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Green Manufacturing in Iron & Steel industry to win the Threat of Global Climate Change

Shahzad Ahmad[1], Dr P.Pachauri[2]

Assistant Professor, Department of Mechanical Engineering, Al-Falah University, Faridabad, Haryana, India[1]

Professor, Dept of Mechanical Engineering, Noida Institute of Engineering and Technology Greater Noida, India[2]

Abstract: In this research paper an attempt has been made to look into necessary actions to be taken for meeting global climate change .Green product , green manufacturing and green energy are essential for this purpose .Specific emphasis has been laid on polluting iron and steel industries . Work done in this direction so far has been summarized. Special attention has been drawn to clean energy concept and its urgent requirement. Historic decisions taken by Paris summit December, 2015 have also been included. The climate change problem has been deeply focused and possible solutions have been suggested.

Keywords: Green Manufacturing, Clean Energy, Green products, Challenge of Climate Threat, Sustainable Development in Iron and Steel Sector.

I. INTRODUCTION

Threat from climate change is highly serious and ever growing .None can escape the impact of climate change. Already nature has been giving alarming signals like rising sea level, powerful tornados, failure of crops frequent droughts, excessive rain falls, floods melting ice caps & tsunamis etc. Slackness of the nations world over to postpone the solution of the problem will prove to be miserable and future generations will never excuse us for the irreversible catastrophe by which they will be pushed to a hell.

The iron and steel sector is a massive consumer of coal in particular. This has generated severe environmental problems in the coal mining regions and around the iron and steel plants (Zeng et al.,2009).

It is well known that coal based power plants , iron & steel industries ,chemical industries , oil refineries , transport sector etc have been heavily vomiting poisonous pollutants like CO_2, SO_x, NO_x ,hydrocarbon, arsenic, cyanide , mercury ,soot & other SPM etc .

Above said pollutants have been threatening human life by way of causing Diseases like asthma, heart attack, eye problems, skin problems ,cancer etc. Profit is earned by investors but suffering is borne by the most venerable group of people like children, senior citizens & poor masses without substantial support.

Apart from huge expenditure on treatment of illnesses, men days are lost; the students are unnecessarily put to loss of studies and bad effects of ill health. Besides, many innocent lives are sacrificed on the altar of greed & mismanagement by these rich industrial houses for willfully violating environment protection regulations. Existing power plants are the largest sources of carbon pollution in the world. These pollutants lead to smog, acid rain & produce other secondary pollutants. These substances have been the cause of indoor pollution, outdoor pollution, visible pollution & invisible pollution. In order to get a feel of such emissions from coal based power plants America alone has set a target of reduction of CO_2 at 870 million metric tons at a cost of $54 billion for clean power by 2030.

The literature has emerged that examines various aspects of china's energy consumption (Ma et al., 2010). A subset of this literature has looked at china's iron and steel sector (Ma et al., 2002; Smyth et al., 2011; Wang et al., 2007; Wei et al., 2007; Zhang and Wang, 2008; Zeng et al., 2009).

Currently coal accounts for 75% power production CO_2 emissions in tons of carbon / ton of steel produced are as per best practice 1.4, India's best in Essar steel (DRI) is 1.4. But Tata steel is at 2.7 & Usha Martin 4.2. India is one of the richest sources worth iron ores 9602 million ton of haematite & 4308 magnetite. This can meet our requirement of steel for 10 years. China had been a large supplier of coke & coal. Prices of coal & coke rose so more of iron ore was exported to China for greater exchange funds. Lump-ore of good quality was exported, smuggled to China & Japan. Cast- away- fines was used in India greatly adding to pollution from DRI.

World over number of blast furnaces, basic open hearth furnaces, coke oven plants, sintering plants, chemical factories, and other manufacturing industries are continuously adding the hazardous pollutants. Countries like USA, China, Canada, Japan, Brazil, U.K, India etc. have not done needful to concentrate to find suitable solutions to this yawning dangerous problem.

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II. CLEAN ENERGY/GREEN ENERGY

The need for developing clean, sustainable & secure energy sources is being continuously felt. The economic growth may not be sustained unless reliable clean energy is available at reasonable price continuously. The industrial sector & transport sector are in the dire need of the same.

Reasonable & alternate energy sources like solar energy, wind energy, tidal energy, hydro energy, fuel cell, hydrogen energy, magneto hydrodynamic conversion are some of the possible means to help solve clean energy problem. A lot of funds need to be released by various governments for the purpose. Research in the above fields need to be highly concentrated, cooperation & collaborations are a must in all the countries to get rid of the pollution problems of the current & conventional sources.

Effective energy grids, fully automatic in nature are a must for continuous power supply at cheaper rates to both industrial sector & public sector.

Hydrogen fuel based transport cars, hybrid fuel trucks etc need to be quickly developed by researchers to fight climate change.

Currently more than 3500 varieties of different grades of steels are produced. Per capita consumption of steel in India was 27 kg which is much lower than global average of 120 kg; this is likely going up to 180 kg in 2020.

It is estimated that energy demand alone in steel industry will shoot up to four times.

Indian industries consume more than 50% of commercial energy source. Steel, cement, aluminum, petrochemical, fertilizers, paper & pulp industries consume 65% of total supplies of energy to industrial sector looking to the magnitude of such high energy consumption. Bureau of energy efficiency (BEE) has notified these industries as designated consumers of energy under energy conservation Act.

Now iron & steel industry alone consumes 10 % electricity & 27 % coal. Energy costs reach 20 to 25 % of turnover.

China's CO_2 emissions have increased dramatically over the previous five years (Auffhammer and Carson, 2008; Liu et al., in press), such that China is now the second largest gas emitter in the world (Ma et al., 2009).

China, Japan, America, India, Russia, South Korea, Germany, Ukraine, Italy, etc are major iron and steel producers in the world. These countries are major defaulters on account of producing hazardous pollutants & temperature rise, causing climate change.

Earlier Pig iron was produced by integrated steel plant of SAIL & RINL of late the number of standalone pig iron industries has significantly increased. Direct reduced iron is richer in iron than pig iron, so it is an excellent feed stock to electric furnaces used in mini steel plants.

DRI process uses powered ore avoiding sintering otherwise the same has to be used in blast furnace. DRI process can use natural gas contaminated with inert gases without any problems but pollutants are produced.

Major players from India are Tata steels (TISCO), SAIL, Bhusan power & steel Ltd, Jindal steel & power Ltd, ESSAR steels and others. These companies should greatly contribute towards green energy & green manufacturing objectives.

World crude steel production in 2013 was 1606 MT as per world steel Association (WSA). This growth had been mainly in Asia. There had been 6.6% increase in steel production in China. However in India there had been recovery in property sector and demand for infrastructure is going up after Modi government came to power.

The above information should act as eye opener to the magnitude of energy requirements in various sectors. Besides, if conventional sources of power are permitted to be used than one can guess gigantic contribution of pollutants world over. Therefore, it is exceedingly important that in non-clean energy sources be done away with at fast speed to make the world a healthy place to live.

A. Steps towards Clean Energy

For production of one ton of iron product one needs to 460 cubic meters of natural gas, about 59kg of oil and about 400kwh, electricity, recently most iron & steel organizations use electrical energy in iron & steel industry. The use of electricity has proved economical & leads to reduction of specific energy consumption. Besides, it is less polluting & easy to control operations. However electricity production in turn, if by thermal power plants, pollution from them remains.

Direct reduction plant in LISCO Misurata has used natural gas for steel production. Thermal energy for heating up the plant is created by burning natural gas with air. By cracking the natural gas CO_2 & H_2 are produced. Water vapour and CO_2 are produced by combustion of natural gas. It is a clean & efficient process. However it is not pollution free. However, the pollution effects are not that severe as due to heavy oil.

Solar energy is abundantly available world over. Solar furnaces had been built by France, USA, Germany & Russia for scientific studies. Concentrators, collector & storage devices of the same are the essential components. Researchers have attained temperature of about 3500 degree centigrade in such furnaces. Solar furnaces are clean energy sources. In these furnaces heating is done without contamination no pollutants are produced. Research is greatly needed to create solar energy grids to supply electricity on continuous basis to houses & industries. Solar aero-planes, solar cars, solar house-hold-equipment for heating & lighting purposes should be effectively designed.

Another clean energy source is hydro electricity generators using enormous power of rivers & water falls such sources are absolutely pollution free.

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Wind energy is still another option for generating clean energy. In countries where enough wind flows, use must be made using wind turbine.

Harvesting of waste energy is also a good approach to collect surplus energy and to store it where ever possible.

The authors are of the view that if some device is invented which can tap direct solar energy, store and raise its voltage as per requirements then it will be the best one. Such a research is of top most importance .Such devices will relieve humanity of pollution problems for ever.

If above research seems more time requiring, than at present the last solution to green energy, is making strong non-conventional energy source grid, to meet the energy requirements. May be national/international energy-supply-grids solve clean energy need to a great extent.

B. Cleaner Way to Achieve Electricity from Coal

Researchers at Ohio state university developed a new process '**chemical looping**' to generate electricity having potential to eliminate CO_2 and smog forming NO_x. After successful operation and demonstration on 25 kilowatt test facility, it has been decided that the technology will be implemented on one megawatt plant in collaboration with Babcock Wilcox.

In ordinary coal plants pulverized fine powder is burned in air to produce steam to drive turbine. This process makes very hot flame which can create NO_2 difficult to separate and capture being a small fraction of exhaust gases. Where as in chemical looping coal does not react with air instead it is exposed to iron oxide. Coal reacts with it breaks bond between iron and O_2. The reaction thus produces pure CO_2 and iron along with mineral wiistite. Electricity is generated when molten iron comes in contact it burns. This releases heat to produce steam. The pure CO_2 is easy to capture and to store underground. Besides, burning of iron occurs at lower temperature that does not produce NO_2.

Professor Liang Shin fan at Ohio state university has developed a new type of reactor that enhances O_2 carrying capacity of iron oxide, decreasing the amount of material needed, thus improving economies. Yet in another attempt syngas (H_2+CO_2) reacts with iron oxide. A 250 Kilowatt pilot plant is being used to test the technique; in it pulverized coal will be used in place of syngas which will be highly cheaper. NETL is funding other chemical looping process which uses calcium sulphate instead of iron oxide. Thus clean energy initiatives are on way to help clean the world of pollutants.

C. Green Manufacturing

Green manufacturing is to reduce industrial emissions to minimize green house gases, conserve natural resources to maximize possible extent, practice energy efficient manufacturing technologies recycle & reuse of waste materials & by products, affecting regulatory compliance, pollution control & related issues. If green manufacturing can be put into practice successfully, the contradiction between environmental pollution and sustainable development will be effectively solved (Yin Ruiyu, 2002), (Liu Fei, Zhang Hua, pp.326), (Zhang Xinming, Duan Xiong, 2002).

A green product design should be understood as one which during its production should least pollute the environment during use, also should be non-polluting, after its end of life, should be reusable or be remanufactured economically. All such considerations must be made at design stage, since steel is 100% reusable. Design is critical in saving resources & enhancing product–reuse. Reuse is the best form of recycling as little energy may be needed. Examples of reuse are specially designed structural beams life of same has been extended ten times. Undamaged automobile and furniture parts are reused again. Per ton reuse of steel can save half ton of iron ore and 120kg of lime stone, besides, mining, transportation and related other costs.

D. Repairing and remanufacturing of damaged products

Repairing is making the product operational after reconditioning of the same by metal spraying and deposition, machining and restoring to original size. Besides necessary heat treatment etc are done to restore its properties. Much advance metal deposition process is fused deposition modeling, 3D printing which are computer controlled. Some generative manufacturing processes can create better properties on surface than that of parent materials. Remanufacturing means melting the damaged part and then to remanufacture it all the way again which is costlier but save lot of energy input compared if it was to be started from iron ore. Some such remanufactured products are machine tools, electrical motors, I.C. engines, wind turbine etc.

E. Energy Efficiency

Energy purchases in steel industries are of the order of 20-40%. Realizing the high costs of energy inputs in 35 years, steel companies have cut energy cost to 50%. This has been a significant development in steel processing. [(Zhihong Zhang, Xi Tian, 2008), (Jianling Zhang, Guoshun,)]

F. Making steel more sustainable

Iron & steel producing industries emits CO_2, SO_x, NO_x just as well as polluted water and heat to the environment. With regard to emissions every industry is at a different level of maturity.

Still there are possibilities of continuous improvements based on;

(1) Bench marking the best industrial practices.

(2) Optimization of operations and controls to cut power in driving systems: motors, pumps and compressors, fans, forming machines handling equipments etc. These items consume approximately 20% of primary power

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G. Material efficiency

There are further possibilities of reducing material inputs and of waste production. The by-products need to be fully used for generating money and recycling for maximizing profits either in manufacturing related products or for supplying to society for use. Efforts should be made to reduce yield losses in production processes.

H. Co-products or by-products utilization or recycling

Use of co-products supports sustainability of iron and steel industry. It prevents landfill e-waste, reduces CO_2 emissions and preserves natural resources. Sale of co-products generates money and makes steel industries richer. Certain companies have reported by-products utilization rate of the order of 99%. It is well known that co-products from iron and steel industries are slags, process gases, dust and sludge. More than 400 million ton of irons and steel slags are produced annually. Slags are made up of silica, calcium oxide, magnesium oxide, aluminum and iron oxide. Slags are easily culled from the surface melts. Slag recovery varies from 80-100%. Slag is sale-able for use in road and building construction etc.

Gases from steel making after cleaning can be sold to chemical units. Coke oven gas contains 55% H_2 used in plant power generation. Dust from steel plants has iron oxide which can be sold to Portland cement manufacturer etc EAF create ZnO_2 that is collected and sold as raw material. BF-BOF creates gases which are used in fertilizer plants. Besides BTX is used for plastic products and tar and naphthalene is used for pencil pitch electrodes and plastic plants. World steel manufacturers association reported 94 to 98% raw material utilization. But goal should be at zero waste.

Iron and steel industry is the highest resource consuming and polluting industry. In China alone 76% iron enterprises are running illegally escaping EPA actions. Such industries should be brought to book for punishment for violating pollution norms.

It goes without saying that green manufacturing is the only key for sustainable development meeting global climatic changes. Bao steel, Shragans, Jinan steel, Lai steel have started practicing green manufacturing realizing their social responsibilities seriously.

III. GREENER PRODUCTION PROCESSES ARE MORE ENVIRONMENTS SUSTAINABLE

1. Large number efforts have been made by engineers and metallurgist's in steel production processes to improve energy efficiency. Some of the successful contributors are as follows:
2. Pulverized coal injection in blast furnace has increased productive efficiency. It reduces the coke requirements and does reduce operating costs.
3. Continuous casting technology improves energy utilization by direct formation of product avoid melting again for casting in moulds. Simple shapes in huge volumes are comfortably and economically produced. The technique eliminates initiative roll process and mould casting which have low yields.
4. Coke dry quenching produces harder and stronger coke with lower moisture content. Its use reduces CO_2 by 140000 tons/year. Besides, it has advantage of sensible heat recovery conservation of water and zero air and water pollution.
5. Coke dry cooling plant makes use of gas in place of water in cooling hot cake. The heat is carried away and is used in production of electricity. It also reduces other pollutants besides CO_2 (Worrell E, Price L, Martin N, 2001).
6. Gas from the blast furnace has enough pressure and thermal energy it is expanded in a gas turbine which is coupled to generate yielding electricity. Top pressure recovery turbine thus helps in pressure control on top of blast furnace. Besides noise pollution is mitigated economic advantage accrues from waste.
7. Carbon capture and storage system captures CO_2 emitted from fossil fuel power plants/oil refineries and are stored underground. CO_2 sequestration is a process by which CO_2 from steel plants/power plant is compressed and transported through pipe/ships to suitable and safe locations avoiding pollution of environment.
8. Current research on porous liquid CO_2 absorption is a promising step in this direction.
9. Heat from sintering plants is used for preheating of water or air before combustion. Thus heat is not allowed to be wasted and to heat up surrounding air.
10. Steel slag is used for great economic advantage in building construction , road and water ways, as fertilizer, ready mixed concrete, concrete products cementation, gabions, ripraps, roofing granulation landscape aggregate, mineral wool and soil remineralisation and conditioning etc. It saves lot of energy, otherwise, if such materials were transported & processed for other use.
11. Recycling of damaged products/scraps & process left over are being successfully used to save mineral resources & energy, which would otherwise be needed & pollutants were generated. For every ton of recycled steel scrap 1.5 ton of iron ore , 0.5 ton coal ,0.054 ton lime stone & 40% of water, otherwise required for production from virgin material is conserved. Thus recycling of steel saves lot of pollutants.
12. Production of one ton of steel from scrap steel saves 14.3 G J Calories energy. The emissions are also 85% lesser. UK is using recycling of steel in the process & releasing 18 million ton of CO_2 lesser & has become a great contributor in fight against climate change.
13. Recycling of steel scrap has also reduced the land fill requirements of space.
14. Endless recycling of steel scraps is possible providing opportunity for continuous reduction of GHG, energy saving & efforts in manufacturing of steel. From above it is evident that lot of significant steps have been

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taken to minimize pollutants in air, water & land world over (Brimacombe, L.Shonfield, P , 2001).

A. Chinese approach of building ecological enterprises of circulating economical type

China has two types of circulating economic zones as given under (Zhang Lihong, Cai Jiuju, Du Tao, Huang Fuyou, Wang Lianyong)

Steel plant located at port-industry-zone where large amounts of iron ore & crude oil are imported. In this zone cement plants, thermoelectric plants, shipbuilding plants; steel products processing plants, petrifaction enterprises are also located. These enterprises essentially run in well coordinated manner. The functioning of the system of these industries basically fulfils following objectives:

1- Circulation of resources from one plant to another is assured.

2- Principle is amount reducing, reusing, and recycling for reducing pollution.

3- Low energy & material consumption manufacturing.

4- High efficiencies in plant systems.

5- High reduction in pollution due to pollutants being used as resources in other plants.

6- Transportation costs are minimized due to nearness of plants & near sea shore.

7- Maximum use of all types of resources is made in the system improving economy of all plants.

8- This model has proved highly profitable & sustainable.

China has experimented on second type of circulating economy type too. The plant is located around some city. The steel plant consumes steel scrap from city. Also plastic scrap, being garbage etc is utilized. Plant from its resources supplies hot water & steam to the city. Thus extending the circulation-chain of field materials enhancing resource utilization. The efficiency of energy use of secondary resources minimizes emissions, serves social cause of pollution reduction with profit maximization too. Ma An Shan steels, capital steels had shown the way to actualize the circulating economy in China .

On somewhat similar lines U.S.A, & Canada had set up model parks of ecological industries. Kalundborg ecological industry park is rated the best in the world.

Steel industries all over the world excelled in setting up green belt around for fighting against climate change.

B. Enthusiasm in iron & steel industries to adopt green manufacturing.

In India alone more than 60 iron & steel industries seriously involved in adopting green manufacturing . JSW, ISPAT Limited at Kamleswar Nagpur have proved to be world class players .It has obtained QS9000 and ISO14000 certifications. The company houses the state of art technology in the field of cold rolling, galvanizing colour coating, galvalume, pipe & tube manufacturing.

The company successfully meets the standards prescribed for G.M. The company has fully appreciated, adopted & implemented green energy, green products & green processes.

C. Need of changes in curriculum for sustainability

Development and implementation of sustainable manufacturing modules at university of Northern Iowa(UNI) in united states of America is a praise worthy effort in the direction of adopting new curriculum for training man power with appreciation and skills for fighting climate change problem. They have produced three sustainability curriculum modules that have been developed and integrated in several existing courses. It has been concluded by them that faculty professional, development opportunities, research experiences as well as synchronization and team work are important factors that help faculty more towards sustainability integration in curriculum (Julie Zhang, Nageshwar Rao Posinnasetti and Neelmani Parmarric, 2015) Such efforts must be made by various universities world over to make necessary changes in their curriculum without fail at an early date. This effort will certainly create knowledgeable work force to meet the challenge of climate change.

The world has become conscious about the fate of future generations to leave for them green plant to enjoy happy & healthy life without pollution.

President Barak Obama recently expressed his great concern and finalized America's clean power plan. He announced 870 million metric ton carbon pollution cut at a cost $54 billion due which economic benefits are going to be worth $ 8.4 billion. The clean power plan will result in $ 85 billion worth public health & climate benefits. Further, his plan is expected to cut energy bills of $ 155 billion from 2020-2030. His plan is expected to increase 30% in renewable energy resources by 2030 & cutting carbon emission by 28% below 2005 level. Beside, his plan will create tens of thousands of jobs for Americans.

Government of India has declared to cut GHG by 35% by 2030.

At present more than 150 countries representing over 85% of global emissions have submitted official climate action pledges are called Intended Nationally Determined Contributions or INDC. It is crucial first step in what one hopes will be an iterative process to ramp up their efforts to limit global temperature rise to 2°C. India's INDC includes generation of now fossil fuel based electricity & to expand India's forest carbon sink. It is really impressive that India will undertake these efforts when its economy is expected to grow by more than 3.7 times from current level. Since its inception in 2012 The US-India partnership to advance clean energy has mobilized nearly & 2.5 billion in clean energy finance, investment helping India low carbon strategies. Further, US has appreciated launch of solar alliance to collectively leverage the benefits of solar energy.

P. M. Modi has called upon India to play a vital role in fighting against climate change. Multilateral climate deliberations are in stock to be discussed in Paris at

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UNFCCC in December, 2015. However, Christiana Figueres, executive secretary of UNFCCC said aggregated INDCs of will finish 75% of the worlds carbon budget by 2030. It is further reported that the global cumulative CO_2 emission are expected to reach 541.7 GT in 2025 & 748.2 GT in 2030. It means world will have 250 GT of C space by 2030.

D. Historic climate deal done at paris summit (cop21)

The differentiation of responsibilities in fighting climate change, between developed and developing countries and the stress on sustainable development in Paris agreement was an "important achievement" for India. The differentiation is maintained across all pillars of actions mentioned in the draft-mitigation, adaptation, finance, technology transfer, capacity building, and transparency.

In the pact, the countries commit to limiting the amount of greenhouse gases emitted by human activity to the same levels that trees, soil and oceans can absorb naturally, beginning at some point between 2050 and 2100. Some scientists who had criticized earlier drafts praised the agreement for including language that essentially means the world will have to all but stop polluting with greenhouse gages by 2070 to reach the 2^0C, or by 2050 to reach the 1.5^0C. Though climate finance (money to be given by rich nations to developing countries for adaptation and mitigation efforts) has also been taken care of, the move to put it in the decision text is a bit of a concern as the quantum of contribution will not be legally binding on rich nations.

The developed countries will provide $100 billion by 2020 and potentially scale it up later, but this point is not there in the agreement (legally binding) part of the text. Still, it stipulates that the $100 billion will be a floor and not the ceiling as the new quantified target will need to be set by 2025.

Environmentalists see red in shifting the point to the decision (non-binding) text of the final draft, "The differentiation has been maintained by stating that developed countries will provide support to developing countries for both mitigation and adaptation. This is the only place where equity has been operationalised. "But we know that the promise of finances has always been illusionary. So, whereas the previous draft mentioned $100 billion to be made available, it has now been removed in the current draft agreement".

The draft agreement is under the UN Framework convention on climate change (UNFCCC) and will be guided by its principles of equity and common but differentiated responsibilities (CBDR) the point very crucial for all developing countries ever since they had been working on the draft.

The shift in the finance clause, however, brought rich countries on board. It is learnt the US-led umbrella group of developed countries and EU nations are fully agreed to the text. Though they did not want differentiation to be maintained on all pillars of the UN convention, they moved a bit when developing countries sought to compromise on the clause of finance and the issue of loss and damage (financial help extended to vulnerable countries hit by disasters).

The agreement put loss and damage in a separate article but it does not provide basis for compensation or liability. These kinds of compromises are there in the agreement for both rich bloc and developing countries.

E. Final print of deal after 13 days of negotiations

Legally-binding climate deal text released on Saturday, the 12th December 2005 forms bedrock of deal

It has 31 pages, 21 of these legally binding.

This text has zero dissent, a month ago, there were 1,600 sticking points.

India's concerns taken care of-sustainable lifestyles, consumption patterns, climate justice addressed in preamble.

Text has India's stand on sharing climate action responsibilities between developed and developing countries.

Countries to do more on climate actions in 2018, it will be voluntary.

Developed nations must enhance climate action; developing nations can do it on the basis of their capacity.

Finance legally binding, but haze over amount

Developed world will continue to contribute $100 billion a year .this point not in legally binding segment.

IV. R& D FOR LOW CARBON TECH

Governments of following countries join hands as partners to increase R&D in low-carbon technologies—India , France , United states , China , Japan, Morocco, Sweden, Brazil, UAE, Columbia, Thailand, African union (54 countries of the continent), United Kingdom, European Commission;

These countries will cooperate with each other under "Mission Innovation"

Every Country will try to double their R&D expenditure for finding clean energy or low-carbon energy solution

It will work towards carbon capture technology and storage capacity for clean energy.

It will accelerate public and private global clean energy innovation

The countries will join hands with the breakthrough energy coalition-the group of world's 28 richest investors led by Bill Gates-that was launched on November 30, 2015.

The world on Saturday the 12th December, 2015 got a historic climate deal with all 196 countries approving the Paris text that aims to transform fossil fuel-driven economies within decades and slow global warming. It will formally be inked in New York on April 22, 2016 when the UN secretary general invites all world leaders for a high-level signature ceremony.

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V. CONCLUSION

In the end it is concluded that:

1-Green energy, green products & green processes are a must for planet earth's green survival to guard interest of future generations.

2- Government must provide guide lines regulations & regulatory mechanisms for industries.

3- Governments should give incentives for the purpose.

4- Industry associations & stake holders must be continuously prompted to take up social responsibilities towards climate change challenge.

5- Necessary communication channels should be set up to educate industries about advantages of adopting green manufacturing.

6- Messages must go to oneself that without sustainable development humanity will perish.

7- Investment on green manufacturing is not expenditure but rewarding & it gives multiple benefits.

8- Purchasers must buy products from companies which have green energy & green manufacturing certification from appropriate bodies.

9- Deforestation should be stopped by regulation. Plantation of saplings having long life should be taken up on a large scale world over.

10- Alternate job opportunities are provided to people who will be unemployed due to closure of polluting & coal industries.

11- Funding for research should be made compulsory on green energy by industrialists & institutes and governments.

12- Best technologies developed must be made known to industries world over to adopt & benefit all humanities.

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