be noted that despite the current dominance of price-based and "soft cap" approaches, the core debate between price-based and quantity-based approaches goes back at least a century, with quantity-based approaches finding favor when the stakes were at their highest and quantities least negotiable. As historian Mark Roodhouse summarizes,

> *"the use of taxes alone to control consumption was rejected in the World Wars, and they would not achieve the quick, dramatic cut in carbon consumption that we need now to avert environmental disaster. Tradable carbon rations would have a real impact, if the public could be persuaded that they are necessary, temporary and fair."* [56; see also 57]

And it is in that last caveat that we find the real challenge for *any* effective climate policy framework – persuading society as a whole that the framework should be retained as it enables the tightening carbon budget to affect industry, lifestyle choices and the economy as a whole.

This is where the literature on socio-technical transitions can make an essential contribution. It emphasizes that since society and its practices are made up of "institutions, techniques and artefacts," as well as "rules, practices and networks that determine the 'normal' development and use of technologies" [11], we need to alter not only our policy tools and structures, but also "markets, user practices, policy and cultural meanings" [10].

As we will examine, TEQs engages fully with these imperatives. The real question for the carbon management community, therefore, is not simply which frameworks could theoretically enable effective and sufficient carbon reductions, but whether the evidence from all relevant fields suggests that TEQs may stand a better chance than the alternatives of doing so without being overthrown by public or political opprobrium.

Public acceptability

We have seen above that carbon pricing frameworks have been struggling with popularity, and this partly explains why public acceptability has been the most active area of research into PCT schemes.

Fawcett's reviews of the research to date [35,45,58] show that the findings are remarkably consistent. When PCT schemes are compared with existing climate policies they are usually preferred by the public, with the key benefits seen as fairness and effectiveness. This popularity relative to the alternatives immediately makes PCT an interesting proposition, especially considering that "the research highlighted that the way that personal carbon trading is presented and described and the context in which it is set, can have a considerable impact on its acceptability" [59]. Accordingly, even more positive results might be expected from acceptability research which puts significant effort into framing and communicating the TEQs scheme's design and principles. Interestingly, the research to date also identified that respondents who were *not* in favor were primarily concerned about implementation and unfairness, which serves to underline the importance of perceived fairness in achieving social acceptance [45].

TEQs addresses such concerns over fairness in three main ways. Firstly, the system is based on the principle of equal per-capita allowances for all, with the guaranteed regular entitlement of TEQs units for every individual designed to ensure that essential "subsistence emissions" are safeguarded as society adapts to a low- or no-carbon future, irrespective of the price trends of TEQs units [38]. As mentioned above, what constitutes "subsistence" or "luxury" is highly culturally subjective

and subject to change over longer periods, but TEQs incorporates these shifting perspectives by leaving these choices with the energy consumer.

If a citizen wishes to consume more than her share, she may do so – and without compromising the integrity of the emissions cap – but only if she is willing to, in effect, pay those who use less for the privilege of doing so. And if others choose to be exceptionally energy-thrifty, they can expect to be rewarded for this. This freedom for individuals, families and communities to decide for themselves what is essential and what is not is critical both politically and practically. Sharing ownership of the problem across society encourages both active, engaged participation in creatively reducing energy demand, and a sense of legitimacy around the TEQs framework, which can be seen guaranteeing entitlements to essential energy while defending people's independence from excessive top-down regulation and/or taxation [39,60].

Secondly, TEQs is a progressive policy instrument, since lower income households tend to use less energy and thus could sell surplus allowances to gain extra income. Distributional impact modelling has found that 71% of households in the lowest three income deciles would be better off under TEQs, while 55% of households in the highest three income deciles would be worse off. From a total of 24.6 million UK households, 2.1 million (8.5%) would be low-income households that would be worse off [61,62]. However, this is an important minority, primarily because they may not be in any position to be further disadvantaged, but also because any opposition to the scheme after implementation would be likely to focus on those in difficulty. Consequently, further research has been undertaken into moderating the distributional impacts on these households, finding that all but 250,000 of the poorest 10% of households could be compensated through the benefits system [63]. Finding ways to identify these remaining 250,000 households and target them with compensatory measures remains an area of active research [64].

And thirdly, TEQs provides an alternative to the unpopular "rationing by price" approach currently in effect. While TEQs incorporates a market mechanism to do what markets do best – finding a price for scarce goods and facilitating exchange – it is not a market-based framework. Rather, it is a framework within which the market would be constrained, in line with the national carbon budget; the ongoing financial crises of recent times show all too clearly that markets are not good at regulating their own appetites. It is not what they are for.

At the heart of TEQs is a non-negotiable respect for the limits set by physical reality, as revealed by climate science. This gives society as a whole a clear signal as to future emissions limits, stimulating a collective focus on adapting to these limits. In particular, government need no longer concern itself with attempting to raise the carbon price, but can straightforwardly join and support [65] the collective drive to keep the price of energy *as low as possible*. This is a simply understood task that all sectors of society can enthusiastically engage with.

A longer term perspective

An independent body responsible for setting national carbon budgets (or "cumulative emissions pathways" [66]) decades in advance was anticipated by the TEQs literature [67] and is now extant in the UK in the form of the Committee on Climate Change. However, the Committee currently lacks a means to see its budgets effectively implemented.

This undermines the benefits of its long-term carbon budgeting, as investors across society recognize both the uncertainty that the budgets will be achieved and government inconstancy in defending the budgets themselves. TEQs would provide a clear, consistent policy framework to guarantee the budgets, while its acceptability benefits (and the public engagement anticipated in the next section) would offer the greatest possible confidence that the framework will persist over the long term.

The system would also aid confident long-term financial budgeting across the economy by helping to stabilize national energy prices in the face of global fluctuations. If global energy prices rose, this would be reflected in reduced national demand for energy and thus for TEQs units. As a consequence, the TEQs unit price would drop as global energy prices rose, and vice versa, leaving the effective price paid by energy users (energy price + TEQs price) more stable than the price of either energy or TEQs units alone.

Integration – cross-sector engagement, motivation and collaboration

TEQs' design draws on principles from social psychology. It is explicitly designed to generate a shared sense of common purpose (or, in behavioral economics terms, "conditional co-operation" [68]) in a nation, in recognition of both the vital role of public engagement in any large-scale transition [11], and the fact that social forces are an important and enduring influence on individual choices [69,70].

All sectors buy and sell TEQs units at a single national price, and since supply of the units is fixed by the hard cap, the fluctuations in this price are determined solely by national demand for (carbon-rated) energy. Hence, it is in all sectors' interest to keep this price low, not only by reducing their own energy use (or its carbon intensity), but also by collaborating with others in doing so, and bringing pressure to bear on those who are perceived to not be "pulling their weight." In this way, it aligns individual and collective interests in order to harness the creativity

and innovation of a nation toward the clearly visible aim of lower energy prices [39,46], providing "a perceptual and cognitive framework enabling individuals to integrate understanding across emissions from different activities, and in the context of energy use as it occurs" [34].

In addition, a number of studies suggest that the clear demarcation of a "normal" or even "appropriate" level of carbon consumption (in the form of the declining entitlement) may be expected to reduce energy demand accordingly, with the high visibility of the national price of TEQs units also generating positive mental accounting effects and generating "stop and think moments" that disrupt high-carbon habits [65,71,72]. The public's understanding of their own energy use and emissions will inevitably improve, with the national TEQs price – published daily in the press and online [46] – providing a clear indicator of how successfully, or otherwise, the country is adapting to its carbon cap. Research suggests that as such understanding grows and people gain a sense that they are contributing to an adequate solution, they may become increasingly committed (even morally) to "doing their bit" to play a role in an overall solution, and thus more supportive of ambitious climate policy [73,74].

Also, as Smith and colleagues note, "even in transition contexts where end-points are highly contested or only partially understood, ideas about what might (or ought to) be are essential to envisioning the possibility, let alone motivating the pursuit, of change" [11]. A positive, enticing image of where we are headed is essential, and with the UK government itself bound by the TEQs framework, it would be far better placed for the task of articulating a coherent vision [75] for the low-carbon society that its Climate Change Act commits the country to.

Above all, while academics and policy makers can try to predict some of the societal effects of a transparent and accessible carbon framework, under TEQs the need to do so is removed. No longer would government be responsible for micro-managing the transition itself. Instead, once the common frame is set, many of the changes within that framework can be allowed to emerge organically, in the diverse – even "messy" – way that new collaborations and local innovations tend to develop [39,76]. Such "bottom up" initiative and ownership is also likely to encourage wider engagement with, and buy-in to, the overall societal transition [77].

However, while acknowledging that, "from this distance, it is hard to describe its nature in any detail," Fleming has nonetheless speculated as to some of the forms such cross-sector co-operation might take, from communities and companies co-operating in sourcing local goods and services to households working together on conservation, renewable energy systems, repairs and local food [39]. Where supplementary institutional support is needed, it will be called for by those involved – those individuals, communities or institutions with intimate knowledge of the practical detail – rather than government or NGOs trying to develop and provide resources and/or expertise on the basis of what they anticipate may be needed [11,60]. Meanwhile, the revenue from the auction of TEQs units provides funds that can be pulled down by those involved in such projects [39]. (For further discussion of the allocation of auction revenue, see online supplemental material, available from the article's Taylor & Francis Online page at http://dx.doi.org/10.1080/17583004.2015.1021563.)

Some such collaborations do already exist, with the Transition Towns movement and its REconomy strand, for example, providing a myriad of practical examples of such cross-sector co-operation toward reduction in energy demand and carbon emissions [78,212]. Crucially, however, under current policy frameworks, such efforts are always swimming against the tide. For example, a hard-won reduction in petrol use in one city might serve to bring down the price a little, thus encouraging greater consumption elsewhere and leading to little or no net reduction in emissions. Understanding this can be disheartening for those trying to contribute toward solving large-scale problems like climate change, which helps explain why those involved with such local climate initiatives have consistently been among the strongest campaigners for TEQs [79,80].

With its hard cap on emissions in place, TEQs would reverse this effect. Any local reductions in energy use would not only save money for those involved, but also play a clear, practical part in aiding the energy transition of the nation as a whole, with the contribution to lower energy prices for all becoming a straightforwardly desirable outcome which helps to defend the political sustainability of the TEQs framework and its hard cap. The implementation of TEQs would provide clear reassurance that we really are "all in it together" at the national scale, greatly diminishing established psychological barriers to energy demand reduction, such as concerns about free riders and the sense that your personal contribution cannot make a difference [46,81].

TEQs is also here drawing on the distinction between extrinsic and intrinsic motivation. By defining a clearly understood and intrinsically desirable goal (sustaining affordable access to energy, and by so doing ensuring that the nation plays its part in preserving a benign climate), TEQs aims to make shared intrinsic motivation explicit across society.

Note that even those individuals with below-average energy use who regularly have surplus to sell from their TEQs entitlement – who might be thought to gain financially from high TEQs unit prices – would not stand to benefit from rises in national (carbon-rated) energy demand. Such rises would cause the price of *both* TEQs units and energy to increase, so in addition to a direct rise in the price of their energy purchases (offset to some

extent by increased income from the sale of their TEQs entitlement) our energy-thrifty individual would encounter a general increase in the prices of products and services throughout the economy, caused by higher energy prices. Even in the unlikely scenario that such an individual mistakenly believed that TEQs unit price rises were in their personal short-term financial interest and decided to attempt to drive them up by somehow blocking demand reduction, they could come under intense peer pressure to desist. In a society consciously working hard to adapt to the energy transition, those seen as responsible for raising energy prices might be treated even less warmly than they are today. The tide would have turned.

This focus on the importance of intrinsic motivation again draws on social psychology research, which shows not only that external financial incentives and disincentives generally fail to produce improved performance at tasks requiring long-term behavior change, insight or creativity, but that they can actually have a detrimental effect. This is because they can undermine both people's belief in their own abilities and any pre-existing intrinsic motivation toward the goal [82–84], while acting to reinforce materialistic values and frames (that have been found to suppress systemic concern for society or the shared environment) [83]. Accordingly, policy based purely on financial rewards and/or penalties may be unsuited to stimulating radical socio-technical transitions from the grass roots up; such policy runs the risk of unintentionally engaging society's ingenuity in the wrong challenge – that of seeking out clever ways to receive the rewards or avoid the penalties without heed to the policy's intended aim – instead of that of reducing collective energy demand.

In short, as the UK Environmental Audit Committee's report on PCT summarized,

> *"We remain to be convinced that price signals alone would encourage significant behavioural change comparable with that resulting from a carbon allowance…. A meaningful reduction in emissions will only be achieved, and maintained, with significant and urgent behavioural change."* [33]

Having examined the arguments as to why TEQs may represent a more appropriate carbon management framework than carbon pricing, we now outline TEQs' political and research history, and consider why it has not yet moved closer to implementation.

A political history of TEQs

The TEQs framework was developed in 1996 [39,85,86]. In 2004, 11 UK Members of Parliament (MPs), led by Colin Challen (who would later found the All Party Parliamentary Group on Climate Change), introduced a Private Members' Bill advocating the scheme [87]. This led to extensive international research and popular interest, although much of this was published in the form of books and reports rather than in academic journals [48,79,80,88–91].

In 2006, the then-Secretary of State for Environment, David Miliband, gave a strong speech in support of PCT, shortly followed by the announcement of a feasibility study, which was completed in 2008 [92,213]. The authors of the four reports that make up this study were instructed to take the TEQs scheme as their subject, since this was deemed to provide the best insight into the merits or otherwise of PCT as a model [93]. The study found that there were no technical obstacles to implementation, that PCT would be a progressive policy and that public acceptability was comparable with, or slightly better than, the presented alternatives of upstream trading and carbon taxation (these conclusions were in line with the existing wider research into PCT).

However, the most influential report within the study assessed the "potential effectiveness and strategic fit" of PCT [94]. Unlike the other reports, this explicitly considered a PCA scheme (i.e., PCT applied only to individuals), thus removing several of the key benefits that TEQs claims, such as providing a framework for intrinsic motivation, innovation and common purpose. It also argued that "uncertainty about how high the price of allowances may go poses a political risk that makes it unlikely that a hard cap would be used" and argued instead for a more flexible "soft cap," whereby the cap is loosened if prices go too high. In other words, before conducting its analysis, it converted PCAs into a price-based framework. On this basis, its analysis concluded that the costs of PCT would outweigh the benefits, leading to Defra's overall conclusion 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."

Accordingly, Defra announced that

> *"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."* [93]

A number of thoughtful and critical responses to the government's decision to discontinue its research program followed, including from The Lean Economy Connection [22], the Centre for Sustainable Energy [214] and the Institute for Public Policy Research [95]. Significantly, the influential House of Commons Environmental Audit Committee (EAC) published its own report just a few weeks after Defra's, based on its own concurrent

collection of evidence. This described PCT as "the kind of radical measure needed to bring about behavioural change," "regretted" Defra's decision to discontinue its research program and concluded that PCT

> *"could be essential in helping to reduce our national carbon footprint…. 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."* [33]

However, the UK government's response to this report largely restated the findings of Defra's feasibility study and did not express any change of viewpoint in response to the EAC's evidence and support, reiterating the opinion that high costs and fears over public acceptability outweighed the potential of the proposition [96]. There were press claims that the idea had been banned by Gordon Brown at the Treasury [215].

This slowed the momentum behind the scheme, although in June 2009 a ministerial debate was called by Tim Yeo MP, then chair of the EAC, who opened with the statement:

> *"Whatever we are doing now by way of generating low-carbon electricity, constructing more energy-efficient buildings, developing low-emission vehicles and so on, it is nowhere near enough…. Every single citizen as a consumer needs to be directly engaged in the battle against climate change. That is why personal carbon trading deserves far more attention than it is getting, either from the Government or from other people."* [97]

He went on to call for a pilot scheme, volunteering the Barbergh District Council area in his own constituency of South Suffolk for the role [97]. There is significant debate within the research community as to whether PCT is suited to a pilot (which would be likely to have its effectiveness undermined by significant boundary issues, as well as limited duration and participation [89,98,99]), and this opportunity was not pursued, but interest in the idea remained, with academic research continuing to accelerate [58]. After the 2010 UK general election, Tim Yeo became Chair of the House of Commons Energy and Climate Change Select Committee, and has remained a keen advocate of PCT [100,216].

High-profile public support over the next couple of years included the Sustainable Development Commission highlighting PCT as one of 19 breakthrough ideas for the 21st century [101], and the chairman of the Environment Agency declaring that "rationing is the fairest and most effective way of meeting Britain's legally binding targets for cutting greenhouse gas emissions" [217].

The government's commitment to monitor future PCT research, and to reconsider implementation if higher benefits or lower costs could be demonstrated, prompted the All Party Parliamentary Group on Peak Oil to publish a report on TEQs in 2011. This made a strong case that the government's criteria for again considering the introduction of TEQs had been met, and that a fresh and thorough feasibility evaluation was now called for [39].

Drawing on the research published since 2008, the report argued that Defra's cost-benefit analysis had taken its cost estimate from an analysis of a whole-economy TEQs scheme [50] while comparing this with the benefits of a more limited households-only PCA scheme [94]; that the likely costs of a TEQs scheme would be far lower [22,95]; that Defra's purely financial analysis failed to give regard to several additional benefits of TEQs, including ensuring fair entitlements to energy during reductions in supply (whether due to rapid decarbonization or insecure energy supply chains) [39], shifting perceived norms in acceptable behavior [65], contributing to a national sense of common purpose and the importance of the hard cap in providing both effectiveness and an improved long-term signal [22]; and that the methodology adopted in the cost-benefit analysis was subject to such large uncertainties over critical variables that even with all of these shortcomings the conclusion could still easily have been positive [218].

The association with a cross-party parliamentary group and a report launch featuring presentations from high-profile MPs helped the report to achieve extensive media coverage, both nationally and internationally [219]. However, it garnered no official response from DECC, who later confirmed that despite the government's commitment to monitor ongoing research, the department had no staff allocated to take responsibility for this area [Owen L. Pers. Comm., Email to S. Chamberlin, 7 June 2011].

As a consequence, without a public groundswell of support to drive political engagement with such radical climate policy, TEQs' development (and that of PCT generally) has slowed. Nonetheless, it remains core policy for the Green Party of England and Wales [220], while Sweden's Green Party [221] and Left Party [222] have both passed resolutions in support of a feasibility study. Member of the European Parliament Dario Tamburrano, of Italy's Five Star Movement, is another significant, long-standing advocate within European politics [223], while wider interest is sustained by academia [35,58,224], NGOs [102,103,225], independent campaigners [226,227], community groups [99] and a PCT-related trial on Norfolk Island, a self-governing protectorate of 1750 people 1600 km east of Australia [104,228].

As the EAC concluded in 2008,

> *"what is needed, urgently, is a shift in the debate away from ever-deeper and more detailed consideration of*

how personal carbon trading could operate towards the more decisive questions of how it could be made publicly and politically acceptable" [33].

Conclusion

As Maslow noted, "it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail" [105]. The carbon management community must frankly recognize the inherent shortcomings of our hammer – carbon pricing – as a framework for a task as delicate and demanding as the socio-technical transitions needed to rapidly limit emissions. This article has laid out a number of these shortcomings and outlined several principles that we believe are essential if any framework is to stimulate an effective, sufficient reduction in emissions.

Given the stakes, we argue that the climate policy community should favor quantity-based frameworks that can guarantee the emissions trajectory that science demands. With such a firm framework established, economists, designers, engineers, policy specialists, society and the market could unleash their full focus on devising brilliant means for maximizing wellbeing within that context. And we have evidenced the case that the TEQs framework stands the best chance of retaining the requisite public support and engagement over the long term.

Returning to political realities, the implementation of such an unyielding framework will only happen if the political risk of failing to prevent the destabilization of our climate comes to be seen as outweighing the risk of high prices. This would undoubtedly represent a fundamental shift in the direction of both politics and carbon policy. Yet if we do not change direction, we are likely to end up where we are headed.

The UK government's description of TEQs as "ahead of its time" in 2008 implied that it was too radical and too different from the prevailing public and political thinking. However, Fawcett highlights that this charge could also be laid against that government's own Climate Change Act pledge of 50% carbon reductions by 2025 [45]. In relation to current emissions trends, the government's target must itself be recognized as radical, and any reasonable definition of "politically realistic" must include holding governments to existing legally binding policy. Any government with such commitments cannot shy away from the policy framework that can actually enable the deep socio-technical changes needed to deliver these targets (as well as laying the groundwork for the yet greater ambition many scientists deem necessary [106]).

For our part, the carbon management community must take responsibility for reminding governments of this, in every way open to us, in order to address our own complicity in perpetuating the science/politics rift described above. It behooves us all to consistently remind ourselves and others of the severity of the likely climatic consequences should such a framework be abandoned (or never adopted). If political and scientific reality are not reconciled, only one will pull rank. Allowing this would be perhaps the greatest abrogation of responsibility ever seen.

Future Perspective

The coming years are the "last chance saloon" for climate policy. Continued failure to address atmospheric concentrations of greenhouse gases is likely to mean committing our planet to climate destabilization [1–3,6], while consigning the field of carbon management to failed obsolescence. As Kevin Anderson put it at the December 2013 Radical Emissions Reduction conference, "avoiding dangerous climate change remains a feasible goal of the international community. Just." [229]. Significant changes to energy supply infrastructure are not possible on such a short timescale, so dramatic energy demand reductions of the kind that TEQs were designed to facilitate are now the only option, allowing time for low-carbon energy supply to come on stream [39, 205].

Bird and Lockwood [95] and Fawcett [58] have argued that the most likely political circumstance to lead to the introduction of TEQs or any form of PCT is the convergence of three factors: the failure to meet national greenhouse gas reduction targets; political leaders needing new ideas in the face of pressure from the public, NGOs or other powerful stakeholders; and a fully developed policy option, ready to go.

While the first of these is already unfolding before us, we in the carbon management community have a role to play in *all three factors* if society is to achieve decarbonization. With regard to the first – the failure of current policy – we must communicate: we have access to resources and knowledge, and the responsibility to use these for the benefit of all. We can speak up, both within academia and more widely, about the failure to meet targets. And we can use our positions to demonstrate both that the findings of climatology demand more rigorous targets and that radical policies to deliver the required targets are available.

We can also actively contribute to the second factor by helping build pressure on governments and creating the political space for radical policy change. Extreme weather events continue to contribute to this, from Hurricane Katrina to the 2014 flooding in the UK [230], but as powerful and well-informed stakeholders we must play our part. For too long, our community has sheltered behind the notion that our responsibility is simply to publish research and hope that it is picked up. If we exercised our minds individually and collectively, utilizing an understanding of how to realize socio-technical transitions, we could devise many effective ways of building and using our influence, for example through shared petitions, position papers and writing for wider print

and social media. In this era where research is increasingly assessed on its "impact," many opportunities present themselves. We can also work collaboratively with NGOs, activists and progressive companies/think-tanks, informing their work as to appropriate policy interventions, and supporting them in building the widespread public support for policy change that is required.

Finally, we can further develop the evidence base behind TEQs by contributing to a comprehensive research program informed by political and social realities. This could be undertaken in the old "winner takes all" model, where one large research center successfully bids for funding to carry out the complete program. However, more likely, this program will be as internationally dispersed and diverse as the research carried out into TEQs/PCT to date, with some carried out by established centers with grant funding and some driven by the good will and enthusiasm of individuals, communities, research centers, businesses and NGOs. Other papers have already sketched out a multidisciplinary research and implementation program [37,44,45,58,89,98]. What matters is that this effort is targeted and collaborative, so that we develop a robustly evidenced, ready-to-go policy option that satisfies the needs of every stakeholder, from politicians to the public, from industry to the third sector.

While there is broad consensus within the research community that outstanding questions remain to be answered before TEQs is implemented, there is much that can be done now toward that end. In the words of the UK House of Commons Environmental Audit Committee,

> *"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"* [33].

That implementation represents the point at which calculating appropriate emissions pathways would become more than a paper exercise. In the fight against the destabilization of our climate, society would finally have teeth.

Supplementary Online Material

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Executive Summary

Framing

- Politics is not reflecting the urgency of climatology findings.
- Interdisciplinary analysis shows that carbon pricing is an unsuitable policy framework to guide the unprecedented emissions trajectory required.

Carbon pricing cannot deliver four essential features of an effective climate policy framework

- Ensuring real and radical emissions reductions in practice.
- Facilitating public/political acceptability for the implementation of such cuts.
- Embedding a longer term perspective into societal decision making.
- Integrating cross-sector engagement with intrinsic motivation and society wide co-operation.

An alternative policy framework: TEQs (tradable energy quotas)

- TEQs is similar to a national electronic rationing scheme for energy, but with legally tradable allowances. It could meet the four criteria outlined above.
- It combines downstream engagement with upstream enforcement and would cover all sectors of a national economy, including households.
- It would act as an umbrella framework, ensuring a hard cap on emissions and supporting other climate policy.
- Research into the scheme suggests that it may be expected to meet with greater public acceptability than carbon pricing frameworks, as it is a progressive scheme that would safeguard entitlements to energy while leaving households to manage their consumption as they see fit.
- TEQs draws on principles from social psychology in engaging a nation's ingenuity in reducing energy demand. It attempts to define new norms of acceptable carbon consumption and create a clear shared goal, generating common purpose around intrinsic shared desires to overcome climate change and retain secure access to essential energy services.

A political history of TEQs

- TEQs was first developed in 1996.
- A UK government feasibility study in 2008 declared it "ahead of its time" on grounds of cost and public acceptability, and so the government withdrew from funding further research at that time, although expressing continued interest.
- Substantial research since, including 2011's high-profile cross-party parliamentary report, has challenged these negative conclusions.

Conclusion

- As members of the carbon management community, we must frankly recognize the shortcomings of carbon pricing frameworks.
- Hard cap-based schemes are called for, and TEQs is the best placed to reconcile the rift between science and politics.
- Governments must be challenged on their failure to implement their own carbon targets, and why they do not implement frameworks suited to do so.
- The carbon management community has a key role to play in refining, promoting and driving the implementation of TEQs in a national context.

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