Time to dig up Climate Tax Reform

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Abstract
The Kyoto Protocol is criticized by a significant part of academia and is not adopted by major carbon emitting countries. Ditching Kyoto is recommended but coherent, effective and pragmatic alternatives are not ready.
Realizing the necessary almost carbon-free energy system is but affordable when energy use intensities are decimated. Intensities being purely technical, rational economics dominate such that high end-use prices and low intensities are coupled for keeping energy bills constant. It follows climate policy must boost energy prices by taxes.
The post-Kyoto policy proposal is fully bottom-up: participating countries design their home-made climate tax reform that pulls the energy intensities down and induces strong technological innovation. Sovereign states commit to improvement trajectories easy to monitor. Participation is attractive for not missing the technological boat and by limited transfers from wealthy to poor nations.
Resigning the climate tax reform duty is 'the greatest and widest-ranging policy failure ever seen'.

Keywords: climate tax reform, climate policy, energy intensity, electricity intensity, post-Kyoto, harmonized carbon tax

1. Introduction

The stalemate on the Kyoto Protocol and its implementation is not settled. Judgments vary from the best one can get up to a waste of time and resources [Stavins, 2004; Nordhaus, 2007]. The protocol does not provide a global regime for an essentially global problem. Quantitative emission reduction targets are not generally accepted. Implementation by the adopters of the protocol is based on flexible mechanisms. A patchwork of tradable emissions permits schemes is growing in the industrialized states, failing in delivering a "clear, consistent, stable cost of carbon that is predictable over the long-term" as buoyancy for investors [Sherri Stuewer, Exxon Mobil in EurActiv, 2007]. Clean Development Mechanisms (CDM) is the other instrument for lowering costs for the Kyoto adopters and for transferring resources and technology to developing countries. BP's John Browne [2004] states "In principle, the CDM was a good idea. In practice, it has become tangled in red tape and has required governments and investors to do the impossible: estimate the level of emissions that would have occurred in the absence of a project and then to calculate the marginal effect of their actions". Red tape has been removed by bankers, consultants and factory owners in not so poor countries, that enrich on the CDM dollars, as revealed by Bradsher [2006], Lohmann [2006], Wara [2007], Open Europe [2007].

The performance of the Kyoto Protocol and of its mechanisms has been monitored inter alias by Resources for the Future [Stavins, 2004; Kruger et al, 2007]. Pizer [2007] derives lessons and describes alternative approaches under development. Many of his points are echoed in a Commentary in Nature by Prins and Rayner [2007]. They propose to ditch Kyoto, but the recommended alternatives are not coherent and in particular not effective, while time is urging for deep cuts in carbon dioxide emissions [Stern, 2006; IPCC, 2007]. This contribution explores in section 3 the intensity of fossil fuels and electricity use, being the root of climate change and nuclear risks. Understanding what drives the intensity is crucial for policy design of stepping up energy end-use prices, triggering higher efficiencies, inventions and innovations. Empirical evidence shows such policy is not economically destructive. Before (section 2) are analyzed the Kyoto alternatives referring to Prins and Rayner's commentary. Section 4 digs up climate tax reform as necessary instrument. When embodied in a global agreement on tax reforms and energy intensity reductions, it is also a sufficient substitute for the flawed Kyoto Protocol. Section 5 rounds up and adds more arguments why resigning the taxing duty is 'the greatest and widest-ranging policy failure ever seen'.

2. Ditching Kyoto, but what is the alternative?

Continuing building on Kyoto's shaky foundations is defended with practical and sunk-cost arguments and with claims on theoretical models [Stavins, 2004]. Prins and Rayner [2007] reject to 'throw good money after bad money', and argue it is time to ditch Kyoto. The facts obey to join their criticism, but their alternatives are not coherent and overlook the main attribute a policy is intended for: physical effectiveness or carbon dioxide emissions must come down in an urgent, relentless and irreversible way.

2.1 The Nexus of Climate Change

Prins and Rayner [2007, p.974] use as a policy definition: "Climate change is not amenable to an elegant solution because it is not a discrete problem. It is better understood as a symptom of a particular development path and its globally interlaced supply-system of fossil energy. Together they form a complex nexus of mutually reinforcing, intertwined patterns of human behaviour, physical materials and the resulting technology. It is impossible to change such complex systems in desired ways by focusing on just one thing". Agreed, but the short definition omits for climate change crucial characteristics, climate being a 'global commons' requiring a globally 'coercive' policy – effective, efficient and fair – to avoid the tragedy of the commons [Hardin, 1968]. It is also necessary to add that the complex nexus rests upon, runs on, and expands on low-priced fossil fuels (and nuclear power). It is 'low-priced' and not 'low-cost' because the immense externalities of that commercial energy use are rolled of on nature, the environment and future generations. Stern [2006, p.i] observes "Climate change (as) a unique challenge for economics: it is the greatest and widest-ranging market failure ever seen". It is in the interest of man, society and their future to correct such failure by setting the prices right, not continue to go around the pricing issue as Prins and Rayner do.

2.2 Emissions Permits Markets

Prins and Rayner [2007, p.974] want to "allow genuine emissions markets to evolve from the bottom up", because "there are serious political obstacles to establishing a level of (carbon) tax sufficiently high to encourage energy efficiency, let alone to stimulate serious investments in innovation". On the one hand they repeat the common talk that in the past decades policy makers have eschewed energy and carbon taxes. On the other hand they forget the necessity of "strong and urgent collective action" and "the first element of policy is carbon pricing; carbon pricing gives an incentive to invest in new technologies to reduce carbon; indeed, without it, there is little reason to make such investments" [Stern, 2006, p. xxvii, xviii and xix].

Is Prins and Rayner's lip service to "genuine emissions markets" coherent? First, when people is not willing to pay a carbon tax, why should they be willing to 'evolve to genuine emissions markets from the bottom up' ("genuine" at least involves a real carbon price). Second, Prins and Rayner [2007, p.974] admit it is only cap-and-trade gaming because "in the final analysis, cap-and-trade cannot deliver the escape velocity required to get investment in technological innovation into orbit, in time. That calls for something else."

2.3 Public Energy R&D on a wartime footing

The something else is to "put public investment in energy R&D on a wartime footing" [Prins and Rayner, 2007, p.974]. It is difficult to disagree with more energy research given the reality of climate change. However, there are caveats.

First, on what type of energy issues and aspects is it worthwhile to spend public money? Are we going to continue the business-as-usual of the past up to today, pouring the lion share of public energy R&D in nuclear technology [IEA, 2006], while this is part of the problem rather than a solution [Verbruggen, 2008]. At least one must recognize that business-as-usual R&D themes and approaches have created the non-sustainable energy systems bedeviling the planet with climate change and nuclear risks during the last, the present and the coming centuries. A complete redirection of the R&D focus towards efficiency and renewable energy sources is first needed to avoid 'throwing good money after bad money'.

Secondly, R&D and innovation is also a complex nexus, impossible to change in desired ways by focusing on just one thing [Pizer & Popp, 2007]. Fri [2003] explains why the Prins and Rayner's something else may after all not work that well. He studied energy innovation successes and failures over the past few decades and finds that "innovation is incremental, cumulative, and assimilative. Over time, the impact of this process can result in revolutionary change. In rare cases, disruptive technology offers new performance characteristics that can transform markets. The private sector is reasonably successful in dealing with this untidy process, although sometimes it cannot realize enough of the available economic benefit from the innovation to warrant the costs of development. And in other cases, public benefits exist outside the market and so provide no economic incentive for innovation. Public intervention must either bring the costs and risks of innovation into line with the available benefits, or must attach to the public benefit a value that gives the private sector an incentive to engage in the innovation process" [Fri, 2003, p.66]. He argues to "prefer broadly-based incentive structures to create economic demand for innovations that produce public goods" [Fri, 2003, p.67]. "Reward outcomes (…) can be done in a variety of ways – taxes, emission caps, performance based regulation – not equally efficient but all effective. The great importance of this type of demand creation is that it puts all of the actors in the untidy innovation process to work in the public interest. Of course, the other side of the coin of rewarding innovation in the

public interest is that someone has to pay for the reward, either consumers or investors. Since the former vote and the latter lobby, imposing these costs is politically difficult" [Fri, 2003, p.68]. "The best place to look for revolution is in the market place, not in technology programs. The first of these possibilities is to track and respond to the fundamental forces shaping the future demand for energy services" [Fri, 2003, p.72]. The analysis and recommendations are clear and outspoken. Energy technology innovation is incremental, cumulative and assimilative; it must be demand-driven and the demand is driven by policies that value the benefits of efficiency and charge the externality costs of risky and polluting systems [Owen, 2004].
Investment in energy technology R&D is of course valuable and necessary, but needs the demand pull of high end-use prices. Again the way around the pricing issue is closed.

2.4 Public concern and consent for action

Prins and Rayner's Commentary is helpful in emphasizing that Kyoto did not work and will not work, and one "needs to radically rethink climate policy". "Not least, this is because today there is strong public support for climate action, but continued policy failure 'spun' as a story of success could lead to public withdrawal of trust and consent for action" [Prins and Rayner, 2007, p.975]. The fear of wasting public willingness to contribute to the common good is a valid fear. Public economics teaches that policies must be effective, efficient and fair to keep the public rallied together. Hardin [1968] adds that we should care not to spill goodwill on voluntary initiatives but to invest it all in "mutual coercion mutually agreed upon". The Kyoto Protocol falls short as argued by Prins and Rayner, and many other scholars [Böhringer, 2002; Stavins, 2004, Nordhaus, 2005, 2007]. Mixtures of loose trial and error voluntary initiatives can be instructive for some time [Kruger et al, 2007; Pizer, 2007], but "the economic and scientific consensus points to the need for a credible international approach" [Stavins, 2004].

3. Focus on Energy and Carbon Intensities

Revisiting the basic drivers of carbon dioxide emissions reveals what can and should be the subject of climate policy, and what not. It is true that climate change is interlaced with all four dimensions of a sustainable development [WCED, 1987; IPCC, 2007], but it is of little help to block progress in climate policy by futile efforts to address simultaneously the full complexity of sustainable development. Limiting the focus on just carbon intensity of energy use and on energy intensity of wealth, levels the ground for a global climate agreement.

3.1 Drivers of Carbon Emissions

The stage of blueprinting a workable climate policy is set by basic facts related to carbon dioxide emissions. Ehrlich & Holdren [1971] developed the IPAT identity, expressing Impact (on the environment) as a product of (number of) People x Affluence ($/person) x Technology (Impact/$). Hybrids of the identity can focus on carbon emissions as the indicator of impact [Ekins, 2004], such as: Total carbon emissions equals the number of people x wealth per person x energy intensity of the wealth x carbon intensity of the energy used.

$$TotalCarbonEmissions = \sum Population.x\frac{Euros}{Person}x\frac{Joules}{Euros}x\frac{CarbonEmission}{Joule}$$

The mission is bringing down emissions by working on the right side factors. The first and second factors are highly personal, cultural, political, social and economic driven. Population is intertwined with demographic structure, cultural factors, religious beliefs, migration policies, excluding it from quantitative settlements in our diverse world. Reducing wealth and wealth growth is neither an option because the poor majority wants a better life and the rich minority is not giving in. Also some economies export a lot of their production (e.g. around 23% of China's carbon dioxide emissions in 2004 result from goods made for export [Wang & Watson, 2007]), and climate policy should avoid to bias comparative advantages and trade among countries.
Kyoto followers want to agree on quantitative targets and timetables on the Total Carbon Emissions of the various nations (the left hand side of the formula). So they drag in all the complexity of the first and second factors on the right hand side, making their efforts futile. Except for global emission trajectories designed to obey a ceiling concentration of greenhouse gases in the atmosphere [IPCC, 2007], it is not possible (intellectually and politically) to split and assign the global target to the various UN member states.
It is also not necessary for advancing climate policy that better focuses on factors three and four of the formula. Cutting total carbon emissions requires energy intensities and carbon intensities to decrease. A backstop solution is found when a sustainable carbon-free supply of energy can be deployed. First (3.2) we focus on such solution; we find next (3.3 to 3.5) that lowering energy intensity is the crucial prerequisite.

3.2 Lowering Carbon Intensity of Commercial Energy Use

Four contenders offer to lower carbon dioxide emission: fuel substitution, nuclear power, carbon capture and storage, and renewable energy.
Fuel substitution is familiar. After coal had driven out wood as a fuel in the industrializing economies hydrogen weight in fossil fuel use has steadily progressed. Oil for coal, natural gas for oil, and hydrogen for natural gas, raise the hydrogen content so lowering carbon/hydrogen ratios. However, the third substitution where the ratio could fall to zero (and solve the emission problem) contains a circular reference because hydrogen is not freely available on earth. It has to be derived from fossil fuels or by use of nuclear or renewable energy.
Nuclear power is second contender. No energy technology on earth enjoyed a similar vast support by the scientific, business and political communities during decades. Still some belief the full nuclear option can save the world; I argue that atomic power is part of the problem not of the solution [Verbruggen, 2008]. As much as possible nuclear was tried during the last 50 years. As part of the business-as-usual gallery it cannot bring the drastic changes needed. The particular risks of nuclear are documented (accidents, waste, proliferation), nullifying its sustainability score. Apart from this, nuclear is competing or opposite with the next two contenders for low carbon emissions.
Carbon dioxide Capture and Storage is under development to keep the vast coal resources accessible for energy supply in the future [IPPC, 2005]. It is still early day to judge the performance of this option but when successful, the centralized conversion of coal into

grid electricity or into synthetic fuels (including hydrogen) will stay part of the energy system.
Fourth, there are the renewable energy sources, covering a wide range of technologies and applications. The sustainability characteristics of centralized hydro-power and biomass are critical. Apart from their sustainable appeal and zero or low carbon intensity, decentralized renewable energy owns few attributes to smoothly fit in the business-as-usual energy structures and habits. Many do not deliver at command but intermittent, are not centralized but distributed, not concentrated but diffuse, not cheap to mine but expensive to collect. As they stand now, they are technically and economically not ready to respond to the exigencies of the energy intensive practices of the industrialized and industrializing societies. But what is today must not be tomorrow. The renewable energy technologies surf on most new technological developments of the last decades: micro-electronics, new materials, bio-technology, and their progress in performance and cost reductions is significant and promising. But even then, we cannot change the universal laws of the daily rotating earth circulating the sun on a particular ellipse. An almost fully renewable energy economy will be clean but not cheap. The cost is such that the world cannot afford to meet the past and present energy intensive habits. When the only sustainable backstop alternative – decentralized renewable energy use – has to take over, focus on energy intensity comes first.

3.3 Energy Intensity is a Composed Variable

Addressing energy intensity of wealth, best focuses on commercial end-use energy, i.e. the energy used in our appliances, buildings, transport engines, industrial equipment, etc. There are two main types: fuels (oil products, delivered gas, coal) and grid electricity (two thirds derived from fossil fuels, mainly coal, one sixth from nuclear fission and one sixth from renewable sources, mainly large scale hydro).

Energy intensity is a composition of efficiency (how much energy is used for an activity?) and of structure[1] (what activities make up the domestic product of a country?):

$$Energy\ Intensity = \sum_A \frac{kWh}{Activity} x \frac{Activity}{Euro}$$

Several studies analyse energy intensities of OECD economies forthcoming from about 20% by structure and about 80% by efficiency in using energy [Geller and Attali, 2005].

The statistics and analysis further discussed in this section focus on electricity use, being of high importance for developing, industrializing and industrialized countries.
Figure 1 shows 2004-statistics on electricity end-use intensities of 122 UN member states (data on some countries were not readily available; some outliers were removed). The data transmit high intensity spreading for all GDP/capita levels. The overall mean of the panel data is at 248 kWh/1000 US$-2004-PPP, with OECD countries (58% GDP share of the panel data) on average 268 kWh and the other countries (42% GDP share) on average 236 kWh. Economics explains demand variance by mainly three variables: income, price and technology (although the latter mostly in abstract terms).

[1] Structure covers the diverse activities in an economy and ranges from sector composition (how much industry and what type of industries, etc.) to lifestyles (what type of education, recreation, etc.).

The argument of Medlock and Soligo [2001] that the energy intensity first increases with income (GDP/capita) and after a first level of development then declines is not confirmed by the data of figure 1. Yet a denser occurrence of observations in the corner near the origin supports the evidence that the first steps in economic and industrial development push energy intensity up.

Figure 1

Demand for end-use energy depends on end-use technology which development is induced and which implementation is decided by prices and incomes [Newell et al, 1999]. Most researches do not focus on energy intensity as such but on energy use, mingling up people's high request for the goods & services delivered with the help of energy on the one hand and their neutral, indifferent attitude towards how much energy to use on the other hand. Also many studies do not properly distinguish the short-run from the long-run perspective. In the short-run people is not allowed the time to adapt to new conditions, in particular a changed energy price level. Changes on short notice always bring unease. Sudden and sharp price hook-ups like the ones experienced in the 1970s create significant economic loss and disturbance, also distress for the poor that cannot fall back on buffered wealth. In the long-run, i.e. the period long enough for adapting to higher price regimes, households, industries, drivers, etc. know well to re-optimize their economic positions by becoming more energy efficient. The relationship between energy prices and commercial energy use has been the subject of much research [Lafferty et al., 2001; Sterner, 2003].

3.4 End-use Energy Prices Determine Intensities

Investigating the relationship between prices and intensities is based on data referring to the electricity use by a panel of wealthy industrialized nations. This selection singles out the price effect because all countries are equally wealthy with access to the global electricity end-use technologies that global companies supply to all willing to pay.
Figure 2 shows the least-squares fitted curve between price and intensity on 14 observed data pairs (black squares with the names along) [Verbruggen, 2006]. In climate policy jargon it is a 'marginal mitigation cost' curve. The panel data and the curve reveal price x intensity ~ constant, or the long-run price elasticity ~ -1. The meaning of the constant (in the example ~3.4) is the share of the GDP the countries pay for the supply of electricity.

Figure 2

Lessons to learn from such analysis are multiple. First, intensities diverge a lot between otherwise similar countries, all with a high income per person and with access to the globally available electricity end-use technologies and solutions. Every country owns some particularities but about 80% of the differences are due to diverging end-use efficiencies in using electricity. Differences are striking: when USA intensity would equal the Japanese one, about half of the TW (a billion kW) USA power generation complex could be mothballed.
Second, there is a strong relationship between end-use price and intensity. When prices are high, so is efficiency bringing intensity down. When prices are low, so is efficiency

pushing intensity up. There are no short-cuts here, and policy should live upon this basic economic law, just as engineers must live upon the basic laws of thermodynamics. People are truly uncommitted to energy efficiency but economically rational. Although some barriers exist to attain the theoretical first-best economic optima (as they do in most markets), the re-optimizing reactions come swift and effective once the signals are clear. What is behind the reactions looks as a conservative propensity: households and industries strive for a return to their original positions of spending a particular share of their income / total budget on electricity bills.

Third, high end-use prices are not destroying economies but rather make them efficient. The share of GDP that countries spend on electricity supply is overall almost equal whatever the end-use price regime being adopted. This is expressed by the equal areas of the rectangles in figure 2.

Fourth, transiting from high intensity to low intensity electricity economies requires "rotating bills": transform the flat horizontal rectangle towards a square, remodel the square to a standing rectangle, up to an obelisk type when very low intensity is necessary to afford electricity supplies based almost fully on renewable sources. The remodelling process of the electricity bills is but possible when price pressure is relentless and increasing.

The example is based on electricity use (generally said to be little price elastic). Similar results are observed for car fuels [Hammar, et al., 2004]. Price elasticity of energy demand at ~ -1 in the long-run is documented frequently [Lafferty et al, 2001; Sterner, 2003]. The example illustrates the static case of 'frozen' technology. However, high end-use prices induce technological invention and innovation in the field of efficiency and renewable energy that eases remodelling the bills [Newell et al, 1999; Edenhofer et al, 2006; IPCC, 2007].

3.5 Lowering Energy Intensities as Prerequisite for Low Carbon Technologies

In 3.2 is stated that decentralized renewable energy sources and technologies are the sustainable low-carbon backstop supply options. Their drawbacks are that they are not affordable to meet the high intensity energy use processes of the present economies. Two main developments can bridge the gap between the present and the future: first, reduction of the end-use energy intensities and second, technological invention and innovation that lowers the costs of on the one hand energy end-use efficiency technologies and on the other hand sustainable renewable energy supplies. Both developments are triggered, pushed and pulled by the same force: the end-use prices of energy. This is illustrated qualitatively with two graphs (figure 3 and 4).

Figure 3 shows the frozen technology case of a given year. As revealed by figure 2 countries implement available efficiency options very differently according to the adopted end-use price levels. More efficiency is realized when the end-use prices are high. Assuming the observed curve can be extrapolated it is straightforward to construct an affordable path (stair) of end-use price increases that leads the end-users to a higher implementation of efficiency technologies contributing to lower intensity. The end of the efficiency effort is to make sustainable backstop supplies within reach of the end-users budget at the crossing of the marginal mitigation cost curve with the high price of the backstop option. Symmetrically the corresponding intensity level is called backstop intensity.

Figure 3

Higher end-use prices create many dynamic effects. In particular they induce technological invention and innovation [Newell et al, 1999; Popp, 2002; Edenhofer et al, 2006; Pizer and Popp, 2007; IPCC, 2007]. The impact of such processes on the marginal mitigation cost curves is shown qualitatively in figure 4 by shifts to the left. One can discuss whether the cost of the sustainable backstop option also will come down. On the one hand the costs of decentralized renewable energy capturing and conversion technologies are falling significantly. But on the other hand the energy supply system almost fully and exclusively depending on renewable supplies faces unchangeable physical handicaps of diffuse offer, intermittency, unpredictability to some degree and difficult storage. These factors may balance the advances in the capturing and conversion technologies. That is why figure 4 does not show a lowered cost price of the backstop options.

Figure 4

Disruptive revolutionary technology invention, demonstration and implementation are the responsibility of the wealthy industrialized and industrializing nations of the world. It requires full focus, support and resources. Such focus is diluted by flexible instruments that foot the reductions in greenhouse gas emissions to the developing world (CDM).

3.6 Rational Economics Suffices

Talking commercial energy end-users is talking about all people of the world except the most deprived ones having no access to commercial energy. People using energy do so in the most diverse activities for the most diverse purposes on the most diverse moments and in the most diverse places. Telling all that people to reduce their commercial energy use intensity, requires a global language they understand, are willing to listen to and at the end adopt the message conveyed. But one language is up to the job, i.e. the language of energy end-use prices [Arrow, 1974].

In the last 60 years this language tells people that energy is cheap, that fossil fuels are abundant, that the atmosphere is an unlimited sink for our waste products and that the earth can absorb all the pressures and risks we put on it. That is why end-users use a lot of commercial energy in meeting the goals they strive for. Indeed, the height of the energy intensity end-users adopt is the outcome of a rational decision-making process. Although there may house a lot of personal preference, adopted customs, cultural heritage, even passion, etc. in the end-uses we use energy for, energy itself is something no end-user really is interested in. No-one has ever seen or smelled an electric kWh and touching it is very unpleasant: electricity kills, while coal is dirty, oil stinks and gas is explosive. High energy intensity is not what we want. But low intensity is not our interest neither when we must spend effort or other economic resources on being efficient. All of us balance the optimal energy-use intensity at the point of least financial and personal costs.

It is a very comforting observation that people decide on energy intensity in a neutral, economic way: people excelling above themselves (Al Gore) is not required. One can stay at the earth's surface and has not to climb to heaven and fall to hell. But move is needed and triggered by a planned, deliberate trajectory of energy end-use price increases. In the next section is argued why the price step up trajectory should be organised through climate tax reform.

4. Dig up Climate Tax Reform

Section 3 concludes the necessity of step-wise increasing end-use prices for fossil fuels and grid electricity. This section discusses how such policy can be set up based on "sound science, rational economics and pragmatic politics" [Stavins, 2004].

4.1 Who Appropriates the Rents?

End-use prices of energy are composed of costs (including return on capital) and rents. Rents on end-use energy use can be appropriated by foreign states, by private (mostly international) companies or by domestic public authorities. When left over to market forces and international conflicts of interest, end-use prices tend to be volatile and unpredictable, causing high tensions for the living standard of people and for the value of the capital stock. Energy price volatility in particular chokes the orderly deployment of energy end-use efficiency, while improving efficiency is the first victim of the own success (that lowers demand, so pulls prices downwards, so makes more efficiency less cost effective). Beginning of the 1980s this was showcased by the first try-outs in energy efficiency by end-users. Demand fell and supply rose, both triggered by the price hook-ups of 1979-80. Suppliers have a strong incentive to stay in business because supply infrastructures are long-lasting and mainly sunk-cost. Energy prices fell down once the tightness of the markets released. End-users re-optimized: they did not scratch the acquired efficiency but projects for further improvements were shelved when requiring effort or investment.

Volatility and unpredictability in end-use prices are resolved by applying flexible excise taxes that make up the difference between market price and targeted end-use price along the progressing stair (section 3). Related benefits of such taxing policy are: first, the reservation of a larger part of the rents for the domestic public interest, second, the opportunity to match the taxing to the Pigovian principle of pricing externalities, third, the provision of the "clear, consistent and stable price" signals as buoyancy for investors. Recycling the tax returns in the own economy not only avoids major economic setbacks caused by volatile and externally imposed high energy prices, but also provides the resources to develop and to invest in efficiency and renewable energy technologies.

When the principle of taxing as a most suitable instrument is adopted, there still remain many questions about how the policy "architecture" should look like.

4.2 Harmonized Carbon Taxing

A globally harmonized carbon tax is a theoretical attractive instrument [Cooper, 1988, 2001, 2005], [Dresner et al, 2006], [Nordhaus, 2005, 2007], Kahn and Franceschi [2006], [Shapiro, 2007]. Nordhaus [2007, p.35] can assume the problems of spatial and temporal efficiency solved "because carbon prices would be equalized" and "conceptually, the carbon tax is a dynamically efficient Pigovian tax that balances the discounted social marginal costs and marginal benefits of additional emissions".

Nordhaus [2007, p.36-40] provides convincing arguments why price approaches are preferable above quantity approaches and Kyoto mechanisms in climate policy. As above (3.1) he characterizes “quantity limits are particularly troublesome where targets must adapt to growing economies, differential economic growth, uncertain technological change, and evolving science” [p.36]. He adds arguments related to uncertainty, volatility of permit prices, public finance, rents, corruption. However, his proposal is troubled by measurement problems in the quest for the harmonized carbon tax rate (the unicorn?). But as theoretical attractive, the quest for a harmonized global carbon tax is politically not pragmatic. The allegation of uniform taxing leading straight to cost-effectiveness is based on the hypothesis that marginal abatement cost curves of the various emission sources are comparable. They are comparable when grown out of transparent competitive conditions (the EU speaks of harmonization, leveled playing fields, etc.). Workable competition is met in some energy submarkets (e.g. USA oil refinery, USA fossil fuel fired power generation) but cannot be stretched globally over all diversified activities that emit carbon dioxide. “Equalized carbon tax rates will have significantly different cost implications for different economies, depending on their per capita incomes and energy intensity.” [Kolstad and Toman, 2001, p.49]. Installing a harmonized carbon tax globally seems a mirage similar to creating the global carbon permit markets.
The narrow focus on carbon dioxide emissions is not helpful in laying out the master plan of the transition to a low-carbon energy economy. When “it is apparent that the optimal abatement is today somewhat short of 100 percent of GHG emissions” [Nordhaus, 2007, p.28], what else than a full carbon-free backstop supply can be the goal? One of the challenging puzzles is to design the transition trajectory towards that future. We feel free to add to the discussion a down-to-earth, easy to implement and to monitor, global climate policy approach.

4.3 Global Agreement on Tax Reform & Energy Intensity Reduction

A Global Agreement encompasses:

1. **Participation.**

All UN countries are invited to participate but the agreement can start when only the largest emitters agree. The agreement is attractive for poor nations to join because it entails better economic development and receipt of transfers from the wealthy countries when they perform well.

2. **Commitment to Home-made Climate Tax Reform**

Participants commit to a domestic climate tax reform that abolishes subsidies for fossil fuel and grid electricity use and shifts part of the tax burdens on merit goods to taxes on energy end-use [www.worldecotax.org]. How a country organizes the tax reform is left over to its own scrutiny, while the World Bank and regional organisations (ASEAN, LACEA, OECD, EU, etc.) can develop templates adapted to various economic structures. Every country’s tax reform clearly earmarks fossil fuel and grid electricity use taxes for adding to yearly revenues (called “Climate Tax Revenues”) to compare to total GDP. It is recommended or mandated to tax end-use fossil fuels according their carbon dioxide emission factors.
The performance of a country on this commitment is measured by the value of the total climate tax bill (in local currency) compared to total GDP and total energy bills.

3. **Commitment to Reducing Commercial Energy Intensities**

Participants commit to trajectories of stepwise reducing fossil fuel and grid electricity intensities, alias carbon intensity of energy use, over the next N years. Figure 2 shows such trajectories imply 'rotating energy bills' from 'long and flat' to 'high and narrow'. The remodelling needs increasing and lasting pressure exercised by end-use prices bolstered by suitable tax rates on fossil fuel and grid electricity end-use.

The country commitments are vectors of targets {climate tax revenues, energy intensities, carbon intensities} specified by grid electricity and fossil fuel end-use sector (transport, heating, particular industrial activities, horticulture, etc.). Trajectories vary by country depending on the actual state of the energy economy, natural and historical factors, national policies, etc. Obligatory is that reduction in fossil fuel and grid electricity intensities, alias carbon intensities, progresses year after year along constant energy bill curves (figure 2).

The N-year trajectories can be reviewed every N/2 years for tuning up to technological innovation that will be induced strongly by the set-up policies (figure 4).

4. **Reporting, monitoring and statistics**

Annual reports to the UNFCCC secretariat reveal performance in decreasing fossil fuel and grid electricity intensities and in realizing climate tax revenues. IMF and the World Bank can support and verify the reporting. Data needed by country are yearly energy balances as structured by WEC [2001], IEA [2001], OLADE [2007], EUROSTAT [2006], etc. and yearly national income statistics as assembled by IMF. Few countries lack these data today (none of the big emitters). The effort in collecting and processing the required statistics is limited, and is anyhow helpful in every attempt to structure climate policy.

5. Transfers from Wealthy to Poor through a Global Carbon Fund

A "Global Climate Fund" is organised. Wealthier countries commit to payments to the fund for providing drawing rights to poorer countries. Payments and receipts are depending on the countries' GDP/capita and on their performance in energy and carbon intensity reductions and in realising climate tax revenues by the tax reform policies undertaken. Self-regulating transfer mechanisms are suggested by Verbruggen [2007]

4.4 Evaluation of the Policy Proposal on Standard Criteria

In trying to avoid a biased evaluation of the own proposal, its attributes are mentioned after the name of major criteria discussed in the literature.

Physical Effectiveness: In the climate change nexus permeating all aspects of human life, the invisible hand of price is the only workable and effective (as most admit, even when they stay on the bandwagon of rejecting taxes as being politically not feasible) coercive system to change course. For full effectiveness the hand must intervene permanently, everywhere in all activities using commercial fossil fuels and electricity.

Carbon intensity targets are criticized for not imposing absolute limits [Pizer, 2005], but the context is different for intensity trajectories that make a full low-carbon backstop supply affordable.

Spatial efficiency: Home-made climate tax reforms do not strive for the equalized carbon tax rate at the global level. So doing the opportunity is open to set the best tax rates for the real economic activities according real capabilities. Because most of the determinants that make up the marginal mitigation cost curves are differing country by country, and not ready to be harmonized in the foreseeable future, there is no point in equalizing tax rates but rather in diversifying the rates. When intensity reduction trajectories are designed well, spatial efficiency is the result of converging together to the low-carbon energy backstop solutions.

Temporal Efficiency: When "it is apparent that the optimal abatement is today somewhat short of 100 percent of GHG emissions" [Nordhaus, 2007, p.28], that urgent action is needed [Stern, 2006; IPCC, 2007], the fastest feasible trajectory towards a low-carbon backstop energy supply is the temporally efficient one. Climbing the present marginal mitigation curves upwards step-by-step in a relentless pace and irreversible order (figure 3) and inducing reduced mitigation curves to climb (figure 4), may be quite near the optimal path the economies of the various countries can afford.

Fairness: Important attributes are related to fairness. First, the wealthy industrialized nations have to deliver first and most in bringing down intensities, developing the revolutionary energy use efficiency solutions and inventing and demonstrating the sustainable backstop energy economy. Second, transfers from wealthy to poor nations are organized according income levels and both their performance on the committed progress in efficiency and tax stimuli. Third, tax reform helps in abolishing perverse subsidies and taxes on merit goods, and in setting the right price on externalities due to commercial energy use. Fourth, a significant part of the rents on commercial energy use is dedicated to the public interest.

Pragmatic politics: Construction and operational costs of the policy architecture are rather limited; most data are available and most work to deliver is home-made by experienced administrations and offices, also in developing countries.

Every country can fine-tune the home-made tax reform in order to avoid unwanted distributional effects or hardships for particular economic activities demanding a longer transition period than the average. The money that every country collects by tax reform remains within the own country – with caveat for the transfers from wealthy to poor nations – because "it is necessary to locate the decision making at the political level that can internalize the spill-over" [Nordhaus, 2005]. Only the effective energy and carbon intensities and the total 'climate tax revenues' are monitored and source of adjustments (of the intensity reduction trajectory and of the tax rate growth pattern), and of transfers and rewards. No obligations are imposed on sovereign states; they remain the architects of the own tax reform/intensity reduction trajectory, although within an internationally agreed common road map.

The argument that taxes do not work because suicidal politicians are rare, merits special attention and is part of the conclusion coming next.

5. Conclusion

Solving the climate change nexus requires full change of course: approaches, structures and technologies that created the present state of the world are rather part of the problem than part of the solution. Low-priced fossil fuels and nuclear heat on the one hand deliver the power for growth and on the other hand accumulate risks in a non-sustainable way. Full change must be spearheaded by setting the prices right. Higher prices on the use of fossil fuels and grid electricity signal inventors the direction of their search, innovators the optimal technologies, companies and households the efficient investments

[Weizsäcker, 1990]. Low commercial energy use intensities make the backstop solution of sustainable renewable energy affordable, what levels the field for the needed very low-carbon economy.
The Kyoto Protocol offers no solid ground for the global climate policy architecture. As alternative is proposed a bottom-up approach of home-made climate tax reforms guiding participating countries on individual trajectories of ever decreasing energy intensities. Transfers from wealthy to poor participants depend on income levels and on performance on the committed trajectories. It seems that such policy architectures can house the large diversity across UN member states, and therefore tests good on most evaluation standards.

Discussing tax reform is rejected mostly by the prejudice of 'politically not feasible' [Prins and Rayner, 2007]. Well: the time is high to step over prejudices and to break the locks on the policy instrument that only can safeguard our common future for the catastrophes of climate change (and of nuclear risks).
The reality of climate change mandates drastic change, also in the adoption of instruments that were played down successfully by lobbyists during the last decades. The strongest lobbyism was (is) forthcoming from the energy supply companies. Beginning of the 1980s energy end-users reacted rationally on higher end-use prices by first try-outs in energy efficiency. This short effort made obsolete before they started the megalomaniac plans of coal revival in Europe, nuclear breeders and serial construction of atomic power plants, and endangered investments in off-shore oil & gas winning. Supply companies were facing high reserve margins (euphemism for overcapacities and sunk costs). They understood first the irresistible force of the end-use energy price signal; second, that only taxes could make up for the erosion and fall of end-use price levels; third, that high prices through taxes were not blowing inflation, grinding economies and devastating employment when the money was recycled well in the own economies; finally that taxes, directing the rents on the common heritage of fossil fuel stocks to the public interest, conflict with the companies' private rent seeking ambitions. Energy taxes were put on the black list, resulting in mushrooming high intensity energy economies. The unpaid bills in climate change and nuclear risks are presented in the 21st century.
The challenge now is to preserve the global energy economic commons. The public concern and consent to action growing very strong today must be guided in an effective, efficient and fair "mutually coercion mutually agreed upon" [Hardin, 1968].
A growing majority of the public understands that the personal longer-term interest is served by effective climate policies and that higher energy prices are necessary. A worldwide Poll by the BBC [2007] reveals support for higher taxes on the most harmful types of energy amounts to 50% of the respondents without tax revenue being explained and to 75% when tax reform is explained.
Citizens and companies are willing to pay for mitigation and adaptation. Announced policies (positive fall-out of Kyoto) result already in households and companies earmarking budgets for climate actions. Now the money is directed to a variety of voluntary initiatives that in the aggregate are little effective, because efforts are open-ended: gains of lower home heating bills are spent on extra airborne city trips, etc.
Daily decisions are rooted in the personal short-run self-interest of billions of decision-makers that make their counts with the help of price signals. Today the signals still convey the message that the atmosphere is an infinite buffer, while the opposite message

is needed. Only end-use energy prices can tell the truth continuously to the billions of decision makers [Arrow, 1974]. Policy makers disregarding this basic law of economics compare to engineers disregarding the basic laws of thermodynamics in designing machinery: both efforts are a waste of time and money, and what they set up is not working.

When policy makers continue to resign their basic duty of climate tax reform, the necessary price pressure will be delivered by private companies and resource owners cashing higher royalties and rents and loading a double burden on the citizens that also must finance the transition to low-carbon infrastructures and lifestyles.
There is no way around climate tax reform to avoid ‘the greatest and widest-ranging policy failure ever seen’.

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Figure 1: Scatter diagram of Electricity Intensity versus Wealth (GDP/capita) for 122 countries (data 2004)

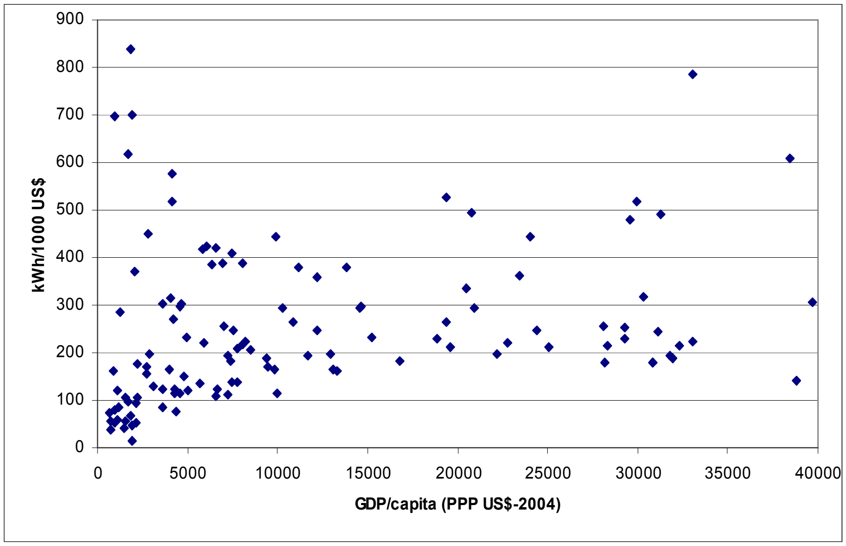


Figure 2: Marginal Mitigation Cost function of Electricity Intensity: Price x Intensity = Constant [based on 1997 data of wealthy OECD nations; GDP in Purchasing Power Parities]

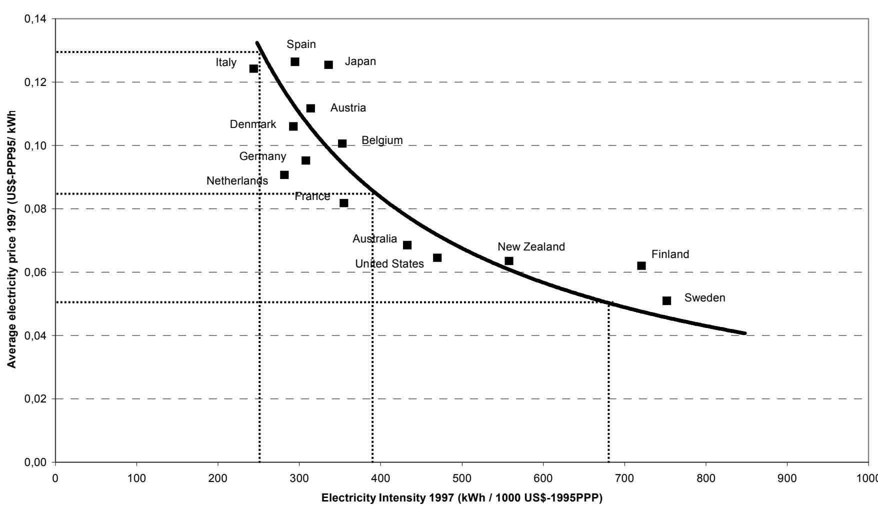


Figure 3: Deep Cuts in Intensities requires Stepping Up End-use Prices (static efficiency or 'frozen' technology)

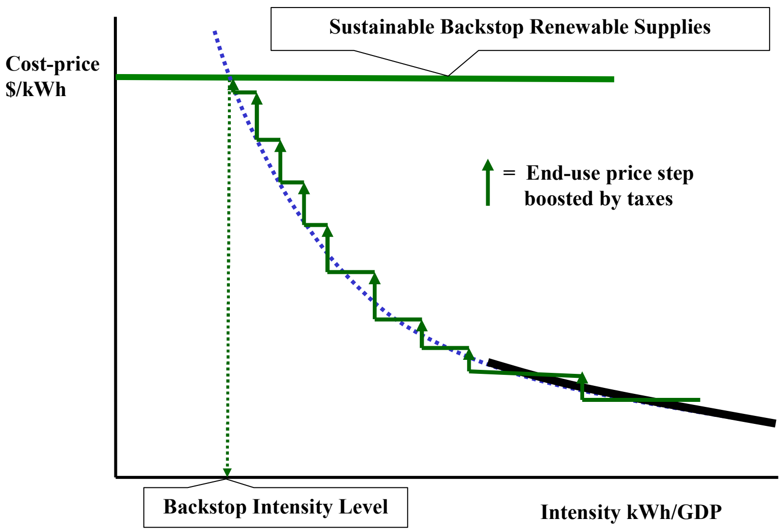
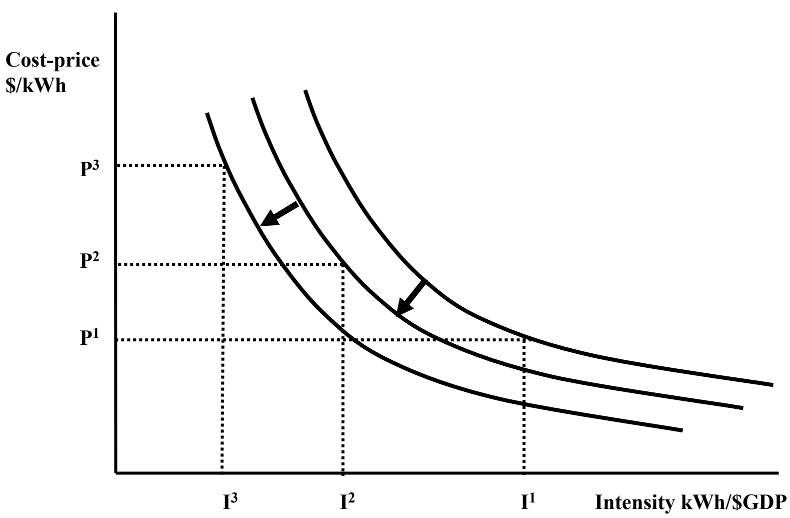


Figure 4: Dynamic efficiency: Induced Technological Invention and Innovation Reduce Marginal Mitigation Costs



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