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Analysis of Some Environmental Policy Instruments

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Abstract

Benjamin Franklin once said that "[i]n this world nothing can be said to be certain, except death and taxes" (Franklin, 1840 p.410) and a significant body of the scientific literature, including the IPCC, have indicated that the climate change problem has become such a pressing issue that we now face a stark choice between the premature death of hundreds of millions of the people on this planet (from storm, flood, starvation, war or pestilence) and the use of taxation or other financial strategies to change the relative cost of carbon intensive sources of energy compared to the cost of 'green' sources of energy. A change in the relative cost of 'green energy' will not itself solve the problem, but it is a necessary (though not sufficient) step if there is to be the required behavioural change which will support the application of engineering solutions to the problem which has been signalled by a large group of climate scientists.

This paper addresses possible approaches to solving the problem of climate change by reducing greenhouse gas emissions (GHGEs). It considers the European Union's emissions trading scheme (ETS) as an example of a market and government failure to achieve a reduction in emissions through a neoliberal approach to pricing emissions. The North American Acid Rain Program is also discussed as a more successful market-based example, though it also exhibited considerable price volatility and in reducing the amount of SO₂ in the atmosphere it is making the global warming issue worse. The discussion then focuses on the design features of a carbon tax and some alternative policy instruments that could contribute to a solution to the problem and it raises the main advantages of a carbon tax over an ETS.

1. Introduction

In recent years the build-up of greenhouse gas emissions in the atmosphere has been recognized as a major environmental problem which has led to global warming, with a range of negative long-term impacts upon the planet's climate (IPCC, 2001, 2007; The Allen Consulting Group Pty Ltd, 2006; Climate Commission, 2013). There seems to be a developing consensus that urgent action is necessary to curb the build-up of carbon in the atmosphere, but no global consensus on the urgency of the action required and the best way to deal with this problem (IPCC, 2007). In this paper the key roles of science and technology in relation to the problem are recognised, as science has identified the problem and the solution lies in developing and sharing alternative technologies (see for example Diesendorf, 2007; The Allen Consulting Group Pty Ltd, 2006). But a key requirement is for behavioural change, as people and businesses will have to change their energy sources from those currently dominated by carbon fuels to alternative 'green energy' sources over time and this can be facilitated by a price signal or by regulation. If we are to deal with the problems of climate change the cost of carbon-based energy must be changed to reflect its full cost, including its environmental damage (Andrew et al., 2010), and there are three main policy instruments available to governments for imposing a price on greenhouse emissions which will make business internalize the cost of their CO₂ emissions, which are currently borne by the community (see e.g. Anthoff & Hahn, 2010; Mokyr, 2008). One popular approach is based on a 'cap-and-trade system', such as the European Union Emissions Trading Scheme (EU ETS) and the Australian Carbon Pricing Scheme [1]. This approach imposes a quantity cap on emissions and expects the resulting scarcity to create a market determined price for emissions (Garnaut & Marnie, 2011). A second approach would levy a charge directly upon polluters through a carbon tax or an emissions fee, this approach would directly impose a price upon emissions and the cost increase could be expected to reduce demand, which will reduce the quantity of emissions over time (Baumol & Oates, 1971; Coase, 1960; Pigou, 1952). A third approach would regulate emissions directly through pollution controls, renewable energy requirements or other controls, directly reducing emissions by requiring action by polluting industries to reduce their emissions.

In recent years many governments seem to have accepted the need to impose a price upon carbon emissions into the atmosphere as the way to generate a market-based adjustment to the relative cost of various sources of energy. Most developed countries seem to favour a 'cap-and-trade' system (an emissions trading system or ETS) to produce a market adjustment. This approach aims to adjust relative prices for emissions over time so as to produce a long-term result which is favourable to the environment, but it may act too slowly and uncertainly to have the desired result. The European Union's attempt to put in place a 'cap-and-trade' system should be a warning to all as it almost collapsed, because of the lack of transparency in reporting emissions from industries in certain countries, extreme price volatility and the range of exclusions from the trading base. This has so far had a limited overall impact on emissions, with 2008 emissions being 145 million tonnes above the cap (Carbon Market Data, 2009).

This study can guide future policy adjustments or the implementation of environmental policies by drawing lessons from the shortcomings of currently existing and past policy instruments.

The remainder of this paper is organised as follows: In section two some literature about the European Emissions trading scheme (EU ETS) is presented, in section three the North American Acid Rain Program is discussed as another example of emissions trading. In

section four British Columbia's carbon tax will be reviewed. After a comparison of carbon tax and ETS in section five, some hybrid policy instruments and alternative policy instruments will be considered. The final section presents a conclusion.

2. The European Union Emissions Trading Scheme (EU ETS)

1 January 2005 marked the start of the EU greenhouse gas emissions trading scheme (EU ETS), which is the largest multi-country, multi-sector greenhouse ETS worldwide (Convery & Redmond, 2007). During the first phase of the EU-ETS the companies included were limited to certain industries and covered only CO₂-emissions. Across the 25 Member States of the European Union approximately 12,000 installations, covering energy activities, production and processing of ferrous metals, the mineral industry and pulp, paper and board activities were included in Phase 1 of the EU ETS (EC, 2011).

Under EU Directive 2004/156/EC large emitters of carbon dioxide within the EU must monitor and annually report their CO₂ emissions (EC, 2004). In order to achieve a reduction in CO₂ emissions governments had to ensure that the total amount of allowances issued to installations was less than the predicted amount of CO₂ emitted under a business-as-usual (BAU) scenario. Member States' National Allocation Plans set the amount of allowances to be allocated by Member States to their respective installations (Andrew, 2008; Moselle et al., 2010).

Installations have the obligation to surrender an amount of emissions allowances equivalent to their annual emissions. Installations could get most of their allowances for free as the Directive 2003/87/EC required government to allocate at least 95 percent of the emissions allowances for free, with a maximum of 5 percent of emissions to be auctioned during the first phase (Ellerman & Buchner, 2007; EU Parliament, 2003). The open market for emission allowances has enabled installations either to buy permits in the case of allowance shortage or to sell accumulated excess allowances to other installations or traders. Additionally, carbon credits from Joint Implementation (JIs), and the Clean Development Mechanisms (CDMs) (needs a note) can be acquired up to a certain limit from Member States' predetermined amount which had to be mentioned in each Member States' National Allocation Plan (Convery & Redmond, 2007; ECOFYS et al., 2006).

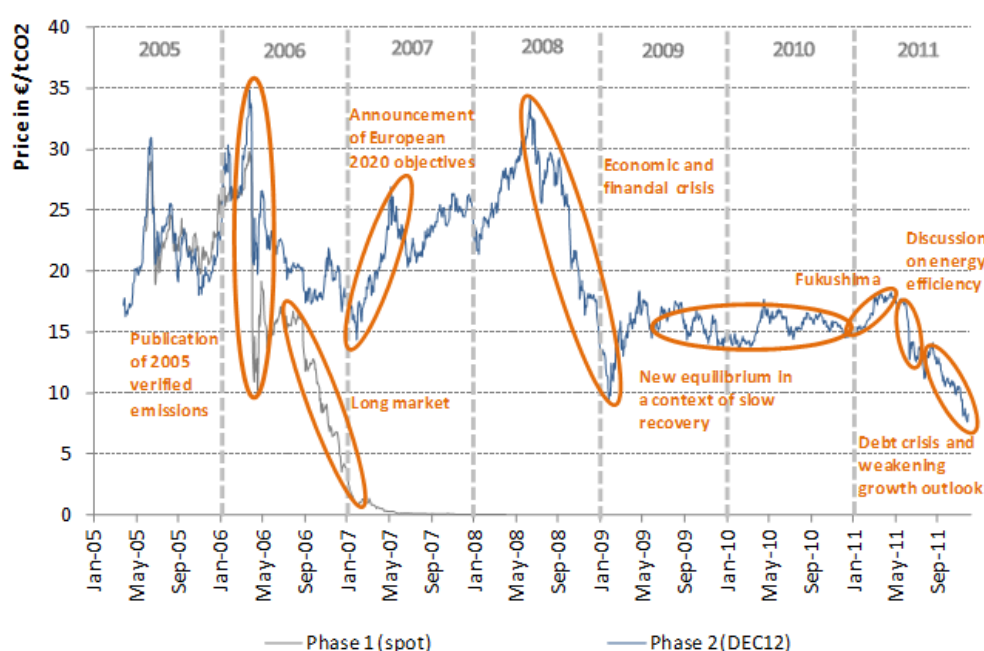
During Phase 1 of the EU ETS, European governments allowed their industries as much CO₂-emissions as they could emit which can be seen as a 'major disappointment' (CAN Europe, 2006). Most governments were found to be generous in distributing emission allowances, resulting in the virtual collapse of the carbon market in 2007 and an overall increase in emissions over the initial period. Especially in 2005, emission allowances granted exceeded the actual emissions from installations obliged to participate in the EU ETS by 152 MtCO₂ (Committee on Climate Change, 2008). This meant that actual CO₂ emissions were 4 percent below the initial number of emission allowances (Ellerman & Buchner, 2008).

The trading volume in the EU ETS during the year 2005 was about 362 Mt CO₂ at a total value of €7.2 billion. The price for emission allowances increased from about €7 per tonne in February 2005 to almost €30 per tonne in July and ranged between €20 per tonne to €24 per tonne in the second half of the year 2005 (Point Carbon, 2006). From the peak price of €30 per t CO₂, in April 2006 the price fell rapidly and over the next year it fell to €1.2 a tonne due to the excess supply of permits. Price declines continued to virtually zero by September 2007, which discredited the market and caused calls from many NGOs for more stringent

restrictions on CO₂ and tighter allocations of emission credits in the second phase of the scheme (Andrew, 2009b; CAN Europe, 2006; ECOFYS et al., 2006).

Those involved in the second phase of the ETS are confident that the mistakes of the first phase of the system will not be repeated. National Allocation Plans are said to be tighter in the second phase (EC, 2008). In December 2008 future contracts for permits, also known as European Union Allowances (EUA), were traded at around €24, and a derivative market developed, whereby a financial intermediary accepted the risk of a guaranteed delivery of EUA for a price around €18 (Andrew, 2008). Volatility creates the opportunity for market speculators to gain profits without making any commitment to greenhouse gas reductions (Markandya, 2009). Additionally, gains to market speculators do not provide funds to compensate lower income groups for the additional cost of their contribution to greenhouse gas abatement (Antonia & Creedy, 1996; Callan et al., 2009). High price volatility of an EUA may confront companies with difficulties in business budgeting and planning. As illustrated in Figure 1 below, in July 2008 the price of an EUA was above €30 while falling below €9 later in 2008. Although high volatility is good for speculators it has caused the EU ETS to fail to satisfy the needs of all parties to the system during both phases.

Figure 1: Price Volatility in the EU ETS



Source: Climate Economics Chair from BlueNext and ICE ECX Futures

As can be seen above the first phase of the EU ETS was characterised by extreme price volatility with the price of an EUA falling from above €30 to zero in a short period, largely as a result of EU and Member States' management failures within the system and the over-allocation of permits. The second phase of the system shows evidence of more price stability, yet a fall from above €30 in June 2008 to below €9 in February 2009 is still quite dramatic.

3. The North American Acid Rain Program

The 1990 US Title IV SO₂ Cap is considered to be the most successful ETS, putting a limit on sulphur dioxide emissions (Tiefenberg, 2010). However, Ellerman et al. (2000) claim that the program has not encouraged a movement towards modern renewable energy technologies. Instead, it supported traditional end-of-the-pipe controls (scrubbers) and pollution prevention through application of low sulphur coal (Driesen, 2003). The focus of this scheme was on coal-fired electricity generators and this was relatively easy to manage and monitor. Although the scheme has a narrow focus, prices per tonne varied from a low of US\$70 in 1996 to US\$1,500 in 2005 (Nordhaus, 2005) and varied during the year ending 29 March 2007 alone from US\$400 per tonne to US\$1,500 per tonne (Smith, 2007). That meant a variation in companies' base operating cost between 7 percent and 26 percent during 1996 (Smith, 2007). She argued that the price variation in the EU ETS over the years 2005-2007 from about US\$2 per tonne to US\$35 per tCO₂ would cause a coal-fired unit to face variations of base operating costs from about 10 percent to 175 percent (Smith, 2007). These fluctuations would impose huge burdens on the management of electricity suppliers and "would be extremely undesirable, particularly for an input (carbon) whose aggregate costs might be as great as petroleum in the coming decades" (Nordhaus, 2005, p. 15).

The failure of the Regional Clean Air Emissions Market (RECLAIM) in Southern California is in contrast to the success of the Title IV program in reducing acid rain. RECLAIM commenced in 1995 setting targets for SO₂ and NO_x emissions and a wide range of trading was encouraged, for example between stationary and mobile sources of emissions (Green et al., 2007). However, the program was substantially abandoned in 2001 since it did not operate as expected. That is, the NO_x emissions fell only by 3 percent between 1994 and 1999 compared to an emissions decline of 13 percent during a five year period before RECLAIM (Green et al., 2007).

These markets showed some mixed success in emissions reduction which might be due to different approaches, design and enforcement of the systems (Ellerman et al., 2000). Further issues in relation to RECLAIM are: the small number of participants with large SO₂ emissions, design problems of the scheme, the complicated nature of operating the US Acid Rain Program (Green, 2007) and after studying the schemes Ellerman et al, (2000, p.321) concluded that "[t]here is a potentially large distance between embracing emissions trading in principle and producing a detailed program that will perform well in practice".

4. British Columbia's Carbon Tax on Polluters

The Canadian Province of Quebec introduced North America's first carbon tax on 1 October 2007 with a rate of Can\$3 per tCO₂ (Duff, 2008), this was followed by British Columbia (B.C.) on 1 July 2008, which introduced a broad consumption-based carbon tax on combustion of fossil fuels and other specified combustibles within the province (Duff & Hsu, 2010). The tax bases, which covered 70% of B.C.'s Carbon Dioxide equivalent (CO₂-e) emissions, are the respective CO₂-e emissions of each fuel used [3]. Fuels exported from British Columbia are excluded or exempted from the carbon tax base as well as CO₂-e emissions resulting from industrial processes from oil, gas, aluminium, or cement production. Also exempted are GHG from disposal of solid waste, the agricultural sector and the combustion of bio-fuels and there is no tax on imported goods and services from other jurisdictions. However, the carbon emissions embedded in exported products and services are not exempt. The rate started off in July 2008 at Can\$10 per tCO₂-e, increasing by Can\$5 per tCO₂-e on 1 July, of each year until 1 July 2012 when it was Can\$30 per t CO₂-e (British Columbia Ministry of Finance, 2008, p.12). The tax revenues gained from this carbon

tax are by law required to be returned to taxpayers in the form of tax credits or tax cuts. This includes a tax credit of Can\$100 per adult and Can\$30 for each child for low income households, which is paid quarterly; reduced personal income taxes (by 5 percent on the first Can\$70,000 of income); and lower general corporate income tax (British Columbia Ministry of Finance, 2008).

The revenues resulting from the carbon tax were Can\$306 million (M) in 2008/2009, Can\$541M in 2009/2010, Can\$741M in 2010/2011, Can\$939M in 2011/2012 and this is expected to increase to Can\$955M in 2014/2015 (Minister of Finance B.C., 2011, Sumner, 2011, Minister of Finance BC, 2012). Apart from increased revenues B.C.'s Provincial Greenhouse Gas Inventory Report mentions a CO₂-e emissions decrease of 4.5 percent between 2007 and 2010, while B.C.'s population increased by 5 percent over the same period (B.C. government, 2012).

5. Comparison between Carbon Tax and ETS

There is little difference between a carbon tax and a market determined price on carbon in economic terms. "The essential differences between a well-designed and credible ETS (Emissions Trading Scheme) and a well-designed and credible carbon tax are not as large as often supposed. Many economists prefer a carbon tax because they hold the view that the alternative is not a well-designed and credible ETS, but a distorted one, surrounded by uncertainty about key parameters. It could be said that they have experience to date from the established carbon ETS schemes on their side" (Garnaut, 2007, p. 10). The most prominent argument in favour of an ETS is that the economic cost would be lower from an ETS because those firms with a lower marginal cost of abatement would have an incentive to abate and the opportunity to profit from their lower cost of abatement (Hashem, 2010). There is a large body of informed opinion in support of a carbon tax [4] yet the public debate has been dominated by the ETS alternative and it is likely that the current ideological focus on markets has coloured the argument and driven the actions of governments.

It seems logical to consider imposing a tax on carbon emissions, and it is argued that this alternative approach to pricing emissions should be thoroughly examined. Political fear of introducing a new tax, however, may be the major explanation for government decisions to adopt an ETS (see for example DiPeso, 2005; Green et al., 2007), as the economic argument in favour of an ETS, that it would drive the least cost abatement, also applies to a carbon tax. The same incentives would exist in the case of a carbon tax, firms would reduce their tax if they abated their pollution and all firms would have the same incentive not just those with a low marginal cost of abatement. Some of the advantages of a carbon tax over an ETS are that the tax would be simpler to administer, more economically efficient (Pizer, 1999), more transparent (less open to manipulation) (Markandya, 2009) and more visible (and thus harder to evade or avoid) (Hovi & Holtmark, 2006).

Much of the revenue under an ETS, if allowances are not auctioned, would flow to a range of market participants who were motivated solely by their economic interests and who would be encouraged to develop a range of exotic market instruments with uncertain economic and environmental consequences over time. Under a carbon tax the revenue would flow to an accountable government which would be able to use the extra funds for a socially useful purpose such as providing access to 'green' energy for low income households (Callan et al., 2009) and to fund green energy sources (Andrew, 2008). The revenue could also be used to

improve the economic efficiency of business by cutting a range of inefficient taxes (Stern, 2006). The economic efficiency of a carbon tax would stem from its broad base and its capacity to fund the abolition of a number of inefficient, narrowly-based taxes which exist at the moment (Clarke, 2011; Nordhaus, 2006). To the extent that a carbon tax distorted economic decisions by encouraging investment in low emissions technology it would require a justification from the science as reducing the harm caused by emissions and an economic justification based on the opportunities provided in the new low-emissions economy of the future.

Another feature, in economic efficiency terms, is that a carbon tax could be levied upon the consumers of products which generated carbon pollution in the production process directly through a carbon tax upon consumers. Such a carbon tax upon consumers would operate in the same way as a Goods and Service Tax (GST or VAT) and could be administered without any further complications than a change in the rate (or rates) of tax collected through the GST (Andrew, 2009a; Andrew et al., 2010; Garnaut, 2008). The tax could then be remitted at the border for all exporters in the same way as the GST and this would correct a major inequity in the current Clean Energy Act 2011 to compensate some exporters only. Under the current Act some exporters will be compensated for the impact of the carbon price by receiving up to 94.5 percent of permits free, while other exporters will receive no compensation and thus be forced to bear the full cost of compliance with the new system (Commonwealth of Australia, 2011b).

Further, in a report to the Committee for the Economic Development of Australia (CEDA) (2007) Access Economics' "modelling shows, for the same assumed carbon price... [t]he projected decline in welfare, as measured by GNP per t CO₂-e abated within Australia, is smaller for the consumption-based approach than a production-based CPRS approach" (Access Economics Pty Limited, 2009, p. i). The chief executive of CEDA David Byers (CEDA, 2009) said in response to the Access Economics concept modelling that the emissions trading scheme modelled "would involve losses of real GDP per million tonnes of abatement about 50 percent higher than a consumption-based carbon tax".

A significant advantage of a carbon tax over other instruments is the simplicity of its introduction. In its most basic form it will only require a relatively minor change to the existing tax administration without the need for a major new expansion of administrative machinery or a significant increase in personnel (Andrew et al., 2010; Nordhaus, 2007). Under either an ETS or a carbon tax it will be necessary to monitor emissions from firms and these emissions will provide the tax base if a carbon tax was applied. The existing tax administration could be used to levy and collect the tax from the small number of firms that become liable to pay the tax under any reasonable emissions threshold, such as the current level used for the reporting threshold under the National Greenhouse and Energy Reporting (NGER) legislation of 25 kilotonnes of CO₂-e emissions, this threshold would mean that the tax was collected from less than 500 large firms in Australia (Commonwealth of Australia, 2011f) making enforcement activity quite easy because of the small number of firms involved and their size and visibility.

Under a carbon tax the cost increase for business would be specified by the tax rate, which was likely to be stable over time or increasing at a rate specified in the legislation. The tax could start at a low level, which may be too low to have a significant impact on business costs and unlikely to drive investment decisions but which would give business time to develop systems to deal with the tax and to plan abatement strategies so they could avoid

paying the tax. If accompanied by a ten year plan to slowly increase the tax this would signal a clear government intention to steadily raise the cost of carbon through tax increases over a specified number of years. In the initial years of the tax it could be structured in such a way as to make it easy for business to adjust to a price on carbon and later tax rate changes would only be one part of the change in total business cost (Andrew, 2009a). This is in contrast to the price determined in a market, which experience from Europe and North America shows to be highly volatile, and the volatility of a market price can be contrasted with the stability of a tax levy. Price volatility in a market will make business budgeting and planning much more difficult and it will encourage market speculators to profit from market instability.

To develop a carbon tax we need to consider two key variables, the tax base and the rate. Clearly the easiest tax base would be stationary energy suppliers which are large and highly visible and which could pass the cost of the tax onto both private and business users of their energy (Aldy et al., 2010). This would have a broad enough spread to have a direct impact on the quantity of energy demanded and thus the amount of greenhouse gases generated, and the stationary energy producers generate a little less than 48 percent of total greenhouse gases in Australia (Beder, 2009). This approach would address a large part of the problem by encouraging energy conservation strategies. It would also drive investment in green energy as the change in relative price of the various energy sources, with green energy becoming relatively less expensive, because it would not bear the carbon tax (Commonwealth of Australia, 2011e). The carbon tax base could start with the easy targets such as the energy producers or those entities required to report under the NGER Act, where evasion and avoidance was very difficult. Large fixed installations could also be monitored by satellites further making avoidance very difficult (Nader & Heaps, 2008). Heavy industrial users of energy would provide another identifiable and auditable source of emissions, with transport being the most likely target after the stationary energy providers and heavy industrial users. Transport could more easily be dealt with through a carbon tax on aviation and motor fuel, again indicating the flexibility of a carbon tax which could be designed to impose separate levies upon different industries to reflect differences in their structure (Andrew, 2009a).

There are many features that make a carbon tax a superior approach to pricing greenhouse emissions. The design of a carbon tax is likely to be much simpler than that of an ETS if the aim is to change the relative price of generating carbon into the atmosphere as a way of reducing the volume of greenhouse gases, a carbon tax will change the price of carbon-based energy by a specified and predictable amount (Aldy et al., 2008). A carbon tax could be levied on either the consumers of products which contain some carbon or on the carbon footprint of those firms which generate carbon during their production, it could be levied as an excise on fuels if this is a more efficient way to levy and enforce the tax.

A carbon tax could be administered by existing tax institutions and the revenue could be used to remove or reduce, existing narrowly based taxes which distort economic activity, it could be used to compensate low and middle-income households affected by the tax or used to invest in the new technology which is needed to address the current problem. It could be collected and managed by the existing tax authorities and the tax could be remitted at the border for all export industries as is done with the GST. Reimbursement of the tax at the border for all exporters would be fairer than a system which nominates some as emissions intensive trade exposed (EITE) firms which receive massive compensation while other exporters do not receive compensation (Andrew, 2009a; Nordhaus, 2006).

A comprehensive solution to the greenhouse problem is not possible without eventually including the large developing countries, especially China, India, Indonesia and Brazil, none of which should be forced to bear the cost of the bureaucracy which will be needed for an ETS. However, they may be able to monitor and tax the greenhouse gases emitted from stationary power sources and large industrial sites at relatively little cost (Andrew, 2009a). Many developing countries have difficulty in operating an effective income tax system (Andrew & Hughes, 1999; Bird & Zolt, 2005) and raise most government revenue from indirect taxes and charges for services and the levy of a carbon tax on the carbon content of goods and services would give them an additional revenue stream. The extra revenue that they raise from a carbon tax could then be used to compensate lower income people who were likely to be disadvantaged by an energy cost increase (Antonia & Creedy, 1996; Callan et al., 2009) and it could be used to invest in low emissions technology (Andrew, 2008).

6. Hybrid Policy

The hybrid policy most often found in literature is the ‘safety valve’ which could reduce price volatility (Jacoby & Ellerman 2004). The ‘safety valve’ was first suggested by Roberts and Spence (1976) and then further developed by Pizer (2002). Governments using such a policy instrument agree to sell an unlimited number of additional permits at a certain price, which is attractive to companies when the price of permits in the cap-and-trade market exceeds the set price. This will tend to act as a cap on the market price as firms will not normally pay a higher market price than the level set by the government. This is a combination of the two alternatives of environmental tax and ETS (Aldy et al., 2008; Gillingham & Sweeney, 2010; Murray et al., 2009). Pizer (2002) mentions that such a system can make imperceptible welfare improvements and is more predictable than a pure ETS. Keohane (2009) states that “the advantages and disadvantages of such hybrid instruments relative to a cap-and-trade program are essentially the same as those of a tax, differing in degree rather than in kind” (Keohane, 2009, p. 48). In addition to the price ceiling (safety valve) governments could implement a price floor; as happened with Australia’s Carbon Pricing Scheme (2014/2015 onwards). This means that governments would offer to buy permits back at a certain price. Baumol & Oates (1988) however, claim that this would be a subsidy program which is likely to create dynamic inefficiencies. From an economic perspective the combination of safety valve and price floor seems to be prudent.

7. Some Other Policy Instruments

There are a range of other policy instruments which could be used to encourage the abatement of GHG, ranging from direct limits on pollution, subsidies to GHG abatement activities, renewable energy targets, ‘green’ projects like tree planting and sequestration of carbon in the soil using biochar (Sohi et al., 2009) [5]. A range of these policy instruments have been applied in different contexts with a certain level of success, especially direct government limits on pollution, but these measures tend to be costly to enforce and costly to business subject to the restrictions. The Australian Government’s Wilkins Committee identified 62 different programs as having been set up by the government and recommended that many of these should be discontinued as they were not compatible with an ETS (Wilkins, 2008). Many of these measures were short-term in impact and only affected a small section of the community and these would not have a long-term impact on prices and behaviour. Without behavioural change it will be impossible to solve the climate change problem (Gupta et al., 2007).

Command and Control Approach

Perhaps the policy instrument with the most potential to reduce emissions in a short time is to mandate a level of renewable energy from all energy supply firms, such as the Renewable Energy (Electricity) Act 2000, as amended (Commonwealth of Australia, 2011d). On the face of it this Act requires energy suppliers to generate 20 percent of their electricity from renewable sources by 2020 in Australia [6], but it has been compromised by concessions to various interest groups, for example coal seam gas (methane) is deemed to be a renewable energy source under the legislation, a patent absurdity. Energy suppliers are encouraged to invest in renewable energy sources and as they supply power from this source they gain Large-scale Generation Certificates (LGCs) [7] which can be sold on the open market or to their customers, such as the energy retailers, who can use LGCs to meet their obligations under the renewable energy target (RET). The energy producers must first invest in renewable energy sources before they obtain LGCs and the financing costs of the new investment will be passed on to consumers as energy prices rise (e.g. Kydes 2007). The longer term impact of the policy will be to increase the volume of energy from renewable sources (see e.g. Carley, 2009; Yin & Powers, 2010; Rabe, 2008) and the extra investment will cause a rise in energy prices which may encourage consumers to cut their energy consumption or themselves invest in decentralized energy from photo-voltaic cells or small wind generators or similar, again having the effect of increasing the supply of renewable energy (see also Gumley & Stoianoff, 2011).

The renewable energy target (RET) can be seen as a command and control (CAC) policy instrument, namely as a performance standard to be met by energy producers. The CAC approach can be divided into two broad groups which are: 1) technology standards and 2) performance standards (Hahn & Stavins, 1991). A technology standard determines the pollution abatement technologies a company has to install, while a performance standard determines the environmental output per unit of a product and is likely to be more flexible and cost-effective (Driesen, 2004; Goulder & Parry, 2008). A technology standard specifically tailored to industries can result in more control, thus might lead to higher net emissions abatement benefits compared to an ETS (Hahn & Axtell, 1995; Oates et al., 1989). But technology or performance standards may lag behind the best available technology and they offer little incentive to continue improving pollution abatement (Bohm & Russell, 1985). However, the example of German companies' responses to standards for SO₂ control shows that technology innovations were achieved (Wätzold, 2004 see also Cole & Grossman, 1999; Driesen, 1998). One serious problem with governments setting technology standards is that they lack sufficient information to determine cost minimizing carbon emission standards (Metcalf & Weisbach, 2009).

Performance standards in order to achieve cost-effectiveness, have to be set with different performance requirements for companies with different production capabilities (Goulder & Parry, 2008). According to, Goulder and Parry (2008, p. 158) “[d]irect regulatory instruments also fail to engage optimally all of the major pollution reduction channels and, if nontradable, fail to equate the marginal costs of emissions reductions across heterogeneous firms”.

Subsidy

Subsidies, either direct or indirect, have implications for markets and might decrease or increase emissions depending on their specific nature. Subsidies aimed at emission reduction can take the form of support in R&D, investment tax credits and price support for renewable energy. The latter was established in the EU, who set prices at which utilities must buy electricity from renewable electricity generation. These so-called ‘feed-in tariffs’ have promoted the development of renewable energy sources (Ackermann et al., 2001; Menanteau

et al., 2003). By contrast, subsidies in the fossil fuel sector would increase the consumption of fossil fuels which will lead to higher GHG emission (see e.g. Riedy & Diesendorf, 2003) . Economically, subsidies have the same mechanism as a carbon taxes or an ETS. That is, each additional emission implies a cost to the firm in the form of forgone subsidy receipts (Goulder & Parry, 2008). Subsidies are used where a desired outcome (e.g. renewable energy production) would not occur or would occur too slowly under market forces or regulation (Nielson, 2010).

The Productivity Commission (2007) mentions investment support as a means to reduce risk and costs of investments in low emission technology R&D, demonstration and deployment. Accelerated depreciation allowances, tax credits and tax offsets that allow small companies to cash out investment equivalents are included in this type of policy. Subsidies can be technology independent and can encourage firms to invest. Yet, this instrument has to be designed in a way that encourages developments which would not be taken in business as usual. However, strategic behaviour by companies to engage in certain activities to gain subsidies would result in a less than efficient allocation of economic resources (Nielson, 2010). Additionally, subsidies do not remove market failures which hinder energy efficiency improvements and with each subsidy program administrative costs arise which increase the overall cost of abatement (Productivity Commission, 2008). Under the Clean Energy Act 2011 several subsidies to companies and Australian citizens are mentioned (Commonwealth of Australia, 2011a) [8].

‘Feed-in tariffs’ as implemented by the EU increase the cost of electricity for producers relying on fossil fuels and perhaps their customers. The feed-in tariff quantifies the amount of electricity from renewable sources. Additionally, without those kinds of subsidy an energy shift which can prevent future CO₂ emissions might not be feasible. By contrast, subsidies (direct or indirect) to the fossil fuel sector, which in Australia during 2005-06 made up between \$9.3 billion to \$10.1 billion (Riedy, 2007) The economic incentives provided by those subsidies distort the shift towards renewable energies and can be seen as supporting status quo and attracting further investments in the current sources of pollution, thus they are not in line with abovementioned principles.

Research and Development

In order to achieve the GHG emission reduction plan to cut Australia’s emissions by 80 percent by 2050, substitution among known technological processes is not sufficient; it requires major technological changes and some breakthroughs. Governments can encourage R&D through grants, contracts, tax credits and allowances and public/private partnerships (Gupta et al., 2007). Promotion of R&D in clean technology addresses the market failure beyond the pollution externality such as the inability of companies to fully appropriate the return from their technology development. It was found that the (marginal) private return of innovative activities in general is several times less than the (marginal) social return (Griliches, 1992; Jones & Williams, 1998).

There are different points of view on the role of R&D and its contribution to overall energy innovation. For example Sagar and van der Zwaan (2006), found that there is no correlation between industrialized countries’ spending on R&D and the national energy intensity or carbon emissions per unit of energy consumption. While Watanabe (1999) argues that government R&D can trigger breakthroughs. Under the Clean Energy Act 2011 several R&D projects are supported (Commonwealth of Australia, 2011a) [9].

Support for R&D through grants, contracts, tax credits and allowances and public/private partnerships as happening in Australia is not directly in line with the PPP or the prevention and sustainable development principles. Polluters in this case do not have to pay extra, neither do consumers. Prevention and sustainable development might only take place indirectly, that new technologies would help to reduce future emissions. However, the precautionary principle applies, because of R&D's potential to address future not yet quantified risks of potential harm.

8. Summary

Previous sections shed light on the capacity of several policy instruments to contribute to the reduction of GHG-emissions with some discussion of underlying policy principles. While some instruments such as the EU-ETS and RECLAIM had the (theoretical) potential to follow underlying principles, implementation issues, political pressure, lobbying and other related issues prevented this achievement. Especially, the EU-ETS, as the largest ETS, has faced issues of getting EU nations' consensus and complying with each countries' legal standards, which has been more difficult than in a single state setting.

The comparison between an ETS and a Carbon tax went beyond the discussion between policy instruments to indicate some of the implementation and systemic issues related to the EU-ETS and US Title IV SO₂ Cap compared to a carbon tax such as British Columbia's.

9. Conclusion

In economic terms there is no significant difference between a carbon tax and an ETS. They both aim to raise the cost of emitting greenhouse gases, either directly through a tax imposed or indirectly through a price generated in a market which is established after a cap is placed on the quantity of emissions. A tax on carbon emissions would be simpler to apply and more certain to increase the cost of fossil fuels without the price volatility that we have seen in established carbon markets. Pricing carbon is essential if there is to be an impact on personal and corporate behaviour, and price volatility would make budgeting and pricing decisions much more difficult for business. The political fear of introducing a new tax seems to be a major explanation for the adoption of the market option by many governments, though some have argued that a market-based solution will produce the required change in behaviour at the least cost. The evidence so far indicates that the range of non-market policies put in place are very expensive and this argument seems to be appropriate if the comparison is between market and non-market policies. But a carbon tax and an ETS are both market policies which rely on the price mechanism to drive behavioural change.

A carbon tax has a range of advantages over an ETS. The impact and incidence of a tax would be more certain than that of an ETS as the tax could be levied on the quantity of emissions at a publicly announced rate. The impact could be gradual, as a tax can be introduced with scheduled rate adjustments specified in an announced timetable, which would give industry time to adjust. The tax charge itself would be stable, in contrast to the price fluctuations that have occurred in the largest established ETS market, the EU ETS and the only ETS which was clearly successful in reducing emissions, the US Acid Rain Program. The economic effect of a tax would be more certain, because the increased cost of emissions would be stable. The instability of prices in an ETS market adds uncertainty to business management which could adversely impact on investment decisions and the level of economic activity in the productive sectors of the economy.

With a tax, there would be no need for a new market of securities related to emissions units created by a government determined scarcity. Trading in the EU ETS is now dominated by option and future trading with up to 95 percent of trading on the London market being in these two derivatives. Derivatives can be used to hedge against risk or used as speculative instruments and it is likely that a range of complex derivatives will be developed in the future which could distort the flow of revenue and economic activity and which would divert income from abatement activities to a small number of market players who were able to exploit the market volatility of an ETS. The management of a carbon tax would be simpler than an ETS and could become the responsibility of existing institutions – unlike an ETS which requires a range of new institutions such as a registry and enforcement body, a monitoring authority, and a new trading entity. The integrity of a tax would be far higher than an ETS, because cap-and-trade systems are inherently more exposed to fraud and evasion. In the EU ETS there appears to be much selling of allowances which do not reduce emissions elsewhere. Emissions units have been stolen from some registries recently and the ‘missing trader’ fraud has been reported involving the manipulation of VAT and buyers have not known about the fraud or mistake in such a time frame as to allow transactions to be unwound (Frunza, 2011).

An ETS is an artificial market based on a scarcity created by a government for an intangible commodity, it requires a government to create an artificial scarcity for the commodity to have value, whereas a carbon tax does not require any such economic fiction (Nordhaus, 2006, 2007). However, a well-constructed market with appropriate access to diverse information sources does provide the possibility of emissions reductions at lower cost through the capacity of high cost firms to trade allowances with lower cost firms. Both systems will have to be driven and managed by government at all times and to describe an ETS as a market system without further explanation does not have regard to the reality of government intervention at all stages of market development and operations. An ETS is driven from above, where government establishes all the market parameters and it will be a market for a very small number of items where it will always be hard for market participants to diversify risk through a rational investment strategy.

Notes

[1] Under the Australian Carbon Pricing Scheme carbon permits are available to companies at a fixed price from July 2012 to July 2015, increasing by four percent per year. After this fixed price period the permit price will be variable, however a price floor and ceiling applies (Commonwealth of Australia, 2011a).

[3] Fuels subject to the Carbon Tax are: “fossil fuels used for transportation by individuals and in all industries, including the combustion of natural gas to operate pipelines, as well as road, rail, marine and air transportation. As well, the tax base includes fuel used to create heat for households and industrial processes, such as producing cement and drying coal” (British Columbia Ministry of Finance, 2008).

[4] There is a large body of literature in economics comparing a carbon tax and an ETS and a Wall Street Journal survey found that most economists surveyed favoured some form of carbon tax (Green et al., 2007). A recent report published by the Committee for Economic Development of Australia (CEDA) included a number of papers from economists who favour

a carbon tax (CEDA & Marsh 2009) and Professor Gregory Mankiew of Harvard (former chair of the President's Council of Economic Advisers under the Bush Administration) operates a web site entitled the Pigou Club, which includes the names of a very large number of economists and public figures who favour a carbon tax (Mankiew, 2011).

[5] Sequestration using biochar appears to be a cost effective method of CO₂ reduction; e.g. 30 percent of U.S. fossil fuel CO₂ emissions according to Stavins and Richards (2005), might be sequestered at a cost of below US\$20 per t CO₂.

[6] The current obligation of Large-scale Generation Certificates (LGC) to be surrendered by electricity producer is determined by the Office of the Renewable Energy Regulator (ORER) through setting a company-specific Renewable Power Percentage (RPP). This requires a company to surrender a certain amount of LGC in order to fulfill their obligation. If a company does not surrender the required number a shortfall charge of currently \$65 per LGC applies.

[7] Prior to January 1, 2011, there existed a market for renewable energy certificates which were replaced by LGCs and 'Small-scale Technology Certificates' (STCs), when the renewable energy target (RET) was separated into two parts, the 'Large-scale Renewable Energy Target' (LRET) and the 'Small-scale Renewable Energy Scheme' (SRES). Demand for the latter is created by SRES which places a legal liability on liable entities, mostly electricity retailers, to purchase an amount of small-scale technology certificates each year at a price of \$40 or under (Commonwealth of Australia, 2011c).

[8] Approximately \$9.2 billion in transitional assistance over the first three years of the Jobs and Competitiveness Program will be received by organizations in the emissions-intensive, trade-exposed (EITE) business environment. \$3.2 billion over nine year from 2011-2012 will be provided by the Australian Renewable Energy Agency (ARENA) in order to fund projects through a range of competitive grants programs. \$200 million on foregone revenue over the period from 2012-2013 to 2014-2015 will be provided in a form of an increased small business instant asset write-off threshold. Finally, \$32 million are provided under the Clean Technology Focus for Supply Chains Program.

[9] \$1.2 billion over seven years from 2011-2012 are provided under the Clean Technology Program which is subdivided into following programs: 1) Clean Technology Investment Program (\$800 million over seven years from 2011-2012); 2) Clean Technology Food and Foundries Investment Program (\$200 million over six years from 2011-2012) and 3) Clean Technology Innovation Program (\$200 million over five years from 2012-2013).

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