ENERGY DIGEST

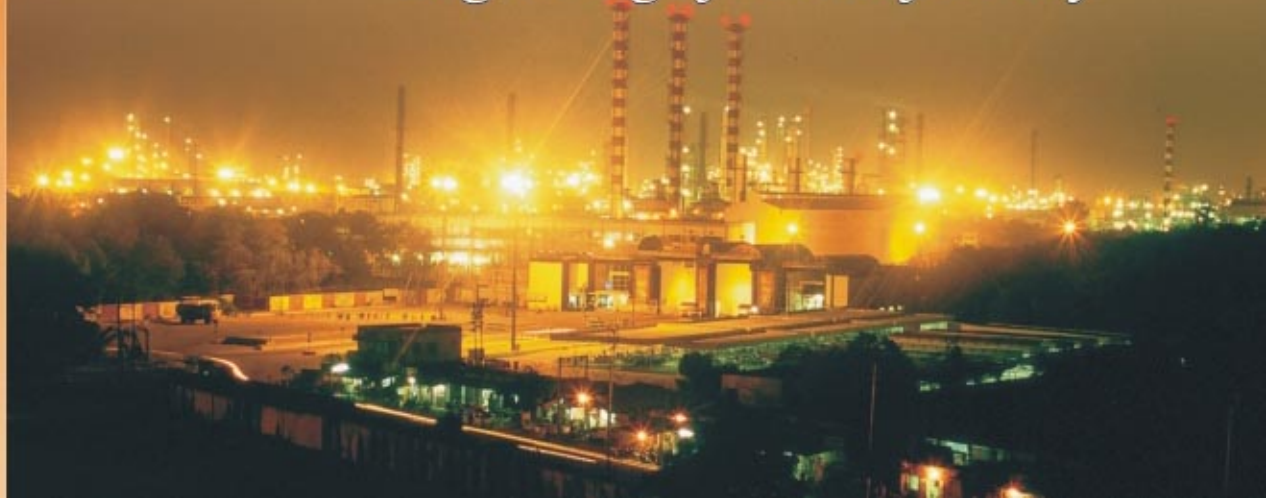
Economy • Energy • Environment

Vol. I, No.1, September, 2009

Also Inside.....

Vision...

Beginning of a new journey



IndianOil 50 स्वर्णिम वर्ष Golden Years 1959 - 2009

भारत की ऊर्जा | The Energy of India

The energy to fly to newer horizons.

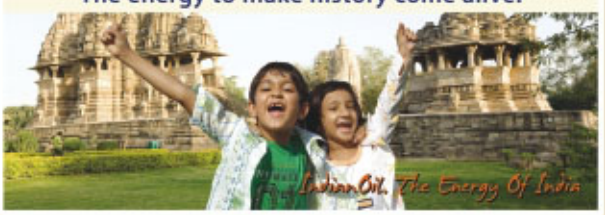
The Energy Behind India's Secure Borders.

The energy behind every satisfying meal.

The Energy to Light a Billion Smiles.

The energy behind every golden harvest.

The energy to make history come alive.



इंडियनऑयल
IndianOil
50 स्वर्णिम वर्ष
Golden Years
1959 - 2009
भारत की ऊर्जा | The Energy of India

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"The only irreplaceable capital an organization possesses is the knowledge and ability of its people. The productivity of that capital depends on how effectively people share their competence with those who can use it."

-Andrew Carnegie

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From the Editor's Pen

Organizations grow when people acquire relevant knowledge through easy access and with effortless assimilation, and then apply them with their aptitude and skills. Need for improved performance places different demands on enterprises everywhere. They must provide knowledgeable, intelligent behavior that requires building new capabilities.

To achieve the objectives of the new Vision of IndianOil to become 'A Globally Admired Company' and to be 'The Energy of India', there is a need to build, apply and deploy knowledge and understanding to support innovative and effective work. In this era of Internet, data and information are available plentiful, but the knowledge acquired with years of experience is revered, unexplored and mostly unshared. *"Energy Digest"* would provide a platform for bringing this competence and knowledge within the organization and also from outside to share and derive the intended benefits.

The direction of growth is given by the Vision of the company and it channelizes the thought process, efforts and energies of all for achieving a unified objective. Over a period of time, when the objectives of the Vision are met and there is a considerable change in the business environment, to infuse new vigour and purpose, the Vision is to be revisited. The article ***Vision…Beginning of a new journey*** takes us through this process of developing a 'Shared Vision' of IndianOil.

Today, greenhouse gas emissions trading has become a commodity market in its own right. The article ***Carbon Trade & Carbon Credits*** provides a perspective on the process of putting price on carbon & the dynamics of world carbon markets in the context of international conventions and treaties.

Energy is paramount to economic development, but excessive and irresponsible use of fossil fuels strains the environment and threatens our very existence. The article on ***Economy, Energy and Environment - A Perspective*** brings out various aspects of this paradox and endeavours to provide a direction for creating a sustainable world.

To meet the high economic growth of India, electricity demand is growing rapidly, thereby creating a huge supply-demand gap. The key to tackle climate change issues related to power generation through fossil fuels is to generate power from renewable sources, even though they are presently not cost effective. The article ***Feed-In Tariffs –Renewable Energy Policy that Works*** delves on the most effective policy option available for fostering and nurturing power from renewable sources.

The Vision of this Corporate journal is to be a cache of the abundant available knowledge, which would be shared with all, including other important stakeholders.

This journal would be enriched and enhanced with your articles on the entire spectrum of the energy business. We look forward for your contribution and valuable suggestions to make it more informative and expansive.

I take this opportunity to wish you all the best on this propitious occasion of IndianOil Day.

(A.M.K. SINHA)

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(Send in your contributions and suggestions to singhjessica@iocl.co.in)

Chairman's Message

At IndianOil, we aspire to become the 'Energy of India'. Today's energy business is highly dynamic, complex and multi-faceted. I believe that developing sound understanding and pragmatic perspective on various facets of the energy business will be instrumental in realizing our vision.

In this context, I am pleased to learn that an initiative has been taken by our Corporate Planning & Economic Studies department to bring out ***"Energy Digest"***, a quarterly journal focusing on vital issues of the energy business. Such step as the Energy Digest, with the aim of knowledge enhancement and refinement is highly commendable.

Experience has shown that in large organizations, there is a marked distinction between organizational knowledge and individual knowledge, this anomaly acts as a constraint on organizational excellence. On the other hand, if symbiotic channels between the two are created, this constraint can be turned into strength. I hope that the Energy Digest by providing such a channel takes our collective knowledge to an altogether higher plane.

My best wishes for the success of Energy Digest.

(Sarthak Behuria)
Chairman

Director's Message

I am happy to share that befitting the occasion of golden jubilee celebrations; our Corporate Planning and Economic Studies group has decided to bring out an in-house quarterly journal ***"Energy Digest".***

Corporate Planning of IndianOil has been always associated with critical responsibilities and time lines towards achieving several developmental goals. Initiatives taken by the department in bringing out this journal is therefore, decidedly yet another step to collectively engage the diverse groups of intellectual mindsets from within the corporation to scale new heights.

During the last fifty years journey of IndianOil, from a struggling start-up to a multibillion dollar home-grown company has been distinctly marked by exceptional performance with a sense of purpose and dedication. We are in the business of relentlessly meeting the growing energy needs of this great nation. The intrinsic motivation of the company has been always guided by its set of core values, vision and confluence of factors that has earned the company a competitive differentiation in the marketplace. Today, IndianOil is actively engaged in enlarging its international presence and we envisage to be recognized as a globally admired company.

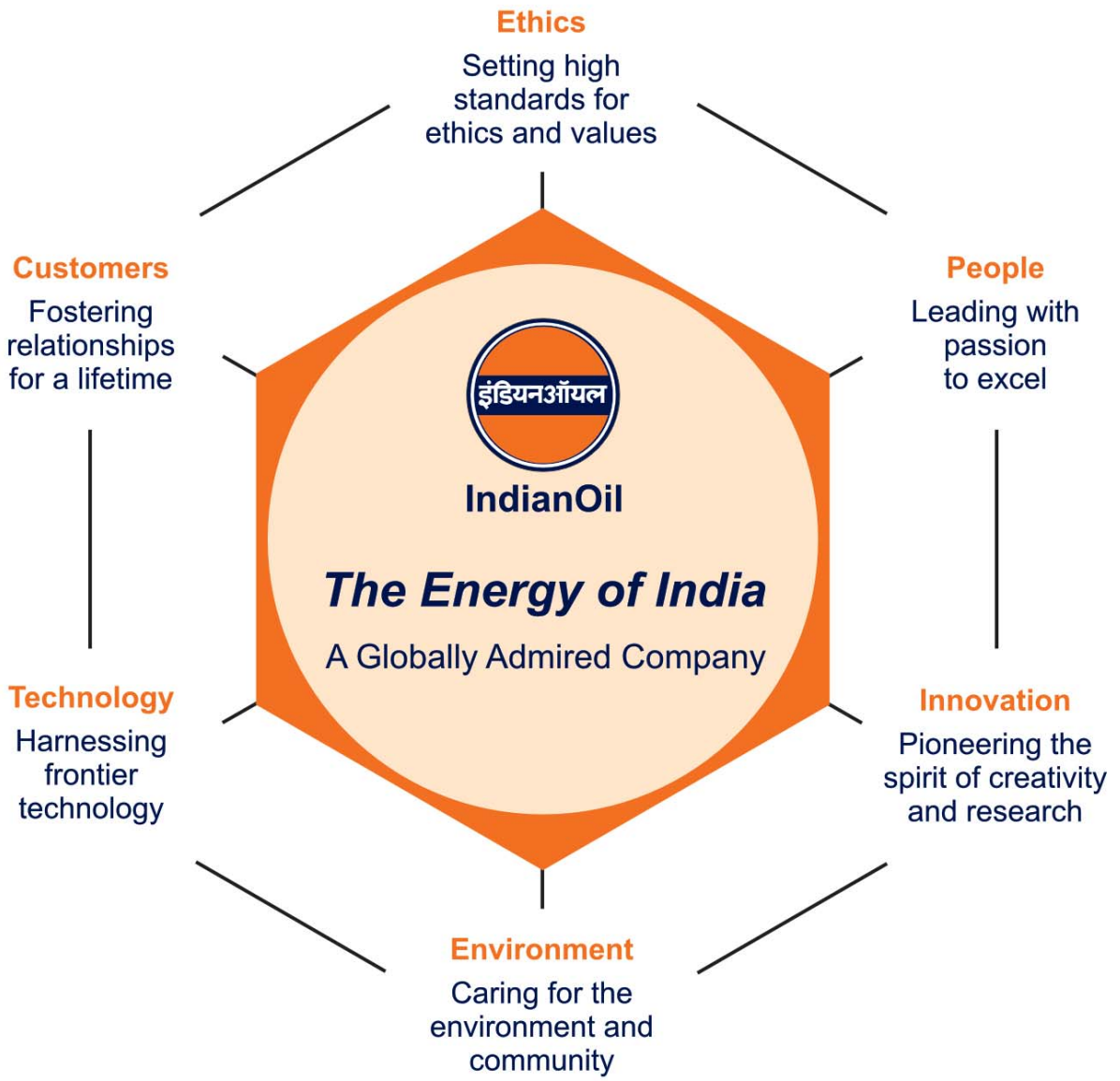
The rocky road to the unbounded future of the company will be constantly subject to deepening global competitive forces where the scale and scope of our business will be determined by higher degrees of probity, ignited by knowledge and productivity. In this context, I am sure, the initiatives taken through such publications will soon unlock its fullest potential through an interactive flow of information and knowledge across the organization.

One of the fundamental characteristics of today's organizational environment is change. Much has been written on this fact. Today's change has been called discontinuous, rapidly accelerating, and pervasive. I sincerely hope, ***"Energy Digest"*** will maintain a rigorous standard and serve as a knowledge support truly reflective of the corporate entrepreneurship.

My best wishes to the editorial team.

(B.M. BANSAL)
Director
Planning & Business Development

VISION



VALUES

Care • Innovation • Passion • Trust

Vision... beginning of a new journey

Thomas Antony

Vision is a realistic, credible, attractive statement about the future of an organization. Vision provides strategic direction and is the reason d'etre of an organization. A right vision takes the organization out of the present, and focuses it on the future. Revisiting of IndianOil's previous vision became necessary in view of rapid changes in energy sector scenario in India and abroad. It was desired that the new vision should reflect the collective aspiration of IndianOilPeople and be a 'shared vision'. This article explores this journey of deriving this new vision, which was guided by a philosophy called Aspiration Driven Transformation (ADT).

The first *Vision* of the Corporation was formulated in 1999 in the face of proposed large scale deregulation of oil industry during 1998-2002 and the likelihood of entry of private players & MNCs. Through the people workshop titled 'The Third Eye', following *Vision* was finalized focusing on *integration* and *diversification:*

A major diversified, transnational, integrated energy company, with national leadership and a strong environment conscience, playing a national role in oil security & public distribution

During an audit undertaken at that time, the major issues emerged were; largely regulated industry, limited scope for innovation, low vertical integration of firms, industry fragmentation, stand alone refineries, small marketing firms, growing demand and demand supply gap, lack of focus on market/ customer and lack of global exposure etc.

In last about a decade, a lot of ground realities have undergone change. The prices of crude oil experienced unprecedented volatility in 2008; there have not been major discoveries of new crude oil sources globally, which have pushed the oil exploration companies to go for further deep-water exploration and hence commitment of high capital expenditure. Impact of energy on weather has taken centre stage with focus on global warming. This has encouraged national economies to lay more emphasis to explore the possibility of extracting oil and gas from the lesser known sources like oil sand or coal bed methane and also investing heavily in renewable sources of energy. Mergers have taken place between Exxon and Mobil, Chevron and Texaco and among Total, Fina & Elf.

While there has been rapid churning globally, the oil and gas scenario in India has also undergone a massive makeover - India has become a product surplus country from being product deficient one, private oil refiners set up huge refining capacity to harness economies of scale and India has shown potential to emerge as the petroleum refining hub of Asia-Oceania. Oil industry in India is also not as fragmented today as it was about a decade back with a slew of mergers and acquisitions.

IndianOil has also made rapid strides to realize its *Vision* during last one decade. For example, industry is not as fragmented today, as it was in 1999 - IndianOil had merged with itself the IBP Co Ltd.

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and BRPL, the stand alone refiner. It has made successful forays in international markets by setting up subsidiary companies in Sri Lanka, Mauritius and Dubai. Significant investment has already been made in petrochemicals business and more is planned as part of diversification strategy. Similarly, efforts have also been made to integrate vertically by acquiring blocks within the country and overseas. Significant efforts have also been planned in the area of bio-fuels.

In view of such changes in the business domestically and internationally, it was necessary to revisit the above *Vision* in order to capture the aspirational state of IndianOil, where an ambitious target of USD 300 billion turnover by 2030 has been envisaged.

What is *VISION* and why it is necessary to have it

Vision is a *realistic, credible, attractive statement about the future* of an organization. *Vision* is a means to inspire everyone in the organization to achieve the next level of excellence and to provide purpose & direction for the work to all in the organisation. *Vision* is not in the present but in the future. *Vision* is not about where we are now; it's about where we want to be in the future. *Vision* provides strategic direction and is the *reason d'etre* of an organization.

Vision attracts commitment and energizes people. It creates meaning in lives of everyone in the organisation. It establishes a standard of excellence and endeavours to bridge the gap between the present and the future. The right *vision* takes the organization out of the present, and focuses it on the future. For people in the organization, a good vision should answer the question, "Why do I go to work?" With a good vision, the answer to that question should not only be, "To earn a pay-check," but also, "To help build an attractive future for the organization and achieve a higher standard of excellence."

Since an organisation is as good as its people, the collective aspiration of the people actually becomes a surrogate for its performance. It has been established that the great companies are built on two broad pillars of success – a core ideology and a passion for change (Built to Last). According to a study, it has been calculated that while $1 invested in 1926 in general stock market would have yield a return of $ 415 in 1990, the same amount if invested in visionary companies would have yielded $6356.

"Vision establishes an over-arching goal. The loftiness of the target compels new ways of thinking and acting…

In the presence of greatness, pettiness disappears. In the absence of a great dream, pettiness prevails."

Peter Senge
"The Fifth Discipline"

Developing a new Vision for IndianOil

The process for re-visiting the *Vision* was designed, based on the process named Aspiration Driven Transformation (ADT), with the assistance of Boston Consulting Group (BCG) to capture the collective aspiration of IndianOilPeople and also other stake-holders so as to develop and formulate a *'Shared Vision'* rather than *'Vision that is Shared'*.

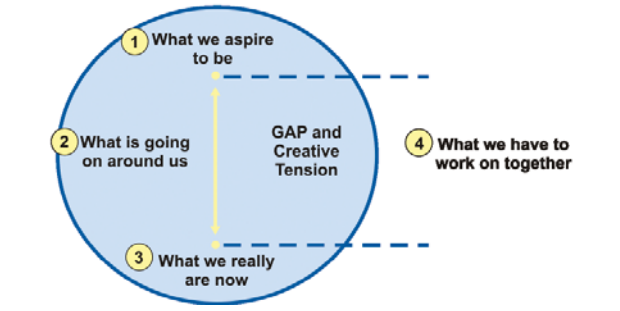
The Process

The process of developing the new *vision* was a three tier exercise:

1. The existing and past leaders of IndianOil, under phase-I, came together at IndianOil Institute of Petroleum Institute (IiPM) for a two day workshop in October'07, when the broad

elements of new *Vision* were identified. However, before this group met, a web survey was administered to IndianOilPeople to know their perception about their employer and how they would like to see IndianOil in the coming years. The input from this web-survey formed the basis of a 2-day focus-group discussion.

2. **ADT:** The driving force of ADT is *'creative tension'*, the gap between aspiration and current reality, which leads to a sense of discomfort. This results in the people themselves coming up with ideas, solutions and initiatives to bridge the gap. Under phase-II of *Vision* development, the process was designed based on this principle and an attempt was made to involve as many people as possible within a finite timeframe through a number of workshops.



Components of ADT

3. Workshops were conducted to get inputs from the participants, in a structured manner, on four broad elements of *Vision – business, key success metrics, people* and *stakeholders*. This was synthesized to come up with the contours of the emerging *Vision*. The inputs gathered from the people were synthesized to come-up with a broad *Vision* statement. It was then put through a number of iterations with the Executive Committee (EC) of the functional Directors and then with the entire Board to capture their views.

Workshops

The workshops with the IndianOilPeople were the building blocks of the new *vision*. Forty eight workshops were conducted by BCG and identified IndianOil coaches (specially trained by BCG for the workshops) during the period March'08 to May'08 which directly engaged about 1500 people. Multiplier effect of getting more people involved was achieved through different communication media- posters; web; straight talk; IndianOil news and discussion forum initiated by Director (HR).

Communication

As stated above, during the re-visioning exercise, IndianOilPeople were kept informed about the progress on regular basis through internal communication channels like 'Straight Talk' by Chairman, letters and e-mail communications from Director (HR), daily e-bulletin IndianOilXpress and monthly IndianOil News etc. During the exercise, intranet was used widely for web-surveys.

Synthesis

The process of synthesis went through multiple steps from June'08 to early August'08:

1. Collation of all the inputs from the workshop was done with appropriate categorization and then key *themes* were identified.
2. This output was processed with the coaches in a synthesis workshop to
   - Identify the prioritized list of V*ision* elements
   - Define metrics for the key V*ision* elements
   - Prioritize gaps
   - Evolve an *action agenda*
3. This was followed by one-on-one discussions with Executive Committee (EC) members to get their inputs on the V*ision* elements and key gaps.
4. *Post* one-on-one discussions, an EC synthesis workshop was held to identify the "must have" vision elements and separate them from the "good to have" elements.

5. Finally a senior management workshop (with over 60 participants) was held to crystallize the *Vision* and deliberate on an *action agenda* emerging on the basis of the identified gaps during the process.
6. Lastly, the Board of IndianOil deliberated extensively on the *Vision*, thus emerged, in two of its meetings and the new *Vision* was finalized in April 2009.

Connect between people aspiration and the elements of Vision

While the process detailed above might appear to be esoteric to some extent, but those who participated in the various meetings and the workshops will recall that a lot of their individual and collective dreams and aspirations are included in the six different elements of the *Vision*. Since we received different and varied inputs from a wide cross section of IndianOilPeople cutting across divisions, functions, geographies and hierarchical position etc., we undertook 'content analysis' of the inputs received from participants in various workshops and meetings. This was necessary to come up with 'labels' which captured the collective aspirations. These labels describe the individual and collective aspirations, as described below:

The energy of India

- Dynamic company with market leadership in all areas of business
- To be among the top 50 and among top three energy companies in the world
- Energy leader in Asia-pacific
- Become a global Oil, Gas & Energy Major
- Biggest energy company in the world with global footprint
- Integrated company with global presence and strategic sharing of facilities for cost advantage
- Along hydrocarbon value chain, catalyst development and services
- Into all elements of energy chain, consistent with business dynamics
- Through mergers and acquisitions in the hydrocarbon industry
- Expansion of business through M&A in value chain
- Integrated world leader in Oil, Petrochem, E&P, Bio-fuel, Gas and Power

A globally admired company

- Profit sharing with max wealth creation for stakeholders
- High dividend and bonus share paying company
- Best company for creating value for stakeholders
- Maximize wealth of the stakeholders
- Maximize ROI for all the stakeholders
- Highest dividend paying company in the world
- Highest market capitalization in India
- Most admired company

Ethics: Setting high standards for ethics & values

- Ethics and transparency before everything else
- Dependable, trusted and respected
- Most trusted business entity
- Admired by the society
- With strong business values
- Clean product, people, environment & image

Customers: Fostering relationships for a lifetime

- Drivers of the nation's economy by winning customer confidence through quality product and services
- Maintaining high standards with focus on customer care and expectation
- Ensure customer excellence and loyalty through products and services – internal and external
- Customer satisfaction at all touch points
- Public image as provided of highest quality and services
- Most customer centric organization
- Customers' delight through right quality and quantity delivered trough retail outlets

Technology: Harnessing frontier technology

- World-class facilities and a leader in technology
- Become market-leader in technology and service oriented sector
- Growth with cutting edge technology

- Leveraging technology and setting global benchmarks
- R&D leaderships in traditional and non-traditional fuels

Environment: Caring for the environment and community

- To be a global corporate citizen and go beyond customer expectations with respect to community development, eco-movement and event sponsorship
- Responsible corporate citizen with emphasis on health, education, environment and poverty alleviation
- Promote education in rural India through retail network
- World-class CSR through environment friendly technology focusing on bottom of pyramid
- Sensitive to social and environmental issues
- Adopt socially relevant issues

Innovation: Pioneering the spirit of creativity and research

- World-class benchmark for technology and business processes
- Strong knowledge base amongst the employees
- Knowledge driven and innovation based company
- Innovative leadership with breakthrough process/ technology leader
- Pioneer in technology, knowledge and standard
- Based brains in R&D, Fuel-cell tech, solar cell-tech etc.

People: Leading with passionto excel

- Competent, customer focused, committed and satisfied employees
- Fun place for a pool of highly talented, passionate and committed people with respect for each other
- Motivated, committed, competent, satisfied and engaged employees at all levels
- Most knowledgeable, competent and result oriented people
- Creative, progressive, empowered and motivated

The new vision has two dimensions: (1) It envisages IndianOil to be the *Energy of India* and (2) and be *Globally Admired Company*. The aspiration of becoming a Globally Admired Company will be facilitated by initiating action on the six Vision elements: Ethics, People, Innovation, Environment, Technology and Customers.

The new Vision thus finalized, was unveiled on 30th June 2009, during the inauguration of golden jubilee celebrations of IndianOil, which helped in garnering wide scale dissemination of the new Vision.

With the unveiling of new Vision, the focus now needs to be on converting Vision to reality with an action agenda for its implementation to reap the benefits for all stakeholders.

It is proposed to benchmark our processes under each of the Vision elements against national / international organizations. The benchmarked organization will be our desired state and we will begin our journey towards attaining that state.

Thus with the active co-operation of all of us, we hope to live and realize the Vision of becoming the 'Energy of India' while being 'A Globally Admired Company', which will be able to achieve the target turnover of USD 300 billion by 2030.

Carbon Trade & Carbon Credits

S. K. Sarangi, B. Barpujari & B. R. Pradhan

Carbon is present in all life forms and is the second most abundant element in human beings. It is the sixth most abundant element in the earth's crust. The quantity of carbon in the atmosphere/earth is dynamically maintained by an exchange mechanism called Carbon Cycle. Human activities such as burning of fossil fuels and deforestation lead to release of carbon, one of the most damaging forms of which is carbon dioxide (CO_2). The quantity of CO_2 and other such greenhouse gases (GHGs) in the atmosphere has been steadily increasing in the atmosphere leading to increase in global temperatures. There have been numerous attempts to reduce emission of GHGs in the past. The most novel attempt so far is a market-driven mechanism, popularly known as ***Carbon Trading*** *or* ***Carbon Emissions Trading****. This phenomenon, with a macro view, can be simply explained in the following manner - "If a country/entity is a 'consumer' of an environmental value like 'clean air', it must pay the 'producer' an equivalent value"; i.e. if a country/entity is emitting more pollutants than required, it must buy some 'fresh air' from another country/entity that has stopped/reduced emitting such pollutants and has, in effect, earned fresh air. This is analogous to the oft-quoted cricketing phrase, 'A run saved is a run scored' or the household phrase 'A rupee saved is a rupee earned'.*

Greenhouse Gases – Good as well as Bad!

Life on earth is made possible by the sunlight. Out of the total sunlight reaching the earth's atmosphere, 70% gets to the earth's surface, out of which a part is reflected back to the atmosphere. However, its eventual escape to the space is delayed by presence of Greenhouse Gases (GHGs) viz. water vapor, carbon dioxide, methane, nitrous oxide and ozone in the atmosphere. Greenhouse gases make up only about 1 per cent of the atmosphere, but they act like a blanket around the earth, or like the glass roof of a greenhouse, which traps heat and keeps the planet some 30^0C warmer than it would be otherwise, thus sustaining life on earth. However, enhanced burning of fossil fuels, changing farming practices, etc. are releasing carbon dioxide to the atmosphere at an unprecedented rate, thus trapping more heat than required and resulting in undesirable warming of earth's surface and lower atmosphere (a phenomenon popularly known as '*Global Warming*'), resulting in melting of ice caps and resultant rise in sea levels.

'Enhanced Greenhouse Effect' – Future in Peril!

The enhanced accumulation of greenhouse gases has caused the average temperature of earth to increase by 0.74^0C since 1800. As per United Nation's Intergovernmental Panel on Climate Change (IPCC), if left unchecked, the world's average temperature could rise by as much as 5.4^0C by the end of the century, causing serious harm to economies, societies and ecosystems worldwide. It may also lead to increase in sea levels, extinction of numerous plant and animal species, frequent extreme weather events, reduction in agricultural yields, etc. In fact, the average sea level rose by 10 to 20 cm during the 20^{th} century, and an additional increase of 18 to 59 cm is expected by the year 2100.

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Extinction of Dinosaurs due to 'extreme' Climate Change

The prevailing theory is that the dinosaurs didn't survive when a giant asteroid struck the earth 65 million years ago, spewing so much dust into the air that sunlight was greatly reduced, temperatures plummeted, many plants didn't grow, and the food chain collapsed. This is a rare example of extreme climate change, which led to extinction of species on the earth.

'Enhanced Greenhouse Effect' primarily due to Carbon Dioxide

Carbon dioxide is responsible for over 60% of the 'Enhanced Greenhouse Effect'. Humans are burning fossil fuels at a rate that is much, much faster than the rate at which these fossil fuels were created, thus upsetting the carbon cycle, the millennia-old, precisely balanced system by which carbon is exchanged between the air, the oceans, and land vegetation. Use of fossil fuels, deforestation activities, etc. have led to increase in CO_2 levels in the atmosphere, which are rising by over 10 per cent every 20 years. Climate change is inevitable because of past and current emissions. The climate does not respond immediately to external changes, but, after 150 years of industrialization, global warming has gained momentum, and it will continue to affect the earth's natural systems for hundreds of years even if greenhouse gas emissions are reduced and atmospheric temperature levels stop rising.

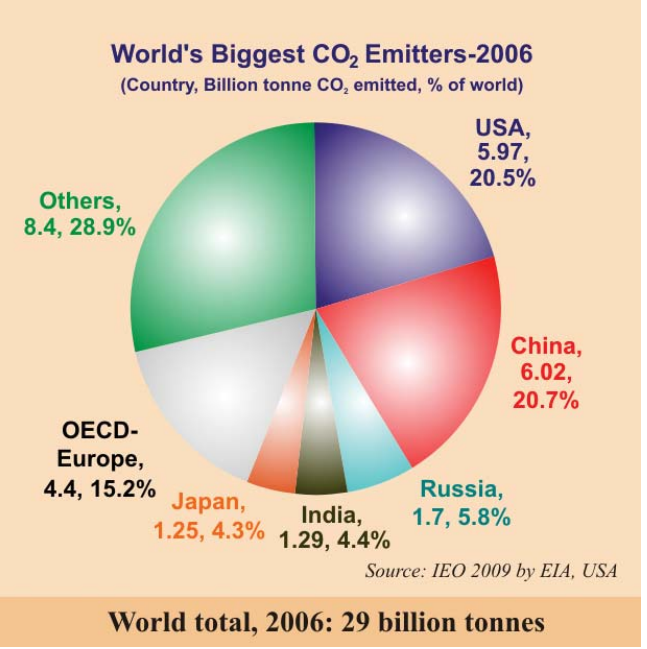
Maldives & large parts of Bangladesh will vanish!

Higher temperatures cause melting of glaciers and ice caps resulting in expansion of ocean volumes. At the higher end of that scale, the seas could overflow the heavily populated coastlines of such countries as Bangladesh, and foul freshwater supplies for billions of people. It could also cause complete disappearance of the island state of the Maldives!

Biggest CO_2 Emitters

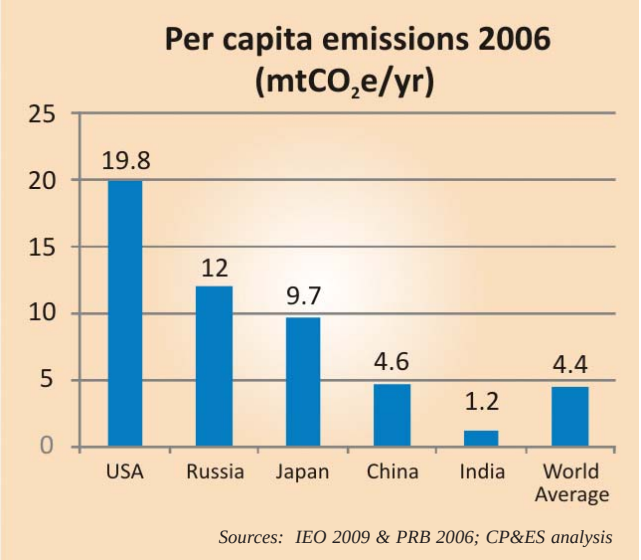
Countries with larger population, larger economies and higher level of industrialization use more energy and thus emit more CO_2. As per 2006 estimates (Source: Energy Information Administration, USA), the 5 biggest CO_2 emitting countries in the world are China (20.7% of the world), (USA (20.5%), Russia (5.8%), India (4.4%) and Japan (4.3%). Total world CO_2 emissions in 2006 were 29 billion metric tonnes (BMT).

However, with respect to per capita emissions, USA *(19.8 million tonne CO_2 equivalent per head per annum) emits 17 times more than India (1.2 mtCO_2e) and 4 times more than China (4.6 mtCO_2e).*



United Nations Framework Convention on Climate Change

During 1992, at the United Nations Conference on Environment and Development (UNCED) held at Rio de Janeiro, popularly known as the ***Earth Summit***, most countries joined an international treaty – known as the *United Nations Framework Convention on Climate Change (UNFCCC or FCCC)* - to consider what could be done to reduce global warming and to cope with the temperature increases that were inevitable. The treaty, as originally framed, set no mandatory limits on greenhouse gas emissions for individual nations and contained no enforcement provisions; and is, therefore, considered legally non-binding. However, the treaty included provisions for updates (called



"protocols") that would set mandatory emission limits. The principal update is the ***Kyoto Protocol***,

Kyoto protocol: Country-wise GHG emission reduction targets by 2012 (% of 1990 levels)

Country/Groups	Targets
Iceland	+10%
Australia	+8%
Norway	+1%
New Zealand, Russian Federatin, Ukraine	0%
Croatia	-5%
Canada, Hungary, Japan, Poland	-6% each
USA	-7%
Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, European Community, Finland,France, Germany, Greece, Ireland, Italy, Latvia, Liechtenstein, Monaco, Netherlands, Portugal,Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK & North Ireland	-8% each

which has become much better known than the UNFCCC itself.

Kyoto Protocol

The Kyoto Protocol to the UNFCCC is an amendment to the international treaty on climate change, assigning *mandatory* targets for the reduction of greenhouse gas emissions to signatory nations. This Protocol was adopted at the third session of the Conference of Parties (COP) to the UNFCCC on 11th December 1997 in Kyoto, Japan. Countries, those ratify this protocol, commit to reduce their emissions of CO_2 and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases.

Under the Protocol, 36 States (called Annex-I countries), consisting of highly industrialized countries and countries undergoing the process of transition to a market economy, have legally binding emission limitation and reduction commitments of greenhouse gases to the extent of 5.2% compared to the year 1990. Compared to the emissions levels that would be expected by 2010 without this Protocol, this target represents a 29% cut. National targets range from 8% reductions for the European Union, 7% for the USA, 6% for Japan, 'no change' for Russia/Ukraine/New Zealand, and permitted increases of 1% for Norway, 8% for Australia and 10% for Iceland (see adjacent table). As of 30th June 2009, 186 countries and 1 regional organization (EC) have ratified the agreement (representing over 63.7% of emissions from Annex-I countries).

As is evident, the Kyoto Protocol clearly differentiates between developed and developing economies. Developed economies, which consume more fossil fuels and emit more carbon dioxide than the developing economies, have emission reduction targets, whereas developing countries have none. Notable exceptions include the United States, which has signed the treaty but refuses to ratify it. Countries like India and China, which have also ratified the protocol, are not required to reduce carbon emissions under the present agreement.

The Concept behind Carbon Trading: 'Trade' vs. 'Invest in Clean but Expensive Technology'

Simply put, there are two ways by which carbon dioxide emission targets can be met. One is by adopting efficient & environment-friendly technologies and the other is by purchasing carbon credits. Typically, the cleaner technologies would be very expensive in the developed countries (who have commitments under the Kyoto Protocol to reduce emissions), leading to the second choice of purchase of carbon credits. For example, if it costs US$20 to reduce one tonne of CO_2, and the market price of

Bulb vs. CFL

A simplified example of the high costs involved in change in technology to reduce emissions is the 'Bulb vs. CFL' illustration. It is well known that, in India, about 67% of electricity is produced from thermal power, which consumes fossil fuels like coal and oil and emits majority of carbon dioxide. One way of reducing emissions could be to change all bulbs and fluorescent lights to CFLs, which consume much less electricity, but costs 5 to 20 times. Imagine the kind of expenses that would be required to do this for entire India!

one Carbon Credit (which is equivalent to one tonne of CO_2,) is US$ 15, one would prefer to purchase carbon credits rather than invest in cleaner technologies. Typically, the seller of the credits would be located in a developing/third world country, who would have acquired the credits by investing in clean technologies (e.g. wind/solar/biomass power projects, flue gas recovery, etc.). This cost would be much less than that in a developed country. In addition to contributing to a cleaner world, this mechanism would encourage developing countries to go for relatively inexpensive technology adoptions, acquire carbon credits, sell the same in the international markets and reinvest the proceeds in more environment-friendly projects. In this way, the desired carbon reductions in the world can be met at the lowest possible cost to the society.

Three mechanisms to reduce carbon emissions under Kyoto Protocol

The Annex-I countries in order to achieve their carbon emission reduction targets, can use 3 different mechanisms viz. a) Clean Development Mechanism or CDM; b) Joint Implementation or JI; and c) Emission Trading. We have tried to explain below these three concepts through simple examples.

- Through **Clean Development Mechanism,** Annex-I countries can invest in emission reduction projects in *non-Annex-I* countries, which will generate credits and the Annex-I countries get the right to purchase these credits. Entities in non–Annex-I countries can initiate emission reduction projects themselves too. The developing countries, in this process, get access to the much-required resources, technology and help in developing their economies at a lower cost vis-à-vis the developed countries. The credits acquired through CDM are called *'Carbon Emission Reductions' or CER* and can be traded in the carbon exchanges around the world. One CER is equivalent to one metric tonne of carbon dioxide equivalent, or tCO_2e. An 'Executive Board' under UNFCCC supervises CDM. Projects under CDM are externally verified and certified by third party organizations, which are designated by the parties to the Protocol. CDM project developers range from small cooperatives to large industrial corporations. Typical project types include renewable energy, methane capture from landfill, agriculture and coal mines, fuel-switch in boilers for heat and electricity generation, energy efficiency and reduction of industrial gas emissions such as HFCs and N_xO. CDM touches every economic sector, from agriculture to heavy industry.
- **Joint Implementation** (JI) mechanism is similar to CDM except that the emission reduction project is commissioned jointly; e.g. a company in an Annex-I country, which commissions a project in a non-Annex-I country, gets the credits for the resultant emissions avoided. These credits are called *'Emission Reduction Units', or ERUs*. Just like CER, one ERU is equivalent to one metric tonne of carbon dioxide equivalent, or tCO_2e. Another difference between JI & CDM is that the JI projects are subject to national caps/ policies of the two countries (involved in the project) under the Kyoto Protocol. JI mechanisms are mostly being implemented in 4 countries viz. Russia, Ukraine, Bulgaria and Romania.
- **Emission Trading** (also called "cap and trade") is a mechanism, where a total amount of allowable emissions for all Annex-I countries is agreed to (i.e. the cap). The designated governing body in the Annex-I country gives '*allowances*'

corresponding to this '*cap*'. Let us say, a company gets 1000 such '*allowances*'. It means that it is allowed to emit 1000 tonnes of CO_2 equivalent (tCO_2e). If this company emits, say 750 tCO_2e, it can sell the balance 250 tCO_2e to another entity. Similarly, if it exceeds 1000 tCO_2e, it has to purchase additional credits or allowances or pay heavy penalties. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for contributing to reduced emissions.

Typically, carbon trading through 'Emission Trading' mechanism is called '***Allowances*** transactions' (since it's the differential *allowances*, which are traded). When carbon credits, earned through projects commissioned through JI and CDM, are purchased or sold in the markets, they are called '***Project-based transactions'.***

World Carbon Market – US$ 126 billion in 2008

As per a World Bank report (May 2009), the estimated cash value of carbon traded worldwide in 2008 was US$ 126 billion. The market has taken a quantum 200% jump from 2007 (US$ 63 billion). Total traded volume in the global carbon market reached 4.8 billion tonnes in 2008, up from 3 billion tonnes in 2007. The European Union's Emissions Trading Scheme (ETS) accounted for 73% of the total traded value & 64% of the total traded volume. Project based transactions (CDM & JI) accounted for 26% of the total traded value & 32% of the total traded volume. The 2008 numbers & its growth show that greenhouse gas emission trading has become a commodity market in its own right.

World CDM market – Dominated by China

China continues to dominate the world CDM market as a seller with 84% share in 2008. India occupied a very distant second position with only 4% market share (At 3rd position is Brazil with 3% share). China has dominated the market primarily because of economies of scale in exploration, sourcing and lower transaction costs and its favorable carbon investment climate viz. strong support from institutions and presence of experienced project developers.

European Union's Emissions Trading Scheme (EU ETS), world's first and largest carbon market

EU ETS was created in conjunction with the Kyoto Protocol and has 27 member countries at present. The scheme commenced operation on 1st January 2005. Out of the US$ 93 billion world 'allowance' market in 2008, EU ETS alone contributed US$ 91.9 billion (98.8% market share), corresponding to 3 billion tCO_2e. EU ETS market has doubled in both volumes and value as compared to 2007. Just like BSE or NSE (where individuals can trade in shares through brokers like ICICI, HDFC, India Infoline, etc.), which gives access to shares of the listed companies, EU ETS is an internet based CO_2 marketplace, that provides direct access to European carbon market.

Other active Carbon Markets

Three other active carbon markets of the world are New South Wales Market (NSW), Chicago Climate Exchange (CCX) and United Kingdom Emissions Trading Scheme (UK ETS).

Voluntary Carbon Markets

The voluntary carbon market refers to any sale or purchase of emission credits or emission reductions that occurs outside a regulated market (viz. CDM, EU ETS, CCX, etc.). This market size during 2006 was an estimated US$ 100 million. Experts say that voluntary carbon markets offer a huge untapped potential.

Carbon price trends

As explained earlier, the three carbon based products traded in the markets are 1) CER (*Carbon Emission Reductions*, credits acquired through CDM); 2) ERU (*Emission Reduction Units*, credits acquired through JI mechanism); and 3) Allowances (for emissions trading amongst Annex-I countries). During 2008, 73.5% of the market value came from allowances trading and only 26.5% from CER/ERU trading. The name given to the allowances traded in EU ETS is European Union Allowance (EUA). Given below are

the price trends of EUA, CERs/ERUs during the last 2 years.

Carbon price trends of EUA

The price per tCO_2e or EUA reached its peak of € 30 (euros) during April 2006. During middle of 2006, over-allocation led to drastic reduction in prices - during March 2007, the EUA prices hit rock bottom (less than €1) due to excess availability of EUAs, hedging and prohibition to carry forward the unused allowances from Phase-I (2005-07) to Phase-II (2008-12). Prices recovered to reach € 25 during Sep-08. The economic recession of late 2008 and the resultant lower consumer demand and industrial production led to lowering of EUA prices. From around €25 during September 2008, EUA prices have gone below € 10 during end of February 2009. As on 11th August 2009, the price of EUA was €14.18.

Carbon price trends of CER/ERU

Unlike the high volatility in the EUA market, price per tCO_2e of CER has been more or less steady. During 2008, Project-based emission reductions attracted, on an average, a price of US$ 17 per tCO2e for CER (as against US$ 13 in 2007) and $15 per tCO_2e for JI (as against US$ 12 in 2007). The likely price outlook for CERs will be influenced by three key factors viz. a) the demand and supply dynamics of EUAs and CERs in Phase II (2008-12); b) the actual delivery of CERs; and c) competition to the EU from Japan and the voluntary markets.

Positive signs of emission cuts from USA - Waxman-Markey bill passed on 6th June 2009

The most significant change in the policy landscape over the past years is the reemergence of the United States in the climate change debate. The Waxman-Markey bill {otherwise known as the American Clean Energy and Security Act – ACES}, the first legislation of its kind in the US aimed at tackling climate change, was passed by the US House of Representatives on 6th June 2009. This bill sets a target of a 17% reduction in emissions from 2005 levels by 2020 and an 83% reduction by 2050 and would introduce a cap-and-trade system. Energy suppliers would be required to generate 15% power from renewable sources by 2020 and new efficiency standards would be set for buildings, lighting and industry. Passage of this bill marks a very important step for the politicians, negotiators and scientists world over, who would be assembling in Copenhagen later this year to negotiate for the Carbon roadmap beyond 2012.

IPCC, the climate specialist of UN – joint Nobel Peace Prize winners, 2007

IPCC (*Intergovernmental Panel on Climate Change*), a predominantly scientific body, was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), both belonging to the United Nations. This Panel is composed of representatives appointed by governments and organizations. The main task of IPCC is to evaluate the risk of climate change due to human activities through publishing of special reports on topics

Dr. Rejendra Pachauri, the 7th Indian Nobel Laureate, an ex-Director on IndianOil Board

IPCC has been chaired by Dr. Rajendra Pachauri since May 2002. He is also the Director General of 'The Energy and Resources Institute' (TERI), the institute that promotes sustainable development. He was also on the Board of IndianOil from January 1999 to September 2003. He is the 7th Indian to claim the Nobel Prize and the second Indian (after Mother Teresa) to win it for Peace.

On 11th December 2007, when delegates were attending the UNFCC Climate Change conference at Bali, Dr. Pachauri, on behalf of IPCC, accepted the Nobel Peace Prize in Oslo (Norway) and began his speech with the words 'Vasudhaiva Kutumbakam', (i.e. the whole universe is one family) and emphasized the urgency of fighting the global warming menace as one family. He also quoted the famous statement of the President of Maldives: "...a mean sea level rise of two metres would suffice to virtually submerge the entire country of 1,190 small islands, most of which barely rise two metres above sea level. That would be the death of a nation."

relevant to UNFCC/Kyoto Protocol. The research output of this scientific body is popularly known as *Assessment Reports*; so far 4 such reports have been published, the last one being the Fourth Assessment Report (AR4), released in 2007. These reports indicate the possible changes in global mean temperatures until 2100. For example, as per AR4, under various economic and environmental scenarios, the global mean temperatures by 2100 will increase by 1.1^{0}C to 5.4^{0}C. IPCC (presently chaired by Dr. Rajendra Pachauri, Director General, TERI) along with Mr. Albert Arnold (Al) Gore, former vice president of the USA, have shared the 2007 Nobel Peace Prize "*for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change*".

Oscar winning documentary film on Global Warming starred by Mr. Al Gore

'An Inconvenient Truth', a documentary film (2006) on global warming presented by Mr. Al Gore, won two Oscars, one for 'best documentary' and the other, believe it, for 'best original song'! It is the first documentary to win an Oscar for best original song! This film was also an unlikely box-office hit, grossing about US$ 50 million till mid-2007. Mr. Gore's book under the same title published in 2007, contains additional information and scientific analyses. Another documentary (2007) titled 'An Update with Former Vice President Al Gore' features Mr. Gore discussing additional information that came to light after the first film was completed.

Epilogue

In the words of Mr. Mark Franklin, head of TZ1, a stock exchange formed in January 2008 to deal with carbon trading in New Zealand, 'Whether we like it or not, the world is going to go into a carbon economy'.

GHG emissions and global warming are modern and complicated problems, involving the entire world; emission reduction strategies are tangled up with paradoxical objectives such as poverty alleviation, economic development, etc. A price needs to be put on the emissions released by organizations to encourage more efficient strategies. On the other hand, rewards need to be given to those doing the right things e.g. preserving the forests, plantations, environment and ecology in general.

For a country like India, the paradox is to reach the fine balance between economic growth and curb in greenhouse gases. As per EIA, India emitted 1.2 billion tonnes of CO_2 in 2006, which was one fifth of USA (5.9) & China (6.0). In terms of per capita emissions, an average US citizen emits 17 times more and an average Japanese, 8 times more than an Indian. A slightly bitter truth put forth by many third world countries (Especially China & India) for not accepting emission cuts is that – *'The developed world has become 'rich & developed' at the cost of environment; the environment mess of today is due to last many years' of emissions primarily by the large scale industrialization in the developed world'. Whence third world does not have the primary responsibility of the environment mess we are in today, why should they be asked to pay for the same?'* As per one expert in the CDM arena, if tackled today, it may cost 1% of world GDP to curb emissions to the desired levels (5% less than 1990 levels), but if delayed, may cost many times more. The more quickly world political and scientific community comes to a consensus, the better the chances are for our future generations to breathe something fresh and to possibly survive! And in a still short-term view, better the chances of delaying the extinction of many island nations like Maldives!

Economy, Energy and Environment – A Perspective

Sanjoy Kumar Dam

World economy has largely grown along a development path, which has been driven by excessive dependence on fossil fuel. Skewed utilization of resources has left scars on the environmental landscape in such away that it is no more sustainable to adopt this growth model. The present recessions offer an opportunity to address the global imbalances and reinvent growth aspirations with due considerations to environment.

Economy – development features

Economic growth in the world has never been uniform. History also suggests that developments have never been smooth or linear. Time and again, the economic system has been often characterized by boom & bust, greed & failure, euphoria & panic, fast growth & recession. Growth has come earlier in some places than to others. Based upon the experience of over past two centuries since the industrial revolution and several literatures on the subject, it is generally argued that as countries develop, people and economic activities tend to become more and more concentrated. Speed of concentration may vary depending upon the economic activities and spatial scale. Power of such concentrated growth and economic activites has an enormous impact on the balance of global trade. Today, it is estimated that a quarter of the world's GDP is produced on just 0.3 percent of the land area, half on 1.5 percent and nine-tenths on 16 percent. China, Japan, and the United States produced about half of global GDP in 2006 and 15 largest economies produced more than 80% of the global output (World Bank, 2009). Such growth models adopted in the past and currently repeated by the emerging economies, therefore, raise some serious questions internationally, as to how to address the issues relating to high poverty, illeteracy and mortality in some parts of the world set against prosperity, literacy, and logevity in other parts of the world. Concerns for the 'bottom billion' of people below the poverty line in the global hierarchy of nations are the biggest developmental challenges of the millenium stemming out of unbalanced economic growth. World economy today therefore, is at crossroads engaged in finding a solution to a spatially balanced, sustainable, and inclusive growth model.

Use of energy in growth of world economy therefore, offers interesting insights, some of which are dealt with as follows.

Economy-Energy

Transition to modern energy services is influenced by the economic growth

Transition to modern energy services is an important indicator of economic growth. Lack of electricity and heavy reliance on traditional biomass are hallmarks of poverty in the developing countries. In absence of appropriate policy intervention, around 1.4 billion people will still lack electricity in 2030 (IEA). As poor families in the developing countries enhance their income, they show preference to more and more modern and efficient energy services replacing traditional sources. This stage of economic

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development will be therefore, marked by availability, affordability, and accessibility of energy services in the economy as has been brought out by several studies.

Use of secondary energy source is a proxy indictor for economic growth

A composite measure of energy use vis-à-vis economic development is best assessed through the strength of its linkages to the different sectors of the economy. The most visible form of energy, which is often identified with the progress of economic development of any country, is electricity. This is a secondary form of energy, produced from primary energy sources, including coal, hydrocarbons, hydro energy, nuclear energy, renewable energy etc. The extent of use of electricity and other commercial forms of energy determine the level of economic development of a country. Asymmetrical global economic growth has in turn created direct impact on energy use. Literature suggests that about 1.6 billion people in developing countries did not have access to electricity in their homes in 2002, representing a little over a quarter of world population. Most of the electricity-deprived population is from Sub Saharan Africa and South Asia. UN Millennium Development Goals (MDG) targets to bring down the population of people living below the poverty line ($1 a day) by half in 2015. This will in turn mean that there will be a need to extend the use of modern cooking and heating to 700 million people by 2015(IEA).

Post World War II, world economy grew on cheap fossil fuel

Reconstruction phase of world economy during the post Second World War period and afterwards saw the developed economies taking full advantage of the large quantities of cheap oil available during the 1950s to early 1970s. As a result of extensive use of fossil fuel, the industrialized economies became overtly dependent on its fragile sources of supplies of hydrocarbon resources. With the first oil crisis in 1973-1974, and then the second in 1979-1980, all the oil-importing industrialized countries woke up to the fact of just how delicately balanced and vulnerable their position had become due to their heavy dependence on imported fuels. Being heavily dependent on oil imports means that the availability of supplies can be at risk and that the trade balance has negative repercussions, with all the consequences that these factors can have on the country's economic growth, employment, and inflation. The impact on the balance of payments when the price of oil rose during 1973-1974 was simply enormous on oil importing countries. It was only logical, therefore, that the oil-importing countries began to implement policies aimed at reducing dependence on oil imports so as to decrease the negative effects on their balance of payments, the inflation rate, and employment.

Variation in energy use in linked to the structure of output of the economy

The variations in relationships between energy use and growth of GDP across the regions can be reasonably attributed to the fact that countries that industrialized earliest pursued a highly energy-intensive pattern of growth, largely because at the initial stages of industrialization, emphasis was placed on basic mineral industries and heavy manufacturing. It was only later that services sector grew which demanded comparatively less energy. It can also be argued that countries, which industrialized later, had the benefit of technological development and choices towards a more energy efficient technology. Here the choice of technology is again guided by government policies and resource endowments, which are two more important factors, which contribute to the energy use.

Changing structure of output, technology and allocative efficiency decide energy intensity

Pattern of economic development also to a large extent decides on the energy mix. Energy plays significant role in the countries, which are at intermediate stages of economic development,

because industrial production constitutes a large share in the structure of their output. At this stage, energy intensity defined as amount of energy used in producing a unit of GDP is expected to be much higher than that of other economic activities. As the economy grows and countries become more and more competitive on a world scale, the intensity of energy is expected to decline due to more energy efficient technology, whose contribution is largely captured by total factors of productivity (Pachauri, 2008)

Fossil fuel dominating the energy mix is a result of the development model of world economy

Fossil fuel (Coal, Natural Gas & Oil) will continue to remain the vital source of primary energy supply in the world economy even with the most optimistic assumptions about the pace of development of alternative fuel. As the demand for world primary energy grows at the rate of 1.6% per year on average in 2006-2030, from 11.7 Btoe to 17.0 Btoe-an increase of 45%, global demand for oil is expected to rise by 1% per year on an average from 85 million barrels per day in 2006 to about 106 million barrels per day in 2030. Global demand for natural gas as well as coal, the other two constituents of fossil fuels also exhibit an average growth of 1.8% and 2% per year respectively (IEA).

High-income countries are energy seekers

Energy trade across the globe presently indicates that High-income countries[1] are net energy importers and Middle-income countries[2] are their main suppliers (World Bank, 2009). World economic growth is clearly linked to the increasing availability of energy sources. Countries are determined to secure for their economies against the energy resources needed for their growth.

Use of energy resources are skewed as a result of development process

Skewing of energy resources intended to meet the targets of several economic activities is now a matter of serious concern across the globe. Services of energy in meeting basic human needs have been seen from several perspectives. Per capita energy consumption across the globe fluctuates widely from as low as 151 kgoe (Bangladesh) to 20,140 kgoe (Qatar) (World Bank, 2009). Today, five of the world economies viz. US, China, Russia, Japan and India consume[3] more than 50 percent of world primary energy (BP Stats, 2008). Growth of China and India, the two Asian giants, likely to lead the post recession recovery of world economy, will be fuelled by massive energy requirements in the days to come.

World economy has been following carbon intensive development path

Carbon dioxide emissions, largely by products of energy production and use, account for the largest share of greenhouse gases, which are associated with global warming. Anthropogenic carbon dioxide emissions result primarily from fossil fuel combustion. Different fossil fuels release different amounts of carbon dioxide for the same level of energy use. Oil releases about 50 percent more carbon dioxide than natural gas and coal releases about twice as much. Energy is a prerequisite to economic development. Use of energy is closely interlinked with economic development. Prosperity of economic development in turn demands more and more of quality-energy services.

It is therefore, largely argued that development of world economy is associated with a carbon intensive path as a result of extensive use of fossil fuel in its economic activities. An overwhelming body of

[1] GNI $ 11,116 and above

[2] GNI $905 - $11,115

[3] US (2361 mtoe), China (1863 mtoe), Russia (692 mtoe), Japan (518 mtoe), India (404 mtoe). Total world (11,099 mtoe)

scientific evidence indicates that earth's climate is rapidly changing predominantly as a result of increases in greenhouse gases caused by human activities. Human activities are rapidly changing the composition of the atmosphere and its properties. Literature suggests that since the pre-industrial times (around 1750), carbon dioxide concentration has increased over one third from 280 parts per million (ppm) to 380 ppm presently, mainly due to burning of fossil fuels, deforestation and other land use changes. This has also been accompanied with rising concentration of other Kyoto gases[4] and more particularly methane and nitrous oxide. In total, the warming effect due to all (Kyoto) green house gases emitted by human activities is now equivalent to around 430 ppm of carbon dioxide (CO_2 equivalent or CO_2e) and rising at around 2.3 ppm per year (Stern, 2008).

Extensive use of fossil fuel is a serious concern for climate change

Climate change is the greatest market failure, the world has ever seen, it is largely acknowledged. 'We do not inherit the earth from our ancestors; we borrow from our children'[5].

Central features of the debate on climate change therefore, raises serious concerns on the policy intervention and cooperation on a global scale as to how to address the developmental issues by defining a workable relationship between climate change issues and the divergent paths for growth. This calls for unprecedented global response if world community has to avoid the worst impacts of climate change not known to be experienced by the human beings so far in the history.

Some of the major threats in the climate change arising out of the over deployment of fossil fuels and mitigation thereto are briefly discussed below.

Energy-Environment

Full warming effect of past emissions is yet to be realized

Observations suggest that the oceans have taken up around 84% of the total heating of the earth's system over the past 40 years (Barnett, 2005). If emissions were to stop today, some of this heat would be exchanged with the atmosphere as the system came back to equilibrium as a result of which there would be additional warming. Climate models suggest that world is committed to further warming of around $0.5^0 – 1^0$ C in future due to past emissions.

If GHG concentration were to remain at today's level, world temperature would rise by 2-5^0 C

At today's level of annual emissions, GHG levels would likely to reach 550 ppm by 2050. This will in turn commit the world to a warming of around 2-5^{0}C. This figure is almost double the pre-industrial level by the middle of the century. This level of global warming is far outside the experience of human civilization.

Impact of warming will lead to change weather patterns and more severe impacts

Some of the severe impacts following the global warming can be seen in terms of change in rainfall patterns, increase in the size of areas to more risks, frequent and intense recurrence of hurricanes and other storms, rise in sea levels etc. In sum, the warming has the potential to trigger abrupt, large-scale and irreversible changes in the climate system.

[4] Six Kyoto green house gases are carbon dioxide(CO_2), methane (CH_4), nitrous oxide(N_2O), Perfluorocarbons (PFCs), Hydrofluorocarbons (HFCs) and Sulphur hexafluoride (SF6)

[5] A Native American proverb

Climate change therefore, demands an international response

Countries are therefore, awakening to the urgent need to steer several policy options to address the issues of climate change. Kyoto Protocol (UN, 1998) to the UN framework Convention on Climate Change (UNFCCC) is considered to be a well structured document on the basis of which countries intend to come closer to the heels of addressing the climate change concerns through specific commitments in achieving its quantified emission limitation and reduction commitments in order to promote sustainable development. In a few months from now, world is expected to seal an effective climate change agreement in Denmark, Copenhagen. Such an agreement is expected to be turning point in the fight to prevent climate change. This also in turn is expected to offer an opportunity for the both developed and developing economies to shift from unsustainable paths of development towards a cleaner, greener future.

Action for climate change need not necessarily cap the aspirations of growth

The basic idea here is to focus on judicious distribution of cost of mitigation and subsequent adaptation across the globe without impinging upon the aspirations of growing economies. This means that significant business opportunities will need to be created for development and dissemination of low carbon energy technologies, goods and services. Carbon markets in the developed countries are intended to deliver flow of finances to support low-carbon development through institutional processes. Besides, economic argument to shift to green energy is highly compelling. Studies from Woods Hole Research Center, Massachusetts Institute Technology, US and others suggest that there is a wide possibility to create millions of new green jobs globally.

Cost of mitigation will offset the long-term benefits

Studies suggest that stabilization of GHG emissions at the current level of 430 ppm CO_2e range will call for emission cut by at least 25% below current level by 2050 and perhaps more. It is estimated that the cost of stabilizing emissions between 500 – 550 ppm CO_2e will be around 1% of world GDP, if strong action is taken right now (IPCC, 2001). Cost will be even less if other co-benefits are measured.

Conclusion – confluence of economy, energy and environment

The economics of moving into a low-carbon global economy, with a long-term perspective keeping in view of the choices of policies and institutional mechanisms are the key challenges to the policy makers' world over.

World recession has a direct impact on energy sector plans

As the world economy is passing through an unprecedented recession pressure, the deteriorating world business climate has had significant impact on the energy sector. There are evidence that world over energy investments have plummeted by around $ 100 billion during 2009. Investment in renewable energy assets which showed an upward trend till the pre recession period is expected to fall by as much as 35% (IEA). Falling energy investment will have far reaching effect on climate change, energy security, and energy poverty.

In the shorter term, slower economic growth will curb in emissions, but in the medium and long term, the crisis is likely to lead to higher emissions as weak fossil fuel prices coupled with curbed investments in green technologies only will enhance the reliance on fossil fuel. Funding of clean fuel technologies is likely to remain confined in assured markets and with proven technologies. Investment in RD&D is also expected to be limited due to risk- averse attitudes.

Providing access to electricity to 'bottom billion' may likely to remain a dream in the pipeline as

financial problems will remain critical to connect the large pool of downtrodden people.

The growing consensus towards a sustainable development programme

In the Energy-Climate era, while the world economy is orchestrating conflict, chaos and confusion, government interventions through a growing consensus to invest in clean technology infrastructure within the context of economic stimulus packages seems to be slowly capturing the minds of the world fora. This has the potential to tackling climate change; enhance energy security and combat recession.

A series of important summits already held at Washington (G-20, November, 2008), London (G-20, April,2009), Yekaterinburg (BRIC, June 2009), L'Aquila (G8, MEF -July, 2009) and the forthcoming summit scheduled be held at Pittsburg in September 2009, point out that there is a growing urgency for the world community to address an inclusive growth in the development model of world economy. It also signals a paradigm shift in global balance of power that intends to overhaul the economic architecture towards a sustainable growth model with more and decisive roles from the developing economies.

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Feed-In Tariff: Renewable Energy Policy that Works

Rohit Dawar

Today, it is well recognized that policy intervention is critical to the promotion of renewable energy technologies. Across the globe many policy models have been adopted, amongst these Feed-In Tariffs & Renewable Purchase Obligation are the most popular ones. This article discusses how Feed-In Tariffs have proved to the most effective policy option for promotion of renewable energy.

Introduction

The criticality of energy as an input in economic growth & human development is well recognized, accordingly, the criticality of management of energy systems cannot be over emphasized. Today, the world economy is mired with enormous challenges on the energy front. There is compelling scientific evidence that two centuries of fossil fuel dominated, carbon-intensive growth has induced ***climate change***, which is pushing the world towards an ecological disaster, with potentially irreversible impact on human development. And yet millions across the developing and third world countries still live in the darkness of ***energy poverty***, with no access to electricity and dependence on traditional fuels (biomass & firewood) for meeting cooking, lighting and heating needs. On top of all this, is the challenge of ***energy security*** i.e., continuous availability of energy in varied forms, in sufficient quantities and at reasonable prices, given the finite reserves of conventional fuels and their highly skewed distribution.

Potential of Renewable Energy

Although not a panacea, Renewable Energy (RE) has the potential of being a critical solution to climate, energy and economic security.

Renewable energy is derived from resources that are generally not depleted by human use, such as wind, wave, solar, hydro, tidal and biomass. Renewable energy sources are deployed for generation of electricity, heat and as automobile fuels.

There are some mature technologies for conversion of renewable energy such as hydropower, biomass, and waste combustion. Other conversion technologies, such as wind turbines and photovoltaics, are already well developed, but they have not achieved the technological efficiency and market penetration that many expect they will ultimately reach. In 2006, renewable energy sources (excluding traditional biomass) met just 7% of global primary energy needs The share was around 6% for heat (mostly from direct consumption of biomass), 1% for transport (biofuels) and 18% of electricity generation (Source: International Energy Outlook 2008).

In terms of potential to meet energy needs, renewable energy sources can generate enough electricity to replace fossil fuels. In fact, theoretically these can cater to about 3000 times our current global energy needs (Source: Greenpeace/EREC). Renewable energy technologies have considerably lower life-cycle CO_2 emissions vis-a-vis fossil-fuel-based electricity production, with most emissions occurring during manufacturing and deployment stages. A

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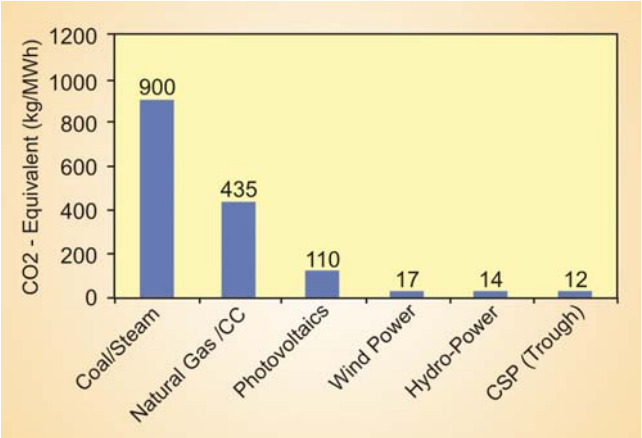


comparison of emissions between conventional fuels & renewables is provided in the adjoining chart. Renewable energy technologies (RETs) are suitable for use in remote, rural areas for Decentralized Distributed Generation (DDG) and accordingly, present a unique opportunity to break the conventional patterns of energy development, which have failed to meet the needs of the poor so far.

Economics of Renewable Energy

The economics of RETs have not been favorable. The economics depend on three drivers:

(i) The market price or value of renewable electricity

(ii) The costs of renewables relative to those of other energy resources

(iii) The policies to promote renewables and environmental goals (particularly climate and energy security policies) that raise costs of using fossil fuels and/or subsidize costs of renewables.

In addition to this, because supplies are contingent on natural forces, there are problems with intermittent output. Building transmission infrastructure for connecting to national grids entails huge capital costs, which also acts as a constraint to the expansion of RETs.

On account of unfavourable economics, market penetration of RETs vis-à-vis conventional fuels remains low and their potential substantially unexploited.

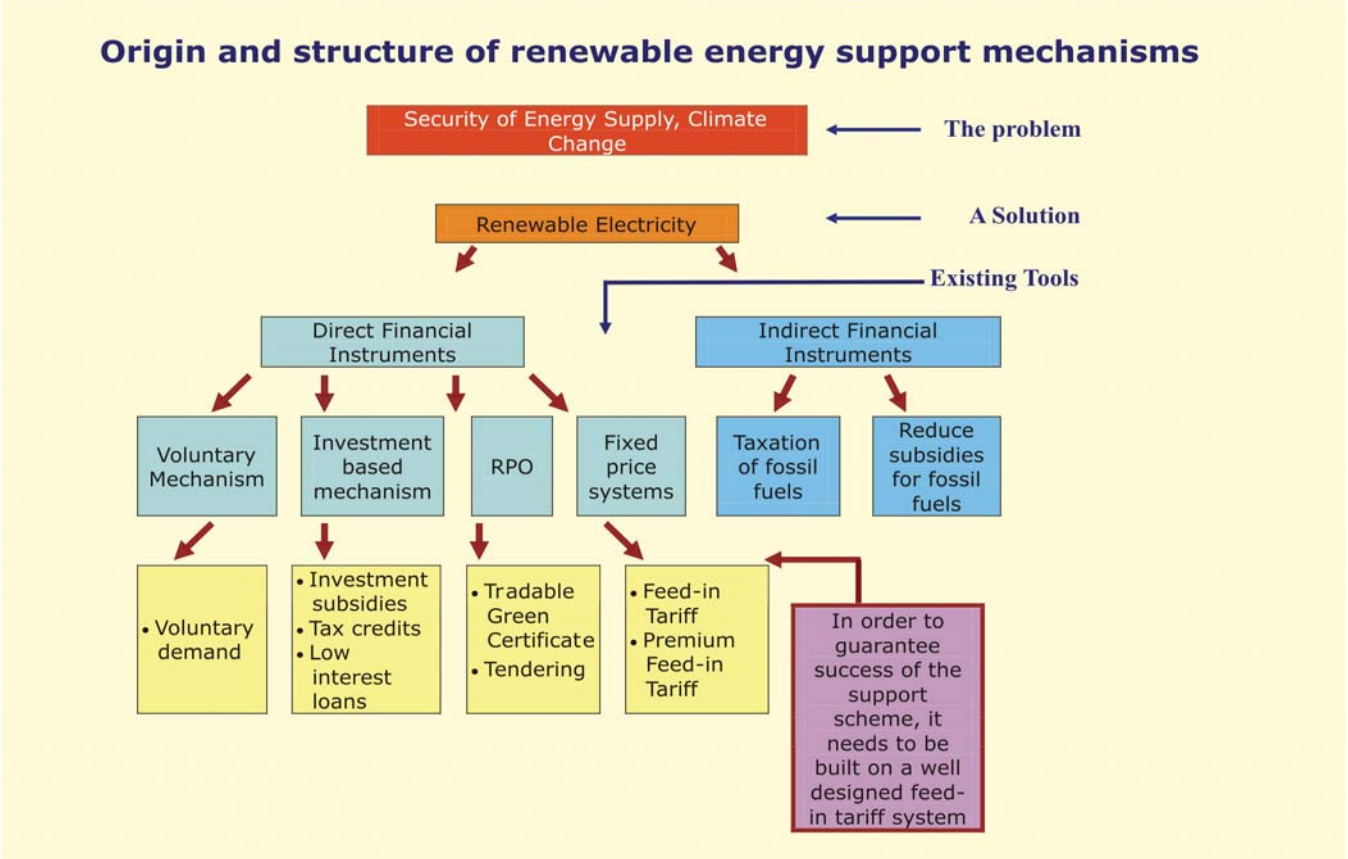
Need for Policy Intervention

Ignoring full costs of different energy systems distorts allocational decisions by both consumers & producers. Under pricing of a resource leads to its overuse, while over pricing leads to sub-optimal investment. Fossil fuels are heavily subsidized across the globe; either through price subsidies or indirectly in the form of absence of tax on carbon emissions produced by these, and therefore, their prices do not reflect their true cost to the society. This makes a case for policy interventions to create a level playing field between RETs & fossil fuels and induce optimal resource allocation. Public policies have the potential to support rapid expansion of RETs.

The nature of RETs is such that economies of scale are achieved at the equipment manufacturing stage rather than through construction of large facilities at the generating site as in the case of coal fired power plants. Costs should come down noticeably with increased scale of deployment and as technologies mature. However, without increased consumer demand, manufacturers cannot produce the volumes needed to bring prices down and drive technological innovation. Public policy interventions are required to make RETs reach this stage. By encouraging greater market penetration of RETs today, policy support can create a basis for long term self-sustaining growth for RETs.

Types of Policy Interventions

Governments of various countries have experimented by implementing various incentives, policies and regulations for fostering and promoting renewable energy. These incentives not only persuade investors to invest in new renewable electricity generation capacity, but also to promote the necessary R&D efforts, mainly by equipment developers. Technology innovation and the economies of scale associated with a larger equipment production have lead to improvement of current technologies and brought down production costs.



The two widely used support mechanisms for promoting renewable electricity are Renewable Purchase Obligation (RPO) and the Feed-in Tariff laws (FIT). Some Governments have implemented either of the above two mechanisms or have put in place both of these.

Renewable Purchase Obligation (RPO)/ Quota System

In a RPO/quota system, governments mandate a minimum share of capacity or grid-connected generation of electricity to come from renewable sources. The share often increases over time, with a specific final target and end-date. The mandate can be placed on producers, distributors or consumers. There are two main types of quota systems used today:

(i) Renewable Energy Portfolio Standard (RPS):

Under RPS, a target is set for the minimum amount of capacity or generation that must come from renewables, which should increase over time. Investors and generators then determine how they will comply, in terms of the type of technology to be used except in the case where specific targets are established by technology types. They determine the developers to do business with, and the price and contract terms they will accept. At the end of the target period, depending upon the policy design, electricity generators and suppliers must demonstrate (through the ownership of credits that they earn through transactions) that their targets are met, in order to avoid paying a penalty. Producers receive credit in the form of green certificates for the electricity they generate from renewables. Those with surplus of certificates can trade or sell them; and those with too few can build their own renewables capacity, buy electricity from other plants using renewables (which generally includes a bidding process), or buy credits from others. Once the system has been established, the government's role includes the certifying of credits, and compliance monitoring and enforcement.

(ii) Tendering System:

In the tendering system, a regulatory agency issues a call for tender of a specified amount of generating capacity. Companies then propose projects and submit bids to provide that capacity at a certain price. The agency typically then selects the lowest bidders. Developers compete against each other to build projects at the lowest price.

Feed-In Tariff (FIT)

FITs put a legal obligation on utilities and energy companies to guarantee access and purchase electricity from renewable energy producers at a mandated and long-term (usually upto 20 years) premium price. Tariff rates are usually determined for each renewable technology and its size in order to take account of their differing generation costs, and to ensure profitability. Usually FITs are decreasing over time as technology development brings down the production cost. The additional costs of FIT schemes are paid by suppliers in proportion to their sales volume and are passed down to the power consumers by way of a premium on the KWH end-user price. The result of financing an FIT by spreading its cost between all end-users is that the increase in price per household/consumer is very small.

Feed-In Tariff vs RPO

There is a long and ongoing discussion both on the theoretical level as well as in practical politics whether FITs or RPO are the best suitable mean to foster the market dissemination. Neoclassical economic theory predicts that both systems lead to an optimal and efficient solution. In FIT the price is fixed and the amount of generated RE electricity is adapted. An individual generator will produce until his marginal costs equal the regulated price. With RPO, the total amount of RE electricity is fixed and the price is flexible. In order of their generation costs, RE electricity will be generated until the targeted amount is reached.

By the late 1990s, RPO in the US and in FIT in Europe seemed to be evolving along parallel tracks. Some viewed this evolution as an extension of the philosophical divide between the laissez faire market orientation of the US and the command-and-control traditions of European social democracies.

Countries with FITs (e.g. Germany, Spain Denmark and France) have seen the largest growth of RE electricity. This applies particularly to wind and solar power. At the same time, a viable RE manufacturing industry has been established in these countries.

Success story of FIT in Germany

The first successful FIT was implemented in Germany in 1990. Germany's first FIT (StrEG) in 1990 was based on a percentage premium above average tariff and assisted producers of electricity from small hydro and wind energy installations.

The StrEG was modified and the EEG Act was introduced in 2000. This Act introduced number of changes, including a differentiation in tariff rates depending upon renewable energy type, size, location, and/or resource availability, range of technologies to be covered and provided fixed rates over fixed periods – 20 years from the start of operation of each new qualifying plant. The Act also provided that adjustments in rates could be proposed every two years, to keep up with technological and market developments. The EEG Amendment in 2004 stipulated that rates of the guaranteed tariff would reduce each year at a fairly high rate, ranging from 1%-6.5% annually, depending on the technology to encourage technical innovation and cost cutting.

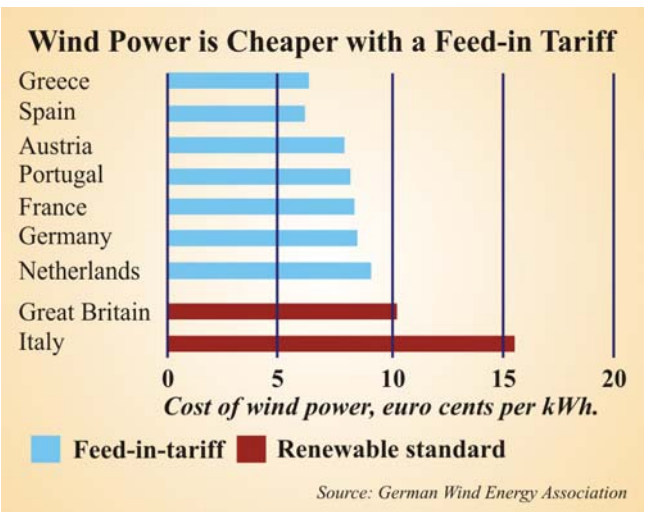
How successful has the German programme been? In 2005, not including hydropower, over 7% of electricity came from renewable energy, almost 50% higher than European Union average, with the sector generating US$27 billion in total turnover and US$ 11 billion worth of investment. Spin-off benefits include the employment of an estimated 170,000 people and German domination of the growing global market of photovoltaic cells. The reduction of CO_2 is estimated at 52 MT in 2010, this has played an important role in enabling Germany meet its Kyoto Protocol commitment.

Distinctive advantage of FIT over other support mechanisms

(i) Investor confidence, price and cost

One of the most heated arguments in Europe has been whether feed-in tariffs or RPO policies are more cost effective from a societal perspective. It is often argued in both Europe and in the US that fixed price policies are inherently more costly than RPO because they do not encourage renewable energy competition. The intent of Renewable Energy Certificates (REC) trading is to create an efficient incentive that supports renewable energy capacity at a minimum cost to society.

The counter argument to this is that feed-in tariffs create a stable investment climate, while RPO policies do not. More weight was lent to this argument by the United Kingdom Treasury's Stern Review on the economics of climate change. The Stern Review (2006) concludes that, compared to RPO policies, "feed-in mechanisms achieve larger [renewable energy] deployment at lower costs. Central to this is the assurance of long-term price guarantees...uncertainty discourages investment and



increases the cost of capital as the risks associated with the uncertain rewards require greater rewards." Various studies of the European electricity markets find that electricity from wind turbines is less expensive in countries with FITs than those with RPS.

(ii) Effectiveness

FITs have clearly been the most effective renewable energy policy in terms of installed capacity in Europe. Denmark, Germany, and Spain, for example, have used FIT to install 31 gigawatts (GW) of wind energy capacity, equal to 53% of the global total, between 1990 and 2005. Germany's FIT has also created the world's largest solar energy market, and analysts report that Spain's solar market is poised for similarly rapid growth.

Feed-in tariff nations are again clear leaders for wind power, hydropower, and solar electricity and analysts conclude that FITs are more effective in reducing greenhouse gases and responding to climate change.

(iii) Innovation and technology diversity

The 1999 Commission of the European Committees (CEC) report states that RPO policies create more of an incentive for dynamic efficiency. Dynamic efficiency refers to the ability of a policy to support innovation and price reductions over time. The CEC also argued that feed-in tariffs were ineffective tools for dynamic efficiency, because fixed prices cannot flexibly adapt to falling costs.

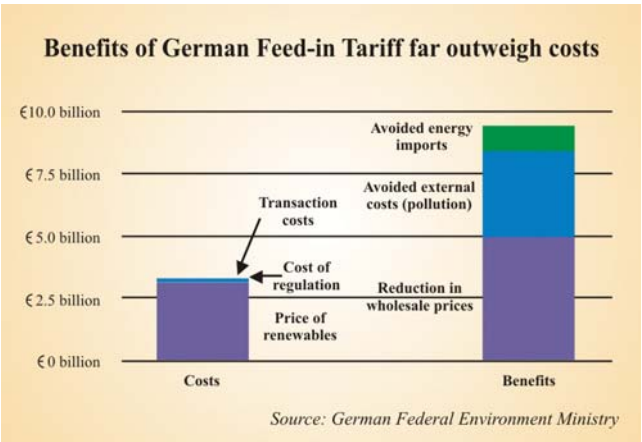
However, one of the primary arguments for the dynamic efficiency of FIT is that it creates market competition between technology manufacturers, rather than between renewable energy generators. Under FITs, market price risk is non-existent and profitability depends on a project's ability to control costs. For wind and solar power, the upfront equipment cost is one of the largest costs that projects incur. The FIT system therefore, places pressure on technology manufacturers to supply low-cost, reliable systems to project developers.

A second argument for the dynamic efficiency of FITs is that they can be structured to support both near-term and emerging technologies. US RPO policies have not encouraged the development of less mature (and more expensive) technologies. Countries like Germany, Austria, Luxembourg, and Spain, on the other hand, have successfully used FITs to drive Solar Photovoltaic markets.

Under feed-in tariffs, by contrast, longer-term technologies are typically targeted in parallel with near-market technologies. The longer-term technologies are therefore pushed more quickly down their experience curves.

(iv) Total Benefits Far Outweigh the Costs

Overall, the benefits of a feed in tariff can outweigh the costs of the premium paid to renewables even without taking into account the economic development impacts. The German ministry overseeing their feed-in tariff estimates that the total benefits of the legislation have exceeded the costs by a factor of three as can be seen from the adjoining figure.



Feed-In Tariffs in India

In 2005, India become the first developing country to adopt the Feed-In Tariffs systems. The central regulatory authority has also announced the adoption of RPS by all states in India, such that at least 10% of power is generated from renewables by 2012. In 2008, the Ministry of New and Renewable Energy announced two feed-in laws for (1) grid-connected solar-PV-based power generation and (2) grid-connected solar-thermal-based power generation. In both these cases, the time period is 10 years and the maximum capacity set is 10 MW. The central subsidy per kWh for PV and for solar thermal is Rs 10 and Rs. 12 respectively. This will be in addition to the state subsidy. This policy makes renewable power generation an attractive option for renewable energy technology developers and investors in India.

Interesting Facts
About Recycling

GENERAL FACTS

- On average, 16% of the money spent on a product is for the packaging, which ultimately ends up as waste. Packaging represents about 65% of household trash.
- Up to 60% of the rubbish that ends up in the dustbin could be recycled.
- The unreleased energy contained in the average dustbin each year could power a television for 5,000 hours.
- As much as 50% of waste in the average dustbin could be composted.
- 70% less energy is required to recycle paper compared with making it from raw materials.
- Up to 80% of a vehicle can be recycled.
- 9 out of 10 people would recycle more if it were made easier.
- On average, it costs $30 per ton to recycle trash, $50 to send it to the landfill, and $65 to $75 to incinerate it.
- An average US citizen produces 4.4 pounds of solid waste each day. This adds up to almost a ton of trash per person, per year.

ALUMINIUM RECYCLING

- In United States alone over 80 billion aluminum cans are used every year.
- An aluminum can that is thrown away will still be a can 500 years from now!
- A used aluminum can is recycled and back on the grocery shelf as a new can, in as little as 60 days. That's closed loop recycling at its finest!
- There is no limit to the amount of times aluminum can be recycled.
- One recycled aluminum can could save enough energy to power a television for 3 hours or the equivalent of a half a gallon of gasoline.

PAPER RECYCLING

- Approximately 1 billion trees equivalent of paper is thrown away every year in the United States alone.
- Each tonne of recycled paper can save 17 trees, 380 gallons of oil, three cubic yards of landfill space, 4000 kilowatts of energy, and 7000 gallons of water. The saved trees can absorb a total of 250 pounds of carbon dioxide from the air each year.
- The construction costs of a paper mill designed to use waste paper is 50-80% less than the cost of a mill using new pulp.

PLASTIC RECYCLING

- In USA alone, 2,500,000 plastic bottles are used every hour! Most of them are thrown away!
- Plastic bags and other plastic garbage thrown into the ocean kill as many as 1,000,000 sea creatures every year!
- Recycling plastic saves twice as much energy as burning it in an incinerator.

GLASS RECYCLING

- Mining and transporting raw materials for glass produces about 385 pounds of waste for every ton of glass that is made. If recycled glass is substituted for half of the raw materials, the waste is cut by more than 80%.
- A modern glass bottle would take 4000 years or more to decompose — and even longer if it's in the landfill.
- The energy saved from recycling one glass bottle can run a 100-watt light bulb for four hours. It also causes 20% less air pollution and 50% less water pollution than when a new bottle is made from raw materials.

Source: Compiled from various sources including the National Recycling Coalition, the Environmental Protection Agency and Earth911.org.

Statistics

World Energy Statistics

	2004	2005	2006	2007	2008	2004	2005	2006	2007	2008
Oil Production										**Oil Consumption**
					(Million tonnes)					
Total North America	667.4	645.3	646.7	642.0	619.2	1134.6	1139.4	1130.2	1134.5	1076.6
Total S. & Cent. America	337.9	347.1	345.0	332.7	335.6	227.5	234.8	243.0	260.0	270.3
Total Europe & Eurasia	850.1	844.8	848.0	860.0	851.0	951.6	958.3	968.5	947.6	955.5
Total Middle East	1192.7	1210.8	1221.0	1202.2	1253.7	257.2	268.7	278.3	290.1	306.9
Total Africa	440.9	467.2	473.3	488.5	488.1	122.0	128.0	126.3	129.9	135.2
Total Asia Pacific	375.8	376.4	375.0	377.0	381.2	1117.9	1132.6	1147.7	1177.4	1183.4
Total World	**3864.8**	**3891.6**	**3908.8**	**3902.3**	**3928.8**	**3810.8**	**3861.8**	**3894.0**	**3939.4**	**3927.9**
India	36.3	34.6	35.8	36.2	36.1	120.2	119.6	120.4	128.5	135.0
Natural Gas Production										**Natural Gas Consumption**
					(Million tonnes oil equivalent)					
Total North America	684.9	677.3	695.3	708.8	740.0	711.4	705.4	702.1	739.3	751.2
Total S. & Cent. America	118.6	124.1	136.0	139.5	143.0	105.7	111.3	121.7	124.1	128.7
Total Europe & Eurasia	929.2	934.4	945.7	947.9	978.6	978.5	999.6	1019.2	1024.5	1029.6
Total Middle East	256.6	287.9	305.2	321.9	343.0	222.4	251.3	262.3	273.0	294.4
Total Africa	139.6	158.1	173.4	184.0	193.3	69.6	71.4	75.5	80.3	85.4
Total Asia Pacific	303.1	326.3	340.7	356.7	370.1	335.1	362.0	385.0	411.2	436.8
Total World	**2432.1**	**2508.1**	**2596.3**	**2658.8**	**2768.0**	**2422.8**	**2501.0**	**2565.8**	**2652.2**	**2726.1**
India	26.3	26.7	26.4	27.1	27.5	28.7	32.1	33.5	36.0	37.2
Coal Production										**Coal Consumption**
					(Million tonnes oil equivalent)					
Total North America	611.8	620.9	635.2	630.6	638.4	603.0	614.9	606.1	614.6	606.9
Total S. & Cent. America	43.0	46.3	50.9	54.0	55.5	20.5	20.8	20.9	22.5	23.3
Total Europe & Eurasia	438.7	438.4	445.3	447.0	456.4	527.8	514.1	526.6	528.9	522.7
Total Middle East	0.6	0.6	0.5	0.5	0.5	9.0	9.1	9.1	9.3	9.4
Total Africa	140.9	140.7	140.5	142.1	143.4	103.4	100.8	102.3	105.7	110.3
Total Asia Pacific	1496.9	1637.1	1764.0	1875.4	2030.7	1502.5	1647.6	1777.2	1913.5	2031.2
Total World	**2732.0**	**2884.2**	**3036.3**	**3149.5**	**3324.9**	**2766.2**	**2907.4**	**3042.3**	**3194.5**	**3303.7**
India	155.7	162.1	170.2	181.0	194.3	172.3	184.4	195.4	212.9	231.4
Electricity Generation										**Primary Energy Consumption**
					(Terawatt-hours)					(Million tonnes oil equivalent)
Total North America	4966.5	5087.7	5103.3	5222.3	5171.7	2803.6	2819.2	2803.2	2849.4	2799.1
Total S. & Cent. America	901.3	937.7	988.1	1024.0	1049.7	490.9	511.6	538.4	563.5	579.6
Total Europe & Eurasia	5035.9	5115.9	5229.3	5301.5	5353.5	2925.9	2937.7	2978.7	2956.9	2964.6
Total Middle East	579.0	625.0	664.3	699.0	738.6	492.6	533.2	555.1	577.6	613.5
Total Africa	538.6	559.9	583.5	612.5	638.4	318.2	323.5	327.5	341.0	356.0
Total Asia Pacific	5542.5	5975.6	6469.8	7030.3	7249.8	3227.6	3430.0	3617.9	3816.0	3981.9
Total World	**17563.9**	**18301.8**	**19038.3**	**19889.5**	**20201.8**	**10258.8**	**10555.3**	**10820.8**	**11104.4**	**11294.9**
India	673.8	708.7	759.7	808.8	834.3	343.9	362.2	378.8	409.2	433.3

Source: BP Statistical Review of World Energy 2009

Indian Oil and Gas Industry

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09*
Crude oil production, including condensates						(MMT)
- ONGC	26.057	26.485	24.409	26.050	25.941	25.364
- OIL	3.002	3.196	3.235	3.107	3.100	3.468
- Private/JVs	4.314	4.300	4.552	4.830	5.077	4.674
Total	**33.373**	**33.981**	**32.196**	**33.987**	**34.118**	**33.506**
						(Source : MoP&NG)
Natural Gas Production in India						(bcm)
- ONGC	23.585	22.985	22.574	22.250	22.334	22.491
- OIL	1.886	2.007	2.270	2.265	2.341	2.268
- Private/JVs	6.491	6.782	7.358	7.040	7.727	8.090
Total	**31.962**	**31.774**	**32.202**	**31.555**	**32.402**	**32.849**
Refinery crude throughput	121.841	127.117	129.835	146.552	156.103	160.772
						(Source : MoP&NG)
Production of Petroleum Products in India						(MMT)
Light Distillate	31.503	34.671	34.241	39.166	41.020	41.644
Middle Distillate	59.207	61.870	63.919	70.950	76.340	80.193
Heavy Ends	17.755	18.808	18.369	20.330	21.289	23.250
Others	9.176	7.400	7.551	9.624	11.245	9.569
Total	**117.641**	**122.749**	**124.080**	**140.070**	**149.894**	**154.656**
						(Source : PPAC)
Consumption of Petroleum Products in India						(MMT)
Light Distillate	29.070	32.489	31.297	34.021	35.791	37.325
Middle Distillate	51.407	53.335	53.914	57.104	62.244	65.978
Heavy Ends	17.745	18.215	18.418	18.350	19.513	19.291
Others	9.529	7.596	9.586	11.275	11.399	10.806
Total	**107.751**	**111.635**	**113.215**	**120.750**	**128.947**	**133.400**
						(Source : PPAC)

India Oil Industry Marketing Infrastructure (As on 31.3.2009)

Particulars	IOC+AOD+IBP	BPC	HPC	Others**	Total
Terminals/Depots	167	91	109	7	**374**
LPG Bottling Plants	89	49	43	0	**181**
Aviation Fuel Stations	101	21	16	18	**156**
Retail Outlets	18278	8389	8569	2896	**38132**
SKO/LDO Dealerships	3963	1015	1648	0	**6626**
Indane Distributorships	4999	2117	2235	0	**9351**
Consumer Pumps	7341	444	440	69	**8294**
*** Others include Shell, RIL, Essar and NRL*					*(Source : Marketing HO, IOCL)*

** - Provisional Data*

Crude Oil Price Trends

Year/Month	Dubai	UK Brent	US WTI	Average Crude	Indian Basket
2001-02	21.5	23.2	24.1	22.9	22.4
2002-03	25.9	27.6	29.2	27.6	26.6
2003-04	26.9	29.0	31.4	29.1	27.8
2004-05	36.4	42.2	45.0	41.2	38.9
2005-06	53.4	58.0	59.9	57.1	55.4
2006-07	60.9	64.4	64.7	63.3	62.4
2007-08	77.1	82.1	81.9	80.4	79.3
2008-09	82.8	84.5	86.8	84.7	83.6
April 2009	50.1	50.3	49.8	50.1	50.1
May 2009	57.9	57.5	59.1	58.2	58.0
June 2009	69.4	68.6	69.6	69.2	69.1
July 2009	64.8	64.6	64.1	64.5	64.8

Source: International Trade Department, IOCL

Chronology: Indian Refineries

REFINERY	Company	Location (State)	Commissioned in the year	Current Capacity (MMTPA)
AOD-Digboi	IOC	Digboi (Assam)	1901	0.65
HPCL-Mumbai (erstwhile ESSO)	HPC	Mumbai (Maharashtra)	1954	5.50
BPCL-Mumbai (erstwhile Burmah Shell)	BPC	Mumbai (Maharashtra)	1955	12.00
HPCL-Vizag (erstwhile Caltex)	HPC	Visakhapatnam (Andhra Pradesh)	1957	7.50
IOCL-Guwahati	IOC	Guwahati (Assam)	1962	1.00
IOCL-Barauni	IOC	Baruani (Bihar)	1964	6.00
IOCL-Koyali (Gujarat)	IOC	Koyali -Vadodara (Gujarat)	1965	13.70
KRL-erstwhile Cochin Refineries (Phillips)	BPC	Cochin (Kerala)	1966	7.50
CPCL (erstwhile MRL) -(Amoco, NIOC)	IOC	Manali -Chennai (Tamil Nadu)	1969	9.50
IOCL-Haldia	IOC	Haldia (West Bengal)	1974	6.00
BGR-Bongaigaon	IOC	Bongaigaon (Assam)	1979	2.35
IOCL-Mathura	IOC	Mathura (Uttar Pradesh)	1982	8.00
CBR-Narimanam	IOC	Nagapattinam (Tamil Nadu)	1993	1.00
MRPL-Mangalore	ONGC	Mangalore (Karnataka)	1996	9.69
IOCL-Panipat	IOC	Panipat (Haryana)	1998	12.00
NRL-Numaligarh	BPC	Numaligarh (Assam)	1999	3.00
RIL - Jamnagar	RIL	Jamnagar (Gujarat)	1999	33.00
ONGC-Tatipaka	ONGC	Tatipaka (Andhra Pradesh)	2002	0.08
Essar Oil Refineries Ltd.- Vadinar	ESSAR	Vadinar (Gujarat)	2007	10.50
RIL - Jamnagar - Expansion	RIL	Jamnagar (Gujarat)	2009	29.00
All India Capacity upto 01.04.2009				177.97

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