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POTENTIALITIES OF CARBON EMISSION MARKET & ASSOCIATED COSTS TO RELATED INDUSTRY: A STUDY IN THE LIGHT OF KIGALI AMENDMENT, 2016

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ABSTRACT

Montreal Protocol in 1987 came up with a target of shrinking ozone hole by banning ozone-depleting coolants like chlorofluorocarbons (CFCs) giving birth to a new genre of international market known as Carbon Emission Trading. With a successful implication of reducing the production and consumption of compounds that deplete ozone in the stratosphere Montreal Protocol was an effective step towards environmental sustainability. But in replacement to CFCs with Hydro fluorocarbons (HFCs) gave birth to a new threat to global atmosphere of accelerating global warming. Kigali Agreement on October, 2016 amends the 1987 Montreal Protocol aims to phase out Hydro fluorocarbons (HFCs), a family of potent greenhouse gases by the late 2040s. Against this backdrop, the present study shows the industrial uses and the potential of refrigerants in Asian markets and its associated costs at the outset of present carbon emission market. 79% of the HFC emission is generated in refrigerant industry, which depicts the immediate need of substitutes in this industry. The Global Warming Potential (GWP) of HFC is much higher than all other threats to global warming. With regulated and supportive gestures by all the countries Kigali amendment is expected to mitigate the increasing threat of global warming and to maintain the sustainability of the environment.

Keywords: CFC; HFC; GWP; Kigali Amendment.

Introduction

16th September 1987 major countries came together to fight the consequences that were being faced due to use of substances that were depleting ozone layer in the stratosphere. Steps towards regulating and abolishing the production and consumption of harmful gases like chlorofluorocarbon,halons, carbon tetrachloride, and methyl chloroform were to be phased out within the year 2000 (2005 for methyl chloroform). Scientific theory and evidence proved that use of these gases depleted the stratospheric ozone layer which protects us from harmful ultraviolet light called UVB which causes many harmful effects like skin cancer, cataracts, harm to plants and marine life also. The ozone layer absorbs the required portion of radiation from the sun and reflects the harmful portion back. For over 50 years CFC's were considered to be a miracle substance but in late 1970's researchers investigated the reason for climatic changes and found CFC to be the primary reason for ozone depletion. It isnow statistically proven that conditions of the ozone layer is improving as the use of CFC has been completely phased out with a substitute known as hydro fluorocarbon but this was not a solution rather gave birth to a new global situation of global warming. HFCs are a family of greenhouse gases that are largely used as refrigerants in home, car air-conditioners and air sprays etc. These are artificial factory made gases which replaced CFCs under the 1987 Montreal Protocol to protect Earth's fragile protective Ozone layer and heal the ozone hole over the Antarctica.The global warming potential of hydro fluorocarbon is much higher than other gases which are considered to play a role in global warming. Within few years of its use hydro fluorocarbon has already started to show its impact so the need of a revolutionary step was felt. A historic global climate deal was signed in Kigali, Rwanda at the Twenty-Eighth Meeting of the Parties to the Montreal Protocol on Substances that deplete the Ozone Layer. The Kigali Amendment amends the 1987 Montreal Protocol which aims to phase out Hydro fluorocarbons (HFCs), a family of potent greenhouse gases by the late 2040s. Under Kigali Amendment, in all 197 countries, including India have agreed to a timeline to reduce the use of HFCs by roughly 85% of their baselines by 2045.

All signatory countries have been divided into three groups with different timelines to go about reductions of HFCs.

- First group: These groups include developed countries like US and those in European Union (EU). These countries will freeze production and consumption of HFCs by 2018. They will reduce them to about 15% of 2012 levels by 2036.
- Second group: Includes countries like China, Brazil and all of Africa etc. They will freeze HFC use by 2024 and cut it to 20% of 2021 levels by 2045.

- Third group: Countries like India, Pakistan, Pakistan, Iran, Saudi Arabia etc. will be freezing HFC use by 2028 and reducing it to about 15% of 2025 levels by 2047.

Review of literature

Solomon et al. (1991) concluded that emission rights of every country would be allocated according to emissions per purchasing power adjusted GDP index and will channelize the flows of development capital in a global emissions trading programme or from the World Bank's Global Environmental Facility (GEF).

CorfeeMorlot et al. (2003) integrating scientific information are required for long term capital policy, along with socio - economic assessments and ethical judgments. Short-term decisions that create political, economic, and social constituencies will accelerate towards better future and enhance the capacity to achieve long term capital goals.

Tang Ling et al. (2015) stated that Carbon Emissions Trading (CET) will result in lower carbon emissions, higher carbon price has an adverse effect on GDP and impact on carbon emissions follows an inverted U-shape, suggesting that carbon price should be estimated carefully, penalty rate also hinders the econtomy and must be kept within estimates.

Xu Zhang et al. (2015) studied the emergence of multi-region emissions trading system will maximise the allocation of emissions space and reduce the carbon abatement cost regionally and substantially adverse impact on energy intensive industries in China. Involvement in the multi-region emissions trading system, allowance of emission will become more limited, and finally result in the promotion of energy efficiency, with effect of decline of fossil energy consumption and the development of clean energy in China.

Objective of the study

- Analysing the effect of HFC in respect of global warming and their potentials till the year 2050.
- Alternatives that is available for substituting HFC in respect to their properties and global warming potentials.
- Evaluating the scenario of carbon trading and the impact over past few years.
- Judging the future perspective of Kigali amendment of phasing out HFC by late 2040's.

Data analysis

Kyoto protocol and carbon trading

In the year 1997, 185 countries of the world signed a treaty regarding reduction of emissions of greenhouse gases in the atmosphere. This treaty is known as the Kyoto Protocol. It was developed under UNFCCC- the United Nations Framework Convention on Climate Change, all the signatories committed to reduce their emission of not only carbon di oxide but also other greenhouse gases like methane (CH4), Nitrous oxide (N2O), hydro fluorocarbon (HFC), Per fluorocarbon (PFC), Sulphur hexafluoride (SF6). But a commercial view was attached to the emission control as if the signatory country emits more than prescribed amount then they are required to engage in emission trading also known as carbon trading. Countries can exchange units of carbon in respect to money as they are emitting less than their prescribed emission and countries emitting more than prescribed amount is benefitted by buying the required amount of carbon emission. Developing countries are given a relaxation as they have emerging industries and potentials. Kyoto protocol was well intended but there are no signs of reduction in CO2, in fact the CO2 levels are increasing eventually. Considering the trend that history shows there is no visible effect of Kyoto protocol this is why the need of Kigali amendment was felt and a complete elimination of HFC were proposed.

Chart#1: Global land ocean temperature index.

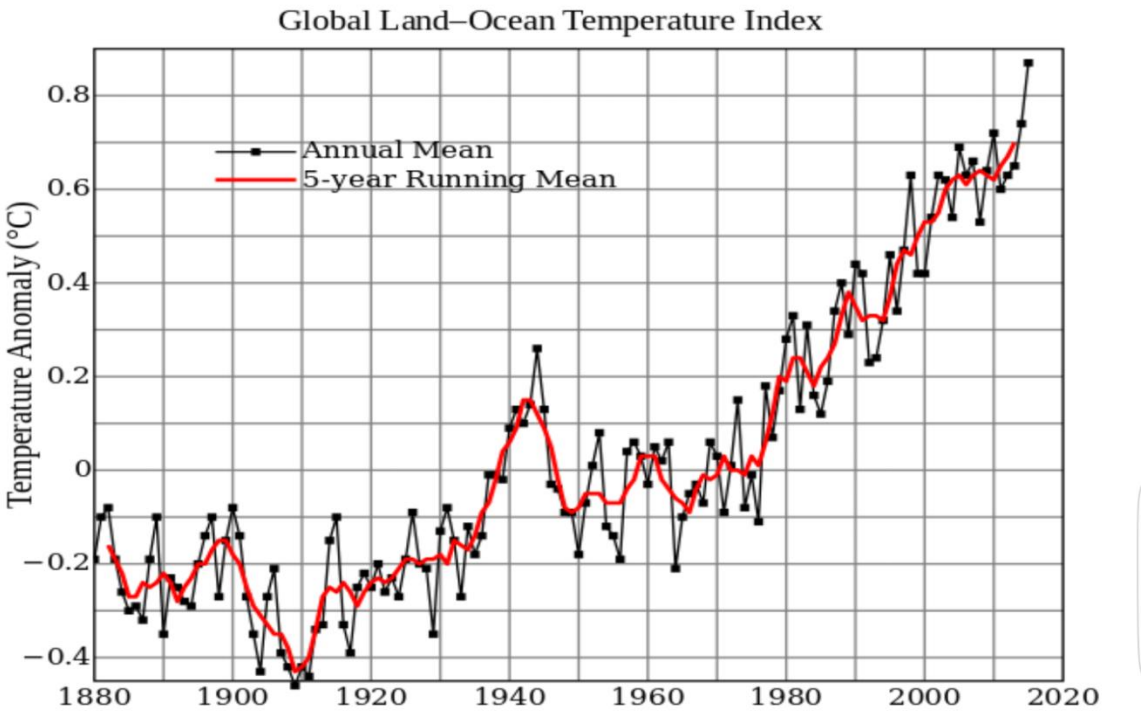


Chart 1 is a line graph representation to show the effect of annual mean temperature in Celsius throughout the years from 1880 to 2020. The fact is represented in this chart which depicts the annual increase in temperature. This is further represented in the tables below which compare the data between 2011 and 2014.

Table#1: Emission comparison of 2011 to 2014.

Country	% Emission of 2011	% Emission of 2014	Net increase or decrease
China	27	29.55	2.55
United States	17	14.95	-2.05
India	5	6.56	1.56
Russia	5	4.95	-0.05
Japan	4	3.58	-0.42

Percentage of emission as of 2011 and 2014 of major countries those are responsible for emitting GHG. United States and Russia have decreased their emission by 2.10% combined. But other major countries have increased their emission as of 2014.

Table#2: Comparison of emission per capita of 2011 to 2014.

Country	Emission per capita 2011	Emission per capita 2014	Net increase or decrease
China	6.52	7.6	1.08
United States	17.62	16.5	-1.12
India	1.45	1.8	0.35
Russia	12.55	12.4	-0.15
Japan	9.26	10.1	0.84

Table 2 represents per capita emission of top 5 countries responsible for emitting greenhouse gases are China, United States, India, Russia, and Japan. A similar trend is noticed as United States and Russia decreased their GHG emission so their Per capita emission also decreased. But other three countries emitted more than 2011 so their per capita emission also increased. China topped the list with an increase of 1.08 per capita emissions.

HFC's and its potentials

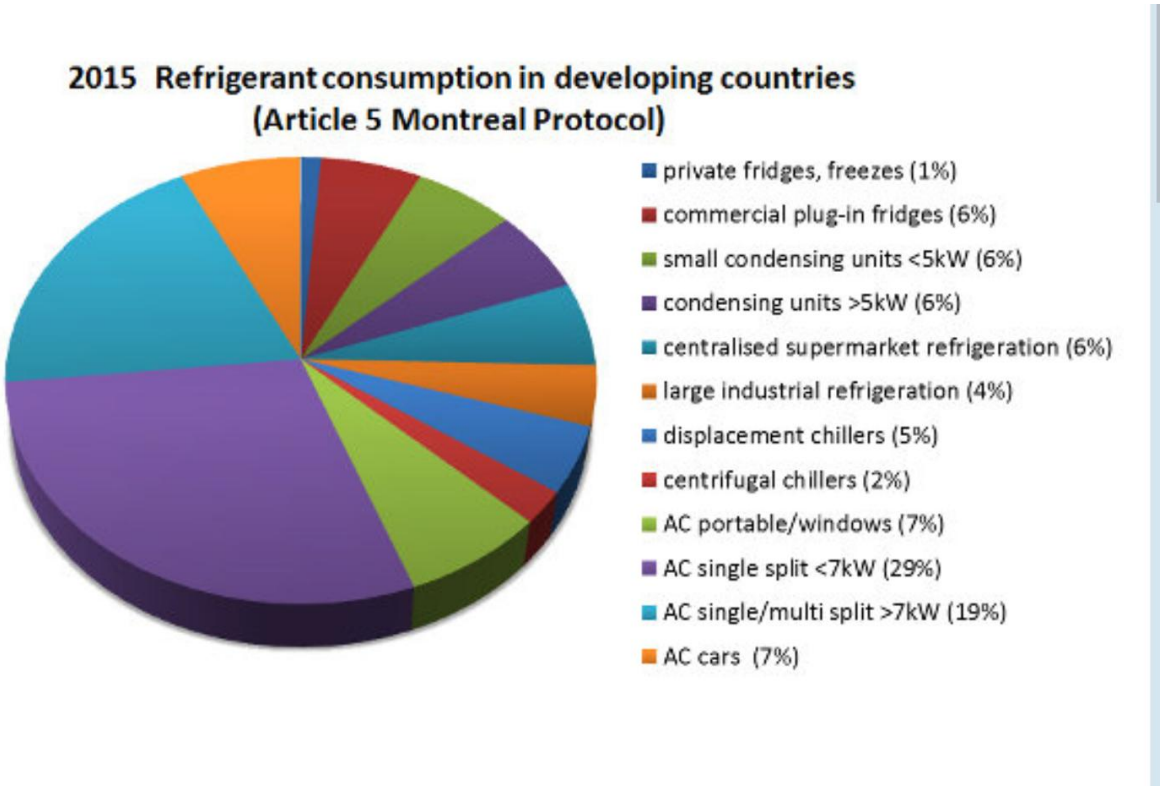
Analysing the use of HFC represents the industries that are affecting the atmosphere through the use of HFC's. Of which the refrigeration and air conditioning industry uses 79% of the total HFC and also contributes the same amount of harm to the environment in emitting HFC. The remaining 21% is being used by other consolidated industries like foams, Aerosols and others. A whopping 11% of these gases are being used by Foam industry.

Table#3: HFC usage.

HFCuse	Percentage
Refrigeration and air-conditioning	79%
Foams	11%
Aerosols	5%
Other (fire protection, solvents, etc.)	5%

Source: HFCs: A Critical Link in Protecting Climate and the Ozone Layer (2011), United Nations Environment Program.

Chart#2: Refrigerant consumption in developing countries.



Source: https://ec.europa.eu/clima/policies/f-gas/alternatives_en

The consumption pattern of the developing countries in respect to refrigerant consumption in 2015 depicts the classification of uses by household and industry separately. Households consume only 1% of total refrigerant use and the remaining 35% is being used for commercial purposes. In case of air conditioning households are using 36% of the total consumption 19% are being used in commercial purposes whereas 7% of the total air conditioner consumption is being used by commercial and private use cars. This study represents the spread of uses made by different sectors and it also represents the outflow of HFC's as per consumptions.

Greenhouse gases are known for its global warming but there are few gases with a high global warming potential. Global warming potential is a measure that represents the gases included in Greenhouse gases and their potential to affect the world as these gases contribute towards global warming by increasing the Earth's average surface temperature by trapping heat which wouldotherwise escape from Earth. Table 4 represents the GWP of various Greenhouse gases and recognises the harm that is being made to the society as a whole. Hydrofluoric carbon is one of the most dangerous gases in context to other green-house gases. HFC-23 which is used in industrial refrigeration is considered to be the most effective gas as its global warming potential is 11700 which is more than 2 times of other CFC's which is to be eliminated by India within 2030.

Table#4: GWP of Greenhouse gases.

Gas		**GWP**
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydro fluorocarbons (HFCs)	HFC-23	11,700
	HFC- 32	650
	HFC-125	2,800
	HFC-134a	1,300
	HFC-143a	3,800
	HFC-152a	140
	HFC-227ea	2,900
	HFS-236fa	6,300
	HFC-4310mee	1,300

Per fluorocarbons (PFCs)	CF_4 C_2F_6 C_4F_{10} C_6F_{14}	6,500 9,200 7,000 7,400
Sulfur hexafluoride	SF_6	23,900

Source: steadystaterevolution.org/addressing-global-climate-change/

Considering the alternatives of HFC's there are ample amount of options that substitutes the use of HFC. Kigali amendment promises to eliminate the use of HFC's by late 2040 and is accepted by all the countries so an alternative is compulsion for smooth flow of these industries. Table 5 highlights the available options that can be considered as per availability and requirement of industry. Considering these alternatives in respect to their properties and commercial availability with a simultaneous interest in GWP can help in maintaining the environmental balance and sustainable flow of business.

Table#5: Alternatives to HFC.

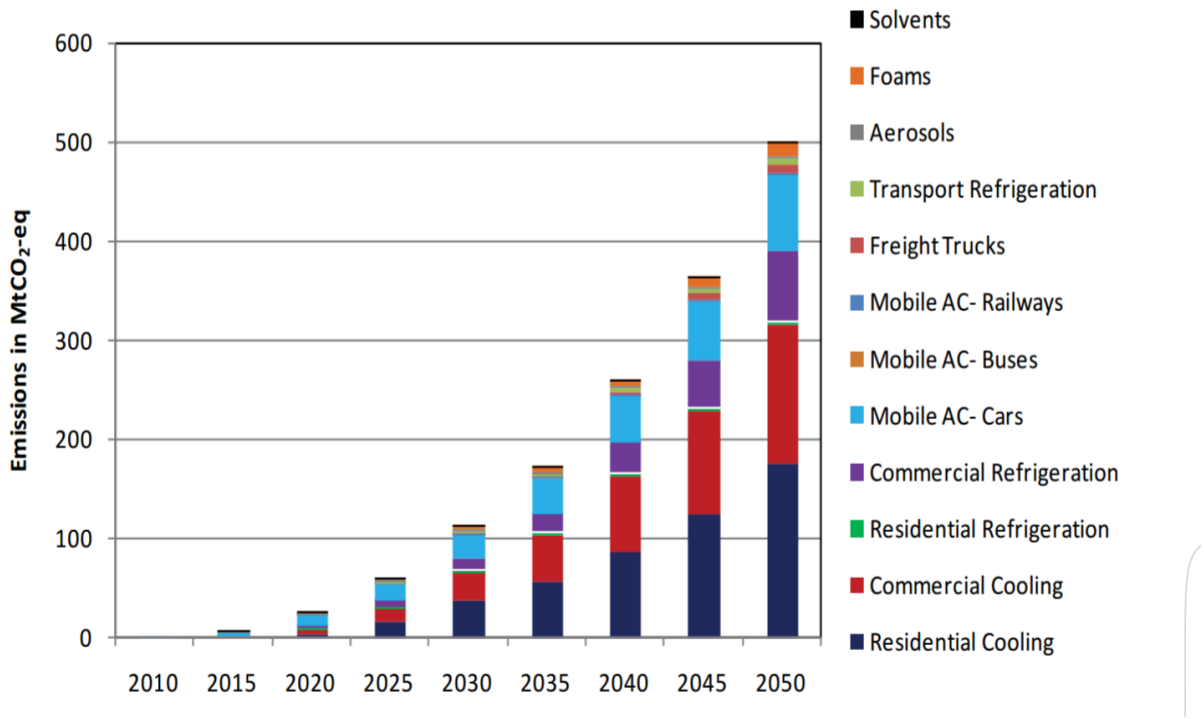
Alternative	**Global Warming Potential (GWP)**	**Properties to be addressed**	**Commercial availability**
Hydrocarbons	3-5	Flammable	Immediate
CO_2 (R744)	1	High pressure	Immediate
Ammonia (NH3, R717)	1	Toxic	Immediate
Water (R718)	1	No risks	Immediate
R32 (an HFC)	675	Mildly flammable	Immediate
HFOs	4-9	Mildly flammable	Immediate/Short-term
R32-HFO blends	200-400	Mildly flammable	Mid-term

Source: https://ec.europa.eu/clima/policies/f-gas/alternatives_en

All these alternatives come with risk which is to be taken for reduction other immediate risks. CO2, Ammonia and Water have a GWP of 1 which shows the hell and heaven difference of current HFC and future perspectives. Chart 3 depicts the requirement for Kigali amendment, as the future would have been warmer if steps were not taken for HFC elimination. Pollution potential by 2050 would scare the world and leave us with no option to change it for better future. The consolidated bar diagram in chart 2 shows the emissions which is measured in

metric CO2 and their pollution that was to be emitted if not amended. Residential and commercial cooling would have emitted more than 300 metric ton of CO2 on the other perspective ac cars and buses would have emitted 100 metric ton of CO2 within 2050. A gradual increase of 10-20% is noticed in every five years. The study emphasises on the requirement to phase out HFC's as an immediate task for the world.

Chart#3: Estimated emissions till 2050.



Source: https://ceew.in/newsDetails.php?id=327

Summary of findings

The study represents the use of HFC's by different industries and the harm that is being made by these industries. The cooling industry needed an alternative after CFC's were phased out by Montreal protocol so HFC's emerged as a substitute but came with a cost of global warming. These gases had a global warming potential of more than two times in respect to other green-house gases.Refrigeration and air conditioning industry uses 79% of the total HFC and also contributes the same amount of harm to the environment in emitting HFC. The remaining 21% is being used by other consolidated industries like foams, Aerosols and others.Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride are the gases with maximum global warming potential. Alternatives to HFC's are available but depend upon the industry and its requirement. Kyoto protocol was intended to reduce green-house gases but inclusion of carbon trading increased the GHG emissions what is observed in

the analysis of 2011 and 2014. The per capita emission and total emission of top 5 countries responsible for emitting greenhouse gases are China, United States, India, Russia, and Japan. As noticed United States and Russia is able to reduce its emission to some extent but not effective overall.

Limitation of the study

- The study is conducted on secondary data so the accuracy and validity needs to be validated in real field.
- The study is limited to India only and the work is conducted on the basis of availability of data.
- Time is also an important limitation in this study.
- Present study is based on the information's before Kigali amendment.
- A detailed analysis could have been made if costs reports could have been collected.

Conclusion

Kigali amendment is a step towards reducing global warming that is being caused by HFC's. Being a gas with high global warming potential it has already made a difference in temperature in just few years. The availability of alternatives is yet to be adopted but these are strict steps that will be taken through the course of time. Kyoto protocol was adopted to reduce global warming but inclusion of carbon trading made it more complicated and the temperature rise is still being noticed. Decision of phasing out HFC's is rather a better action than restricting its usage. The carbon emission market was created to regulate CO2 emissions a similar market may be formed to regulate HFC's as the use of these gases are depleting the ozone layer in massive scale. Although corrective steps are being taken for sustainable future but the effectiveness is to be judged yet.

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