THE ENERGY COMMONS

A Governance Framework for Climate Stability and Energy Security

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1. Introduction

This paper has the ambitious objective of reconciling the economic and the environmental impacts of energy usage. It is an unpolished "work in progress," and covers a wide range of themes from a variety of perspectives. Despite the generous assistance that I have been given I am very aware of its inadequacies, and suggestions and criticisms are most welcome. It is in this participative spirit that this paper is intended to contribute to discussion about appropriate global governance systems, and the provision of climate stability and energy security.

These two worlds of energy and the environment tend, in both their academic and their practical manifestations, to speak different languages. The paper develops a simple interpretive framework connecting the two worlds using the concept of the commons, a communal form of governance without a central authority. It contends that the interrelationship between energy and the environment at a global level can be understood from the context of an energy commons, and shows that the failure of the Kyoto Protocol is comprehensible—und was predictable—from this perspective.

The paper examines attempts to impose demand-side constraints over the emission of carbon dioxide. It concludes that control must instead be achieved by addressing the fundamental causes of carbon emissions—the extraction and combustion of fossil-fuels. This implies the control of current and future extraction through an international authority.

The characteristics of energy security are examined as the critical requirement for economic growth and development. The paper then assesses the extent to which the apparently divergent needs of energy security and climate stability can be reconciled in an energy commons regime. It examines the characteristics of a possible institutional structure and assesses the most important governance objectives of such a system, concluding with a brief review of the financing, feasibility and fairness of the proposal.

2. The Concept of the Commons

The word "commons" originally described an area in England of communal ownership, such as the village green. While perhaps evoking images of country cricket and bucolic rural scenes, the expression has been broadly extended and is often associated with central issues which generate intense social conflict. In general it refers to common pool resources (or common property resources, CPRs), where resources are held in common and the use by one actor reduces the utility derived from that resource by everybody else. In contrast to open access resources CPRs are characterised by property rights, but they are exercised by a collective or community rather than one private entity.

It has long been recognised both theoretically and practically that resources may be subject to overuse if property rights are not clearly and appropriately assigned. In particular this happens when competing parties gain the entire benefit from an activity, such as fishing, while the costs are spread over all users of that resource—in this case all fishermen. Garret Hardin coined the memorable expression "The Tragedy of the Commons" for this

phenomenon, which has been observed in a wide variety of areas and eras.[1] Hardin's analysis is widely interpreted to imply that communal usage will lead generally lead to sub-optimal management of CPRs and that private property rights are preferable.

This line of thinking has been challenged by important research generally associated with Elinor Ostrom and her co-workers who have shown, through use of an inter-disciplinary framework and detailed examination of particular cases, that communal rights do not automatically lead to overuse of CPRs. Instead outcomes are not pre-determined, depending instead upon the characteristics of each particular case. In the face of what appear to be very similar situations, it is not uncommon for one community to develop an excellent management regime, while the neighbouring village does not. A related finding is that externally recommended or imposed solutions, such individual property rights to replace collective rights, may lead to substantially inferior outcomes.[2]

Resolving this apparent dichotomy between the apparent advantages of private property and common property is made easier if we look at the details of the arguments that Hardin and Ostrom have made, and recognise that property rights are embedded in a complex institutional framework which supports their definition, enforcement, and exchange. Partha Dasgupta created a generalised theoretical analysis of CPRs, showing that the provision of private property rights is a particular institutional solution that leads to socially optimal results in certain conditions, but that:

> both privatisation of the grazing land and cooperation over the use of that land as a CPR involve trust. If the allocation defined by equation … is to be realised, the herdsmen have to trust the 'legal system' to enforce private property rights to their parcels of land. Similarly, if cooperation over the use of the pasture as a CPR is to be achieved, they have to trust one another to enforce the agreement to limit each herd size …[3]

Dasgupta's analysis helps to tease out the various elements of various CPR governance solutions. In particular he demonstrates the relative attractiveness of a private property solution when there is a trustworthy external actor, typically the state with its judicial systems, to assist the definition and maintenance of property rights. In contrast it is generally more difficult for a community to create arrangements which result in socially beneficial collective agreements. Communities find it difficult to create credible and long-term commitments to impose punishments and sanctions on those that exploit common property and therefore tend to unravel. In general:

- the higher the discount rate (the value of goods today as compared to in the future)
- the greater the uncertainty about the future

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[1] See G. Hardin, "The Tragedy of the Commons," *Science* 162, no. 3859 (1968); ———, "Extensions of "The Tragedy of the Commons"," *Science* 280, no. 5364 (1998).

[2] B. Vollan and E. Ostrom, "Cooperation and the Commons," *Science* 330, no. 6006 (2010); E. Ostrom, "A General Framework for Analyzing Sustainability of Social-Ecological Systems," *Science* 325, no. 5939 (2009).

[3] Partha Dasgupta, "Common Property Resources: Economic Analytics," *Economic and Political Weekly*, no. April 16 (2005), p. 1617

- the larger the size of the community
- the lower the productivity of the resource

the more difficult it will be to induce actors to limit their individual self-interest for the collective good.[4]

Ostrom's research meshes with this observation, as the following list of design principles which she has found are associated with successful CPRs illustrates:

- Clearly defined boundaries
- Congruence between appropriation and provision rules and local conditions
- Collective-choice arrangements allowing for the participation of most of the appropriators in the decision making process
- Effective monitoring by monitors who are part of or accountable to the appropriators
- Graduated sanctions for appropriators who do not respect community rules
- Conflict-resolution mechanisms which are cheap and provide easy access
- Minimal recognition of rights to organize (e.g., by the government)
- In case of larger CPRs: Organisation in the form of multiple layers of nested enterprises, with small, local CPRs at their bases.[5]

These rules have the effect of creating clearly defined and easily enforceable property rights without private property as such. They show that clearly defining the group that "owns" a resource, and then giving it appropriate structures to monitor activity and impose sanctions, is central to the prospects for success. Similarly, Hardin's argument can by no means be regarded as simply advocating private property rights:

> The tragedy of the commons as a food basket is averted by private property, or something formally like it. But the air and waters surrounding us cannot readily be fenced, and so the tragedy of the commons as a cesspool must be prevented by different means, by coercive laws or taxing devices that make it cheaper for the polluter to treat his pollutants than to discharge them untreated. We have not progressed as far with the solution of this problem as we have with the first. Indeed, our particular concept of private property, which deters us from exhausting the positive resources of the earth, favors pollution. The owner of a factory on the bank of a stream--whose property extends to the middle of the stream, often has difficulty seeing why it is not his natural right to muddy the waters flowing past his door. The law, always behind the times, requires elaborate stitching and fitting to adapt it to this newly perceived aspect of the commons.[6]

More generally, authors such as Karl Wittfogel have argued that the coordination needed if a community is to meet the challenges of a complex irrigation system was a central factor behind the creation of large and effective states.[7] Extending this idea, such a capacity

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[4] Ibid..

[5] http://en.wikipedia.org/wiki/Common-pool_resource

[6] Hardin, "The Tragedy of the Commons", p. 1244.

[7] Karl August Wittfogel, *Oriental despotism; a comparative study of total power* (New Haven,: Yale University Press, 1957) ; Karl August Wittfogel and G. L. Ulmen, *Society and history: Essays in honor of Karl August Wittfogel* (The Hague: Mouton, 1978) .

can be regarded as an important dimension by which to measure the ability of a society to coordinate individual behaviour in order to achieve collective goals. In Dasgupta's words "we usually reserve the term 'society' to denote a collective that has managed to equilibrate at a mutually beneficial outcome".[8]

3. Energy and the Commons

3.A. Energy from the Perspective of the Commons

At first sight it may seem odd to consider addressing energy resources, especially those derived from fossil-fuels, from the perspective of the commons.[9] For the most part fossil-fuels are subject to clearly defined property rights. Yet closer investigation reveals that in the vast majority of jurisdictions there are no simple private property rights which provide for the ownership and sale of energy resources in a similar way to other resources such as land or buildings. Instead governments are generally the legal owners of energy resources, and control extraction either directly, through their own enterprises, or indirectly through the creation of licences to extract for certain periods under certain conditions. Those few countries which allocate direct ownership rights for energy resources, such as the United States, have very extensive systems of laws and regulations governing multiple dimensions of energy extraction, from financial payments through to technical and environmental provisions.

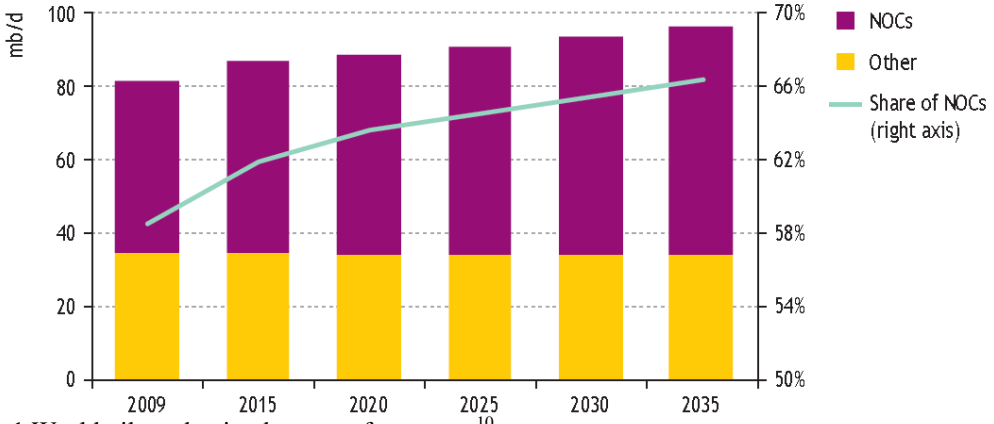

Fig. 1 World oil production by type of company[10]

There are a myriad of reasons for this special role for the energy sector which include strategic, financial, technological and environmental factors, but which would go beyond the

[8] Dasgupta, "Common Property Resources: Economic Analytics", p. 1617.

[9] The focus here as noted is primarily on the fossil-fuels, particularly oil, gas, and coal. While it is something of a misnomer to term them „energy" or „fuels", as this may not be their most valuable usage, we will continue to use this convention. The property rights issues associated with alternatives to fossil-fuels such as nuclear, wind, solar, biofuels, geothermal and hydro are interesting but beyond the scope of this section.

[10] International Energy Agency, "World Energy Outlook," (Paris: IEA, 2010), p. 127. NOCs are national oil companies. This is based on the IEA New Policies Scenario. The three scenarios in the IEA's 2010 Outlook are reviewed in the discussion on governance mechanisms below.

scope of this paper to explore further. This government control of energy property rights is especially apparent where energy resources lie outside conventional land property definitions. In the United States, for example, there is no private ownership of mineral rights in territorial waters. They belong to either State or Federal governments, who sell leases to energy companies.

A second form of commons is at the "energy frontiers". These are regions, such as the Arctic, where the territorial sovereignty is not clearly ascribed to particular states.[11] The value of energy resources is so high that where such rights do not exist solutions tend to be rapidly found. Important developments in the demarcation of rights under the Law of the Sea and in areas such as the Arctic and the South China Sea can be ascribed to this pressure.[12] Similar processes have led to the resolution of extractive commons, as when several parties had rights to gas resources which were linked to create one common pool.

A third form of commons relates to attempts to harvest "free" renewable resources such as wind, wave, tidal or solar energy. These are open access resources, and with increasing energy extraction we can expect increasingly negative spatial externalities among the producers. This is leading to calls for the establishment of legal frameworks which provide solutions to this aspect of the commons, such as by assigning appropriate property rights.[13]

The fourth usage of the energy commons is somewhat more abstract and normative. We can speak of a village community's governance of its fishery, forestry, or river commons, even when individuals have legal or customary rights of management and usage of particular resources in that system. Such commons regimes balance the rights and duties enjoyed by individuals with the economic, social, and environmental needs of the community.

In a similar fashion we can speak of the governance of the global energy commons, especially those linked to fossil-fuels, and it is this sense that the expression is used in the rest of this paper. The international system has no clear authority, so that the logic of the fundamental collective action problem is very similar.[14] Good behaviour of one country alone, even if large and well-intentioned, is doomed to failure unless other countries are similarly cooperative. It is a similar logic to that of the "good villager" who restricts his fishing catch only to watch others exploit the resource.

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[11] See e.g. R. C. Powell, "Configuring an 'Arctic Commons' ?," *Political Geography* 27, no. 8 (2008); O. R. Young, "Global Commons - the Arctic in World Affairs," *Technology Review* 93, no. 2 (1990).

[12] See e.g. Alexander Skaridov, Myron Nordquist, John Norton Moore „International Energy Policy, the Arctic and the Law of the Sea" Martinus Nijhoff, 2005;

[13] See e.g. D. T. Kaffine and C. M. Worley, "The Windy Commons?," *Environmental & Resource Economics* 47, no. 2 (2010).

[14] A seminal paper in this respect is R. O. Keohane and E. Ostrom, "Local Commons and Global Interdependence: Heterogeneity and Cooperation in 2 Domains - Introduction," *Journal of Theoretical Politics* 6, no. 4 (1994), which integrates the perspectives of a leading international relations theorist with Ostrom's of local CPRs.

This applies even when states have particular rights to specific resources, and these are allocated further to particular private companies and other commercial entities. It is the states that are in competition with each other in the international system, so that it is the states as actors that have the role of villagers as actors in a local commons. As with a village commons the international system has multiple possible equilibria, typically some associated with high-trust solutions which lead to maximisation of the general welfare and some with low-trust solutions.

The current organisation of the global energy industry is strongly reminiscent of an uncoordinated commons. The "anarchic" character of the international system is particularly visible here, as states have ultimate control over the energy resources within their jurisdiction and generally use this control for their national and strategic purposes. The role that energy plays in international relations is critical but difficult to precisely specify, as it may be associated with relationships ranging from highly cooperative to commercially and militarily conflictual—depending upon the particular parties and situation involved.

Coalitions and alliances have been created between energy supplying states, such as OPEC, but they are generally focused on coordinating production to maximise financial and strategic interests, rather than maximising general welfare. In general the current energy commons is dominated by a search for "energy security" by each country and low levels of trust and cooperation between states. The provision of energy security conventionally implies "securing adequate energy supplies at reasonable and stable prices in order to sustain economic performance and growth", but the combustion of conventional fossil-fuels has dramatic implications for carbon emissions and the global environment. The next sections focus on this interaction and appropriate responses in preparation for a reconsideration of energy security in the context of the energy commons in section 7.

3.B. Environmental Externalities and the Failure of the Kyoto Protocol

The use of energy resources is fundamental to modern economies and societies, yet is coupled to critically important negative externalities. As Lord Stern has written: "Climate change presents a unique challenge for economics: it is the greatest and widest-ranging market failure ever seen." [15]

The widespread acceptance of the role of anthropogenic climate change through greenhouse gas emissions has led to a focus on the externalities of fossil-fuel usage. The figure below indicates the extent of the challenge. Humans have already emitted 500 Gt of carbon from fossil-fuels since 1750 and climate researchers estimate that humans should only emit a further 500 Gt in all future generations, if there is to be a fair probability of keeping the global temperature rise under 2°C. This is the increase which is widely regarded as being the reasonable limit, beyond which unpredictable and non-linear reactions could lead to dramatic climatic effects.

The bars at the bottom of the figure show the vast extent of current estimates of fossil-fuel resources, and make clear that if these were to be converted to CO2 the resultant global warming would exceed 2°C in even the most conservative models and is likely to be

[15] N. H. Stern, *The economics of climate change : the Stern review* (Cambridge, UK ; New York: Cambridge University Press, 2007), p.1.

considerably more. The model is based on current estimates of fossil-energy resources, which is optimistic, however, in that they do not reflect the results of future discoveries, a factor of fundamental importance as discussed below.

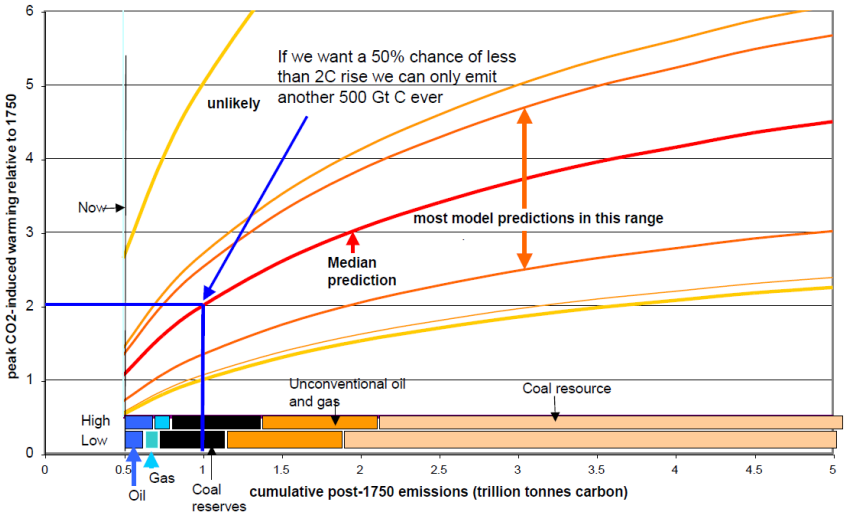

Fig. 2 Illustrative peak global warming vs. cumulative emissions 1750-2500 [16]

The potentially devastating effects of climate change has brought forth an enormous flux of activity, including governance changes in widely differing domains and at international, national and regional levels. For reasons that go beyond the scope of this paper the enormous debate on climate change policy has generally proceeded without a comprehensive assessment of the role of the energy commons. Both international institutions such as the United Nations Framework Convention on Climate Change (UNFCCC), and national or regional governments such as those of the EU, have focused almost entirely on demand-side rather than supply-side policies. These include programmes such as:

- market interventions including emission trading schemes (ETSs) and carbon taxes
- international offsets, such as the Clean Development Mechanism
- technological improvements, such as to buildings and cars
- support for alternative energy sources such as wind, biofuels, and solar

These initiatives are generally designed to reduce demand for carbon by both reducing total energy demand, and by inducing switching to non-fossil energy forms, and have been financed and supported by the Annex I countries of the Kyoto Protocol, principally members of the OECD.[17] It has been widely recognised that these measures can give rise to "carbon

[16] D. Newbery, "Oil shortages, climate change and collective action," *Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences* 369, no. 1942 (2011), Fig. 3. p. 5, drawn from M. Meinshausen et al., "Greenhouse-gas emission targets for limiting global warming to 2 degrees C," *Nature* 458, no. 7242 (2009).

[17] See e.g. D. Streimikiene and S. Girdzijauskas, "Assessment of post-Kyoto climate change mitigation regimes impact on sustainable development," *Renewable and Sustainable Energy Reviews* 13, no. 1 (2009); P. Buys et al., "Country stakes in climate change negotiations: two dimensions of vulnerability," *Climate Policy* 9, no. 3 (2009).

leakage", principally through energy consumers "voting with their feet" and transferring to non-Annex I countries.[18] Although theoretical and empirical estimates have indicated that such effects could be strongly significant they have not led to policy reconsiderations.[19]

In comparison remarkably little attention has been paid to the dynamic behaviour of energy producers. An exception is the seminal work of Sinn, and it is enlightening to consider his following depiction of the behaviour of the owner of energy resources, for example an oil company, under four scenarios:

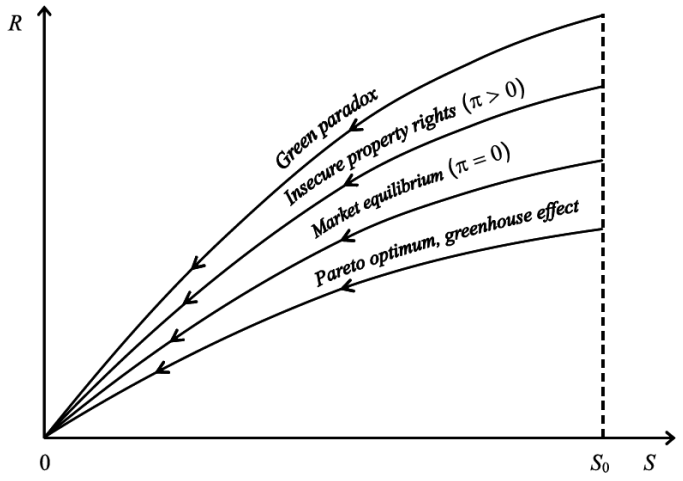

Fig. 3 Efficient and actual time paths in the presence of global warming [20]

The managers of a profit-maximising oil company will plan a particular long-term extraction programme in order to maximise the profits generated for its owners, such as shareholders or a government. As forward looking strategic actors they will adopt measures to protect the interests of their stakeholders in the face of prospective developments.

The climate-change policy measures discussed are intended to reduce demand for fossil-fuels in specific geographic regions, in this case Europe. Assume for the sake of argument that the cost of extraction is low, and that the oil company desires to continue supplying the same amount of energy. In response to the reduction in demand from Europe it will reduce the price of the price of oil to other countries, in this example China. The net result is the total amount of fossil-fuels consumed remains the same, but that energy consumption and associated industrial production and economic growth shifts from Europe to

[18] James Hansen has consistently emphasised the importance of such effects and the consequent importance of limiting fossil-fuel extraction e.g. J. E. Hansen, "Can we still avoid dangerous human-made climate change?," *Social Research* 73, no. 3 (2006);

[19] See e.g. Bard Harstad, "Buy coal? Deposit markets prevent carbon leakage," *NBER Working Paper No. 16119* June(2010); M. Hoel, "The triple inefficiency of uncoordinated environmental policies," *Scandinavian Journal of Economics* 107, no. 1 (2005); M. Babiker, "Climate change policy, market structure, and carbon leakage," *Journal of International Economics* 65, no. 2 (2005)

[20] Hans-Werner Sinn, "Public policies against global warming: a supply side approach," *International Tax and Public Finance* 15, no. 4 (2008), p. 375.

China. If the assumption of an unchanged supply of oil is relaxed the fundamental principle remains unchanged.

Sinn has coined the expression "green paradox" for this general category of environmental policy initiatives and "paradoxical" possibly counter-productive responses, including scenarios where the total greenhouse gas emissions could be increased as a consequence of climate-change policies (the topmost curve in the figure):

> Environmentalists often argue that carbon taxes are needed to reduce the demand for carbon and slow down global warming, and they advocate increasing the tax rate over time so as to give the economy time to adjust and fight global warming more aggressively as it evolves and damages increase. The green paradox implies that such a policy is likely to backfire and create even more harm for the environment by speeding up global warming.[21]

Such discussions could perhaps give rise to the idea that a more appropriate policy response might be to partially or totally expropriate the owners of fossil-fuel resources. Setting aside the legality and practicality of such a proposal, consideration of Sinn's figure can help us to assess the probable reaction of the threat of such threats to property rights by market participants. If we consider again our hypothetical oil company, its optimised extraction policy can be assumed to balance production now as against production in the long-term future, and to have been developed under expectations about the length of time it would be able to extract and the conditions under which it would be able to sell its products. Any uncertainty about these expectations being fulfilled will tend to lead it increasing extraction so as to minimise its risks. In the extreme case, a serious debate about expropriations would give strong incentives to increasing current and limiting future energy production—exactly the opposite effect to that desired.

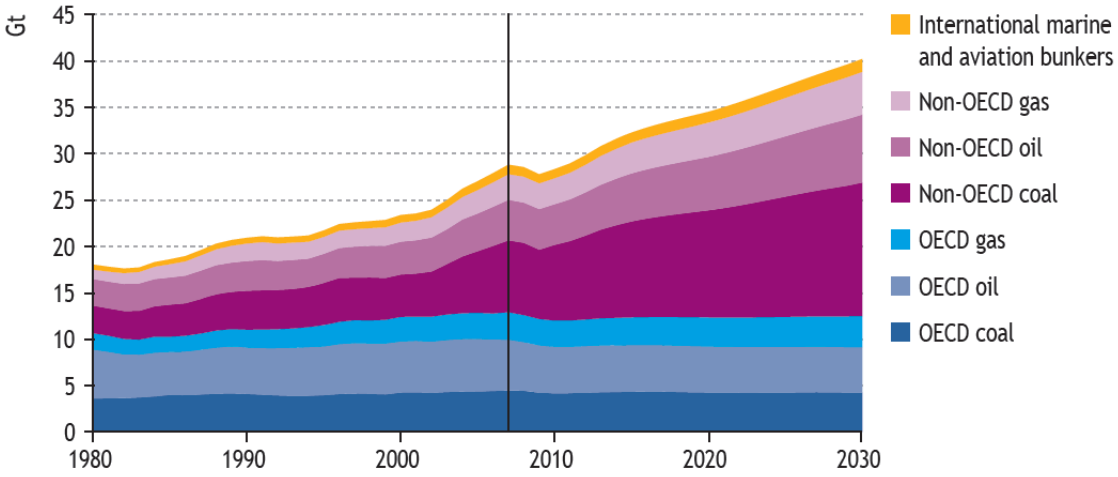

Fig. 4 Energy-related C02 emissions by fuel and region, in Gigatons [22]

The irony—and tragedy—of this analysis is that, as currently structured, these policy measures are destined to fail with respect to their prime objective of reducing carbon emissions and anthropogenic climate change. They may even perhaps be globally

[21] ibid., p. 380.

[22] International Energy Agency, "World Energy Outlook," (Paris: IEA, 2009), p. 80. This is based on the "reference scenario" which is created on the basis of "Business as Usual" (BAU).

counterproductive, because they may induce more rather than less extraction by the owners of fossil-fuel resources. At the same time they will have a negative impact on the economies of the states imposing them, increasing relative energy prices as compared to those countries which do not impose such measures.

The above graph gives empirical support to this analysis, based on the International Energy Agency's "reference scenario" which assumes the continuation of current policies for the projections until 2030. The global CO2 emissions from fossil-fuel usage climb strongly due to increases in non-OECD countries, more than doubling over the period 1980-2030 and with the only significant drop that associated with the global recession 2008-2010. In sharp contrast CO2 emissions from the OECD countries stays relatively stable at about 10 Gt, reducing from more than half to about a quarter of global consumption.

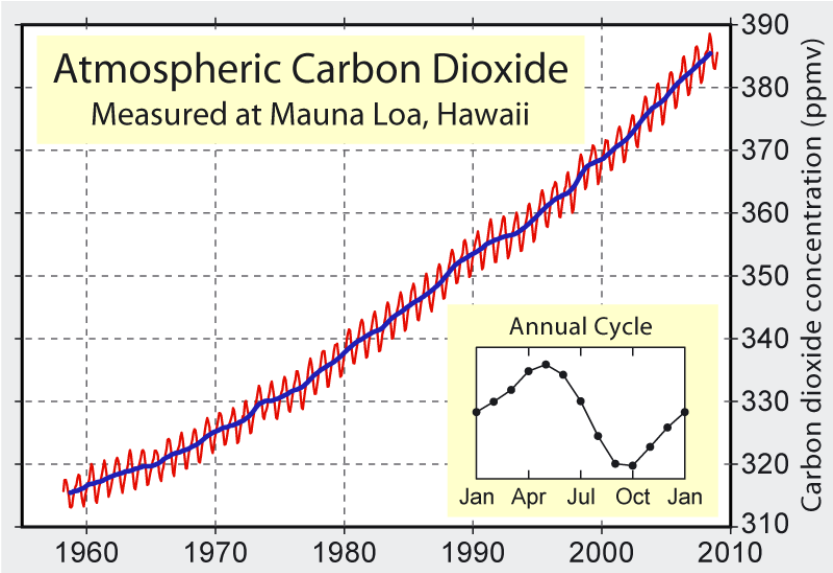

Fig. 5 The "Keeling Curve" of atmospheric carbon dioxide[23]

The consequence is that the stock of atmospheric carbon dioxide has continued to increase at an essentially constant rate since Keeling started the measurements for his famous curve in the 1960s. It is to thus to be expected that, despite two decades of research and policy changes since the UNFCCC was signed in 1992, carbon emissions will continue essentially uninterruptedly. At the same time the countries implementing the climate-change policies will suffer economically in comparison to those countries which do not have to bear the costs. It is countries such as the BRIC states Brazil, Russia, China and India whose fast growth rates and consequent demand for fossil-fuels are essentially unimpeded by global climate-change policies.

The purpose of the UNFCCC is defined in the founding treaty as:

> stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be

[23] Courtesy of the Global Warming Art Project
http://www.globalwarmingart.com/images/8/88/Mauna_Loa_Carbon_Dioxide.png

> achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.[24]

Measured by these objectives the Kyoto Protocol can be pronounced unequivocally a failure.

3.C. Restricting Extraction and Exploration

The widespread recognition that the Kyoto Protocol has not delivered an adequate response to the challenges of climate change has led to a large variety of suggestions for alternatives. Assessing and comparing these is beyond the scope of this paper, but there have been a number of reviews which have attempted to systematise and characterise the different proposals.[25]

From a theoretical perspective the appropriate analogy for the energy commons is not with a specific CPR such as fisheries, where the principal problem results from multiple users valuing the same resource in a similar way. Nor is the essence of the problem the common property regime itself. By providing private property rights subject to strong state controls, as in the United States, or directly through state ownership, a "representative" indirect community solution is achieved which gives state control but avoids the perils of direct multiple ownership.

Fossil-fuels are in many ways similar to a resource such as a river, where users' values differ dramatically depending upon whether their focus is on the value of the river as a source of electricity; a transportation route; a habitat for fish and a fishing location; a source of drinking and sanitation water; a place to swim; or a source of irrigation water. The negative externalities from one usage, such as for irrigation, may have severe consequences for other usages, such as a habitat for fish. If the river passes through multiple jurisdictions the challenges become worse, as it can be exceedingly difficult to coordinate and reconcile competing water treatments and uses.

It is taken for granted that no state will grant unrestricted property rights to river resources, and that sophisticated governance regimes are required to ensure that optimal social results are generated from the "river commons". This is especially true for rivers that pass through different countries.

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[24] http://unfccc.int/resource/docs/convkp/conveng.pdf Article 2 - Objectives.

[25] See e.g. J. E. Aldy, S. Barrett, and R. N. Stavins, "Thirteen plus one: a comparison of global climate policy architectures," *Climate Policy* 3, no. 4 (2003); W. Hare et al., "The architecture of the global climate regime: a top-down perspective," *Climate Policy* 10, no. 6 (2010); E. Ostrom, "Polycentric systems for coping with collective action and global environmental change," *Global Environmental Change-Human and Policy Dimensions* 20, no. 4 (2010); S. Titz, "On the way to super-kyoto?," *Internationale Politik* 64, no. 2 (2009); D. Helm, "Government failure, rent-seeking, and capture: the design of climate change policy," *Oxford Review of Economic Policy* 26, no. 2 (2010); Ronal Gainza-Carmenates et al., "Trade-offs and performances of a range of alternative global climate architectures for post-2012," *Environmental Science & Policy* 13, no. 1 (2010); Aviel Verbruggen, "Beyond Kyoto, plan B: A climate policy master plan based on transparent metrics," *Ecological Economics* 68, no. 12 (2009); Streimikiene and Girdzijauskas, "Assessment of post-Kyoto climate change mitigation regimes impact on sustainable development".

We can draw similar conclusions for the "energy commons", and recognise that achieving the best global results from the extraction of fossil-fuels will require the development of a comprehensive governance framework. While there are a vast number of complicating factors, the fundamental challenge is clear: an appropriate governance regime should address both the continued need for fossil-fuel forms of energy in the global economy and the need to limit carbon emissions into the global environment.

The challenge of developing such a framework will not be easy, as it seems likely the resistance to creating an effective commons management regime increases with the following factors:

- *with the importance of the resource to the parties involved*. The economic impact of energy is critically important to every advanced economy.
- *to the extent that alternative uses are conflictual rather than complementary.* Here the positive economic impact from the burning of fossil-fuels leads directly to the negative environmental consequence of increased CO2 in the atmosphere.
- *where actors are not bound into communities with recurring interactions, interdependencies, and high levels of trust*. Both energy production and consumption is divided between competing states and companies, many of whom have had histories of conflict rather than cooperation.
- *where the negative consequences of resource usage is not salient to those with power in the governance systems.* Political elites may pay lip service to the importance of climate change but in the majority of countries they, and their general populations and electorates, have been generally unwilling to adopt decisive policies
- *where there has only been limited time after the recognition of the character of the commons for the development of governance solutions*. The importance of climate change took a long time to be recognised by the scientific community and is still unrecognised by many in the general public[26]

Yet the general characteristic of the energy commons as a social dilemma remains: if there is no adequate response then continuation of the status quo brings very high costs for all. The analogy of the commons helps us to focus on the core logic of the situation with respect to fossil-fuel energy. Imagine a coastal community threatened by overfishing that

[26] These principles have been distilled from research findings of Ostrom and colleagues and the institutional economics literature, especially Douglass Cecil North, *Institutions, institutional change, and economic performance*, The Political economy of institutions and decisions (Cambridge ; New York: Cambridge University Press, 1990) ; ———, *Structure and change in economic history*, 1st ed. (New York: Norton, 1981) ; Oliver E. Williamson, *The mechanisms of governance* (New York: Oxford University Press, 1996) . The relevance of these factors is also indicated by empirical research on international environmental agreements, e.g. Peter M. Haas, Robert O. Keohane, and Marc A. Levy, *Institutions for the earth : sources of effective international environmental protection*, Global environmental accords series (Cambridge, Mass.: MIT Press, 1993) . See also R. B. Mitchell, "International environmental agreements: A survey of their features, formation, and effects," *Annual Review of Environment and Resources* 28(2003).

focused on limiting the demand for fish. Or overexploitation of a meadow, where the local community attempted to limit the consumption of mutton and wool. It should be apparent that such responses would have little chance of success, especially if these communities engage in trade outside their borders.

For the globalised international economy the ease of strategic responses by suppliers makes controlling supply imperative. It is this logic which has been followed with respect to nuclear proliferation: the focus of non-proliferation efforts is to control the production and use of atomic materials rather than the demand for nuclear weapons.

Carbon leakage and the green paradox were predictable effects of an attempt to reduce and divert fossil-fuel demand in a limited number of countries. It should be clear that an effective energy commons needs to manage supply and limit extraction, just as a fishery commons needs to limit catches, or a pastoral commons needs to limit grazing.

Control through ownership

It might initially appear that having an appropriate institution own and manage fossil-fuel resources could be an appropriate governance response. It would be rather like an ecological foundation purchasing wetlands or other habitats because of their ecological value.[27] Yet further consideration and comparisons indicate that buying up and setting aside fossil-fuel resources is not generally an attractive strategy.

- In terms of a local commons it is like taking resource ownership and control from villager A and giving it to villager B. Applied to the energy commons, given the value of these resources and the character of the international system there can be no guarantee that any entity will continue to manage it for the general good.
- The likelihood that state and corporate owners of coal, oil and gas resources would allow extensive sales is about as high as the prospect that enough domestic taxpayers of sufficient countries would finance the purchases.
- That being said, it may be that there is a particular role for direct ownership of fossil-fuel energy resources in specific situations, just as there is for national parks. The most important of these are potential resources, where property rights have not yet been allocated to states or companies as discussed with respect to exploration below.

Control through cap and trade

The most likely form of extraction control would be through regulatory measures. The fundamental objective is to internalise what had been externalities so as to lead the cost of energy to reflect its total cost to society: in this case the direct economic cost and the indirect environmental cost of carbon emissions.

Financial levies (“taxes”) and quantitative limits (“caps”) on resource extraction can often be implemented so as to provide similar incentives and have similar impacts, but in the case of the climate change discussion the arguments have tended to support tradeable

[27] See e.g. Harstad, "Buy coal? Deposit markets prevent carbon leakage".

quotas.[28] In the particular case of fossil-fuel resources, taxes generally generate a perverse incentive to increase current at the expense of future extraction. The exceptions are taxes which are initially high, but where there is a credible commitment to reduce them over time which is politically extremely unlikely.[29] A further disadvantage of taxes is that their impact is indirect – levels of actual extraction will depend upon the relevant elasticities, and there is substantial empirical evidence that the demand for fossil-fuel energy is very inelastic with respect to price.

In contrast a cap would set a specific limit on the amount of fossil-fuel extraction and allow the market to set the prices at which fuel is traded. Permitting the permits generated by the cap to be traded allows resources to be directed to their most efficient usage. There is an extensive theoretical literature on "cap and trade" regimes which indicates that they are the optimal method of implementing a quantitative restriction.[30]

While the primary focus of this literature is on carbon emissions rather than fossil-fuel extraction, from a static perspective the economic outcome from both systems is equivalent.[31] These theoretical advantages of cap and trade structures have been supported by empirical demonstration of their efficacy, especially the success of emission trading for sulphur dioxide in the United States.[32] A cap and trade regime which creates tradeable permits for the extraction of fossil-fuels thus appears the governance mechanism of choice for the energy commons.

Control of exploration

The last decades have seen a remarkable development of "unconventional" fossil-fuel technologies, such as the Canadian tar (or oil) sands and shale oil and gas. Figure 1 indicates

[28] See e.g. T. C. Schelling, "What makes greenhouse sense? Time to rethink the Kyoto Protocol," *Foreign Affairs* 81, no. 3 (2002), p. 5.

[29] See e.g. Sinn, "Public policies against global warming: a supply side approach"

[30] See generally e.g. R. Cleetus, "Finding common ground in the debate between carbon tax and cap-and-trade policies," *Bulletin of the Atomic Scientists* 67, no. 1 (2011); M. Betsill and M. J. Hoffmann, "The Contours of "Cap and Trade": The Evolution of Emissions Trading Systems for Greenhouse Gases," *Review of Policy Research* 28, no. 1 (2011); N. O. Keohane, "Cap and Trade, Rehabilitated: Using Tradable Permits to Control US Greenhouse Gases," *Review of Environmental Economics and Policy* 3, no. 1 (2009).

[31] „Whether there is an upstream cap (e.g. the point of regulation is the point of entry of fossil-fuels into the economy) or a downstream cap (the point of regulation is the end user of the fossil-fuels, or the end user of energy derived from fossil-fuels), the ultimate economic outcome is the same" M. Hanemann, "Cap-and-trade: a sufficient or necessary condition for emission reduction?," *Oxford Review of Economic Policy* 26, no. 2 (2010), p. 226.

[32] See e.g. D. Burtraw and D. A. Evans, "Tradable rights to emit air pollution," *Australian Journal of Agricultural and Resource Economics* 53, no. 1 (2009); Hanemann, "Cap-and-trade: a sufficient or necessary condition for emission reduction?"

the size of these resources which dwarf conventional oil and gas reserves.[33] In general it is the expansion of energy supply which, despite the scenarios of resource shortages of the Club of Rome or peak oil proponents, has succeeded in keeping fossil-fuel prices relatively flat in the last decades.[34]

Allocation of fossil-fuel prospecting and exploration licences creates interests in potential energy resources. Once these property rights are allocated it unleashes the creative power of the international energy industry to discover and extract such resources. It should be apparent that limiting the issuance of such licences before such rights are created and pressures emerge is eminently advisable, and is part of the governance framework developed below. A further advantage of such a mechanism is that it takes advantage of an asymmetry in the effects of uncertainty.[35] Uncertainty before exploration reduces exploration activity and hence limits the possibilities for current extraction. Uncertainty after owners possess proven reserves increases current extraction, as discussed with respect to the "green paradox" above.

The principal conclusion is thus that the proposed international energy commons needs to establish a governance framework capable of restricting the extraction and exploration of fossil-fuels if the demands of climate stability are to be achieved. The next section examines the issue of energy security, and the extent to which it is compatible with such structures and objectives.

3.D. Enhancing Energy Security

The central meaning of the expression energy security is the „reliable and adequate supply of energy at reasonable prices",[36] but it has been given a large number of additional dimensions and meanings.[37] Energy security became a major priority of the industrialised world after OPEC producers restricted oil production and raised prices.

It may thus seem that an energy commons governance regime like the IEO which had the intention of systematically limiting production and letting prices increase could

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[33] See e.g. R. Gerlagh, "Too Much Oil," *Cesifo Economic Studies* 57, no. 1 (2011); A. Mejean and C. Hope, "Modelling the costs of non-conventional oil: A case study of Canadian bitumen," *Energy Policy* 36, no. 11 (2008); International Energy Agency, "World Energy Outlook,".

[34] See e.g. Donella H. Meadows and Club of Rome., *The Limits to growth; a report for the Club of Rome's project on the predicament of mankind* (New York,: Universe Books, 1972) ; Donella H. Meadows, Jørgen Randers, and Dennis L. Meadows, *The limits to growth : the 30-year update* (White River Junction, Vt: Chelsea Green Publishing Company, 2004) ; D. H. Meadows and D. Meadows, "The history and conclusions of The Limits to Growth," *System Dynamics Review* 23, no. 2-3 (2007).

[35] See e.g. Warwick J. McKibbin and Peter J. Wilcoxen, "Uncertainty and climate change policy design," *Journal of Policy Modeling* 31, no. 3 (2009).

[36] Janusz Bielecki, "Energy Security: Is the Wolf at the Door?," *The Quarterly Review of Economics and Finance* 42, no. 2 (2002), p. 237.

[37] See e.g. F. Ciuta, "Conceptual Notes on Energy Security: Total or Banal Security?," *Security Dialogue* 41, no. 2 (2010). A wide number of different dimensions are reviewed in Benjamin K. Sovacool, *The Routledge handbook of energy security* (London ; New York: Routledge, 2011) .

fundamentally undermine energy security. This would seem to be confirmed by the economic history of the last decades, where oil and energy price spikes have regularly been followed by recessions and depressions.[38]

On further consideration the issue is somewhat more complex. It is first useful to note that not only does the expression have different academic meanings, but different countries interpret the term in very different ways. One of the leading analysts of the field differentiates energy security by the particular needs of the countries involved:

> Energy-exporting countries focus on maintaining the "security of demand" for their exports, which after all generate the over whelming share of their government revenues. For Russia, the aim is to reassert state control over "strategic resources" and gain primacy over the main pipelines and market channels through which it ships its hydrocarbons to international markets. The concern for developing countries is how changes in energy prices affect their balance of payments. For China and India, energy security now lies in their ability to rapidly adjust to their new dependence on global markets, which represents a major shift away from their former commitments to self sufficiency. For Japan, it means offsetting its stark scarcity of domestic resources through diversification, trade, and investment. In Europe, the major debate centers on how to manage dependence on imported natural gas—and in most countries, aside from France and Finland, whether to build new nuclear power plants and perhaps to return to (clean) coal. And the United States must face the uncomfortable fact that its goal of "energy independence"—a phrase that has become a mantra since it was first articulated by Richard Nixon four weeks after the 1973 embargo was put in place—is increasingly at odds with reality.[39]

As is illustrated by the Nixon quote, for many countries energy security is perceived as being enhanced by seeking independence from foreign supply. The geopolitical strategies of the Northern states in the Arctic, and of China to secure energy resources in Africa and the South China Sea, are but illustrations of many such attempts.[40] The underlying presumption is that energy security is a zero-sum game: either one's own state will gain security through access to these resources or other states will.[41]

Yet such mercantilist attempts at autarky do not bode well for a global system based on international trade and interdependence: an attempt by an energy importer such as the EU to increase energy security may decrease the "security of demand" of an energy exporter such

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[38] See e.g. Andreas Goldthau, "The Public Policy Dimension of Energy Security," in *The Routledge handbook of energy security*, ed. Benjamin K. Sovacool (London ; New York: Routledge, 2011), p. 132.

[39] D. Yergin, "Ensuring energy security," *Foreign Affairs* 85, no. 2 (2006), p. 71.

[40] See e.g.D. M. Anderson and A. J. Browne, "The politics of oil in eastern Africa," *Journal of Eastern African Studies* 5, no. 2 (2011); J. S. Lee, "Energy security and cooperation in Northeast Asia," *Korean Journal of Defense Analysis* 22, no. 2 (2010); E. Thomson and N. Horii, "China's Energy Security: Challenges and Priorities," *Eurasian Geography and Economics* 50, no. 6 (2009); I. G. Brosnan, T. M. Leschine, and E. L. Miles, "Cooperation or Conflict in a Changing Arctic?," *Ocean Development and International Law* 42, no. 1-2 (2011); K. N. Casper, "Oil and Gas Development in the Arctic: Softening of Ice Demands Hardening of International Law," *Natural Resources Journal* 49, no. 3-4 (2010); Powell, "Configuring an 'Arctic Commons' ?".

[41] A. Goldthau and J. M. Witte, "Back to the future or forward to the past ? Strengthening markets and rules for effective global energy governance," *International Affairs* 85, no. 2 (2009), p. 374.

as Russia. Such attempts are also likely to suffer the fate of Nixon's goal of energy independence: for many countries traded energy became a much more important significant portion of their economy in the last decade as shown in the accompanying figure.

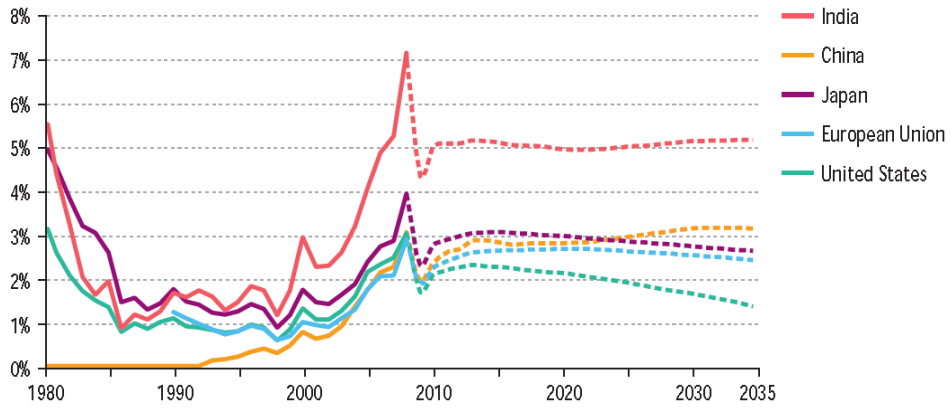

Fig. 6 Expenditure on net imports of oil and gas as a share of real GDP [42]

It is instructive here to examine the primary regime established by the representatives of sixteen major industrialised countries as a response to the perceived OPEC threat. The system that they created was not unilateral or bilateral—instead it was a multilateral attempt to allow a coordinated response to future shocks and to share information and reserve buffers:[43]

> The current energy security system was created in response to the 1973Arab oil embargo to ensure coordination among the industrialized countries in the event of a disruption in supply, encourage collaboration on energy policies, avoid bruising scrambles for supplies, and deter any future use of an "oil weapon" by exporters. Its key elements are the Paris-based International Energy Agency (IEA), whose members are the industrialized countries; strategic stockpiles of oil, including the U.S. Strategic Petroleum Reserve; continued monitoring and analysis of energy markets and policies; and energy conservation and coordinated emergency sharing of supplies in the event of a disruption.[44]

Initially the IEA was intended to administer an Integrated Emergency Program (IEP) which was principally intended to handle emergencies and assist longer term initiatives to reduce dependence on oil. This was expanded to the International Energy Program which involved obtaining detailed information from the international oil companies, as well as

[42] International Energy Agency, "World Energy Outlook,", p. 93. The projections are for the New Policies Scenario which assumes that country climate change commitments are implemented. As discussed further below it appears more realistic to focus on the "Current Policies Scenario". Unfortunately there are very few depictions based on this scenario in the 2010 IEA Outlook. Fig. 2.3 in the 2009 IEA Outlook depicts dependency of over 50% on imported oil in 2008 in all regions considered, which then eithr grows or stabilises in the period until 2030. The exception is ASEAN with under 30% in 2008 and over 70% in 2030. This is based on the "Reference Scenario" which is equivalent to the 2010 Current Policies Scenario.

[43] See Mason Willrich and M. A. Conant, "The International Energy Agency: An Interpretation and Assessment," *American Journal of International Law* 71, no. 2 (1977), esp. pp 199-201.

[44] Yergin, "Ensuring energy security", p. 75.

mechanisms to improve the cooperation between producer and consumer countries. Over time the IEA has diversified away from these original responsibilities and has expanded its membership. It now plays a somewhat similar role to the OECD, serving as an important source of information and advising its member states as to appropriate energy policies.[45]

Yergin cogently argues that ensuring energy security will require more rather than less international cooperation, and refers approvingly to the development of the International Energy Forum (IEF) which has a much larger membership than the IEA and includes major producers.[46] A further institutional innovation is the Energy Charter Treaty (ECT) which came into force in 1994 and which was primarily designed to increase the EU's energy security with elements to encourage trade and investment and a dispute resolution mechanism.[47]

Comparison of the energy commons discussion with Yergin's proposals and the characteristics of the IEA, IEF, and ECT reveal many similarities. The core message of both the energy security and the energy commons frameworks is that it is only through international cooperation that welfare maximising solutions can be found.[48]

This is made more apparent if we perceive that an underlying commonality among the different country perspectives on energy security is the desire for stability of expectations and the limitation of uncertainty. Energy suppliers make long term investments and desire "security of demand". European Union countries do not want to be dependent on gas from Russia which could subject to political disputes with transit countries. It was not the high prices as such that caused the 1973 recession—it was the "oil shock". Similarly it has been the volatility in energy prices in the last decades that have induced recession—rather than the level of the energy prices as such.[49]

There is no doubt that significant quantitative restrictions on fossil-fuel extraction and the transition to alternative energy sources will be associated with costs and adjustment difficulties, especially to the major energy consuming states. It is thus essential that the

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[45] See e.g.Goldthau and Witte, "Back to the future or forward to the past ? Strengthening markets and rules for effective global energy governance", p. 380.

[46] The two decades of the history of the IEF have been described in Bassam Fattouh and Coby van der Linde, *The International Energy Forum: Twenty years of producer-consumer dialogue in a changing world* (Riyadh, Saudi Arabia: International Energy Forum, 2011) ; see also International Energy Forum, http://www.ief.org. The IEF appears as yet to have received relatively little academic attention.

[47] See e.g. Goldthau and Witte, "Back to the future or forward to the past ? Strengthening markets and rules for effective global energy governance", p. 380, and the contributions to Thomas Waelde, ed. *The Energy Charter Treaty: an East–West gateway for investment and trade* (London: Kluwer Law International, 1996).

[48] A second more informal community linking energy security and environmental concerns has been observed between China and Japan—seeE. Wishnick, "Competition and cooperative practices in Sino-Japanese energy and environmental relations: towards an energy security 'risk community'?," *Pacific Review* 22, no. 4 (2009).

[49] Goldthau, "The Public Policy Dimension of Energy Security," .

governance measures introducing these changes be undertaken in a responsible, accountable and transparent way, so that all those affected have ample information and time to make the adjustments needed, and do not feel a threat to their energy security.

An international organisation that coordinates and communicates such changes should increase rather than decrease the energy security of those concerned and is envisaged as a core responsibility of an energy commons solution. It would seem thus seem that integrating energy security and environmental objectives into one governance framework offers potential advantages, and this prospect is explored further in the next section.

4. A Potential Institutional Structure

There are a myriad of different possible architectures which could help coordinate the international energy market so as to meet the needs for energy security and environmental responsibility. The following sections set out in broad brush-strokes the key elements of one such governance regime.[50] The purpose is to demonstrate the possibility of an alternative social solution; it does not attempt to demonstrate its feasibility, nor does it claim to represent the best possible system. It is offered in the recognition that there is no predetermined result to the challenges to commons regimes at either local or international levels. Some local communities fail to create successful solutions whereas their neighbours succeed in very similar domains. The international society has been able to successfully limit ozone emissions but has tragically overexploited its ocean fisheries.[51] The proposal is offered in the conviction that open analysis and debate can help facilitate the creation of a broadly beneficial governance of the energy commons.

4.A. An Analogy with Central Bank Governance

The establishment of effective quantitative restrictions on energy supply is critical for the proposed energy commons framework. The existing national and international mechanisms have been able to ensure acceptable levels of energy security, principally because this lies in the direct national interest of each state involved. The Kyoto Protocol has, in contrast, been unable to effectively limit carbon emissions, so this will be the most important innovation—and test—for the new governance framework.

The setting of the quantitative limits would require delicate and difficult judgments. If the limits are too high then there will be essentially no limitation of fossil-fuel usage and carbon emissions will continue to climb. If they are set too low there could be dramatic shortages and/or energy price increases with very negative consequences for economic growth and energy security.

The task is made more complex because of the dynamic nature of the problem. Predicting both the economic and the environmental effects of quantitative restrictions is an

[50] This outline includes many elements proposed by others. See e.g. Oliver Tickell, *Kyoto2 : how to manage the global greenhouse* (London ; New York: Zed Books, 2008) ; Harstad, "Buy coal? Deposit markets prevent carbon leakage".

[51] See generally Haas, Keohane, and Levy, *Institutions for the earth : sources of effective international environmental protection*: .

inexact science. It may be necessary to weaken the restrictions in the face of an impending world recession, or to strengthen them given new evidence on carbon emissions and climate change.

Such difficulties are exacerbated given the laboriousness of gaining the support of individual countries for quantitative restrictions and their implementation. It is to be expected that the associated negotiations would be long and arduous. Should a decision be finally be reached then similarly tortuous processes could be expected before it could be amended. It is in the nature of such political mechanisms that short term benefits, especially those that lift the probability of incumbent governments staying or gaining power, will be preferred to long term advantages. In the case of the energy commons the short term benefits are likely to come from an easing of quantitative restrictions and associated economic impetus, whereas the long-term benefit would be climate stability through appropriate quantitative restrictions.

These problems possess a close similarity to those facing monetary authorities: to balance the short term positive impact of monetary expansion on nominal demand with the long term negative consequences of monetary policy for inflation. Over the last decades extensive theoretical work on time inconsistency, credible commitment, and other principles has transformed the understanding of the creation of an optimal monetary policy.[52] The key governance recommendation has been to separate the setting of monetary and inflation objectives from the particular measures to achieve them. The former strategic decisions are typically made by the government and/or parliament; the latter operational decisions are delegated to an independent central bank. These recommendations have been implemented in a wide range of countries, and have led to systematic reductions in levels of inflation while allowing short term adjustment of monetary policy to meet economic requirements.[53]

4.B. An Intergovernmental Framework

Given the caveats with respect to governance frameworks discussed above let us assume that an International Energy Organisation (IEO) is created by an international treaty, with an intergovernmental institutional form as follows:

The International Energy Organisation (IEO)

The principal organs of the IEO would be:

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[52] See e.g. G. B. Eggertsson and E. Le Borgne, "A Political Agency Theory of Central Bank Independence," *Journal of Money Credit and Banking* 42, no. 4 (2010);C. Crowe, "Goal independent central banks: Why politicians decide to delegate," *European Journal of Political Economy* 24, no. 4 (2008); J. Libich, "An explicit inflation target as a commitment device," *Journal of Macroeconomics* 30, no. 1 (2008).

[53] See e.g. S. Alpanda and A. Honig, "The Impact of Central Bank Independence on Political Monetary Cycles in Advanced and Developing Nations," *Journal of Money Credit and Banking* 41, no. 7 (2009); B. Wessels, "Are African central banks sufficiently independent for monetary convergence?," *South African Journal of Economics* 74, no. 2 (2006); F. Gilardi, "The formal independence of regulators: A comparison of 17 countries and 7 sectors," *Swiss Political Science Review* 11, no. 4 (2005).

- a decision-making authority composed of the signatory states—the International Energy Council (IEC).
- a coordinating authority—the International Authority for Energy Security and the Environment (IAESE)
- and a dispute resolution tribunal or court—the International Energy Tribunal (IET, discussed in the next subsection)

The IEO would be based on the principle of delegated authority from individual states. It has a coordinating function to ensure the meeting of supranational objectives, but decision-making lies with the IEC and implementation in the hands of the member states.

- The IEO has the general purpose of facilitating the governance of the world's energy resources so as to support economic development and energy security while limiting the negative environmental impacts of energy use.
- The IEO is most directly focused on the control of the supply of oil, gas and coal, the dominant sources of the world's primary energy which are transformed into CO2 during combustion. It has a broad mandate for all forms of energy, however, as this is needed to ensure that an integrated international energy market develops.

The International Energy Council (IEC)

The International Energy Council would be responsible for setting the energy security and environmental objectives, similar to a parliament setting inflation or monetary aggregate targets. The IEC is the intergovernmental organisation which would be responsible for the creation of rules which are binding upon the member states.

- It would bear some resemblance to intergovernmental bodies such as the European Council and the Council of Ministers within the EU
- It would be composed of representatives of the member states
- The details of voting rules and rights would depend upon what results from international negotiations. Unanimity rules could protect each state from disadvantageous decisions but tend to be slow and unwieldy. Weighted voting rules require more trust and would be more complex.
- The IEC would be the intergovernmental forum where the representatives of the member states come together to make decisions. It is in this forum that the negotiations with their associated political tradeoffs would take place that would be needed to ensure that all necessary actors agree to proposals.

The IEC would make the critical decisions underlying the entire IEO system, including:

- it would be the forum where member states could engage in credible bilateral and multilateral commitments
- it would specify the general energy security and environmental objectives
- it would decide upon the IEOs budget

- it would establish the nature of the relationships and applicable mechanisms linking the IEO member states to countries outside the IEO system.

The International Authority for Energy Security and the Environment (IAESE)

The IAESE would be responsible for delivering the energy security and environmental objectives set by the IEC, similar to the role of a central bank in adjusting monetary policy to meet an inflation target. The IAESE would be tasked with analysing the interaction between energy, energy security and the environment, and developing specific strategies to ensure that the competing claims on energy resources are met in appropriate ways. The IEAAA is envisaged as a relatively small and highly effective organisation. It bears strong resemblances to an independent central bank, but also has some points in common with institutions like the European Commission.

- It could be structured in a similar way to the Federal Reserve, the Bundesbank and the European Central Bank with a division of responsibility between the executive and the governing council. The executive council would be comprised of a small number of highly qualified appointees, who/which would be primarily responsible for operational decisions and accountable to the IEC. The governing council would comprise the executive council together with representatives from the member states, and would be responsible for more strategic decisions and for linking the operational policy to the member states.
- it would be accountable to the IEC for meeting the energy security and environmental targets that had been set
- it would ensure the integrity of the global energy supply chain through planning and monitoring of the responsible international, national and sub national bodies
- The IAESE would propose specific measures to the IEC to ensure that the objectives of the IEO are met.
- It would be responsible for ensuring the maintenance of the transparency, monitoring, modelling and sanctioning regimes discussed below, and proposing policy corrections where required.

4.C. The Division of Judicial Power

The ECJ and WTO as examples

It is one of the commonalities of a local resource commons and the international energy commons that neither system has an external authority capable of resolving disputes or imposing sanctions on illegal behaviour. While the lack of such an authority is often regarded as a fundamental feature of international law, there are domains where judicial authorities exist and sanctions are regularly and effectively imposed. The European Union

and the World Trade Organisation are two of the most important and are examined briefly below.[54]

With increasing economic interdependence the member states of the EEC and later EC/EU found that the general advantages of having an external arbiter of disputes outweighed the particular disadvantages they experienced when cases went against them. With the Van Gend and Los and Keck cases the European Court of Justice (ECJ) asserted that its judgements should prevail over laws and court decisions of the member states. Despite initial opposition both the governments and the judicial systems of the member states eventually accepted these doctrines, effectively creating a federal legal system within the specific jurisdiction covered by the European treaties. [55]

The success of this strategy was doubtless enhanced by the particular judicial mechanisms chosen which divides powers in a highly effective way between the national and the European legal systems. Instead of being a simple appellate court like the European Court of Human Rights, any court in a member state can make a request for a preliminary ruling to the ECJ. The ECJ then replies with a decision on the principles of the case to the initiating court, which then passes judgement and imposes sanctions as appropriate.[56]

The WTO dispute settlement system similarly embeds conflicts in the beneficial interdependence of trade relationships, and has created what is arguably the most comprehensive delegation of state powers to an international legal authority. The GATT panel procedure was established in 1955 and forms the basis of the system. This was developed over time into a more structured process, especially as part of the Uruguay round, including provisions that effectively prevent a country that loses a case from blocking adoption of the ruling.[57] With the establishment of the Apellate Board in 1995 the powers of the WTO system were further extended, with the ability to modify or reverse the legal

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[54] The following discussion concerns the imposition of sanctions by the ECJ. The intergovernmental Council of Ministers failed to impose the mandated punishments following the breaking of the rules of the Stability and Growth Pact. This is one of the factors underlying the crisis with the Euro and confirms the difficulty of imposing sanctions without an external authority

[55] See e.g. J. H. H. Weiler, "The Transformation of Europe," *Yale Law Journal* 100, no. 8 (1991); ———, "Federalism and constitutionalism: The special path of Europe," *Revista De Occidente*, no. 249 (2002).

[56] See M. P. Broberg and N. Fenger, "Preliminary References as a Right: But for Whom? The Extent to which Preliminary Reference Decisions can be Subject to Appeal," *European Law Review* 36, no. 2 (2011); see also A. Pliakos and G. Anagnostaras, "Who is the Ultimate Arbiter? The Battle over Judicial Supremacy in EU law," *European Law Review* 36, no. 1 (2011); T. Tridimas and G. Gari, "Winners and losers in Luxembourg: A statistical analysis of judicial review before the European Court of Justice and the Court of First Instance (2001-2005)," *European Law Review* 35, no. 2 (2010).

[57] See generally M. Klimenko, G. Ramey, and J. Watson, "Recurrent trade agreements and the value of external enforcement," *Journal of International Economics* 74, no. 2 (2008). See also A. D. Mitchell, "Proportionality and remedies in WTO disputes," *European Journal of International Law* 17, no. 5 (2006); K. J. Alter, "Resolving or exacerbating disputes? The WTO's new dispute resolution system," *International Affairs* 79, no. 4 (2003).

findings and conclusions of a panel and to examine a state's domestic compliance with their WTO obligations.[58]

The Proposed International Energy Tribunal

The intention of the proposed International Energy Organisation is to facilitate the peaceful resolution of disputes, just as the WTO and EU have facilitated the peaceful resolution of disputes within their respective domains. The International Energy Tribunal (IET) is intended to have jurisdiction over disputes:

- between the organs of the IEO
- in the relationships between the IEO and member states
- over IEO-relevant disputes between the member states
- and in other cases where the parties explicitly recognise the jurisdiction of the IET

It is intended to play a similar role to the Appellate Body of the World Trade Organisation or the European Court of Justice within the European Union, and would hopefully be similarly successful. The details of its organisation and jurisdiction would be subject to intense scrutiny and debate in the negotiations between the member states, but one could imagine it adopting key characteristics from both the WTO and the EU.

It could for example adopt the WTO's flexible panel system, allowing any IEO member (or coalition of members) to initiate a panel procedure if it felt that another country was breaking an IEO agreement or not living up to its obligations. This should increase each member state's confidence that the other members were obeying the IEO rules.

From the ECJ it could possibly implement the judicial doctrines of supremacy and direct effect with respect to a very limited domain of IEO issues, such as those related to quantitative restrictions on energy extraction and associated IEO mechanisms. The IET could similarly be able to give preliminary rulings when the issues were within its jurisdiction, and on application from a member state court.

These procedural powers taken together would empower civil society and other actors to file actions in domestic courts and for them to be decided under the rules and jurisprudence of the IEO. This would empower actors, such as companies, private individuals, or NGOs, to use accessible und trusted local courts to enforce IEO rulings and provisions. Such a system would play to the strengths of each actor. Civil society initiatives are ideal to raise "the fire alarm", as they have wide coverage and capable of reacting to rule breaking. They find it difficult to resolve the collective action problems involved in imposing sanctions, however, tending to initiate social movement style campaigns on particular incidents or issues while not reacting to the vast majority of illegal behaviour. Courts find it initially difficult to react to rule breaking, but once an action has been initiated then they are appropriate "fire fighters". They have the appropriate resources and procedures to evaluate and make judgements on particular cases and then impose sanctions as appropriate.

[58] See S. Picciotto, "The WTO's appellate body: Legal formalism as a legitimation of global governance," *Governance-an International Journal of Policy and Administration* 18, no. 3 (2005).

4.D. States and Subsidiarity

While the IEO would be responsible for international objectives and the coordinated implementation of governance measures, it is state authorities who would be primarily responsible for what occurred within their own jurisdictions.[59]

- Each state would be responsible for adjusting its domestic governance mechanisms so as to enable its IEO commitments to be met, and for ensuring that the actors subject to its jurisdiction meet their commitments.
- In particular each state would be responsible for ensuring that the applicable quantitative limits on extraction and exploration were not being exceeded.
- Each state would also be responsible for ensuring that its obligations with respect to energy security were being met
- Each state would receive the revenues gained by the sale of the quantitative permits within its jurisdiction, and would be responsible for transferring the agreed revenue share to the IEO.

4.E. Institutional Models

The previous sections have sketched a theoretical blueprint of a potential international governance framework for energy. There have clearly been a large number of practical problems that have affected groups of states or the entire international community, and it is helpful to consider appropriate aspects of governance solutions that have served successfully with respect to other international issues.[60] The development of the International Energy Agency, the International Energy Forum, and the Energy Charter Treaty were reviewed briefly above; the following list sets out further institutions which demonstrate important developments and principles:

The G20 Major Economies

- the G-20 countries represent a critical global mass, comprising 85% of global gross national product, 80% of world trade, and two-thirds of the world population
- it follows the tradition of the G7 and G8 in taking a leadership role in addressing international energy security and environmental issues
- the informal structures foster the finding of mutually acceptable solutions

The International Atomic Energy Agency (IAEA) and the Nuclear Non-Proliferation Treaty (NPT)

- fulfil a similar role to the proposed IEO, supporting the positive economic effects of nuclear energy, while attempting to ensure that the negative externalities of nuclear misuse do not occur

[59] This is similar to the subsidiarity principle of the European Union.

[60] For a review focusing on environmental issues see e.g. Haas, Keohane, and Levy, *Institutions for the earth : sources of effective international environmental protection*: .

The European Union (EU)

- based on voluntary participation to achieve collective goals
- has been so attractive to further countries that it has expanded from 6 to 27 members with more wishing to join
- the complex institutional structure has built trust and has allowed an increasing number of issues to be dealt with at a European level

The General Agreement on Tariffs and Trade (GATT) and the World Trade Organisation (WTO)

- has demonstrated a similar process of the achievement of collective benefits to the European Communities
- and a similarly rapid expansion

The Montreal Protocol

- successfully established controls over substances that deplete the ozone layer
- provides an international example of economic restructuring in order to obtain global environmental benefits

The United Nations Framework Convention on Climate Change (UNFCCC)

- demonstrates international commitment to combating global warming
- has developed deep competence and strong networks in this field

The Organisation for Economic Co-operation and Development (OECD)

- analyses international issues such as sustainability and climate change with rigour and vigour and independently of the United Nations

The World Bank

- possesses deep competence with respect to both energy and economic development
- has recognised the importance of looking beyond directly economic issues and has now a strong focus on issues related to climate change

This listing indicates some of the institutional responses that have been found to international problems. They show that it is possible to overcome collective action problems and to successfully coordinate effective solutions. One of these organisations could possibly serve as the base for the proposed IEO, which would focus negotiations on reforms and extensions of existing structures rather than the creation of a completely new institution.

5. Governance for Climate Stability and Energy Security

An international coordinating institution is necessary for the achievement of climate stability and energy security but not sufficient. The specific objectives that must be achieved must be ascertained and appropriate governance responses developed. The following sections examine a range of such objectives and issues from both perspectives.

5.A. Supply Restrictions and Market Expectations

Achieving reliable and adequate supply at reasonable prices

A primary responsibility of the proposed International Energy Organisation is the imposition of appropriate quantitative restrictions on the supply of fossil-fuels. Let us assume that the member states in the International Energy Council (IEC) would:

- specify as a target a quota for the extraction of oil, gas, and coal for fuel purposes – the Global Carbon Extraction Quota (GCEQ).[61] This would be based on an informed assessment of the maximum permissible level for the combustion of carbon given the consequences for global warming and climate change
- similarly specify as a target the maximum amount of exploration activity that would be permitted— the Fossil-fuel Exploration Quota (FFEQ)
- allocate these quotas among the member states – the Carbon Extraction Quota for States (CEQS) and Fossil-fuel Exploration Quota for States (FFEQS)

The International Authority for Energy Security and the Environment (IAESE) would then, in a similar way to a central bank, be responsible for achieving these objectives. In particular it would:

- monitor and manage the GCEQ and FFEQ limits
- partition the GCEQ and FFEQ into tradeable Carbon Emission Permits (CEPs) and Fossil-fuel Exploration Permits (FFEPs)[62]
- oversee and manage energy extraction and exploration to ensure energy security and environmental objectives are being met

Discussion of the limiting of energy supply brings back for many the negative images of lines of cars in front of empty petrol stations in the 1970s. Yet intelligently managed quantitative restrictions can be made compatible with energy security, if we return to the definition of energy security as being the „reliable and adequate supply of energy at reasonable prices“.[63]

“Reasonable prices” can clearly be interpreted as those that reflect the total welfare cost of energy to society: any lower price is implicitly subsidising energy usage and not representing its full impact on the environment. In addition ensuring the supply of energy is

[61] Coal, oil and gas production can be used for non-combustion use as feedstocks and raw materials. These governance proposals are intended to encourage such usage while at the same time ensuring that their illicit usage as fuels does not take place.

[62] The concept of Carbon Extraction Permits is not dissimilar from the certificates used in carbon emission trading schemes such as the EU’s ETS, but they limit the supply of fossil-fuels rather than giving permission to pollute with fossil-fuels. See e.g. Karsten Neuhoff, *Climate policy after Copenhagen : the role of carbon pricing* (Cambridge ; New York: Cambridge University Press, 2011) ; K. Neuhoff, "Reflections on implementing EU ETS Pricing Carbon: The European Union Emissions Trading Scheme," *Climate Policy* 11, no. 1 (2011).

[63] Bielecki, "Energy Security: Is the Wolf at the Door?", p. 237.

"reliable and adequate" can be fully compatible with quantitative restrictions, as the following examination of alternative developments attempts to make clear.

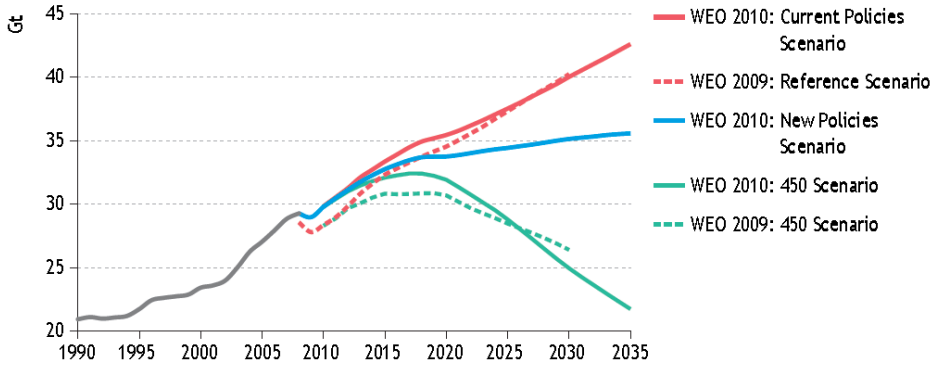

Fig. 7 World energy-related CO2 emissions by scenario [64]

Consider the IEA's scenarios for CO2 emissions depicted in the above figure.[65] Imagine that an international agreement existed among the International Energy Council members to implement a particular scenario—assume IEA's "450 Scenario". The IEC would then specify the Global Carbon Extraction Quota (GCEQ) so that fossil-fuel extraction and supply matched the desired dynamic path of emissions, and would divide this as Carbon Extraction Quotas for States among each of the fossil-fuel producer countries. The countries would then have the responsibility for ensuring that their national policies allocated these quotas to the appropriate sectors so as to generate the desired extraction trajectory. The IAESE would have the responsibility for monitoring the entire supply of fossil-fuels, and ensuring that it increased, stabilised, and then declined as planned. The plan would be "reliable and adequate", in the sense that fossil-fuel supply can be reliably predicted and has been agreed upon by the countries concerned to give adequate time to make the necessary adjustments.

If we now consider the likely market dynamics that will ensure then the similarities between the proposed energy regime and a monetary regime becomes more apparent. Just as financial markets analyse and respond to the expected supply of and demand for money so energy market participants will be proactive with response to the supply and demand of fossil-fuels. Analysts will create scenarios which will model the energy market and expected price responses to the projected excess of demand over supply. In particular they will model

[64] International Energy Agency, "World Energy Outlook,", p.384.

[65] The scenarios are described by the IEA as follows: "In the New Policies Scenario, which takes account of both existing policies and declared intentions, world primary energy demand is projected to increase by 1.2% per year between 2008 and 2035, reaching 16 750 million tonnes of oil equivalent (Mtoe), an increase of 4 500 Mtoe, or 36% (Figure 2.1). Demand increases significantly faster in the Current Policies Scenario, in which no change in government policies is assumed, averaging 1.4% per year over 2008-2035. In the 450 Scenario, in which policies are assumed to be introduced to bring the world onto an energy trajectory that provides a reasonable chance of constraining the average global temperature increase to 2° Celsius, global energy demand still increases between 2008 and 2035, but by a much reduced 22%, or an average of 0.7% per year." Ibid., p. 78.

the divergence between the development of the "capped carbon" price, for usage that causes carbon emissions, and the "uncapped carbon" price for other purposes.

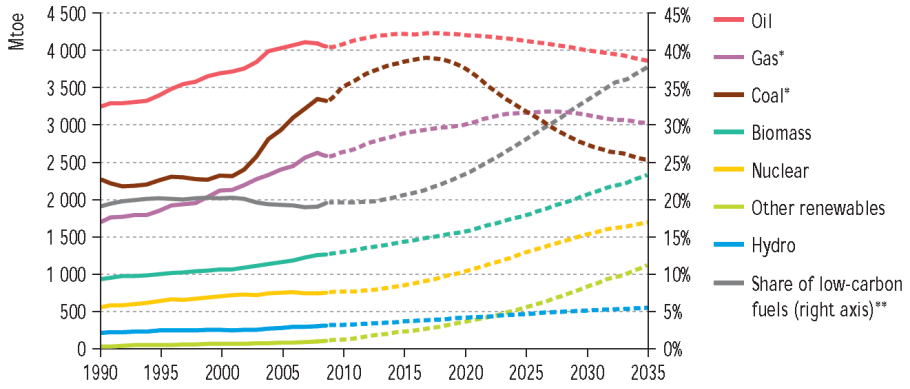

Fig. 8 World primary energy demand by fuel in the 450 Scenario [66]

These scenarios will lead to current responses to correct to expected imbalances. In particular it will lead to quantitative responses, including

- increasing demand for technologies that decouple combustion from emission, including Carbon Capture and Sequestration and similar technologies, which will allow the usage of uncapped fossil-fuels
- increasing demand for non fossil-fuel energy sources, such as nuclear, hydro, wind and solar

and to increases in permit and fossil-fuel prices:

- a futures market will emerge which will enable the efficient trading of both capped and uncapped fossil-fuels into the future
- the spot price of fossil-fuels will adjust to reflect the discounted value of the expected future prices—otherwise arbitrage opportunities would exist
- the price of permits will reflect the expected behaviour of the market. In particular they will tend to rise immediately to reflect expected demand and the desire of some market participants to go "long carbon" at current prices in order to profit from the higher prices in the future

The central role of expectations thus allows quantitative controls to be immediately effective even if the current extraction quotas are higher than current production. They provide producers with long term security, allowing them to continue to use their existing capital stock while providing strong incentives to substitute away from fossil-fuels in new investments.

An empirical attempt at estimating supply side responses to governmental commitments to reducing carbon emissions has been made by the IEA, apparently using a very sophisticated methodology:

> The IEA oil supply model has been improved for this year's Outlook, to allow for more complex modelling of global supply scenarios, with more detailed assumptions per country

[66] Ibid., p. 397. *Includes CCS. **Excludes CCS

and resource category. This modelling includes simulating the impact of different assumptions about resource endowment and accessibility, oil prices, costs (finding and development and lifting), fiscal terms and investment risks, logistical constraints on the pace of resource exploration and development, production profiles and decline rates, carbon emission regulations and CO2 prices, and technological developments. The model projects supply, investment in exploration and production, and company and government revenues by country/region and by resource category. The projections are underpinned by current field production profiles and decline rates, drawing on the detailed results of the field-by-field analysis of WEO-2008 (IEA, 2008), and take into account specific near-term project development plans (IEA, 2010b). OPEC production projections take into account stated policies on resource depletion and investment.

The following figure sets out the IEA's projected paths for oil production under each of the three scenarios

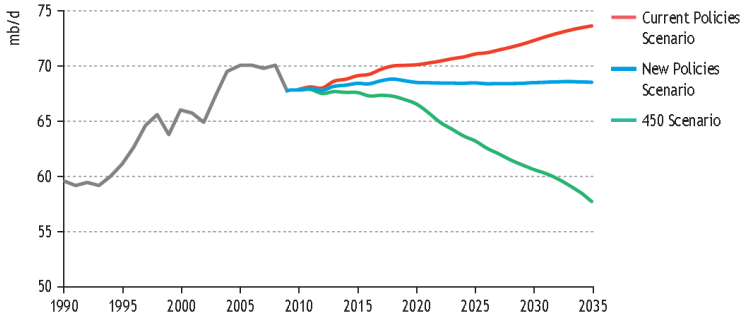

Fig. 9 World crude oil production by scenario [67]

Setting aside the apparent discrepancy that the 450 Scenario in the figure does not appear to match the path of oil in Figure 8, the discussions of supply side effects and the Green Paradox above should engender grave doubt about the realism of such predictions.

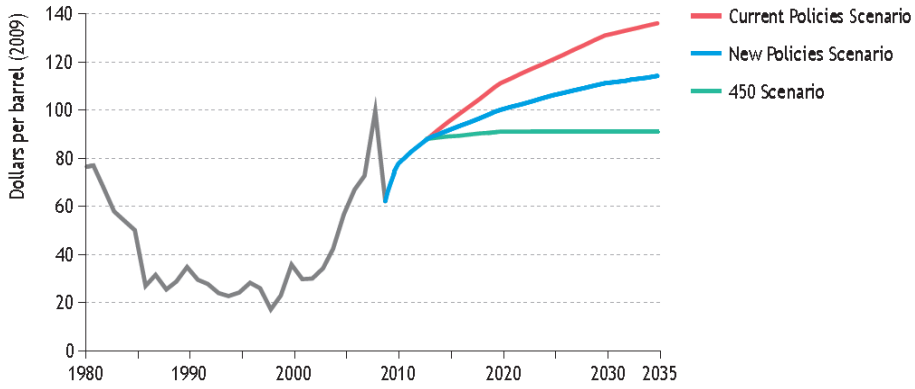

Fig. 10 Average IEA crude oil import price by scenario [68]

The IEA asserts that "energy prices ensure that projected supply and demand are in balance throughout the Outlook period in each scenario"[69] Yet Figures 9 and 10 indicate that the IEA assumes that some remarkable combination of policies in the 450 Scenario is able to

[67] Ibid..

[68] Ibid., p. 72.

[69] Ibid., p.78.

reduce demand for oil and at the same time reduce its price. They further appear to assume that fossil-fuel energy suppliers passively accept lower prices and reduce their production accordingly.

If the energy industry truly believed that the "New Policies" or the "450" scenarios were going to be implemented, then they would presumably be loath to invest in new production capacity because of the anticipated flattening or reduction of future production. The reality is that these companies increased upstream investment 10% in 2010 to about $470 billion.

Table 1 Oil and gas industry investment (nominal dollars) [70]

Company	Upstream			Total		
	2009 ($ billion)	2010 ($ billion)	Change 2009/2010	2009 ($ billion)	2010 ($ billion)	Change 2009/2010
Petrobras	18.4	23.8	29%	35.1	44.8	28%
Petrochina	18.9	23.1	22%	39.1	42.9	10%
ExxonMobil	20.7	27.5	33%	27.1	28.0	3%
Royal Dutch Shell	20.3	19.4	-5%	26.5	26.0	-2%
Gazprom	11.5	12.9	13%	15.2	23.7	55%
Chevron	17.5	17.3	-1%	19.8	21.6	9%
Pemex	16.8	16.0	-4%	18.6	19.5	5%
BP	14.7	13.0	-12%	20.7	18.0	-13%
Total	13.7	14.0	2%	18.5	18.0	-3%
Sinopec	7.5	8.2	9%	15.9	16.4	3%
Eni	13.2	13.8	5%	19.0	14.6	-23%
Statoil	11.8	11.1	-6%	12.4	13.0	5%
ConocoPhillips	8.9	9.7	9%	10.9	12.0	10%
Rosneft	5.9	6.5	11%	7.3	9.5	31%
Lukoil	4.7	5.5	17%	6.5	8.0	22%
CNOOC	6.4	7.8	22%	6.4	7.9	24%
Repsol YPF	2.5	3.4	36%	12.1	7.9	-35%
BG Group	4.4	6.2	41%	6.5	7.0	8%
Chesapeake	4.8	4.5	-7%	6.1	6.8	12%
Apache	3.1	4.7	49%	3.8	6.0	58%
Anadarko	4.0	4.5	12%	4.6	5.5	20%
Suncor Energy	4.2	4.5	8%	4.9	5.3	8%
Devon Energy	4.2	4.7	12%	4.9	4.7	-4%
EnCana	3.7	4.4	19%	4.6	4.5	-3%
Occidental	3.0	3.6	21%	3.6	4.5	26%
Sub-total 25	*244.7*	*270.0*	*10%*	*350.1*	*376.0*	*7%*
Total 70 companies	*345.9*	*378.4*	*9%*	*n.a*	*n.a.*	*n.a.*
World	428.0	468.1	9%	n.a.	n.a.	n.a.

Similarly, the allegedly immanent decline in coal production forecast in Fig. 8 is incompatible with substantial increases in coal investment:

[70] Ibid., p. 127. The world total for upstream investment was derived by prorating upwards the spending of the 70 leading companies, according to their share of oil and gas production in each year. Sources: Company reports and announcements; IEA analysis.

> BHP Billiton stands out in terms of its 2009 investments. Its financial year runs to 30 June, so the $2.4 billion reported includes investment made in the second-half of 2008. The figure includes a tripling of investment in Australian coking coal production, a doubling of investment in South African steam coal production and investment in a third coal terminal at Newcastle, Australia. Production at China's three largest coal companies rose 7% in 2009, in line with a rise in national production. The future investment plans of these three companies reflect China's ambition to continue the rapid expansion of its coal industry by opening large new mines. Taken together, the Shenhua and China National Coal Groups have announced 2010 investment plans that are 70% higher than in 2009.[71]

It is finally the behaviour of energy suppliers that will determine future extraction rates and carbon emissions—not the assertions of the international community at well meaning conferences, nor the scenarios of the IEA. These investment decisions in oil, gas, and coal demonstrate that market participants intend their production of fossil-fuels to expand strongly in the coming years. It may be difficult to ascertain whether this results from an expectation that the demand for fossil-fuels will develop strongly in the coming years; attempts to accelerate current extraction in response to possible future reductions to demand; or combinations of these and other factors. The conclusion is, however, clear: the expectations of energy suppliers should be made compatible with energy governance objectives in order to ensure environmental stability and energy security.

The role of expectations, and the question as to whether the proposed IEO will be associated with a „reliable and adequate supply of energy at reasonable prices", should not be examined in a vacuum but in the context of the alternative. For approximately two decades there have been international proposals, negotiations and agreements in response to the challenges of climate change. All of these have had fundamental implications for fossil-fuel energy suppliers—generally reductions in revenues and profitability through policies to limit demand and encourage substitutes. It is these negative and uncertain prospects that have given fossil-fuel energy producers "green paradox" and "carbon leakage" incentives to increase current production and divert sales to the non-Annex I countries.

In comparison to this very uncertain current environment energy companies would "know where they are" under the proposed IEO system. The "central bank" governance structure would provide clear parameters and reduce uncertainty, with the intention of ensuring that the expectations of market participants are fulfilled and trust in the system develops. The resulting process should allow the achievement of both energy security and environmental objectives in a system in which all participants play by the same transparent set of rules.

Restrictions on exploration

Changing the expectations of market participants may be easiest through the imposition of quantitative restrictions on as yet undiscovered fossil-fuels. While Fossil-fuel Exploration Permits could be allocated for the coming years in a similar fashion to Carbon Extraction Permits, a clear and unmistakeable signal would come from an international moratorium on exploration. The impact on expectations would be dramatic: it would make immediately apparent that the "the fossil-fuel age" had come to an end. It would clearly

[71] Ibid., p. 215.

convey the messages that the quantity of fossil-fuels that had already become proven reserves exceeded the amount that could be used without causing dangerous climate change, and that all energy stakeholders needed to orientate themselves to this new reality.

An international exploration moratorium could be achieved at relatively low direct cost—as no ownership or usage rights have been defined over such resources little or no compensation would have to be provided. It could also be flexible amended if necessary. Should non CO2-producing usage of fossil-fuels—as industrial feed stocks or through decoupled combustion, for example—expand to the extent that they needed extra supplies, then the policy could be appropriately changed.

The restriction of fossil-fuel supply through extraction and exploration limits would create positive pressures to increase the relative price of fossil-fuels and decrease their usage as against alternatives. The extent to which these pressures lead to appropriate global restructuring depends on the integration and efficiency of the energy markets, the subject of the next section.

5.B. An Integrated and Efficient Energy Market

International Integration

Yergin in his insightful analysis of the requirements for energy security emphasises the "… the reality of integration. There is only one oil market, a complex and worldwide system that moves and consumes about 86 million barrels of oil every day. For all consumers, security resides in the stability of this market. Secession is not an option" [72] For Yergin, this implies in particular in globalising the traditionally western and OECD-based energy security system based on the IEA, "which can be achieved especially by engaging China and India. …It would be wiser—and indeed it is urgent—to engage these two giants in the global network of trade and investment rather than see them tilt toward a mercantilist, state-to-state approach". [73]

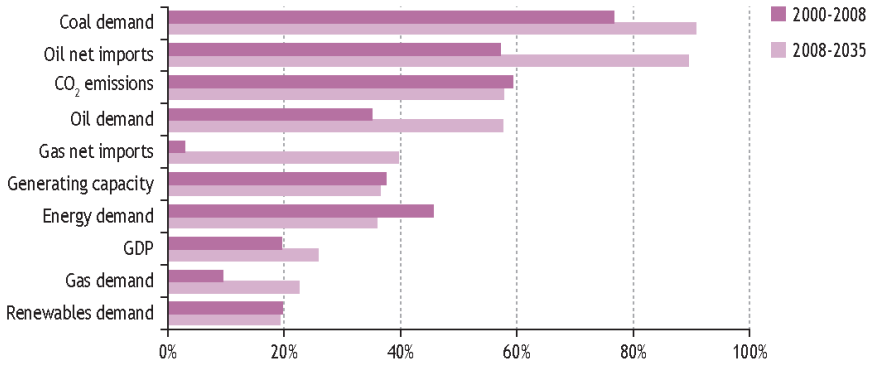

Fig. 11 China's share of the projected net global increase for selected indicators [74]

[72] Yergin, "Ensuring energy security", p. 78.

[73] Ibid., p. 78.

[74] International Energy Agency, "World Energy Outlook,", p. 99.

The restriction of carbon emissions operates in a similar direction. Just as a local forestry or grazing commons perspective requires the participation of the most important co-users so the energy commons needs the participation of the most important states.[75] The above diagram indicates the central importance of the Chinese energy demand, and hence its participation in an energy regime. Ideally all significant energy producer and consumer states would be members of the IEO, and would help to both establish quantitative restrictions and to implement them in their own countries. This would dramatically simplify the key potential challenges the IEO: how to regulate relations between IEO member states and those outside the system. The more states there are inside the IEO the less there to potentially undercut the regime effectiveness in general, and the restrictions on extraction and exploration in particular. This implies that not only should the major consumer countries including China and India need to be members of the regime, but the major producers such as the USA, OPEC, Russia, and Australia need to be members as well.

The question of the appropriate handling of countries outside the IEO is one of the most difficult challenges facing the establishment of an effective energy commons regime. A comprehensive examination of this issues lies outside the scope of this paper. It can however be noted here that while it is possible to attempt to impose compensating border adjustments, such arrangements tend to be fraught with difficulties.[76]

Sectoral Integration

Creating an integrated market with many suppliers and many consumers restrains the exertion of market power by any one actor. This diversification reduces the impact of strategic market behaviour, such as by monopolists or monopsonists, and helps increase energy security by increasing market stability.

Yergin's quotation above focuses on oil markets, but there are a large and increasing number of energy sources, and similar energy security advantages are to be had by the integration of sectors. Energy industries are generally network industries, and as such there tends to be substantial market power among incumbents and very high barriers to entry for new entrants. Energy needs to be transported from producers to consumers across different types of energy media and across country boundaries. The role of the international energy transmission infrastructure, especially the electricity ("smart grid") and the gas networks, will play a critical role here. They should allow electricity generated in wind parks on the Danish coast to be converted into hydrogen, transmitted through the European gas network, and used

[75] In the terms of the collective action literature it should be an „encompassing coalition" see e.g.Mancur Olson, *The logic of collective action; public goods and the theory of groups*, Harvard economic studies, (Cambridge, Mass.,: Harvard University Press, 1965) ; ———, *The rise and decline of nations : economic growth, stagflation, and social rigidities* (New Haven: Yale University Press, 1982) .

[76] See generally M. H. Babiker and T. F. Rutherford, "The economic effects of border measures in subglobal climate agreements," *Energy Journal* 26, no. 4 (2005); T. L. Brewer, "The WTO and the Kyoto protocol: interaction issues," *Climate Policy* 4, no. 1 (2004); F. Biermann and R. Brohm, "Implementing the Kyoto Protocol without the USA: the strategic role of energy tax adjustments at the border," *Climate Policy* 4, no. 3 (2005); P. Holmes, T. Reilly, and J. Roll, "Border carbon adjustments and the potential for protectionism," *Climate Policy* 11, no. 2 (2011);

in Southern Germany for example. This example also illustrates the importance of sectoral integration if the environmental benefits from the pressures to reduce fossil-fuel usage are to be achieved. There is thus a large role for the IEO to play in ensuring the integration of energy markets: both internationally, and with respect to different energy technologies.

Improving market mechanisms

Yergin emphasises the importance of well-functioning markets for energy security:

> Markets need to be recognized as a source of security in themselves. The energy security system was created when energy prices were regulated in the United States, energy trading was only just beginning, and futures markets were several years away. Today, large, flexible, and well-functioning energy markets provide security by absorbing shocks and allowing supply and demand to respond more quickly and with greater ingenuity than a controlled system could. … Thus, governments must resist the temptation to bow to political pressure and micromanage markets. Intervention and controls, however well-meaning, can backfire, slowing and even preventing the movement of supplies to respond to disruptions. At least in the United States, any price spike or disruption evokes the memory of the infamous gas lines of the 1970s-even for those who were only toddlers then (and perhaps even for those not yet born at the time). Yet those lines were to a considerable degree self-inflicted-the consequence of price controls and a heavy-handed allocation system that sent gasoline where it was not needed and denied its being sent where it was.[77]

In particular markets help establish diversification among buyers and sellers, reducing the market power of the dominant actors and increasing the ability to respond to disruption. These energy security reasons for well-functioning markets are paralleled by environmental advantages. Efficient markets ensure that energy flows to where it is most needed, and is not wasted or inappropriately used. An increase in the relative price of fossil-fuels, for example, will automatically lead consumers to substitute renewable for fossil-fuel energy sources, and to engage in energy saving behaviour because of the direct benefits that such measures provide.

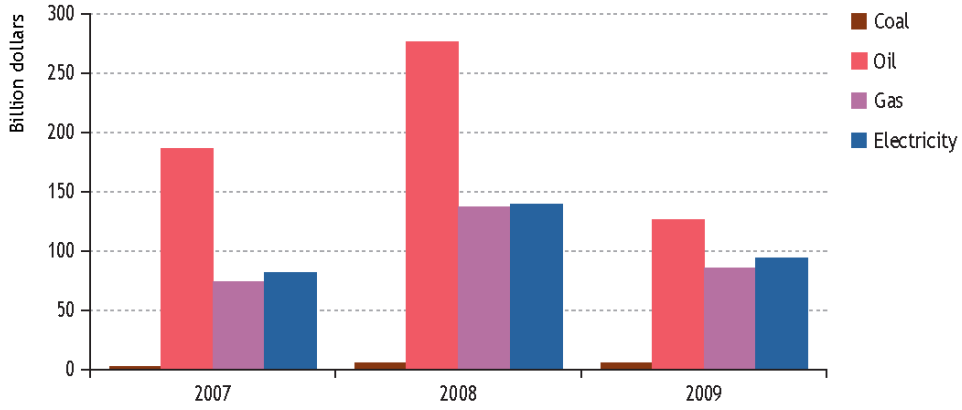

Fig. 12 Economic value of fossil-fuel consumption subsidies by type [78]

An immediate environmental benefit would come from the removal of interventions which serve to distort national and international price signals. The most egregious example is

[77] Yergin, "Ensuring energy security", pp. 79-80.

[78] International Energy Agency, "World Energy Outlook,", p.579.

the subsidisation for the combustion of fossil-fuels. This has the opposite effects from what is needed, not only encouraging the burning of fossil-fuels in less valuable usages but also discouraging substitution away from coal, gas and oil.[79] Figure 9 shows the enormous scale of these subsidies, and Figure 10 shows estimates for the substantial impact that removal would have on carbon dioxide and other greenhouse gas emissions.

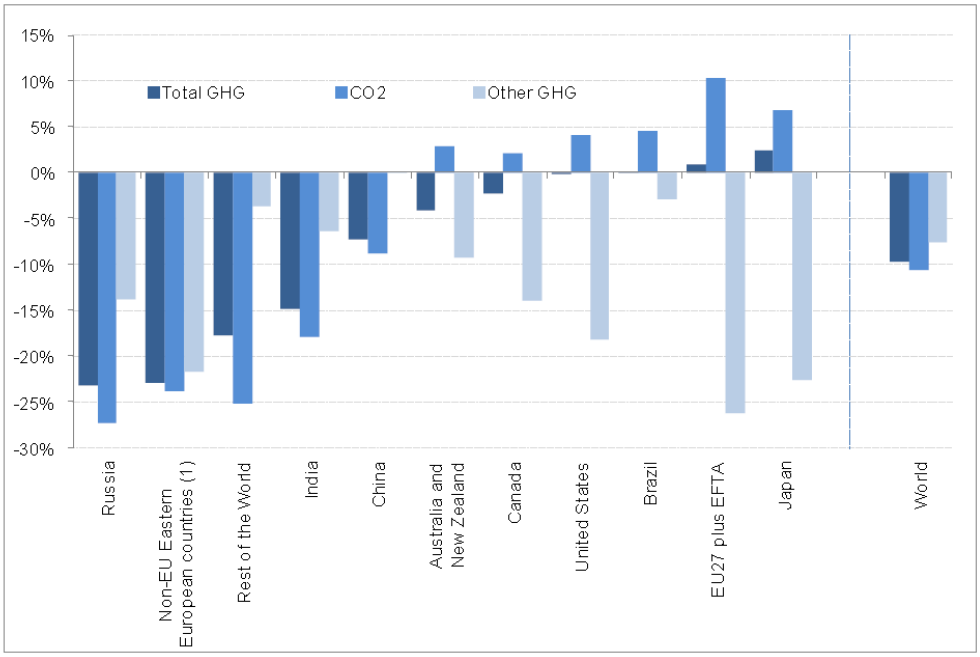

Fig. 13 Long-term impact of a phasing-out of fossil-fuel subsidies on GHG emissions [80]

The establishment of integrated and efficient markets also implies the removal of the highly complex systems of supports and sanctions which has evolved to give encouragement to the development of renewables such as biofuels and wind and solar energy. These programmes which include feed in tariffs, regulatory requirements and investment incentives among other mechanisms, involve in essence governments "choosing champions". As has been seen in the case of the conflict between agricultural biofuels and food production such market interventions harbour the danger of unintended consequences which undermine or even reverse the original purpose.[81]

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[79] International Energy Agency, OECD, and World Bank, *Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative*, IEA, OPEC, OECD, World Bank Join Report Prepared for submission to the G-20 Summit Meeting Toronto (Canada), 26-27 June 2010 (Paris: OECD Publishing, 2010) ; OECD, "The Scope of Fossil-Fuel Subsidies in 2009," (2009); Jean-Marc Burniaux and Jean Chateau, *Mitigation Potential of Removing Fossil Fuel Subsidies: A General Equilibrium Assessment*, OECD Economics Department Working Papers, No. 853 (OECD Publishing, 2011) ; J. Ellis, "The effects of Fossil-Fuel Subsidy Reform: A Review of Modelling and Empirical Studies," (2010)..

[80] International Energy Agency, OECD, and World Bank, *Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative*: , p. 31.

[81] See e.g. A. Muller et al., "Some insights in the effect of growing bio-energy demand on global food security and natural resources," *Water Policy* 10(2008); J. H. Spangenberg and J. Settele,

An institutional environment which created more integrated and efficient markets could thus be expected to lead to an increase in energy security and a decrease in CO2 emissions. Market forces alone do not always lead to optimal solutions, however, a theme continued in the next section.

5.C. Improving Resilience, Infrastructure, and Property Rights

Improving Resilience

Yergin emphasises that ensuring energy security involves going beyond what the market would offer alone, in particular he stresses the importance of "resilience" which he characterises as

> a "security margin" in the energy supply system that provides a buffer against shocks and facilitates recovery after disruptions. Resilience can come from many factors, including sufficient spare production capacity, strategic reserves, backup supplies of equipment, adequate storage capacity along the supply chain, and the stockpiling of critical parts for electric power production and distribution, as well as carefully conceived plans for responding to disruptions that may affect large regions. [82]

That resilience is strengthened by an appropriate institution is demonstrated by the impact of the IEA which has successfully coordinated the development of strategic buffers and other mechanisms following the 1973 oil crisis.

A second form of resilience, of importance to both energy security and environmental objectives, relates to market operations. Although markets normally operate relatively efficiently they are social institutions and sometimes are subject to extreme movements.[83] This is especially likely during the introduction of quantitative restrictions, as the market participants learn to work within the new framework.

Just as financial markets are subject to the stabilising influences of central banks and governments, so it is appropriate for energy markets to be stabilised by activities of the IAESE. In particular it would aid stabilisation for the IAESE to hold a reserve of CEPs and FFEPs which would allow it, like a central bank, to supply "energy liquidity" to the market at short notice.

Provision of Supply Chain and Environmental Infrastructure

A further requirement for energy security is support and protection for the supply chain and its associated infrastructure. As Yergin emphasises, this involves going beyond what the market would offer and involves the provision of public goods such as ensuring the security of oceanic transport routes:

> Today, the concept of energy security needs to be expanded to include the protection of the entire energy supply chain and infrastructure-an awesome task. … . None of the world's complex, integrated supply chains were built with security, defined in this broad way, in mind. Hurricanes Katrina and Rita brought a new perspective to the security question by

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"Neither Climate Protection nor Energy Security: Biofuels for Biofools?," *Uluslararasi Iliskiler-International Relations* 5, no. 20 (2009).

[82] Yergin, "Ensuring energy security", p. 76.

[83] See e.g. Schiller Irrational Exuberance.

> demonstrating how fundamental the electric grid is to everything else. After the storms, the Gulf Coast refineries and the big U.S. pipelines were unable to operate—not because they were damaged, but because they could not get power.
>
> Energy interdependence and the growing scale of energy trade require continuing collaboration among both producers and consumers to ensure the security of the entire supply chain. Long-distance, cross-border pipelines are becoming an ever-larger fixture in the global energy trade. There are also many chokepoints along the transportation routes of seaborne oil and, in many cases, liquefied natural gas (LNG) that create particular vulnerabilities: the Strait of Hormuz,…[84]

The coordination of the provision of such an energy security infrastructure between the different governance levels of private companies, individual countries, and groups of states is clearly an appropriate role of the IEO. In addition it could help ensure that the necessary general energy infrastructure is undertaken, which is estimated to require trillions of dollars of investment in the oil and gas industries alone.[85]

An even more extensive role may be needed in the environmental domain, as public goods as such are typically not- or under-produced by market systems. This could begin with similar infrastructural support as that needed for energy security, such as distribution networks capable of transporting renewable energy forms from producers to consumers, and could extend through to the provision of the IEO governance system itself, including the extensive monitoring and sanctioning mechanisms discussed below.

Improving Property Rights and Dispute Resolution

A central aspect of energy security is the dependability of contractual supply relationships. One of the consequences of the geopolitical role of energy is that it can lead to a complex intermixing of political and economic concerns which can undermine the dependability of energy supplies. Much of the current concern about energy security in the European Union, for example, comes from the interruptions to gas deliveries from Gazprom.[86]

The creation of clear and protected property rights for energy producers, especially those with sovereign or quasi-sovereign contractual partners, would deliver an immediate energy security advantage by making contracts more dependable and thus directly increase energy security. Improving property rights would also producers more confidence over the length of time that they would enjoy extraction rights. This should lead to the positive environmental result of inducing them to flatten their extraction trajectory, changing the balance from current towards future production. It follows that the IEO should advance the

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[84] Yergin, "Ensuring energy security", p. 78

[85] See International Energy Agency, "World Energy Outlook," *passim*; Goldthau and Witte, "Back to the future or forward to the past ? Strengthening markets and rules for effective global energy governance", p. 386.

[86] See e.g. F. Umbach, "Global energy security and the implications for the EU," *Energy Policy* 38, no. 3 (2010); A. Grivach, "Putting Pressure on Gazprom," *Current Digest of the Post-Soviet Press* (2009); A. Heinrich, "Under the Kremlin's Thumb: Does Increased State Control in the Russian Gas Sector Endanger European Energy Security?," *Europe-Asia Studies* 60, no. 9 (2008); A. Goldthau, "Rhetoric versus reality: Russian threats to European energy supply," *Energy Policy* 36, no. 2 (2008).

further development of legal initiatives, including perhaps the simplification of the use of international law and international arbitration, and perhaps including the use of the International Energy Tribunal.

5.D. Informational Transparency, Monitoring, and Modelling

Informational Transparency

Yergin's analysis of the requirements for energy security also stresses the central importance of information:

> High-quality information underpins well-functioning markets. On an international level, the IEA has led the way in improving the flow of information about world markets and energy prospects. That work is being complemented by the new International Energy Forum, which will seek to integrate information from producers and consumers. Information is no less crucial in a crisis, when consumer panics can be instigated by a mixture of actual disruptions, rumors, and fear. Reality can be obscured by accusations, acrimony, outrage, and a fevered hunt for conspiracies, transforming a difficult situation into something much worse. In such situations, governments and the private sector should collaborate to counter panics with high-quality, timely information.[87]

This emphasis on information becomes increasingly important as areas not covered by the IEA become increasingly important. Examples are the Nationally Owned Companies (NOCs) that typically provide much less information about their activities than publicly traded companies such as the supermajors.[88] These requirements for information in order to advance energy security mesh with the need for transparency to ensure that environmental objectives are not undermined by illegal activity and defection.

A common factor in analyses of the commons is the importance of credible and effective monitoring and sanctioning to ensure that nobody is abusing the system or "defecting".[89] The proposed imposition of quantitative restrictions would have a transformative effect on global energy markets. In particular it would result in relative increases in fossil-fuel energy prices, giving energy suppliers with incentives to bypass quotas, increase extraction, and expand supply.

Whatever the specific details, international arrangements to limit of fossil-fuel supply would in all likelihood unleash pressures greater than any previous attempt at quantitative restrictions in any other field such as alcohol prohibition, wartime sanctions, or weapons sales. The illicit drug trade will perhaps prove to be the closest analogy, where despite intense national and international efforts it has proved impossible to exert effective international control. This strong tendency of the suppliers to expand rather than limit production would have to be credibly and transparently counteracted for any governance system based on quantitative restrictions to be effective and is addressed in the following two sections.

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[87] Yergin, "Ensuring energy security", p. 76.

[88] See Goldthau and Witte, "Back to the future or forward to the past ? Strengthening markets and rules for effective global energy governance", p. 384.

[89] The expression is used here and below in the game-theoretic sense of an actor who follows his or her own immediate interests rather than following socially prescribed norms and rules.

Transparency is a principle that has proved very effective in helping ensure that socially undesirable behaviour does not occur—in this case primarily the bypassing of the quotas. When relevant and accurate information is widely available then monitoring and control becomes much easier.

Certain aspects of the energy are already subject to transparency requirements in certain jurisdictions. An example is the necessity for U.S. gas pipeline operators to frequently publish detailed information on gas flows through their facilities. The IEF's Joint Oil Data Initiative (JODI) indicates the potential of international integration of such data sources – in this case as applied to oil.[90] The global revolution in communications technologies, particularly mobile and sensor technologies and the internet, would provide for the publication online and real time in easily accessible forms, such as websites, and in machine readable formats to enable standardised computerised access. A Comprehensive Energy Transparency Initiative (CETI) regime would build on this principle and ensure transparency at the following levels:

Global

- decisions and analyses of international bodies such as the International Energy Organisation, especially regarding the quantitative limits on extraction and exploration at global, national, and permit levels

States

- the allocation of the permits to the various energy producers and the extent to which quotas are being met
- the collection and distribution of revenues

Production, Distribution, and Consumption

- the specific details of fossil-fuel production and distribution from specific producers and distributers, through to final fuel combustion or non-fuel usage
- the CETI might require, for example, coal-fired power stations to install sensors on each of their smokestacks which provide online and real time information about the volume and specific characteristics of their atmospheric emissions. Such data will become increasingly important as Carbon Capture and Sequestration (CCS), torrefaction, and other technologies allows existing power stations to reduce carbon emissions while maintaining generating capacity
- the Extractive Industries Transparency Initiative (EITI) has already done path-breaking work in this field, showing the power of extractive industry data in a related context. It cooperates with energy and other resource producers to publish data on financial flows from the extractive industries. This

[90] See Joint Organisations Data Initiative (JODI), www.jodidata.org and Goldthau and Witte, "Back to the future or forward to the past ? Strengthening markets and rules for effective global energy governance", p. 384.

transparency helps reduce corruption and the associated misappropriation of resources.

Monitoring

Some energy security requirements, such as the security of the supply chain, need to be actively monitored to ensure that they are being achieved. Fortunately it such monitoring is generally in the interest of market participants, but ensuring that the coverage is sufficiently extensive and that the quality is appropriate is an appropriate role for the IEO.

Monitoring is even more critical to ensure that environmental objectives are being met, as there are no direct incentives to monitor extraction, exploration, or emissions limits—but strong motivations to evade them. Just as external audits help increase the trust of company owners and partners, so a regular system of external audits of appropriate institutions and processes help increase confidence in the proposed energy governance system. This would apply to the IEO and its constituent organisations; states and their respective administrations; and producers, distributors and consumers of fossil-fuels. The auditors would both be users of the CETI data themselves, and would confirm that the CETI information provided was accurate.

All commons regimes place particular emphasis on monitoring, as it is only when the community knows what it is happening to its resources that it is able to act and react appropriately. Monitoring and sanctions are often intimately connected in the management of a village commons, where the village community can rapidly learn if one of their members is cheating, and apply sanctions such as ostracism where necessary.

Monitoring at a global scale has traditionally required dedicated and expensive agencies and organisations, giving rise to the difficult problem of *Quis custodiet ipsos custodes*? Global monitoring regimes have often become dulled and ineffective through processes such as regulatory capture.

Around the world individuals, families, non-profit and for-profit organisations attempt to make the world a better place, for example by reducing their carbon footprints. Yet the collective-action nature of the energy commons means that, without international coordination, such civil society efforts will not adequately address the challenge.

Modern communications technology allows the possibility of creating a "global village" community with the specific objective of monitoring the energy commons and its associated economic and environmental systems. Initiatives such as The Globe Program, ClimateWatch, and Bhuu indicate the power of linking social networks to the collection and exchange of empirical information.[91] Databases such as the Renewable Energy Foundation's Energy Data project show the potential of linking energy data and environmental data.[92] CETI could allow these and further projects to develop into enormously powerful monitoring systems. Such civil society projects can draw on the power of the CETI infrastructure and comprehensive data coverage and focus on areas where they enjoy a comparative advantage,

[91] See generally ClimateWatch, http://www.earthwatch.org/australia/get_involved/climatewatch/; Globe Programme, http://globe.gov/; Bhuu, www.bhuu.org.

[92] Renewable Energy Foundation, http://www.ref.org.uk/energy-data.

such as ensuring that their observations match the CETI entries and focusing on exceptions where there are discrepancies; initiating the sanctioning of illegal behaviour; and extending the CETI database into new data fields and domains.

Modelling and Simulation

Auditing and monitoring are thus important to energy security but further objectives such as resilience require a fuller understanding of inter-relationships in the energy market. Supply interruptions or natural disasters are abnormal situations that by definition are not usually observable, but understanding and preparing for them is critical to establishing energy security. Modelling and simulation allows the assessment of both the immediate impact of a disruption and the system responses, enabling the posing of 'what if' questions prior to any actual event.

Understanding the impact of fossil-fuel emissions on climate change requires understanding the complex interactions between fossil-fuel production and usage, greenhouse gas emissions, and the fundamental mechanisms that drive our climate. The inter-relationships between these complex and correlated issues are imperfectly understood, but are critical to the success of the proposed governance system with respect to the prediction of future events, the setting of objectives, the choice of mechanisms, the monitoring of planned and observed developments, and the proposal of corrections.

Global modelling initiatives, such as the International Centre for Earth Simulation (ICES),[93] model the earth with its various systems and subsystems. They include the interaction between the traditional domains of the natural sciences (such as meteorology and hydrology), and the human sciences (such as geography and economics). Such initiatives could even extend the participatory monitoring principles discussed above to participatory modelling, applying for example the engagement and infrastructure of citizen science projects such as SETI to issues of direct relevance to life on earth.[94]

Sophisticated modelling and simulation is thus necessary to both energy security and limiting human impacts on the future climate. Ensuring the development and implementation of such systems is thus another appropriate avenue of the IEO, as modelling and simulation can help ensure that the correct governance measures are chosen are appropriately implemented.

5.E. Compensating for Environmental Externalities: Mitigation and Adaptation

Compensating for Environmental Externalities

The discussions above have examined each governance objective and demonstrated their utility for both energy security and climate stability. There is an important asymmetry,

[93] ICES's mission is „helping guide the successful transformation of human society in an era of rapid climate change and frequent natural disasters". See International Centre for Earth Simulation (ICES), www.icesfoundation.org.

[94] SETI's intention is "explore, understand, and explain the origin, nature and prevalence of life in the universe". It is currently the largest distributed computing effort with over three million participants. SETI Institute, www.seti.org.

however, in that ensuring an adequate and reliable supply of energy is in the direct interest of economic actors. The role of an energy security system like the IEA is primarily to ensure the achievement of systemic objectives, such as resilience, which might be underprovided by pure market solutions.

Carbon dioxide emissions, by contrast, are negative externalities resulting from economic activity. Economic incentives generate pressure to increase emissions, and to bypass restraints on profit maximisation such as quotas. It is thus critical for the environmental domain of the proposed governance system that incentive systems support reductions in fossil-fuel usage, and that the consumption that does take place provides resources for compensation following the "polluter pays" principle.[95]

Mitigation and the Energy Transition

It follows that in the case of the energy commons it is appropriate for some of the revenues flowing from the proposed cap and trade system be used to redress the negative consequences of carbon emissions. Given the nonlinear nature of the feedback effects involved, and the danger that we may be nearing "tipping points", the mitigation of possible dangers appears the most important priority.

Given the focus of the IEO a prime mitigation mechanism is clearly to assist an accelerated transition to non- and low-carbon energy sources. There are a large number of specific measures that the IEO could undertake that could help facilitate such a transition. These include support for fundamental research not able to be financed by the private sector; accelerating development such as through "incubator" assistance to pilot projects; and assisting the creation of the appropriate infrastructure. A central responsibility of the IEO would be to ensure that all its governance measures complement each other, rather than sending contradictory signals. This implies, for example, that "clean" technologies such as CCS are not subject to the Carbon Extraction Permit limitations, and that assistance to the renewable energy does not undercut the principles of market integration and efficiency discussed above.

Direct reduction of carbon emissions is not always the most cost-effective means of combating climate change. The Kyoto Protocol contains "flexible mechanisms" such as the Clean Development Mechanism (CDM) intended to allow emitters of carbon dioxide to "offset" their emissions by buying credits in carbon markets. The supply of these credits comes from approved projects which reduce greenhouse gas concentrations, generally through increasing sinks or reducing gas emissions. The CDM mechanism has unfortunately been subject to abuse. The underlying principle—that carbon emissions should be prevented in the most efficient manner possible—remains however valid and important. This implies that it would be appropriate for the IEO to support such initiatives, perhaps building on this aspect of the Kyoto Protocol.

[95] See e.g. J. R. Nash, "Too much market? Conflict between tradable pollution allowances and the "polluter pays" principle," *Harvard Environmental Law Review* 24, no. 2 (2000); H. J. Kim, "Subsidy, polluter pays principle and financial assistance among countries," *Journal of World Trade* 34, no. 6 (2000).

It could also be appropriate for the IEO to participate directly in the support and protection of resources which provide global "environmental services", such forests and moors as natural sequesters of carbon.[96] There could even be a role for the purchase and ownership of such resources, to be held in trust by the IEO, in a similar manner to the way that national parks are held in trust for national populations. This would be particularly appropriate if the IEO were able to prevent exploration and extraction in these areas, and could also provide an "honest broker" solution in sensitive regions such as the Arctic.

Adaptation

The impact of climate change is already making itself felt, particularly through the increase in the frequency and impact of extreme weather events. One appropriate policy to assist adaptation would be the establishment of an emergency fund similar in character to the energy security emergency provisions. It would allow a rapid international response to extreme weather events, many of which are predicted to take place in countries without sufficient emergency capacities to be able to cope with crises themselves.

Such a fund would be appropriate for the major disasters that reach the international "radar screen". A climate insurance initiative could be an appropriate mechanism to assist with the large number of smaller weather events, that none-the-less have major impacts on the lives of those involved. Many of those affected will not be able to purchase such insurance themselves, both because their incomes will be too low and because they live in countries without the necessary financial infrastructure. Redressing these limitations could be a further appropriate role for IEO adaptation policy.

6. Financing, Feasibility, and Fairness

Financing

The streams of revenue generated from the sale of the CEPs and FFEPs would be likely to be extremely large, and would initially principally accrue to the major fossil-fuel producing states. Accurate estimation is beyond the scope of this paper and will depend upon parameters such as the level of the GCEQ together with a wide range of further factors such as income and price elasticities, the expectations of market participants, the development of substitutes, etc. Let us assume that the IEAAA issues 30 billion CEPs permitting the combustion of 30 Gigatons of carbon in the form of fossil-fuels. If producers are willing to pay $10 USD per CEP then that would generate $300 billion in revenues per year; at $100 USD it would be $3 trillion annually.[97]

Precise calculation and distribution of these revenues is beyond the scope of this paper, but they could be expected to be divided between the collecting country and the IEO.

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[96] See e.g. Ronal Gainza Carmenates, "Three Economic Perspectives on Post - 2012 Global Climate Policy" (Lausanne, 2011); A. Bowen and N. Stern, "Environmental policy and the economic downturn," *Oxford Review of Economic Policy* 26, no. 2 (2010).

[97] The latter figure is approximately the level estimated by Oliver Tickell in his proposal for international upstream restrictions—see Tickell, *Kyoto2 : how to manage the global greenhouse*: *passim*.

Whatever the final distribution, they could provide for substantial revenues for both the collecting states and the International Energy Organisation.

At the same time such potential revenues have themselves important implications. They imply the creation of an international governance system with both the financial resources and mandate to fundamentally reshape the world's energy markets and their impact on their environment. Ceding sovereignty to—or sharing sovereignty with—such a powerful institution is quite different from making aspirational statements at an international environmental conference, and is one of the factors likely to inhibit the proposal's feasibility.

Feasibility

One purpose of the proposed International Energy Organisation is to increase energy security, and in this sense it could be regarded as a Super-IEA. The other purpose is to impose quantitative restrictions which raise the relative prices of fossil-fuel energy—in this sense a sort of Super-OPEC. Perspectives on the relative attractiveness of each of these aspects can be expected to vary with the ideological and national identities of the reader, especially as the "power" in the organisation is likely to lie with the fossil-fuel producers who collect the revenues from the extraction quotas.

A relatively successful energy security regime can be established with a limited group of states as the IEA demonstrates. Successful quantitative restrictions require, in contrast, that all the principal fossil-fuel producing states be subject to the proposed governance framework— or at least do not undercut it. If one or more states were to be successful free riders, continuing full extraction and production at high prices at the expense of the other states, then the system would tend rapidly to unravel.

A representation of the principal fossil-fuel consuming states would also be desirable in the proposed IEO, principally because of energy security considerations in the wider sense. Given the impact of the original OPEC, the creation of a "Super-OPEC" is likely to be associated with extreme distrust and could foster international disputes and conflicts. Embedding decision-making about energy in a framework which allowed states to articulate—and if necessary protect—their perceived interests would be essential to gain trust and support. A secondary reason for the desirability of energy consumers is that this would enhance the stability of the proposed system in two ways. It would firstly limit the demand for fossil-fuels from non-member states aiding transparency, monitoring and control. And it would secondly enable the IEO consumer states to impose border adjustments for non-member energy suppliers as appropriate.[98] Such handling of non-member countries would be one of the most difficult issues facing the organisation. Ideally incentive and sanction structures should be so designed that non-participating states do not undercut the agreement, but instead find it advantageous to join, but detailed examination and analysis of such structures is beyond the scope of this paper.

Such a need for broad heterogeneous participation conflicts with the likely ease of establishment. Some of the most effective international organisations, such as the IEA, the

[98] See e.g. Biermann and Brohm, "Implementing the Kyoto Protocol without the USA: the strategic role of energy tax adjustments at the border"; C. Weber and G. Peters, "Climate change policy and international trade: Policy considerations in the US," *Energy Policy* 37, no. 2 (2009).

first three European Communities, and GATT initially started with a small number of relatively homogenous states, and expanded as they were seen to be successful. In contrast the current proposal requires wide participation of the fossil-fuel suppliers and benefits substantially from membership of fossil-fuel consumers.

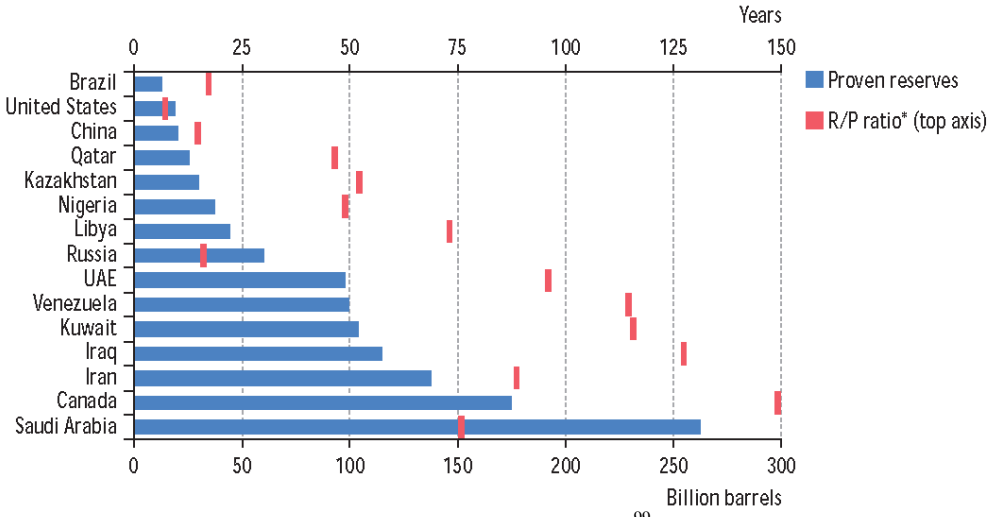

Fig. 14 Proven oil reserves in the top 15 countries, end-2009 [99]

Figure 14 above shows the distribution of principal oil reserves to give an indication of the geopolitical issues at stake. No European countries are included in the major fifteen oil producers, the two OECD countries being the U.S. and Canada. Figure 15 below indicates that gas reserves are distributed somewhat more evenly, but are still heavily concentrated—particularly in the Middle East and Eastern Europe / Eurasia.

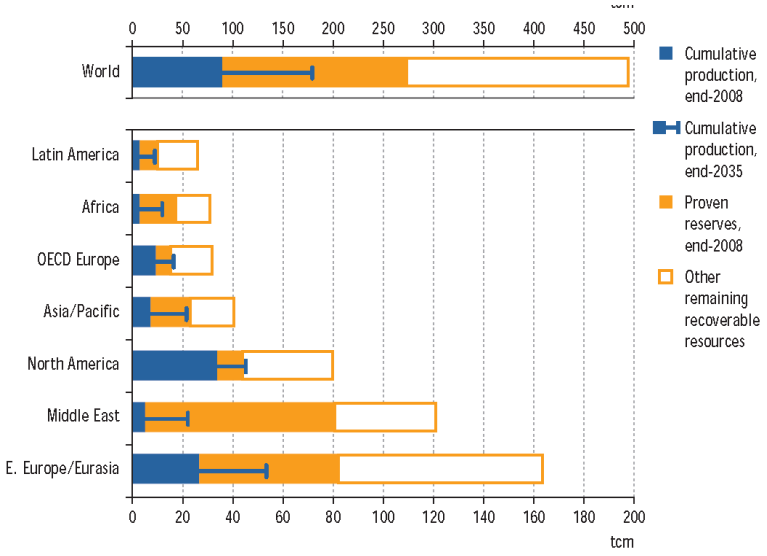

Fig. 15 Proven reserves, recoverable resources and production of conventional natural gas[100]

Table 2 indicates that by comparison coal is primarily extracted in the East. Coal production in Asia is already approximately double that of the entire OECD, and it is

[99] International Energy Agency, "World Energy Outlook,", p. 114

[100] Ibid., p. 188. The estimates are based on the IEA's New Policies Scenario.

estimated that China will continue to dominate international production, with the other major producers being the United States, Canada, India, Indonesia, Russia and South Africa.

Table 2 Coal production by region (million Tons) [101]

	1980	2008	2015	2020	2025	2030	2035	2008-2035*
OECD	1 384	1 478	1 461	1 382	1 306	1 219	1 106	-1.1%
North America	672	883	863	825	773	709	621	-1.3%
United States	*640*	*828*	*807*	*775*	*731*	*670*	*589*	*-1.3%*
Europe	609	258	195	161	138	118	89	-3.8%
Pacific	103	337	403	396	395	392	396	0.6%
Australia	*74*	*331*	*399*	*392*	*392*	*389*	*393*	*0.6%*
Non-OECD	1 196	3 401	4 099	4 284	4 388	4 473	4 514	1.1%
E. Europe/Eurasia	519	401	376	351	344	336	325	-0.8%
Caspian	*n.a.*	*72*	*77*	*80*	*80*	*78*	*76*	*0.2%*
Russia	*n.a.*	*239*	*224*	*208*	*203*	*197*	*193*	*-0.8%*
Asia	568	2 712	3 403	3 610	3 724	3 806	3 862	1.3%
China	*444*	*2 076*	*2 605*	*2 747*	*2 814*	*2 839*	*2 825*	*1.1%*
India	*77*	*322*	*364*	*410*	*434*	*461*	*500*	*1.7%*
Indonesia	*0*	*236*	*319*	*328*	*351*	*376*	*400*	*2.0%*
Middle East	1	2	2	2	2	2	2	1.4%
Africa	100	208	217	222	221	225	226	0.3%
South Africa	*95*	*204*	*202*	*205*	*203*	*206*	*210*	*0.1%*
Latin America	9	79	101	99	97	104	99	0.8%
Colombia	*4*	*68*	*85*	*84*	*83*	*89*	*84*	*0.8%*
World	2 579	4 880	5 561	5 665	5 694	5 692	5 621	0.5%
European Union	*n.a.*	*254*	*188*	*143*	*118*	*96*	*70*	*-4.7%*

On the other side Fig. 16 below shows the major primary energy consumers and their predicted consumption patterns over time. Here it is China, the United States and the EU that currently provide the majority of total demand, with predictions that India and the Middle East will rapidly expand their shares in the coming years.

Fairness

We cannot be sure whether it might be feasible for enough of these diverse countries to reach an international agreement to create the proposed IEO or a similar organisation. One of the factors that could play an important role is the perceived fairness of the proposal. From this perspective it is perhaps an advantage that important powers in the proposed organisation would lie outside the OECD. One of the challenges of the Kyoto Protocol is that many non Annex I countries have continued to reject limitations on their growth and development to correct an environmental problem that the "rich West" caused. Such

[101] Ibid., p. 209. The estimates are also based on the IEA's New Policies Scenario.

considerations of fairness can play an important role in public as in private life and appear to have hindered finding effective solutions within the UNFCCC negotiations.[102]

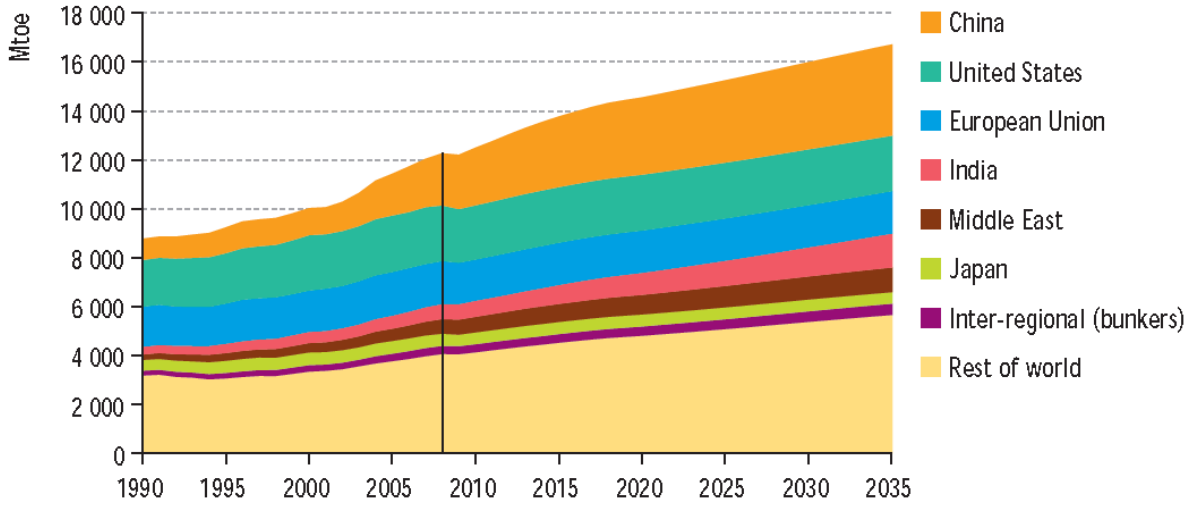

Fig. 16 Primary energy demand by region [103]

The proposed IEO system will be ultimately financed by the consumers who pay higher prices for their goods and services utilising fossil-fuels. These consumers will predominantly be in the OECD / Annex I countries, although the regime would be non-discriminatory, burdening the middle classes of Mumbai and Moscow just as it would the inhabitants of Manhattan.

A governance structure that transferred funds from energy-using and predominantly Western consumers and distributed them around the world might have considerable chance of appearing relatively fair to much of the world's population. The energy producing countries would have a major role in the critical division of the revenues between the producer states and the IEO, and could be expected to be correspondingly influential in determining organisational characteristics such as location and staffing.

Another aspect of the fairness of the proposed governance structure is the treatment of excluded production: reserves and resources that cannot do not receive extraction permits and remain unutilised for the foreseeable future. Canada's large proven reserves are "unconventional oil", in the form of viscous oil (or tar) sands, for example.[104] Utilising oil sands requires special techniques which have a large environmental impact, through both the energy and the processing used.[105] It seems likely that as the intention of the IEO is to

[102] See e.g. Dirk T. G. Rübbelke, "International support of climate change policies in developing countries: Strategic, moral and fairness aspects," *Ecological Economics* 70, no. 8 (2011)

[103] International Energy Agency, "World Energy Outlook,", p. 85. The estimates are from the IEA's New Policies Scenario and quantities are in Millions of tons of oil equivalent (Mtoe).

[104] Ibid., pp. 146 ff.

[105] See e.g.Mejean and Hope, "Modelling the costs of non-conventional oil: A case study of Canadian bitumen";

achieve both energy security and environmental objectives, the distribution of extraction permits would discriminate against unconventional oil in Canada on environmental grounds. Part of the income of the IEO could appropriately be used to compensate such producers for the loss of their expected revenues and profits. Such proposals are likely to unleash major discussions about fairness, as would compensation payments for consumers, the other "losers" in the proposed regime. Consumers pay the cost of the increases in fossil-fuel prices directly in their fuel costs, and indirectly as increases in prices for energy feed through to price increases for goods and services. [106]

This brief discussion is intended to indicate some of the issues that are likely to arise in the negotiation of a successful international agreement, but a comprehensive assessment of such fairness issues and indeed of the feasibility of the proposed regime is beyond the scope of this paper.

The majority of international institutions are strongly Western in their history and orientation, and it is often difficult for them to establish trust in their relations outside the West. It may be a somewhat novel and instructive experience for Western countries to be part of an international organisation where important powers are wielded by others.

A return to the discussion of local pastoral or fishing commons systems reminds us that the achievement of communal advantages requires a degree of trust in collective governance. Some communities manage to achieve communally beneficial governance solutions while others, facing inherently similar challenges, do not.

Thomas Schelling cites the examples of the Post-War allocation of funds for the Marshall Fund, and the division of burdens under NATO, as examples where divisive issues have been effectively solved.[107] There are a large number of environmental domains, including anthropogenic pollution of a range of substances, where successful international solutions have been found. The intention of this paper has been to sketch a blueprint of an international governance system capable of meeting the needs of both energy security and climate stability. I hope that that the ideas presented will contribute to this discussion, and perhaps help to tip the balance towards an economically and environmentally beneficial solution to these critical issues.

7. Summary and Conclusions

The paper contends that understanding the interrelationship between the environmental and the economic aspects of energy use is best achieved in terms of the concept of an energy commons. It argues that the current energy commons governance system fails to adequately address environmental externalities, and that the attempts of the

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[106] See generally Y. Bhatti, K. Lindskow, and L. H. Pedersen, "Burden-sharing and global climate negotiations: the case of the Kyoto Protocol," *Climate Policy* 10, no. 2 (2010); Rübbelke, "International support of climate change policies in developing countries: Strategic, moral and fairness aspects".B. C. Parks and J. T. Roberts, "Inequality and the global climate regime: breaking the north-south impasse," *Cambridge Review of International Affairs* 21, no. 4 (2008).

[107] Schelling, "What makes greenhouse sense? Time to rethink the Kyoto Protocol"; see also ——, "The cost of combating global warming - Facing the tradeoffs," *Foreign Affairs* 76, no. 6 (1997).

Kyoto Protocol to control carbon emissions through measures by energy consuming states is fundamentally flawed. Energy producers have been given perverse incentives to increase rather than curtail extraction, and to divert energy production to non-Kyoto states which generally possess dirtier energy technologies.

The appreciation of supply-side feedback mechanisms leads to the conclusion that controlling carbon emissions will require quantitative restrictions on extraction and exploration. The implementation of a cap and trade system for fossil-fuel extraction and exploration is proposed, to be administered by an intergovernmental organisation. While such controls might superficially appear to conflict with the need for „reliable and adequate supply of energy at reasonable prices", further consideration reveals that energy security is best fostered by international cooperation rather than attempts at national energy independence.

The suggested governance structure is based on the successful model of independent central banks: strategic decisions would be made by an intergovernmental council, with operational implementation delegated to an accountable and effective executive. The achievement of comprehensive energy security and effective carbon emission objectives requires particular policies and mechanisms as discussed in section 5 and summarised in the table below. It is argued that these measures are generally common to both domains, with the exception of the compensation of environmental externalities through mitigation and adaptation.

Table 3 Governance objectives for energy security and climate stability

Objective	**Energy Security**	**Climate Stability**
Specified and Stable Supply	Dependable trajectories for supply. Credible governance commitments allowing stable expectations to be formed	Restriction of fossil fuel extraction and so as to be compatible with carbon emission targets. Possible moratorium on exploration.
Geographical and Sectoral Integration	Increases diversification; reduces market power; and reduces the risk and extent of disruptions	Builds an encompassing coalition of states; links conventional and alternative energy forms.
Improving Market Efficiency	Extends abilities to assess and manage risks	Removing subsidies would increase efficiency and reduce carbon emissions. Efficient markets would give incentives for not using fossil fuels
Support Resilience	Coordination of strategic reserves and other buffering mechanisms	Market stabilisation through governance authority
Protect and Create Infrastructure	Ensuring security of the energy supply chain	Establishment of environmental infrastructure - from transport networks to monitoring and sanctioning structures

Improve Legal Environment	Improve dependability of contracts	Improved property rights should lead producers to delay extraction
Informational Transparency	Ensure the provision of energy information from all producers and countries	Transparency provides the information needed for monitoring, modelling, and sanctioning
Monitoring	Ensures characteristics such as supply chain security	Monitoring identifies illegal activity
Modelling	Underpins provision of resilience by modelling system behaviour	Assesses complex interactions between fossil-fuel production and usage, greenhouse gas emissions, and climate change
Mitigation		Assist transition to non- and low-carbon energy sources; support further mitigation
Adaptation		Emergency fund and support for climate insurance

It is generally accepted that in a local pastoral, forest or water commons a cooperative solution, based on the self-restraint of individuals, can maximise the welfare of the all. The proposed governance framework offers a similar vision for the energy commons: a cooperative international solution, based on the self-restraint of individual states, ensuring energy security and climate stability.

This governance solution represents a remarkable opportunity, given the centrality of the issues at stake. Realising this vision, however, requires the energy producing countries to accept explicit quotas on their extraction and exploration, and would be most stable with a broadly based agreement encompassing both energy producing and energy consuming countries. In essence this implies the proposed International Energy Organisation would be combination of a Super-IEA with respect to energy security and a Super-OPEC with respect to restrictions on fossil-fuel supply. Such an international institution would have strategic implications for each state, as the broad participation needed for stability requires the sharing of sovereignty between countries that have often experienced conflictual relationships. The geopolitical dynamics within this heterogenous group of states would be particularly complex and the collection of the revenues from the extraction permits would place the energy producers in a position of relative power. Whether such an international cooperation would be feasible is clearly one of the central issues that the proposal raises.

The governance framework has similarly fundamental consequences for energy suppliers and consumers, and indeed all those affected by climate change. Involving the most relevant stakeholders at an early stage would bring their expertise to the evaluation and improvement of both the overall proposal, and its particular elements. It is in this

participative spirit that this paper is intended to contribute to discussion about appropriate global governance systems, and the provision of climate stability and energy security.

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