

The Trend of Greenhouse Gas Emission for Japan Large Emitting Industries under Kyoto Protocol

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Abstract. In the recent years, Global Warming has become an increasingly popular topic in our society. Reduction of Greenhouse gas (GHG) emission and the speed of global warming are important issue that will affect the entire human race. The Kyoto Protocol has helped many countries to establish their own GHG emission reduction target, but has failed to help the participating countries to devise an appropriate allocation plan. This paper looks at the trend in Japan's GHG emission as well as examines its major contributors. Based on the historical performance; reduction target and Grandfathering method, the allocation of emission allowance among the high emitting industries was determined. According to the calculation results, the Cement Industry was on track and is expected to keep its emission generation level within the allocation cap under the first commitment period of the Kyoto Protocol. The Iron & Steel; Chemical and Paper & Pulp Industries will require extra measures in order to keep their emission level under the allocation cap.

Keywords: Greenhouse Gas (GHG) emission, Emission allowance allocation, Kyoto Protocol

1. Introduction

The Kyoto Protocol was established in December 1997 and entered into force in February 2005. Under the Protocol, participating countries are required to set up and follow their own GHG emission reduction target. The Kyoto Protocol, however, does not provide specific guidance to the participating countries on the allocation of its target to different sector/industry. Consequently, without allocating the appropriate target for each sector/industry, many countries relied heavily on each sector/industry to set up their own reduction target. This often caused the actual reduction performance as a whole to deviate from the established reduction target. This situation has also occurred in Japan. Under the Kyoto Protocol, Japan has made a commitment to reduce its emission level by 6% compared to its 1990 emission level. But until now, a clear allocation plan of emission allowance still remains undefined.

In this study, we began by identifying the high greenhouse gas emitting industry in Japan. Then we allocated target emission allowances to these high emitting industries under the Kyoto Protocol period based on their historical performance and the proposed reduction target/policy. In the conclusion, we analysed the trends and necessary actions that need to be taken by these high emitting industries and compared their current emission generation to their allocation targets.

2. Background

2.1. Trends in Japan's GHG emission

In 2008, Japan's GHG emission was 1282 million tons (CO₂ equivalent), representing a 6.2% increase in comparison to the 1990 level (base year of the Kyoto Protocol). This is a 12.2% gap compared to the 6% reduction target prescribed under the first commitment period of the Kyoto Protocol. Among the 6 different

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gases classified as GHG emission, Carbon dioxide was dominant and contributed on average 94% of Japanese GHG emission total during 1990-2008. This percentage has increased from 91% in 1990 to 95% at the end of year 2008. This is likely to continue to grow in the future [1,2]. Since CO₂ gas was dominant, most of the reduction policy/activity was targeting on CO₂ emission reduction. This concept was also applied to our research. Therefore, we focused on CO₂ gas under Japan's GHG emission reduction program.

According to the historical emission data, it was shown that in Japan the energy conversion was the largest emitting sector followed by industrial sector. The total amount emission generated by these two sectors contributed to around 65% of Japan national emission total from 1990-2008. The other 35% is attributed to the transportation; commercial and residential sector. The historical emission performance data also indicated that the Iron & Steel, Chemical, Paper & Pulp and Cement were the top four largest emitters in Japan's industrial sector. These top four emitting industries contributed nearly 62% of the industrial sector's total emission amount during 1990-2008 [1,2]. Usually the emission generated by the industrial sector has been much more controllable and less controversial to the general public than the other sectors. Based on this characteristic, many countries have targeted the industrial sector first in their emission reduction program. In this paper, we also targeted the industrial sector and analysed the necessary actions that need to be taken by them in order to keep their emission levels within the reduction target under the first commitment period of the Kyoto Protocol.

2.2. Kyoto Protocol Target Achievement Plan

Under the Kyoto Protocol, Japan has a commitment to reduce its GHG emission level by 6% compared to its 1990 level. In order to achieve this target, the Japanese Government has proposed the action plan named "Outline for Promotion of Efforts to Prevent Global Warming" in 1998. Under this action plan, the Japanese Government has specified the necessary emission reduction action/target for each Japanese sector that needs to be taken in order to achieve the 6% target. In February 2005, the Japanese Government changed the name of this action plan to the "Kyoto Protocol Target Achievement Plan". Although the name has been changed, its contents are still exactly the same as before. Since the establishment of Target Achievement Plan in 1998, the Japanese Government has so far made three major revisions. The latest revision was started in November 2006. After nearly one and half year of reviews and discussions, the final revision was announced on February 2008. In this latest revision, the Plan indicated that Japan's amount of GHG emission reduction will be short by 20 to 34 million tons CO₂ equivalent from its Protocol's target. However, the Kyoto Protocol target can be achieved if each sector takes additional measures to cut its current emission level [2,3]. These additional measures were included in the latest revision, but mostly were voluntary action which depended on eco-consciousness of the citizens. Therefore, although Japan may be able to achieve the Kyoto Protocol target under the Target Achievement Plan, it still remains uncertain when the real market behaviour is taken into consideration.

Another main feature of the Target Achievement Plan was focus on the emission reduction of the industry sector. Due to economic growth, the GHG emission from the commercial; residential and transportation sector have been increasing rapidly since the early 1990's. Furthermore, emission generated by these sectors usually has been considered difficult to control, as it is mostly dependent on human activity. Therefore, most of countries did not include these sectors when considering their emission reduction program. On the other hand, the control of emission generated by energy conversion and the industrial sector could be performed more easily, and is less controversial to the general public. This makes it ideal for the government to design its emission reduction program around these two sectors. This situation has also occurred in Japan, large proportion of the emission reduction target relied on the industrial sector. According the latest revision of the Kyoto Protocol Target Achievement Plan, Japanese industrial sector was required to reduce 11.3%-12.1% of the 1990 emission level under the Kyoto Protocol period. On the other hand, the commercial; residential and transportation sector was allowed to increase its emission level by 26.5%-27.9%; 8.5%-10.9% and 10.3%-11.9% respectively [2,3].

In this research, we have calculated the allocation of emission allowance for each of the high emitting industry in Japan. The calculation was based on the emission reduction target proposed under the Kyoto Protocol Target Achievement Plan.

2.3. Grandfathering Rule Approach

Historic grandfathering rule is a simple and straightforward allocation method that utilizes the historical performance data to produce a best estimate for the allocation of GHG emission reduction allowance. This type of free allocation method was popular and has been welcomed by most of general public. Many of the European countries chose this approach to allocate its emission allowance. We have also applied this allocation method in our study to determine the allowance allocation among the high emitting industries in Japan under the first commitment of the Kyoto Protocol.

In our study, grandfathering allocation method allowed each regulated entity to receive a share of the total GHG emission allowance. This is equivalent to its share of total emissions from all regulated entities in a defined baseline year. In another word, the emission allowance allocated to a particular entity is equal to the emission of that particular regulated entity in the baseline year multiplied by the ratio of the emissions cap to total emissions in the baseline year. The formula is as followed:

$$EA(i) = BS(i) \times CF(i)$$

$$CF(i) = AT / BST$$

Where:

AT: Emission allowance total

EA(i): Allocation of emission allowance for regulated entity i

BS(i): Baseline year emission for regulated entity i

BST: Summation of baseline year emission for all regulated entities

CF(i): Correction Factor, which to make sure the summation from all entity's allocation is equal to the overall emission allowance total

The above formulae have shown that, the grandfathering allocation method distributes the emission allowance for each regulated entity from the historical performance. For example, if entity A generated 10 units GHG emission in the baseline year, then 10 units emission allowance will be allocated to this entity accordingly. However, due to the economic cycle, a particular baseline year data may not be the true representation of the overall performance for a particular entity in the past. We have adjusted the baseline year value by taking the average value of a selected time period. Compared to the data selected from a particular year, this better captured the overall condition.

3. Result & Discussion

In this research, we took the average value of the 2000-2004 emission data to represent the baseline year. This value is used in the grandfathering allocation method to distribute the emission allowance among the four highest emitting industries in Japan (which mentioned in previous section 2.1). In addition, we have assumed these four industries would take full responsibility on the reduction target (11.3-12.1%) of the industrial sector's commitment under the Kyoto Protocol Target Achievement Plan. We have also assumed the emission level from all other industries will remain constant (based on the 2008 performance) until the end of year 2012.

By applying the grandfathering allocation method as described in section 2.3, we have calculated the emission allocation for each of these four large emitting industries under the first commitment period of the Kyoto Protocol. According to the calculation result, the indirect CO₂ emission allowance under the first commitment period of Kyoto Protocol for the Iron & Steel; Chemical; Paper& Pump and Cement industries were 144.01; 50.88; 26.39 and 32.68mt respectively. The detailed results are given in Fig.1 to Fig.4. below

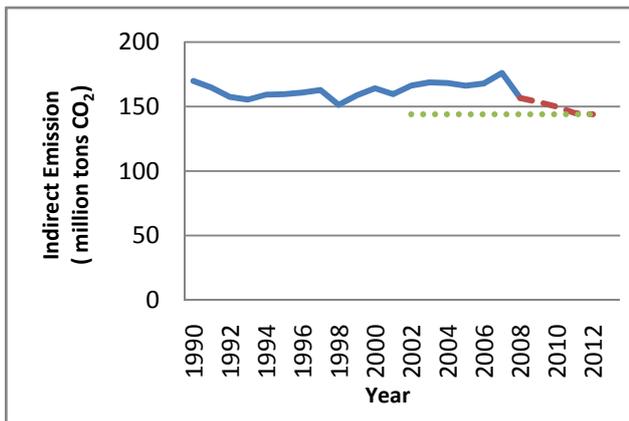


Fig. 1: Emission trend of the Iron & Steel Industry

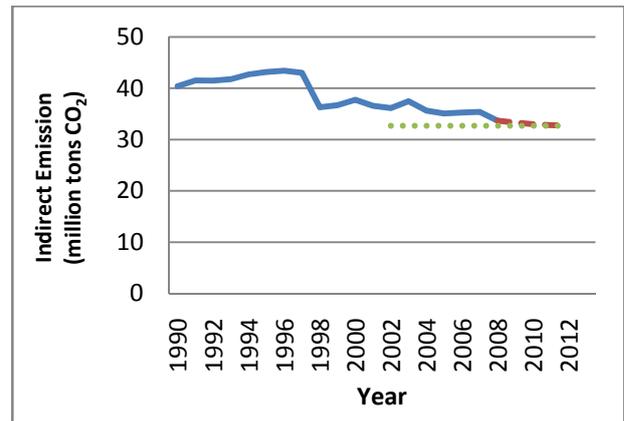


Fig. 3: Emission trend of the Cement Industry

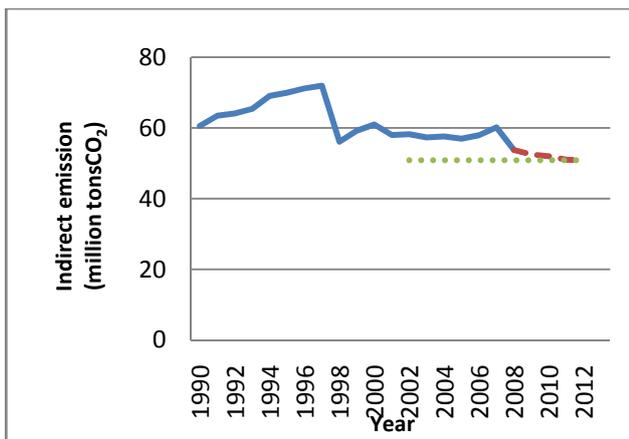


Fig.2: Emission trend of the Chemical Industry

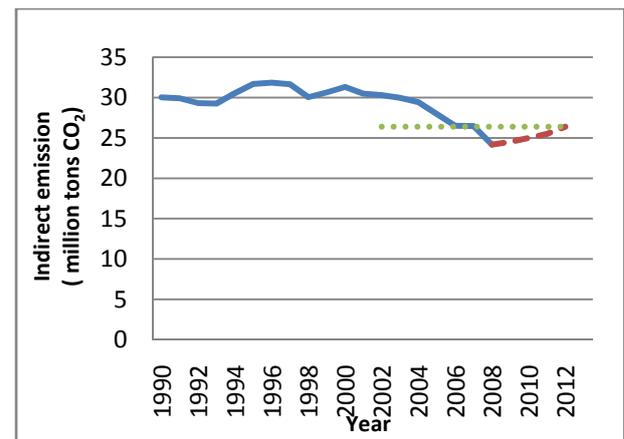


Fig.4: Emission trend of the Paper & Pulp Industry

— Actual emission - - - Forecast trend Allocation result

In Fig.5, we calculated the difference between the allocation result and the actual 2008 emission level for each of the main emitting industry in Japan. The result indicated the allowance allocation for the Paper & Pulp and Cement industries were higher than their year 2008 actual emission generation. In another word, these two industries would be allowed to generate more emission than their 2008 level under the Kyoto Protocol period. Conversely, the Iron & Steel and Chemical industries would be required to reduce 8.7% and 5.7% based on their 2008 emission level in order to keep their emission generation level under the allocation cap. Due to economic recession in 2008, Japanese industry has suffered seriously. Therefore, the 2008 emission level may not be an accurate representation of the true performance in the past. Based on this consideration, we have compared the allocation result to the 2007 emission level. When we compared the result to the 2007 emission level, the gaps have become larger for all industries. The surplus allowance for the Paper and Cement industries when compared to 2008 emission data have become deficit when compared to 2007 level. This result indicated that all of four large Japanese emitting industries would be required to take extra measures on emission reduction to keep the emission level under the allocation cap.

Industry	Allocation result in Year 2012 (million tons CO ₂)	2008 indirect emission data (million tons CO ₂)	2007 indirect emission data (million tons CO ₂)
Iron & Steel	144.01	156.64	176.06
Chemical	50.88	53.75	60.15
Paper & Pulp	26.39	24.17	26.47
Cement	32.68	34.08	35.98

Fig. 5: Allocation result and 2008&2007 indirect emission data for four large emitting industries in Japan

In this research we have forecast the emission generation in 2012 for each Japanese emitting industry. The forecast was based on the forecasting production value and the proposed reduction target/scheme under the Kyoto Protocol Target Achievement Plan [4]. According to the calculation result, the Iron & Steel; Chemical; Paper & Pulp and Cement industry will expect to generate 154.59; 64.45; 24.42 and 29.65mt of indirect CO₂ emission respectively at the end of year 2012. When comparing the forecast to the allocation results derived earlier, the Iron & Steel and Chemical industries are expected to generate more emission than their allocated amount at the end of year 2012. This implied that, these two industries would be required to take additional measures now to keep their emission generation level under the allocation cap during the Kyoto Protocol period.

Industry	Allocation result in year 2012 (million tons CO ₂)	Forecasting indirect emission in year 2012 (million tons CO ₂)
Iron & Steel	144.01	154.59
Chemical	50.88	64.45
Paper & Pulp	26.39	24.42
Cement	32.68	29.65

Fig. 6: Allocation and forecasting indirect emission generation result for four large Japanese emitting industries in year 2012

4. Conclusion & Future Work

In this research, we began by analysing the emission trends and then identified the high emitting industries in Japan. We then allocated the emission allowance to the four largest Japanese emitting industries under the Kyoto Protocol period based on their respective historical performance and the proposed reduction target/scheme. According to the calculation results, the Cement industry is on track and expects to keep its emission generation level within the allocation cap established under the first commitment period of the Kyoto Protocol. On the other hand, the Iron & Steel; Chemical and Paper & Pulp industries will be required to take additional measures in order to keep their emission level under the allocation cap. In this research, we applied the grandfathering rule approach to allocate the emission allowance. This type of allocation method was simple and straightforward but it does come with some drawbacks. For example, this type of allocation mechanism only considers “Historical Performance” and not the “Historical effort”. This may created an unfair allocation between each sector and industry. Therefore, in the future study, a further analysis would be required to address this particular issue in more detail.

5. References

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