Wardley, N. (2014). What factors are important for effective Greenhouse Gas emissions trading? In: Opportunities for the Critical Decade: Enhancing well-being within Planetary Boundaries. Presented at the Australia New Zealand Society for Ecological Economics 2013 Conference, The University of Canberra and Australia New Zealand Society for Ecological Economics, Canberra, Australia.

What factors are important for effective Greenhouse Gas emissions trading?

Neale Wardley[1*]

[1] Victoria Institute of Strategic Economic Studies, Victoria University, Melbourne, Australia

[*] Email: nealewardley@bigpond.com

Abstract

This paper has sought to shed some light on the controversial cap and trade programs favoured for the mitigation of greenhouse gas (GHG) emissions. In this paper the complexities of the GHG emissions trading process are examined further to establish a platform for the use of these market-based mechanisms. Evidence from two case studies has identified an effective avenue by which to gain compliance from the industrial sectors that are participating. On the surface the results of the research suggest that this compliance can be translated into emissions reductions.

Other aspects of this paper synthesise from the data, a factorial framework for the design of programs for GHG emissions trading. The factorial framework has been engaged in this paper to assess the design parameters of the case studies. I.e. the European Union Emissions Trading Scheme (EU ETS) and the US Regional GHG Initiative (RGGI).The factors in this framework, for the trade of allowances in carbon dioxide (CO_2) emissions, are also discussed in terms of the US Acid Rain Program (ARP) for sulphur dioxide (SO_2) emissions.

Keywords

Greenhouse gas emissions trading, Acid Rain Program

Introduction

This paper was driven by the apparent controversy that has been associated with the introduction of a system for market based environmental management. The proposed mechanism is GHG emissions trading, which aims to put a price on carbon emissions (CO_2) and reduce the levels of anthropogenic Greenhouse Gases in the atmosphere. In some regions a paradox exists between on one hand the theoretical popularity and on the other hand the political unpopularity of this mechanism (Ellerman 2011). From the nineties this contradiction is exemplified in Australia where there have been a number of failed proposals for putting a price on carbon (Beder 1999).

Between 1992 and 1997 the United Nations Framework Convention on Climate Change (UNFCCC) formulated the Kyoto protocol. This protocol outlined emission reduction targets for the so called Annexe 1 countries. It also introduced mechanisms that, it was thought, could mitigate climate change. The UNFCCC model introduced GHG emissions trading as a path to international cooperation to reduce emissions through a process of linked national trading schemes. The theory suggested that this would provide distributional flexibility and wide industrial sectoral coverage.

In 2007 the research began observing a period of high activity in the development of cap and trade schemes for GHG emissions trading. In the literature these schemes are also known as tradeable permit and quota programs. Despite the successful application of quota programs in other areas, policy for GHG emissions trading is regarded with a degree of derision.

This paper will discuss some of the broad findings of the research where it has been shown that it is reasonable to expect that emissions can be reduced in line with the modest program aims. This paper also reveals that a number of factors have been found to be common across the policy development and implementation of GHG emissions trading.

In the prior experience with the use of emissions trading, this paper has identified support for cost effectiveness as a key element. In theory the emission abatement costs will be minimised as the participants covered by an emissions trading scheme seek the least expensive manner to reduce emissions. There is evidence which suggests that the large-scale implementation of GHG emissions trading is difficult. After limited experience with the pilot programs there are many unresolved issues. An examination of these issues has revealed some of the fundamental factors that contribute to a better informed conversation on the application of GHG emissions trading.

The case studies in this paper are the European Union Emissions Trading Scheme (EU ETS) and the U.S. Regional GHG initiative (RGGI). These case studies have provided a data sample that has been able to address the parameters of the research questions shown below.

Q1. Is there evidence from the case studies that the emissions of greenhouse gases been reduced using emissions trading?

Q2. What factors are fundamental in the design of programs for GHG emissions trading?

Q3. Of these factors, which ones are important in terms of the internal operation of the programs and a carbon market?

Q4. Of these factors, which ones are driven by external forces that effect the implementation of GHG emissions trading?

To tax or to trade

The pollution from the greenhouse gases is known to be an undesirable externality. An emission-trading scheme is a quantity-based approach to account for an undesirable externality. A carbon tax on the other hand is a price-based approach (Pearce 2003). From the 1950's pollution was managed using one of two techniques, i.e. Command and Control (CAC) or a so called Pigouvian tax on damaging externalities, named after economist Arthur Pigou. (Tietenberg 2006; Baumol and Oates 1988).

Hahn and Hester (1989) suggest that emissions trading theory has grown from a property rights perspective and has covered a range emission types. Under CAC policies governments allocated the spatial parameters for emission sources and determined the upper limits for various pollutants, an end of pipe approach. This approach has attracted some criticism because it requires an estimate by policy makers as to the marginal cost of reducing emissions as does an environmental tax.

Both CAC and environmental taxes are subjective approaches which it has been said "bristles with difficulties" (Coase 1960). It has been stated that the processes of CAC or a tax on pollution did not ensure the highest possible value was placed on the externality of pollution. Whereas in a market of tradable permits where the right to pollute was made a factor of production, the social cost would be reflected in a more accurate fashion. In Australia the recent application of a carbon tax was to be carried out in an iterative fashion in accordance to the appraised social cost and environmental damage caused by emitters.

Proponents of a carbon tax often refer to the marginal abatement cost curve (MACC) which indicates that a tax can be cost effective in the early stages of abatement when the marginal emission reduction costs are low (Nordhaus 1993, 1991; McKitrick 1999). The MACC graphically represents the cost of abatement plotted against the corresponding reduction of GHG emissions over time.

Several observers suggest there is a convergence in the economic efficiencies of the alternative approaches of environmental taxes and tradable permits (Grubb 1990, McKibbin et al 1999, Stavins 1995, Pezzey and Joskow 2012). A result of this convergence has been the development of a hybrid design that combines both fixed pricing (a tax) and permits or allowances for GHG emissions trading (McKibbin and Wilcoxen 1997).

The Australian carbon pricing mechanism was to have followed the hybrid approach that has been discussed by a number of authors such as McKibbin and Wilcoxen (2002), McKitrick and Collinge (2000). The hybrid approach is aligned with the use of

a carbon price collar to constrain costs in the early stages of an emissions trading scheme (McKibbin et al 2009 and CRPS 2008).

The evidence has been collected in the context of a changing Australian approach to this problem as described by Sandu 2007; Howe 2007; Sandu and Sharma 2010. There remains a degree of uncertainty about the best methods to mitigate the greenhouse gases. In other cases in order to gain acceptance, it has been common in the pilot programs for GHG emissions trading to set modest reductions targets at the start. Some critics of emissions trading hold a view that the targets for emission reductions are inadequate for the desired environmental outcomes (Walters and Baird 2009). In regard to emission trading programs generally there has been concern about the polluters being given the right to pollute at a price determined in an unproven marketplace (Pearce 2003; Pearse 2010 and Beder 2009).

The methodology used benefits from a lengthy observation of the U.S. Acid Rain Program (ARP) for SO_2 . It was thought that the principles of SO_2 emissions trading would be applied directly to a trading program for CO_2. It would seem that the concept of interchangeably of design factors between SO_2 allowance trading and CO_2 allowance trading is credible. As many of the factors that were identified as prominent in the SO_2 trading program do appear in the pilot programs for GHG emissions trading.

Significantly for the U.S. SO_2 trading program there was a level of bipartisan support across the major political parties in the U.S. More at question perhaps was the limited use of market based environmental regulation that SO_2 emissions trading introduced. In the U.S. before the ARP the Lead Trading Program (LTP) was a ground breaking use of tradeable permits to manage the public health concern about the lead content of gasoline. The impetus for cutting emissions from the ARP and the LTP had a high public profile. In contrast, some countries perceive that the potential damage from global warming does not yet appear to support the need for decisive action.

A factorial framework

In Australia Shergold (2007), the National Emissions Trading Taskforce (NETT 2007) and later, Garnaut (2008), enhanced the literature with possible designs for a cap and trade GHG emissions trading scheme. Submissions to the Garnaut Climate Review included the Productivity Commission (2008) which stated that a credible model should be a pure emissions trading scheme (ETS), one that shares the burden for greenhouse abatement across as many sectors as possible. This data on factors that appeared in proposals for an Australian GHG emissions trading program have shaped the research process. What follows is a synthesis of the Shergold report of 2007, the NETT report of 2007 and the Garnaut Review which was released in 2008.

Areas of focus according to Shergold (2007) in a Prime Ministerial paper were price caps, permit allocation, scope of the program and provisions for alternatives to emissions reduction i.e. offsets. These basic elements were the focus points that led to more detailed “key features of the proposed scheme”. These were the targets for long-term emissions abatement which could facilitate a flexible overall emissions trajectory (reduction target), also a forward pricing mechanism in the carbon market and the maximum practical coverage for all sources and sinks. It was recommended that permit liability be placed on large facilities and upstream fossil fuel suppliers, along with the exclusion of agriculture and land-use emissions. To reduce the initial negative economic impacts free initial allocation of single year permits, with periodic auctioning of subsequent permits was the preferred path.

The report also detailed a carbon price safety valve, a wide range of carbon offset regimes and the capacity for international linkages.

The NETT proposals were underpinned by: economy-wide coverage; stringent “monitoring, reporting and verification”, strong disciplinary measures for non-compliance; a transparent offset process; and a permit allocation that does not compromise the schemes ability to achieve a GHG emissions reduction target (NETT 2007). A summary of the NETT design criteria follows.

The NETT recommended governance structures that exhibited collaborative scheme designs and a coherent climate change strategy. Under the NETT, sectoral coverage would include the stationary energy sector, transport, energy intensive industry, and fugitive emissions. A NETT-based scheme would have a cap (emission reduction target) with suitable emissions reduction trajectories and annual permits to emit one tonne of carbon dioxide equivalent (CO_2-e).

The NETT also suggested the free allocation of permits to the stationary energy sector and Trade Exposed Energy Intensive Industry (TEEII), with auctioning of permits among other participants with a level of equity assistance to disadvantaged parties, and compliance in the surrender of NETT permits and the NETT offset credits, with offsets to include GHG reductions outside the NETT, as well as the flexible Kyoto mechanisms of JI and CDM. The NETT recognised that complex legislative measures would be necessary to facilitate implementation of the NETT. Another fundamental requirement would be extensive processes for monitoring, reporting, and verification. It proposed linking with international schemes, complementary measures for agriculture, research into low-carbon technology, non-monetary energy efficiency incentives, and climate change adaptation education.

The Garnaut Climate Change Review was established by the Australian government to recommend medium to long term policy and policy frameworks that would shape a response to climate change. The principles of design and intrinsic design features below are adapted from the Emissions Trading Scheme Discussion Paper which

called for submissions on an Australian emissions trading scheme proposal. The resulting principles shown below were established to guide design:

> …permit scarcity aligned with emissions target; i.e. demand drives the value of permits. Tradability; characteristics of permits are clearly defined and mechanism for trade is transparent. Credibility; faith in the enduring nature of critical elements. Simplicity; rules are easily explained, concessions and exceptions avoided. Integration with other markets; minimal distortions within the domestic scheme relative to international markets. Coverage, offsets, point of obligation, permit design, permit issuance, international trade and linkages.
>
> (Garnaut 2008)

This review considered that external price control would be necessary to minimise distortions in the market. The review supported inter-temporality: banking and borrowing to help avoid trade distortions. It called for scheme reviews, strong governance and stringent compliance driven by appropriate penalties.

In a synthesis of the data on market based environmental regulation a group of factors that are important in terms of a standard scheme design have been identified and are they are shown below.

Internal (operational) factors, from the evidence in the case studies these factors are considered to be important for normal functioning of a program for emissions trading. They are legislation, governance, rules, compliance and entry and exit provisions. Also fundamental are the allowances to emit greenhouse gases. Aspects of which can be taken to include their allocation, allowance price discovery, the treatment of surplus allowances and allowances as a financial asset.

External (acceptance) factors, from the evidence in the case studies can be shown to be less stringently applied and vary according to particular socio economic characteristics of a region. This categorisation includes the targets for emission reductions, complementary policy, scheme coverage and a phased introduction. In the case studies, each region has a unique set of variable traits, e.g. existing environmental priorities and a reliance on fossil fuels.

While the relative importance attributed to each of the factors considered in the cases studies varies, it has been established that they can be categorised. Generally it has been found that the first group of factors, i.e. legislation, governance, rules, compliance, entry and exit provisions are related more to the internal operation of the programs. While the second set of factors, i.e. allocation of allowances, surplus allowances, financial asset, targets, complementary policy, coverage and a phased introduction are considered to be generally more related to acceptance of the

program. Some factors also exhibit a dual role and can be considered to have crossed the boundaries of both operation and acceptance.

The factors are shown in the table below in categories that are used for the purpose of comparison in the research.

Table 1 Factors and the categories used for a comparative methodology in the research

Internally driven factors (Operational)	**Externally driven factors (Acceptance)**	**Factors that appear in both categories**
Legislation	Coverage	Entry and exit provisions
Governance	Phased introduction	Allocation of allowances
Rules	Allowances as a financial asse	Treatment of surplus allowances
Compliance	Targets	Complementary policy

Using the factorial framework to compare SO_2 trading and CO_2 trading

In an extension of the original research aims, factors seen as important in the US Acid Rain Program (ARP) were tested for applicability in the GHG emissions trading case studies. Each of the factors from the case studies is compared with the U.S. ARP. This approach highlights the differences between the three programs for emissions trading (US ARP, EU ETS & US RGGI). The distribution of the allowances initially in the EU ETS was free of charge (grandfathered on historical emissions) while from the outset of the RGGI all allowances were auctioned. In the case of the U.S. ARP, the allowances were initially distributed free of charge.

The comparison has noted some similarities between the emissions trading programs for both SO_2 and CO_2, e.g. the sectors that were covered. In the U.S. ARP stationary energy or large electric generators were covered. This was also the case for the RGGI, although the actual numbers of generators covered was considerably more for the U.S. ARP as it applied across all parts of the U.S. mainland. Other similarities between the ARP, EU ETS and US ARP included a strong legislative process, clear governance structures, transparent participant based reporting and a phased introduction.

In the U.S.ARP and in the EU ETS, a pre-existing body acted in oversight of the statutory elements of a novel program. In the case of the U.S. ARP the body was the

U.S. Environmental Protection Agency (EPA). While in the case of the EU ETS this oversight was by the European Commission, for the European nations that were participating. In the case of the RGGI a new body was established, RGGI Inc. to cede down the macro level plan for emissions trading to a state based level.

In each of the programs the level of emission reduction targets varies considerably. The U.S. ARP had aggressive reduction targets, whereas the programs for CO_2 were relatively benign. Complementary policies also seemed to reflect regional differences especially the case of the U.S. ARP. The nature of the threat from the deposition of acid was not evenly distributed across all the regions covered. As a result additional rules were developed to cover this anomaly.

Complementary policy remains fundamentally important for GHG emissions trading. This refers to alternatives such as energy efficiency rating carbon offset schemes or mandated renewable energy targets. As suggested below these complementary policies may introduce a perverse incentive to reduce the cost effectiveness of a pure cap and trade regime.

> Complementary policies, by contrast, designate in advance how greenhouse gases ("GHGs") must be reduced and the sources from which these reductions must come. While complementary policies can effectively reduce emissions, they also constrain the market options available under cap-and trade by limiting the choices emitters have about how to reduce their emissions. That constraint can lead to higher compliance costs.
>
> (Carlson 2012)

The framework for the factorial analysis was developed in the early stages of the research using data from prior tradeable permit programs. These programs ranged from the Lead Trading Program that began in 1985 to later developments in United Kingdom, other part of Europe and Australia. There are now further unique designs for GHG emissions trading that have emerged, e.g. The New Zealand Emissions Trading Scheme and Californian Emissions Trading Scheme.

Discussion

The literature on tradeable permits and on GHG emissions trading has grown considerably. Goulder (2013) suggests that the outcomes of cap and trade emissions trading can also now be better understood in relation to other policies. During its' initial stages the US sulfur allowance program (SAP) was considered as being successful in reducing the very visible impact of acid rain in the US (Schmalensee Stavins 2013 and Ellerman et al 2000). The US EPA suggests that under the ARP to 2010 SO_2 emissions from electricity generation plant have been greatly reduced since the program's inception in 1995.

Prior research papers have suggested elements of the US SO_2 SAP would be transferable to a program for GHG emissions trading. These include Chan et al (2012), Hansjurgens (2011), Burtraw et al (2005) and Ellerman et al (2003). What this literature also reveals are the design factors inherent in the U.S. ARP that contributed towards its success. Evidence from Tietenberg et al (1998) and Stavins (1998) identifies a short, but significant, list of factors to consider. Tietenberg considered that emission caps, allowance trading, compliance and stringent environmental standards are fundamentally important, to SO_2 emissions trading. Stavins expands the category to include a phased introduction and cost effectiveness in trade between facilities. Stavins acknowledges that the banking of allowances is important as was the compliance encouraged by a US $2000 per ton penalty.

The phased introduction of SO_2 emissions trading was mirrored in the EU ETS in particular. In the case of the US ARP a phased introduction relates to the targets for emission reductions which became more stringent in a staged manner. It has been noted by Stavins and others that the US ARP emission reduction targets were achieved. He also felt that while the original motivation was the mitigation of acid rain, human health improved as a complementary outcome.

As the experience with the US ARP and SO_2 emissions trading grew so too did the level of understanding about the important elements of the program. As evidenced in the literature by Ellerman et al (2003) and Burtraw et al, (2005) all of whom contributed to a deeper understanding of the process. Noted in the contribution of Ellerman et al (2003) is the success in lowering the cost of meeting emission reduction goals and the enhanced achievement of environmental goals.

These authors also observed that allowances were clearly defined to allow trade without case by case verification and that banking improves economic and environmental performance. Their remaining observations related to the targeted electricity sector, where there was verifiable measurement of emissions and the free issuance of the majority of allowances. Ellerman et al (2003) also considered that the allowance market was slow to develop due to external forces.

It was thought that the principles of SO_2 emissions trading may be applied to a trading program for CO_2. On comparison it does seem that the concept of interchangeably of design factors between SO_2 allowance trading and CO_2 allowance trading is credible. As many of the factors that were identified as prominent in the SO_2 trading program do appear in the two case studies described by this paper.

It has been noted that the SO_2 trading program had some level of bipartisan support across the major political parties in the US. More at question perhaps was the limited use of market-based environmental regulation that SO_2 emissions trading introduced. A precedent to the Acid Rain Program (ARP), the Lead Trading Program

(LTP) was a ground breaking and successful use of tradeable permits to manage an airborne pollutant. The very real public health concern about the lead content of gasoline was the principal issue in this case. This impetus for cutting emissions from the US ARP and the LTP may have had a higher profile in terms of public awareness. While the damage from global warming is it seems, at the time of writing, settling into the mainstream consciousness it does not appear that there is the perceived need for summary action.

There were also a number of factors from the evidence about SO_2 allowance trading that did not show a strong correlation to the case study data. These were related to the identification of positive environmental and health outcomes, establishing a base case from which to assess cost effectiveness and substantial penalties for non-compliance.

Conclusion

This paper has identified a number of the flexible design decisions that are fundamental to effective policy for GHG emissions trading. These include the legislation, issuance of allowances, emissions caps and sectoral coverage. This paper also introduces some factors that are growing in importance when implementing programs for GHG emissions trading. These include the treatment of allowances as a financial asset, the entry and exit provisions for new entrants and retiring plant as well as the management of the associated allowances

As well this paper has raised questions about the wide variance of emission trends for the participating countries and states in the case studies. In the EU ETS, while all countries exhibited a downward trend in their emissions these emission reductions varied from between 0.01 per cent and 31.34 per cent. In the RGGI the emissions of five participating states declined while the emissions of the other five states increased. This paper indicates an overall RGGI emission reduction of 0.8% over the first control period. The force behind these divergent trends has not been explained in the research.

Complementary emission abatement policy remains an area of importance given the uncertainties attached to the future of GHG emissions trading in its own right. In some cases complementary policies may introduce constraints in terms of what are the most cost effective options to reduce emissions. Some popular but less effective complementary policies may introduce perverse outcomes toward more cost effective options for reducing emissions. Ongoing research would be helpful to determine how complementary policies can best enhance the efficient operation of a trading program.

The data used for the research on the EU ETS has been impacted by a period of economic uncertainty that resulted from the global financial crisis (GFC) that took effect in 2008. The trends of emissions covered by the EU ETS appear to have been

shaped by the external forces of the GFC. The effect that the GFC has had on emissions intensity has been observed but is not well understood by this researcher. As there is only limited academic research available in the prior literature on aspects of this link. A deeper understanding of this important element was not within the scope of the current research. This limitation to the research, i.e. the impact of broader economic trends, leads to another direction for further research.

Acknowledgement

I am grateful to my principal doctoral supervisor Professor Peter Sheehan and also Margarita Kumnick both from the Victoria Institute of Strategic Economic Studies at Victoria University, for their helpful comments on the earlier versions of this paper. As well additional comments from an anonymous reviewer have been considered in the current version. Any errors or omissions are my own.

References

Beder, S. 1999. Emissions trading - a vehicle for achieving greenhouse targets. *Engineers Australia*, August 1999, pp. 28-29.

Burtraw, D., Evans, D., Krupnick, A., Palmer, K., Toth, R. 2005. Economics of pollution trading for SO_2 and NOx. Discussion paper, Resources for the Future. Washington D.C.

Carlson, A. 2012. Designing effective climate policy: Cap-and-Trade and Complementary Policies. Harvard Journal on Legislation. Vol. 49. pp. 208-248.

Coase, R. H. 1960. The problem of social cost, The Journal of law & Economics, Volume III, pp. 1-44.

Ellerman, D.A., Joskow, P.L., Schamalensee, R., Montero, J.P., Bailey, E.M. 2000. *Markets for Clean Air: The U.S. Acid Rain Program*. Cambridge University Press. Cambridge U.K.

Ellerman, D., Joskow, P., Harrison, D. 2003. Emissions Trading in the U.S. Experience, Lessons, and Considerations for Greenhouse Gases. Policy paper, Pew Centre on Global Climate Change. Arlington VA.

Ellerman, D. 2011. The European Union Emissions Trading System: Dead End or Path to the Future? A speech from the MIT Joint Program on the Science and Policy of Global Change. Accessed 19th November 2103 @ http://globalchange.mit.edu/news-events/communications/11.

Garnaut, R. 2008. Garnaut Climate change review draft report June 2008, Accessed @http://www.garnautreview.org.au/CA25734E0016A131/pages/about on 5th July 2008.

Goulder, L., 2013. Markets for Pollution Allowances: What Are the (New) Lessons. Journal of Economic Perspectives. Volume 27, Number 1. Winter 2013. pp. 87–102.

Grubb, M. 1990. The Greenhouse Effect: Negotiating Targets. International Affairs (Royal Institute of International Affairs 1944), Vol. 66, No. 1(Jan., 1990), pp.67-89.

Hahn, R., W, Hester, G. 1989. Marketable Permits; Lessons for Theory and Practice, Ecology law quarterly. Accessed @ www.heinonline.org on 12th June 2008.

McKibbin, W.P., Wilcoxen, P.J. 1997. A Better Way to Slow Global Climate Change, Brookings. Policy Brief no 17, June, The Brookings Institution, Washington D.C.

McKibbin, W.J., Shackleton, R., Wilcoxen, P, J. 1999.What to expect from an international system of tradable permits for carbon emissions. *Resource and Energy Economics*. Vol. 21, Issues 3-4 August 1999, pp. 319-346.

McKibbin, W.J., Wilcoxen, P.J. 2002. The role of economics in climate change policy, *Journal of Economic Perspectives*, Vol. 16, No. 2, pp. 107-129.

McKibbin, W.J., Morris, A., Wilcoxen P.J. 2009. A Copenhagen Collar: Achieving comparable effort through carbon price agreements, Paper: Recommendations from the 2009 Brookings Blum Roundtable.

McKitrick, R. 1999. A derivation of the marginal abatement cost curve. *Journal of Environmental Economics and Management*, 37, pp. 306-314.

NETT, 2007, National Emissions Trading Taskforce, Possible design for a national GHG emissions trading scheme: Final framework report on scheme design, (prepared for ongoing consideration by the Garnaut Climate Change Review).

Nordhaus, W. 1991. To Slow or Not to Slow: The Economics of The Greenhouse Effect, *The Economic Journal*, Vol. 101, No. 407. pp. 920-937.

Nordhaus, W. 1993, Reflections on the economics of climate change. *The Journal of Economic Perspectives*. Vol. 7, No.4. pp. 11-25.

Pearce, D. 2003. The social cost of carbon and its policy implications. *Oxford Review of Economic Policy*, Vol. 19, No. 3.

Pezzey, J.C.V. Jotzo, F. 2012. Tax-versus-trading and efficient revenue recycling as issues for GHG abatement, *Journal of Environmental Economics and Management* Vol. 64(2), pp. 230-236.

Plumb, M., Davis, K. 2010. *Developments in Utilities Prices*. Reserve Bank of Australia Bulletin, December quarter, 2010.

Productivity Commission. 2008. (Aust) What role for policies to supplement an emissions trading scheme? Productivity Commission Submission to the Garnaut Climate Change Review.

Schmalensee, R., Stavins, R., 2013. The SO_2 allowance trading system: The ironic history of a grand policy experiment. *Journal of Economic Perspectives.* Vol. 27, No. 1. Winter 2013. pp. 103-122.

Shergold, P. 2007. Report of the Task Group on Emissions Trading, Australian Government, Prime Ministerial Task Group on Emissions Trading, Canberra, ACT.

Stavins, R., 1995. Transaction costs and tradeable permits. *Journal of Environmental Economics and Management*, Vol.29, pp133-148.

Stavins, R. 1998. What can we learn from the grand policy experiment? Lessons from SO_2 Allowance Trading. *The Journal of Economic Perspectives*, Vol. 12, No. 3, pp. 69-88.

Tietenberg, T., Grubb, M., Michaelowa, A., Swift, B., Zhang, Z, X. 1998. International rules for GHG emissions trading. Defining the principles, modalities, rules and guidelines for verification, reporting and accountability. Special report United Nations Conference on Trade and Development (UNCTAD/GDS/GFSB/Misc. 6,) United Nations. Geneva.

Tietenberg, T. H. 2006. *Emissions Trading: Principles and Practice*. 2nd Edn. Resources for the Future, Inc. Washington DC.

US EPA. 2010. Special report. Climate Change Indicators in the United States. Accessed at www.epa.gov/climatechange/science/overview.html, on 29th November 2013

Vesterdal, M., Svendsen, G.T. 2004. How should GHG permits be allocated in the EU? Energy Policy, Vol. 32, No. 8. pp. 961-968.