Volume 3, Issue-12(2), December, 2016
International Journal of Academic Research

Published by
Sucharitha Publications
Visakhapatnam – 530 017
Andhra Pradesh – India
website :www.ijar.org.in

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Design by
SS Xerox, Visakhapatnam

Special issue on

"ENERGY, ENVIRONMENT AND ECONOMY

-The Nexus, Implications and Initiatives"

Edited by
P.RamaKrishnamRaju
A.V.NagaVarma

INVITATION

UGC Sponsored
Two day National Seminar on

"ENERGY, ENVIRONMENT AND ECONOMY

-The Nexus, Implications and Initiatives"

On9th& 10th, December 2016

Organised by

Departments of Economics (PG & UG)

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Editor-in-Chief, IJAR – December, vol.3, issue 12(2), 2016

Typeset and Printed (Sucharitha publications) in India:

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December, 2016

C O N T E N T S

Volume 3 **Issue 12(2)** **December, 2016**

International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Renewable Source of Energy is sine qua non for India's Development

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Abstract: The pressure on Indian power sector has been snowballing in recent years because of population growth and industrial development. The analysis revealed that the Government of India is serious to provide electricity across India and launching of *Deen Dayal Upadhyaya Gram Jyoti Yojana* is a laudable step but it is suggested that more measures should be taken to promote renewable sources of energy like more use of solar energy, wind energy, biomass etc. as data reveal many states many biomass energy has not been promoted at all.
Key words: fossil fuels, renewable resources, Biomass, ground temperature

The research paper has been prepared for presentation as Key Note paper for the UGC Sponsored National Seminar on "Energy, Environment And Economy -The Nexus, Implications and Initiatives" to be held on 9th& 10th December 2016at the P.G and U.G Departments of Economics, D.N.R College(Autonomous), Bhimavaram – 534 202, Andhra Pradesh, India

Introduction

The pressure on Indian power sector has been snowballing in recent years because of population growth and industrial development. Although India is in the sixth position in the world energy market after the United States, Russia, China, Japan and Germany, its energy sector is highly dependent on the use of fossil fuels, mainly coal. As compared to population against the size of the economy the domestic energy production is low. "India's share of global energy production is 2.3% compared with the United States 21% and Europe 12%" (Aruna 2011). In view of this renewable sources of energy which are having enormous scope may be tapped. The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. Themain objective of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. Its need was felt long ago. The way back in 1981 Commission for Additional Sources of Energy (CASE) was created, after that Department of Non-Conventional Energy Sources (DNES) in 1982. Subsequently, Ministry under the banner of Ministry of Non-Conventional Energy Sources (MNES) was set up in 1992 and later on Ministry of Non-Conventional Energy Sources (MNES) renamed as Ministry of New and Renewable Energy (MNRE) in 2006 (mnre.gov.in/mission-and-vision-2/mission-and-vision). The role of new and renewable energy has been assuming increasing significance in recent times with the growing concern for the country's energy security. Energy self-sufficiency was identified as the major driver for new and renewable energy in the country in the wake of the two oil shocks of the 1970s. The sudden increase in the price of oil, uncertainties associated with its supply and the adverse impact on the balance of

payments position led to the establishment of the Commission for Additional Sources of Energy in the Department of Science & Technology in March 1981. The Commission was charged with the responsibility of formulating policies and their implementation, programmes for development of new and renewable energy apart from coordinating and intensifying R&D in the sector.

The Mission of the Ministry is to ensure

- **Energy Security:** Lesser dependence on oil imports through development and deployment of alternate fuels (hydrogen, bio-fuels and synthetic fuels) and their applications to contribute towards bridging the gap between domestic oil supply and demand;
- **Increase in the share of clean power:** Renewable (bio, wind, hydro, solar, geothermal & tidal) electricity to supplement fossil fuel based electricity generation;
- **Energy Availability and Access:** Supplement energy needs of cooking, heating, motive power and captive generation in rural, urban, industrial and commercial sectors;
- **Energy Affordability:** Cost-competitive, convenient, safe, and reliable new and renewable energy supply options; and
- **Energy Equity:** Per-capita energy consumption at par with the global average level by 2050, through a sustainable and diverse fuel- mix.

In India coal is the major source of providing energy which is obviously a non-renewable source. The power from renewable energy source is only around 12 per cent so there is enormous scope to harness this sector. It is pertinent to mention that sources of energy are many such as minerals, wood, coal, natural gas, wind, water, plants, animals and many more. Some of these are renewable and some are non-renewable. The difference is that some renew at faster rates than others, making them more sustainable than those that do not renew very fast. For benefit of readers, few lines about renewable and non-renewable sources of energy are mentioned here.

Renewable and Non-renewable Resources:

Renewable Resources: a natural resource that can be used to benefit people and then can be replaced for others.

Non-Renewable Resources: A resource that is in limited supply and cannot be replaced once it has been extracted and used. Sometimes generations together may require replenishing.

The natural resources such as coal, gas/ oil that once consumed cannot be replaced immediately. Most energy resources presently in use in India are non-renewable while the renewable ones (such as wind solar power etc.) are non-renewable.

Renewable resources are an important aspect of sustainability. According to the U.S. Energy Information Administration, the most frequently used renewable resources are biomass, water, geothermal, wind and solar. Unlike fossil fuels, we can regenerate or replenish these resources. With the rising cost and decreasing availability of non-renewable fossil fuels, renewable resources are receiving increasing attention. Some of these renewable-resources are presented below:

Renewable Resources:

Biomass: Biomass resources include trees, food crops, algae, agricultural and forestry by-products, and even Methane fumes from landfills. These biomass resources provide fuels, power production and products typically made

from non-renewable fossil fuels. Such bio products include plastics, insulation, adhesives and fabric. Energy production from biomass is important because it can help reduce dependence on foreign oil. In addition, it has the potential to reduce greenhouse gas emissions. The agricultural and forestry industries also benefit from the demand for biomass.

Water: Like wood, water has a long history as an energy source. Hydroelectric power plants proliferated with the ability to transmit electricity over longer distances. The release, as needed, of water stored in reservoirs behind dams produces electricity by spinning turbines as it flows through pipes.

Geothermal: Geothermal energy comes from harnessing heat from the earth. It is pertinent to mention that geo means earth and thermal means heat so the word is Geothermal. A large utility company, for example, can directly use a geothermal reservoir to drive generators and produce electricity for their municipality. In contrast, residential heat pumps use the shallow ground temperature of the earth to heat and cool a home on a smaller scale. The shallow ground temperature remains between 50 and 60 degrees Fahrenheit. Other applications put geothermal heat to use in commercial buildings, roads, agriculture and industrial factories.

Wind: Wind is just moving air created as the sun heats the earth's surface. As long as the sun is shining, the wind remains an infinite, renewable resource. Wind power is clean energy because wind turbines do not produce any emissions. The classic Dutch windmill harnessed the wind's energy hundreds of years ago. Modern wind turbines with three blades dot the landscape today, turning wind into electricity. Although wind only generated little power in the United States in 2009, it is the fastest-growing source of new electric power, according to U.S. Energy Information Administration.

Solar: The sun has produced energy in the form of heat and light since the Earth formed. Solar energy systems do not produce emissions and are often not harmful to the environment. Thermal solar energy can heat water or buildings. Photovoltaic devices, or solar cells, directly convert solar energy into electricity. Individual solar cells grouped into panels range from small applications that charge calculator and watch batteries, to large systems that power residential dwellings. PV power plants and concentrating solar power plants are the largest solar applications, covering acres. Most renewable energy comes either directly or indirectly from the sun. Sunlight, or solar energy, can be used directly for heating and lighting homes and other buildings, for generating electricity, and for hot water heating, solar cooling, and a variety of commercial and industrial uses. The sun's heat also drives the winds, whose energy, is captured with wind turbines. Then, the winds and the sun's heat cause water to evaporate. When this water vapour turns into rain or snow and flows downhill into rivers or streams, its energy can be captured using hydroelectric power.

Other sources: Hydrogen also can be found in many organic compounds, as well as water. It's the most abundant element on the Earth. But it doesn't occur naturally as a gas. It's always combined with other elements, such as with oxygen to make water. Once separated from another element, hydrogen can be burned as a fuel or converted into electricity.

Not all renewable energy resources come from the sun. Geothermal energy taps the Earth's internal heat for a variety of uses, including electric power production, and the heating and cooling of buildings. And the energy of the ocean's tides come from the gravitational pull of the moon and the sun upon the Earth.

In fact, ocean energy comes from a number of sources. In addition to tidal energy, there's the energy of the ocean's waves, which are driven by both the tides and the winds. The sun also warms the surface of the ocean more than the ocean depths, creating a temperature difference that can be used as an energy source. All these forms of ocean energy can be used to produce electricity.

Non-renewable Resources: Some important non-renewable energy resources are

Coal: Coal is one of the oldest and most plentiful forms of non-renewable energy used by humans. It is relatively cheap, provides a high amount of energy in relation to its weight. However it is also one of the dirtiest forms of fossil fuels and mining it is fairly dangerous.

Pros and Cons of coal:

- Plentiful: Its cost to use is lower than other forms of energy.
- Fairly Efficient: Out of the potential energy present in coal, a high percentage of it is utilized when coal is burned.
- Safe Power Plants: Compared to nuclear power, coal plants are much safer.
- Relatively Cheap: It is a mature industry and relatively cheap source of energy to set up.
- Dirty: Out of all the fossil fuels, coal burns the dirtiest. Burning it releases high levels of carbon dioxide into the atmosphere. Coal plants also release dangerous levels of mercury and arsenic. Local pollution around coal plants are a problem.
- Dangerous to Mine: Coal mining is a very dangerous job. In addition, mining has negative environmental effects, including flooding, increased erosion, and release of methane gasses.
- Highest Energy Output Likely Reached: While efficient, the maximum potential has likely already been reached in energy available to draw from coal compared to other technologies that have potential for increased efficiency.
- Finite Source: While currently plentiful compared to other sources of energy, it is a limited supply likely to be exhausted within a couple centuries unless other alternatives are explored.

Petroleum: It is widely used worldwide for fuel and even in non-energy uses like making plastics. Petroleum is not as common for power plants, but is a very common fuel source for transportation like automobiles, airplanes, boats and trains.

Pros and Cons:

- Well Developed Infrastructure: Many countries produce and refine oil and global distribution is already in place. Gas stations to refuel personal vehicles are plentiful, compared to a more limited infrastructure like recharging stations for electric vehicles.
- Easy to Transport: Being a liquid it can be transported through pipelines meaning a large amount of oil can be transported long distances relatively quickly.
- Efficient: According to the U.S. Energy Commission, no other kind of fuel contains as much energy per unit of volume as diesel and gasoline does.
- Dangerous to Environment: Like coal, burning oil releases carbon dioxide into the atmosphere in addition to nitrous oxide and methane. Spills at drill

sites or pipelines also cause negative effects to the surrounding environment and wildlife.

- Limited Supply: Like all fossil fuels, it takes potentially millions of years to produce more. The demand for oil is so high, that based off currently known oil deposits in 2013, the U.S. Energy Commission estimates we will deplete our supplies by approximately 2063.

Natural Gas: Primarily composed of methane, natural gas can be used for heating, cooking and generating electricity.

Pros and cons:

- Cleanest of Fossil Fuels: Burning natural gas releases 45 percent less carbon dioxide than coal and 30 percent less than petroleum. It also leaves almost no waste like ash or other residues after being burned.
- Easy to Transport: Can be sent via pipeline to homes for heating and cooking.
- Cheap: Cheaper than other fossil fuels. In addition gas appliances in the home tend to be cheaper than their electric counterparts.
- Toxic & Flammable: Natural gas is very flammable and potentially explosive, making leaks problematic. It is also dangerously toxic to inhale and completely odourless in its natural state.
- Needs More Processing: In order to be usable as a fuel, natural gas requires more processing compared to coal or oil. The process of refining it creates several by-products like sulphur, hydrocarbons, water vapour, etc.

Biomass

Biomass energy uses the natural process of photosynthesis and other biological energy production that occurs with organic subjects.

Pros and Cons

- Renewable: If you can grow it, it can be used in biomass energy production. This makes it a highly renewable source.
- Carbon Neutral: This is one of the few forms of energy that is considered to be carbon neutral. It does have a carbon impact, but it is considered to be part of the natural carbon cycle on the planet and causes no additional burden on the atmosphere.
- Cost-Effective: Compared to the fossil fuels, biomass energy is almost 1/3 cheaper to produce. Over 10 to 15 years of use, the average user will see a significant savings in energy cost.
- Abundant: Wherever you can grow you can create biomass energy. There is no need for extra transport such as pipelines to deliver it to areas.
- Expensive: This can be one of the more expensive energies to produce as it is dependent on a growing and harvesting cycle.
- Extensive Footprint: While new technologies are being developed to allow for plants to used smaller spaces, right now extensive space is needed to grow enough of the biomass to produce energy.
- Resource Drain: Growing requires water and that can be a problem in some areas of the world and would limit the effectiveness of biomass energy production.

Hydro power: Hydro power harnesses the power of water flow to generate electricity by using the flow to turn turbines. In many ways this is one of the cleanest technologies, but it also has a cost that has to be considered.

Pros and cons

- Reliable: Compared to the other “clean” powers such as geothermal, solar and wind; hydro power is far more reliable as the water is more predictable in its amounts and delivery.

- Clean: Using hydro power reduces the need to burn fossil fuels. The output from the plant also has a very light carbon and air pollutant emission rate.
- Cost Effective: While costly to build and having a high maintenance budget, the long term cost of a hydropower system is much cheaper than traditional power plants.
- Renewable: Water exists on the Earth and in the atmosphere. It is constantly renewing itself so this makes hydro power a renewable energy source.
- Multipurpose Raw Material: If you view water as a raw material, and the reservoir as the holder for that material than you can see that there are multiple uses for the water at the same time it is used for power. It can host wildlife, irrigate farmland, provide drinking water and be a point of recreational activities for the community.
- Marine Life Endangerment: While building a dam creates a reservoir that becomes a marine habitat, it only does so by destroying the natural one that exists. This can interrupt the ecology of the area. Also, the turbines used by the power plant can hurt the fish population by changing the currents in the water and interrupting feeding and spawning patterns.
- Natural Occurrences: This is the term used to describe such factors as drought that can change the expected capacity of a hydro power plant. As of yet, there is little man can do to control certain natural occurrences that can reduce the plant's output.

List of Examples of Renewable Commodities

- Major grains such as Wheat, Rice and Corn
- Leather and meats supplied by animals
- Fruits and vegetables
- Paper, furniture and oxygen all supplied by trees
- Bio based chemicals such as butanol and acetone

Sources of Power Generation in India-Discussion: In this section main sources of power generation along with other scopes are discussed. As may be seen from the table-1, coal is the major source of power generation followed by hydro-electricity.

Table1: Main sources of Power Generation in India

Source	Utilities Capacity (MW)	%
Coal	164,635.88	61.51
Hydroelectricity	41,267.43	15.42
Renewable energy source	3,692.14	11.84
Natural Gas	23,062.15	8.61

Source: www.google.co.in/different+soruces+of+power+generation+in+india (dt.15/11/16)

In table-2, gives an idea about the sources of non-renewable energy in India. Among the sources solar power is the major one followed by wind power. As per the Ministry of New and Renewable Energy, Government of India, the renewable power target to be achieved by the year 2022 are Andhra Pradesh (9834 MW), Haryana (4142 MW), Rajasthan (5762MW), Punjab(4772MW), Uttar Pradesh (10697MW), Gujarat (8020MW), Maharashtra(11926MW), Tamil Nadu (8884MW) and West Bengal(5336MW) .

In case of wind power, Andhra Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu and Telangana are in the list– highest Tamil Nadu with 11900 MW and lowest Telangana (2000MW).

Table 2: Scheme wise Physical Progress of Non-renewable sources in 2016-17 (upto September 2016)

Sector	1. 2016-17	
	Target	Achievement (April-September 2016)
I. GRID – INTERACTIVE POWER (CAPACITIES IN MW)		
Wind Power	4000.00	1305.50
Solar Power	12000.00	1750.38
Small Hydro Power	250.00	49.40
Bio Power (Biomass & Gasification and Bagasse Cogeneration)	400.00	51.00
Waste to Power	10.00	7.50
Total	16660.00	3163.78
II. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN MW)		
Waste to Energy	15.00	2.24
Biomass (non-bagasse) Cogeneration	60.00	0.00
Biomass Gasifiers		
Rural	2.00	0.00
Industrial	8.00	2.40
Aero-Generators/ Hybrid systems	1.00	0.20
SPV Systems	100.00	48.13
Water mills/ micro hydel	1 MW + 500 Water Mills	0.10 MW + 100 Water Mills
Total	187.00	53.07
III. OTHER RENEWABLE ENERGY SYSTEMS		
Family Biogas Plants (in Lakhs)	1.00	0.17

Source: Ministry of New & Renewable Energy, Government of India

Wind energy was not generated in other states so if possible scope may be found out. In case of biomass power, power target to be achieved by the year 2022 for the leading states are Uttar Pradesh (3499 MW), Maharashtra (2469 MW) and Karnataka (1420 MW). Here also scope may be exploited for generation of biomass power for other states.

Use of Solar Light: A Case from Tamil Nadu: The case was studied by the author at*Annavasal* village of *Perumangalam* hamlet, *Kodavasal* block, *Thiruvarur* district Tamil Nadu. Out of total population 453 (134 households) at *Perumangalam*, 308 were scheduled caste (SC) and 145 other caste. All the SC households were landless. The male members of the hamlets for their livelihood go to nearby town (Kovasal) and work as non-agricultural activities like mason helper to mason etc. The women members in the village sometimes work as agricultural labourers. In this village for the use

women and children, solar light was installed under a programme of Government of India in a sanitary complex.

This solar light is a part of a sanitary complex used by SC women. A sanitary complex in 2002-03 was constructed for the use of SC women in the hamlet from the State's fund. Altogether 10 toilets - 8 for adults and one each for the children and persons with disability and 4 bathrooms were constructed for the use of women with an amount of Rs. 2.5 lakh. From panchayat fund one bore well with pump set was installed for continuous availability of water by costing Rs. 1.80 lakh as without water sanitation and bathing are meaningless. Since the users were women so at the night women had to face problem to use latrines or bathrooms and lighting arrangement was the felt ad demanded. To address the issue under PMAGY, two solar lights costing Rs. 80,000 (each costing Rs 40,000) were installed in the sanitary complex in 2011-12 and thus problem was neutralized to a great extent. While carrying out the field study it was observed that the sanitary complex was used by the members of 5 SHGs (30 members)viz. i) Mullai SHG ii) Tamarai SHG iii) Anandam SHG, iv) Mettili SHG and v) Arpothan SHG. As user charge each family had to pay at the rate of Rs. 20 per month and thus it was reported that a sum of Rs. 600 per month was collected as those only use the latrine and bathroom pay the cost. With the money they purchase bleaching powder and other items required for cleaning the complex. The SHG members every month on rotation basis at free service charge maintain the complex. To get an idea about the utility of the complex after installing of solar light few persons were contacted. They were Ms. Durga Devi (35 years), Ms. Kodiarasi (36 years), Ms. Madhumati (34), Ms. Nagavalli (40), Ms. Renuka (30), Ms. Ramamirdham (36), Ms. Sudha (27), Ms. Satya Vani (40) and Ms. Challamma (44). All in unison told they were fully satisfied with the installation of solar light project. Earlier at night they were scared to go to sanitary complex because of darkness but the issue with the installation of solar light was addressed. Now at any time complex was used by the women and children of the locality.

Government of India's initiative of power supply in rural India:

The Prime Minister Shri Narendra Modi has launched *Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)* on 25th July 2015. The DDUGJY is one of the flagship programmes of the Ministry of Power and will facilitate 24x7 supply of power. The DDUGJY Scheme approved by the Union Government draws its inspiration from the similar pioneering scheme implemented by the Government of Gujarat. This scheme will enable to initiate much awaited reforms in the rural areas. It focuses on feeder separation (rural households & agricultural) and strengthening of sub-transmission & distribution infrastructure including metering at all levels in rural areas. This will help in providing round the clock power to rural households and adequate power to agricultural consumers.The earlier scheme for rural electrification viz. *Rajiv Gandhi Grameen Vidyutikaran Yojana* (RGGVY) has been subsumed in the new scheme as its rural electrification component.

The major components of the scheme are feeder separation; strengthening of sub-transmission and distribution

network; Metering at all levels (input points, feeders and distribution transformers); Micro grid and off grid distribution network & Rural electrification- already sanctioned projects under RGGVY to be completed.

The Scheme has an outlay of Rs 76000 crore for implementation of the projects under which Government of India shall provide Grant of Rs 63000 crore. A total of Rs 14680 crore worth projects have already been approved out of which projects amounting to Rs 5827 crore have been approved for Bihar state.

Under this scheme, an Agriculture intensive state like Bihar shall benefit from works of feeder separation. Thousands of kilometres of new lines shall be laid and hundreds of new substations have been planned. The implementation of this scheme shall ensure the improvement in agricultural productivity and electrification of all the households.

Benefits from the scheme

- All villages and households shall be electrified
- Increase in agriculture yield
- Business of Small and household enterprises shall grow resulting into new avenues for employment
- Improvement in Health, Education, Banking (ATM) services
- Improvement in accessibility to radio, telephone, television, internet and mobile etc.
- Betterment in social security due to availability of electricity
- Accessibility of electricity to schools, panchayats, hospitals and police stations etc
- Rural areas shall get increased opportunities for comprehensive development

As per the data till February 2016, 5855 villages in India were electrified in 11 months.

"253 villages were electrified across the country during February 8-14, 2016 under *Deen Dayal Upadhyaya Gram Jyoti Yojana*," the power ministry said in a statement. Again, out of 253 villages, 111 were in Odisha, 81 in Assam, 40 in Jharkhand, 13 in Rajasthan, 4 in Bihar, 3 in Madhya Pradesh and 1 in Uttar Pradesh,.

Conclusion and suggestions:

It is evident from the above that Government of India is serious to provide electricity across India and launching of *Deen Dayal Upadhyaya Gram Jyoti Yojana* is a laudable step but it is suggested that more measures should be taken to promote renewable sources of energy like more use of solar energy, wind energy, biomass etc. as data reveal many states many biomass energy has not been promoted at all. So scope may be found outin this regard along with otherrenewable sources.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

The Indian Energy Sector – Emerging Scenario

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Abstract: *Energy plays an important role in the process of economic development of a country. It is because, energy requires in every sphere of activity. Hence, achieving energy security is of fundamental importance not only to India's economic growth, but also for the human development objectives that aim at alleviation of poverty, unemployment and meeting the Millennium Development Goals. Indian share in the World consumption of coal is more than its production to the extent of 123.3 million tonnes of oil equivalent and thus imports of coal account for 43 per cent of Indian production of coal. Indian share in the World consumption of oil is more than its production by 3283 thousand barrels per day. Hence, India is noticed to import 3283 thousand barrels per day and thus import of oil recorded for 375 per cent of Indian production of oil. Indian share in the World consumption of natural gas is more than its production by 21.4 billion cubic meters and thus, import of natural gas recorded for 73 per cent of Indian production of oil. India is found to consume nuclear energy to the extent of 8.6 million tonnes oil equivalent (1.5 percentage of share in World), 28.1 million tonnes oil equivalent (3.2 percentage share in World) hydroelectricity and 15.5 million tonnes oil equivalent (4.2 percentage in World) of renewable energy. The analysis implies that based on the projected estimates of availability and requirement of energy by 2030, a change in the mix of generation of energy by fuel source is observed. Renewable sources will account for 9 per cent of power generation in 2017, up from 6 per cent in 2012; they will then increase again to 16 per cent in 2030. On the other hand, power from hydro-capacity is expected to fall from 15 per cent in 2012 to 11 per cent in 2030, and nuclear power generation to increase from 3 per cent in 2012 to 5 per cent in 2017, then to 12 per cent in 2030. Overall, the renewable sector is expected to increase from 26 per cent in 2012 to 39 per cent in 2030. Further, wind power accounts nearly 8.6 per cent of India's total installed power generation capacity and generated 28,604 million KWh (MU) during year 2015-16 which is nearly 2.5 per cent of total electricity generation. The capacity utilisation factor accounts for nearly 14 per cent. Hence, it is better for the India to concentrate more on the generation of energy from wind power.*

Key words: *energy, economic development, Millennium Development Goals*

Introduction:

Energy plays an important role in the process of economic development of a country. It is because, energy requires in every sphere of activity. Energy is required right from primary sector to secondary manufacturing sector and even in service sector. Hence, the per capita energy consumption can be considered as a barometer of economic development of a country. Definitely after food, energy can be regarded as most important requirement for economic development of a country and for improving the quality of life of the people. Hence, every economy should plan to ensure sharp increase in the production of energy.

Achieving energy security in this strategic sense is of fundamental importance not only to India's economic growth but also for the human development objectives that aim at alleviation of poverty, unemployment and meeting the Millennium Development Goals (MDGs). However, the development of energy source is highly capital intensive and as a result, attracts major allocations in various plans. However, despite such large investments in energy sector, it is pertinent to note that there is a growing shortage of energy in all sectors of our economy.

India and Global Energy Reserves:

The global coal reserves[1] were estimated to be at 8,91,531 million tonnes by the end of 2015. The USA had the largest share of the global reserve (26.6 per cent) followed by Russia (17.6 per cent), China (12.8 per cent), Australia (8.6 per cent) and India (6.8 per cent). The global oil reserves[2] were estimated to be 1700 billion barrels by the end of 2015. Venezuela had the largest share of the reserve with 17.7 per cent followed by Saudi Arabia (15.7 per cent), Canada (10.1per cent), Iran (9.3 per cent), Iran (8.4 per cent), Russia and Kuwait each with 6 Per cent. However, India has a reserve capacity of only 0.2 per cent. The global natural gas reserves[3] were estimated to be 187 trillion cubic metres by the end of 2015. Iran had the largest share of the reserve with almost 18 per cent followed by The Russian Federation (17.3 per cent), Qatar (13.1 per cent), Turkmenistan (9.4 per cent), USA (5.6 per cent). However, the natural gas reserves in case of India accounted for only 0.3 per cent.

As per expert estimates, World oil and gas reserves[4] are estimated to deplete within just 45 years and 65 years respectively, while coal reserves are likely to last a little over 200 years. Although, 80 percent of the world's population lies in the developing countries, their energy consumption amounts to only 40 percent of the world total energy consumption. The high standards of living in the developed countries are attributable to high-energy consumption levels. Also, the rapid population growth in the developing countries has kept the per capita energy consumption low compared with that of highly industrialized developed countries.

India and Global Production and Consumption of Energy:

The World coal production[5] by 2015 stood at 3830.1 million tonnes of oil equivalent, while China stood first among the World producers of coal with 1827 million tonnes of oil equivalent (47.7 per cent) followed by USA with 455.2 million tonnes of oil equivalent (11.9 per cent), India 283.9 million tonnes of oil equivalent (7.4 per cent), Australia 275 million tonnes of oil equivalent (7.2 per cent) and Indonesia 241.1 million tonnes of oil equivalent (6.3 per cent). Among the World consumers of coal, China topped the list with 1920.4 million tonnes of oil equivalent (50 per cent) followed by India with 407.2 million tonnes of oil equivalent (10.6 per cent), USA 119.4 million tonnes of oil equivalent (10.3 per cent), Japan 119.4 million tonnes of oil equivalent (3.1 per cent), Russia 88.7 million tonnes of oil equivalent (2.3 per cent), South Korea and South Africa each with 85 million tonnes of oil equivalent (2.2 per cent). It is clear that Indian share in the World consumption of coal is more than its production to the extent of 123.3 million tonnes of oil equivalent and

thus imports of coal account for 43 per cent of Indian production of coal.

The World oil production[6] by 2015 recorded as 91670 thousand barrels per day. Among the countries, USA stood first among the World producers and consumers of oil with 12704 thousand barrels per day (13.85 percentage share in World) and 19396 thousand barrels per day (19.7 percentage share in World) respectively. Thus, USA is noticed to be net importer of oil by 6692 thousand barrels per day and thus accounted for 53 per cent of US production of oil. However, China is noticed to be the second largest consumer with 11968 thousand barrels per day (12.9 percentage share in World) against production of 4309 thousand barrels per day (4th biggest producer with 4.9 percentage share in World) followed by India with 4159 thousand barrels per day (4.5 percentage share in World) against production of 876 thousand barrels per day (5th biggest producer with 0.9 percentage share in World). Thus, it is clear that Indian share in the World consumption is more than its production by 3283 thousand barrels per day. Hence, India is noticed to import 3283 thousand barrels per day and thus import of oil recorded for 375 per cent of Indian production of oil. India has been importing oil from Middle East, West Africa, South & Central America, Mexico, North Africa and other Asia Pacific.

The World natural gas[7] production by 2015 stood at 3538.6 billion cubic meters. Among the countries, USA stood first among the World producers and consumers of natural gas with 767.3 billion cubic meters (22 percentage share in World) and 778 billion cubic meters (22.8 percentage share in World) respectively. Further, Russia is noticed to be the second largest producer of natural gas with 573.3 billion cubic meters (16.1 percentage share in World) and second largest consumer with 197.3 billion cubic meters (11.2 percentage share in World). China is found to the third largest consumer of natural gas with 197.3 billion cubic meters (5.7 percentage share in World) against production of 138 billion cubic meters of natural gas (5th largest producer with 3.9 percentage share in World). However, India is observed to be the 6th largest consumer and producer of natural gas with 50.6 billion cubic meters (1.5 percentage share in World) against the production of 29.2 billion cubic meters (0.8 percentage share in World) respectively. It is clear that Indian share in the World consumption is more than its production by 21.4 billion cubic meters and thus, import of natural gas recorded for 73 per cent of Indian production of oil. India is found to import natural gas in liquefied gas form from Qatar, Nigeria, Australia, Oman, Yemen and Malaysia.

The Nuclear energy[8] consumption of World by 2015 is noticed to be 583.1 million tonnes oil equivalent, while USA is observed to be the first largest consumer with 189.9 million tonnes oil equivalent (32.6 percentage share in World) followed by France 99 million tonnes oil equivalent (17 percentage share in World), Russia 44.2 million tonnes oil equivalent (7.6 percentage share in World) and China 38.6 million tonnes oil equivalent (6.6 percentage share in World). However, India is found to consume nuclear energy to the extent of 8.6 million tonnes oil equivalent (1.5 percentage of share in World).

The Hydro Electricity[9] consumption of World by 2015 is noticed to be 892.1

million tonnes oil equivalent of which China is observed to be the first largest consumer with 254.9 million tonnes oil equivalent (28.5 percentage share in World) followed by Canada with 86.7 million tonnes oil equivalent (9.7 percentage share in World), Brazil 81.7 million tonnes oil equivalent (9.1 percentage share in World), USA 57.4 (6.4 percentage share in World) and Norway 31.1 million tonnes oil equivalent (3.5 percentage share in World). However, India is found to consume 28.1 million tonnes oil equivalent (3.2 percentage share in World) hydroelectricity.

The World Consumption[10] of Renewable energy (which includes wind, geo-thermal, solar, biomass and waste) stood at 364.9 million tonnes oil equivalent and USA with a consumption of 71.7 million tonnes oil equivalent (19.7 percentage in World) is noticed to be largest consumer in the World. China is the second largest producer in the World with 62.7 million tonnes oil equivalent (17.2 percentage in World) followed by Germany with 40 million tonnes oil equivalent (11 percentage in World) and India with 15.5 million tonnes oil equivalent (4.2 percentage in World).

The World Bio fuels[11] production by 2015 stood at 74847 thousand tonnes oil equivalent. Among the countries, USA topped the tally with producers of 30983 thousand tonnes oil equivalent (41.4 percentage share in World) followed by Brazil with 17636 thousand tonnes oil equivalent (23.6 percentage share in World), Germany 3130 thousand tonnes oil equivalent (4.2 percentage share in World), China 2430 thousand tonnes oil equivalent (3.2 percentage share in World) , Indonesia 1344 thousand tonnes oil equivalent (1.8 percentage share in World) and India 362 thousand tonnes oil equivalent (0.5 percentage share in World) respectively.

The global primary energy[12] consumption by the end of 2015 was equivalent to 13147.3 million tonnes of oil equivalent. Among the countries, China is noticed to be the highest primary energy consumer with 3014 million tonnes of oil equivalent (22.9 per cent share in World) followed by the USA with 2280.6 million tonnes of oil equivalent (17.3 per cent share in World), India 700.5 million tonnes of oil equivalent (5.3 per cent share in World), Russia 666.8 million tonnes of oil equivalent (5.1 per cent share in World), Japan 448.5 million tonnes of oil equivalent (3.4 per cent share in World) and Canada 329.9 million tonnes of oil equivalent (2.5 per cent share in World). Thus, India is said to be 3rd largest primary energy consumer next only to China and USA.

Energy Crisis:

The crisis is not only related to India alone, but can be considered as a global crisis. However, the impact of crisis would be much more on an economy like India, which is striving to achieve development, besides heavy population pressures. Shortage of oil, coal and power affects the Indian economy to a large extent due to linkages. For example, oil shortage affects not only the transport sector directly, but also industrial sector as movement of raw materials from the source to the factory and finished goods from the factory to the markets depend on transport sector. In 2009, India was the sixth largest net importer of oil in the world, importing nearly 2.1 million barrels per day, or about 70 percent, of its oil needs. The EIA expects India to become the fourth largest net importer of

oil in the world by 2025, behind the United States, China, and Japan. EIA expects approximately 100 thousand barrels/day of annual consumption growth through 2011. In a similar manner, coal shortage affects not only the industrial sector as an agent of heat, but also the electricity generation and thus, hampers the economic development. Coal consumption in India is expected to increase from 359 million tonnes in 2000 to 430 million tonnes by 2010. Power shortage in turn not only hampers industrial production, but also agricultural production.

Indian Energy Sector:

India is the world's sixth largest energy consumer. However the per capita energy consumption in India is still one of the lowest in the world. The per capita consumption of energy in the country is found to be 510 KG Oil equivalent (KGOE)/day against, the per capita consumption of 803 KGOE/day in Indonesia, 1191 KGOE/day in Brazil, 1433 KGOE/day in China and 1702 KGOE/day in Mexico. At the same time, the world average per capita consumption of energy is noticed to be 1818KGOE/day. Further, Per capita consumption of energy in India was only 6.5 percent of that in the USA, 7.3 percent of Singapore and 8.6 percent of Australia.[13] Although commercial energy consumption in India has been steadily increasing over the last two decades, yet it is much lower than that of the developed and even developing countries. Further, urban areas are consuming 80 percent of total energy with only 28 percent of the population, while rural areas consume only 20 percent with 72 percent of population.

With economic growth rate of about 7 per cent and over 15 percent of the world's population, India is a significant consumer of energy resources. In 2009, India was the fourth largest oil consumer in the world, after the United States, China, and Japan. Despite the global financial crisis, India's energy demand continues to rise. According to the International Energy Agency (IEA), by 2007 coal/peat account for nearly 40 percent of India's total energy consumption, followed by nearly 27 percent for combustible renewable and waste. Oil accounts for nearly 24 percent of total energy consumption, natural gas 6 percent, hydroelectric power almost 2 percent, nuclear energy nearly 1 percent, and other renewable energy with less than 0.5 percent[14]. Although nuclear power comprises a very small percentage of total energy consumption at this time, it is expected to increase in the light of international civil nuclear energy cooperation deals.

Table 1 furnishes information about estimates relating to 12th Plan energy estimates[15]. India's twelfth five year plan estimates that an additional capacity of 75,785 MW is required over the plan period, giving a total capacity of approximately 276,000 MW. Of this added capacity, the Plan estimates that thermal energy derived from coal and lignite will account for 79 per cent, up from 76 per cent in the previous plan. Hydro-power is expected to generate 10,897 MW (about 14 per cent of the estimated additional capacity), and nuclear capacity 5,300 MW (about 7 per cent). Energy imports from Bhutan are expected to total 1,200 MW (1.36 per cent). In the renewable sector, the planned total addition to capacity of 30,000 MW comprises wind power account for 15,000 MW (50 per cent), while solar power account for 10,000 MW

(33 per cent) and small-hydro power is expected to provide 2100 MW (7 per cent) and the remaining 2900 MW (about 10%) is expected to produce from biomass. Thus, the projected growth rate in power generation over the period 2012-2017 is expected to be 9.8 per cent.

Table 2 presents information about the estimates of availability and requirements relating to 13th Plan period 2017 – 2022 and up to 2030[16]. The estimates are based on projected growth rate 6 per cent and 9 per cent. Thus, based on expected growth rate of 6 per cent, the estimated availability of energy for the 13th Plan period increased from 151,570 MW to 177,571 MB, while the requirement increased from 164,801 MW to 191,467 MW. At the same time, based on expected growth rate of 9 per cent, the estimated availability of energy increased from 157,483 MW to 191,597 MB, while the requirement increased from 169,876 MW to 203,506 MW. Thus, the analysis implies that based on expected 6 per cent of growth rate, the availability of energy during the 13th Plan is expected to grow at an annual rate of 17 per cent, while at an expected growth rate of 9 per cent, the availability of energy is expected to increase at annual rate of 29 per cent.

Table 3 presents information relating to expected capacity Expansion for 13th Plan (2017 – 22)[17]. The Plan estimates an expected additional capacity of 93,400 MW of which thermal energy will be expected to generate 63,400 MW (about 68 per cent), Hydro-power is expected to generate 12,000 MW (about 13 per cent of the estimated additional capacity), and nuclear capacity 18,000 MW (about 19 per cent). In the renewable sector, an additional capacity of 30,500 MW is planned to generate, out of which wind power is planned to account for 11,000 MW (36 per cent), while solar power account for 16,000 MW (52 per cent) and small-hydro power is expected to provide 1500 MW (5 per cent) and the remaining 2900 MW (about 7%) is expected to produce from biomass.

The estimates also reveal that based on expected growth rate of 6 per cent, the estimated availability of energy for the period (2022 – 2030) increased from 13,50,970 MW to 17,49,042 MB, while the requirement increased from 14,75,694 MW to 19,12,633 MW. At the same time, based on expected growth rate of 9 per cent, the estimated availability of energy increased from 14,75,557 MW to 21,01,358 MB, while the requirement increased from 15,63,417 MW to 21,92,571 MW. Thus, based on expected 6 per cent of growth rate, the availability of energy during the period 2022 – 2030 is expected to grow at an annual rate of 22 per cent, while at an expected growth rate of 9 per cent, the availability of energy is expected to increase at annual rate of 42 per cent.

Conclusion:

The analysis implies that based on the projected estimates of availability and requirement of energy by 2030, a change in the mix of generation of energy by fuel source is observed. Renewable sources will account for 9 per cent of power generation in 2017, up from 6 per cent in 2012; they will then increase again to 16 per cent in 2030. On the other hand, power from hydro-capacity is expected to fall from 15 per cent in 2012 to 11 per cent in 2030, and nuclear power generation to increase from 3 per cent in 2012 to 5 per cent in 2017, then to 12 per cent in 2030. Overall, the renewable sector is expected to increase from 26 per cent in 2012 to 39 per cent in 2030.

Further, wind power accounts nearly 8.6 per cent of India's total installed power generation capacity and generated 28,604 million KWh (MU) during year 2015-16 which is nearly 2.5 per cent of total electricity generation. The capacity utilisation factor accounts for nearly 14 per cent. Hence, it is better for the India to concentrate more on the generation of energy from wind power.

Table 1: 12th Five Year Plan Estimate of Energy (2012 – 2017)

Total Installed Capacity at Start of Plan Period	1,99,877 MW
Estimated Demand Over Plan Period	2,76,000 MW
Planned Expansion Type wise:	
Thermal (inc. coal & lignite)	59,870 MW (79%)
Hydro	10,897 MW (14%)
Nuclear	5,300 MW (7%)
Total	76,067 MW (100%)
Planned Expansion of Renewable Energy Type:	
Wind	15,000 MW (50%)
Solar	10,000 MW (33%)
Small Hydro	2,100 MW (7%)
Biomass	2,900 MW (10%)
Total	30,000 MW (100%)

Source: Meeting India's Energy Requirements in 2030

Table 2: Estimates of Energy for 13th Five Year Plan (2017 – 22) and up to 2030

Year	6% GDP Growth		9 % GDP Growth	
	Availability (MWh)	Requirement (MWh)	Availability (MWh)	Requirement (MWh)
2017-2018	1,51,570	1,64,801	1,57,483	1,69,876
2018-2019	1,57,806	1,71,225	1,65,370	1,77,716
2019-2020	1,64,218	1,77,810	1,73,706	1,85,953
2020-2021	1,70,805	1,84,557	1,82,357	1,94,470
2021-2022	1,77,571	1,91,467	1,91,597	2,03,506
2022-2023	13,50,970	14,75,694	14,75,557	15,63,417
2023-2024	13,98,593	15,38,556	15,44,625	16,43,502
2024-2025	14,61,028	15,84,480	16,32,590	17,09,702
2025-2026	15,08,974	16,53,073	17,10,152	18,03,428
2026-2027	15,63,755	17,17,948	17,96,590	18,95,032
2027-2028	16,29,881	17,73,016	18,98,458	19,80,141
2028-2029	16,83,787	18,47,725	19,92,190	20,89,603
2029-2030	17,49,042	19,12,633	21,01,358	21,92,571

Source: Meeting India's Energy Requirements in 2030

Table 3: Capacity Addition for 13th Five Year Plan (2012 – 2017)*

Planned Expansion Type wise:	
Thermal	63,400 MW (68%)
Hydro	12,000 MW (13%)
Nuclear	18,000 MW (19%)
Total	93,400 MW (100%)
Planned Expansion of Renewable Energy Type:	
Wind	11,000 MW (36%)
Solar	16,000 MW (52%)
Small Hydro	1,500 MW (5%)
Biomass	2,000 MW (7%)
Total	30,500 MW (100%)

Source: Meeting India's Energy Requirements in 2030

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Environment and Climate Change - India's Perspective: Issues and intricacies

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Abstract:
Climate Change is a serious global environmental concern. It is primarily caused by the building up of Green House Gases (GHG) in the atmosphere. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture. Global Warming is a specific example of the broader term „Climate Change" and refers to the observed increase in the average temperature of the air near earth's surface and oceans in recent decades. Its effect particularly on developing countries is adverse as their capacity and resources to deal with the challenge is limited. Scientific studies have shown that the global atmospheric concentrations of carbon dioxide, methane and nitrous oxide which are the most important Green House Gases, have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values.
Key words: *Climate Change, Green House Gases, fossil fuel,*

Introduction

Climate Change is a serious global environmental concern. It is primarily caused by the building up of Green House Gases (GHG) in the atmosphere. The Intergovernmental Panel on Climate Change is a specialized body jointly established by the United Nations Environmental Programme (UNEP) and the World Meteorological Organisation mandated to prepare scientific assessments on various aspects of Climate Change.

Intergovernmental Panel on Climate Change (Ipcc)

The Intergovernmental Panel on Climate Change is a specialized body jointly established by the United Nations Environmental Programme (UNEP) and the World Meteorological Organisation mandated to prepare scientific assessments on various aspects of Climate Change. The IPCC is currently engaged in the preparation of Fifth Assessment Report on Climate Change through three working group's viz. Working Group I on Climate Change will present the physical science basis; Working Group II on Climate Change deals with impacts, adaptation and vulnerability; and Working Group III deals with assessment for mitigation of Climate Change.

Impacts Of Climate Change On India

The key environmental challenges in India have been sharper in the past two decades. Climate change is impacting the natural ecosystems and is expected to have substantial adverse effects in India, mainly on agriculture on which 58 per cent of the population still depends for livelihood, water storage in the Himalayan glaciers which are the source of major rivers and groundwater recharge, sea-level rise, and threats to a

long coastline and habitations. Climate change will also cause increased frequency of extreme events such as floods, and droughts. These in turn will impact India's food security problems and water security.[2]

The International Response to Climate Change

The United Nations' Framework Convention on Climate Change (UNFCC)

The UNFCCC entered into force on 21 March 1994. The 195 countries that have ratified the Convention are called Parties to the Convention. The UNFCCC is a "Rio Convention", adopted at the "Rio Earth Summit" in 1992. The ultimate objective of the Convention is to stabilize Green House Gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to Climate Change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner." The Convention puts the onus on developed countries to lead the way. The idea is that, as they are the source of most past and current Green House Gas emissions, industrialized countries are expected to do the most to cut emissions on home ground. They are called Annex I countries and belong to the Organization for Economic Cooperation and Development (OECD). They include 12 countries with "economies in transition" from Central and Eastern Europe. Industrialized nations agree under the Convention to support Climate Change activities in developing countries by providing financial support for action on Climate Change. The Convention takes this into consideration by accepting that the share of Green House Gas emissions produced by developing nations will grow in the coming years. Nonetheless, in the interests of fulfilling its ultimate goal, it seeks to help such countries limit emissions in ways that will not hinder their economic progress.

The Kyoto Protocol:

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012.

Under the Protocol, countries must meet their targets primarily through national measures. However, the Protocol also offers them an additional means to meet their targets by way of three market-based mechanisms: (i) International Emissions Trading (IET); (ii) Clean Development Mechanism (CDM); and (iii) Joint implementation (JI).

The mechanisms help to stimulate green investment and help Parties meet their emission targets in a cost-effective way. In Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of Green House Gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020.

The Bali Road Map: The Bali Road Map was adopted at the 13th Conference of the Parties and the 3rd Meeting of the Parties in December 2007 in Bali. The Road Map is a set of forward-looking decisions that represent the work that needs to be done under various negotiating "tracks" that is essential to reaching a secure climate future. The Bali Road Map includes the Bali Action Plan, which charts the course for a new negotiating process designed to tackle Climate Change. The Bali Action Plan is a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision. All Parties to the Convention were involved in crafting the Bali Road Map. The COP decided that the process would be conducted under a subsidiary body under the Convention, the Ad Hoc Working Group on Long-term Cooperative Action (AWG-LCA). The Bali Action Plan is divided into five main categories: shared vision, mitigation, adaptation, technology and financing.[5]

The Copenhagen Accord:

The 15th session of the Conference of the Parties to the UNFCCC and the 5th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol took place in Copenhagen, Denmark in 2009. It produced the Copenhagen Accord. The Copenhagen Accord contained several key elements on which there was strong convergence of the views of the Governments. This included the long-term goal of limiting the maximum global average temperature increase to no more than 2 degrees Celsius above pre-industrial levels, subject to a review in 2015. It also included a reference to consider limiting the temperature increase to below 1.5 degrees - a key demand made by vulnerable developing countries. Developed countries promise to fund actions to reduce Green House Gas emissions and to adapt to the inevitable effects of climate change in developing countries. Developed countries promised

to provide US$30 billion for the period 2010-2012, and to mobilize long-term finance of a further US$100 billion a year by 2020 from a variety of sources. The work of the two central negotiating groups, the AWG-LCA and the AWG-KP was extended by the COP.[6]

The Cancun Agreements:

The Cancun Agreements form the pillars of the largest collective effort the world has ever seen to reduce emissions, in a mutually accountable way, with national plans captured formally at international level under the banner of the UNFCCC. The Cancun Agreements, reached on December 11 in Cancun, Mexico, at the 2010 United Nations Climate Change Conference, represented key steps forward in capturing plans to reduce Green House Gas emissions and to help developing nations protect themselves from climate impacts and build their own sustainable futures. The main objectives include: (i) Mitigation; (ii) Transparency of actions; (iii) Technology; (iv) Adaptation; (v) Forests; (vii) Capacity building; and (viii) Finance. The objectives also include setting up the **Green Climate Fund** to disburse $100 billion per year by 2020 to developing countries to assist them in mitigating Climate Change and adapting to its impacts.

The Durban Agreement:

The United Nations Climate Change Conference at Durban in 2011, delivered a breakthrough on the international community's response to Climate Change. All Governments committed in Durban to a comprehensive plan that would come closer over time to delivering the ultimate objective of the Climate Change Convention: to stabilize Green House Gas concentrations in the atmosphere at a level that will prevent our dangerous interference with the climate system and at the same time will preserve the right to sustainable development. The developing countries, especially the poorest and most vulnerable, will need much more support to adapt to the change that is already embedded in the global climate system.

The Durban outcomes looked to address these challenges in a more connected way by embodying a road map for implementation. On this map, four main areas of coordinated and complementary action and implementation, designed also to build and preserve trust among countries, were agreed viz. (i) Second commitment period of the Kyoto Protocol; (ii) The launch of a new platform of negotiations under the Convention to deliver a new and universal Green House Gas reduction protocol, legal instrument or other outcome with legal force by 2015 for the period beyond 2020; (iii) Conclusion in 2012 of existing broad-based stream of negotiations; and (iv) To scope out and then conduct a fresh global Review of the emerging climate challenge, based on the best available science and data

The Doha Climate Gateway:

At the 2012 UN Climate Change Conference in Doha, Qatar (COP18/ CMP8), and Governments consolidated the gains of the last three years of international Climate Change negotiations and opened a gateway to necessary greater ambition and action on all levels. Among the many decisions taken, Governments:

- Strengthened their resolve and set out a timetable to adopt a

universal climate agreement by 2015, which will come into effect in 2020.

- Streamlined the negotiations, completing the work under the Bali Action Plan to concentrate on the new work towards a 2015 agreement under a single negotiating stream in the Ad hoc Working Group on the Durban Platform for Enhanced Action (ADP).
- Emphasized the need to increase their ambition to cut Green House Gases (GHGs) and to help vulnerable countries to adapt.
- Launched a new commitment period under the Kyoto Protocol, thereby ensuring that this treaty's important legal and accounting models remain in place and underlining the principle that developed countries lead mandated action to cut Green House Gas emissions.
- Made further progress towards establishing the financial and technology support and new institutions to enable clean energy investments and sustainable growth in developing countries.

So that the world has a chance to stay below an agreed maximum 2 degrees Celsius temperature rise, beyond which even more serious Climate Change impacts will occur, the Governments agreed to find ways to scale up efforts before 2020 beyond the existing pledges to curb emissions. Also in Doha, the UN Secretary General Ban Ki-moon announced that he would convene world leaders in 2014 to mobilize political will to help ensure the 2015 deadline is met.

Climate change and India's actions:

India's emissions are estimated to be of the order of 1331.6 million tones of the carbon dioxide equivalent Green House Gas (GHG) emissions in 2007. The emissions indicate an annual growth of 4.2% from the levels in 1994. Whereas India's CO2 emissions are only about 4% of total global CO2 emissions and much less if the historical concentrations are taken into account. Still India has been conscious of the global challenge of Climate Change.

In pursuance of the obligations cast on parties to the United Nations Framework Convention on Climate Change (UNFCCC), India has undertaken to communicate information about the implementation of the Convention, taking into account the common but differentiated responsibilities and respective capabilities and their specific regional and national development priorities, objectives and circumstances. The elements of information provided in the communication include a national inventory of anthropogenic emissions by sources and removals by sinks of all Green House Gases, a general description of steps taken to implement the Convention including an assessment of impacts and vulnerability and any other relevant information. India has submitted the Second National Communication (NATCOM) to the UNFCCC in 2012. The first National Communication was submitted in 2004. As per the Second national Communication submitted by India to the UNFCCC, it is projected that the annual mean surface air temperature rise

by the end of the century ranges from 3.5 c to 4.3 c whereas the sea level along the Indian coast has been rising at the rate of about 1.3 mm/year on an average. These climate change projections are likely to impact human health, agriculture, water resources, natural ecosystems, and biodiversity. India's strategy for addressing Climate Change is reflected in many of its social and economic development programmes.

National Environment Policy: National Environment Policy, 2006 outlines essential elements of India's response to Climate Change. These, *inter-alia*, include adherence to principle of common but differentiated responsibility and respective capabilities of different countries, identification of key vulnerabilities of India to Climate Change, in particular impacts on water resources, forests, coastal areas, agriculture and health, assessment of the need for adaptation to Climate Change and encouragement to the Indian Industry to participate in the Clean Development Mechanism (CDM).

Prime Minister's Council on Climate Change: The Prime Minister, Dr. Manmohan Singh, has set up a High Level advisory group on climate change issues which include: Government Representatives and Non-Government Members. The Council coordinates National Action Plans for assessment, adaptation and mitigation of Climate Change. It also advises the Government on pro-active measures that can be taken by India to deal with the challenge of Climate Change. It will also facilitate inter-ministerial coordination and guide policy in relevant areas.

The National Action Plan on Climate Change (NAPCC): The National Action Plan on Climate Change (NAPCC) coordinated by the Ministry of Environment and Forests is being implemented through the nodal Ministries in specific sectors/areas. On June 30, 2008, Prime Minister, Dr. Manmohan Singh released India‟s first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight core "national missions" viz. National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a "Green India", National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change. Emphasizing the overriding priority of maintaining high economic growth rates to raise living standards, the plan "identifies measures that promote our development objectives while also yielding co-benefits for addressing Climate Change effectively." The NAPCC also describes other ongoing initiatives, including: (i) Power Generation; (ii) Renewable Energy; and (iii) Energy Efficiency

All national missions have been approved by the Prime Minister's Council on Climate Change and are at different stages of implementation. Under advice of the Central Government, State Governments are also preparing State Action Plans on Climate Change that are aimed at creating institutional capacities and implementing sect oral activities to address Climate Change. So far, 21 States namely Andaman and Nicobar, Andhra Pradesh, Arunachal Pradesh, Assam, Delhi, Jammu & Kashmir, Kerala,

Karnataka, Lakshadweep, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tripura, Uttarakhand, and West Bengal have prepared document on State Action Plan on Climate Change (SAPCC).[11]

Parliamentary Forum on Global Warming and Climate Change: The Forum was constituted for the first time in 2008 and since then has been involving parliamentarians to interact with specialists working on Global Warming and Climate Change. Shri Girish Sant, Co-Founder of Prayas, Pune and Coordinator of the Energy Group along with representatives of the Ministry of Environment and Forests and the Ministry of Science and Technology had been invited for giving a presentation on the Road Map for 20-25% Reduction in the emission intensity of Indian GDP by the year 2020 as communicated by Government of India to the UNFCCC". About specific plans of the Government in regard to Climate Change, Shri Sant apprised that Government was doing two major things, one the NAPCC and second the low carbon strategy for inclusive growth.

The Members of the Forum have been taking a lot of interest in the meetings by participating in the discussions. Presentations on various subjects relating to Climate Change like: Impact of Climate Change on Agriculture; Population, Resources & Biodiversity with reference to Climate Change; Technology and Climate Change; National Solar Mission and related initiatives under the National Action Plan on Climate Change; National Mission on Sustainable Habitat, etc. have take en place. These give insight into different perspective on the issue of Climate Change and mitigation methods.

Climate Change Action Programme (CCAP):

Various other science initiatives are planned by the Ministry as part of the Climate Change Action Programme (CCAP). These include National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO), and Coordinated Studies on Climate Change for North East region (CSCCNE). The NCAP is a major activity involving multi-institutional and multi-agency study. e-Action Programme (CCAP). These include National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO), and Coordinated Studies on Climate Change for North East region (CSCCNE). The NCAP is a major activity involving multi-institutional and multi-agency study launched in 2011. In this initiative, Ministry of Environment and Forests will collaborate with the Ministry of Earth Sciences, the Indian Space Research Organization, the Ministry of Science and Technology and other associated agencies to enhance the understanding of the role of Black Carbon in climatic change through monitoring and assess the impacts of black carbon through various modeling techniques. The work programme envisages three Working Groups namely Long term Monitoring of Aerosol (Working Group-I), Impact of Aerosol on Himalayan Glaciers (Working Group-II) and Modeling of Black Carbon emissions inventory India and assessment of its impacts (Working Group-III).

Indian Network for Climate Change Assessment (INCCA):

Steps have also been taken to increase capacity at the institutional level for conducting research into Climate Change science and making necessary assessments. The Ministry has already set up a network, namely the Indian Network for Climate Change Assessment (INCCA) comprising of 127 research institutions tasked with undertaking research on the science of Climate Change and its impacts on different sectors of economy across various regions of India. INCCCA has helped the Ministry put together its Green House Gas (GHG) Emissions Inventories and in carrying out other scientific assessments at more frequent intervals.

Twelfth Five-Year Plan and Climate Change: The Government has a domestic mitigation goal of reducing emissions intensity of Gross Domestic Product (GDP) by 20-25% by 2020 in comparison with 2005 level. The energy intensity of India‟s output has shown a declining trend owing to improvements in energy efficiency, autonomous technological changes and economical use of energy. This domestic goal and the objectives of the National Action Plan on Climate Change are proposed to be achieved through a sustainable development strategy under the Twelfth Five-Year Plan. Several thrust areas have been identified in the Twelfth Five-Year Plan for this purpose and a coordinated initiative to identify Nationally Appropriate Mitigation Actions and implement them towards this end will be taken during the Plan period. At the initiative of the Ministry, Planning Commission has recognized Climate Change as a major area of environmental intervention. „Climate Change Action Programme (CCAP) ‟ - a new thematic/umbrella Scheme has been approved by the Planning Commission for implementation during the 12th Five year Plan. The scheme aims at advancing scientific research, information and assessment of the phenomenon of Climate Change, building an institutional and analytical capacity for research and studies in the area of Climate Change, and supporting domestic actions to address Climate Change through specific programmes and actions at the national and state level. The scheme comprises of eight activities, of which, three relate to scientific studies on Climate Change, two to institution and capacity building and three others to domestic and international actions.

Other Initiatives:

The year 2012 was also marked by several parallel international initiatives on Climate Change. India organized the Xth BASIC Ministerial Meeting on Climate Change in New Delhi during 13-14 February, 2012 to facilitate exchange of views on outcomes of the Durban Conference and evolution of common BASIC position on key issues in Climate Change. Besides the BASIC countries comprising of Brazil, South Africa, India and China, representatives of Swaziland, Singapore and Qatar were also invited to the meeting. During the year three more meetings of the BASIC group were held in different locations in South Africa, Brazil and China. India also participated in the meetings of the Major Economies Forum and the organized by the United States of America (USA) and the Petersburg Dialogue initiated by Germany. At the sub-regional level, India partnered with Bhutan, Nepal and Bangladesh for cooperation to address adverse effects of Climate Change

through adaptation actions in the four thematic areas of Food, Water, Energy and Biodiversity. [16]

Renewable Energy Procurement Obligation (RPO) has been the major driving force in India to promote the renewable energy sector. However, the NAPCC has not set any target for RPO. The Mission Document on Jawaharlal Nehru National Solar Mission has indicated that RPO is the key driver for promoting solar power. Further, the National Tariff Policy (NTP) 2006 was amended in 2011 to prescribe that solar-specific RPO be increased from a minimum of 0.25% in 2012 to 3% in 2022.

The Government closely works with its partner countries in the international negotiations on Climate Change. Negotiations in this regard are being conducted under the auspices of United Nations Framework Convention on Climate Change (UNFCCC). At the Doha Conference, India pursued the strategy of working together with the Group of77 & China in order to protect the overall interests of developing countries. During the Conference, India raised the issues of equity in Climate Change related actions and commitments, technology-related **Intellectual Property Rights (IPRs)** and unilateral measures taken by some countries in the name of Climate Change and succeeded in having these issues included in the ongoing work of various bodies of the Convention. India successfully defended the nature of its voluntary domestic goal of reducing emissions intensity of its Gross Domestic Product (GDP) by 20-25% by 2020 in comparison with 2005 level and ensured that agriculture, a sensitive sector of our economy, was not included in the mitigation work programme proposed to be launched at the global level.

Conclusion:

The World Bank Report "Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience" published in June 2013, projects that a scenario of 4o C rise in global temperature, would result in increased climate extreme events such as heat waves, sea level rise, more storm surges, droughts and flooding in the South Asian region including India. The coastal and deltaic regions of India are reported to be particularly vulnerable to the risks of flooding including two Indian cities of Mumbai and Kolkata. The Ganges, Indus, and Brahmaputra—are also vulnerable to the effects of climate change due to the melting of glaciers and loss of snow cover resulting in significant risk of flooding. The Government is implementing the National Action Plan on Climate Change (NAPCC) with a view to enhance the ecological sustainability of India's development path and address Climate Change. The Government regularly reviews the progress under the National Action Plan on Climate Change (NAPCC), based on the information provided by the concerned nodal Ministry. The Government has also constituted an Executive Committee on Climate Change in January, 2013, under the chairmanship of Principal Secretary to Prime Minister to assist the Prime Minister"s Council on Climate Change in evolving a coordinated response to issues relating to Climate Change at the national level and to monitor the implementation of the eight National Missions and other initiatives under the NAPCC.[19]

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Solar Energy and Economic Development in India: Issues and intricacies

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Abstract: *Shortage of electricity prompted the countries to give a momentum to renewable energy resources. Renewable energy refers to energy resources that Aries naturally and repeatedly in the environment and can be harnessed for human benefits. It includes solar, wind and geothermal energy. We also get renewable energy from tree and plants, rivers and even municipal solid waste. We discuss in this paper about solar energy. In rural areas the major problem is deficiency of electricity and because of this these areas are still far behind then urban areas in case of development.. India's grid system is considerably under developed, with major section of its populace site surviving in deficiency for electricity. As per the record of 2006, there are 80,000 un-electrified villages in the country, out of which 18,000 villages are not electrified till now. Indian government in the budget of 2010- 11 has allocate Rs. 1000 crore approx for Jawaharlal Nehru National Solar Mission including clean energy fund establishment. It can give satisfactorily result towards the development and enhancement of solar energy equipment. In this paper we discuss an overview of global solar energy, Indian solar energy, economic development and solar energy potential.*

Keywords: *Renewal Energy, solar energy, thermal Energy, solar PV*

I. Introduction:

Source of reliable renewable energy production and development become a major challenge to the most of the part of the world. For human development renewable energy source specially solar power can have positive effect, since energy is one of the important factor for the development of country as well as individuals, also as we all know that many other renewable energy plants are of large scale. For the development of country energy sector plays an important role.

As the country's expenditure on the conventional products like petroleum product increase and the availability of these products in future in insecure and volatile, that's why alternative approach has to be done to explore and developed other sources of energy. Solar energy is one of these alternative sources. India is densely populated and has high solar insolation, an ideal combination for using solar power in India.

Ii. Renewable energy:

Renewable energy source also called non-conventional source of energy that are continuously recycled by nature. For example wind energy, solar energy, hydro power, bio fuel etc. Directly or indirectly renewable energy comes from either sun or wind and these can never be exhausted, that's why these are called renewable source of energy. A renewable energy system converts the energy we get

from wind, sunlight, falling water, geothermal heat, sea waves, or bio mass in to a form we can use as electricity or heat. However most of the world's energy sources are derived from conventional sources fossil fuels such as oil, coal and natural gases. These sources are termed as non-renewable energy resources. Although the quantities of these fuels are very large, they are finite and hence in future they will be run out some time. In 2008, renewable energy has a contribution of 19% in the total energy consumption globally, in which about 13% of energy contribution is from traditional biomass, 3.2% of energy contribution from hydroelectricity and 2.7% of energy contribution is from other source of renewable energy like wind power, hydro power, solar power, geothermal energy. As on 31 March 2012 the total potential coming from renewable source in India is about 89774MW.

There are many application of solar energy the main applications are: water heating, space heating, solar air conditioning, solar distillation of water, solar ponds for the production of salt, cooking, electricity production etc. Total Renewable Energy Installed Capacity in India (October 2013): Source Total Installed Capacity (MW) Wind Power 19,933.68 Solar Power (SPV) 2,079.97 Small Hydro Power 3,746.75 Biomass Power 1,284.80 Bagasse Cogeneration 2,392.48 Waste to Power 99.08 Total 29,535.76 III. SOLAR ENERGY Solar energy is the energy coming from the sun in the form of solar radiation for heat or to generate electricity. Solar powered electricity generation uses either photovoltaic or heat engines (concentrated solar power). The other important application which uses solar eneryc includes space cooling and heating through solar architecture, day lightning using solar panel, and industrial purposes like high temperature process heat, solar hot water and solar cooking.

We can broadly classify solar technologies in to two types as active technology and passive technology depending upon the method how we can capture, convert and distribute the energy coming from the sun. In active solar techniques solar thermal collector and photovoltaic panels are used to extract the solar energy from sun. In passive solar techniques includes a building oriented to the sun, material selection wit favorable light dispersing properties or thermal mass and designing naturally circulating air spaces. The captured solar energy can also be linked to research which involves carbon dioxide reduction and water splitting for solar fuel or artificial photosynthesis development. The International Energy Agency in 2011 said that "for longer-term benefits it is essential to develop of clean, inexhaustible and affordable solar energy technologies. Thus countries' energy security can be increased by this through reliance on an inexhaustible, indigenous and mostly import independent resource, reduction in pollution, enhance sustainability, cost reduction in mitigating changes in climate condition, and keep the price of fossil fuels lower than otherwise.

Iv. Solar energy in India:

India was the first country in the world to set up a ministry of non-conventional energy resources, in early 1980s. India already becomes a leader in wind power production. In the field of solar energy production, some large scale projects have been proposed, and a 35,000 km2 area of the Thar Desert has been set

aside for solar power projects, sufficient to generate 700 GW to 2,100 GW. Also India's Ministry of New and Renewable Energy has released the JNNSM Phase 2 Draft Policy, by which the Government aims to install 10GW of Solar Power and of this 10 GW target, 4 GW would fall under the central scheme and the remaining 6 GW under various State specific schemes.

According to a 2011 report by BRIDGE TO INDIA and GTM Research, India is facing a perfect storm of factors that will drive solar photovoltaic (PV) adoption at a "furious pace over the next five years and beyond". From August 2011 to July 2012, India went from 2.5 MW of grid connected photovoltaics to over 1,000 MW. India's theoretical solar power reception, with about 300 clear, sunny days in a year, on only its land area, is about 5000 Petawatt-hours per year (PWh/yr) (i.e. 5000 trillion kWh/yr. The daily average solar energy incident over India varies from 4 to 7 kWh/m2 with about 1500– 2000 sunshine hours per year (depending upon location), which is far more than current total energy consumption. However, India is ranked number one in terms of solar energy production per watt installed, with an insulation of 1,700 to 1,900 kilowatt hours per kilowatt peak (kWh/KWp) also 25.1 MW was added in 2010 and 468.3 MW in 2011. The Charanka Solar Park, at 221 MW the largest in the world, was commissioned on April 19, 2012, along with a total of 605 MW in Gujarat, representing 2/3 of India's installed photovoltaic. Large solar parks have also been announced in the state of Rajasthan. The 40 MW Dhirubhai Ambani Solar Park was commissioned on March 31, 2012.

V. Solar energy in the world:

Germany is the world's top photovoltaic (PV) installer, with a solar PV capacity as of December 2012 of more than 32.3 gig watts (GW). The German new solar PV installations increased by about 7.6 GW in 2012 and solar PV provided 18 TWh (billion kilowatt-hours) of electricity in 2011, about 3% of total electricity. Some market analysts expect this could reach 25 percent by 2050. Germany has a goal of producing 35% of electricity from renewable sources by 2020 and 100% by 2050. As of April 2013, the largest individual photovoltaic (PV) power plants in the world are Agua Caliente Solar Project, (Arizona, over 250 MW connected - to increase to 397 MW), California Valley Solar Ranch (CVSR) a 250 megawatt (MW) solar photovoltaic power plant, by Sun Power in the Carrizo Plain, northeast of California Valley, Golmud Solar Park (China, 200 MW), Welspun Energy Neemuch Project (India, 150 MW), Mesquite Solar project (Arizona, 150 MW), Neuhardenberg Solar Park (Germany, 145 MW), Templin Solar Park (Germany, 128 MW), Toul-Rosières Solar Park (France, 115 MW), and Perovo Solar Park (Ukraine, 100 MW). Solar power in the People's Republic of China is one of the biggest industries in mainland China. Chinese solar panel production reportedly quadrupled between 2009 and 2011 to surpass the entire global demand. As a result, the EU accused China of dumping its solar panels in Europe at below-cost prices, involving20 billion U.S. dollars of trade between the two powers.

Solar thermal power stations include the 354 megawatt (MW) Solar Energy Generating Systems power installation in the USA, Solnova Solar Power Station (Spain, 150 MW) and Andasol solar power station (Spain, 150 MW). The 370 MW

Ivanpah Solar Power Facility, located in California's Mojave Desert, is the world's largest solar thermal power plant project currently under construction. The Solana Generating Station is a 280 MW solar power plant which is under construction about 70 miles (110 km) southwest of Phoenix, Arizona. There are plans to build many other large solar thermal plants. a) Solar PV: Led by Europe, the total operating capacity globally of solar photovoltaic reached up to 100 GW milestones, including last year significant increment in Asia. The market of solar photovoltaic is increasing day by day in almost all the region in the world like Africa, Asia, and Latin America. This can be due to the decrement in the price of solar PV. In 2012, there is an increment in self- generation and community owned systems, but scale of solar PV projects and the number of these projects also increases.

Many European, Chinese and United State manufacturer have to go out from the business, due to the decrease in the margin and prices sparred more industries consolidation. Also the manufacturer of module and cell has to struggle as the competition is very extreme in the market. The production of thin film's decreases 15% to 4 GW which further decreases the PV production globally. b) Concentrating Solar Thermal Power (CSP): An increment of more than 60% has been seen lately in total concentrating solar thermal power capacity globally which is about 2,550 MW approx. In which more than 75% of the world's capacity of concentrating solar thermal power was added in Spain. While about 1,300 MW in US is under construction process no increment in concentrating solar thermal power capacity has been seen in last year. In North Africa more than 100 MW of concentrating solar thermal power capacity was in operating mode. The industry of CSP is expanding in to Chile, Australia, India China, South Africa and the MENA regions. In Spain, for concentrating solar thermal power developers and manufacturers an uncertainty has been created due to the falling price of natural gas and Photovoltaic, policy changes and the downfall of global economy.

Vi. Energy and economic development:

For social as well as economic development of a country power sector plays an important role. However for the development it is essential to improve efficiency of the energy generation and avoiding too much dependency on fossil fuels, as the use of fossil fuel plays a key role for pollution and undesirable change in climate conditions. The power sector is the essential part of a country's economy as well as it contain the interaction of demand and supply of energy. Almost every economic activity requires energy. For the continuous production and final consumption supply of energy is essential need, hence enhancement of power sector is important for the economic development. But the economic factors like prices of energy, costs of capital, infrastructure etc affect the development and enhancement new technologies of power generation system. In concern to the environment, demands of energy should be combined with the effect on ecological system locally as well as globally. Hence the economic and environmental factors are considered in the planning and preparation of the energy generation to meet the demand of energy for the development of that region. India faces a significant challenge in providing access to adequate,

affordable and clean sources of energy, especially cooking fuel to a large section of the population, most of who live in rural areas. As per the 2011 Census, almost 85% of rural households were dependent on traditional biomass fuels for their cooking energy requirements. National Sample Survey 2009-10 reveals the continued dependence on firewood in rural areas for cooking. Solar energy is also a sustainable source of energy which is produced without any type of pollution, greenhouse effect or other affect to the environment. The development of low cost solar technologies can be a potential alternative with distributed energy generation consisting of a cluster of local grid of electricity network. It could be a cheap and environment friendly alternative to the centralized power grid system having long distance, expansive wires delivery system. Fuel consumption in the vehicles can be reduced by using solar panel for air conditioning purpose.

Vii. Conclusion:

In India renewable energy sources are in large quantity which can contribute significantly in the increasing demand of electricity. In this paper solar energy growth in India is reviewed¬ since its beginning in 1980's. Solar energy technology is currently making a major contribution in the field of economic development of country. A brief assessment of global status of solar energy in this paper indicates that a minimum level of maintenance appears necessary to encourage solar power deployment. At present there are several municipal incentive¬ provided to the solar power producer from state government and central government. In improving the level of villages, in this paper we have discussed to provide electricity on a cheap base to the consumers. A preliminary assessment of the status of solar power development in potential states of India indicates that there should be a stable and uniform policy to make solar power projects financially attractive across the country. An extension of off-grid relates to rural electrification. Over 40% of the country's population is currently denied energy access. This has become a major problem and, inspite of large investments under the RGGVY for rural transmission, it has been found increasingly difficult to provide this access, especially in certain identified areas, partly because of continuing supply constraints. But biomass and Solar PV based solutions are possible.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Energy And Environment - An approach to effective assessments in low data Environment: Evidence from Sikkim, India

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Abstract: *Program evaluations for conservation interventions have to take into account the complex interrelationships of various components in an ecosystem. Measuring direct impact can be difficult, given that changes are often the result of complex systemic interactions and can take a long time to evolve. Therefore, the focus of the paper is to bring forth the importance of designing an effective program evaluation in low data environments by adopting a multi-disciplinary approach. The paper illustrates this by identifying a framework to evaluate specific measurable ecological and societal outcomes that also assist in reviewing relevance and importance of implemented policy. For this, the paper uses learning's from an ongoing research project on evaluation of grazing exclusion policy in West district of Sikkim. The findings of study would serve as an input to further impact assessment studies on grazing ban. The paper reveals how program impacts can be established by using a mix method approach. It identifies precise measurable environmental outcomes that also assist in reviewing relevance and importance of implemented*
Key words: *conservation policy, impact assessment, grazing ban, effective assessment*

Introduction:

Pastoralism is an age-old practice and a livelihood strategy adopted by many communities across the globe. In India itself there are many indigenous pastoral tribes still practicing traditional pastoral forms supported by community norms: Gujjars and Dhangars in North India, Gaddis in Himachal Pradesh, Bakarwals in Kashmir, Toda and Kuruba in southern India and Gurungs and Monpas in North East to state a few. However of late, there is a rise in cases of conflicts between the pastoral communities and the governing regimes over the resource use issue. This can be largely attributed to lack of transparency in explicit property rights regime and absence of robust institutional arrangements and rapid increase in resource exploitation rate. The problem is compounded by the fact that livestock numbers have been increasing exponentially, but technology and management practices have not kept up with the increased pressure on resources. With environmental degradation concerns rising, the outlook of central government has shifted to adoption of conservation-centric policies. Under the conservation-based approach, long term policies balancing economic development and conservation are being formulated. In the forestry sector, the paradigm shift towards environmental conservation and social focus was brought in with the revision of National Forest Policy, 1988. The emergence of Wild life population provides an opportunity for the degraded forest ecosystems to recover from degradation. Considering the high dependency of the rural population on forest resources,

policy implementation is a difficult task. There are contrasting perspectives on the suitability and appropriateness of such policy majors. Conservationists on one hand feel the need of such conservation centric policies while social scientists on the other hand are skeptic of them. Measuring direct impact can be difficult, given that changes are often the result of complex systemic interactions and can take a long time to evolve. Therefore, the focus of the paper is to bring forth the importance of designing an effective program evaluation in low data environments by adopting a multi-disciplinary approach. The paper illustrates this by identifying framework to evaluate specific measurable ecological and societal outcomes that also assist in reviewing relevance and importance of implemented policy. For this, the paper uses findings from an ongoing research project on evaluation of grazing exclusion policy in West district of Sikkim.

This section briefly describes the design alternatives for impact assessment type of exercise for conservation intervention and the challenges associated in applying them to low data environments. Subsequently, we discuss an effective framework that can be used to measure the impacts of conservation interventions. The area of conservation policy evaluation is still evolving and the rationale behind discussing the framework provided

Available impact assessment frameworks:

Based upon when the program evaluation is conducted, the two broad types of evaluation approaches for impact assessment type of studies are:

- ***Before and after assessment*** - Comprises of comparing a scenario before the intervention to the one after the completion of the intervention. Such an assessment can be resource intensive, particularly when new data sets need to be collected. These are difficult to carry out in the absence of baseline data. The exercise is most applicable for programs that are regularly monitored and where baseline information is available.
- ***Ex-post impact assessment***- Comprises of comparing an area or a group that has received the intervention to a similar area or group from whom the intervention was withheld. Such an assessment is characterized as summative evaluation and cross sectional data sets suffice the data need. The challenge in this case lies in establishing the "similarity" of the treatment and control groups – our ability to attribute current differences between the "treatment" and "control" group to the intervention being studied depends on how sure we can be that the two areas were similar before the intervention.

Adopting any of the above type of evaluation approach requires / necessitates a rich repository of available data sets which is usually difficult in real life projects. Establishing clear control sites or control groups is the crucial step in the ex-post assessments. For conservation intervention in the forestry sector that would mean identifying a site that has similar environmental, social, and economic characteristics as the proposed study site, but where the implementation of the conservation intervention differs from the study site.

Quantitative strategies using either of experimental, quasi experimental or non-experimental designs can then be applied to attribute the causal relationship. Experimental designs require complete random assignment of subjects to the control group and hence are tricky to apply in field situations for conservation interventions. Quasi experimental designs are relatively easier than experimental designs but they too require establishing a comparison group and their effectiveness depends a lot on the way the comparison group is established. In real life situations, the resource and time constraints are overriding factors that affect conducting such in-depth evaluations. Also, such evaluation shows the impact on a single entity i.e. dependent variable which could be variable on deforestation rate or species specific. Such evaluations rarely capture or provide an explanation for the change in the ecosystems due to the intervention.

Prolonged interval between intervention and the impacts:

Conservation interventions take substantial time for the ultimate impacts to show. Usually the policy interventions are designed for short to medium time frames. While the time taken by ecosystem to reflect the impacts of the intervention could be considerably more than that. In such cases, the evaluations conducted immediately after the intervention would not be able to capture the ultimate impacts. In such cases selecting appropriate associative parameters to measure the intermediate outcomes and to gauge the direction of the impact becomes a crucial step.

Expert knowledge: Conservation interventions require a multidisciplinary approach. For a robust design inputs are needed from a variety of fields such as ecology, pedology, hydrology, imagery & social sciences. Besides these, local experts having in-depth knowledge and understanding of the area are also essential. Getting a multi-disciplinary team for small scale projects is an enormous challenge.

Resource constraints: This is an overriding in most of the impact assessments constraint. Impact assessment studies are time and cost intensive. The scope of the study and design that can be employed depends to a great extent on the type of budget and time available for the study. Typically limited gets and time are available for such studies as policy makers or governmental bodies who mostly commission such studies require rapid and informative assessments.

Mismatch of scales: The boundary of protected area network does not match with the administrative boundaries of districts and states. For example in Indian Forestry, the records might be available at a forest circle or forest division level which would not correspond with administrative boundary of a district. So it becomes to inter-link the socio-economic and ecological variables in such cases. Also sometimes the study is conducted at the micro level and secondary information is available only at district level. It becomes difficult in either case to utilize the data as micro level site could differ significantly from the larger landscape such as district in many ways.

Blanket policy prescriptions: Forming control groups is an essential approach in most of impact evaluation designs. For

conservation projects, to ascertain the causal relationship this translates to finding a control site and a control group similar to the study site (treatment) but which differs in implementation of the conservation policy. Usually policy prescriptions in conservation are brought in for a larger landscape (national or state level) and they usually cover all the protected forest areas and reserved forest areas. Thus, establishing control site or a control group becomes in these contexts.

Evaluation design components for effective assessment: The various elements in an ecosystem are inter-linked with each other. A change in the status of one is bound to cause an alteration in some of the other elements. Accordingly, successful implementation of the ban is supposed to improve the condition of the degraded forest dscape, but it is necessary to fully understand what aspects of the forest it helps more than others as well as where its impact could be strengthened. Evaluations can also help understand other, potentially confounding, influences on forest health. Restricting the analysis to ecological characteristics in such a study can provide highly misleading policy inputs as it would overlook the opportunity costs of livelihood foregone by local communities. Thus, indicators referring to impact on welfare of people and ecology, both should be used as the basis of designing a holistic & effective program evaluation of the conservation intervention.

Vegetative component:

One of the prominent and observable changes induced due to grazing is on vegetation in an area. When the density of domestic livestock increases, it leads to overgrazing of an area. Continued grazing pressure on forests could lead to change in species composition in the long run due to selective lopping and cutting of preferred fodder and firewood species. Also, this may cause increased abundance of unpalatable species and introduction of nonnative invasive species. Other than grazing by livestock the vegetation is also impacted by the activities of the herders. Also, increase in livestock densities leads to competition between wild herbivores and domestic livestock. Some of the issues could be site specific and it is important to understand and include those vegetative parameters in the evaluation. Table1. Presents a list of important parameters that should be considered for a grazing related evaluation study. **Physical component:**

Overgrazing is a common phenomenon in pasturelands and forest areas and consequently it leads to deterioration in land quality and creation of wasteland. Typically an area subjected to overgrazing becomes more susceptible to threats like soil erosion, soil compaction and loss in moisture holding capacities besides other. While overgrazing could be a problem, available literature also shows instances where controlled grazing is beneficial to the site and has helped in improving the fertility of the area. Study of edaphic factors and hydrology constitutes a challenging task. Table 2 presents some main parameters to capture the soil stability and hydrologic functions for grazing affected forest lands.

Table: 1 Identified Vegetative parameters for evaluation of grazing related studies

Parameter	Description	Recommended Indicators
Forest structure	Forests are characterized by vertical layers typically consisting of ground floor, understory, and middle storey and over storey. Lopping and cutting of trees introduce alterations in the forest structure by making forests more open. And sometimes the pressures are felt more by a particular age-class distribution of trees.	Percentage of canopy density, Presence and status of forest layers, DBH distribution, tree height distribution
Species composition And distribution	Grazing and associated activities possibly could alter the vegetative composition of an area via activities like selective grazing, lopping etc. It is important to examine the extent of change brought about mainly in key species & medicinal plants from ecosystem and community needs point of view.	Three most common species as percentage of total growing stock, Ten most common species aspercentage of total growing stock, Diversity indices, Species at risk, Fodder species as percentage of total growing stock, Fuel wood species as a percentage of total growing stock, Existence and distribution of medicinal plants, litter distribution, presence and distribution of medicinal plants
Wildlife sightings	Wild animals are extremely sensitive to changes and disturbances in their habitat. It is a measure to predict the impact on wildlife in the area	Area of plantations for habitat improvement works Number of sightings of wildlife /calls
Regeneration	Regeneration is one of the most important functions that are hampered by grazing. It is a measure to observe the status of recovery via regeneration	Species wise number of saplings, Coppice Regeneration
Forest disturbances	It is important to examine the extent of change brought about by disturbance such as grazing, fire, cutting, lopping and introduction of nonnative and invasive species. This measure captures the vegetative health of the ecosystem	Presence of domestic livestock Percentage of vegetation affected by grazing, Area affected by forest fire, Percentage of area affected by lopping, cutting etc Species affected by the disturbance, Percentage of area under non native or invasive species

Social component:

In order to do a holistic impact evaluation, the study of the impact of conservation policy (in this case grazing exclusion) on the local economy and the lives of dependent local communities is essential. The significance of this aspect is for several reasons: first, the social component is important for assessing successful proliferation of the intended outcomes of the conservational policy i.e. grazing exclusion. Second, peoples' perceptions of the impact of a ban can be as important, if not more important, than its actual impact. The sustainability of any changes depends on the policy being either enforced or incentive compatible with the local community. Third, the social component may help to develop a more robust strategy if credible historical data based on peoples' recollections can be gathered. Such data must be handled with care, but it could help us do some limited before-and-after comparisons, which would in turn strengthen confidence in our results.

Table 2 : Identified physical parameters for evaluation of grazing related studies

Parameter	Description	Recommended Indicators
Soil composition, texture and structure	Soil constitutes a basic element of forest ecosystems. Health of the vegetation in an area is directly dependent on the health of the soil at a place. This measure attempts to capture the soil properties in the area	Percentage of Moisture Water holding capacity Bulk Density Particle Density Porosity Soil texture
Soil chemical composition	Nutrient rich soil aids vegetative growth and in turn assists in improving habitat quality. Fertility of soils is a significant factor especially in hilly areas. Controlled grazing is considered beneficial for improving the soil quality at a place. This parameters gauges the effect of grazing on the nutrient levels	Level of acidity (or alkalinity) Soil Nutrients (N,P,K) Soil Organic Carbon content Cation exchange capacity
Soil stability	Vegetative cover or presence of organic matter in the top layer of the soil binds the soil particles together, in turn decreasing the erosion potential. The other factor is the Structure of the top layer of soil itself. Loosely bind soils are more prone for erosion. In hilly terrains having steep slopes, water flow increases gullies and rills formation, which in turn accelerates soil degradation	Soil stability test results Soil erosion status Soil compaction Gullies and Rills formation

	Livestock tracks tend to result in gully formation especially in mountainous regions. This parameter classifies the erosive properties and degradation at site.	
Water quality	Quality of water in a catchment is a function of many factors. Undisturbed catchments will tend to have better water quality than the ones with disturbance. This parameter evaluates the water attributes.	Status of Water streams (seasonal/perennial), water quality tests
Water quality	Quality of water in a catchment is a function of many factors. Undisturbed catchments will tend to have better water quality than the ones with disturbance. This parameter evaluates the water attributes.	Status of Water streams (seasonal/perennial), water quality tests
Recharge of aquifers	pressures hamper the hydrological regime by impacting infiltration rates and percolation rates and increasing surface run off. This parameter attempts to capture any change in hydrological properties after the ban on grazing	Status of Water streams (seasonal/perennial), water quality tests average ground water level in water bodies in the vicinity of forests during past 3-5 years

Evolution of pastoral practices:

Sikkim is a small peaceful State in the Himalayan Ranges with total geographical area of about 7096 sq. km. About 80% percent of its geographic area is notified as recorded forest area (FSI, 2009). The State plays a vital role in biodiversity conservation at the global level as it is located in Eastern Himalayan Region, one of the 34 global biodiversity hotspots (DFEWM, Sikkim, 2011). In the study area, local communities such as Gurungs, Bhutias, Limboo, Chettri and Sherpas have been traditionally practicing agro-pastoral form of livelihood. The livestock composition of the area included *cow, yak, dee, dzo & urang (yak* and cow cross breeds), and sheep. In the area, the pattern of domestic livestock composition has changed a lot over the last 7 decades. Until mid-1970's, the livestock ownership was more for subsistence purpose and was mainly composed of a few cows or buffaloes or sheep.

With Sikkim becoming part of Republic of India in 1973, and the markets opening, the subsistence model started changed to commercial scales. Around this time yak herding was introduced in the landscape and this led to the advent of heavier animals such as yak, dee, urang & dzo (yak-cow hybrids) grazing in the landscape. Over the next two decades, the livestock population (of yak, dee, urang, dzo) increased exponentially while that of

sheep and buffalo reduced drastically. The increased livestock density started affecting the health of forest ecosystems and subsequently the State government of Sikkim laid a ban on open grazing of domestic livestock in reserved forests in 1998. The ban was implemented phase-wise and now covers all the protected forest areas in the State.

Impacts of pastoral life style: need for conservation centric approach:

Prior to the ban, pattas (permits) were given to herders for grazing their livestock in forest areas. As part of the livestock management system, a goath (cattle-shed) would be established in the forest area where the herder would reside sometimes accompanied by family or caretaker. Average herd size in the region was 20-25 cattle. Vegetation in and around the cattle-shed would be cleared to create kharka (open space for grazing). Also in adjacent areas of the cattle-shed trees would be heavily lopped off for fodder and cut for firewood and timber. Herders would stay in one location till there was sufficient grass in the area to support the livestock. After grass depletion in an area, they would move to the next location. The movement of the herders depended upon availability of fodder, water, livestock type and hence was seasonal in nature. During summer, particularly from April to September, cows were left to graze freely in forests in the temperate zones while movement of yaks, urang and dzo was restricted to sub alpine zone. During winter, cows would be brought back to the agricultural fields while other livestock types would proceed to lower altitudinal mixed coniferous forest and temperate forests. Each herder would lop on an average two head load of firewood (1 head load is approximately 40 kgs) and minimum 2 equal quantity of fodder from the forests every day. It was this with increasing anthropogenic pressure that led to rapid degradation of the forest areas. Consequently a ban was implemented in order to stop the degradation further.

Evaluation of socio-economic aspects– our approach:

The key aspects studied under socio-economic aspects include livelihood strategies, resource use, asset ownership with details from this section a total of 100 households were surveyed with 50 ex-herders and 50 non–herders. A combination of techniques was used to capture the data. Focused group discussions (FGD) and key informant interviews were conducted at each of the sites. Members from Eco development committees and Joint Forest Management Committees were present for the FGDs. Most of the members were ex-herders. Evolution of pastoral practices in the area, livestock composition and population change dynamics over the years, fodder and firewood preferences, distribution of key species before the imposition of grazing ban across forest types and their perceptions on the policy were the key points that were covered during these discussions. Also, resource maps were prepared for the forest types depicting important grazing areas and water sources. Thus, a rich repository of information was generated through these participatory methods. The study has adopted the framework discussed in the earlier section to carry out a rapid and robust assessment of the grazing exclusion issue at the study sites. While designing the evaluation framework for impact assessment, we encountered huge data gaps. There was no baseline data for the given study areas. Alternatively

selecting a control site was a most challenging task. As the policy implementation was done simultaneously across the district, it was difficult to establish robust control site and control group. The study has been carried out in a low data environment and the framework was designed to provide inputs to policy makers on critical parameters.

Conclusion:

The purpose of carrying out evaluation of conservation policies is to provide the policy makers with meaningful and reliable information on the outcomes and impacts achieved by the policy on ecosystems as well as on the local communities. The quantitative designs of impact assessments are statistically more robust and establish casualty but in real life conservation projects, it is difficult to implement such designs. Also in certain cases it is difficult to create treatment and control groups. In low data environment, using alternative design options and frameworks using mix method approach as presented in the paper offer useful insights on policy relevant parameters. The presented framework integrates qualitative and quantitative techniques, and it serves as an effectual approach to program evaluation for conservation interventions. The quantitative techniques provide the necessary logical base and ascertain the relationships statistically while the qualitative techniques help in substantiating the findings of the study. Thus it presents a feasible methodology for assessing impacts in the absence of detailed longitudinal ecological or socio-economic data.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

India's intended nationally determined contributions: renewable energy and the pathway to Paris

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Abstract: *Countries such as India, likely to be acutely impacted by climate change would need to develop a strategy on two formats: pressing major emitters to increase their mitigation targets; and ramping up its own ambition to reduce the vulnerability of its own population to climate risks. Our analysis suggests that India could push its ambition towards a target of 1,041 billion units of electricity from renewable energy sources by 2030. Therefore, it is imperative that discussions around technology partnerships and financial mechanisms be an important pillar of any new climate agreement.*

Key words: *Climate Change, vulnerability, renewable energy*

Introduction:

The 20th Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) concluded in the early hours of 14 December 2014. While some basic directions on areas of inclusion for the Intended Nationally Determined Contributions (INDCs) have been provided in the COP decision at Lima, for the most part it still remains an open ended decision left to individual countries. The safe level has been assumed as one that provides greater than 66% likelihood of staying within a 2oC degree rise in temperature above pre-industrial levels. 2 Our analysis suggests that India could push its ambition towards a target of 1,041 Billion Units (BU) of electricity from renewable energy sources by 2030. This would translate to cumulative emissions of 3.4 Gt of CO2 equivalents (CO2 eq.) and per capita emissions of 2.25 tonnes of CO2 eq. in 2030. However, this target would require an incremental cost of approximately INR 39,320 billion (2010, INR) (2010, US$ 715 billion) over the next 15 years and could make the consumption of a threshold level of electricity unaffordable for the bottom two deciles of Indian households. Contributions and Actions of Major Emitters: Implications for the Rest of the World –In order to assess the fairness of a potential Indian INDC, it is important to understand the actions and intended contributions of other major emitters (the United States, the European Union, China, Japan, Australia and Canada). Following an analysis of the contributions, this section also analyses the carbon space that remains for the rest of the world including India.

Contributions and Actions of major Emitters: Implications for the rest of the World: In order to limit to a 2oC global rise in temperature, various reports

including Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5) and the United Nations Environment Programme's 2013 version of the Emissions Gap Report estimate that the total budget for CO2 emissions is approximately 1,000 Gt of CO2 eq. While the scientific community has broadly reached consensus on the global emissions pathway, allocation of the annual budgets to each individual country remains a hotly debated topic. This brief does not attempt to create an equity allocation framework, but merely lists out the actions undertaken, the pledges that the major emitting countries have made and how these translate to the carbon space available for remaining countries.

European Union:

During the 15th COP in Copenhagen, the EU had declared a 20% reduction target by 2020 below 1990 levels. Additionally, it also had a target of 30% reduction by 2020, conditional on commitments made by other countries in proportion to the one made by EU. These two numbers were used to create straight line projections of reduction pathways for the region . Consequently, the grey band indicates the maximum and minimum extent of the region's ambition (the former subject to global commitments). In late October 2014, the EU announced its intention of reducing the region's GHG emissions by 40% over 1990 levels by 2030 and 80%-95% by 2050 (indicated as Pre-Lima).

United States: In 2009 at Copenhagen, the US announced its reduction targets of 17% and 83% for 2020 and 2050, over 2005 levels, respectively. Additionally, the announcement also included a tentative reduction target of 42% for 2030 to indicate the expected pathway leading up to 2050. The three numbers were interpolated and resulted in a straight-line reduction pathway. In November 2014, the US and China made a joint announcement which would be the bases of their respective INDCs. For the US this entails a 26%-28% emissions reduction by 2025 over 2005 levels. 7 This Pre-Lima announcement for the US lies on the lower side of the straight line interpolation, hence indicating nothing new or ambitious as compared to its Copenhagen announcement. The Kyoto Protocol target for the first commitment period is not indicated in the graph below for reasons that the United States did not ratify to the protocol. However, as per the GHG inventory submissions made to the UNFCCC, the United States had actually increased its GHG emissions by 4.3% in 2012 as compared to 1990 levels (excluding LULUCF). 8 Further, this accounted for a net increase of 0.28 Gt of CO2 eq. in 2012 from 1990 as opposed to what should have been a net decrease of 0.70 Gt of CO2 eq. as per the KP-I targets.

China: China, still a developing country, has not declared any absolute emissions reduction target so far. Prior to Copenhagen, China announced a carbon intensity reduction target of 40%- 45% by 2020 over 2005 level. Most recently, alongside the US, China announced its peaking target around 2030 and 20% contribution of non-fossil fuel in its total primary energy consumption mix by 2030. While the increase in the share of primary energy consumption sounds ambitious, a straight-line projection including previous domestic targets indicates that the declared target of 20% may be lower than what the country could achieve with a constant rate of

growth of non-fossil fuel consumption beginning in 2013.

India and china: differences in scale and nature of emissions

Any submission made by India as its INDC is bound to get compared with that of China. This is largely due to that the fact the two countries rank as the fourth largest and largest emitters respectively, and have been members of the same negotiating groups within the UNFCCC. Consequently, it is important to understand the differences in scale and context that exist between the two countries before analyzing components of India's INDC that would qualify as fair and ambitious. Table 2 provides economy and energy related information for India and China at different levels of development (2000, 2010 and 2020). India's and China's emissions have differed both in quantum and nature in the past While the story of incredible growth in both countries is well known, what is discussed less are the differing pathways of the respective development in the two countries. Specifically, India witnessed a growth in per capita GDP (PPP) of 121% between 2000 and 2010, but this occurred with a concomitant growth in absolute emissions of 69%. China on the other hand, grew at almost twice India's growth rate at 216 % but registered more than double the growth rate in emissions (143%). This difference in the nature of growth is reflected in both their emissions intensities. While both India and China aim to reduce their emissions intensities, and have done so, China's emission intensity has been higher in the past and is projected to be higher than that of India even in 2020. India's and China's actions to curb growth in emissions have been different at comparable levels of income Emissions intensity, are a function of macroeconomic policies, advancing technologies and industrial policies (which in turn are driven by a multitude of factors). On the other hand, the thrust on increasing renewable energy generation is a clearer indicator of the two countries' climate ambitions. Further, since both India and China house mammoth populations, energy needs feature high in their list of priorities. Renewable energy contribution to electricity was negligible in 2000 in both India and China.18 However, in 2010, its share in India increased to 4.4%, leaving China far behind at 1.7%. If large hydropower were included, China's share of renewable energy was only marginally more than India's in 2010 and would be slightly higher in 2020. For India, with a much smaller overall electricity generation capacity and a vast electricity deficit, share of more expensive renewable energy is a more commendable achievement. Consequently, In 2009, China and India came together with South Africa and Brazil to form the BASIC. More recently in 2012, the two countries joined ranks with ten other countries to form the group of Like Minded Developing Countries on Climate Change (LMDC)

Renewable energy here does not include hydro projects, as most of the hydro projects in both countries are classified as large. India and China: Differences in Scale and Nature of Emissions in the Past, Present and Future India will need to rapidly increase its installed capacity to provide electricity access to a quarter of its population. However, even in 2020, as per GCAM projections (as well as respective government publications), India will continue to march ahead of China in terms of renewable energy

contribution to electricity (GCAM projects 13.8% share of renewable energy in India's and 3.0% in China's electricity mix). The nature of emissions will remain different for both India and China in the decades to come Growth in China has chiefly been driven by manufacturing and industry, evidenced by the sector's contribution of 44% to the total GDP in 2013.20 This sector has been the major contributor to the country's emissions and is responsible for the increased demand for energy. Considering that China was already at a GDP per capita (PPP) of $11,907 in 2013, the country may not witness large growth in its already massive industrial sector in the years to come. In contrast, the industrial sector in India contributed a mere 25% to the national economy in 2013, with a much larger services sector accounting for 57% of GDP.23 At GDP per capita (PPP) of $5,412, India still requires many years of rapid growth to combat its development challenges. With an already dominating service sector, it is likely that the country will turn to industry to sustain its growth. The country's new government has similar plans of transforming India into a global manufacturing hub. 24As a result, although currently at a much lower level, the future rate of growth in emissions may be significantly more for India than China. This underscores the need for an adequate carbon space to accommodate India's industrial growth and energy needs.

India's contributions: balancing ambition and fairness:

The information provided by the Lima Call for Climate Action on form and content of the INDCs can be described as vague guidance at best. It is now up to individual countries to decide upon the appropriate balance between ambition and fairness, which in turn, will drive their climate targets. The following section therefore analyses the renewable contribution of India's climate targets as part of its INDC submission. Despite the fact that it is unlikely for most developing countries to commit to an absolute emissions reduction in 2030, it is critical that the various forms of ambitions be translatable to an absolute emissions number. This will help in assessing the adequacy of the communicated targets in limiting the rise to 2oC. Consequently, the final part of this section translates the suggested target to an overall emission number for India in 2030. This section forms the basis of point 14 of Decision -/CP.20, the Lima Call for Climate Action document, which calls for parties to justify the ambition and fairness of their INDCs.25 It specifically outlines three aspects of the targets – Ambition – the extent to which India can push its ambition for increasing domestic– funding, creating facilitating environment and ultimately make binding commitments for increasing the use of clean energy and decline that of fossil fuels Fairness – how these targets will be attained alongside India's primary goal of– achieving inclusive growth and eliminating the extant development challenges. An assessment of affordability of electricity in 2030 is presented in this sub-section. Reconciling Ambition, Fairness and Overall Emissions – includes the target, the– appropriate context that deems the target ambitious and the implications for India's emissions in 2030.

Ambition: In April 2014, an Expert Group on Low Carbon Strategies for Inclusive Growth submitted its report to the Planning Commission. The Expert

Group estimated the potential share of non-fossil sources in India's electricity mix, drawing on solar, hydropower, wind, biomass and nuclear energy. For the purposes of this analysis, we include renewable energy sources as solar, hydropower, wind, biomass and others (including geothermal, tidal etc.). Including large hydropower, renewable energy contribution to electricity in India was already at 16.3% in 2020. The current pace of growth in renewables and recently announced increase in targets indicate the presence of both ambition and enabling environment required to aid the acceleration of this contribution.26 However, aggressive targets for renewable electricity generation sources imply that tremendous growth rates in installation would be required in the years ahead. It would be useful to ground the expectations of such rapid growth in the realities associated with environmental clearances, acquiring of land for the projects and project financing cycles. For this reason, we conducted a bottom-up analysis as opposed to the extant modeling results that project growth of renewable endogenously based on macro-level growth patterns and projected demand in energy. Our analysis studies industry-specific growth patterns, government policies announced and are based on discussions held with industry experts and practitioners. Tables 4 and summarize the results of our analysis and include a comparison with the Low Carbon Inclusive Growth (LCIG) scenario numbers from the Planning Commission Report.

India generated almost 140 billion units of renewable energy in 2010. Consequently, renewable-based power generation needs to increase by more than seven times by 2030 to reach the above stated target of 1,041 billion units. By way of comparison, Germany achieved similar growth from 1990 to 2012. 28 India has to meet its targets in a much shorter timeframe. This indicates the scale of India's ambitions but also recognizes that renewable energy prices have fallen rapidly, technologies have moved along learning curves and new business models have developed. The aggressive renewable energy targets would not be easy to achieve but are not outside the realm of possibility either. The assumptions used to estimate growth rates for each renewable energy technology, and the supporting justifications for these assumptions –are outlined below.

Solar: All the discussions surrounding an aggressive target for solar are based on the recent announcements by the Government of India. While the programmatic details of these targets are yet to be announced, given the performance of the industry in the last four years, reaching 100 GW of solar by 2022 will be more than a challenging feat to accomplish. Although India is endowed with a large potential, the issues of grid connectivity for large solar parks and for roof-top systems is far from certain. Additionally, with a minute domestic manufacturing capacity, ramping up installations will require coordinated effort across policymakers, manufacturers, engineering contractors and other stakeholders. A National Wind Mission to have 100 GW by 2022 was one trigger for the industry to express that confidence in installations is rebounding. Discussions with industry stakeholders are being conducted to explore the possibility of increasing the target to 200 GW by 2030. Our assumptions of annual installations of between 10 and 12 GW

per year for a good part of the next decade are in line with these aggressive targets. Wind (unlike solar) is already cheaper than thermal generation in many states, if the Feed-in-Tariffs provided are any indication. 4. Nuclear – The 2006 Integrated Energy Policy envisaged that India would have up to 63 GW of installed capacity by 2032.34 In December 2011 this was revised down to 27 GW. In addition to the 4.3 GW that is under construction, 22 units have been proposed (with identified sites and technology) amounting to 21 GW of capacity35. Assuming suitable lead times for projects and accounting for the fact that more than half this proposed capacity is using 'imported' technology; an added lag is expected to account for negotiation and cost finalization. Spreading the proposed projects and under construction projects over the next fifteen years results in an annual addition of about 1.1 GW per year.

Fairness: With nearly 60% of its population surviving on less than USD 2 a day, India faces mammoth development challenges in the decades to come.36 despite the fact that the country is one of the biggest economies, the fact remains that India has more in common with some of the least developed nations in terms of growth needs. India's climate targets need to be consonant with its development needs. While this need not cap India's ambition in increasing renewable energy generation, it could have ramifications on the extent of renewable energy contribution in the total electricity mix. Our estimated target of 1,041 billion units from renewable energy translates to more than 30% of the total electricity generation in 2030 from renewable energy.37 further; the cumulative electricity generation number indicates 2,246 kWh of per capita electricity consumption. In contrast, consumption in China was already at 3,298 kWh per capita. 38 These numbers represent economy-wide consumption. However, for reasons of political and development concerns, actual residential consumption and affordability of the electricity would form the cornerstone of the country's policy decisions on increasing renewable energy generation. Therefore, we assessed the affordability of electricity in 2030 among household income deciles of the country. We studied the twin challenges of affordability and aggressive renewable targets through multiple scenarios.

India would not be in a position to declare peaking targets for a considerable time to come. Consequently, alternative formulations have been included in the list below to ensure that while India tackles its development challenges, ambition in climate change remains rooted in its actions: 1. Convergence in Income and Electricity Consumption – Along with periodic commitments on renewable energy targets, India could commit to declaring a peaking year when threshold levels for per capita GDP (PPP) and electricity consumption reach $10,000 and 4,000 kWh respectively. Strength this formulation would allow India to ensure sustained ambition in renewable energy growth, while allowing flexibility on the actual structure of the economy (for instance, relative growths in manufacturing versus services sector). It also avoids locking India into a peaking year, which would have no relation to how the overall economic development of the country is progressing.

Convergence in Human Development index (HDI) – In addition to periodic commitments on renewable energy

targets, peaking year commitments could be made contingent to India reaching a 0.70 value (against the 2013 value of 0.56) on its HDI. Strength There is many advantages to using HDI instead of GDP. First, HDI along with incorporating income also looks at other aspects of social welfare of the population. Further, actions on adaptation and increasing resilience to climate change are better captured by the HDI. Finally, UNDP has plans in the pipeline to link climate change impacts with the human development index, which would further strengthen the applicability of this indicator. Weakness linking a peaking year with the achievement of HDI may delay reduction in absolute emissions. Since the HDI is a relative value, dependent upon observed maximum values, in the remote event that rate of growth of the most developed country outpaces that of India's, achievement of 0.70 value may take longer than expected. Assuming an annual increase of 1%, India's HDI is expected to reach 0.75 in 2038 as compared to 0.586 in 2013. Finally, we translated the renewable energy target of 1,041 billion units in 2030 into absolute emissions, using GCAM numbers. A cumulative amount of 3.38 Gt of CO2 eq. is projected to be emitted by India; 2.25 metric tonnes of CO2 eq. in terms of per capita emissions. We assumed an overall generation of 3,373 TWh, with renewable energy accounting for over 30% of the total electricity generation. Coal still dominates amongst the fossil fuels accounting for nearly 50% of total electricity generation, followed by gas at 15%. When compared with the EU, the US and China, even in 2030 India's per capita emissions are a fraction of these countries' per capita emissions. This is despite housing nearly a fifth of the world's population.

Conclusion:

The INDCs present an important opportunity for India to showcase its climate leadership through the communication of its past, present and future ambitions in the climate arena. It is clear that leadership in climate change has not been forthcoming from some of the largest emitters. Therefore, countries such as India, likely to be acutely impacted by climate change would need to develop a strategy on two formats: pressing major emitters to increase their mitigation targets; and ramping up its own ambition to reduce the vulnerability of its own population to climate risks. Our analysis suggests that India could push its ambition towards a target of 1,041 billion units of electricity from renewable energy sources by 2030. This would be greater than the cumulative generation from all sources in 2013-14. 43 However, this ambitious target would add a significant burden to the economy and may even make electricity unaffordable to a large section of its population. Therefore, it is imperative that discussions around technology partnerships and financial mechanisms be an important pillar of any new climate agreement. Additionally, it may be useful to formulate a comprehensive framework to assess the capacity of developing countries to commit to peaking targets and similar climate commitments.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

The Geopolitical dimension of Maritime Security: Policies and Challenges

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Abstract: *This research article discusses the geopolitical dimension of maritime security, which has been neglected by scholars despite the growing number of studies devoted to a variety of aspects related to maritime security. The first step consists in clarifying the definitions of the two concepts; 'geopolitics' and 'maritime security'. Then the article introduces the geopolitical dimension of maritime security from a conceptual perspective, and then analyses three practical examples of maritime security geo-strategies released in 2014. The results demonstrate that states' and international institutions' maritime security objectives and interests are indirectly and directly influenced by geographical and geopolitical considerations, although this link is only tacitly acknowledged in official documents. Scholars and practitioners interested in maritime security are encouraged to further engage with this dimension.*
Keywords: *Maritime security, Geopolitics, Maritime security strategy, Projection.*

1. Introduction:

Maritime security is a fairly recent expression, which has become a buzzword in the past decade, especially within the maritime community. Maritime security can be understood as a *concept* referring to the security of the maritime domain or as a *set of policies, regulations, measures and operations* to secure the maritime domain. In academia, the term 'maritime security' was almost absent from the debates about the security of the maritime domain until the beginning of the 2000's. Since 2002, the number of references to maritime security in the academic literature has increased linearly. This increase in academic literature on maritime security can be explained by the conjunction of the three following factors: 1) the impacts of the 9/11 terrorist attacks (notably the launch of counter-terrorist operations at sea), 2) the occurrence of three high visibility terrorist acts against ships (USS Cole in 2001, French tanker Limburg in 2002 and Filipino passenger ship Super Ferry 14 in 2004), and 3) the rise of piratical attacks in the Strait of Malacca at the beginning of the century. Then the surge of piracy at the Horn of Africa between 2007 and 2012 largely contributed to generating academic debates beyond strategic and security studies, with scholars from various disciplines discussing the legal, criminal, cultural, economic, military, environmental and energy dimensions of piracy in particular and maritime security in general.

Between 1989 and 2014, Google Scholars lists more than 16,000 references comprising the exact phrase 'maritime security' compared to only 218 between 1914 and 1988. However, despite this academic interest, the geopolitical dimension of maritime security has been overlooked by

practitioners and scholars alike. Only a handful of scholars have started to discuss the link between maritime security and geopolitics, mainly focusing on the Indian Ocean, the European Union (EU). The aim of this article is to shed light on this overlooked dimension and to propose ways to integrate it within the emergent field of maritime security studies. The first step consists in clarifying the definitions of the two concepts; 'geopolitics' and 'maritime security', since both of them are open to various, often divergent and modular, interpretations. Then the article introduces the geopolitical dimension of maritime security from a conceptual perspective and analyses three practical examples of maritime security geo-strategies released in 2014, which demonstrate the importance of geographical and geopolitical considerations for maritime security studies.

Geography and maritime security:

Geographical 'permanence' such as the length of a country's coastline or the absence of direct access to the high seas constrains sea power in general and maritime security policies in particular, "for geography do not argue. This in no way means that politics and policies are determined by geography but that geographical factors need to be taken into account in the list of explanatory factors along with other material, structural and ideational factors.

Maritime security has to do with (illegal and disruptive) human activities in the maritime *milieu*, that is to say a certain geographically delimited space. Thus, states are differently impacted by maritime security threats depending on their actual geographical location. For example, in the case of illegal immigration by sea, Italy is more directly impacted than (for instance) the United Kingdom, because of its very geographical location. Sicily and especially the island of Lampedusa are located directly on the main (and one of the shortest) immigration route from North Africa to the EU and has thus sustained a constant flow of illegal migrants for the past decades. In other words, even if Britain, France or Germany may be the ultimate destination goal of illegal migrants crossing the Mediterranean on small boats, Italy, Spain (through the Gibraltar Strait) and Malta are more easily, quickly (and relatively safely) accessible by boat than the UK or even France, due to evident geographical factors. As a result Italy has to spend more resources on counter-immigration than many other EU states, which explains its recent request for the EU's assistance in dealing with counter-immigration at sea in central Mediterranean, leading to the launch of FRONTEX operation Triton in November 2014. This example illustrates that simple geographical realities have constraining impacts on states' maritime security policies, notably when it comes to regulating human activities at sea.

The same reasoning works for other types of illegal flow within the maritime domain. For example, drug smuggling directly impacts countries located on the main routes, such as Spain through the Gibraltar Strait, or those whose coasts are difficult to monitor due to a negative ratio between the length of the coast to police and the resources at the disposal of the navy/coast-guard. This can be the case for small states such as for example Ireland with limited resources and a rather extended coastline or powerful states such as the United States, which

despite the resources at the disposal of its coast-guard service has such a long coast to monitor and is the intended destination goal of so much drug trafficking that it still struggles to 'seal' its maritime borders. Here the geographical factor (length of coasts) is clearly not sufficient to explain the burden of counter-narcotics. Material power (such as the coast-guard budget) and drug traffickers' business strategies (privileged destination countries) need to be factored in the explanation. As shown in Table 1, the geographical factor is still very relevant. Despite the US deploying almost 20 times more coast-guard vessels, each of those vessels have a theoretical length of coast to monitor that is just 62 km shorter than the one devoted to each Irish offshore patrol vessels (OPV).

Table 1

Ratio between length of coast and coast-guard resources **(comparison Ireland –USA).**

	Length of coast (in km)	Number of coast-guard vessels	Ratio (km of coast per ship)
Ireland	1500	8 OPV	187
USA	20,000	More than 159 coast-guard vessels	125

States' involvement in maritime security also depends on non-geographical factors such as governments' capabilities and/or will to tackle maritime security threats. For example, Somalia has not been in a position to control illegal activities in its own territorial waters (hence the need for foreign maritime capacity-building operations, such as EUCAP Nestor). Empowering secessionist Somaliland's and autonomist Puntland's own coast-guard forces shows the importance of political will and material realities as explanatory factors. It has also been argued that in certain South East Asian countries, police or naval forces are reluctant to engage in counter-piracy activities and could even be "complicit in these crimes, especially in areas where a culture of corruption (possibly boosted by underpaid maritime security forces or smuggling activities) has evolved under years of authoritarian governments".

Due to the global nature of the maritime domain and to the transnational nature of many of the current maritime security threats (immigration, drug smuggling, piracy, etc.), countries not directly impacted by the threats coming from the sea can nevertheless decide to contribute to the policing efforts, based on the understanding that they will eventually be impacted later.

Maritime security (geo) strategies:

States and regional organizations such as NATO and the EU have interests linked to maritime security, which go beyond securing the freedom of the seas. Thus maritime security concerns integrate within broader geo-strategies. A number of states, as well as the EU, have recently elaborated specific maritime security strategies. These documents tend to include a geopolitical dimension,

although sometimes rather tacitly. This section analyses three maritime security strategies, all released in 2014: the UK National Strategy for Maritime Security (NSMS), the EU Maritime Security Strategy (EU MSS), and the EU Strategy on the Gulf of Guinea (GoG). This choice of text responds to the need to discuss current narrative practices, since the concept of maritime security has only recently been broadened (as discussed above). The texts are located in different planes, since the first was elaborated by a state (the UK) whereas the second and the third by a supranational actor (the EU). This allows conducting a comparison between the UK (that is to say a state with pro-active security policies and substantial material power to back it) and the EU Two variables are under scrutiny: 1) the 'geopolitical approach towards maritime security', for which two categories are defined; a tacit versus an explicit approach, and 2) the 'extent to which geopolitical considerations inform policy objectives', for which two categories are defined; a direct versus indirect influence. The indicators employed for the coding are exposed in Table 2. They are then applied to the analysis of the three above-mentioned strategies (codes in brackets). The presence of an explicit link between maritime security and geopolitics is measured by the occurrence of unequivocal references to the concept of geopolitics and to the fact that geography influences maritime security. The direct influence of geopolitical factors on maritime security objectives is measured by the occurrence of unequivocal references to geopolitical interests in the maritime domain and to geographical locations when referring to maritime security objectives.

Table 2: Indicators for coding.

	Indicators	
Tacit link between maritime security and geopolitics	Geographical definition of MS risks and threats (Tgeopol1)	Recurrent geographical references throughout the text (Tgeopol2)
Explicit link between maritime security and geopolitics	Reference to the concept of geopolitics (Egeopol1)	Reference to the influence of geography re MS (Egeopol2)
Indirect influence of geographical and/or geopolitical factors on maritime security objectives	Reference to the need to tackle MS threats beyond one's boundary and/or territorial waters (IgeoInfl1)	Reference to the need to police the 'global' maritime domain (IgeoInfl2)
Direct influence of geographical and/or geopolitical factors on maritime security objectives	Direct reference to geopolitical interests in the maritime domain (DgeoInfl1)	Mention of geographical locations when referring to MS objectives

The UK National Strategy for Maritime Security (NSMS):

The NSMS stresses that the UK is "an island trading nation" with overseas territories and global interests. Consequently, maritime security is very important for Britain both in terms of economic and national security: fisheries protection in the territorial waters and EEZs of Great Britain and overseas territories, security of sea lanes of communication, energy security, and drug-interdiction represent vital interests (Tgeopol1). Some regions are specifically described as prone to maritime security issues and of interest to the UK's security: the Arctic, the South and East China seas, the Horn of Africa, the Gulf of Guinea and the Caribbean. The UK NSSM explicitly acknowledges the UK's political will and capabilities to protect British maritime security interests wherever needed, i.e. with no geographical limitation.

We deploy Royal Navy ships acting independently or as part of an international force to maintain vital trade routes and ensure freedom of navigation, including a persistent forward presence in the Atlantic, Indian Ocean and the Persian Gulf. We also deploy specialized Naval shipping and capabilities to key chokepoints in order to understand and influence these areas, and if necessary to take action to prevent and respond.

The European Union Maritime Security Strategy (EU MSS):

The EU MSS was drafted by the Commission in March 2014, and then the Council adopted a revised version on 24 June 2014. The two documents do not diverge much, although some important omissions are to be found in the Council's approved version, which reflect member states' reservations about the deployment of the EU's sea power. The EU stresses its will, interests and responsibility to contribute to promoting "better maritime governance", for example by launching maritime capacity building missions (such as EUCAP Nestor at the Horn of Africa or EUBAM in Libya) focusing on coast-guard and maritime governance capabilities (IgeoInfl2). But beyond the stewardship of the oceans, the EU's maritime security strategy is informed by geopolitical elements. Maritime areas in the periphery of Europe and beyond have a "strategic value" to the EU (Tgeopol1, Tgeopol2 and DgeoInfl2): Some maritime zones or areas within the global maritime domain are, because of their strategic value or potential for crisis or instability, of particular importance to the EU and its Member States. The Mediterranean, the Atlantic and the global network of shipping lanes to and from Asia, Africa and the Americas are of critical importance. This Strategy takes particular regard of each of the European sea and subsea basins, namely the Baltic Sea, the Black Sea, the Mediterranean and the North Sea, as well as of the Arctic waters, the Atlantic Ocean and the outermost regions. Contributing to the security of the seas beyond the EU's jurisdictional waters also serves the Union global geo-strategy, which requires visual presence. The Commission advocated regular "EU-flagged maritime exercises with third countries in order to improve the visibility of the EU in the global maritime domain" (2014: 7). Without mentioning this very possibility, the Council nevertheless stressed the fact that the EU has interests to defend over the world's oceans, which are not bounded by geographical considerations. Although they revolve around the

'liberal' notions of the freedom of the sea and the promotion of good governance at sea, they are nonetheless informed by 'realist' power politics considerations.

The EU Strategy on the Gulf of Guinea (GoG):

One maritime region which has attracted the EU's attention is the GoG, for which the Council has adopted in March 2014 a Strategy. This strategy highlights the various regional threats, including IUUF, illicit dumping of waste, piracy and armed robbery at sea, trafficking of human beings, narcotics, arms and counterfeit goods, smuggling of migrants, as well as oil theft. In other words, the EU has acknowledged the need to be more active in the GoG due to maritime security threats (Tgeopol1). This is a striking example of how maritime security issues, even very distant from home, can engender and justify the need to take into consideration distant (maritime) regions. In practice, the EU is committed to "identify geographic and thematic priority zones to focus the EU response, including in cooperation with other international actors" (9) and to help "states to strengthen their maritime capabilities, the rule of law and effective governance across the region, including improvements in maritime administration and law enforcement through multiagency cooperation by police, navy, military, coastguard, customs and immigration services". In 2013, the Union launched the Critical Maritime Routes programme (CRIMGO) "to reinforce regional and international initiatives against piracy and armed robbery at sea in the Gulf of Guinea".

Discussion:

Maritime security is intrinsically geopolitical, since it is about projecting public power beyond one's external boundary within the 'global' maritime domain. The results from the analysis of the three above-discussed examples show that geographical and geopolitical considerations do inform states' and the EU's maritime security objectives and goals, although geopolitical considerations remain tacit. The fact that the EU MSS was approved by 27 member states allows some generalizations beyond the very EU's dynamics. Not only geography does impact on the boundary of what is possible to achieve in terms of freedom of the seas and good governance at sea, but states (and the EU) have also developed maritime geopolitical visions, based on the fact that securing adjacent and distant maritime spaces will positively impact on one's security on land. Furthermore, contributing to global maritime governance may well 'hide' more 'realist' policy agendas in the form of a justification for power and forces projection beyond one's legal zone of competencies.

It is interesting to note that the difference between the UK and the EU documents is limited despite the fact that they are very different actors. References to geopolitical considerations are tacit in both the UK and EU documents whereas policy objectives are directly and indirectly influenced by geographical considerations. This shows that, despite its peculiar decision-making process that often reduces foreign and security policy decisions to the smaller common denominator between member states, geopolitical considerations have been taken into account by the EU. This may indicate that member states have successfully uploaded their strategic and security policy objectives into the European Union. In the case of the EU

MSS, since it originated in the Commission's IMP and subsequent initiatives, it is not surprising to find that it advocates a global vision for the EU and thus frames maritime security objectives within the broader role and place of the EU as a global actor.

The fact that geopolitics is only tacitly acknowledged but that it does influence states' and the EU's policies and objectives shows that the geopolitical dimension of maritime security exists and matters but is still not acknowledged explicitly, which may be due to the enduring negative connotation of the term 'geopolitics' discussed above. Practitioners, especially in the Western liberal democratic world tend to negate their using geopolitical (or simply power politics) factors when it comes to foreign and security policy decisions-making. This can be explained by their accountability to a (supposedly) peaceful public opinion that will expect 'liberal' justifications for the projection of power into the maritime domain (such as 'contributing to the security of the global commons') rather than 'realist' arguments (such as 'the need to control space beyond one's external boundary'). For their part, academics who overlook the geopolitical dimension of maritime security take out of the equation a factor that contributes to explaining states' and the EU's maritime security policies.

6. Conclusion:

Maritime security refers to a geographical space, that is to say the sea, which has different characteristics compared to the land. The location of threats impacts on the way states and non-sate actors' security is affected. States' maritime security interests result in a practice consisting in projecting security beyond their external boundary into the global maritime domain. Thus, zones of interests are defined, which extend beyond one's legal zone of competencies. In security narratives, those maritime zones are represented as vital for one's security, which justifies power projection activities. In sum, as demonstrated by the analysis of three recent maritime security strategies, the geopolitical dimension of maritime security indirectly and directly informs states' and the EU's maritime security policies. Beyond technical, operational, legal/judicial, economic, military and cultural elements, there is a geopolitical dimension of maritime security, which is tacitly acknowledged by practitioners who are nevertheless still reluctant to talk about geo-strategy. This dimension is also rather neglected by scholars who tend to focus on other dimensions due to the fragmentation of social science in general and of maritime security studies in particular. When states and regional organizations stress their need, will or duty to 'secure the freedom of the seas', to 'police the global commons', to 'promote good governance at sea', or to 'assure the stewardship of the ocean', there are geopolitical forces and factors at play and not only 'benign' intentions. The goal of this article is to initiate debates within maritime security studies, so as scholars acknowledge the relevance of this geopolitical dimension and further engage with it.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Environment and fairness in International Trade Negotiations: Developing Countries in the GATT & WTO

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Abstract: *Many developing countries feared that open dissent to a motion that a developed country was supporting would result in retaliatory consequences and penalties against them outside of the meeting room, and hence chose to remain silent. Silence, however, was also interpreted as consensus. Third, to facilitate consensus-building, many "Green Room" meetings, which often worked on the invitation of the Director General and resulted in the exclusion of many developing countries from the key discussion and negotiation stages. Of course, one could argue that developing countries could have collectively overridden the norm of consensus decision-making and insisted on majority voting as per the GATT rule-book. However, besides the obvious problems of collective action in employing such a strategy, this strategy would have entailed the risk that developed countries might withdraw their commitment to the GATT and turn to alternative bilateral and regional arrangements. The costs of such arrangements and the decline of the multilateral trading system would have been the highest for developing countries.*

Key words: *GATT, free-ride,* equity

Introduction:

These would include susceptibility to greater bilateral arm-twisting, but also the losses that would result from the end of the free-ride that they had enjoyed on tariff reductions by developed countries.19 As a result, despite the commitment of the GATT to variations 19 Most tariff reductions in the early days of the GATT were conducted under the "Principal Supplier Principle" whereby tariff concessions were negotiated bilaterally between the principal suppliers and then 13 of fairness other than equity, developing countries remained members of a forum that they frequently dubbed "The Rich Man's Club". But in the first phase, lasting into the launch of the Uruguay Round, their participation was sullen, and they tried hard to incorporate their own concerns with equity and distributive justice into the GATT and in other parallel forums. Phase I: Emphasis on Equity and Outcomes The agenda of developing countries in the first phase of their participation in the GATT was typified in the eloquent statement of the Indian representative: "Equality of treatment is equitable only among equals. A weakling cannot carry the burden of a giant."20 In practical terms, this view translated into the demand for preferential treatment by developing countries in the GATT, which took two forms - special market access for the products from developing countries, and exemptions from GATT obligations - and went back to the days of the ITO negotiations. These demands took more concrete shape as the writings of economists like Raul Prebisch achieved greater prominence, and fitted well with

the economic nationalism of the newly-independent countries of the South. Developing countries were convinced that despite its one-member-one-vote system, the GATT was an institution weighted against them due to its commitment to liberalization, lack of balancing development provisions or special treatment for primary commodities, the shenanigans of the consensus diplomacy of the Green Room that worked to their exclusion, and negotiating formulae such as the Principal Supplier Principle. As a result, they made few attempts to engage actively in the give-and-take of GATT negotiations, and instead tried to lobby for a change in the norms of the GATT to a qualified liberalization that involved notions of fairness emphasizing equitable outcomes rather than just equitable processes by institutionalizing preferential treatment for development purposes. Given institutional constraints in the GATT against majoritarian voting and coalition-building, many of these lobbying efforts took place outside the GATT in forums like the UN General Assembly and subsequently the UNCTAD. multilateralized.

As developing countries were seldom principal suppliers or demanders in the areas that fell within traditional GATT rules, it meant that they could free-ride on the tariffs thus negotiated. The downside, however, was that developing countries found them marginalized from the agenda-setting process. 20 Quoted by Kock (1969). These demands of developing countries generated some successes. The only clause in the GATT that had allowed limited infant industry protection was Article XVIII. This was modified in 1954-55 to include XVIIIb that allowed countries the use of Quantitative Restrictions for Balance of Payments purposes whenever foreign exchange reserves fell below the level they considered necessary for economic development. In 1958, the Haberler report was issued to provide guidance for the work of the GATT, and recognized that "prospects for exports of non-industrial policies in industrial countries, and on balance their development will probably fall short of the increase in world trade as a whole." As a result of the efforts of developing countries to bring development onto the agenda of the international economic organizations, the 1960s was designated as the UN Decade for Development. Dissatisfaction of developing countries also led to the formation of the UNCTAD in 1964, which was presented as an alternative to the notion of fairness that the GATT had emphasized. The UNCTAD was formed pointedly under the auspices of the UN General Assembly to address the trade and development concerns of developing countries, to correct, by implication, the failures of the GATT in this area. Faced with these epistemic and institutional alternatives to its own vision, the GATT incorporated some changes. The Committee on Trade and Development was established in the GATT, and Part IV, devoted specifically to Trade and Development, was added on in 1965. While much of the language of Part IV suggests good intentions rather than obligations (e.g. the recurrent use of the term "there is a need for", and qualifications such as "to the fullest extent possible"), the addition was important and unprecedented as it recognized the principle of non-reciprocity for developing countries. Article 8 thus stated: "The developed contracting parties do not expect reciprocity for commitments made by them in trade negotiations to reduce or

remove tariffs and other barriers to the trade of less-developed contracting parties." For the first time, developing countries had successfully introduced a concept of fairness into the GATT that recognized the importance of equity of outcomes rather than just legitimacy of process as a general principle. Institutionalizing this principle further, in 1968, the UNCTAD passed a resolution in favor of an early establishment of a "generalized, non-reciprocal, nondiscriminatory system of preferences". The GATT followed in 1971 with a waiver to the 15 MFN principles allowing the Generalized System of Preferences (GSP) for the next ten years. The GSP was given a permanent and legal basis in the GATT in 1979 when the contracting parties to pass the "Enabling Clause." While all these changes might appear to suggest norm evolution in the GATT to incorporate a notion of fairness as extended to outcomes and equity, and preferred by developing countries, a closer look at S&D in the first phase suggests that this might not have been the case. First, even though the Enabling Clause had been negotiated in the Tokyo Round, it was accompanied by an inclusion of the "Graduation Principle". The Graduation Principle was an important qualification to the Enabling Clause that ensured that developing countries would be progressively taken off the GSP lists of particular developed countries as they began to show higher levels of development. In other words, the Enabling Clause was only a stopgap measure before developing countries assumed their "normal" responsibilities of reciprocal trade liberalization. Second, the Enabling Clause was no more than a waiver to the MFN and reciprocity rules, which continued to be the foundational principles of the GATT. The waiver meant that developed countries could, if they so chose, remove or reduce trade restrictions on the specific imports of particular developing countries, but it was not a universal obligation imposed upon developed countries. Developed countries could unilaterally withdraw concessions granted under the GSP, unlike the commitments to which they had bound themselves in the GATT. As a result, the institutionalization of S&D within GATT rules was little more than the permission to have a temporary exception to its norm of reciprocal trade liberalization; what the GATT treated as fair continued to be a matter of process and legitimacy, rather than outcomes and equity. While the successes of developing countries in inducing norm change in the GATT remained limited, their gains from S&D as institutionalized by the GSP were also few. Martin Wolf, for instance, has argued that the GSP was used as a bait to divide the South. For late entrants in an area covered by GSP, the costs were especially high in the form of distorted international markets that were already occupied by the more advanced The official name for this provision is "Differential and More Favorable Treatment, Reciprocity and Fuller Participation of Developing Countries." Even for the beneficiaries, the scheme had declining marginal utility as increasing overall trade liberalization undermined the utility of preferences. And in return for such ad hoc and uncertain preferences, developing countries paid a heavy price. By accepting schemes such as GSP that represented a violation of the MFN principle, developing countries could not legitimately demand the end to exceptions on areas that were of key exporting interest to them.

These issues would be picked up by developing countries in Phases II and III. Phase II: Equal Process and Reciprocity By the time of the launch of the Uruguay Round, notions of fairness that developing countries appealed to seemed to be changing. Their most concrete manifestation lay in the apparent willingness of developing countries to engage on an equal and reciprocal basis in the "Grand Bargain" of the Uruguay Round. Developing countries had agreed to an inclusion of the so-called "new issues" (services, TRIPs and TRIMs). In return, for the first time, agriculture and textiles were placed within the multilateral rules of the GATT. This was unprecedented and resulted in some important quid pro quos for developing countries. It also induced institutional innovations within the GATT, the most important of which were the creation of the Single Undertaking and the establishment of the World Trade Organization. Many economists of a liberal disposition have argued that the willingness of developing countries to accept reciprocal exchange was a result of their ideational conversion to the liberal enlightenment. Hoekman and Kostecki trace the changes in the attitudes of developing countries to the debt crisis, the lessons of the East Asian experience with export-oriented growth, the failures of central planning, and the emergence of export interests within developing countries that created new domestic constituencies for liberalization. However, these accounts omit the significance of power politics in influencing the greater engagement of developing countries, their limited successes in the pursuit of their fairness-as-equity agenda in Phase 1, and their adaptation and learning experiences within the institution over the years. Interviews with developing country negotiators of the time suggest that the economic downturn of the 1980s made it almost inevitable that they would be driven to 17 the negotiating table. Rather than a choice voluntarily exercised, economic liberalization was seen almost as inevitability. It was also nearly certain that given their weak BATNA, developing countries would have to negotiate on the terms of the developed ones. These terms included an acceptance of the developed country notion of fairness as defined in terms of legitimacy and equity in process.

While power politics and economic imperatives rendered rhetorical appeals to equity of outcomes an indulgence that few countries could afford, institutional learning specific to the GATT had thrown considerable doubt on their old strategies. First, it was becoming clear even to the most ardent supporters of S&D that the free-ride on the Principal Supplier Principle had generated heavy costs, and benefits from the GSP in its existing form did not compensate for these costs. Non-tariff barriers in the form of various grey-area measures were increasing, and developing countries recognized that one of the few defenses that they had against the "aggressive unilateralism" of the developed countries was the multilateralism of the GATT. Developing countries also began to realize that they could not influence the expanding rules of the GATT – rules that would have far-reaching implications for them – by standing on the sidelines. Second, the experiments with different coalition types by developing countries also revealed the limitations of bloc-type coalitions that had stood on a moral high horse, emphasized the concept of fairness in terms of equity, used strict distributive bargaining tactics, and refused to engage

in any reciprocal exchange. The euphoria accompanying the call for the New International Economic Order had melted into the debt crisis. The last traditional-type Third World-list coalition in the GATT was the G10. In the face of all odds, led by Brazil and India, the G10 attempted to block the inclusion of services into the Uruguay Round, and refused to engage in any trade-offs until its demands were met. In contrast, under the initiative of Colombian Ambassador Felipe Jaramillo, and almost simultaneously with the machinations of the G10, a counter coalition emerged that used integrative bargaining tactics.

Conclusion:

In this paper, I have relied on the distinction made by Thomas Franck between the two notions of fairness of legitimacy and equity. Institutional structures determine, in good measure, which particular vision will provide the basis for its rules. I argued that in the case of the GATT, decision-making and negotiation processes that led to the effective marginalization of developing countries in the early years also led to the dominance of the legitimacy-as-fairness view. Attempts by developing countries to bring equity-based fairness into the mainstream trade discourse generated poor results. The failures of Phase 1 prompted an extreme swing by developing countries to Phase II when traditional Third World-ist politics and demands for preferential treatment and exceptions took a back seat, and developing countries seemed to have converted wholesale to assumptions of reciprocal trade concessions. In the wake of the disappointments of the Uruguay Round, a more nuanced position is in evidence. Issues of equity have returned to the fore, but this time they are premised upon at least a qualified commitment to economic liberalization rather than an epistemic alternative. Developing countries have been careful to frame their demands for equity of process and substance in the WTO within the norms and rules of the organization.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Climate change legislation in India: Policies and programmes

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Abstract: *India is a non-Annex I country under the Kyoto Protocol and thus has no binding target for emissions reduction. It is an active participant in the Clean Development Mechanism (CDM) established by the Protocol. It had more than 1,479 registered CDM projects as of February 2014.In 2010 India released a GHG inventory for 2007 (not officially submitted to the UNFCCC), and stated that it would be the first developing country to publish its emissions inventory in a two-year cycle going forward. In 2012, India published its second communication to the UNFCCC, which includes an emissions inventory for the year 2000. The communication also includes a section on vulnerability assessment and adaptation: it presents climate change projections and impact assessments on water, forests, agriculture and human health. Consultations are under way for a third communication.*

Key words: *Kyoto Protocol, human health, resource conservation*

Introduction:

India has pledged to reduce the emissions intensity of its GDP by 20-25% below 2005 by 2025. Efforts include improved energy efficiency, increased use of renewable and nuclear power, expanded public transportation and energy pricing reform. Rather than integrative binding legislation, India is developing a policy process to specifically target climate change. It adopted a "National Action Plan on Climate Change" (NAPCC) in 2008 outlining existing and future policies and programmes directed at climate change mitigation, adaptation and knowledge management. The focus of the NAPCC is on promoting understanding of climate change, and action on adaptation, mitigation, energy efficiency, and natural resource conservation while pursuing overall economic growth. In 2010, the Ministry of Environment and Forests at the Government of India released India: Taking on Climate Change – Post Copenhagen Domestic Actions, which evaluates the progress of the policies announced in the 2008 NAPCC. The forests and human health – in four critical regions of India – the Himalayan region, the North East, Western Ghats and Coastal India. INCCA comprises 127 research institutions tasked with undertaking research on the science of climate change and its impacts on different sectors of the economy across the various regions of India. The Indian Space Research Organization (ISRO) plans to launch a satellite to monitor GHG emissions later in 2015. Under the new Government elected in 2014, the Ministry of Environment and Forests has become the Ministry of Environment, Forests and Climate Change. In the

COP20 in Lima in December 2014, the Indian Minister, Prakash Javadekar, announced that in 'the next budget session (India is) going to introduce comprehensive climate legislation'.

Carbon Pricing: In 2010, India created the National Clean Energy Fund, to finance and promote clean energy initiatives and fund related research. The corpus of the fund is built on a levy on coal, originally set at the rate of INR50 (USD0.81) per tonne, which will apply to both domestically-produced and imported coal. In order to increase the size of the National Clean Energy Fund (NCEF), the levy has been increased to INR200 (USD3.22) per tonne in the 2015 budget. This money will go into a National Clean Energy Fund that will be used for research, innovative projects in clean energy technologies and environmental remediation programmes. Until late 2014, Viability Gap Funding of INR165.11bn (USD2.66bn) has been recommended from the NCEF for 46 projects.

Energy demand: India's cabinet approved the National Mission on Enhanced Energy Efficiency (NMEEE) in 2010. The Mission includes several new initiatives – the most important being the Perform, Achieve and Trade (PAT) Mechanism, which will cover facilities that account for more than 50% of the fossil fuel used, and help reduce CO_2 emissions by 25m tonnes per year by 2014–2015. A number of regulations and incentives promote energy efficiency and the use of renewable energy, at the Federal and the State levels. These include a revision in 2007 of the Energy Conservation Building Code that sets minimum requirements for building envelope components, lighting, HVAC, electrical systems and water heating and pumping systems. The Government has approved National Mission on Enhanced Energy Efficiency (NMEEE) in August 2014 with an outlay of INR7.75bn (USD125m). It will enhance investments for better technology, creation of a venture capital with partial risk guarantee fund, appliance rating system and notification of a new building code for energy conservation.

Energy Supply: The Electricity Act 2003 sought to better co-ordinate development of the power sector and to promote efficient and environmentally benign policies. The Act recognizes the role of renewable energy in the country's National Electricity Policy (issued in 2005) and contains key provisions relating to renewable energy. This Act was supplemented by the 2006 National Tariff Policy, which stipulates that the targets for the Solar RPO (Renewable Purchase Obligation) shall be 0.25% by 2012-13 extending to 3% by 2022, which would require 34GW of installed solar capacity by 2022. The government has announced that it will raise the country's target for solar power five-fold from 20GW to 100GW by 2022. There are separate RPOs for other renewable sources. The 2006 Integrated Energy Policy that received Cabinet approval in 2008 aims to meet energy demand "at the least cost in a technically efficient, economically viable and environmentally sustainable manner". It contains a number of policies that contribute to avoiding GHG emissions. In 2007, the cabinet proposed an indicative target of 20% blending of biofuels, both for biodiesel and bioethanol, by 2017. A National Policy on Biofuels outlining the same target was approved in 2009. In order to avoid a conflict between energy security and food security, the policy

promotes only fuels derived from non-edible plants, in waste, degraded or marginal lands. The policy offers farmers and cultivators a minimum support price for non-edible oil seeds, as well as a minimum purchase price for fuel.

The National Solar Mission is a large-scale solar energy programme that runs from 2010 to 2022 and promotes electricity generation from both small- and large-scale solar plants. Presently, wind farm projects qualify for Generation-Based Incentives (GBI) and a tax holiday as infrastructure projects, but accelerated depreciation under the Income Tax Act has been withdrawn from the 2013-14 Budget. Lots of local projects are also being implemented such as the Solar Photovoltaic Programme, the Solar Water Heating System Programme and the Village Electrification Programme.

Budget outlay for renewable has been increased by 65.8% (including direct hike in solar financing by INR10bn (USD161m) primarily for solar water pumps and setting up of ultra-modern solar power projects. The anti-dumping duty issue has been resolved as well with an impetus on "Make in India" solar manufacturing, and a priority for domestic content.

The government has also restored accelerated depreciation benefit to wind-power developers to ramp up wind generation capacity. Ad-hoc termination of this benefit in 2012 resulted in a nearly 50% fall in capacity installations in 2013. New directives from the Prime Minister's office have announced a target for wind-power of 65GW by 2022.

Other regulatory moves such as amendments to the Electricity Act 2003 and tariff policy have been finalized, allowing for the next wave of reforms such as competition in retail and Renewable Purchase Obligations (RPO) enforcement.

In September 2014 the minister of power, coal and renewable energy said the country is looking to invest USD100bn in renewable energy over the next five years; additionally, it was announced that 8,000-10,000MW of wind power can be generated per year. In 2013, A 'Green Energy Corridor' was announced, with USD7.9bn set aside to facilitate flow of renewable energy into the national grid. Various initiatives taken include: allocation of INR1bn (USD16.1m) for the development of 1MW Solar Parks on the banks of canals; allocation of INR4bn (USD64.5m) for launching a scheme for solar power driven agricultural pump sets and water pumping stations.

REDD+ and LULUCF:

The National Mission on Sustainable Habitats (NMSH) was approved as one of the eight National Missions under the Prime Minister's National Action Plan on Climate Change (NAPCC). A comprehensive strategic plan is being drafted to implement it.

The National Mission for Green India (GIM), also one of the eight National Missions under NAPCC, is being finalized. It aims to double the area to be taken up for forestation/eco-restoration in the next 10 years, taking the total area to be afforested or eco-restored to 20m ha. This would increase the above and below ground biomass in 10m ha of forests/ecosystems, resulting in increased carbon sequestration of 43m tonnes CO_2-equivalent annually.

In 2012, India held a national consultation on the preparedness for

REDD+. A Technical Group has been set up to develop methodologies and procedures to assess and monitor REDD+ actions. Additionally, a National REDD+ Co-coordinating Agency has been approved in principle and methodologies for National Forest Carbon Accounting are being institutionalized.

A high level committee is currently reviewing environmental laws including the Forest (Conservation) Act of 1980 and the Indian Forest Act of 1927.

Adaptation: India's population depends greatly on climate sensitive sectors – agriculture and forestry – for its livelihood. India's climate risk assessment in the second communication to the UNFCCC states that climate change, leading to recession of glaciers, decrease in rainfall and increased flooding, could threaten food and water security; put at risk natural ecosystems including species that sustain the livelihood of rural households; and adversely impact the coastal system due to sea-level rise and increased extreme events. A National Adaptation Fund was set up in July 2014 to address the impacts of climate change and to develop climate resilient agriculture. INR1bn (USD16.1m) has been allocated for the "National Adaptation Fund" for climate change. India's National Bank for Agriculture and rural development (NABARD) has been accredited as a national implementation entity for the adaptation fund created by the UNFCCC. The National Mission for Sustaining the Himalayan Ecosystem focuses on evolving suitable management and policy measures to sustain and safeguard the Himalayan glacier and mountain ecosystem.

Sub-National Activities:

All Indian States have to prepare State Action Plans for Climate Change (SAPCCs) in line with the objectives of the National Action Plan on Climate Change (NAPCC) and ensure its implementation at state level. As of the end of 2014, 27 states and 4 Union Territories have prepared plans; the National Steering Committee on Climate Change has endorsed the SAPCCs of nine states (Andhra Pradesh, Arunachal Pradesh, Madhya Pradesh, Manipur, Mizoram, Rajasthan, Sikkim, Tripura and West Bengal. The SAPCCs of Assam, Meghalaya and Orissa are being considered by the Expert Committee on Climate Change. Other states are at various stages of preparing the SAPCCs.

State governments are preparing State-specific Action Plans on Climate Change, which draw upon the National Action Plan and operationalise state-level measures in mitigation and adaptation. Delhi became the first state to complete and launch their Action Plans. Most other States are finalizing their Action Plans.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Environmental effects on public health: An economic perspective

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Abstract: *Every minute, five children in developing countries die from malaria or diarrhoea. Every hour, 100 children die as a result of exposure to indoor smoke from solid fuels. Every day, nearly 1,800 people in developing cities die as a result of exposure to urban air pollution. Every month, nearly 19,000 people in developing countries die from unintentional poisonings. This paper provides a review of the literature on valuation studies eliciting monetary values associated with reduced environmental risk and in particular focusing on reduced indoor and outdoor air pollution, enhanced water quality and climate change mitigation. The findings of the valuation studies have important policy implications, since the environmental risk factors that are studied can largely be avoided by efficient and sustainable policy interventions.*

Key words: *reduced indoor and outdoor air pollution, eliciting monetary, environmental risks*

Introduction:

This paper provides a review of the literature on valuation studies eliciting monetary values associated with reduced environmental risk and in particular focusing on reduced indoor and outdoor air pollution, enhanced water quality and climate change mitigation. The findings of the valuation studies have important policy implications, since the environmental risk factors that are studied can largely be avoided by efficient and sustainable policy interventions. Minimizing exposure to environmental risk factors by enhancing air quality and access to improved sources of drinking and bathing water, sanitation and clean energy is found to be associated with significant health benefits and can contribute significantly to the achievement of the Millennium Development Goals of environmental sustainability, health and development. The environment affects our health in a variety of ways. The interaction between human health and the environment has been extensively studied and environmental risks have been proven to significantly impact human health, either directly by exposing people to harmful agents, or indirectly, by disrupting life-sustaining ecosystems. Although the exact contribution of environmental factors to the development of death and disease cannot be precisely determined, the World Health Organization (WHO) has estimated that thirteen million deaths annually are attributable to preventable environmental causes. The report also estimates that 24% of the global disease burden (healthy life years lost) and 23% of all deaths (premature mortality) are attributable to environmental factors, with the environmental burden of diseases being 15 times higher in developing countries than in developed countries, due to differences in exposure to environmental

risks and access to health care. However, huge economic development and population growth result in continuing environmental degradation. Intensification of agriculture, industrialization and increasing energy use are the most severe driving forces of environmental health problems. For countries in the early stages of development the major environmental hazards to health are associated with widespread poverty and severe lack of public infrastructure, such as access to drinking water, sanitation, and lack of health care as well as emerging problems of industrial pollution. Climate change is also posing risks to human population health and well-being and thus is emerging as a serious concern worldwide.

Economic Valuation Techniques:

Quantifying the impacts of environmental degradation on human health is essential for the development of well-informed policies by the health sector and consequently many valuation studies have been conducted worldwide the past decades addressing environmental risks to public health. The main approaches for health impact valuations can be broadly classified into revealed and stated preference techniques. The first take into account observable market information which can be adjusted and used for revealing an individual's valuation. Revealed preferences include cost of illness, human capital surveys, hedonic pricing and the Quality Adjusted Life Year studies. In stated preferences studies the market for the good is 'constructed' through the use of questionnaires. The two most-well-known stated preference methods are the Contingent Valuation Method (CVM) and the Choice Experiments (CE).

Cost of illness studies measure the direct (medical costs, nursing care, drugs) and indirect (opportunity) economic costs associated with a disease and estimate the potential savings from the eradication of the disease. Human capital surveys estimate the productivity loss measured in workdays due to illness. This approach also values loss of life based on the foregone earnings associated with premature mortality. The notion is that people should be willing to pay at least as much as the value of the income they would lose by dying prematurely.

Damage costs estimates from environmental hazards for the economy as a whole are also obtained through general equilibrium macroeconomic modeling. These studies assess welfare impacts in a national or international level by examining all the sectors of the economy and estimating environmental health impacts on parameters of the economy like income and consumption.

The Quality Adjusted Life Year (QALY) studies measure both the quality and quantity of life. The values for a Life Year range from 0, implying death, to 1, implying a year of perfect health. Therefore, QALYs provide an indication of the benefits from a healthcare intervention in terms of health-related quality. Combined with the costs of providing different interventions, a cost-effectiveness analysis (cost per QALY) can follow to allow for comparisons of different interventions. A monetary value can also be placed on a QALY to estimate the dollar benefits of a health intervention or policy and allow for a subsequent cost-benefit analysis. Stated Willingness to Pay, elicited through a contingent valuation study or a discrete choice study, is often used, to monetize QALYs. Other methods to value a QALY

include time-trade-offs, standard gamble and the visual analogue scale. Hedonic pricing methods assess differences in the price of housing in polluted or unpolluted areas, or the difference in wages between hazardous and non-hazardous jobs. Variations in housing prices and wages reflect the value of health damages avoided to those individuals and therefore reveal individual's willingness to pay to avoid damages.

Before valuing the health damage the establishment of a dose-response function relating pollutant concentrations to health impacts is required. The impacts of environmental degradation on mortality, expressed as the increase in the probability of premature death, and quality of life, expressed as reduction of the morbidity risk, are thus initially considered. Accordingly respondents are asked to either state their willingness to pay for a prevention scenario (stated preference approach) or the benefits are elicited through the costs that would be saved if the risk was eradicated (cost of illness studies). Benefits are mainly reported by calculating the Value of a Statistical Life (For a review of the literature calculating the value of a statistical life based on labor and housing market data see Viscusi and Aldy). The Value of Statistical Life (VSL) is calculated by dividing the value of a small risk change by the actual change in risk and thus captures the effect of small changes in the risk of premature death for a large population of potentially exposed people.

The contingent valuation method (CVM), although widely used, has been criticised for its lack of reliability since it is associated with biases, such as hypothetical bias, strategic bias, yes-saying bias and embedding effect. Hypothetical bias contends that respondents may be prepared to reveal their true values but are not capable of knowing these values without participating in a market in the first place. Strategic bias occurs when respondents deliberately under- or overstate their WTP. Respondents may understate their WTP if they believe that the actual fees they will pay for provision of the environmental resources will be influenced by their response to the CV question. Conversely, realising that payments expressed in a CV exercise are purely hypothetical, respondents may overstate their true WTP in the hope that this may increase the likelihood of a policy being accepted. Yea-saying bias indicates that respondents may express a positive WTP because they feel good about the act of giving for a social good although they believe that the good itself is unimportant while embedding bias implies that WTP is not affected by the scale of the good being offered. To address these, the Blue Ribbon Panel under the auspices of NOAA has made recommendations regarding best practice guidelines for the design and implementation of contingent valuation studies.

Economic Assessment of Environmental Health Impacts: Empirical Evidence:

There is increasing recognition that linked environment and health impacts require economic assessment in order to receive adequate consideration in policy . Consequently, a huge increase in the number of valuation studies trying to quantify the environmental impacts on human health in monetary terms and elicit public preferences for health and environmental policies that reduce the risk of illness or mortality has been experienced in recent years.

In the subsequent sections important applications of the valuation techniques that have been conducted to estimate social benefits associated with increased air and water quality as well as climate change aversion are reviewed. Limitations of the existing research are addressed in the concluding section and directions for future work are suggested. For quick reference a table summarizing each study's main features (that is author, case study country, environmental hazard and valuation result) can be found in the Appendix. All valuations have been converted to 2006 euros (2006 average $0.797 = 1 euro).

Air Quality:

Air pollution is a major environmental risk to health and is estimated to cause approximately two million premature deaths worldwide per year [24]. A reduction of air pollution is expected to reduce the global burden of disease from respiratory infections, heart disease, and lung cancer. As air quality is a major concern for both developed and developing countries, a large number of empirical studies attempting to monetize the benefits to health generated by improved air quality have appeared in the literature worldwide.

Pearce provides a summary of the main studies conducted to that day valuing health damages from air pollution in the developing world. In particular, valuation estimates for health symptoms and risks of mortality attributable to particulate matter, lead, nitrogen and sulphur oxides and low level ozone are reported. The main conclusion from the literature review is that some forms of air pollution, notably inhalable particulate matter and ambient lead, are serious matters for concern in the developing world since they are associated with severe health damages in monetary terms.

Since then a number of valuation studies have been conducted in developing countries estimating social benefits from air pollution reduction in terms of either averted mortality or averted morbidity due to air pollution mitigation strategies. To provide economic estimations of health risk reductions authors rely on existing epidemiological studies that establish the relationship between pollution concentrations and health hazards. Valuation studies are then conducted to monetize health outcomes given the number of exposures and the associated risk predicted from the dose-response functions.

In the literature addressing air pollution in both developed and developing world, contingent valuation studies are mainly implemented. The health consequences from alternative pollution abatement policies are explicitly stated in the valuation scenario and respondents are asked their maximum willingness to pay to contribute in the implementation costs of the policy under evaluation.

Hedonic studies have been also applied to estimate a relationship between housing prices and housing attributes, including health risks associated with air pollution. The value people place on reduced health risks through improved air quality are inferred by their willingness to pay more for houses with better air quality, all else being equal. Delucchi et al. [36] provide a meta-analysis of hedonic pricing studies addressing health risks from air pollution. Comparing results with studies applying the damage function approach, authors find evidence that hedonic price analysis does not capture all of the health costs of air pollution because individuals

are not fully informed about all of the health effects to incorporate them into property values.

Water Quality:

Contact with unsafe drinking or bathing water can impose serious risks (both acute and delayed) to human health. Microbe contamination of groundwater due to sewage outfalls and high concentration of nutrients in marine and coastal waters due to agricultural runoff are among the most serious threats. According to the European Commission's (EC) recent statistics, 20 percent of all surface water in the EU is seriously threatened by pollution. In the infrastructurally disadvantaged developing world the water contamination problem is even more prominent Although epidemiological studies have provided evidence of severe morbidity attributed to polluted water the issue has received limited attention in terms of valuation studies. Only few studies explicitly address health effects of drinking and bathing water quality to inform efficient water resources management policies mainly in high income countries.

The Bathing Water Quality Directive. Benefits were estimated based on data from a contingent valuation study and were then related to their costs. Results indicate that mean WTP amounts, representing the economic benefits of the revision are of the same order of magnitude as the estimated potential cost increases in average annual household water bills necessary to implement the revision.

Deviating from the contingent valuation framework, Dwight et al. apply the cost of illness approach and Shuval calculate the disability-adjusted life years (DALY), to quantify the health burden from illnesses associated with exposure to polluted recreational coastal waters. In the former study, health data on illness-related lost activity days and medical care use were used and the economic burden per gastrointestinal illness was estimated at € 31.9, the burden per acute respiratory disease at € 66.94, the burden per ear ailment at € 32.95, and the burden per eye ailment at € 23.81. In the later, the total estimated impact of the human disease attributable to marine pollution by sewage is about three million DALY per year, with an estimated economic loss of some11.16 billion euros per year.

In the developing world, health damages from drinking water contamination are examined by Dasgupta and Maddison et al. The former study estimates a health production function to derive the total cost of illness related to Diarrhoeal diseases in urban India,. Annual health costs are calculated and aggregated over the whole population are found to equal € 2,821,587. The latter estimates aggregate willingness to pay to avoid health risks, including various cancers, associated with consumption of arsenic contaminated groundwater in Bangladesh. Based on Value of Statistical Life estimation from studies in India, authors report an aggregate WTP of $2.7 billion annually to avoid mortality and morbidity cases.

Climate Change:

An understanding of the likely impacts of climate change on human welfare is crucial for making an informed decision about the best response strategy to the enhanced greenhouse effect. Consequently, a number of studies have attempted the evaluation of climate change-related health hazards.

Health effects from illnesses associated with climate change are also examined in the developing world by Tseng et al.using the dengue fever in Taiwan as a case study. The relationship between climate conditions and the number of people infected by dengue fever was first established and the monetary assessment was then attempted applying a contingent valuation study. Results indicate that people would pay € 15.78, € 70.35 and € 111.62 per year in order to reduce the probabilities of dengue fever inflection by 12%, 43%, and 87%, respectively.

Conclusion:

Environmental degradation poses a significant threat to human health worldwide. Harmful consequences of this degradation to human health are already being felt and could grow significantly worse over the next 50 years [2]. Because environment and health are so intimately linked, so too should be environmental and health policies. However, health impacts are non-marketed and thus hard to quantify in monetary terms. The subsequent risk of being ignored in policy-making is a major concern worldwide. To address this challenge a number of valuation studies have been conducted in both developing and developed countries applying different methods to capture health benefits from improved environmental quality. Valuation results are crucial for the formulation of economic instruments to internalize the externalities created by the public nature of environmental resources. Enhancing air quality and securing adequate supplies of safe drinking water is associated with significant benefits for human health and well-being. Significant benefits are also found to be associated with bathing water quality socially justifying the costs for abatement policies. Climate change effects mitigation is also of great importance in terms of public health benefits. However, certain limitations of the existing literature have been identified.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Energy for cooking in developing Countries: Some Issues

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Abstract: *In developing countries, especially in rural areas, 2.5 billion people rely on biomass, such as fuel wood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking. In many countries, these resources account for over 90% of household energy consumption. In the absence of new policies, the number of people relying on biomass will increase to over 2.6 billion by 2015 and to 2.7 billion by 2030 because of population growth. That is, one-third of the world's population will still be relying on these fuels. There is evidence that, in areas where local prices have adjusted to recent high international energy prices, the shift to cleaner, more efficient use of energy for cooking has actually slowed and even reversed. Use of biomass is not in itself a cause for concern. Halving the number of households using traditional biomass for cooking by 2015 – a recommendation of the United Nations Millennium Project – would involve 1.3 billion people switching to other fuels. Alternative fuels and technologies are already available at reasonable cost. Providing LPG stoves and cylinders, for example, would cost at most $1.5 billion per year to 2015. Switching to oil-based fuels would not have a significant impact on world oil demand. Even when fuel costs and emissions are considered, the household energy choices of developing countries need not be limited by economic, climate-change or energy-security concerns.*

Key words: *Households, consumption, cylinders*

Introduction:

Household Energy Use in Developing Countries According to the best available figures, household energy use in developing countries totaled 1 090 Mtoe in 2004, almost 10% of world primary energy demand.1 Household use of biomass in developing countries alone accounts for almost 7% of world primary energy demand. In OECD countries, biomass demand comes mostly from the power generation and industry sectors, while in developing countries these sectors represent only 12%. There are enormous variations in the level of consumption and the types of fuels used. While a precise breakdown is difficult, the main use of energy in households in developing countries is for cooking, followed by heating and lighting. Because of geography and climate, household space and water heating needs are small in many countries. This chapter concentrates on fuels for cooking. Households generally use a combination of energy sources for cooking that can be categorized as traditional (such as dung, agricultural residues and fuel wood), intermediate (such as charcoal and kerosene) or modern (such as LPG, biogas, ethanol gel, plant oils, diethyl ether (DME) and electricity).2 Electricity is mainly used for lighting and small appliances, rather than cooking, and represents a small share of total household consumption in energy terms.3 Supplies of biomass are abundant in many developing countries, although local scarcity exists. Indeed, they are the only affordable energy source for some households. The commercial production

and distribution of fuel wood and 1. Collecting and processing biomass energy statistics is a complex process because of the charcoal generates significant employment and income in rural areas of developing countries, though a switch to alternative fuels would also create employment and business opportunities. In OECD countries and in most transition economies, the technologies used to convert biomass to energy tend to be efficient and the resources are generally harvested in a sustainable way. But in developing countries, the technologies and practices are much less efficient. Many people use three-stone fires, cook without ventilation or harvest at an unsustainable rate. Reliance on biomass resources, important though they are too many communities, cannot be regarded as sustainable when it impairs health and has negative economic and environmental impacts.

Households do not simply substitute one fuel for another as income increases, but instead add fuels in a process of "fuel stacking". Modern forms of energy are usually applied sparingly at first and for particular services (such as electricity for radio and television, or LPG for making tea and coffee) rather than completely supplanting an existing form of energy that already supplies a service adequately. The most energy-consuming activities in the household – cooking and heating – are the last to switch. Use of multiple fuels provides a sense of energy security, since complete dependence on a single fuel or technology leaves households vulnerable to price variations and unreliable service. Some reluctance to discontinue cooking with fuel wood may also be due to taste preferences and the familiarity of cooking with traditional technologies. In India and several other countries, for example, many wealthy households retain a wood stove for baking traditional breads. As incomes increase and fuel options widen, the fuel mix may change, but wood is rarely entirely excluded.

Harmful Effects of Current Cooking Fuels and Technologies Health:

The World Health Organization (WHO) estimates that 1.5 million premature deaths per year are directly attributable to indoor air pollution from the use of solid fuels.8 That is more than 4 000 deaths per day, more than half of them children under five years of age. More than 85% of these deaths (about 1.3 million people) are due to biomass use, the rest due to coal. This means that indoor air pollution associated with biomass use is directly responsible for more deaths than malaria, almost as many as tuberculosis and almost half as many as HIV/AIDS (Figure 15.3). In developing countries, only malnutrition, unprotected sex, and lack of clean water and sanitation were greater health threats (WHO, 2006). Just as the extent of dependence on polluting fuels and inefficient stoves varies widely around the world, so does the death toll due to indoor smoke. The number of premature deaths is highest in Southeast Asia and sub-Saharan Africa (Figure 15.4). Fuel wood, roots, agricultural residues and animal dung all produce high emissions of carbon monoxide, hydrocarbons and particulate matter (Smith et al., 2000). Hydrocarbon emissions are highest from the burning of dung for fuel, while particulate emissions are highest from agricultural residues. Women and children suffer most from indoor air pollution because they are traditionally responsible for cooking and other household chores, which involve spending

hours by the cooking fire exposed to smoke. Young children are particularly susceptible to disease, which accounts for their predominance in the statistics for premature deaths due to the use of biomass for cooking.

Environment:

Inefficient and unsustainable cooking practices can have serious implications for the environment, such as land degradation and local and regional air pollution. There is some localized deforestation, but depletion of forest cover on a large scale has not been found to be attributable to demand for fuel wood (Arnold et al., 2003). Fuel wood is more often gathered from the roadside and trees outside forests, rather than from natural forests. Clearing of land for agricultural development and timber are the main causes of deforestation in developing countries. Studies at the regional level indicate that as much as two thirds of fuel wood for cooking worldwide comes from non-forest sources such as agricultural land and roadsides. Charcoal, on the other hand, is usually produced from forest resources. Unsustainable production of charcoal in response to urban demand, particularly in sub-Saharan Africa, places a strain on biomass resources. Charcoal production is often inefficient and can lead to localized deforestation and land degradation around urban centres.9 Scarcity of wood typically leads to greater use of agricultural residues and animal dung for cooking. When dung and residues are used for fuel rather than left in the fields or ploughed back into fields, soil fertility is reduced and propensity to soil erosion is increased.

The Burden of Fuel Collection:

In developing regions reliant on biomass, women and children are responsible for fuel collection, a time-consuming and exhausting task. The average fuel wood load in sub-Saharan Africa is around 20 kg but loads of 38 kg (Rwelamira, 1999) have also been recorded. Women can suffer serious long-term physical damage from strenuous work without sufficient recuperation. This risk, as well as the risk of falls, bites or assault, rises steeply the further from home women have to walk, for example because of conversion of land to agricultural uses.

Outlook for Household Biomass:

Use in Developing Countries Without strong new policies to expand access to cleaner fuels and technologies, the number of people in developing countries relying on traditional biomass as their main fuel for cooking will continue to increase as the global population increases. In the Reference Scenario, in which no new policies are introduced, the number rises from 2.5 billion in 2004 to 2.6 billion in 2015 and to 2.7 billion in 2030 (Table 15.2). Residential biomass demand in developing countries is projected to rise from 771 Mtoe in 2004 to 818 Mtoe in 2030. These projections take into account the fuel substitution and the market penetration of more efficient technologies that would occur as a result of rising per-capita incomes, fuel availability and other factors. Household sizes by region have been incorporated into the projections, but the rural/urban split has not been estimated through to 2030. Almost all of the growth in population will, in fact, be in urban areas, but the categorization

Implications for Oil Demand:

LPG is generated as a by-product of both oil refining and natural gas production.

The incremental world oil and gas demand which would result from widespread take-up of LPG is negligible. Assuming average consumption of LPG of 22 kg per person per year13 and assuming all of this LPG was derived from oil rather than natural gas, providing 1.3 billion additional people with LPG by 2015 would increase oil demand by 0.7 mb/d, or 0.69% of the 99 mb/d projected in the Reference Scenario (Figure 15.7). The increase would be 0.72% in the Alternative Policy Scenario. If all households currently using biomass switched to LPG by 2030, the rise in oil demand would be 1.4 mb/d. Such a figure is but a tiny fraction of the fuel lost through the flaring of natural gas.14 These are upper bounds because, as noted earlier, LPG is just one of several energy carriers that could be pursued as substitutes for traditional biomass, whereas these calculations have taken LPG as a proxy for them all.

Policy Implications:

Meeting the cooking-fuel target will require government action. On the supply side, it can be difficult to establish a commercially viable LPG distribution network in the face of low population density, poor roads, and low LPG uptake and consumption among those who sign up for LPG. The absence of economies of scale in catering to rural domestic consumers is one of the main factors hindering LPG access. Infrequent delivery of refill cylinders serves as a disincentive to switching to LPG. Demand-side barriers include low per-capita incomes, lack of awareness of the benefits of alternative fuels, inappropriate stove designs and simple force of habit. Moreover, even was LPG widely available, many poor households would not be able to afford the required capital investments. The start-up cost of buying a stove and paying a deposit for a fuel canister represents a serious barrier for many households.

References and notes:

1. Collecting and processing biomass energy statistics is a complex process because of the diversity of consumption patterns, differences in units of measurement, the lack of regular surveys and the variation in heat content of the different types of biomass. The IEA and the Food and Agriculture Organization of the United Nations (FAO) are the main international organizations monitoring biomass energy data in developing countries. Some countries collect specific information on fuel use at the household level, while various regional organizations and independent researchers carry out ad hoc surveys.

2. The terms traditional, intermediate and modern relate to how well-established a fuel is and do not imply a ranking.

3. While electricity is not the focus of this chapter, it provides important benefits to households. The number of people without access to electricity is estimated to be 1.6 billion (Annex B).

4. Although households in developing countries use a combination of fuels for cooking and heating, this chapter focuses on the primary fuel used. This simplification is necessary in order to perform quantitative analysis.

5. Coal is excluded from the targets and projections in this chapter.

6. Liquefied petroleum gas (LPG) is a mixture of propane and butane pressurized in cylinders for storage and transport.

7. Per-capita incomes are taken from World Bank (2006).

8. There are specific targets associated with each of the eight Millennium Development Goals. For each target, several indicators have been established to assess progress in achieving the goals. The WHO is responsible for Indicator 29 (Goal 7) – the proportion of the population using solid fuels. This category includes coal and biomass resources. In this chapter, the targets and projections consider biomass only.

9. As a result of charcoal production for urban and peri-urban households, biomass resources have been devastated in a 200 to 300 kilometer radius around Luanda, Angola (IEA, 2006).

10. See also WEO-2004 and Victor (2005) for further discussion of the link between energy and economic development.

11. The UN Millennium Project recommendation related to energy for cooking is the following: Enable the use of modern fuels for 50% of those who at present use traditional biomass for cooking. In addition, support (a) efforts to develop and adopt the use of improved cook stoves, (b) measures to reduce the adverse health impacts from cooking with biomass, and (c) measures to increase sustainable biomass production (UN Millennium Project et al., 2005).

12. For example, the Indonesian government is commencing a programme to replace kerosene with LPG in urban households and to replace biomass with coal briquettes in some rural areas.

13. A weighted average based on WHO data for developing country households currently using LPG.

14. Around 60% of global LPG supply comes from natural gas processing.

15. The UNDP/WLPGA LP Gas Challenge estimates $45 to $60 for a stove, a cylinder and 6kg of gas.

16. More information is available at www.undp.org/energy/lpg.htm and www.worldlpgas.com

17. The MDG Carbon Facility was founded on the basis that climate change threatens to significantly undermine efforts to achieve the Millennium Development Goals. More information is available at www.mdgcarbonfacility.org

International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

India's intended nationally determined contributions - Balanced and comprehensive: Policies and initiatives

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Abstract: *India has adopted several ambitious measures for clean and renewable energy, energy efficiency in various sectors of industries, achieving lower emission intensity in the automobile and transport sector, non-fossil based electricity generation and building sector based on energy conservation. Thrust on renewable energy, promotion of clean energy, enhancing energy efficiency, developing climate resilient urban centres and sustainable green transportation network are some of the measures for achieving this goal. Planned actions and economic reforms have contributed positively to the rapidly declining growth rate of energy intensity in India. The Government of India, through its various institutions and resources, has taken steps to de-couple the Indian energy system from carbon in the long run*
Key words: *control global emissions, Power Projects, Carbon Sink*

Introduction

In view to control global emissions, India reduces the Emissions Intensity of its GDP by 33 to 35 Per Cent by 2030 from2005. Level. India to create additional Carbon Sink of 2.5 to 3 Billion Tonnes of Co2 Equivalent through Additional Forest and Tree Cover by 2030.India to Anchor a Global Solar Alliance. The Government has said that India's Intended Nationally Determined Contribution (INDC) is balanced and comprehensive. Addressing a press conference here today, Union Minister of Environment, Forest and Climate Change, Shri Prakash Javadekar, said that India is keen to attempt to work towards a low carbon emission pathway, while simultaneously endeavoring to meet all the developmental challenges that the country faces today. Shri Javadekar said that INDC include reduction in the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level and to create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030. India has also decided to anchor a global solar alliance, INSPA (International Agency for Solar Policy & Application), of all countries located in between Tropic of Cancer and Tropic of Capricorn.

The INDC centre around India's policies and programmes on promotion of clean energy, especially renewable energy, enhancement of energy efficiency, development of less carbon intensive and resilient urban centers, promotion of waste to wealth, safe, smart and sustainable green transportation network, abatement of pollution and India's efforts to enhance carbon sink through creation of forest and tree cover. It also captures citizens and private sector contribution to combating climate change.

INDC's proposals:

a. Sustainable Lifestyles

b. Cleaner Economic Development
c. Reduce Emission intensity of Gross Domestic Product (GDP)
d. Increase the Share of Non Fossil Fuel Based Electricity
e. Enhancing Carbon Sink (Forests)
f. Adaptation
g. Mobilizing Finance
h. Technology Transfer and Capacity Building

INDC outlines the post-2020 climate actions they intend to take under a new international agreement. The INDC document is prepared with a view to taking forward the Prime Minister's vision of a sustainable lifestyle and climate justice to protect the poor and vulnerable from adverse impacts of climate change. Ministry of Environment, Forest and Climate Change adopted an inclusive process for preparation of India's INDC. It held stakeholder consultations with the specific involvement of the key Ministries and State Governments. Interactions were also held with civil society organizations, think tanks and technical & academic institutions of eminence. The Ministry had commissioned Greenhouse Gas (GHG) modeling studies for projections of GHG emissions till 2050 with a decadal gap. The gist of all these consultations & studies were taken on board before submitting India's INDC. For India's INDC, Government zeroed-in-on a set of contributions which are comprehensive, balanced, equitable and pragmatic and addresses all the elements including Adaptation, Mitigation, Finance, Technology Transfer, Capacity Building and Transparency in Action and Support.

Planned actions and economic reforms

Planned actions and economic reforms have contributed positively to the rapidly declining growth rate of energy intensity in India. The Government of India, through its various institutions and resources, has taken steps to de-couple the Indian energy system from carbon in the long run. Despite facing enormous development challenges like poverty eradication, ensuring housing, electricity and food security for all, India declared a voluntary goal of reducing the emissions intensity of its GDP by 20–25%, over 2005 levels by 2020, despite having no binding mitigation obligations as per the Convention. A slew of policy measures to promote low carbon strategies and Renewable Energy have resulted in the decline of emission intensity of our GDP by 12% between 2005 and 2010. It is a matter of satisfaction that United Nations Environment Programme (UNEP) in its Emission Gap Report 2014 has recognized India as one of the countries on course to achieving its voluntary goal.

Ambitious measures in India

India has adopted several ambitious measures for clean and renewable energy, energy efficiency in various sectors of industries, achieving lower emission intensity in the automobile and transport sector, non-fossil based electricity generation and building sector based on energy conservation. Thrust on renewable energy, promotion of clean energy, enhancing energy efficiency, developing climate resilient urban centres and sustainable green transportation network are some of the measures for achieving this goal.

Solar power in India is poised to grow significantly with Solar Mission as a major initiative of the Government of India. A scheme for development of 25 Solar Parks, Ultra Mega Solar Power Projects, canal top solar projects and one hundred thousand solar pumps for farmers is at different stages of implementation. The Government's goal of 'Electricity for All' is sought to be achieved by the above programs that would require huge investments, infusion of new technology, availability of nuclear fuel and international support.

The energy efficiency of thermal power plants will be systematically and mandatorily improved. Over one million medium and small enterprises will be involved in the Zero Defect Zero Effect Scheme to improve their quality, energy efficiency, enhance resource efficiency, pollution control, waste management and use of renewable energy.

Urban transport policy will encourage moving people rather than vehicles with a major focus on Mass Rapid Transit Systems. In addition to 236 km of metro rail in place, about 1150 km metro projects for cities including Pune, Ahmadabad and Lucknow are being planned. Delhi Metro, which has become India's first MRTS project to earn carbon credits, has the potential to reduce about 0.57 million tonnes of CO_2 e annually.

The switch from Bharat Stage IV (BS IV) to Bharat Stage V (BS V) and Bharat Stage VI (BS VI) to improve fuel standards across the country is also planned for the near future.

Renewable energy sources are a strategic national resource. Harnessing these sources will put India on the path to a cleaner environment, energy independence and, a stronger economy. The renewable energy technologies contribute to better air quality, reduce reliance on fossil fuels, curb global warming, add jobs to the economy and, protect environmental values such as habitat and water quality. Over the years India has successfully created a positive outlook necessary to promote investment in, demand for, and supply of, renewable energy. India's strategy on renewable energy is driven by the objectives of energy security, energy access and also reducing the carbon footprints of the national energy systems. It has evolved over the years through increasingly stronger commitment at federal level.

The institutional arrangement for off take of renewable energy power will be further strengthened by Renewable Purchase Obligations and Renewable Generation Obligations.

India's share of non-fossil fuel in the total installed capacity is projected to change from 30% in 2015 to about 40 % by 2030. India is running one of the largest renewable capacity expansion programmes in the world. Between 2002 and 2015, the share of renewable grid capacity has increased over 6 times, from 2% (3.9 GW) to around 13% (36 GW) from a mix of sources including Wind Power, Small Hydro Power, Biomass Power / Cogeneration, Waste to Power and Solar Power. On normative terms the CO_2 emission abatement achieved from the renewable power installed capacity was 84.92 million tons CO_2 eq. /year as of 30 June 2015.

To accelerate development and deployment of renewable energy in the country, the Government is taking a

number of initiatives like up-scaling of targets for renewable energy capacity addition from 30GW by 2016-17 to 175 GW by 2021-22.The renewable power target of 175 GW by 2022 will result in abatement of 326.22 million tons of CO_2 eq. /year. The ambitious solar expansion programme seeks to enhance the capacity to 100 GW by 2022, which is expected to be scaled up further thereafter. Efforts will include scaling up efforts to increase the share of non-fossil fuel based energy resources in total electricity mix including wind power, solar, hydropower, biomass, waste to energy and nuclear power.

The range of ecosystem goods and services provided by forests include carbon sequestration and storage. Despite the significant opportunity costs, India is one of the few countries where forest and tree cover has increased in recent years and the total forest and tree cover amounts to 24% percent of the geographical area of the country. Over the past two decades progressive national forestry legislations and policies of India have transformed India's forests into a net sink of CO2. With its focus on sustainable forest management, afforestation and regulating diversion of forest land for non-forest purpose, India plans to increase its carbon stock. Government of India's long term goal is to increase its forest cover through a planned afforestation drive which includes number of programmes and initiatives like Green India Mission, green highways policy, financial incentive for forests, and plantation along rivers, REDD-Plus & Other Policies and Compensatory Afforestation Fund Management and Planning Authority

For the first time devolution of funds to states from the federal pool will be based on a formula that attaches 7.5 % weight to the area under forest. It takes into account the changing realities in order to rebalance the fiscal system of the country in a way that will incentivize greener distribution of resources. This initiative will give afforestation a massive boost by conditioning about USD 6.9 billion of transfers to the states based on their forest cover, which is projected to increase up to USD 12 billion by 2019-20.

For India, adaptation is inevitable and an imperative for the development process. India is facing climate change as a real issue, which is impacting some of its key sectors like agriculture and water. The adverse impacts of climate change on the developmental prospects of the country are further amplified enormously by the existence of widespread poverty and dependence of a large proportion of the population on climate sensitive sectors for livelihood. It is of immediate importance and requires action now. In the INDC, the country has focused on adaptation efforts, including: a) developing sustainable habitats; b) optimizing water use efficiency; c) creating ecologically sustainable climate resilient agricultural production systems; d) safeguarding the Himalayan glaciers and mountain ecosystem; and, e) enhancing carbon sinks in sustainably managed forests and implementing adaptation measures for vulnerable species, forest-dependent communities and ecosystems. India has also set up a National Adaptation Fund with an initial allocation of INR 3,500 million (USD 55.6 million) to combat the adaptation needs in key sectors. This fund will assist national and state level activities to meet the cost of adaptation measures in areas

that are particularly vulnerable to the adverse effects of climate change.

India's climate actions have so far been largely financed from domestic resources. India already has ambitious climate action plans in place. Preliminary domestic requirements to implement national climate plans add upto more than USD 2.5 trillion between 2015 and 2030.Substantial scaling up these plans would require greater resources. Developing countries like India are resource constrained and are already spending enormous amounts on climate change. Implementing climate change mitigation and adaptation actions would require domestic and new & additional funds from developed countries in view of the resource required and the resource gap.

Urgent efforts to reduce GHG emissions need to take place against the backdrop of a growing energy demand and urbanization in India. With the responsibility of lifting around 360 million people out of poverty and raising the standard of living of an even greater number of people, technology is the only powerful solution for countries like India that can simultaneously address climate change and development needs. Technology development and transfer and capacity-building are key to ensuring adequate development and deployment of clean-technologies. The technology gap between rich and poor countries remains enormous and the capacity of developing economies to adopt new technology needs to be enhanced. Enhanced action on technology development and transfer will be central in enabling the full and effective implementation of India's INDC. Developed countries should be supportive and help in transfer of technology, remove barriers, create facilitative IPR regime, provide finance, capacity building support and create a global framework for Research & Development on clean coal and other technologies.

Conference of Parties (COP) of United Nations Framework Convention on Climate Change (UNFCCC) at 19th Session held in Warsaw in November 2013 invited all Parties to initiate domestic preparations for their INDC towards achieving the objective of the Convention and to communicate them, well in advance of the 21st session of the Conference of Parties. The concept of 'Nationally Determined Contributions', taking into account the outcomes of both Warsaw COP 19 and Lima COP 20 has to (i) reflect the principles of equity and Common But Differentiated Responsibilities (CBDR) and (ii) the Country's contributions must be seen in a balanced and comprehensive context.

Expectations from Paris

1) A balanced agreement with all components -mitigation, adaptation, technology, finance and capacity building- consistent with the principles and provisions of the Convention;

2) New, additional and predictable finances from developed and developing countries for mitigation, adaptation, technology transfer and capacity building;

3) Provision of technology development, transfer and diffusion;

4) Paris Agreement must incorporate loss and damage and make operational Warsaw International Mechanism.

Conclusion

India has submitted it's Intended Nationally Determined Contribution on Gandhi Jayanti, The approach of India's INDC has been anchored in the vision of equity inspired by the Father of our Nation Mahatma Gandhi's famous exhortation;*"Earth has enough resources to meet people's needs, but will never have enough to satisfy people's greed"* and formulated under the leadership and guidance of the Prime Minister, Shri Narendra Modi, who has called for 'convenient action' in order to deal with the 'inconvenient truth' of climate change.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

The Geopolitics of Energy in the Asia-Pacific - Energy and Protection

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Abstract: The combination of recent geopolitical tensions, particularly in the Middle *East, with the worsening oil imbalance in major energy consuming states have put the issue of energy security back firmly on the global policy agenda. With new oilfields being discovered at a slowing rate and alternative energy yet to fully deliver on its promise, the resulting competition for scarce energy resources, and the attempts to secure their safe delivery, could constitute a potential trigger for inter-state tensions, even conflict. The energy security strategies of some of the major states, if miscalculated or misaligned, could have severe geopolitical and economic repercussions for all states.*

Abstract: *energy security, energy security strategies, globalization*

Introduction:

In many ways, the return of energy security to the policy agenda is a return to the past, with the foreign and security policies of states driven by material concerns, in this case, energy and the scramble for it. And yet, as the report will show, the current situation is not a perfect analogue of the past: the greater political, social and economic interdependence among states brought about by globalization greatly increase the cost of conflict. At the same time, if the energy security strategies of the major states can be coordinated, then the benefits to the international system, in terms of stability of energy prices and lessened geopolitical tensions, will be significant. This report suggests ways in which this can be achieved.

This article focuses on how the major powers in the Asia-Pacific region are grappling with the challenges of energy security and examines the strategies they have adopted. For each of the countries, the report analyses their strategies at the national, regional and global levels, and evaluates their effectiveness. At the same time, the Asia-Pacific region is examined not in isolation but *vis-à-vis* other regions such as the Middle East and the Caspian Sea region. This surely drives home the point that energy security is a global issue.

This study focuses exclusively on the links between energy and security, and how these links impact the foreign policies of the major players in the Asia-Pacific, including the US A nation's energy plan is certainly informed by a multiplicity of concerns including access to technology, ecological issues and the question of sustainable development. However, the focus of this study is narrow as it approaches the issue of energy from the perspectives of national

security and foreign policy. As a result, several important themes of international significance are not analysed here. For example, there is little or no discussion of an Asian energy market, an Asian price signal mechanism, the so-called Asian oil premium, or a global market for natural gas. Many of these issues, though important, are highly technical and situated in the global political economy. The aim of this study, however, is to understand how the quest for energy is shaping the military doctrines and force structures as well as the alliances and alignments of the key players in the region and the US. In a nutshell, the aim of this study is to understand how the quest for energy security is shaping the foreign policy objectives of key players in the Asia-Pacific, and how their foreign policy objectives are influencing their energy policies. Its task is to illuminate the dynamics that are shaping the politico-military security architecture in the Asia-Pacific region. Finally, its objective is to anticipate and prepare for issues of potential conflict arising from energy competition, and to propose avenues for cooperation.

Energy security issues have come to dominate the global agenda and national debates in many countries in recent years. China's activities to secure energy needs have been viewed with particular suspicion in this regard. The US, still the world's largest oil importer, suggested in its 2006 National Security Strategy that the Chinese are "acting as if they can somehow 'lock up' energy supplies around the world or seek to direct markets rather than opening them up – as if they can follow a mercantilism borrowed from a discredited era". For its part, the strong US reaction to China's bid to take over the US oil firm Unocal last year will have reinforced Beijing's concerns that it cannot rely on the equitable operation of market forces. That the US government has raised its suspicions about China's energy policies to a national security concern will no doubt heighten concerns in China that the US may try to interdict China's foreign energy supplies, especially in the event of an armed confrontation over Taiwan.

The following section addresses the energy profiles of the US, Russia, China, India, Japan and South Korea, and the strategies each have pursued to advance their energy security policies. The countries' energy security challenges and strategies are examined through a conceptual support based on three levels of analysis: national, bilateral and multilateral. At the national level, the impact of energy security on military doctrines, force structures and weapons acquisition will be analysed. At the bilateral level, the impact of the countries' energy security policies on their alliances – both formal military and/or political alliances as well as informal politico-security alignments – will be analyzed. At the multilateral level, the impact of their energy security policies on regional and international groupings will be analysed.

Energy Security: Definitions and Dimensions

Energy security is perceived differently by different people and in different contexts. For example, while some see energy security as a serious policy issue, others view the power of the oil market, and not oil itself, as the force that actuates the state of energy security. Energy security can be simply defined as

"reliable and adequate supply of energy at reasonable prices".

In other words, energy must be supplied without interruption and must meet fully the needs of the world economy. The interpretation of the term "reasonable prices" varies; however, an acceptable definition is that reasonable prices are determined through competitive market dynamics where demand equals supply.

Energy security is centred on the imminence of capacity in the supply of fossil fuels and the availability of alternative energy resources. One way of securing energy supply is to increase one's economic pie and to purchase the necessary energy resources with the resultant increased income. This strategy will work as long as the cost of increasing the economic pie is lower than that of developing a new technology or enhancing existing technologies to secure the energy supply. All this assumes that there are viable energy resources that can be purchased. Faced the ultimate depletion of fossil fuels, however, this may not be a viable long-term solution.

Energy security can be pursued at the national, regional and international levels. Setting up a statutory body that handles energy security issues is one way to deal with energy security at national level. Promoting regional and international cooperation in bolstering energy supply and minimizing fluctuations in energy supply and price volatility will also help. Energy security, in sum, requires local action and global cooperation to enhance domestic energy efficiency and conservation efforts, and to tackle international energy security issues such as the security of supplier states and the energy supply.

There are six factors that affect the imminence, urgency or intensity of energy security. First, whether oil production has peaked or not, the ultimate depletion of fossil fuels, particularly oil and natural gas, is the main determinant of energy security. The ultimate depletion of fossil fuels intensifies competition among countries to obtain the dwindling energy resources. Second, the closest backstop technology – abundant, cheap, viable alternative energy sources that can be supplied infinitely – is not in the offing. In 2004, fossil fuels such as oil, natural gas and coal supplied about 90 per cent of total primary energy consumption in the world. The remainder was met by nuclear energy and hydroelectricity, and a small amount (around two per cent) by renewable energy resources.Third, oil dominates virtually all energy end-uses – residential and commercial, industry, transportation, and electricity. There are no other energy resources apart from oil that are more convenient and efficient in meeting the demand from the transportation sector. Biofuels such as bio-diesel or ethanol are slowly emerging as substitute fuels for combustion engines, but their contribution to ameliorating the demand for oil is still minimal.

Conclusion

Following the definitions and dimensions of energy security, five issues are identified in the context of Asia regarding energy security. First, oil imbalance is deteriorating as demand outstrips supply, with demand expected to accelerate driven by economic growth. Moreover, most Asian economies are net

importers of energy. The demand for oil is generally inelastic both in the short- and long-run due to the fact that oil has few readily available substitutes. This inelasticity adds to the severity of the oil imbalance. Second, unlike OECD countries, stockpiling activity is neither vigorous nor undertaken in any significant fashion, though countries like Singapore have stipulated a clear requirement for oil stockpiles under the Electricity Generation License Act. During the second ASEAN, China, Japan and South Korea Ministers on Energy Meeting (AMEM+3) at Siem Reap, Cambodia, in 2005, the participating countries "reaffirmed the importance of oil stockpiling and to strengthen dialogue with the Middle East and other oil producing countries to foster mutual understanding". Third, there has been limited progress in developing alternative energy sources in Asia. Research in alternatives energy sources such as a "coal fuel alliance" among universities in the US could develop a new technology that enables coal to power vehicles. Coal is abundant in Asia and it can be a cheap and viable option. This area of research deserves more attention from Asian countries seeking to reduce their dependence on oil.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

India's trade liberalization - environmental impact

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Abstract: *This paper mainly focuses on India's liberalization program of 1991 reduced trade barriers and removed investment restrictions across industries. Using a unique industry level dataset aggregated at the all-India level for all manufacturing industries, we compare the pre and post-liberalization periods to examine if India's domestic production and exports showed a greater increase in dirty industries relative to cleaner ones. We also examine whether there has been a greater inflow of FDI into pollution intensive sectors in the post-liberalization period. Our findings indicate that exports and FDI grew in the more polluting sectors relative to the less polluting sectors in the post-liberalization period*

Key words: *liberalization, composition, production*

Introduction

Increasing the India's trade liberalization in countries with weak environmental policies has raised concerns about the adverse environmental consequences of freer trade. As a result of weak environmental policies, trade liberalization in developing countries may result in shifts in the composition of production, exports and FDI to more pollution-intensive manufacturing industries. However, there is little empirical evidence on the environmental consequences of trade liberalization in developing countries. This paper contributes to the literature on the environmental consequences of trade liberalization episodes in developing countries by analyzing the composition (pollution intensive versus less pollution intensive) of manufacturing export, domestic production and foreign investment inflows around the period of India's trade liberalization program of 1991. Faced with a severe balance of payment crisis in 1991, the Indian government embarked on an economic reform program that included industrial and trade policy and financial sector reforms as well as privatization. In this paper we focus on India's trade liberalization policies. India has a weaker environmental enforcement regime relative to its main trading partners, therefore there is concern that trade liberalization could potentially encourage the use of India as a production base for more pollution intensive production. We have assembled industry-level economic and environmental data aggregated at the all India level for the manufacturing sector. Using this unique dataset, we test three hypotheses. First, we examine the composition of domestic production at the all India level pre and post liberalization. We ask whether India's domestic production is larger in the 'dirtier' industries within the manufacturing sector and whether production has shown a greater increase in the dirtier industries between the pre and post-

liberalization periods. Second, we analyze the composition of manufacturing export to determine whether India is specializing in pollution intensive exports in the post-liberalization period compared to the pre-liberalization period. Finally, we examine whether foreign direct investment (FDI) has shown greater increase in the pollution intensive industries in the post-trade liberalization period relative to FDI into less polluting industries.

In the case of India's trade liberalization of 1991, studies suggest that the Indian regulator choice of which industries to liberalize was driven purely by economic considerations, ignoring environmental criteria. Indeed, we do not find any positive correlation between the industry-wise rate of decline of the effective rate of protection and industry-wise pollution intensity. Moreover, at the time of India's liberalization, no major environmental policy changes took place that could explain changes in the pollution intensity of production and exports. Therefore, by examining changes in the pollution intensity of exports, production and FDI between the pre and post-liberalization periods, we are able to measure the possible environmental impact of India's liberalization episode. Like India, many other developing countries have weak environmental policies and previous trade barriers that favored capital intensive production. While the environmental impact of liberalization episodes in these developing countries will depend on their specific endowments and liberalization programs, this analysis of India's liberalization provides an informative case study.

Trade reforms and environmental regime in India

Trade Reforms Faced with a severe balance of payments crisis in 1991, India embarked on an economic liberalization program that encompassed industrial and trade policy, financial sector reforms and privatization. Prior to the 1991 reforms, the Indian government controlled trade through various forms of restrictions such as import licensing requirements and tariffs. Trade reforms broadly covered four areas - reduction of tariff rates, easing exchange control regulations, liberalizing import licensing requirements and the rationalization of export subsidies. Import licensing was an important mode of protection used by the Indian government before 1991. past to 1991, all imports, unless specifically exempt, required a license or a customs clearance permit. All imports classified under one of four main licensing types, namely, restricted items, banned items, limited permissible, or open general license (OGL). In practice, although goods classified to open general license were exempt from licensing requirements, many OGL imports required government approval or were subject to "actual user" conditions. Following trade liberalization of 1991, the different forms of import licenses were replaced by consolidated 'unconstructive List of Imports'. Goods not on the negative list were freely importable. Another, important aspect of India's trading system prior to liberalization was canalization, which granted sole privileges of import and export of certain designated supplies to state trading agencies. Of the trade measures that directly affected exports, export licensing was liberalized significantly. Export subsidies were not

an important aspect of India's trading system, although the government does give incentives to exporters through tax concessions and duty exemption schemes preceding to 1991, FDI was only permitted in a small number of sectors. There were several bureaucratic hurdles, such as compulsory approval from various government ministries, local content and technology transfer requirements that successfully blocked foreign investors from investing in India. Post-1991, the policy with regard to FDI was liberalized by creating an automatic approval process. Thirty out of the total one hundred and eighty six 3-digit NIC industrial categories were placed on the list for automatic approval by the government. Subsequently, this list was expanded to include more industrial categories. The new FDI policy has resulted in a substantial jump in FDI from 1991 – 2001.

Trade liberalization in India methodically removed trade barriers and restrictions on FDI, post- 1991. Our findings indicate that exports and FDI grew in the more polluting sectors relative to the less polluting sectors between the pre and post liberalization periods. This evidence provides some support for concerns raised about the environmental impact of trade liberalization in India. Specifically, we find that trade liberalization has resulted in an increase in exports from industries that are more water and air pollution intensive relative to less pollution-intensive ones. In addition, our analysis of the post-1991 FDI inflows suggests that foreign investments were higher in industries that are more intensive in air and water pollution. After controlling for potential intervening variables and correcting for sample selection bias, we find that the post-1991 coefficients on air and water pollution intensity are positive. These results on FDI and net exports are robust to different empirical specifications. An important caveat worth mentioning is that in the absence of Indian pollution intensity data, we have used pollution measures from the US as proxies. Should pollution intensity data from India become available, it would be useful to reexamine the issue using Indian measures of pollution intensities. Second, because we are using time-invariant measures of pollution intensity rather than actual emission levels, we cannot make statements about changes in actual pollution emission levels. However, by observing changes in the composition of pollution intensive production, we are able to make inferences regarding in changes in pollution levels.

Conclusion

These findings suggest that while trade liberalization measures have been pursued to promote economic growth in India, they have led to some potentially adverse environmental consequences. These results suggest that there is a trade-off between the economic gains from liberalization and the environmental consequences from a liberalization episode that has not been accompanied by a simultaneous strengthening of environmental policies. The government should make an informed decision about how to balance the trade-off between the economic gains from liberalization and the environmental costs. This case study highlights the need to consider strengthening environmental policies at the time when trade liberalization is being contemplated.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Fuelling India's Potential: Issues and Challenges

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Abstract:

India's rapidly growing economy has fuelled an intensifying demand for electricity with which supply has struggled to keep pace. India is now the fourth-largest generator of electricity after Japan, the United States and China – though still comparatively low on a per capita basis and with a relatively low electrification rate of 81% (2013) – leaving about 240 million people without reliable access to power. Where investment in the past has come from government sources, in the future India's policy-makers want to attract the majority of funding from private investors. This means addressing some of the structural issues such as unprofitable distribution companies, along with fuel issues and regulatory obstacles.

Key words: *growing economy, structural issues, unprofitable distribution*

Introduction:

Recognizing these challenges, the Indian government has embarked on a series of progressive reforms, including integrated policies to ensure even development through the value chain, addressing losses that hinder the viability of the transmission and distribution businesses, nurturing a more favorable investment environment by decreasing finance costs, and recognizing the important role of renewable. India is now the fourth-largest generator of electricity after Japan, the United States and China – though still comparatively low on a per capita basis and with a relatively low electrification rate of 81% (2013) – leaving about 240 million people without reliable access to power. India's real GDP grew at 7% over the past decade, and if it continues to meet its economic goals of 6% to 7% annual GDP growth, it will need nearly 800 gigawatts (GW) of additional capacity by 2040, according to the International Energy Agency. Despite this potential, investors are cautious about India's power sector, which has underperformed the market for the past seven years. A record of false starts – reforms in 1990 and 2003 failed to spark the competition and growth policy-makers wanted – have contributed to their caution. But even so, India increasingly depends on private investors to fuel growth in the electricity sector, with private installed capacity share rising from 13% of total capacity in 2007 up to 30%-40% by 2017.

In India, power generation captures most of the sector's $27 billion profit pool (Figure 4), while the transmission and distribution struggle financially due mostly to non-technical losses in distribution – that is, electricity taken off the grid and not paid for. India's distribution losses, estimated at 27% in 2014, are among the highest in the world (Figure 5) and, Figure 4: Non-technical losses limit the potential of India's power sector; even though

distribution and retail account for more than a third of India's power market, it has the lowest levels of profitability Note: EBIT percentage taken from top players in each segment : NTPC, NHDC, CIL, RIL, PTC, BHEL, Full potential arrived using TATA Power's current EBIT margins on distribution (margins high due to min. stipulated ROE/margins by the Govt. on dist. business) Source: Company report, CapIQ, Bain analysis despite successful programmes in several states, this remains a significant issue requiring urgent attention. Solving the financial viability of distribution companies will help India increase the flow of funds in its power markets, help manage peaks and will create incentives for more efficient consumption.

To reduce its reliance on coal imports, India will continue to develop its domestic coal supply, as shown in the aggressive bidding in coal block options in 2015. Private sector participation in coal will help scale up the industry, though the limits of commitment are not yet clear. India will also increase its investment in renewable generation, which represents an important element in the country's goals to become energy self-sufficient. In fact, India aspires to become a global leader for renewable energy and has an ambitious plan to install 175 GW of renewable energy by 2022, including 100 GW of solar and 60 GW from wind. India will need to attract a great deal more private investment in renewable generation to meet these targets. Despite all this planned growth, India's peak deficit is expected to continue to increase, at least until the country implements reforms that allow transmission and distribution operators to recoup costs and generate profits that allow them to maintain and improve their networks. India's electricity sector has other significant issues, included stranded assets due to either a lack of fuel supply or finance issues.

Key recommendations for India India's power sector:

It is at an inflection point, given the government's conviction that electricity is a critical enabler for economic growth. India's government recognizes the need for private investment in the power sector and is planning to adopt progressive policies on renewable and the sector overall. Alignment between federal and state government objectives is critical, as India devolves significant power to its states. Recommendations identified in the best practices section of this report are all relevant for India, but there are also four key imperatives that India can focus on to improve the sector's attractiveness to investors.

1. India needs to fix the viability of its distribution system, and improve the financial health of its distribution companies. – Policy-makers can help by developing and promoting a framework conducive to public-private partnerships in electricity transmission, distribution and generation. In the short term, basics need to be fixed – for example, separate electricity infrastructure for different industries (feeder segregation), and metering systems and collection systems, all of which require strong political will to execute. – Regulators can help by ensuring a level playing field for private players that enter the market, and working to stem non-technical losses. They can ensure transparency in overall industry governance and clear separation between policy-makers and regulators. Regulators also can ensure the delivery of

open access, which is the ability of large commercial and industrial customers to purchase power from an open market. – The private players who enter the distribution market will be able to help improve the viability of the distribution network in several ways. They are most likely to introduce new technologies in the grid, such as outage management systems (OMS), distribution management systems (DMS) and demand management systems (including matching power-purchase agreements to demand curves), while also helping to accelerate adoption of smart grid and meter technology. Private players can bring the capabilities to develop integrated regional or national systems that will yield substantial benefits in load and supply forecasting. They can also help establish an integrated peak power capacity to stabilize the grid and a national ultra-high voltage (UHV) network.

2. India needs to address its fuel-supply challenge. – Policy-makers have an important role to play by moving upstream industries towards the free market and attracting more participation from the private sector. Initiatives such as a streamlined and viable coal-auction process, defined risk-reward frameworks to attract global majors with the right technologies and capabilities, and adopting free market-driven pricing will all help increase supply. – Indian regulators can also optimize and scale the model of Mine-Develop-Operate by accelerating the MDO award process, adopting single-window clearance through a coordinated approach across ministries. – Businesses and investors have an important role to play in improving the operational efficiency of Coal India Ltd (CIL) by streamlining processes, improving productivity and implementing more efficient managerial practices. A new long-term strategic model for CIL needs to be adopted with a better capital management and asset strategy, including potentially breaking out parts of CIL. Power infrastructure needs to be optimized with more pithead plants, which generate power from coal at the mines and UHV lines from coastal locations. – Private players will likely build much of the additional capacity to alleviate bottlenecks in the coal distribution system at the ports and in the railways. Building rail corridors dedicated to coal, dedicated LNG ships, degasification terminals and dredging deeper sea berths for larger ships will also be required. – With potential government support, private players could help build a world-class technology cell to assess and commercialize new technologies (for example, underground mining), which could help attract more skilled technological talent to the industry.

3. India's plan to add 175 GW of capacity from renewable by 2022 can succeed only if the relevant stakeholders act in ways that encourage investment in this part of the sector. – Policy-makers should develop the blueprint for the country's renewable energy capacity by 2022 and provide policy support to foster investment in solar power. They can help attract external capital by reducing borrowing costs through strengthening the state electricity boards. They can also boost the solar industry by simplifying rules and regulations of the construction of distributed solar power across many types of infrastructure. Similarly, land-acquisition regulations should be simplified to accelerate growth of wind and solar power generation. – Regulators should enable distributed generators to

feed excess power into the grid and receive payments or discounts for it. Regulators can enforce the mechanisms underlying renewable purchase obligations (RPOs) and renewable generation obligations (RGOs), while also promoting open access for wind power. Critically, they should ensure long-term tariff consistency with no retroactive changes or flip-flops. – Investors and businesses can contribute in all areas. There are opportunities to set up large solar and wind power plants on idle land through both bilateral and auction routes, promote rooftop PV through solar leasing models supported by feed-in tariffs and tax benefits, and develop the infrastructure to support new capacity. These will require businesses to incubate new technologies (for example, for wind, higher-capacity turbines, gearless generators, offshore masts, central and distributed storage technologies and wind generation forecasting tools) and launch training programmes to create the skills base required for the next wave of investment.

4. Even with the huge investments in renewables, most of the electricity consumed in India over the next two decades will be generated by burning fossil fuel and India can do much to improve the efficiency of the existing power infrastructure. – Policy-makers should develop an integrated outlook for India's energy, including targets for fuel mix, emissions and sector progress, and set a government body to monitor progress. Tariffs and rates for fuel pricing, costs that are passed through to customers, and peak power policies and pricing should all be transparent and consistent across India's states. – Policy-makers should continue to improve demand-side energy efficiency, extending efforts such as the domestic lighting initiative to include other sectors of the economy. – Regulators should define clear guidelines for public and private sector participation and develop "single-window clearance" for large projects such as Ultra Mega Power Projects, assigning to developers only those risks that they can control. – The private sector is best suited to define blueprints for systems that include large coal and gas plants and the coastal infrastructure to import coal and LNG. – Businesses also play a critical role in promoting efficient new technologies, such as ultra-super critical boilers, particularly as they become more financially viable. They can also help optimize the use of the coal through coal-to-power system efficiency initiatives such as heat-rate optimization, gangue re-use, washed coal and fire minimization. They will also be the training ground for the next generation of skilled workforce for the energy industry.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

The rise and implications of the water-energy-environment: Food nexus in Southeast Asia

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Abstract: *This article maps the rise of the water-energy-food 'nexus' as a research, policy and project agenda in mainland Southeast Asia. We argue that introducing the concept of environmental justice into the nexus, especially where narratives, trade-offs and outcomes are contested, could make better use of how the nexus is framed, understood and acted upon. With funding from high-income country donors, it is found to have diffused from a global policy arena into a regional one that includes international and regional organizations, academic networks, and civil society, and national politicians and government officials. The nexus is yet to be extensively grounded, however, into national policies and practices, and broad-based local demand for nexus-framed policies is currently limited. The article contends that if the nexus is to support stated aspirations for sustainable development and poverty reduction, then it should engage more directly in identifying winners and losers in natural resource decision-making, the politics involved, and ultimately with the issue of justice. In order to do so, it links the nexus to the concept of environmental justice via boundary concepts, namely: sustainable development; the green economy; scarcity and addressing of trade-offs; and governance at, and across, the local, national and transnational scale.*

Keywords: *Nexus, environmental justice, sustainable development, water-energy-food, Southeast Asia*

Introduction:

Originating in response to the 2008 global food and economic crisis, the water-energy-food nexus ('the nexus') has been promoted as an emerging global development paradigm and research agenda (Allouche et al., this issue). There are divergent framings of the nexus between its various proponents (Bizikova et al., 2013). However, the dominant approach is through socioecological systems thinking that seeks to understand trade-offs and synergies, increase efficiency and improve governance between food, water and energy systems (Hoff, 2011; Davis, 2014). While much more prominent in international-level policy discussion, in mainland Southeast Asia1 a range of international organizations and civil society, academics and high-income country donors, working with the region's governments and politicians, are translating and diffusing the nexus concept through their research, programming and policy recommendations. In Southeast Asia, economic, social and political trends such as liberalization, regionalization and globalization, urbanization, agrarian transformation and industrialization, and changing aspirations in terms of work, leisure, and consumption all contribute to create a dynamic region in the throes of rapid change (Lebel et al., 2014; Middleton and Krawanchid, 2014). Behind these trends, new – and contested

– visions are being imagined for the future of the region's water, land and forest resources, energy systems, urban and rural areas, and for the people of the region itself (Nevins and Peluso, 2008; Rigg, 2012). In this context, access to, and sustainable use of, food, water and energy resources, which are institutionally fragmented domestically and across borders (Middleton and Dore, in press), is often framed to be within a complex trade-off relationship (Kirby et al., 2010). Inequality is high in the region, and in most countries widening (ADB, 2012a), and access to, exclusion from and contestation over natural resources constitute a key political issue – especially for the region's poor and marginalized (Lebel et al., 2009; Hall et al., 2011). Major decisions around food, water and energy are highly political, and take place within arenas of unequal power relations that often lack democratic equalizers such as transparency and public participation.

In recent years, claims for justice have emerged related to individual components of the nexus, but not towards the nexus itself. These claims often draw on rights-based frameworks given that water, food, and energy, are fundamental to meeting human needs. Food justice, also linked to access to land and related natural resources, is advocated for within a range of social movements such as Via Campasina, as well as more institutionalized processes such as the UN's Special Rapporteur on the Right to Food. Various food justice concepts have emerged, for example Food Sovereignty and Land Sovereignty (Patel, 2009; Borras et al., 2011; Borras and Franco, 2012a; Agarwal, 2014). Regarding water, there have been equivalent movements, including against water grabbing, and in pursuit of the Right to Water (Mehta et al., 2012; Sultana and Loftus, 2012; Franco et al., 2014). Meanwhile, questions have also been raised regarding the production and distribution of energy. Hildyard et al. (2012) highlight that attaining national energy security is typically interpreted as energy to ensure economic growth, which is not necessarily equivalent to 'energy for all' (see also Pasqualetti and Sovacool, 2012). This paper argues that if the nexus approach is to support its commonly stated aspirations for sustainable development and poverty reduction, then it should engage more directly in identifying winners and losers in 'nexused' natural resource decision-making, the inevitable politics involved, and ultimately with the issue of justice. To date, nexus framings that adopt a systems perspective, whilst broadly calling for 'good governance', are yet to seriously meet this challenge (Lele, et al., 2013; Allouche et al., 2014; Foran, this issue). This paper relates current conceptualisations and framings of the nexus to environmental justice via boundary concepts (Mollinga, 2010; 2013), namely: sustainable development; the green economy; scarcity and addressing trade-offs; and governance at and across the local, national and transnational scale. The paper grounds the linkages between the nexus and environmental justice through mapping the rise of the nexus in Southeast Asia and its framings, and by drawing upon examples from the region.

Framing the nexus: a nirvana concept, a frame and a narrative:

The idea of the nexus has traits of 'nirvana concept', 4 analogous to the idea of Integrated Water Resources Management (IWRM) analyzed by Molle

(2008). Elements of the nexus concept as an ideal include aspirations for understanding and managing scarcity, synergies and trade-offs; increasing efficiency; bridging across fragmented food, water and energy policy and institutions; improving governance; and ultimately ensuring that development is sustainable. Whilst each of these concepts is broadly appealing, as Molle (2008: 131) states: "[i]deas are never neutral and reflect the particular societal settings in which they emerge, the worldviews and interests of those who have the power to set the terms of the debate, to legitimate particular options and discard others, and to include or exclude particular social groups". Leach et al. (2010: 43-52) and others (see, for example, Molle, 2008; Walker, 2012: 4-5) highlight that there are many different ways of explaining a socio-technical-environment system with equally rational ways of understanding. This, in turn, can lead to different narratives of explanation between actors of the same system.5 Narratives are causal and explanatory beliefs (Molle, 2008) produced by actors that frame systems in particular ways towards attaining particular goals. The construction of frames involves subjective (normative) judgements and choice of elements. Thus, framing recognizes that any system is subject to multiple forms of interpretation by a range of actors dependent upon how scale, boundaries, key elements, dynamics, and outcomes are labeled and categorized, and how assumptions are made based on varying degrees of subjective/value judgments. Molle (2008) shows how the ideational power of nirvana concepts underpins the construction and framing of narratives. Thus the nexus, and the particularities of how it is defined, can be understood as a framed narrative (or a discourse – see Dryzek, 2005, and Dore et al., 2012), as, of course, is 'environmental justice'. This is not to say that socio-technical-environmental systems cannot be studied and mapped – hence an argument for 'soft constructivism' (see Robbins, 2012: 128-130). Recognition of the nexuses relationship between food, water and energy has the potential to add significant value towards resource-management policy and practice. The point is that there is a need to acknowledge the existence and legitimacy of a range of narratives and frames in pursuing a nexus approach; in other words, the nexus is a political process, not just a technical one.

In Southeast Asia, there has been a growing momentum of meetings and reports around the nexus, and thus the concept itself has grown in prominence since 2011. Dore et al. (2012: 26) observe that it is within the nexus discourse that "many actors see a logical, sectoral entry point for themselves in compelling new, multi-sector, interdisciplinary and transboundary deliberations". Surveying the array of major reports written, and conferences and dialogues hosted with a focus on mainland Southeast Asia (see Appendix A), three broad types of organizations that have led to promoting the nexus can be distinguished, as reflected in the organization's mission statements: Investment/Lending organizations: Asian Development Bank (ADB); World Bank.• Sustainable development organizations and research institutes: Mekong River Commission• (MRC), the CGIAR Challenge Program on Water and Food-Mekong (CPWF-Mekong), the Stockholm International Water Institute (SIWI), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), United

Nations Environment Programme (UNEP), International Water Association (IWA), International Water Management Institute (IWMI), the Stimson Centre, the Commonwealth Scientific and Industrial Research Organization (CSIRO), and the Stockholm Environment Institute (SEI). Conservation organizations: International Union for the Conservation of Nature (IUCN); and the• Worldwide Fund for Nature (WWF).

Another example is the WWF's Mekong Nexus Project initiated late in 2014 designed to "research key links, conflicts and positive synergies between conservation of biodiversity, responses to climate change, and supply of energy, food and water" (WWF, 2014). On the other hand, national and local civil society groups have rarely explicitly utilized the nexus as a framing for their work to date. Despite this, implicit to many campaigns are nexus-type trade-offs, as has been demonstrated in heated debates around the revived plans for Mekong mainstream dams (Grumbling et al., 2012; Matthews, 2012; WWF, 2012). Indeed, it is in these debates that claims for justice are most commonly heard (Middleton, 2012; Rieu-Clarke, 2015). Finally, a number of global-level nexus initiatives have also sought to gather experience from Southeast Asia to both promote the nexus in Southeast Asia and project the region back into global policy arenas. In addition to the CPWF program and Mekong2Rio conferences mentioned above, most notable has been the International Water Association (IWA)-IUCN Nexus Dialogue on Water Infrastructure Solutions that held three 'regional dialogues' including in Bangkok in March 2014 and subsequently a global synthesis meeting in Beijing in November 2014 (GWP-China et al., 2014). Unlikely bedfellows, the IWA in its framing of the dialogue emphasised how the nexus "has led to new demands for water infrastructure and technology solutions"13 whilst IUCN has sought a framing emphasizing 'natural infrastructure' (see Krchnak et al., 2011).

Green economy the concept of the green economy was popularized by the UNDP's Green Economy Initiative during the 2008 global financial crisis (at the same time that World Economic Forum also initiated its discussion on the nexus). It took a central role in the Rio+20 conference, sparking much debate amongst governments, scholars, and activists including over the concept's radical, minimal, or zero transformative potential; and whether it displaces, facilitates, or reinforced the concept of 'sustainable development' (Ehresman and Okereke, 2014). Ehresman and Okereke (2014), surveying recent literature, propose a typology that maps out the relationship between different framings of green economy – which they identify as a 'woolly' and 'amorphous' concept – with principles of environmental justice associated within them: Thin Green Economy, which emphasises the central role of a liberalised market in increasing• resource efficiency, holds beliefs that technological solutions will address resource scarcity, and that creating economic growth will address environmental impacts by following the

Towards Energy, Food and Water Nexus Justice in Southeast Asia:

Governance at and across the local, national and transnational scale through the lens of environmental justice, scale, place and distance are important

considerations in understanding the production of environmental injustices. The emergence of transnational environmental justice movements and analysis grew from a concern over the relocation of polluting industries to the South, alongside the growing consumption patterns in high-income countries facilitated by international trade (Schroeder et al., 2008). More recently, processes of international 'land grabbing' and other natural resource appropriations have garnered public attention (Borras and Franco, 2012b). The growing distance between the point of consumption and the point of production creates spatial disconnects that can render environmental injustices in areas of production invisible to consumers (Agyeman, 2014). Political and economic geographers have highlighted how place-based environmental injustices are produced through the interaction between the specifics of the place and interaction with higher-scale actors, drivers and structures (e.g. Harvey, 1996; Leichenko and Solecki, 2008; Sikor and Newell, 2014). These include, for example international markets, the investments, commodities and knowledge that flow through them, and the local and national institutions that mediate them. Furthermore, a growing ecological footprint of the relatively wealthy in the North (and the South31) significantly raises the likelihood of environmental injustice, including across nexuses natural resources. Given the thin to moderate green economy approach that frames many international organizations approach to the nexus (discussed above), these insights from environmental justice are pertinent.

Towards energy, food and water nexus justice in Southeast Asia This paper has mapped how the nexus has spread throughout mainland Southeast Asia from global level policy conceptualization to within regional policy circles that have included international and regional organizations, academic networks, and civil society, national politicians and government officials, and high-income country donors. The nexus is yet to be extensively grounded, however, into national policies and practices, and broad-based local demand for nexus-framed policies is currently limited. The paper has also highlighted that more attention is required to the politicized nexuses relationships between food, water and energy governance systems (c.f. Foran, this issue).

Pieterse (2010) has argued that for ideas to be significant, social forces must carry them into action. Meantime, Molle (2008: 143) suggests that a 'snowballing effect' results in a growing number of actors promoting and implementing a particular nirvana policy concept, such that it is "gradually established as a consensual and controlling idea". If the nexus is to become embedded in the region, there must be demand for it both from above and below. This paper would argue that to increase demand from below, a technocratic ecological modernisation approach will be insufficient, and the concept must engage more clearly with promoting fair decision-making and thus to the expectations of many of the community resource users themselves.33 It is proposed, therefore, that introducing the concept of environmental justice into the nexus, especially where narratives, trade-offs and outcomes are contested, could make better use of how the nexus is framed, understood and acted upon. To

this end, the article has also demonstrated that there are a number of boundary concepts common to both the nexus and environmental justice, including sustainable development; the green economy; scarcity and addressing trade-offs; and governance at, and across, the local, national and transnational scale. Environmental justice is at its strongest in evaluating fairness in decision-making, and explaining why (in) justices may have occurred. It is institutionally rooted, with an emphasis on understanding processes of decision-making and with strong linkages to policies, law, and systems of justice – a weakness of the current nexus approaches. Environmental justice approaches are arguably weaker than Nexus approaches in explaining inter-sectoral linkages between food, water and energy systems, including consequences of cross-sectoral decisions that could have justice implications. We thus argue that in light of food, water, and energy trade-offs within Southeast Asia, bridging the gap between the nexus and environmental justice – via boundary work (Cash et al., 2003) – can redress in part a weakness of each. This article concludes that justice matters in nexus governance. Yet, even defining justice in water governance from a multi-disciplinary perspective is at an early stage due to its complexity (Neal et al., 2014; Zeitoun et al., 2014), leaving conceptualisation of justice in nexus governance at an even earlier stage. This article has proposed that drawing on environmental justice scholarship and practice offers a promising starting point to redress this deficit.

Conclusion:

This paper has mapped how the nexus has spread throughout mainland Southeast Asia from global level policy conceptualization to within regional policy circles that have included international and regional organizations, academic networks, and civil society, national politicians and government officials, and high-income country donors. The nexus is yet to be extensively grounded, however, into national policies and practices, and broad-based local demand for nexus-framed policies is currently limited. The paper has also highlighted that more attention is required to the politicized nexuses relationships between food, water and energy governance systems (c.f. Foran, this issue).

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Clean Cold Sits at the Nexus of Sustainable Social and Economic Progress: The Nexus

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Abstract: *The UN's Sustainable Development Goals, adopted last year, aim to finish the job set out by the Millennium Development Goals, and to massively widen their scope and ambition. By 2030, the new 'Global Goals' not only commit to abolish hunger and poverty worldwide, and ensure good healthcare, education, gender equality and access to clean water for all, but also set detailed targets around affordable clean energy, sustainable cities, infrastructure, climate action, decent work and economic growth, and responsible consumption. According to resolution A/RES/70/1, if the Global Goals are achieved, "the lives of all will be profoundly improved and our world will be transformed for the better".1 The UN rightly argues its 17 goals and 169 associated targets are "integrated and indivisible", and that this interconnectedness will be vital to their success. Many of the linkages – between hunger, poverty and ill health, for example, or water shortage and conflict, or economic growth and pollution - are already well understood. But it is surprising how many of the Global Goals share one common factor that is not yet widely recognized: cooling*

Key words: *cooling infrastructure, diesel engines, technologies*

Introduction:

What emerges from the new "indivisible" Global Goals is that cooling could also be critical for achieving economic and social progress. Getting cooling right is central to tackling these problems because it is both vital to many aspects of modern life – food, medicine, data – but also energy intensive and highly polluting. The dilemma is becoming most acute in developing countries, where climates are typically hot, cooling infrastructure scant to non-existent and cooling demand now booming - driven by rapid economic growth, rising incomes, urbanization and climate change. Here cooling causes huge problems both by its absence, and by its provision through highly polluting conventional technologies, and in either case it causes or worsens many of the environmental, economic and social challenges identified by the UN.

On the one hand, in most developing countries the lack of a continuous 'cold chain' of refrigerated warehouses and trucks contributes to high levels of post-harvest food loss: the IIR estimates that if developing countries had the same level of cold chain as developed they would save 200 million tonnes of food.2 Food waste depresses farm incomes, raises food prices and worsens hunger. Such colossal food waste has equally large knock-on effects: the FAO estimates that food wastage occupies a land area the size of Mexico; consumes 250 km3 of water per year, three times the volume of Lake Geneva; and accounts for 3.3 billion tonnes of carbon dioxide emissions, making it the third biggest emitter after the US and China.3

In other words, the absence of cooling causes or exacerbates challenges in food, water, emissions, poverty and hunger. It also has a direct impact on health and mortality: a lack of adequate cold storage and refrigerated transport causes two million vaccine preventable deaths each year4, and contributes to endemic low level food poisoning in much of the developing world. On the other hand, demand for cooling is booming in fast growing economies such as China and India, largely driven by urbanization and the rapid emergence of an Asian Pacific middle class – predicted to rise to 3 billion by 20305, whose spending power could rise to $33 trillion.6 Their lifestyles – changing diets, improved healthcare, online data and air conditioning - will be built on cold. As a result, global air conditioning demand at the end of the century is forecast to consume 10,000TWh7, about half the electricity consumed worldwide for all purposes in 2010. To put this in perspective, to generate 10,000TWh from wind would require 4.6TW of wind turbine capacity, more than ten times the world's total wind capacity today.8 In the near term, on current trends cooling will require an additional 139GW of generating capacity by 2030 - more than that of Canada – and raise greenhouse gas emissions by over 1.5 billion tonnes of carbon dioxide (CO_2) per year, three times the current energy emissions of Britain or Brazil.9

The projected growth will dramatically worsen the environmental damage caused by cooling, which is already huge – though little recognized so far. The data is poor, but one estimate suggests that refrigeration and air conditioning cause 10% of global CO_2 emissions10 – three times more than is attributed to aviation and shipping combined.11 Another estimate, from the German government, suggests cooling emissions currently account for 7% of the total, but are growing three times faster, so cooling's share will almost double to 13% by 2030.12 Cooling is also responsible for large amounts of toxic air pollution from the secondary diesel engines ('transport refrigeration units', or TRUs) used to power refrigeration on lorries and trailers. Analysis by Dearman shows these diesel TRUs can emit six times more nitrogen oxides (NOx) and almost 30 times more toxic particulate matter (PM) than the (Euro VI) propulsion engine pulling them around.13 it also suggests the cost to EU countries of TRU emissions of CO_2e, NOx and PM could total €22 billion over the next decade. NOx and PM cause over 400,000 premature deaths in the EU each year14, and 3.7 million worldwide.15 Analysis by Dearman and E4tech also suggests the worldwide refrigerated vehicle fleet could grow from around 4 million16 today to as many as 18 million by 2025 to satisfy currently unmet demand in developing countries.17 This fleet would emit the same amount of particulate matter (PM) from refrigeration alone as around 1 billion diesel cars18, roughly equal to the entire global car fleet today, representing an environmental and health catastrophe. So there is an urgent need to resolve the cooling dilemma; it is crucial that the primary energy demand for providing cold does not grow at the same rate as cold demand itself. But if the environmental, economic and social challenges caused by cooling are horribly entangled, the good news is that, by the same token, clean cold technologies and approaches would have an equally leveraged effect, and could help to

achieve many more of the UN targets than might be suspected at first glance.

Clean cold technologies and the 'cold economy' A recently published report from the Birmingham Policy Commission, entitled Doing Cold Smarter, investigated the environmental and economic potential of developing a 'cold economy' based on novel clean cold technologies and a system-level approach to cooling.19 The cold economy is a radically new approach that applies a system-level analysis to recruit vast untapped resources of waste cold, 'free' cold, waste heat, renewable heat, and 'wrong time' energy – such as wind or nuclear power produced at night when demand is low – to radically improve the efficiency of cooling, and reduce its environmental impact and cost. These waste or surplus resources can be used to provide cooling by converting them into a novel 'vector' – a means of storing and transporting cold - such as liquid air or nitrogen. A key insight of the Cold economy is that energy can be stored and moved as cold rather than converted into electricity and then converted again to provide cooling. The Cold economy is less about individual clean cold technologies – although these are vital – and more about the efficient integration of cooling with waste and renewable resources, and with the wider energy system. A tank of cold: synergies from aggregating applications). It recognizes the scale of cooling demand growth and the need to pre-empt its environmental impact, and the opportunities this will generate. The cold economy approach is powerful in part because it recognizes that there is no demand for cold per se, but for services that depend on it such as chilled food, comfortably cool rooms in hot climates and online data. This approach turns our thinking about cooling on its head. For the first time we are asking ourselves 'what is the energy service we require, and how can we provide it in the least damaging way', rather than 'how much electricity do I need to generate?' If the service required is cooling, current approaches such as burning diesel, which produces power and heat rather than cold, or electric powered air conditioners that expel heat into their immediate environment and so increase the

Waste Cold:

The Commission recognized that one of the key solutions was to recycle some of the vast amounts of waste cold given off during the re-gasification of Liquefied Natural Gas (LNG) at import terminals to reduce the primary energy demand, cost and environmental impact of providing cold. The cold of LNG can be considered the packaging in which natural gas is transported. When natural gas is cooled to -162°C it liquefies and shrinks 600-fold in volume, making it economic to ship by super-tanker to a customer on the other side of the world. On arriving the few instances of LNG waste cold recovery to date, the cold has typically been re-cycled by selling it to industrial gas or petrochemical companies 'over the fence'. But this limits use of the cold to the immediate vicinity of the LNG terminal, and to periods when the LNG is actually being re-gasified, which may be intermittent. Since only 23 of the world's 111 LNG import terminals do any form of cold recovery23, it seems reasonable to conclude that in many locations there is either insufficient local demand for waste cold, or that the business case is not compelling. The key to recycling more LNG waste cold is to separate the

generation and consumption of cold in both time and place. If the waste cold could be converted into a 'vector' or form that is storable and transportable, the energy could then be consumed in distant locations on demand, rather than tied to the location and degasification schedule of the LNG terminal. This should not only allow more of the waste cold to be recy

Clean cold and the Global Goals: The cold economy, and particularly the recycling of LNG waste cold, could have a significant part to play in achieving the Global Goals. It could help solve both the problems caused by the absence of adequate cooling infrastructure in developing countries, and those caused by booming demand and highly polluting conventional cooling technologies. A zero-emission Transport Refrigeration Unit (TRU), for example, by conserving food at far less environmental cost, could make a major contribution towards achieving many of the Global Goals. Because it would help reduce post-harvest food losses and emissions of CO2, NOx and PM, its impact would extend far beyond the environment and into the economic and social dimensions of sustainable development. Altogether "clean cold" could help achieve 14 of the 17 Global Goals:

Goal 1, end poverty in all its forms everywhere: since most of the world's poor work on the land26, the issue of post-harvest food loss is critical. Maximize volume and quality of product to market to maximize revenue The development of clean cold chains would reduce post-harvest losses and increase the volume and quality of product reaching market; allow farmers to produce higher value crops and products; and improve access to national and even international markets. This would raise farmers' incomes, boost local economies and reduce the incentive to migrate to city slums.

Goal 2, eliminate hunger and achieve food security and improved nutrition: clean cold chains would help achieve all three by reducing post-harvest food loss, which would increase the volume, quality and nutritional value of food reaching the market, and reduce food price inflation – widely recognized as the critical cause of hunger. One study found that halving food wastage could feed an extra 1 billion people27, comfortably higher than the 800 million who were chronically undernourished in 2012-14. Since global food demand is forecast to rise 60% by 205028 technologies like cooling that reduce waste will become ever more vital.

Goal 3, ensure healthy lives at all ages: a lack of adequate cold chain causes 2 million vaccine preventable deaths each year29, along with endemic low level food poisoning in the developing world, and conventional transport refrigeration units (TRUs) cause grossly disproportionate emissions of toxic NOx and PM – as do diesel gensets. All three causes of death and illness would be ameliorated by clean cold chains and back-up cold and power generators.

Goal 4, sustainable clean water and sanitation for all: reducing food waste through clean cold chains would also reduce the associated waste of water – estimated at 250km3 per year. According to the World Bank, at least 663 million people lack access to safe drinking water, and by 2025, 1.8 billion people will live in areas with absolute water scarcity.30 Cooling could also increase the fresh

water supply through innovative desalination techniques that work by freezing sea water.31 Since ice is also an effective means of storing off-peak electricity for daytime cooling32, it is possible a single 'desalination' plant could simultaneously provide fresh water, energy storage and cooling, while reducing local air pollution and CO2 emissions.

Goal 5, access to affordable clean energy for all: TRUs running on liquid air or nitrogen would be cheaper than conventional, highly polluting diesel TRUs, and dramatically so if the liquid air were produce with waste cold from re-gasification of liquefied natural gas at LNG import terminals, which are proliferating in developing countries.

Under Goal 6, specific targets include doubling the rate of efficiency improvement and substantially increasing the share of renewable energy, both of which would be supported by liquid air technologies. Since the largest and fastest growing developing economies typically have hot climates, global energy demand for space cooling will overtake that for space heating by 2060, and outstrip it by 60% at the end of the century33, requiring a

Clean cold and the research agenda:

The existence of an agreed set of global challenges is increasingly reflected in the way research funding is organized worldwide. Today government R&D spending is less likely to be allocated to individual academic disciplines, but rather to an overarching challenge, often requiring extensive inter-disciplinary collaboration. The British government adopted this approach in 2015, when it announced its overseas aid budget would be restructured to fund research tackling the challenges of the developing world, such as eliminating targeted diseases, crop protection, and mitigating climate change. The Research Councils will disburse a new Global Challenges Research Fund of £1.5 billion over five years, and expect most of the funding to be inter-disciplinary. Research into cooling has historically failed to match its economic importance and environmental impact. In Britain over the past decade, for example, research into Refrigeration and Air Conditioning (RAC) has attracted an average of just £2.2 million in public funding each year, scarcely 0.2% of total UK funding for engineering research, despite the fact that cooling is by one estimate responsible for 10% of all CO2 emissions.36 Across the EU as a whole, annual public RAC R&D funding has averaged £23.5 million per year or 0.22%.

More recently this shortfall has begun to be rectified, through public and private investments into clean cold– related research projects such as T-ERA, BCCES, CSEF and CryoHub, but these are largely focused on the priorities of developed rather than developing economies. Since research funding is now increasingly organized around the world's major challenges, and since the importance of cooling as a critical link between those challenges is becoming clearer, there is now a strong argument for establishing clean cold as an interdisciplinary research theme within sustainability. The results of such research are likely to have environmental, economic and social impacts in developing countries far beyond the immediate business of cooling.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Economically and Ecologically effective Energy Resources

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Abstract: *Energy resources are categorised as Primary and Secondary sources. Primary resources are those obtained from the Environment like fossil fuels (coal, crude oil, natural gas etc.), Nuclear fuels, Hydroenergy, Geothermal energy, Solar energy, Wind energy, Tidal energy. Secondary resources are those derived from primary energy resources but not occur in nature. Petrol is obtained from crude oil; electrical energy is obtained from burning of coal. Biomass or dried organic matter like wood, leaves, cow-dung, burning oils and fats derived from living organisms can be included in Secodary sources but these are renewable sources of energy. The energy resource availability, its distrubution and the finite nature lead to two management stratagies a) conservation of available natural finite energy resources b) development of non-fossil fuel based renewable energy resource.*

Key words: *Energy resources, resources of energy, renewable and nonrenewable energy, resources, Alternative energy resources, conservation of energy resources.*

Introduction:

Energy resources are categorised as Primary and Secondary sources. Primary resources are those obtained from the Environment like fossil fuels (coal, crude oil, natural gas etc.), Nuclear fuels, Hydroenergy, Geothermal energy, Solar energy, Wind energy, Tidal energy. Secondary resources are those derived from primary energy resources but not occur in nature. The energy sources have been basically divided into two categories as primary and secondary sources. Primary energy resources are those which are mined or otherwise obtained from the environment.

a) Fossil fuels: Coal, Lignite, Crude oil, Natural gas, etc.
b) Nuclear fuels: Uranium, Thorium, Deuterium, other nuclei used in fission and fusion reactions.
c) Hydro energy: The energy of falling water used to turn turbines or mill wheels.
d) **Geothermal:** The heat from the underground steams or the heat stored in the hot rocks beneath the Earth's surface.
e) Solar energy: Electromagnatic radiation from the sun.
f) **Wind energy:** The energy from moving air used by wind mills.
g) Tidal energy: The energy associated with the rise and fall of the tidal waters.
Sun is the source of our energy resources; circulation of atmosphere due to the sun's heat is the basis of wind energy. The natural water cycle and water flow due to difference in altitudes is the basis of hydro energy. Photosynthesis carried out due to solar radiation forms the basis for chemical energy in the plants. The chemical energy stored in fossile fuels is also due to the solar energy.

The primary energy resources can be further classified as renewable resources and nonrenewable resources. Renewable resources are those which are not exhaustible and which can hence provide

continuous supply e.g., wood, tidal energy, solar energy, wind energy, geothermal energy, etc. Non-renewable resources are those, which are finite and exhaustible e.g., fossil fuels (like coal, petroleum, natural gas), nuclear fuels, etc.

Secondary energy resources are those which do not occur in nature but are derived from primary resources. For example, petrol or gasoline is obtained from crude. Electrical energy is obtained from burning of coal; hydrogen is obtained by electrolysis of water.

Biomass or dried organic matter: Dried twigs, wood, leaves, cow-dung, burning oils and fats derived from living organisms can be including in this category. These are renewable sources of energy. Of these fuel-wood constitutes the most important source of energy in developing countries of the world.

Fossil Fuels or Coal, Oil and Natural Gas: Coal, oil and natural gas represent the photoshynthetic output of green plants, which occurred millions of years ago. The oldest coal deposits(anthracites) were laid down about 300 millionsof years ago are more, while the youngest deposits are about two million years old. According to oneestimate coal formation has been taking place at a rate of about 9 million tones per year, oil at a rate of about 0.25 million tons per year while natural gas is beiteng formed at a rate of 0.15 million tons per year. The renewal of fossil fuel resources is taking place somewhere under the sediments deposited today. However, rapid consumption of these materials is many folds faster than their formation fossil fuels are nonrenewable source of enregy as it is impossible to cut their consumption down to level at which they are being formed.

A particular fuel preferred for use when its small quantity produces larger amount of enregy compared to other types of fuels. Oil is one such fuel. Due to its higher calorific value compared to coal. It can be used for production of more efficient fuels like petrol, large spectrum of chemical including polymers, organics, and valuable inorganics the oil generation in nature my be attributed to microbiological in e activity on plant life which got buried deep in earth under sediments.these deposits are younger as compared to coal deposits. Oil abtained from the earth is termed as crude oil as it cannot be directly used as fuel. It is a mixture of complex organics, which are separated as fractions at different temperatures during the distillation of crude. These fractions include petrol, dielsel, fuel oil etc.

The energy resource availability, its distrubution and the finite nature lead to the following two resources management strategies.

- Conservation of available natural finite energy resources
- Development of non fossile fuel based renewable enegy resources.

Alternative Energy Resources

Experiences with the use of fossil fuels have led to the conclusion that the alternative sources should be easy to use or should be convenient to handle, clean (i.e., non-pollution generating), and should be renewable. R&D in this direction as identified various probable sources to generate energy. Though these resources have not yet got the real commercial status, still they are being

studied for their efficient energy production and utilization.

(1)Solar Energy

The major natural source of energy is solar energy. Proper collection of this enormous heat energy and tis utilization by converting it to different forms can create an alternative resource base for energy. Efforts in this direction have led to the development of solar heat utilizing devices for heating purposes. This can substitute the use of fossoil fuel to generate heat. Solar cookers for cooking food, solar collectors for heating water for domestic use, passive heating systems, for space heating (building) are now commercially available. The solar energy has been used through the use of proper insulations to heat and cool the buildings in western countries.

Flow of electric current is by virtue of follow of electrons through the carrieer medium like wire. A device called solar cell has been developed to produce flow of electrons in circute using solar energy. Such cells are now commonly used in solar powered gadgets like calculators, solar battery charges etc. A typical cell consists of two very thin layers of special material. The lower layer, a typical structure of metal, has atoms with single electron in the outer orbit, which can get easily lost. The upper layer has atomic structure, which is lacking in electrons. One electron from lower layer gets transferred to their outer orbital and hence can readily gain electrons. The kinetic energy of light striking this 'Sandwich' dislodges electrons from the lower layer, which are trapped in to the upper layer, thus creating an electric potential between the two layers. This electrical potential provides the electric current through the rest of the circuit. Thus without any moving parts, solar cells convert light energy directly to electrical power. Their current life span is about 20 years, depending upon their use.

Rural electrification projects based on photovoltatic cells are becoming popular in the Thirld world Countries. The Japanese are developing solar-powered air-conditioners to be marketed soon. Experiments with vehicles run on photovoltaic cells are under way using ultra-efficient designs.

1.Solar trough collectors: Solar trough collection systems are a low-cost practical methods for producing electrical power from sun light. Sun light hitting the solar trough collector is reflected on to a pipe running down the center of the trough, and heats a special type of fluid having special properties to absorb large amount of heat circulating through the pipe. The heated fluid is then used to boil water, there by generating steam to run convertional turbo generator. Two more developments have been reported for solar energy collection and conversion to electrical energy. These are solar tower and solar pond. Solar tower utilizes the solar energy for heating a boiler through surrounding mirrors placed round the boiler tower. The solar ponds are working on the density difference of saline water at different temperatures.

Solar energy can also be used for vehicles transport. It can be considered in two ways. The use of solar cells to charge the car batteries which in turn will run the car can be made. However, the batteries are expensive and heavy. The power retention is also limited. Thus it is still not economical to bring it as commercial

option. Some two wheelers have been in the markets which run on battries. They still need enormous developments. Alternatively, the solar energy through the solar cells is used to carry out electrolysis of water to produce hydrogen. This hydrogen can be used as fuel. This is a clean fuel without production of any harmful pollutants because it produces water and energy. Storage of hydrogen, the material of consruction and safety measurs are the major consideration for development of the technology.

(2)Hydropower : The hydro electric power generation is being practiced all over the world. This is clean way to produce energy. The basic principle behind the electricity generation is converson of potential and kinetic energh of water to electric power. The geographic conditions of a region where the power is to be generated are very important factor in efficient production of electricity. Through there are no pollutants released there are other very important impacts of the activity.

One of the important aspects in hydroelectric generation is to collect sufficient water and its storage that can be used for power generation. This requires constructions of dams on rivers. The water impounded due to the dams has great impact on the environment. The stored water impounds large amount of land that may be fertile. Storage of water on forest land destroys foresrts and wild life habitats. Some of tribal population may get ousted from their habitat. Productive farmlands may get impounded and historic and archeological sites may get destroyed. Geological disturbance cause adverse seismic conditions and may lead to earthquakes. Water retention due to dams may cause problems of water shortage down stream of the river. Sarda and Sarovar, Koyna dam and the Krishna-Kaveri river issues are the best examples regarding the dam constructions. With proper planning and carrying out proper impact assessment, building of the hydroelectric projects have great potential.

(3)Wind Power: Harvesting energy from wind has been carried out since ages. The development of wind mills has been carried out since ancient tiems. The mills with propeller blades are the most popular designs. The European countries have quite successfully utilized the wind power and have reached to the generation capacity of around 3000 mega watts. Wind power is a non-polluting and renewable source of energy production. These installations on a large scale again need a very thorough impact assessment studies to avoid the damage to natural course of cloud movement due to the effect of propeller movements and that the bird migratory routs should not be distrurbed.

(4)Geothermal Energy: Heat from the molten core of earth reserves a very large store of energy. Efforts are under way to harvest this energy for utilzation for energy production.

(5)Tidal Energy Utilization: The natural phenomenon of high and low tide in the sea provides a source of energy during high tide, there is a rise in sea water level and water enter the shore. Special turbines are being developed which operate under the tidal effect. A barrier is constructed on the mouth of a bay and the turbins are fitted. The turbine operates in direction of flow of water from sea to land producing power. When low tide conditions are set in the water

from the dam, collected durigh high tide, is allowed to flow back to the sea over the turbin with reversal of its blades. The power can thus be generated continuously. Depositin of sand and silt in the dam is one of the major problems in the system.

(6)Biomass Energy: Biomass in the biosphere accumulates solar energy during its growth and provides a source of energy through its utilization (the direct burning of wood, waste paper, manure, agriculture or any form of biomass or converting them to a fuel). Certain microorganisms when digest biomass in the absence of air produce either alcohol or methane gas, which themselves give energy on combustion. Since biomass is obtained through the process of photosynthesis, biomass energy is considered to be another form of indirect use of solar energy. Firewood can be considered as a sustainable energy resource where forests are plenty relative to population. In fact this was the case in ancient times when the population was scanty. Biomass energy should be preferred wherever energy can be produced as a byproduct from waste disposal (e.g., Sawmill waste, Sugar refinery waste, distillery waste, Muncipal refuse and sewage etc., which can be anaerobically digested). However, even while doing this, advantages of recycling refuse or composting of the wastes should be kept in view. Use of alcohol as fuel is being promoted in some grain-growing regions of developed countries. Alcohol is produced by fermentation of grains, straches, sugar or similar food products. Anaerobic digestion of sewage sludge and animal manure produces methane gas, which can be used as fuel. It is one of the methods for recycling and energy production. Such a method yields biogas and nutrient-rich compost, which is the good organic fertilizer that can be recycled back to the land in order to maintain the fertility.

The above discussed energy resources are ecologically effective. So, these energy resources must be developed economically with growing and innovative technology for sustainable development globally.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Climate Change & Aviation Growth in India: Issues and Challenges

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Abstract: *At present, India is the world's ninth largest aviation market with more than 80 operational airports with 17 airports having international operations, more than 700 aircraft, 14 scheduled airlines and nearly 120 non-scheduled operators. Currently, India's aviation industry caters to nearly 122 million domestic and 47 million international passengers. Over the next decade, the market could reach 337 million domestic and 84 million international passengers. Therefore, the Indian aviation industry has a large potential for growth in the years to come.*

Key words: *climate change, reduction measures,*

Introduction

India continues to face the challenges of sustaining its economic growth while dealing with the global threat of climate change. This threat emanates from accumulated GHG emissions in the atmosphere, anthropogenically generated through long-term and intensive industrial growth of developed nations. Climate change may alter the distribution and quality of India's natural resources and adversely affect the livelihood of its people. With the economy closely coupled with its natural resources and climate sensitive sectors such as agriculture, water and forestry, India may face a major threat because of the projected changes in climate in the years to come. Global aviation's economic impact is estimated at 2.2 trillion US dollars, representing 3.5% of the worldwide Gross Domestic Product (GDP).

The industry transports around 3 billion passengers every year and supports almost 57 million jobs. Within the Asia Pacific region, aviation represents a 470 billion dollar industry, transports 780 million passengers and supports 24 million jobs. 1.3 Intergovernmental Panel on Climate Change (IPCC) report has established that aviation's contribution to climate change, though small at present, could grow if appropriate actions are not taken to offset the growth. Although developing countries such as India do not have any legal binding on reduction of GHG emissions, however, several proactive initiatives are being taken by all its stakeholders to reduce or minimize carbon emissions from aviation sector. 1.4 India signed the UNFCCC on 10th June, 1992 and ratified it on 1st November, 1993. The Kyoto Protocol to the UNFCCC was adopted in 1997, which requires developed countries and economies in transition to reduce their Greenhouse Gas (GHG) emissions below 1990 levels. India acceded to the Kyoto Protocol on 26th August, 2002. As per the UNFCCC and its protocol, developing

countries such as India, do not have binding on GHG mitigation commitments in recognition of their small contribution as well as low financial and technical capacities. 1.5 India is engaging actively in multilateral negotiations in a positive, constructive and forward looking manner with an objective to establish an effective, cooperative and equitable global approach based on the principle of Common but Differentiated Responsibilities (CBDR) and respective capabilities. The success of India's efforts would be significantly enhanced provided the developed countries affirm their responsibility for GHG emissions and fulfill their commitments to transfer new and additional resources and climate friendly technologies to support both adaptation and mitigation in developing countries rather by imposing the same level of standards and requirements on all States to developed countries.

2. Discussion

Carbon Footprint for Civil Aviation Sector:

The carbon footprint represents an important tool to understand the sources and magnitude of carbon emissions of any industry or organization based on which future emission reduction A39-WP/138 EX/52 - 3 - policies/strategies can be formulated. In 2012 the DGCA completed the first-ever detailed carbon footprint of Indian aviation for the year 2011 (i.e., domestic operations, and Indian/foreign flights to/from India). It was released during the 50th DGCA conference held during October, 2012 and obtained significant recognition from the international aviation community. Since then, carbon footprint Report for Indian aviation sector is being developed annually for monitoring purposes.

2.1.2 The salient features of carbon footprint report for 2014 is as follows: a) The total carbon emissions for 2014 was 16.4 million tonnes of CO2; b) In 2014, global airline operations were responsible for the emission of 739 million tonnes of CO2 representing 2-3% of global anthropogenic emissions; c) In 2014, major airports emitted 0.82 million tonnes of CO2; d) India's total carbon emission from aviation represents less than 1% which is significantly lower than the global average; e) In the absence of any reduction measures, CO2 emissions may reach 30 million tonnes by 2020; f) The internationally accepted efficiency indicator for carbon emissions is kgs of CO2 per RTK. Continued efforts of DGCA towards reduction in carbon emissions has resulted in reduction of this value from 1.06 in 2011 to 0.95 in the year 2014 bringing it at par with the global average; and g) Overall, in 2014, CO2 emissions from Indian scheduled passenger airlines has increased which is attributed to domestic operations by new airlines, introduction of new routes and an overall increase in aircraft movements by the airlines as well as passenger growth.

2.2 Airline initiatives:

Fuel cost of any airline is the largest constituent of their operational cost and any saving in fuel cost leads to decrease in the total operational cost with an addition benefit of reduction in carbon emissions as well. With this objective, airlines have started adopting following measures that help them in reducing their fuel consumptions leading to reduction in carbon emissions too: a)

Upgradation of aircraft fleet through renewal and engine modernization program for better fuel efficiency; b) With a view to further improve fuel efficiency, airlines have started looking towards new aircraft models with state-of-art technologies and more fuel efficient engines that may result in substantial reduction in emissions in future. With induction of Boeing 787 Dreamliner which offers superior economic performance with 15% lower fuel consumption and future order of A320NEOs and B737Max options, further improvement in fuel efficiency is expected; c) Engine core water wash at regular intervals to increase fuel efficiency; d) Use of Computerized Fuel Plan (CPF) as conservative criteria for computing fuel requirements for a flight path; A39-WP/138 EX/52 - 4 - e) Usage of APU has been replaced by ground electrical power and air conditioning by airport based support system; f) Airlines have also adopted "Single Engine Taxi–in/out" policies and procedures specific to their operations; g) Airlines have adopted delayed deceleration approaches with aircraft kept in clean aerodynamic configuration during the approach phase of flight to reduce fuel burn; h) Usage of New Flight Planning System leading to preparation of flight plans by optimizing the routes and provides cost effective routing for every flight; and i) Usage of Electronic Flight Bags (EFB) is a major initiative towards paperless cockpit leading to weight and fuel saving in everyday operations.

2.3 Airport initiatives:

Airports in India are committed to conduct its business in an environment friendly and sustainable manner by minimizing the impact of their activities on the environment through optimization of natural resource utilization and energy consumption resulting in reduced emissions. Energy conservation and renewable energy development along with emission reduction is an integral part of their business strategy towards achieving credibility and sustainability in the aviation business. Airports in India have identified the emission sources from airlines and other business units operating within the premises of the airports and started working to minimize them such as on-site fuel consumption and electricity consumption, etc. With this objective, airports have started adopting following measures to reduce emissions: a) Adoption of Carbon Accounting & Management System (CAMS) for reducing airports GHG emissions which is based on the guidelines provided in the ISO 14064-1 for quantification and reporting of greenhouse gas emissions and removals. Airports are also using Environment Management System (ISO 14001), Energy Management System (ISO 50001:2011) and Green House Gas Reporting (ISO 14064) mechanism which helps them to develop and implement policy, objectives and action plans taking into account legal and other requirements for GHG reduction; b) Participation in Airport Carbon Accreditation Programs at various levels for emission reduction; c) Participation in Leadership in Energy and Environment Design (LEED) with an objective to reduce pollution & waste management, provision for eco-friendly vehicles, use of recycled water, energy-efficient electric lighting, etc; d) Use of advanced aerobridges fitted Fixed Electrical Ground Power (FEGP) and Preconditioned Air (PCA) in order to minimize aircraft and vehicular pollution

at the airport and prevents the use of APU at parking bay; e) Use of dedicated Compressed Natural Gas (CNG) vehicles and electrically operated baggage tugs and buggies for transport of baggage, cargo and passenger in the apron, cargo and passenger terminal building; A39-WP/138 EX/52 - 5 - f) Installation of solar power plant at airside premises and solar water heaters at the terminals in order to promote renewable energy use; g) Continuous Descent Approach (CDA) and Continuous Decision Making (CDM) procedures to reduce taxi time leading to fuel saving; and h) As of now, Bangalore, Hyderabad, New Delhi and Mumbai airports are members of Airport carbon Accreditation and have been accredited at different levels such as Optimization and Reduction levels.

2.4 Air Navigation Services initiatives:

India has launched the Future India Air Navigation System (FIANS) initiative, which is based on projects in the fields of communication, navigation and surveillance. Indicative projects include implementation of Performance Based Navigation (PBN), use of Automatic Dependent Surveillance Broadcast (ADS-B), harmonization with international systems, human resources development and training, etc. PBN roadmap has been developed and several projects have already been launched. For example, PBN implementation at some airports has already reduced flight distance resulting in fuel saving. In future, more emphasis will be given on PBN and ATM related technical issues to further streamline congestions at airports and airspace, avoid delays at runways for take-off and landings, etc.

India has launched GPS-aided geo augmented navigation (GAGAN) satellite based navigation system which has been jointly developed by Indian Space Research Organization and Airport Authority of India and certified by the DGCA. The system provides improved efficiency, direct routes, approach with vertical guidance at runways, reduced workload of flight crew and air traffic controllers, increased fuel savings and reduction in carbon emission for the benefit of environment.

3. Conclusion

In conclusion, India and its aviation industry have taken a number of important steps to address aviation's contribution to climate change.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Global connectivity of Solar Energy to meet comprehensive demand at Global: A way to better world

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Abstract: *All life on earth depends in some way upon energy. Energy growth is directly linked to well-being and prosperity across the globe. Modern energy enriches life. There are more than seven billion people on earth who use energy each day to make their lives richer, more productive, safer and healthier. Human desires to sustain and improve the well-being of ourselves, our families and our communities.It is fact that there is no need of power at day time and it may be useless if we have not utilized in a proper way. These countries can export to the darkened countries and vice versa. It may possible by all the nations make effort get together with integration of world nations like UNO towards eliminate power crisis and wars in this regard. Globalism should be replaced in Nationalism for* ***full moon in all nights****.*

Key words: *Global connectivity, Solar Energy, comprehensive demand, full moon in all nights.*

Introduction:

All life on earth depends in some way upon energy. Energy growth is directly linked to well-being and prosperity across the globe. Modern energy enriches life. There are more than seven billion people on earth who use energy each day to make their lives richer, more productive, safer and healthier. Human desires to sustain and improve the well-being of ourselves, our families and our communities.

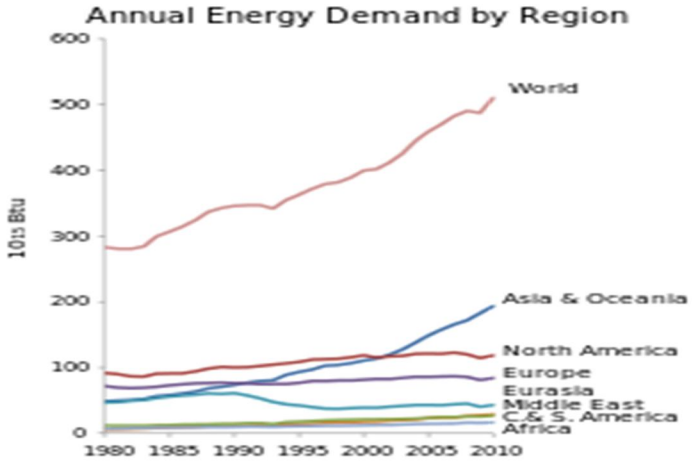
Objectives of the Study

In this paper, efforts have been made to summarize the availability, current status, major achievements and future potentials of renewable energy options in India. This paper also assesses specific policy interventions for overcoming the barriers and enhancing deployment of renewable for the future as future perspectives.

Why global/continental connectivity –

In developing countries, energy demand will grow close to 60 percent as five-sixths of the world's population strives to improve their living standards. In developed economies, energy demand will remain essentially flat. Growing electricity demand will remain the biggest driver of energy needs, with electricity generation even by 2040. Unconventional gas – from shale and other rock formations – has helped unlock up to 250 years of global gas supply at current demand levels.Gains in efficiency across economies worldwide through energy-saving practices and technologies will significantly reduce demand growth and curb emissions. Keeping pace with energy demand

growth will require unprecedented levels of investment and the pursuit of all economic energy sources. In coming decades wars may continue for energy as we seen in the earlier.



Historical crises – bitter evidence

1970s energy crisis - caused by the peaking of oil production in major industrial nations (Germany, United States, Canada, etc.) and embargoes from other producers

1973 oil crisis - caused by an OAPEC oil export embargo by many of the major Arab oil-producing states, in response to Western support of Israel during the Yom Kippur War

1979 oil crisis - caused by the Iranian Revolution

- 1990 oil price shock - caused by the Gulf War
- The 2000–2001 California electricity crisis - Caused by market manipulation by Enron and failed deregulation; resulted in multiple large-scale power outages
- Fuel protests in the United Kingdom in 2000 were caused by a rise in the price of crude oil combined with already relatively high taxation on road fuel in the UK.
- North American natural gas crisis 2000-2008
- 2004 Argentine energy crisis
- North Korea has had energy shortages for many years.
- Zimbabwe has experienced a shortage of energy supplies for many years due to financial mismanagement.
- Political riots occurring during the 2007 Burmese anti-government protests were sparked by rising energy prices.

- 2000s energy crisis - Since 2003, a rise in prices caused by continued global increases in petroleum demand coupled with production stagnation, the falling value of the U.S. dollar, and a myriad of other secondary causes.
- 2008 Central Asia energy crisis caused by abnormally cold temperatures and low water levels in an area dependent on hydroelectric power. At the same time the South African President was appeasing fears of a prolonged electricity crisis in South Africa.*"Mbeki in pledge on*

energy crisis". Financial Times. Retrieved 2008-02-10.

- In February 2008 the President of Pakistan announced plans to tackle energy shortages that were reaching crisis stage, despite having significant hydrocarbon reserves. In April 2010, the Pakistani government announced the Pakistan national energy policy, which extended the official weekend and banned neon lights in response to a growing electricity shortage.
- South African electrical crisis. The South African crisis led to large price rises for platinum in February 2008 and reduced gold production.
- China experienced severe energy shortages towards the end of 2005 and again in early 2008. During the latter crisis they suffered severe damage to power networks along with diesel and coal shortages.Supplies of electricity in Guangdong province, the manufacturing hub of China, are predicted to fall short by an estimated 10 GW.In 2011 China was forecast to have a second quarter electrical power deficit of 44.85 - 49.85 GW.
- *The Economist* predicted that in the years after 2009 the United Kingdom will suffer an energy crisis due to its commitments to reduce coal-fired power stations, its politicians' unwillingness to set up new nuclear power stations to replace those that will be de-commissioned, and unreliable sources and sources that are running out of oil and gas. It is therefore predicted that the UK may have regular blackouts like South Africa.
- Nepal experienced severe energy crisis in 2015 when India created an economic blockade to Nepal. Nepal faces the shortages of various kinds of petroleum products and food materials which affected severely on Nepal's economy.

Global connectivity of solar energy is the ultimate solution

Renewable energy sources and technologies have potential to provide solutions to the long-standing energy problems being faced by the developing countries. The renewable energy sources like wind energy, solar energy, geothermal energy, ocean energy, biomass energy and fuel cell technology. The renewable energy is one of the options to meet this requirement.

Over the globe, from 2000 to 2013 the total renewable energy use has increased 6,450 TWh and total energy use 40,500 TWh. Every country of the world is now spending a lot of money towards energy generation. The following table enumerates the selected renewable energy global indicators.

Solar energy as a source to meet comprehensive power demand

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaics, concentrated solar power and solar architecture, which can make considerable contributions to solving some of the most urgent problems the world now faces.

Table:Selected renewable energy global indicators

Selected renewable energy global indicators	2008	2009	2010	2011	2012	2013	2014	2015
Investment in new renewable capacity (annual) (10^9 USD)	182	178	237	279	256	232	270	285
Renewables power capacity (existing) (GWe)	1,140	1,230	1,320	1,360	1,470	1,578	1,712	1,849
Hydropower capacity (existing) (GWe)	885	915	945	970	990	1,018	1,055	1,064
Wind power capacity (existing) (GWe)	121	159	198	238	283	319	370	433
Solar PV capacity (grid-connected) (GWe)	**16**	**23**	**40**	**70**	**100**	**138**	**177**	**227**
Solar hot water capacity (existing) (GWth)	**130**	**160**	**185**	**232**	**255**	**373**	**406**	**435**
Ethanol production (annual) (10^9 litres)	67	76	86	86	83	87	94	98
Biodiesel production (annual) (10^9 litres)	12	17.8	18.5	21.4	22.5	26	29.7	30
Countries with policy targetsfor renewable energy use	79	89	98	118	138	144	164	173
Source: The Renewable Energy Policy Network for the 21st Century (REN21)–Global Status Report								

The International Energy Agency projected that solar power could provide "a third of the global final energy demand after 2060, while CO_2emissions would be reduced to very low levels. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic systems and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

In the Nature, Sun is one of the miracle gifts to the creatures on the earth. Earth's rotation occurs from west to east, which is why the Sun always appears to be rising on the eastern horizon and setting on the western. While the Earth rotates once in about 24 hours, half day is the full dark to the one region (north or South Pole) and the remaining appears full lighting.

Click on the figure

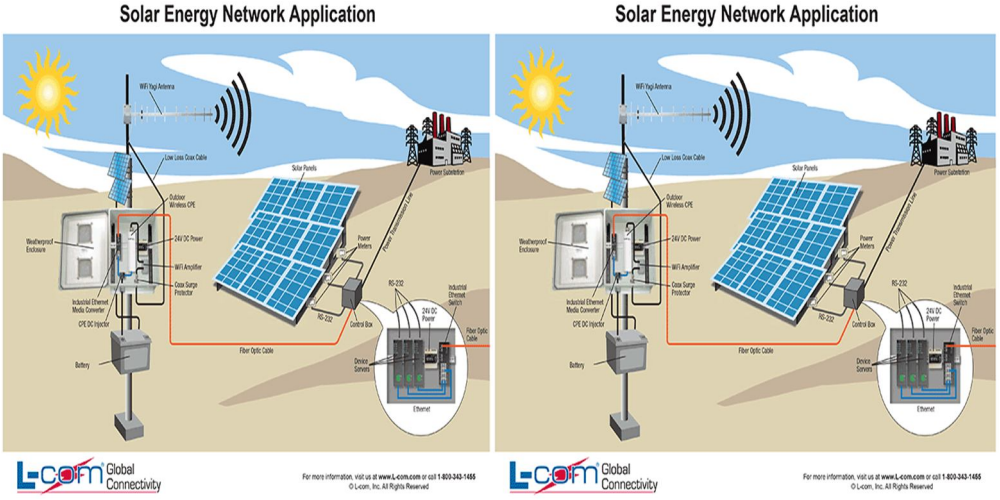
North Pole darken

South Pole darken

In this scenario, the day time (lighting) countries can be produced solar power/energy and could transfer to the darkened /night time countries.

How can transfer the power over the globe- As a challenging task:

The following figure is an illustration to integrate the regions to transfer the power from lighting (region/pole) area to darken area. It is fact that there is no need of power at day time and it may be useless if we have not utilized in a proper way. These countries can export to the darkened (pole) countries and vice versa.



North Pole darken
REGION -1 Network

South Pole darken
REGION -2 network

The above two regions can be connect with submarine communications cable as already established in Eastern Telegraph Company network in 1901. The following figure-Dotted lines across the Pacific indicate then-planned cables laid in 1902-03 with help of special cable layer ships, such as the modern *René Descartes*, operated by Orange Marine.A submarine communications cable is a cable laid on the sea bed between land-based stations to carry telecommunication signals across stretches of ocean. These technology is using for fixing communications cable.Throughout the 1860s and 70's, British cable expanded eastward, into the Mediterranean Sea and the Indian Ocean. An 1863 cable to Bombay, India (now Mumbai) provided a crucial link to Saudi Arabia. In 1870, Bombay was linked to London via submarine cable in a combined operation by four cable companies, at the behest of the British Government.

Is fixing communications cables useful to power transfer?

The already fixed Communications cables can be useful to power transfer without more additional expenditure.For example- Andhra Pradesh government plan to facilitate the households to use three-in-one broad band services transfer through electricity transferring wires (current wires)being offered through the government-funded AP Fibrenet project across the state. Similarly, more research should be needed to discover the technology to transfer the energy and diversify these modules.

Conclusion

An attempt is made to summarize the availability, current status, major achievements and future potentials of renewable energy options in India. This paper also assesses specific policy interventions for overcoming the barriers and enhancing deployment of renewable for the future as future perspectives.It is fact that there is no need of power at day time and it may be useless if we have not utilized in a proper way. These countries can export to the darkened countries and

vice versa. It may possible by all the nations make effort get together with integration of world nations like UNOtowards eliminate power crisis and wars in this regard.Globalism should be replaced in Nationalism for***full moon in all nights***.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

An overview on Climate Change and Renewable Energies: Issues and Challenges in India

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Abstract: *The energy needs to be available at cheaper rates, at least on par with conventional energy sources. This requires a fillip in Research and Development to find cost effective technologies to make available these sources at affordable prices. Secondly, lack of institutional support at the grassroots to promote and maintain programmes relating to these sources. The other important impediment is lack of awareness among the rural community and a lopsided and irrational subsidy policy. The renewable energy excluding electricity is expected to contribute only 5-6 per cent of India's energy mix by 2031-32. This may not be much in the total energy but helps in reducing carbon emissions and mitigate the climate changes besides providing energy security in India.*

Keywords: *climate change, human induce, Research and Development*

Introduction:

Often the terms of global warning and climate change are interchangeably used and misunderstood. The term climate change is preferable to global warming. Global warming means heating of the Earth beyond normal limits all over the world. Climate change means broader set alterations in climate patterns which in its real sense include warming as well as cooling trends and other meteorological variability. The main focus of the global environment to-day is on the climate change. Climate change is of two types. One is natural and the other is human induced. Climate change is presently considered as a global phenomenon which requires global initiatives both for its prevention as well as for mitigating its effects. It has been well accepted by almost all the scientists in the World that human induced climate change is mainly due to the excessive use of fossil fuels largely by the developed countries. Notwithstanding the difference of opinion whether the developed or developing countries are responsible for the increased levels of Green House Gases (GHGs), there is adequate evidence that the developed nations omitted most of the anthropogenic greenhouse gases into the atmosphere[1]. The main comment of greenhouse gases is the Carbon Dioxide (Co_2). The Carbon emission is a result of the combustion of fossil fuels. The industrialized and developed countries with 20 per cent of world population accounts for 80 per cent of emissions while the developing countries with 80 per cent of population accounts for only 20 per cent of the cumulative emissions since 1751[2]. During the 20th Century the carbon emissions rose phenomenally due to the acceleration of

economic growth, especially in the developed nations.

It is estimated that the global carbon emissions increased by 27 per cent between 1990 and 2004 and has been projected to increase by about 59 percent between 2004- 2030. The carbon emissions and their per capita of select countries in 2004 are presented in Table-1.

It may be noted from the Table that per capita carbon emissions of all the developed countries is much higher than that of the developing countries. For instance, the per capita consumption of USA is about 20 tons followed by Canada, Russia, Germany, Japan and South Korea while India and China ranks the least by having only 1.2 and 3.8 tons respectively in 2004. However, it is forecast that developing countries like India and China contributed these emissions much larger and faster than the developed Countries by 2030. It is pertinent to note that the annual Co_2 emission from the Non-OECD countries during 2005 to 2030 is five times higher than the projected increase of the OECD countries[3]. According to International Energy Agency, in recent years, China surpassed

Table – 1: Total and Per capita Carbon Emissions in Select Countries 2004

Sl.No.	Name of the Country	Total (Million Tons)	Per capita (Million Tons)
1	USA	5988 (1)	20.4 (1)
2	China	5010 (2)	3.8 (9)
3	Russia	1617 (3)	11.2 (3)
4	India	1343 (4)	1.2 (10)
5	Japan	1286 (5)	10.1 (5)
6	Germany	886 (6)	10.7 (4)
7	Canada	593 (7)	18.5 (2)
8	U. K	562 (8)	9.4 (7)
9	Italy	490 (9)	8.5 (8)
10	South Korea	466 (10)	9.8 (6)

US as the biggest Co_2 emitter and India would overtake Russia to become the third largest emitter. At present more than half of the global carbon emissions are generated by the developing countries. It is really surprising to note that the developing and least developed countries accounted for about 73 per cent of global emissions growth in 2004[4]. Of course, whether greenhouse gases, particularly the carbon emissions are caused by developed or developing countries, they are bound to cause climate changes and climate changes will have far reaching effects on life, livelihoods and on sustainable development especially in the developing economies though their magnitude and timing of occurrence vary.

Effects of Climate Change:

Effects on Temperature:

Though we cannot attribute the entire rise in temperature to the climate changes, definitely an increase in anthropogenic greenhouse gases is also responsible for the rise in the growth of temperature. It is to be noted that climate changes and the resultant rise in temperatures caused due to global warming and greenhouse gases occur with a time lag. The average temperature growth over the last hundred years has risen to the level of 0.7^{o} C. A part of this growth in temperature may be natural and the rest of it is due to anthropogenic emissions. For instance, the Intergovernmental Panel on Climate Change (IPCC) stated in 2007 that most of the observed increase in global average temperatures since the mid – 20th Century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Discernible human influences now extend to other aspects of climate, include ocean warming, continental average temperatures, temperature extremes and wind patterns[5]. It is to be noted that the current atmospheric concentration is equivalent to a concentration of 430 ppm (particles per million) referred to as Co_2e Carbon Dioxide equivalent.

The past three decades were the hottest in terms of global average near surface temperature since the mid–1800. The global averaged surface temperatures have increased at about $0.7^{o}C$ over the 20th Century would bring changes in the environment. It is estimated that the temperature increases between 1.1 and $6.4^{o}C$ by the end of this century. This is two to ten times more warming than the 20th Century. The scientists and environmentalists are very much worried that at the present level of atmospheric concentrations of 430 ppm Co_2e, the stabilization of temperatures becomes a big challenge.

Economic Effects:

Economists have been making attempts to measure the effects of global warming and climate change by using the cost benefit analysis. The cost benefit analysis weighs the cost of policy interventions and the benefits of damages avoided. However, it is difficult to value and monetize social, ecological and

political issues. But still economists are making attempts to estimate using discount rates[6]. The economic effects of climate change can be divided as two categories - predicted and less predicted. Damages of loss of land area, damages or disruption of water supplies, health damage, increased cost and loss of agricultural output etc. are the predicted effects. According to IPCC studies, the negative effects of climate change are larger than the positive effects as the emissions and temperature increase year to year. Estimates show that a 2.5°C increase in temperature leads to a loss of 1 to 1.5 per cent of GDP in developing countries. It may be noted that the economic effects and losses and the costs of damage control are large in the case of developing countries compared to developed countries. Besides several economic effects, the effect of climate change on agriculture is more evident and large in magnitude. Other sectors of the economy that were expected to be damaged are timber, water energy, coastal and recreation.

Impact on Agriculture:

Climate change impacts agriculture as climate change results in changes in weather patterns, impacts on agricultural production, potentially reducing crop yields and forcing farmer's to adopt new agricultural practices. Agriculture is affected due to the unpredictability of weather, shifting climatic and agro – ecological zone, increasing the imbalance of food production between cool and temperate, tropical and sub - Tropical regions, spread of pests and vector – borne diseases etc. All this may lead to loss in agriculture production and productivity ultimately threatening food security to the world's most vulnerable people living mostly in the developing countries. It is to be noted that agriculture impacts are country and area specific. Studies show that in the United States of America the impacts of climate change in mid-latitude countries are likely to be beneficial for most of this century. However, they are likely to be harmful towards the end of present century. Similarly there will be harmful impacts to agriculture in African, Latin American countries and China. (Kurukulasuriyan and Mendelssohn, 2008.) The developing countries are more vulnerable to climate change as they have a larger share of their economies in agriculture and forestry.

Other Effects:

Climate change in some cases may not affect the global economy but may reduce the quality of life. Climate change causes changes in the ecosystem and in turn it does lead to changes in the range of animals. Endangered species may be lost due to climate change. Climate change may also induce health hazards and extreme events may lead to

Policy Instruments:

Though there is a wide divergence in the forecasts and estimates of timing, occurrence and magnitude of damages due to global warming and

climate change, the impending dangers and disastrous effects of climate change cannot be totally ruled out. Therefore, it is necessary to formulate and initiate some measures and methods to abate or minimize the negative impacts on the people and on the economies, especially on the developing countries. These measures can be divided into two categories – (1) preventive measures and (2) adaptive measures. The objective of preventive measures is to reduce the emission of greenhouse gases and to promote carbon sinks. The aim of adaptive measures is to provide protection or alternative practices to avoid the negative impacts of climate change. Sometimes institutions can also be established to implement practices necessary to avoid the ill effects and also to mobilize resources meant for utilization to minimize the negative impact. The choice in between these two measures preventive and adaptive – depends upon the cost – effectiveness of the respective measure which is again based on Cost – Benefit analysis. On the basis of empirical analysis, economists preferred market based instruments or approaches like the pollution taxes, subsidies, transferable or tradable permits besides adoption of renewable energy and energy efficient technology.

Pollution Taxes:

A.C. Pigou suggested that pollution can be controlled by imposing a tax on the production of goods generating pollution. As greenhouse gases are resulted due to pollution, they can be reduced by controlling pollution activities by imposing a tax. On this theoretical premise carbon taxes have been suggested in recent years to control global pollution. Carbon tax is nothing but charging a unit tax on the pollutant – carbon or the fossil fuels. This tax is levied on the fossil fuels used in the production process or other uses in proportion to the carbon content. It helps in conserving the energy and also shifting of consumers and producers from high carbon to low (or no) carbon sources of energy. Global experience shows that consumers respond positively to carbon taxes by reducing energy use and prefer to buy goods with less carbon content. Pollution taxes or carbon taxes are in tune with the principle of economic efficiency and environmental protection. The revenue thus raised can be utilized for rural electrification in a developing country or can be utilized for developing innovative energy saving technologies. Of course, this instrument likely to rise prices of goods and services and may become a burden to the people.

Subsidies:

This fiscal instrument was also suggested by A.C.Pigou long back to reduce pollution there by reducing greenhouse gases. Subsidies can be used to adopt clean technology or can be provided as a fiscal incentive to non – carbon based fuels. In other words, subsidies or enhancement of existing subsidies for generation and use of renewable energy sources will help in

checking the magnitude of greenhouse gases.

Tradable Permits:

Tradable Permits or tradable carbon permits are another important instrument to reduce carbon emissions. In their approach carbon permits or credits are fixed at the firm, national and international levels. These entities can undertake trading among themselves. In other words once the carbon permits of a firm or country are fixed, they can undertake buying and selling of carbon credits highly polluting countries can buy unused credits from those firms or countries which are allowed to make more emissions than they are actually emitting. This transfer of allowances is referred as trade

Research and Development:

Government need to allocate adequate financial resources on Research and Development to invent innovative and alternative non-carbon energy technology. Also it is equally important to bring the alternative technology for wide application. Such a technology will reduce the economic costs. The new technology need to be available at competitive, affordable and comparable prices compared to fossil fuels.

Carbon Emissions Controversy:

Though there is a consensus that the above market based instruments need to be used to reduce carbon emissions, there exists lot of variance among countries in their implementation. Moreover, there is a mutual blaming in between developed countries and developing countries regarding the nature and quantum of carbon releases. As has been stated above already, while the developing countries are releasing carbon, emissions only in recent decades, the developed nations have been doing the worst for the last several centuries. Several developing countries like China, Brazil and India have per capita emissions far less than that of the developed nations. So the developing nations blame the developed nations as responsible for the accumulations of greenhouse gases. The developed nations in turn blame that the developing nations with their huge population and Methane generation are responsible for the GHGs accumulation. In fact it is really surprising that China surpassed US as the biggest Co_2 estimator and Indian will soon overtake Russia to become the third largest emitter. It is also estimated that more than half of the global emissions come from less developed countries[10]. It is now evident that developing countries are not lagging believed in contributing large quality to the greenhouse bases accumulation in the near future. For instance, the CO2 emissions of India have approximately doubled during the period 1990-2004. Similarly, same is the case with China. That is the reason why U.S. has demanded at the Bali Conference cuts in GHG emissions by India and China even without ratifying Kyoto Protocol. It may be noted that if us succeeds in its attempts to force India to reduce emissions further, the rate of

growth of GDP will be slowed down. There may be some uncertainty about the climate change potential of the developing countries but their high vulnerability of climate change is very certain. Therefore, it is necessary to initiate some measures to mitigate climate change by all the nations in the world.

Global Initiatives:

The world nations for the first time expressed their concern about the impact of climate change on human activities in 1979 at the World Climate Conference (WCC). The establishment of Intergovernmental Panel on Climate Change (IPCC) by the UNEP and the World Meteorological Organization (WMO) inn 1988 is a mile stone with regard to climate change. The IPCC released four Assessment Reports in 1990, 1995, 2001 and 2007. The first Assessment Report, 1990 was instrumental and influential for the development of the United Nations Framework Convention on Climate Change (UNFCCC) which was adopted at the Earth Summit in 1992. As per this document, 154 countries besides the European Community agreed to stabilize the GHG concentrations in the atmosphere at a level that would present dangerous anthropogenic interference with the climate system[11]. Subsequently the Global Environment Facility (GEF) as a joint venture of the UNDP, the UN Environment Programme (UNEP) and the World Bank was established. The Rio meeting assumed significance as the member countries agreed that the Conference of the Parties (COP), the supreme decision making body of UNFCCC, would meet regularly to hold discussions for mitigating climate change. In 1995 the COP at its first meeting in Berlin resolved that there was a need to fix compulsory targets for reduction of Carbon emissions. The Kyoto Protocol to the UNFCCC was adopted on 11th December 1997 at the 3rd meeting of the Conference of the {arties. According to Article 3 of the Kyoto Protocol, Annex-I (developed) countries committed to reduce GHG emissions by at least 5 per cent below the 1990 level by 2012. So far 107 countries signed and ratified the protocol. In the absence of US ratification and consequent upon its withdrawal in 2001, Russia's ratification became important to meet the 55 per cent conditionality for bringing the Protocol into force from 16th February 2005.

Renewable Energy Sources:

There is no difference of opinion that the consumption of conventional energy is leading to high level of carbon emissions resulting in global warming and climate change. Huge amount of money is being invested in the energy sector both for infrastructure and consumption. For instance, an amount of US $ 200-250 billion is invested in energy related infrastructure annually and another US $ 1.5 trillion is being spent on energy consumption. Of the total consumption of energy sources, approximately 82 per cent comes from

non-renewable energy sources while only 18 per cent comes from non-renewable sources of energy in the world.

India has a huge quantity of renewable energy resources. It has one of the largest programmes in the world for generating renewable sources of energy. It has been well recognized by world nations that Renewable Energy Technologies as the best choice to provide energy security and to protect the environment in general and climate change in particular. The most popular renewable energy sources which are commercially and technically feasible to adopt are – solar, wind, bio-mass, small hydro, bio-diesel, Ocean Thermal Energy Conversion (OTEC), tidal energy, geo-thermal energy etc., A more detailed explanation about important sources of renewable energy in India is not out of place.

Solar Energy:

Sun is the ultimate source of energy directly or indirectly. The solar energy of received by the earth space is appropriately 1.4 kilojoules / second / m2 known as solar constant. Solar energy is used for purposes live solar heat collectors, solar cells, solar cookers, solar water heaters, solar plants etc. India has a huge solar potential due to its geographical situation. The sunniest parts are located in between Kolkata and Chennai. India has an expanding solar energy sector with 9 solar cell manufacturers, 22 PV module manufacturers, and 50 PV systems manufacturers. A solar power plant (50 KW capacity) was installed at Gurgaon in Haryana state. Governmental efforts have become successful in the use and application of solar thermal extension programmes. For instance, sale of more than 2 lakh solar cookers and setting up of 10,000 street lighting systems in villages in solar photo-voltaic technology reveal this fact. The harnessing of solar energy in India is quite progressive yet a lot has to be done in future.

Wind Energy:

India is the second largest exploiter of wind energy next only to USA in the World. It was expected that by mid 1990s the sub-continent was installing more wind generating capacity than several countries like North America, Denmark, Britain and the Netherlands. The Indian government has offered several economic and fiscal incentives for the promotion of wind energy. The ten machines near Okha in Gujarat were some of the wind turbines installed in India. By 2006, an installed capacity of 4,430 MW was generated by wind energy.

The wind energy potential in India is about 46,092 MW and the following Table shows the state wise wind power potential in 2006. Wind energy has several advantages compared to the energy from fossil fuels. Following Table-2 shows a comparison between the two kinds of energies.

Table – 2: The Potential of Wind Energy in Different States in India

State	Gross Potential (MW)
Andhra Pradesh	9063
Gujarat	7161
Karnataka	7362
Kerala	1026
Madhya Pradesh	4978
Maharashtra	4519
Orissa	1520
Rajasthan	6672
Tamil Nadu	4159
West Bengal	32
TOTAL	46,092
Total No. of Stations in operation at the end of February 2006	59
Total No. of Stations closed down in March 2006	1
Total No. of Stations Commissioned in March 2006	1
Total No. of stations in operation as on 31st March 2006	59

Source: Global Energy Network Institute (GENI), Overview of Renewable Energy Potential of India, www.geni.org

Bio Mass:

It is the organic matter produced by plants and animals. It includes wood, cattle dung, manure, crop residues, sewage and agricultural wastes etc. The most important forms of biomass pulp and paper residues in forestry and manure. As biomass is considered to be a good substitute to fossil fuels, the Kyoto Protocol encourages further use of this energy source. Energy is produced by using biomass by different methods of combustion, gasification, fermentation and anaerobic digestion. Biogas and bio fuels can be generated with biomass. Biogas is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulplide. It is produced by anaerobic degradation of animal wastes in the presence of water. India with a cattle population of 240 million has large potential for biogas production. It is estimated that from cattle dung about 22,500 Mm3 biogas can be produced annually.

Table – 3: Comparison Between Fossil Fuels and Wind Energy

Item	Wind	Fossil Fuel
Availability	Usable as it exists	Have to be procured and made usable through laborious and environmentally damaging Processes
Limitation on availability	Inexhaustible resource	Limited in reserves, expected to be completely exhausted in the coming 60 years
Transportation	Used where it is available or transported where needed	Has to be transported from its source site for further processing, exposing the environment to pollution from accidents
Environmental effect of use	Zero emission	Used in producing electricity, releasing greenhouse gasses
Geo-political implications	Reduces our reliance on oil, safeguarding national security. Allows for self-sufficiency. There is no adverse effect on global environment. The whole system is pollution free and Environment friendly.	Over-reliance on oil as a resource has undermined India's energy security, e.g. OPEC crises of 1973, Gulf War of 1991 and the Iraq War of 2003.

Source: Global Energy Network Institute (GENI), Overview of Renewable Energy Potential of India, www.geni.org

Hydro Power:

This is nothing but generating electricity by constructing mini or micro hydel power plants across rivers in the hilly regions. Hydro power generation does not cause any pollution and India has an estimated potential of about 4 x 10 KWh. So far we have utilized abut only 11 per cent of the potential. Government of India announced various measures to promote mini-hydro power projects by extending financial and fiscal incentives. For instance, IREDA finances up to 75 per cent of the project cost at concessional rate of interest and buy back arrangement with State Electricity Boards. Presently,

Ocean Thermal Energy (OTE):

Ocean thermal energy can be generated due to the difference in

temperature of surface water of the tropical oceans and deeper levels. For constructing power plants a minimum of 20 C is required. However, in India no fruitful attempts have been made to harness this source of energy.

Geothermal Energy:

Geothermal energy means harnessing energy from the hot rocks underneath the earth. In several places in the world, there exist steam fields with high pressure and high temperature. Though it is yet to be explored in India, several geothermal plants are working successfully in USA and New Zealand. It requires advances in Research and Development to explore this source fully in the world.

Government Initiatives:

The economic, social and economic and environmental benefits of renewable energy sources have been well recognized by several countries like Germany, Spain, and Japan etc. Government of India also has been encouraging these energies by establishing, Indian Renewable Energy Development Agency (IREDA) in 1987. The main objective of IREDA is to promote, develop and finance new and renewable energy technologies with the help of World Bank and the Global Environment Fund (GEF). It has initiated "India Renewable Resources Development Project" to develop wind, solar and hydro power projects besides encouraging direct foreign investment and collaborations. In spite of these efforts, there is a wide gap between the estimated potential and the installed capacity of important renewable energy sources in India as may be seen in the following Table. A perusal of the Table implies that there is a wide gap between the estimated potential and the energy installed capacity of these sources. It is interesting to note that the sum of these recourses potential is about 1.52 lakh MW which is greater than the current total energy generating capacity in India. The growing threat of climate change all over the world including India, the domestic supply of fossil fuels, the energy crisis especially the rural energy crisis, to diversify energy sources and to provide energy security, renewable energy sources assume lot of significance in the energy sector. In spite of several programmes implemented by Government of India, the impact of these programmes is rather marginal. There is large gap betweenthe potential and energy generated in India which is shown in Table-4

This is due to several bottlenecks with regard to exploration, application, especially in the rural areas, and implementation of the renewable programmes. One important problem is huge capital and per unit cost of various sources of renewable energy as shown in the following Table-5.

Conclusion:

The main focus of global environment today is on the climate change. The human induced climate change is mainly due to excessive use of fossil fuels and the resultant carbon emissions mainly by the developed nations. While the increase of carbon emissions was 27 per cent between 1990-2004, it was expected to rise by 59 per cent during 2004-2030.

Table: 4 The Estimated Potential and the Cumulative Achievements of Different Solar Energy Sources in India.

Sl.No.	Source	Estimated Potential	Units	Cumulative achievements
1.	Solar Power	50,000	MW	2.92
2.	Bio Power (agro & Plantation)	16,881	MW	524.80
3	Wind Power	45,195	MW	7092.00
4	Small Hydro Power (up to 25 MW)	15,000	MW	1975.00
5.	Waste to Energy	7000	MW	43.45
6	Co-generation (bagasse)	5000	MW	615.83
7.	Family Type Biogas Plants	120	In Lakh	38.90

Source: Govt. of India, Eleventh Five year Plan, III volume, P. 386

Table-5: Capital and Unit Costs of Electricity Generated

Sl. No.	Source	Capital cost (cr. Rs. Per MW)	Unit cost (Rs. Per KWh)
1.	Small Hydro Power	5.0 – 6.0	1.50 – 2.50
2.	Wind Power	4.0 – 5.0	2.00 – 3.00
3.	Biomass Power	4 – 0	2.50 – 3.50
4.	Biagasse Co-generation	3.5	2.50 – 3.50
5.	Biomass gasifier	1.94	15.00 – 20.00
6.	Solar Photovoltaic	26.5	2.50 – 7.50
7.	Energy from Waste	2.50 – 10.00	2.50 – 7.50

Source: Govt. of India, Eleventh Five year Plan, III volume, P. 387

There exists a wide variation of per capita carbon emissions between the developed and developing nations including India. It is forecast that the developing countries especially India and China are emitting larger and faster carbon emissions compared to developed counties by 2030. Hence the need to use both preventive and adaptive measures both by the developed and developing countries. While the mitigation costs of climate change run into hundreds of trillion dollars, drastic policies of mitigation and abatement will have a negative impact on the growth of Gross Domestic Product especially in the case of developing countries. The developing countries need to depend upon market based solutions. Moreover, the world nations have a responsibility to increase

the momentum in the negotiations relating to ratification of Kyoto Protocol and implementation of flexible mechanism-Joint Implementation, Clean Development Mechanism and Emission Trading. Another important challenge faced by developing economics is adopting mitigation policies of climate change in a framework of Sustainable Development. Another problem faced by the developing countries is whether they should spend their scarce resources to avoid the impacts of climate change in the context of several kinds of vulnerability on social and economic fronts. Adoption of energy efficiency policies are very much needed to reduce carbon emissions

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Energy and Sustainable development

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Abstract: *Energy has been universally recognized as one of the most important inputs for economic growth and human development. Energy has long played a central role in the development and functioning of the world's economy. An essential input to agricultural production, transportation, industry, commerce and the home, reliance on energy will continue to grow as world population increases and standards of living improve. The trend towards increased mobility, urbanization and an integrated global economy will further accelerate our energy use and dependence. The three most basic drivers of energy demand are economic activity, population and technology. Longer-term trends in economic growth for a particular economy depend on underlying demographic and productivity trends, which in turn reflect population growth, labor force participation rate, productivity growth, national savings rate. The factors such as new technology innovations, majority of the world's population has become urbanized, with the largest urban centers emerging in developing regions where energy access is a serious constraint. This paper focuses on identifying the sustainable energy systems, challenges in implementing the systems, promoting the development of sustainable energy systems.*

Keywords: *Energy, sustainable development, energy systems*

Introduction

Energy is a basic necessity for survival and a critical factor affecting economic development and employment. Energy crisis has drawn attention of planners, on the impact of energy costs on economic growth, industrial production, employment, etc. Most of the regions in the developing countries depend on bio-resources. Deforestation and desertification are threatening traditional energy sources and subsistence pattern of agriculture, thus starving the rural sector of biomass fuels at the same time more efficient energy sources are needed for the sustainable development of a region. The term sustainable development was mentioned by the UN Bruntland committee to describe a development, which satisfies the needs of the present without compromising the ability of future generations to meet their own needs. The major steps towards this goal was in the form of educating world people about need and importance of environmental soundness which came in the form of "Earth Summit '92" at Rio De Janeiro in1992. Environmental education played very crucial role in conserving resources and promoting ecologically viable technologies which the key for sustainable development.

Identifying sustainable energy systems

Sustainability and Energy

Sustainability and sustainable development are difficult terms to describe from a technical and quantitative standpoint. No matter how sustainability is defined or measured, a

sustainable socio-economic system will require a sustainable energy infrastructure. Energy extraction, production, distribution, use and by-products are central to the interaction between humans and the environment. Although experts debate the sustainability of our global fossil fuel-based energy infrastructure, it seems clear that our generation is extracting energy resources and filling the earth's atmosphere with the combustion products of fossil fuels faster than they can be recycled by natural processes. Unless we make fundamental changes in our energy nfrastructure, we are likely to leave future generations with fewer energy resources and a more polluted environment than our generation inherited.

When examining today's energy systems we see an extensive network of related activities. For traditional fuels this includes the collection and transport of firewood by household members and small merchants, the production of charcoal in rural areas for transport to cities, or the collection and drying of dung by women and children. When considering commercial fuels there is much more of an infrastructure component, both locally and worldwide. There are resources: oil and gas fields, coal and uranium deposits, forests, rivers, wind and sun. There are technologies for bulk extraction, refinement, transportation and storage. These ultimately reach the end-user as refined products, gasoline, kerosene and electricity for example, ripe for conversion into the final energy service by another tier of technologies, automobiles and trucks, furnaces and air conditioners, machine shops, computers and lamps.

In practice, this gradual, efficiency-oriented approach directs us to look for ways to reduce environmental impacts and improve efficiency along the entire energy "supply-chain." Energy, and its economic value, is lost at every conversion step, with every kilometer of transport, often with every day or week of storage. Each loss or inefficiency, requires that the "upstream" infrastructure be larger or serve fewer people. When assessing the relative efficiency of components and systems, energy professionals can use "life cycle assessment" tools. These consider not only the energy consumption and losses of a device or process, but include the "imbedded energy" and environmental aspects of the technologies' manufacture, transport, use
and disposal. The design of systems which minimize energy losses and material requirements alike is commonly referred to as "eco-efficiency."

The Challenge of Implementing Sustainable Energy Systems

As societies pursue these options, diversifying their energy sources, their generation and distribution infrastructure, and their end-use technologies and practices, they will also face a more subtle challenge: integrating energy sources and systems. For example, most renewable resources are intermittent, and cannot be relied upon to generate power or provide fuels exactly when society requires them. The sun doesn't shine all day, nor does the wind continuously blow. Rainfall for hydropower may have sharp seasonal variations, or be subject to droughts. Droughts also effect the growth of biomass fuels, and many energy crops

cannot be harvested year-round. The more an energy system relies on intermittent renewable resources, the more energy
system managers will need to find new storage technologies and develop new systems for scheduling the delivery of power from different sources.
More broadly, making the transition to a more diversified (and hopefully more sustainable) energy system will require continuous improvements in both technologies and management systems. Such programs need not be cost prohibitive however, since without such initiatives many developing countries would need to import greater amounts of fuel, and develop a larger, less efficient energy infrastructure. Different energy technologies and management systems will be required by country and region, depending upon available local resources, skills, and
initial economic, environmental and social conditions. Both developed and developing countries will need to make steady progress in the development and introduction of cleaner fossil fuel resources and generation technologies; renewable energy resources and generation technologies; and more efficient end-use technologies. Steady improvements in fossil, renewable and end-use technologies, and their efficiency, can lead us in the direction of a more sustainable global energy system. The next question we must answer is how to develop the management systems, policies and financial incentives to take us in this direction.

Promoting the development of sustainable energy systems

The key elements for government and industry policy-makers help promote the development and deployment of more sustainable energy systems are, at the most basic level, the transition demands skilled people, appropriate policies and positive economic incentives in the energy sectors of every country. To ensure that all three are in place requires deliberate–sometimes enlightened–action by government officials, industry leaders and international agencies. Below are just some of the initiatives that they must pursue if the transition is to be successful.

Technology and Resource Initiatives The development and deployment of new energy sources and efficient technologies is clearly a key element in the transition to a sustainable energy infrastructure. If there is no market demand for these new sources and technologies, talented individuals are unlikely to spend their careers trying to develop them. At present, market demand is limited by the relatively low cost of fossil fuels and the relatively high cost of most alternative energy sources in most regions. In addition to R&D on alternative and efficient technologies, there is still an unmet need for R&D on energy systems, going beyond the component and small system levels to include large portions of the supply-chain, including a better understanding of multiple intermittent resources. Governments and industry have numerous ways to promote research, development and demonstration. For basic research topics (e.g. basic chemistry, physics, environmental research and monitoring related to energy production and use), government facilitated R&D appears to be best. Often the results of this
research are not profitable to private firms because they do not lead immediately to marketable products, but they may be very useful to society as a

whole. "Precompetitive" research is an area where government and industry should collaborate. For example, applied research to develop and test the feasibility of new technologies and research on energy systems integration may offer the potential for commercial profits, but may be too risky for any one corporation to undertake alone. Finally, when R&D is likely to result in a patentable product or process, the private sector does not rely on government support.

Getting Prices Right. Earlier, we pointed out that prices for fossil fuel sources of energy are usually lower than prices for alternative fuel sources. Low prices for conventional energy sources reduce incentives for energy producers to develop alternative energy sources, and for consumers to use energy more efficiently. Furthermore, diversifying our current energy infrastructure requires large capital expenditures at the beginning of the diversification process. In exchange, diversified energy systems may offer lower long-term recurring costs for fuel, waste management and waste disposal.

Competition and Market Mechanisms for Sustainable Energy Use. When it comes to getting more sustainable energy technologies and practices into the marketplace, finding ways to promote "best practice" behavior in the energy industry becomes important. Some energy sector analysts believe that increasing global competition, along with deregulation of the energy markets in many countries, are driving private investors to focus on short-term profitability at the expense of long-term investment. They also fear that competition and deregulation are making it harder for governments to regulate environmental and social impacts in the energy sector. Valid concerns, both. Using the electric sector as an example, is it possible for governments to promote long-term investment in a more-sustainable energy infrastructure in a price competitive energy market? In some cases, the answer appears to be yes. While increased competition does tend to demand shorter economic paybacks, it can also promote innovation and accelerate the introduction of more efficient, cleaner technologies. To make sure that competition meets social as well as financial goals, governments need to make clear and fair rules that penalize energy production and service companies for negative impacts and reward them for good environmental performance. Simply stated, a well structured competitive market makes and sells products that do the job they are claimed to perform, and protects the environment and the people making and using the products from harm. These goals may be achieved either by imposing regulations, or pollution fees and other market instruments.

"Performance standards," which tell industries the environmental goals they need to meet, may be a more efficient way for governments to stimulate innovation than "technology standards," which tell industries exactly what technologies or practices they must use to protect the environment. In addition, governments may be able to reduce industry's cost of meeting performance standards by using "economic instruments" in addition to legal obligations.

Coordinating Long-Term Sustainable Energy Development

Governments can use performance standards and economic instruments to direct private investment and behavior in the energy sector, even when competition, privatization and deregulation are limiting governments' ability to use more traditional policy tools. In many countries, state-owned and regulated utilities typically issue long-term forecasts for electricity demand, and follow government-mandated plans to meet this demand. These public forecasts and plans inform investors and firms about the likely demand for new technologies over the succeeding ten to twenty years. It is not clear whether privatized utilities will continue to provide public forecasts, or seek public input on their plans for meeting energy demand.

Conclusion

Energy is an essential component of economic development, and energy sector decisions and practices will play a central role in determining the sustainability of development in every country, region and sector. At the same time, decisions and practices in other sectors have a very direct effect on energy supply and demand options. Energy sector policies and investments must be coordinated with those in the key energy end-use sectors: transportation, housing, construction and manufacturing. In each of these sectors, there are major opportunities for improving the efficiency of energy use and developing new technologies and energy supplies. A sustainable energy infrastructure will ultimately utilize an extensive range of energy resources, distribution systems and end-use technologies. Research and development efforts to create these new technological and operational options are only the first step. Governments, corporations and consumers must develop policies and practices that meet both financial goals and broader economic, environmental and social performance goals. Such transitions in both technologies and policies will require long, sustained efforts. Fortunately, incremental improvements in energy use are less disruptive to the economy and society-at-large, and offer many side benefits. Progress towards a sustainable society is not a sprint, but a marathon. The development of a sustainable energy infrastructure will happen as a result of continuous improvement by individuals and organizations who have the knowledge and the incentives to take a long-term view.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Trade and Environment: Doha Negotiations and the India

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Abstract: The Doha Round of negotiations by the WTO (World Trade Organisation) members for the first time explicitly included 'Trade and Environment' as part of the negotiating agenda - a need emphasised largely by the European Union and supported by Switzerland, Norway and Japan. After much heated opposition developing countries including India, contrary to their customary stand of not linking trade with non-trade issues, agreed to the inclusion of environment in the negotiating agenda of the WTO framework. Currently, negotiations are taking place through the Committee on Trade and Environment Special Session (CTESS). In particular, Members are instructed to discuss inter alia the relationship between existing WTO rules and specific trade obligations set out in Multilateral Environmental Agreements (MEAs), the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services, the effect of environmental measures on market access, the relevant provisions of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS); and labeling requirements for environmental purposes. This paper has examined the linkages between environment and trade and explored the India's position in international environmental standards in the context of WTO framework.

Key Words: World Trade Organisation, Environmental Goods and services, Market access, Eco-labelling

1. Introduction:

World trade expansion has raised the issue of the relationship between trade and the environment. Is trade good or bad for the environment? The answer is not obvious. The production of goods that are imported and exported, like other production, will often have environmental effects. But will these effects increase or decrease with expanded trade? Will they affect the exporting nation, the importing nation, or the world as a whole? And whose responsibility is it to respond to environmental problems associated with trade? Questions such as these have received increasing attention in recent years. International attention was first focused on these issues in 1991, when the Mexican government challenged a United States law banning imports of tuna from Mexico. The U.S. Marine Mammal Protection Act prohibited tuna fishing methods that killed large numbers of dolphins, and banned tuna imports from countries that used such fishing methods. The Mexican government argued that this U.S. law was in violation of the rules of the General Agreement on Tariffs and Trade (GATT).

According to the free trade principles that provided the basis for GATT and for its successor, the World Trade Organization (WTO), countries cannot restrict imports except in very limited cases such as protection of the health and safety of their own citizens. A GATT dispute panel ruled that the U.S. could not use domestic legislation to protect dolphins outside its own territorial

limits. Although Mexico did not press for enforcement of this decision, the tuna/dolphin decision opened a major controversy over issues of trade and environment. In a similar case in 1999, the World Trade Organization ruled that the U.S. could not prohibit shrimp imports from countries using fishing methods that killed endangered sea turtles. The implications of this and the earlier tuna/dolphin decision could affect many other international environmental issues, such as forest protection, ozone depletion, hazardous wastes, and global climate change. All these issues are linked to international trade.

2. Trade and MEAs:

The core concern on environment in the Doha mandate is the harmonisation of WTO laws with trade measures in Multilateral Environmental Agreements (MEAs). The idea is to fine tune governance in cases where trade and environmental issues are interlinked. India with the support of Canada, New Zealand as well as many other countries have placed emphasis on the adaptation of Standard Trade Obligations (STOs) – that is, trade measures taken within MEAs to ensure their compatibility with WTO rules. On the other hand, the EU and Switzerland support an approach that is in favour of tweaking WTO laws to ensure their compatibility with Specific Trade Obligations in MEAs. After much deliberation, members agreed that STOs in six MEAs would be married with WTO laws. Consensus amongst members was achieved to include only trade measures explicitly provided for and mandatory under the related MEAs.

Till date only India among South Asian countries has actively contributed and participated in this negotiation. However, it should be remembered that not only India but also other South Asian countries are a signatory to a number of MEAs. Each country should closely monitor and participate in the procedures of the MEAs to benefit from such agreements. There is a need to identify the MEAs that affect the trade performances of various countries in goods with environmental significance; in this respect specific attention must focus on the Convention on International Trade in Endangered Species of Wild Fauna and Flora, Convention on Biological Diversity, Montreal Protocol, and Basel Convention.

3. Environmental goods and services:

Even after liberalisation, there is little potential for exports of EGS (Environmental Goods and Services) taking place from South Asian countries to saturated developed country markets. There would be more potential for these countries to export to other developing country markets. Also, liberalisation of trade in environmentally preferable products (EPPs), such as coir, jute and bamboo, could generate gains for South Asian countries, particularly countries like India and Sri Lanka who are principle exporters of such goods. During the negotiations there is a proposition to include these EPPs, such as organic products, non-timber forest products and related natural products as a category under EGS. This would imply an attractive enlargement of the global market for EGS.

Countries like India have already indicated its support for the expansion of the list of environmental goods. The Doha Declaration also mandates special attention to environmental products of export interest to developing countries and the special needs and concerns of developing and least developed countries (LDCs) in this regard. Despite all such pronouncements, the lists proposed do not embrace products of interest to developing

countries. Prior to the WTO Ministerial in Hong Kong, two strategies were submitted by WTO Members for the classification of EGS: the list approach and the Environmental Project Approach (EPA). The US, EC, Switzerland, New Zealand and Canada have proposed 'list' approaches to the classification of environmental goods on the basis of listings prepared by Organisation for Economic Cooperation and Development (OECD) and the Asia-Pacific Economic Cooperation (APEC) .

On the other hand, instead of following the submissions of developing countries with regard to the 'list' approach, India submitted the EPA (Environmental Project Approach). It emphasised that the EPA is a rule-based system and that transparency, flexibility and predictability are intrinsic to the process. Transparency is ensured by the involvement of the WTO Committee on Trade and Environment in the determination of a set of criteria concerning the EGS, while flexibility is guaranteed by policy space allowed to the national governments through the operations of a Designated National Authority.

Under this approach, environmental goods and services used in environmental projects would qualify for specified concessions for the duration of the project. Such projects would be approved by the Designated National Authority and could include those endeavouring to meet national or international environmental targets, facilitating thereby the realisation of national environmental goals and compliance with bilateral and multilateral environmental agreements. The strong proactive stand taken by India in these particular negotiations is a sign of India's geopolitical power. Other developing countries are also supporting the EPA, and at the same time, developed countries are also reconsidering their own 'list' approach in the light of the suggested EPA.

4. Market access:

The issue of market access was incorporated into the Doha Declaration as a CTE (WTO Committee on Trade and Environment) mandate because of consideration towards developing countries which feared that their products would be excluded from the international market due to environmental measures implemented by developed countries. In order to deal with the issue, it was agreed that there was a need to examine how environmental measures could be designed by importing countries in a manner that

- was consistent with WTO rules;
- was inclusive;
- took into account the capabilities of developing countries, and
- met the legitimate objectives of the importing country.

According to India's view, developing countries are more vulnerable to the adverse effects of environmental measures on market access and competitiveness. The way forward could be the identification of sector specific examples of environmental requirements impacting export performance. Some requirements may generate positive spillovers in the form of new trading opportunities, either through niche markets for environmentally friendly products or through competitive advantages arising out of factor endowments. These provide win-win opportunities. Other requirements may affect exports adversely, if not addressed properly.

5. TRIPS and the CBD:

The Doha Declaration requires the CTE to review the relevant provisions

of the WTO Agreement on Trade- Related Aspects of Intellectual Property Rights (TRIPS) that contain several environment related provisions and further discuss the relationship between the TRIPS Agreement and the CBD (Convention on Biological Diversity). India is actively involved in these negotiations and has made several important submissions to the CTE on this issue. According to India's proposal, there are two major contradictions between the provisions of CBD and those of the TRIPS Agreement.

The first important contradiction is the lack of any requirements for patent applications to mention the origin of biological/genetic resources and indigenous/traditional knowledge used in the biotechnological invention. The next contradiction is the lack of provisions in the TRIPS Agreement on prior informed consent of the country of origin and the knowledge-holder of the biological raw material meant for usage in a patentable invention. This needs to be reconciled with Article 15.5 of the CBD. Thus, if any inventor wants to develop such biological materials for commercial purpose, he or she would have to get the prior informed consent of the country as well as of the owner and enter into agreements with the country of origin. In order to overcome these contradictions, India has called for an amendment to the TRIPS Agreement to accommodate the essential elements of the CBD. Moreover, India fears that there could be several cases of bio-piracy of traditional knowledge associated with biological resources.

6. Eco-Labeling:

Around the world eco-labels are becoming an important addition to the toolkits of environment regulators. The expectation from eco-labelling, by both international organisations such as the Global Eco-labelling Network and national Governments, is that it will have a positive impact on the environment. Although negotiations have continued, the CTE has produced few tangible outcomes on the issue. Its work has been limited to information collection and analysis of environmental labelling. Some Asian developing countries, including India, Indonesia and the Philippines, have spoken out on the issue at the CTE meeting, and shared the same view as other developing countries. That is, they were reluctant to interpret the WTO compatibility with environmental labelling in a broad sense; these also reject labelling based on life cycle analysis.

Korea and China have had some specific concerns with the issue. For instance, China has stressed the need for more time to consider the issue at the CTE meeting without any clarification on its stance. In this regard, each South Asian country should first develop its own national and voluntary eco-labelling scheme with the help of domestic standard-testing bodies to get access to niche markets. They could even approach their neighbour, India, for such assistance given the fact this country has already established a national eco-label in 1991. Also it is vital that all South Asian countries do ensure that they actively take part in international standard setting bodies such as ISO, Codex, etc. Further, the analysis of the WTO legal system shows that the WTO applies a test of legitimacy that is mainly focused on the danger of protectionism in case of trade measures.

7. India's position on MEAs and compatibility with WTO:

In the Committee on Trade and Environment (CTE), the EU suggested amendments to GATT that would incorporate the possibility of trade measures decided on in an MEA, or else a

confirmation that WTO rules and MEA obligations should be equal in international law and not MEA provisions subordinate to WTO rules, supported by Switzerland. New Zealand also supported a kind of incorporation or official recognition of MEA provisions, but separating between those rules applied to members and those to non-members. This approach is supported by a larger group of countries including ASEAN. India however made official statements of its own, maintaining that the existing GATT provisions are sufficient for the protection of health and environmental purposes and also leave sufficient room for the application of legitimate environmental regulations that are already contained in existing MEAs. Further, it emphasised that future MEAs should be formulated so as to be compatible with WTO rules and be within the scope of GATT Article XX of 1994 to ensure the principle of non-discrimination. During the course of negotiations, it conceded to a MEA-by-MEA analysis (a case by case analysis) to accommodate for specific trade obligations in some MEAs, if WTO member rights are not disturbed.

Indian contribution to the MEA negotiations also include that MEAs should ensure "effective participation in the negotiations by countries belonging to different geographical regions and by countries at different stages of economic and social development", all showing the fear of protectionist measures or agreements that could be a disadvantage for developing countries. India's skepticism towards any further environmental provision within the WTO, even in the form of an official recognition of MEAs under the WTO is evident. It expects safeguards from the WTO system and its emphasis on "specific trade obligations" show that India wants to prevent the use of non-product related PPM measures such as those it claimed against in US-Shrimp/Turtle.

8. India's Position on Environmental Standards:

Environmental standards are typically set by the importing country to prevent cross-border pollution or harm by some polluting products, mainly under SPS and TBT Agreements. Indian exporters have felt the impact of the increasing number of these standards and the growing environmental agenda. India fears that these new issues at the WTO could negate gains from trade liberalisation. Some major export industries in India are particularly sensitive to environmental measures abroad, such as textiles and garments, agro-based items, marine products, pharmaceuticals – these are also industries in which industrialised countries seek higher environmental standards and regulations. India protests against the increasing complexity and stringency of the environmental requirements that affect its export sector.

India claims that importing countries should only seek information on PPM when it is traceable in the end product, such as pesticides. India claims that extending the scope to non-product related PPMs such as in the Shrimp/Turtle case should not be allowed. In setting standards, India demands that TBT and SPS Agreements must be strictly adhered to, and developing countries should be involved in negotiations when new standards are set so that their conditions can be taken into account. Technical and financial assistance is required and enough adaptation time for developing countries. India claims that decisions on standards are made in developed countries who only take into account their own factor endowments, and their availability of

environmentally friendly substitutes and technology – whereas developing countries still face problems on intellectual property rights making access to environmentally friendly technology difficult.

9. India's position on linking trade and environment:

India's general position on the linkage of trade and environment is in line with the overall developing country perspective. India's Minister for Commerce issued a press release in September 2001 saying that he has "underlined the concern of developing countries including India that environment was being used as some sort of a Trojan horse to provide legitimacy to protectionist trends" at the WTO negotiations. India has further stated that the existing WTO rules on environmental protection are sufficient and that there is no need for further rules to that respect. In the CTE, India has emphasised the right of governments to establish their national environmental and development conditions, needs and priorities, and its preference for multilateral solutions in form of MEAs for global and cross-border pollution cases.

India emphasises need to target free trade as much as possible and opposes trade restrictions for environmental purposes fiercely by emphasising the sovereignty of individual countries over environmental resources and over domestic environmental regulations. In the negotiations, India strongly protests against introduction of non-product related PPM standards in any WTO agreement. It also opposes voluntary eco-labeling schemes because of their effect on market access of developing country exports. And India seeks safeguards for developing countries against restrictions on their market access due to environmental regulations in form of product standards. What concerns global pollution, the Indian government promotes equitable burden sharing and consideration for developing country needs. Further, India advocates that ESTs should be transferred to developing countries in affordable terms. To support its statements, India draws on some of the arguments already mentioned in this thesis. It has claimed that trade liberalisation itself has no negative impact on the environment, and that the appropriate response to pollution ought to be correcting regulation and adopting better suited technologies, but not reversing trade liberalisation.

10. Conclusion:

It could be said that the WTO Committee on Trade and Environment (CTE) has only brought to light the changing negotiating positions of developing countries but has achieved precious little apart from that. While numerous proposals have been forwarded by developed countries, there have been very few proposals from developing countries to the CTESS (Committee on Trade and Environment Special Session). Till date, only the negotiations on environmental goods have seen some movement with a few countries proposing lists of environmental goods; many developing countries have yet to put forward their positions. It is quite important for South Asian countries to come together on the basis of mutual interest and geographic considerations, and push a common agenda in negotiations on the Environment. These countries have a lot in common in their economic situation, environmental concerns and interest in the global market. Since the environment issue has already been recognised as a mandate under Doha negotiations, it is always

better for the region to discuss and arrive at a common position. As of now, the Doha Round of negotiations have not yielded much result with developing and developed countries staying poles apart on the issues of agricultural subsidy and market access for industrial goods. However this does not mean that the environmental negotiations have come to a standstill; members have continued discussions in the CTESS on principal issues mandated for negotiation. India frequently asks for aid and technology transfer and safeguards for developing countries against protectionist ambitions of stronger trading partners. India has a very strict understanding of discrimination, which lead to the fact that it rejects some measures such as eco-labeling that had been found to be good alternatives.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Environment and International Trade

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Abstract: *World trade expansion has raised the issue of the relationship between trade and the environment. Is trade good or bad for the environment? The answer is not obvious. The production of goods that are imported and exported, like other production, will often have environmental effects. But will these effects increase or decrease with expanded trade? Will they affect the exporting nation, the importing nation, or the world as a whole? And whose responsibility is it to respond to environmental problems associated with trade? Questions such as these have received increasing attention in recent years.*
Key Words: *Environment, International Trade, Importers, Exporters*

Introduction:

International attention was first focused on these issues in 1991, when the Mexican government challenged a United States law banning imports of tuna from Mexico. The U.S. Marine Mammal Protection Act prohibited tuna fishing methods that killed large numbers of dolphins, and banned tuna imports from countries that used such fishing methods. The Mexican government argued that this U.S. law was in violation of the rules of the General Agreement on Tariffs and Trade (GATT).According to the free trade principles that provided the basis for GATT and for its successor, the World Trade Organization (WTO), countries cannot restrict imports except in very limited cases such as protection of the health and safety of their own citizens. A GATT dispute panel ruled that the U.S. could not use domestic legislation to protect dolphins outside its own territorial limits.

At the national level, the standard economic policy response to environmental impacts is to implement policies that internalize externalities. At the international level, however, the picture is more confused. The burden of environmental externalities associated with trade may be borne by importers, exporters, or by others not directly involved in the production or consumption of traded goods. The authority to formulate and enforce environmental policies usually exists only at the national level. This can create significant problems when environmental impacts are transnational, since most international trade agreements do not include any provisions for environmental protection.

Trade and environment: policy and practice:

Many developing countries grow agricultural crops for domestic sale as well as for export. With increased trade – which is often a major feature of structural adjustment policies required by international agencies such as the International Monetary Fund and the World Bank – the area devoted to export crops increases. What are the environmental effects of shifting to

export crops? In some cases they can be significant, and harmful.

On the other hand, export crops may sometimes be more environmentally friendly than the domestic crops they replace. In Latin America and Africa, tree crops such as coffee and cocoa can help to prevent erosion. In a more controversial case in Kenya, horticulture (growing flowers for the European market) provides a high-value export that is claimed to have little negative environmental effect, although concerns have recently been raised about the health and environmental effects of pesticide use in horticulture. In the Kenyan case, the flowers are flown to Europe by jet, so transportation energy use could raise an environmental issue – but proponents argue that the energy consumed in jet fuel is less than the energy needed to grow similar flowers in heated greenhouses in Europe.

According to GATT Article XX, countries are allowed to restrict trade in order to "conserve exhaustible natural resources" or to protect "human, animal or plant life or health." However, the interpretation of this special exception to free trade rules has led to fiercely contested disputes among countries.

For example, European nations have refused to allow imports of U.S. beef produced with hormone supplements. The U.S. has argued that since there is no proven harm to human health from the use of hormones, this is an illegal barrier to trade. The Europeans, however, cite the precautionary principle: since they fear the possible effects of hormones, shouldn't it be their prerogative to decide what they will allow for domestic consumption?

For example, European nations have refused to allow imports of U.S. beef produced with hormone supplements. The U.S. has argued that since there is no proven harm to human health from the use of hormones, this is an illegal barrier to trade. The Europeans, however, cite the precautionary principle: since they fear the possible effects of hormones, shouldn't it be their prerogative to decide what they will allow for domestic consumption?

Trade agreements and the environment:

What institutions and policies can be effective in balancing the goals of trade benefits and environmental protection? A variety of approaches have been suggested, some similar to the standard free trade model, and some which are significantly different. These approaches include:

The World Trade Organization Approach

This approach retains the overarching policy goal of free or "liberalized" trade, pursued for five decades through "rounds" of trade agreements under the General Agreement on Tariffs and Trade (GATT), which became the World Trade Organization in 1994. The GATT and the WTO, whose membership now includes over 120 nations, have worked to lower tariffs and nontariff barriers to trade, as well as to eliminate subsidies for export industries.

The North American Free Trade Agreement (NAFTA) Approach: In 1993, the United States, Canada, and Mexico signed the NAFTA agreement, lowering trade barriers across the continent.

During the negotiations for this agreement, environmental groups argued strongly that freer trade could lead to negative environmental consequences, pointing to the severe environmental problems already affecting the maquiladoras -- tariff-free industrial zones along the Mexican border. As a result, a side agreement, the North American Agreement on Environmental Cooperation (NAAEC), set up the tripartite Commission for Environmental Cooperation (CEC), while another side agreement, the North American Agreement on Labor Cooperation (NAALC), dealt with labor issues.

The European Union Approach

The European Union is unusual in being a free-trade area that has its own legislative and administrative institutions. Unlike the North American CEC, the European Union has the power to set environmental standards which are binding on its member countries. This is known as the harmonization of environmental standards. Note, however, that this policy involves more than free trade; it entails the creation of a supranational authority with the power to set environmental standards. dominated atmosphere of the WTO standards committees would be likely to harmonize standards down rather than up in many cases.

Multilateral Environmental Agreements (MEAs)

It has long been recognized that some environmental problems require international solutions. The first international treaty dealing with trade and the environment was the Phylloxera agreement of 1878, which restricted trade in grapevines to prevent the spread of pests that damage vineyards. In 1906 an international convention was adopted banning the use of phosphorus in matches. Phosphorous was responsible for serious occupational disease among match workers, but it was the cheapest ingredient for matches. An international convention was required to prevent any exporting country from gaining competitive advantage by using phosphorus in match production. public goods such as biodiversity, protection of the ozone layer, climate stabilization, and the protection of oceans and water systems, would be the responsibility of the WEO.

Conclusion:

Trade expansion can often have environmental implications. Trade may increase environmental externalities at the national, regional, or global level. While it is usually economically advantageous for countries to pursue their comparative advantage through trade, environmental impacts such as increased pollution or natural resource degradation may also occur as a result of trade.

International trade agreements make some provisions for resource conservation and environmental protection, but these are usually limited exceptions to a general principle of free trade. In the World Trade Organization, countries are allowed to take into account the environmental impacts of products, but not those associated with production processes. This has led to numerous trade disputes over whether specific measures are justified on the grounds of protection of life and health, or are simply disguised protectionism. Where

effective environmental protection policies are lacking at the regional or global level, national policies are needed to address trade-related environmental issues. Certification and labeling requirements, instituted by governments or by private non- governmental organizations, can help to promote consumer awareness and "greener" corporate practices in international trade.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Status of Environment and Wetlands in India - A Review of Extent, Ecosystem Benefits: Threats and Management Strategies

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Abstract: *India has a wealth of wetland ecosystems that support diverse and unique habitats. These wetlands provide numerous ecological goods and services but are under tremendous stress due to rapid urbanization, industrialization and agricultural intensification, manifested by the shrinkage in their areal extent, and decline in the hydrological, economic and ecological functions they perform. This paper reviews the wetland wealth of India in terms of their geographic distribution and extent, ecosystem benefits they provide, and the various stresses they are exposed to. The paper also discusses the efforts at management of these fragile ecosystems, identifies the institutional vacuum and suggests priority area where immediate attention is required in order to formulate better conservation strategies for these productive systems. It has been found that management of wetlands has received inadequate attention in the national water sector agenda. As a result, many of the wetlands are subject to anthropogenic pressures, including land use changes in the catchment; pollution from industry and households; encroachments; tourism; and over exploitation of their natural resources. Further, majority of research on wetland management in India relates to the immunological aspects and ecological/environmental economics of wetland management. But, the physical (such as hydrological and land use changes in the catchment) and socio-economic processes leading to immunological changes have not been explored substantially.*

Keywords: *India; Wetlands; Ecosystem benefits; anthropogenic threats; Institutional strategies.*

Introduction:

Wetlands are amongst the most productive ecosystems on the Earth (Ghermandi et al., 2008), and provide many important services to human society (ten Brink et al., 2012). However, they are also ecologically sensitive and adaptive systems (Turner et al., 2000). Wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant species, and soil and sediment characteristics (Space Applications Centre, 2011). Globally, the areal extent of wetland ecosystems ranges from 917 million hectares (m ha) (Lehner and Döll, 2004) to more than 1275 m ha (Finlayson and Spiers, 1999) with an estimated economic value of about US$15 trillion a year (MEA, 2005).

One of the first widely used wetland classifications systems (devised

by Cowardin et al., 1979) categorized wetlands into marine (coastal wetlands), estuarine (including deltas, tidal marshes, and mangrove swamps), lacustarine (lakes), riverine (along rivers and streams), and palustarine ('marshy' – marshes, swamps and bogs) based on their hydrological, ecological and geological characteristics. However, Ramsar Convention on Wetlands, which is an international treaty signed in 1971 for national action and international cooperation for the conservation and wise use of wetlands and their resources, defines wetlands (Article 1.1) as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters". Overall, 1052 sites in Europe; 289 sites in Asia; 359 sites in Africa; 175 sites in South America; 211 sites in North America; and 79 sites in Oceania region have been identified as Ramsar sites or wetlands of International importance (Ramsar Secretariat, 2013).

As per the Ramsar Convention definition most of the natural water bodies (such as rivers, lakes, coastal lagoons, mangroves, peat land, coral reefs) and manmade wetlands (such as ponds, farm ponds, irrigated fields, sacred groves, salt pans, reservoirs, gravel pits, sewage farms and canals) in India constitute the wetland ecosystem. Only 26 of these numerous wetlands have been designated as Ramsar Sites (Ramsar, 2013). However, many other wetlands which perform potentially valuable functions are continued to be ignored in the policy process. As a result many freshwater wetlands ecosystems are threatened and many are already degraded and lost due to urbanization, population growth, and increased economic activities (Central Pollution Control Board, 2008).

The negative economic, social, and environmental consequences of declining water quality in wetlands are also an issue of concern for India. The problem of deteriorating water quality is particularly more alarming in the case of small water bodies such as lakes, tanks and ponds. In the past, these water sources performed several economic (fisheries, livestock and forestry), social (water supply), and ecological functions (groundwater recharge, nutrient recycling, and biodiversity maintenance). Despite all these benefits, many decision-makers and even many of the 'primary stakeholders' think of them as 'wastelands'. Every one claims a stake in them, as they are in the open access regime, but rarely are willing to pay for this extractive use (Verma, 2001).

These freshwater bodies are often subject to changes in land use in their catchments leading to reduction in inflows and deteriorating quality of the "runoff" traversing through agricultural fields and urban areas. On the other hand, many of them act as the "sink" for untreated effluents from urban centers and industries. Encroachment of reservoir area for urban development, excessive diversion of water for agriculture is yet another major problem (Verma, 2001). Lack of conformity among government policies in the areas of economics, environment, nature conservation, development planning is one reason for the deterioration of these water bodies (Turner et al., 2000). Lack of good governance and management are also major reasons (Kumar et al., 2013a).

Given this background, the objective of this paper is to review the status of wetlands in India, in terms of their geographic distribution and areal extent; the ecosystem goods and services they provide; various stresses they are being subject to; and the various legal and policy approaches adopted in India for their conservation and management.

Distribution and extent of wetlands in India:

India, with its varying topography and climatic regimes, supports diverse and unique wetland habitats (Prasad et al., 2002). The available estimates about the areal extent of wetlands in India vary widely from a lowest of 1% to a highest of 5% of geographical area, but do support nearly fifth of the known biodiversity (Space Applications Centre, 2011). These wetlands are distributed in different geographical regions ranging from Himalayas to Deccan plateau. Initial attempts to prepare wetland inventory of India were made between 1980s and early 1990s (Table 1). As per the: Country report of Directory of Asian Wetlands (Woistencroft et al., 1989); and the Directory of Indian Wetlands 1993 (WWF and AWB, 1993), the areal spread of wetlands in India was around 58.3 m ha. But, Paddy fields accounted for nearly 71% of this wetland area. However, as per the Ministry of Environment and Forests (1990) estimates, wetlands occupy an area of about 4.1 m ha, but it excludes mangroves. The first scientific mapping of wetlands of the country was carried out using satellite data of 1992–1993 by Space Applications Centre (SAC), Ahmadabad. The exercise classified wetlands based on the Ramsar Convention definition. This inventory estimated the areal extent of wetlands to be about 7.6 m ha (Garg et al., 1998). The estimates did not include paddy fields, rivers, canals and irrigation channels. Thus, all these early assessments were marred by problem of inadequate understanding of the definition and characteristics of wetlands (Gopal and Sah, 1995).

Importance of wetlands:

Wetlands are considered to have unique ecological features which provide numerous products and services to humanity (Prasad et al., 2002). Ecosystem goods provided by the wetlands mainly include: water for irrigation; fisheries; non-timber forest products; water supply; and recreation. Major services include: carbon sequestration, flood control, groundwater recharge, nutrient removal, toxics retention and biodiversity maintenance (Turner et al., 2000).

Multiple-use water services:

Wetlands such as tanks, ponds, lakes, and reservoirs have long been providing multiple-use water services which include water for irrigation, domestic needs, fisheries and recreational uses; groundwater recharge; flood control and silt capture.

The southern States of Andhra Pradesh, Karnataka and Tamil Nadu have the largest concentration of irrigation tanks, numbering 0.12 million (Palanisami et al., 2010), and account for nearly 60% of India's tank-irrigated area. Similarly, there are traditional tank systems in the States of Bihar, Orissa, Uttar Pradesh and West Bengal, accounting for nearly 25% of net tank irrigated area (Pant and Verma, 2010). Tanks play a vital role of harvesting surface runoff during monsoon and then allowing it to be used later. Apart from irrigation, these tanks

are also used for fisheries, as a source of water for domestic needs and nutrient rich soils, fodder grass collection, and brick making. These uses have high value in terms of household income, nutrition and health for the poorest of the poor (Kumar et al., 2013a).

Tanks are also very important from the ecological perspective as they help conserve soil, water and bio-diversity (Balasubramanian and Selvaraj, 2003). In addition, tanks contribute to groundwater recharge; flood control and silt capture (Mosse, 1999). Water from tanks has also been used for domestic and livestock consumption. Over the years, the multiple-use dependence on tanks has only increased (Kumar et al., 2013a). Similarly, ponds in north-eastern States of India are used for fisheries (Sarkar and Ponniah, 2005) and irrigating homesteads (CGWB, 2011 and Das et al., 2012).

Lakes, such as, Carambolim (Goa); Chilka (Orissa); Dal Jheel (Jammu and Kashmir); Deepor Beel (Assam); Khabartal (Bihar); Kolleru (Andhra Pradesh); Loktak (Manipur); Nainital (Uttarakhand); Nalsarovar (Gujarat); and Vembanad (Kerala), have long been providing recreational, tourism, fisheries, irrigation and domestic water supply services (Jain et al., 2007a and Jain et al., 2007b). These lakes also contribute to groundwater recharge and support a rich and diverse variety of aquatic flora and fauna.

Further, surface reservoirs have also played an important role in providing irrigation and domestic water security in both rural and urban areas. Approximately 4700 large reservoirs (capacity of not less than 1 million cubic metre) have been built in India so far for municipal, industrial, hydropower, agricultural, and recreational water supply; and for flood control (Central Water Commission, 2009). As per the recent estimates, total live water storage capacity of completed reservoir projects is about 225 billion cubic metres (BCM) and the area covered by reservoirs is around 2.91 m ha (Central Water Commission, 2010). These reservoirs also support a wide variety of wildlife. Many of the reservoirs such as Govind Sagar Lake formed by diverting river Satluj (Bhakra Dam, Punjab) and Hirakud reservoir (Sambalpur, Orissa) are a major tourist attraction.

As per official estimates, tourism contribution to India's GDP and employment in 2007–2008 was 5.92% and 9.24% respectively (Government of India, 2012). These are very important numbers as wetlands (such as coral reefs, beaches, reservoirs, lakes and rivers) are considered to be a significant part of the tourism experience and are likely to be a key part of the expansion in demand for tourism locations (MEA, 2005 and Ramsar Convention on Wetlands and WTO, 2012). Every year, on an average nearly seven million tourist visit Kerala's backwaters, beaches and wildlife sanctuaries; three million visit Uttarakhand's lakes and other natural wetlands; one million visit Dal Lake; and 20,000 visits Lake Tsomoriri.

In terms of growth in fish production in India, wetlands play a significant role. At the moment, majority of fish production in the country is from inland water bodies (61% of total production), i.e. rivers; canals; reservoirs; tanks; ponds; and lakes (Table 2). It increased from 0.2 million tonne in 1950–1951 to about 5.1 million tonne in 2010–2011. Carp constitute about 80% of the total inland

aquaculture production. Presently, the State of West Bengal occupies the topmost position (30% of total inland fish production) followed by Andhra Pradesh, Uttar Pradesh, Bihar and Orissa (Ministry of Agriculture, 2012). Overall, fisheries accounts for 1.2% of India's total Gross Domestic Product (GDP) and 5.4% of total agricultural GDP.

In India too, wetlands are polluted through agricultural runoff and discharge of untreated sewage and other waste from urban areas. Under normal conditions, wetlands do retain pollutants from surface and sub-surface runoff from the catchment and prevent them from entering into streams and rivers. However, because of increased urbanization and land use changes, the nutrient loading in wetlands far exceed their capacity to retain pollutants and remove them through nitrification, sedimentation, adsorption, and uptake by aquatic plants. This adversely affects the wetland water quality and its biodiversity. Such wetlands show drastic changes in nutrient cycling rates and species lose (Verhoeven et al., 2006).

Various scholars in India have mainly focused on the usefulness and potential of constructed wetlands in pollution abatement on experimental scale (Billore et al., 1999, Juwarkar et al., 1995 and Kaur et al., 2012). Also, role of wetland plants in ameliorating heavy metal pollution both in a microcosm and natural condition is well established (Dhir et al., 2009). Typha, Phragmites, Eichhornia, Azolla, and Lemna are some of identified potent wetland plants for heavy metal removal (Rai, 2008).

Constructed wetlands are considered to be a viable option for treatment of municipal wastewater. A well designed constructed wetland should be able to maintain the wetland hydraulics, namely the hydraulic loading rates (HLR) and the hydraulic retention time (HRT), as it affects the treatment performance of a wetland (Kadlec and Wallace, 2009). However, one of the major constraints to field-scale constructed wetland systems in India is the requirement of a relatively large land area that is not readily available. Thus, for Indian conditions, batch-fed vertical sub-surface flow wetlands that require just about 1/100th of land area and 1/3rd HRT than the surface flow systems have been suggested (Kaur et al., 2012).

Urbanization and land use changes:

Between 1951 and 2011, total population in India increased from 0.4 billion to 1.2 billion with an average decadal growth rate of around 22%. During the 90 year period from 1901 to 1991, the number of urban centers doubled while urban population has increased eightfold (Bassi and Kumar, 2012). This magnitude of growth exerted tremendous pressure on wetlands and flood plain areas for meeting water and food demand of growing population. Between 1950–1951 and 2008–2009, total cultivated land in India increased from about 129 to 156 m ha. Also, area under non-agricultural uses (commercial or residential use) increased from 9 to 26 m ha (Data Source: India stat). In most of the major river basins of India, the increase in area for both agricultural and non-agricultural use was at the cost of conversion of flood plain areas, primary forests, grasslands and associated freshwater ecosystems to meet demands of growing population (Zhao et al., 2006). For instance, about 34,000 ha of the water spread area of the Kolleru

Lake (Andhra Pradesh) have been reclaimed for agriculture in recent years (MoEF, n.d.).

Already, most of the river basins in southern and western India are experiencing environmental water scarcity, which means the discharge in these basins has already been reduced by water withdrawals to such levels that the amount of water left in the basin is less than that required by the freshwater dependent ecosystems (Smakhtin et al., 2004).

Urbanization exerts significant influences on the structure and function of wetlands, mainly through modifying the hydrological and sedimentation regimes, and the dynamics of nutrients and chemical pollutants. Impact of urbanization is equally alarming on natural water bodies in the cities. A study found that out of 629 water bodies identified in the National Capital Territory (NCT) of Delhi, as many as 232 cannot be revived on account of large scale encroachments (Khandekar, 2011). Similarly, between 1973 and 2007, Greater Bengaluru Region lost 66 wetlands with a water spread area of around 1100 ha due to urban sprawl (Ramachandra and Kumar, 2008). Further, poor management of water bodies, lack of concrete conservation plans, rising pollution, and rapid increase in localized demands for water are pushing these precious eco-balancers to extinction (Indian National Trust for Art and Cultural Heritage, 1998).

Agricultural, municipal and industrial pollution:

Water in most Asian rivers, lakes, streams and wetlands has been heavily degraded, mainly due to agricultural runoff of pesticides and fertilizers, and industrial and municipal wastewater discharges, all of which cause widespread eutrophication (Liu and Diamond, 2005 and Prasad et al., 2002).

As a result of intensification of agricultural activities over the past four decades, fertilizer consumption in India has increased from about 2.8 million tonne in 1973–1974 to 28.3 million tonne in 2010–2011 (Data Source: Indiastat). As per estimates, 10–15% of the nutrients added to the soils through fertilizers eventually find their way to the surface water system (Indian Institute of Technology, 2011). High nutrient contents stimulate algal growth, leading to eutrophication of surface water bodies. Studies indicate that 0.5 mg/l of inorganic Nitrogen and 0.01 mg/1 of organic Phosphorus in water usually stimulate undesirable algal growth in the surface water. Runoff from agricultural fields is the major source of non-point pollution for the Indian rivers flowing through Indo-Genetic plains (Jain et al., 2007a and Jain et al., 2007b). Water from lakes that experience algal blooms is more expensive to purify for drinking or other industrial uses. Eutrophication can reduce or eliminate fish populations (Verhoeven et al., 2006) and can also result in loss of many of the cultural services provided by lakes.

Along with runoff from agricultural fields, untreated wastewater also contributes significantly to pollution of water bodies. Less than 31% of the domestic wastewater from Indian urban centres is treated, compared to 80% in the developed world. In total of 35 metropolitan cities, treatment capacity exists for only 51% of the sewage generated. Conditions in smaller urban centers are even worse as treatment capacity exist for only about 18% of the

sewage generated in Class I cities (population size of 100,000 or more but other than metropolitan cities) and 9% of the sewage generated in Class II towns (population between 50,000 and 100,000) (Table 3). Actual sewage treatment will be further low due to inadequacy of the sewage collection system and non-functional treatment plants. Thus, there is a huge gap in generation and treatment of wastewater in Indian urban centers and most of sewage is discharged without treatment in the natural water bodies such as streams and rivers (Central Pollution Control Board, 2009).

Policy support:

Until the early part of 2000, the policy support for wetland conservation in India was virtually non-existent. The action on wetland management was primarily influenced by the international commitments made under Ramset Convention and indirectly through array of other policy measures, such as, National Conservation Strategy and Policy Statement on Environment and Development, 1992; Coastal Zone Regulation Notification, 1991; National Policy and Macro level Action Strategy on Biodiversity, 1999; and National Water Policy, 2002 (MoEF, 2007 and Prasad et al., 2002).

As a signatory to Ramsar Convention on Wetlands and recognizing the importance of protecting such water bodies, the Government of India identified two sites, i.e. Chilika lake (Orissa) and Keoladeo National Park (Rajasthan), as Ramsar Wetlands of International Importance in 1981 (MoEF, 2012). Thereafter in 1985–1986, National Wetland Conservation Programme (NWCP) was launched in close collaboration with concerned State Governments. Initially, only designated Ramsar Sites were identified for conservation and management under the Programme (MoEF, 2007). Several measures were taken to arrest further degradation and shrinkage of the identified water bodies due to encroachment, siltation, weed infestation, catchment erosion, agricultural run-off carrying pesticides and fertilizers, and wastewater discharge. Subsequently in 1993, National Lake Conservation Plan (NLCP) was carved out of NWCP to focus on lakes particularly those located in urban and peri-urban areas which are subjected to anthropogenic pressures. Initially, only 10 lakes were identified for conservation and management under the plan (MoEF, 2007). There is also a National River Conservation Plan (NRCP), operational since 1995, with an objective to improve the water quality of the major Indian rivers through the implementation of pollution abatement works, to the level of designated best use. The new draft National Water Policy, 2012 which is cleared recently by the National Water Resources Council also recognizes the need for conservation of river corridors and water bodies (including wetlands) in a scientifically planned manner. Further, the policy emphasizes that the environmental needs of aquatic eco-system, wetlands and embanked flood plains should be recognized and taken into consideration while planning for water resources conservation (Ministry of Water Resources, 2012).

Over the years, number of designated Ramsar Sites has increased to 26 (Ramsar Convention on Wetlands, 2012), number of rivers under NRCP has increased to 39 and number of wetlands covered by the NWCP and NLCP has increased to 115 and 61 respectively

(MoEF, 2012). However these initiatives proved to be too little considering the extent of ecologically sensitive wetland ecosystems in the country and the fact that only a selected few wetlands were taken up for conservation and management purpose (Dandekar et al., 2011) (Table 4).

Water quality monitoring plan needs to be devised.

Conclusion:

In India, wetland ecosystems support diverse and unique habitats and are distributed across various topographic and climatic regimes. They are considered to be a vital part of hydrological cycle and are highly productive systems in their natural forms. Wetlands not only support large biological diversity but also provide a wide array of ecosystem goods and services (Wetlands Rules, 2010). In India, wetlands provide multiple services, including irrigation, domestic water supply, freshwater fisheries and water for recreation. They are also playing important role in groundwater recharge, flood control, carbon sequestration and pollution abatement. However, management of wetlands has received inadequate attention in the national water sector agenda. As a result, many of the wetlands in urban and rural areas are subject to anthropogenic pressures, including land use changes in the catchment; pollution from industry and households; encroachments; tourism; and over exploitation of their natural resources. India is signatory to Ramsar Convention on Wetlands and has drafted Wetland (Conversation and Management) Rules in 2010 but still no significant progress has been made on the conservation and wise use of wetlands. The main reason is that only selected number of wetlands has received significant attention (by way of financial and technical assistance from the central government) under the wetland conservation programmes (like NWCP and NLCP) while the remaining ones continue to be in neglected state. Majority of research work on wetland management in India relates to the immunological aspects and ecological/environmental economics of wetland management. But, the physical (such as hydrological and land-use changes in the catchment) and socio-economic (such as population growth and changes in economic activities) processes leading to immunological changes have not been explored substantially. Further, the institutional aspects (policies, rules, regulation and organizations) of wetland management have received limited attention and attracted the imagination of research scholars only recently. Thus more research emphasis on the physical, socio-economic and institutional factors influencing condition of wetlands and their use is required in order to arrive at better and comprehensive management strategies for wetlands that are facing growing stress from a variety of anthropogenic and climatic factors.

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Ambient air quality status over Vijayawada – A Case Study

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Abstract: *The analysis shown great variations from Police control room than the Auto Nagar and Benz Circle. Particulate matter and gaseous pollutants in the atmosphere has been increasing due to rapid increase in urbanization, congestion of roads, older vehicles and inadequate inspections of vehicles. Even though it is directly linked to the health of public. which may lead to narrowing of the airways . Long-term exposure may also cause Asthma, cancer and premature deaths. To meet the above an Air Quality Index (AQI) has been proposed to present the status of Vijayawada air quality. It is a rating scale in quantifying air pollution based on measured air pollutants for reporting monthly status of pollution at various locality. In the present study, an AQI has been calculated based on measured pollutants such as SO_2, NO_2, RSPM and Total Suspended Particulate Matter (TSPM) at selected residential area of Vijayawada city in 2015.*

keywords: *Respirable Suspended Particulate Matter (RSPM), Total Suspended Particulate Matter (TSPM), Air Quality Index (AQI), pollutants.*

Introduction: The atmosphere is having tremendous capacity to dilute and disperse air pollutants. The winds carry them, the turbulence mixes well them, the heat energy transforms them, the precipitation washes them down but yet there is a limit to this dilution. In urban centers, when the emissions are more, the concentrations built up (in spite of dilution) and ask for concerted efforts to control air pollution. Vijayawada is a commercial city and historical city situated at the geographical centre of the AP state in India. It is situated on the banks of River Krishna. (Latitude 16^0 03' 11'' N and longitude 80^o 03'91''E) the climate is tropical with hot summers and moderate winters. The city is peculiar in its own geographical setting. The city is surrounded by hills on all sides with Indrakiladri Hills range on the west where the famous shine of the Kanaka Durga is situated on. The east side there is Mogalrajpuram hill range with a famous temple of the holy mother Mary. At present Vijayawada is having all the bad situations of typical urban centre. The canals in the summer will have nothing but drainage affecting the health of the surrounding population in the neighborhood.

According to Altshuller, A.P and Bufalini, JJ (1965), Materials that are emitted in the atmosphere are subjected to a number of interesting and unusual reactions. These reactions lead too many products whose deleterious effects have now been recognized as one of the most pressing problems in urban areas throughout the world. These effects can be observed in reduced visibility eye

irritation, plant damage, cracking of rubber and corrosion of metals. Many of the problems confronting chemists participating in the study of the photochemical aspects of air pollution have been roughly reviewed by Leighton mainly the actions of the people are the primary cause of pollution increase, the attendant pollution problems also increase proportionately. The first significant change in man's impacts on nature came with the discovery of fire. Prehistoric man built a fire in his cave for cooking, heating and to provide light. The problem of air pollution came into existence at that time. Since then man is making rapid strides of progress in science and technology in utilizing the natural resources for better comforts. His eagerness to increase comforts leads to rapid industrialization and urbanization. The adverse effects of increase in industrialization and urbanization are obsolescence of the infrastructure, the pollution of the city atmosphere, the lack and bad quality of drinking water, overcrowding and traffic difficulties, the decreases in areas of greenery etc. According to Seinfeld (1986),

Air pollution may be defined as any atmospheric condition in which substances are present at concentrations high enough above their normal ambient levels to produce a measurable effect on man, animals, vegetation or materials. By 'substances' we mean any natural or manmade chemical elements or compounds capable of being airborne. These substances may exist in the atmosphere as gases, liquid drops or solid particles. Our definition includes any substance, whether noxious or benign; however, in using the term 'measurable effect' we will generally restrict our attention to these substances that cause undesirable effects.

2.Methodology

2.1.Sources of Air pollution in Vijayawada City

The air sampling station of present study is on Auto Nagar, Benz Circle and Police Control Room of Vijayawada city during 2015 January-December. Autonagar, which is predominantly industrial pollution area. The industrial pollution is also slowly and steadily increasing in Vijayawada. Agro based industrial activity is predominant around the city. The industrial base consists of solvent extraction plants, rice mills, oil and dal mills etc. Auto nagar industrial estate located in the eastern part of the city near Patamata, covering 340 acres, houses, industrial units which are mostly small and medium in nature. Benz Circle and Police control room Traffic Pollution, which are predominantly traffic polluted Vijayawada is well connected to the rest of the country by national highways NH-5, NH-9 and NH-221. There are a number of heavy trucks, busses, lories, cars, three wheeler autos as well as scooters playing on this national highways besides the floating pollution all major streets within the city are connected with local public transport as well as individual transports like car and scooters the three wheeler autos are the major sources of transportation for middle class population. All these contribute to traffic air pollution in the city.

3. Result and discussions:

The sulfur dioxide (SO_2) , Nitrogen dioxide (NO_2) , Respire able Suspended Particulate Matter (RSPM), and Total Suspended Particulate Matter (TSPM) concentrations are fluctuating

throughout the year. However concentrations levels compared to prescribed air quality standards were reported during entire period of study in the form of bar diagrams fig 1 to fig 3. The annual average of Auto Nagar, Benz Circle and Police control room of Vijayawada city, Auto Nagar shows more concentrations Air pollution in the city, and next the Benz Circle Moderate than the Police control room of Vijayawada city when compare to last year to this year.

4. Conclusion

The concentration of SPM is greater in all the stations when compared with other parameters in all seasons in the study. In the present article the air pollution concentrations of conventional pollutants like SO_2, NO_2, RSPM and TSPM have observed at three stations of Auto Nagar, Benz Circle and Police control room of Vijayawada city. The reasons for high particulate matter in general, may be vehicles, commercial activities, Industrial activities, solid waste burning, re-suspension of traffic dust, commercial and domestic use of fuels, etc. The major sources of high RSPM levels in Vijayawada are vehicle traffic, burning of solid refuse and re-suspension of traffic dust during dry season. Man uses the atmosphere not only as a resource but also a place for dumping wastes. He takes from it oxygen, a necessary ingredient for his own survival and return to it a mixture of gases and solids, the byproducts of combustion, respiration and other energy transferring activities thus tampering the ecosystem.

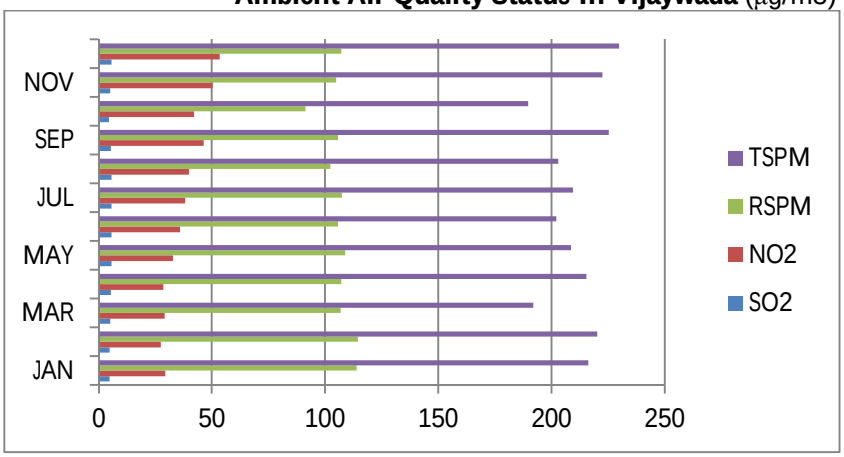

fig 1,Benz Circle 2015

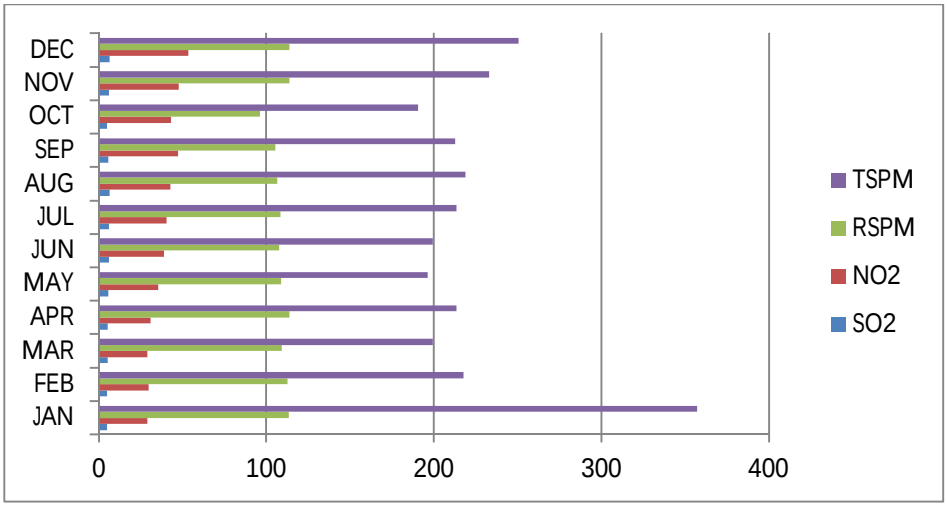

fig 2,Auto Nagar 2015

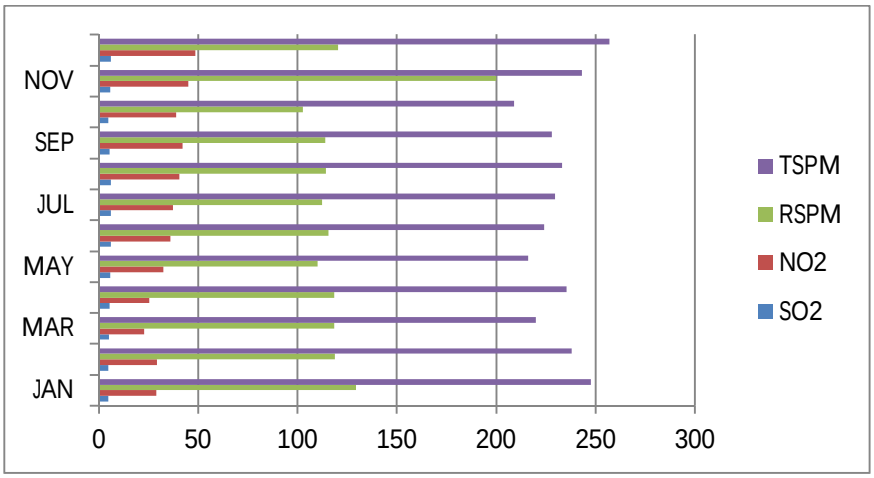

fig 3,Police Control Room 2015

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International Journal of Academic Research
ISSN: 2348-7666; Vol.3, Issue-12(2), December, 2016
Impact Factor: 4.535; Email: drtvramana@yahoo.co.in

Solarizing India – for Energy generation and Conservation

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Abstract: In less than two centuries of industrial revolution, the actions of human beings have led to deterioration of resources on the earth –beautiful and fragile result of millions of evolution. The time has come to act, to repair and prepare for the future. So that humanity will have further progressed in its evolution in a more conscious and fair world. Today, our planet is running out of steam because it does not any longer have its own natural means to compensate man's ecological print. Natural balances prove to be more fragile than men have been used to imagine for decades. India has been facing the energy balance crisis for many decades. Thus solar energy able to reduce emission and no adding infrastructural cost expenses like solar panel and micro inverters requirement.

Key words: Natural balances, solar energy, earth –beautiful

Introduction

India has been facing the energy balance crisis for many decades. The electricity generation primarily depends on coal reserves, secondly on hydro power followed by natural gas. Coal depletion has motivated the country to look for other sources to meet its energy demand. India has a tremendous opportunity for non-conventional energy resources. India is the first country to setup a separate government body for the renewable resources development, Ministry of New and Renewable Energy (MNRE) which is making special tariffs and schemes to reduce the carbon emission. The motivation of solar energy adding the country to meet its energy demand is in exhaustibility, reliability, and ease of installation in limited period of time.

Energy Generation - eco-friendly

The Solar Power Generation is eco-friendly as it does not have any harmful emissions and is a noise free operation. The installation and running costs for a long span of time is less. Moreover, the cost of solar plants has been decreasing as a sign of encouragement to increase the number of installations. The cost of solar panels has reduced from $76.67/watt in 1977 to $0.74 /watt in 2013. Following this trend, the prices are expected to decrease by the end of 2017. There are a few draw backs of Solar Power Generation. As this process mainly depends on climatic condition, suitable battery bank has to be installed for longer period of operation, affecting the cost of the system. Since the power produced through each panel is very low, to produce a huge amount of power, more number of PV panels must be employed in series and parallel, which follows the requirement of a vast area network. Besides these, solar energy has become an emerging strategy across the globe.

In less than two centuries of industrial revolution, the actions of human beings have led to deterioration of resources on the earth –beautiful and fragile result of millions of evolution. The time has come to act, to repair and prepare for the

future. So that humanity will have further progressed in its evolution in a more conscious and fair world. Today, our planet is running out of steam because it does not any longer have its own natural means to compensate man's ecological print. Natural balances prove to be more fragile than men have been used to imagine for decades. The erosion of biodiversity has reached a unique level in life's history on Earth.

Ninety percent of CO_2 emissions originate from fossil fuel combustion and, therefore, are determined by the following three factors :

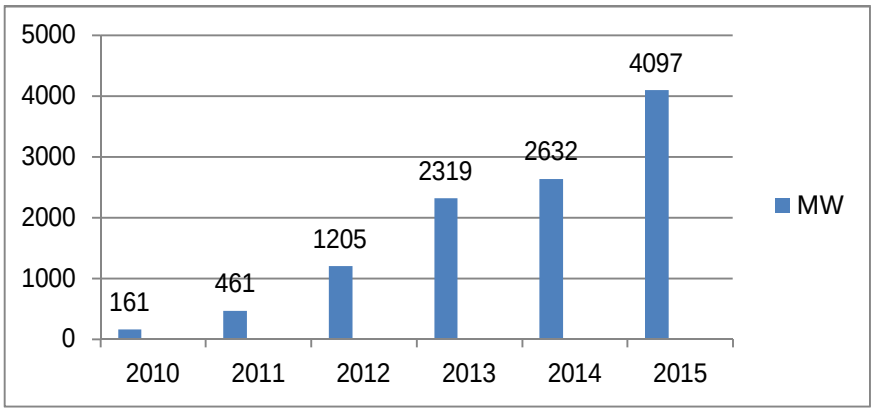
- Energy demand or level of energy – intensive activity; in particular, related to power generation, basic materials industry and transport.
- Changes in energy efficiency.
- Shifts in fuel mix, such as from carbon-intensive coal to low-carbon gas, or from fossil fuels to nuclear or renewable energy.

India's CO_2 emissions in 2013 continued to increase by 4.4 percent to about 2.1 billion tones, making it the fourth largest emitting country. The world must almost completely decarbonizes in the next 30-35 years, and the vast majority of fossil fuels have to be left in the ground, if we are to have any hope of tacking climate change effectively. The warning is based on one of the major findings of "Trends in Global CO_2 Emissions 2014 Report" that the scientific case behind 2^0C as a "Safe" level of global warning – a figure that has underpinned climate policies around the globe is rapidly weakening.

Emerging trends

India is rapidly emerging as one of the most attractive markets for renewable energy investments in the world. Depending on the location the average solar insulation varies from 4-7 Kwh/m^2 with around 1500-2000 sunshine hours per year. The following figure represents the current scenarios of power trend, showing that our energy depends on the availability of coal and next to that depicts the energy harnessed from the hydro power station.

Figure: Cumulative installed capacity of Solar Photo Voltaic System in India



From the above figure, we still have a lot of scope in the above area of the

solar power generation for energy generation and conservation. India has taken the following measures both on demand and supply side. In 2006, the rural electrification programme was the first step taken by the government of India to recognize the importance of solar power. This programme includes solar pumps; street lighting systems, solar latrines, and solar home systems. Thus, this programme gave an idea of off-grid application.

In 2007, India brought semiconductor policy encouraging IT and electronic industries. Silicon and PV manufacturing industries were also included in this policy. This move helped in the manufacturing industry.

Solar mission of the Indian Railways is to achieve the target of harnessing solar energy of 10 percent of Indian Railways Energy Consumption by 2020. The Indian Railways has planned to set up 1,000 MW plants in Railway/Private land and on railway buildings, with the support from Railway Energy Management Company.

Now the time has come to gradually adopt battery less solar street lights, particularly in cities where power availabilities is reliable. Thus solar energy able to reduce emission and no adding infrastructural cost expenses like solar panel and micro inverters requirement. The integration of Solar Thermal Energy and Solar Photovoltaic Technologies in solar food processing technology helps in processing of raw produce. The use of solar cabinet dryer has led to value addition of products to farmers, establishment of co-operatives and micro-operatives and micro enterprises and creation of employment opportunities for youth and women.

Renewable solar energy for fruits and vegetables drying is viable particularly in developing countries, where labour costs are low and cost of fossil fuel energy is very higher. The preservation of fruits and vegetables to enhance their shelf life is necessary for the large consumer base in our country. This preservation is made easy through solar energy system.

Conclusion : Thus solarizing India plays a vital role in reducing the demand – supply gap by installing roof top and solar parks. Facilitating closer government and industry co-operation and creating awareness about the benefits of solar energy among consumers promote the growth of solar sector in India. Certainly there is a ray of hope that India can emerge as one of the leaders in solar energy in the world.

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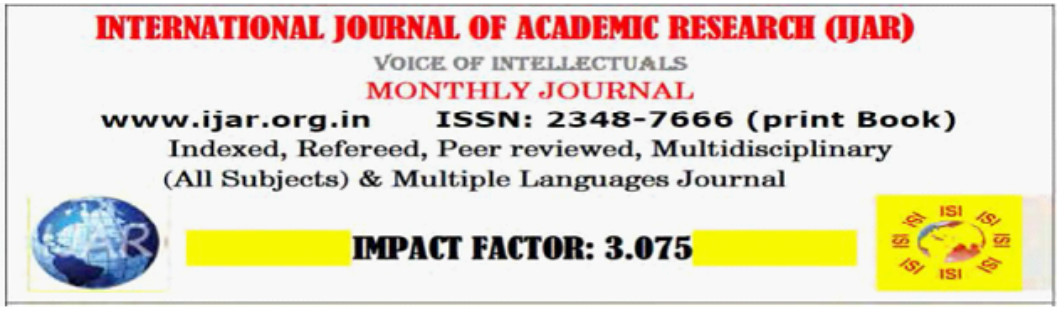

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International Journal of Academic Research
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