though the foreign reactors may have state-of-the-art designs, they come with limited operational experience and perhaps, there is a need for re-evaluation of the safety features before the green signal is given.

How are regulatory issues addressed in India? There is an Atomic Energy Regulatory Board, which is not truly an autonomous body as it comes under the Atomic Energy Commission. We need to have an independent regulatory authority, but where will the expertise to man this Board come from? For the Indo-US nuclear deal and the nuclear liability bill there have been legislative initiatives, but very little for the new regulatory act. The Government promises to grant autonomy, but this is a long process and people are concerned about safety issues.

Another problem, which Balaram pointed out, is that of weighing risks and benefits. He said that people have confidence in the power projections, but one needs to look at how many projections have been met. There are also difficulties in weighing technology options: solar or hydroelectric versus nuclear – how much of one, how much of the other? But what really worries people is the overriding commercial interest in selling technologies to India; today it will be nuclear reactors, tomorrow it will be something else.

Another concern is that of a missing generation of nuclear scientists and engineers in the Indian academic system. There is a need for experts outside the agencies who can contribute to an analysis of these problems. Balaram quoted a former foreign secretary S. Saran, who said that it will be easy for the mass media and anti-nuclear NGOs in India to play on public fears, to retard if not derail. The ambitious nuclear plans that were made possible by the Indo-US civil agreement in 2008 may be compelled to adopt more elaborate and expensive safety methods, to reassure a fearful population. But this would add to the cost of nuclear power. So there are issues of cost, risks and benefits as well as weighing all of these.

The overarching fear has been that of secrecy, a matter of concern for the past 50 years. Balaram stressed on the fact that as one is able to distinguish civilian and strategic applications of nuclear energy, a far greater openness on issues of nuclear power would help people move forward. One should not dismiss the concerns of the common man as foolish and irresponsible.

Parul R. Sheth, E-705/706 Kalp Nagari, Vaishali Nagar, Mulund (West), Mumbai 400 080, India.
e-mail: parulrsheth@gmail.com

IPCC and renewable energy

In May 2011, the Intergovernmental Panel on Climate Change (IPCC) presented its report on potential of renewable energy (RE) which emphasizes significant future role of RE in cutting greenhouse gas (GHG) emissions and powering sustainable development. A global team of technological experts and scientists reviewed over 160 scenarios on the potential of six RE technologies and compiled a report entitled 'Special Report on Renewable Energy Sources and Climate Change Mitigation' (SRREN) approved by member countries of IPCC. The present report is a short summary of approximately 1000-page comprehensive assessment done by 120 scientists for the IPCC Working Group III (WGIII)[1].

IPCC is the leading international body for the assessment of climate change, which was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to review and assess the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. The WGIII 'Mitigation of Climate Change' of IPCC assesses all relevant options for mitigating climate change through limiting or preventing GHG emissions and enhancing activities that remove them from the atmosphere. WGIII analyses the costs, benefits and risks of the different approaches to mitigation, considering also the available domestic instruments and policy measures as well as international arrangements.

According to this report, close to 80% of the world's energy supply could be met by renewable sources by the middle of this century if backed by the right public policies. The findings of the report also indicate that the rising growth of RE could lead to collective GHG savings equivalent to 220 to 560 Gigatonnes (Gt) of carbon dioxide between 2010 and 2050. A cut of around a third in GHG emissions from business-as-usual projections, could assist in keeping the concentration of GHGs at 450 ppm. This could contribute towards the goal of keeping the increase in global temperature below 2°C, as recognized in the Cancun Agreements of the United Nations Climate Convention.

The WGIII is co-chaired by Ottmar Edenhofer of the Potsdam Institute for Climate Impact Research, Germany; Ramon Pichs of the Centro de Investigaciones de la Economía Mundial, Cuba, and Youba Sokona of the Africa Climate Policy Center in Ethiopia.

When the report was presented R. K. Pachauri said, 'The IPCC brought together the most relevant and best available information to provide the world with this scientific assessment of the potential of renewable energy sources to mitigate climate change. The special report can serve as a sound knowledge basis for policymakers to take on this major challenge of the 21st century.'

Six RE sources recognized by 194 IPCC member nations are bioenergy, direct solar energy, geothermal energy, hydropower, ocean energy and wind energy. Scientists believe that of the around 300 GW of new electricity-generating capacity added globally between 2008 and 2009, 140 GW came from RE. Despite global financial challenges, the RE capacity grew in 2009, e.g. wind by over 30%, hydropower by 3%, grid-connected photovoltaics by over 50%, geothermal by 4% and solar water/heating by over 20%. The annual production of ethanol increased to 1.6 Exajoules (EJ)/76 billion litres (bl) and biodiesel by 0.6 EJ/17 bl by the end of 2009.

For the time being developing countries host more than 50% of the current global RE capacity. Bioenergy mainly used for traditional cooking and heating in developing countries, currently represents over 10% of the global energy supply. Bioenergy technologies can generate electricity, heat and fuel from a range of feedstock. Advanced conversion systems which, for example, convert woody wastes into liquid fuels, can deliver 80–90% emission reduction compared to fossil fuels.

Direct solar energy technologies include photovoltaics and concentrating solar power can produce electricity, heat and light. Currently, direct solar energy contributes only a fraction of 1% to the total global energy supply. The deployment of these energy technologies will depend on continued innovation, cost reductions and supportive public policies.

Another promising energy source is geothermal energy which utilizes heat stored in the Earth's interior directly or to generate electricity, with currently about 0.7 EJ/yr. By 2050, geothermal deployment could meet more than 3% of global electricity demand and about 5% of the global heat demand.

Ocean energy technologies are diverse, and use the kinetic, thermal and chemical energy of sea water. Most are at the demonstration and pilot project phases and due to their nascent stage of development, they are unlikely to contribute significantly to global energy supply before 2020. The wind power capacity installed by the end of 2009 met close to 2% of worldwide electricity demand and in the case of hydroelectric power according to long-term scenarios, the share of hydropower in global electricity supply may decrease to 10–14%.

Most of the reviewed scenarios estimate that renewables will contribute more to a low carbon energy supply by 2050, than nuclear power or fossil fuels using carbon capture and storage (CCS). The technical potential of RE technologies exceeds the current global energy demand by a considerable amount, globally as well as with respect to most regions of the world. Under the scenarios analysed in-depth, less than 2.5% of the globally available technical potential for renewables is used or in other words, over 97% is untapped. Accelerating the deployment of REs will present new technological and institutional challenges, in particular integrating them into the existing energy supply systems and end-use sectors.

Four scenarios have been reviewed here which were selected in order to explore possible future worlds, analysing alternative pathways of socio-economic development and technological change. According to these scenarios analysed in detail, the decadal global investments in the renewable power sector range from 1360 to 5100 billion US dollars to 2020, and from 1490 to 7180 billion US dollars for 2021–2030. For the lower values, the average yearly investments are smaller than the renewable power sector investments reported for 2009. A combination of targeted public policies allied to research and development investments could reduce fuel and financing costs, leading to lower additional costs for RE technologies. Public policymakers could draw on a range of existing experiences in order to design and implement the most effective enabling policies.

The IPCC report shows a high expansion rate of the RE technologies in Europe, North America and, more recently, in China and India. A greater geographical distribution of deployment is likely to be needed to achieve the higher deployments indicated by the scenario literature.

Highlights of IPCC report on RE and climate change mitigation

- Consumption of fossil fuels accounts for the majority of global anthropogenic GHG emissions. Emissions continue to grow and CO_2 concentrations had increased to over 390 ppm, or 39% above industrial levels.
- Energy conservation and efficiency, fossil-fuel switching, RE, nuclear and CCS are options for lowering GHG emissions while satisfying global demand for energy services.
- Having a large potential to mitigate climate change, RE can provide wider benefits.
- Under most conditions, increasing the share of RE in the energy mix will require policies to stimulate changes in the energy system.
- Enhanced scientific and engineering knowledge should lead to performance improvements and cost reductions in RE technologies.
- Additional knowledge related to RE and its role in the reduction of GHG emissions remains to be gained in a number of broad areas, including future cost and timing of RE deployment, realizable technical potential for RE at all geographical scales, technical and institutional challenges and costs of integrating diverse RE technologies into energy systems and markets, comprehensive assessments of socio-economic and environmental aspects of RE and other technologies, opportunities for meeting the needs of developing countries with sustainable RE services and policy, and institutional and financial mechanisms to enable cost-effective deployment of RE in a wide variety of contexts.
- Knowledge about RE and its climate change mitigation potential continues to advance, but for the time being, the existing scientific knowledge is significant and can facilitate the decision-making process.

1. Intergovernmental Panel on Climate Change, Special Report on Renewable Energy Sources and Climate Change Mitigation, 9 May 2011.

Jaimini Sarkar (*S. Ramaseshan Fellow*).
e-mail: jaimini_dhane@hotmail.com