

**Keynote Address**

by

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Government of India

at the

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of

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Dr. Manmohan Singh ji, Hon'ble Prime Minister of India; Dr. Rajasekhara Reddy, Hon'ble Chief Minister of Andhra Pradesh; Shri Subbrami Reddy, Hon'ble Minister of State for Mines; Shri Pallam Raju, Hon'ble Minister of State for Defence; Dr. Dasari Narayana Rao, Hon'ble Minister of State for Coal; Prof. Ramamurthi Rallapali, President of the 95<sup>th</sup> Indian Science Congress, Dr. Harsh Gupta, Immediate Past President of the Indian Science Congress, Dr. T. Ramasami, Secretary of the Department of Science & Technology and the President-elect of the 96<sup>th</sup> Indian Science Congress, distinguished members of the scientific community, delegates, media personnel, invitees, ladies and gentlemen.

1. Sir, I have had the privilege of addressing the Indian Science Congress three times. This, at Visakhapatnam is my fourth. To be with India's best and brightest scientific minds is a great honour and kindles the hope of India keeping its tryst with destiny.

2. Sir, every generation considers that its times are unparalleled, its achievements unsurpassed and the problems/challenges it confronts insurmountable. So do we. Science & Technology has enhanced human welfare to enviable and unprecedented levels. New materials, new technologies, new production/distribution systems are continuously made and refined to render our lives more leisurely and less burdensome. S & T becomes part and parcel of our lives much the same way as a shell is to the snail or a web to the spider – as the famous physicist Heisenberg so beautifully put it. Technology enslaves us even while it empowers us. Prodigious

consumption, unbridled monetization, untrammled energy profligacy are threatening the sustainability of our civilization. Today, human civilization is faced with the challenge of global warming. Global and local climate may change faster than our ability to adapt. Climate change is thus an assault on all evolutionary forms of life.

3. For years the world's leading atmospheric scientists have been cautioning us that a gradual warming of global climate was underway, but we paid no heed. As most of you know, the 1990s were the hottest decade of the entire century; perhaps even the millennium, and 1998, 2001, and 2002 were three of the hottest years ever recorded. The growing scientific consensus is that this warming is largely the result of emissions of carbon dioxide and other greenhouse gases from human activities including industrial processes, fossil fuel combustion, and changes in land use, such as deforestation. The scientific community has adduced evidence requiring us to decrease green house gases emissions, mainly CO<sub>2</sub> and methane, by 60 – 70% from the present, for several decades. This will revolutionize the supply and demand of energy. We must do our utmost to develop technologies for energy production which are not, or are to a much lower degree, linked with the emission of greenhouse gases. Unluckily, in the past, de-carbonization of the energy supply was obstructed by the fact that CO<sub>2</sub> could be emitted at zero price. The energy price of the fossil fuel economy was and is until today being heavily subsidized by nature, by the capacity of the atmosphere to assimilate. The Fourth Report of the IPCC has unequivocally reiterated this. As a result the international debate has now moved beyond the reality of climate change to what must

be done to mitigate it and to prepare proactively for its consequences. It is a global problem requiring global solutions based on the principle of common but differentiated responsibilities. The solution should be inclusive benefiting and encompassing all. Low carbon economies alone can ensure global sustainability. What we do to achieve this globally should be discussed, planned and acted upon.

4. In India, there is little doubt that climate will become more unstable in the years ahead. We will witness more unpredictable and extreme weather patterns. This is so as sufficient greenhouse gas emissions have already entered the hemisphere to bring about such change. However, little research has been conducted on how climate change will affect different parts of India and what should be our response to it locally and nationally. Governments, at all levels, must make sustained efforts to meet the challenge of global warming. We must put in place laws and regulations, and modify them as we learn more of the science, and as technology solutions begin to manifest themselves. Industry and business must innovate, manufacture, and operate under a new paradigm. Climate change must drive their decision-making. We must all switch to a more climate-friendly path in our choices, purchases and lifestyles.

5. Sir, today, virtually nothing is made without the use of commercial energy. Access to affordable and reliable energy supplies is an essential ingredient for our survival, progress and prosperity. Economic development needs energy. Human poverty is directly related to energy poverty. The availability of affordable,

secure and environmentally responsible energy supply is key to reach the Millennium Development Goals (MDG) and to decrease the welfare gap globally. Sir, our economy has grown at an average annual rate of almost 9%. We hope to achieve a growth rate of around 10% in the 11<sup>th</sup> Five Year Plan and for the decade ahead. This will require a minimum annual energy growth of at least 5% for the foreseeable future. Energy shortages have hitherto plagued India's growth rate and some estimates put the shortage as high as 10%. This energy deficit will worsen with increasing population, urbanization, industrial production, transport and general rise in living standards.

6. Presently, we in India consume a mere 0.19 kg of oil equivalent per dollar of GDP expressed in purchasing power parity terms. This is equal to the energy intensity of Organization for Economic Cooperation and Development (OECD) countries and compares favorably with China (0.21) and USA (0.22) and the World average of 0.21. However, there are several countries in Europe at or below the figure 0.21kg of oil equivalent with Brazil at 0.14 and Japan at 0.15. Sir, we need to be striving for these levels as the gains achieved so far in energy efficiency in India are only the tip of the iceberg. We need to achieve much lower energy intensity.

7. This should not be difficult. Our technology inefficiencies make us squander an embarrassing amount of energy each day. In our kitchens, less than 25% of the energy used in the standard cooking stove reaches the food. Our thermal power plants discard

more energy in 'waste' heat than is needed to run the economies of five of our largest States. In agriculture, barely 15% of the energy delivered to a pump is actually used to pump ground water. If addressed properly, technology efficiencies will completely eliminate the present electricity power shortages in the country. There needs to be a national drive on two fundamental fronts: first, in the short term to conserve energy and to increase the efficiency of existing energy resources, and second, in the long term to invest for switching the energy systems from existing fossil based energy resources to renewables that are clean and environment friendly. In doing so, we may be able to enhance national security, personal security, financial viability, human comfort and environmental value. The thrust then should be on conservation of fossil fuel resources and in their place to integrate alternate and renewable energy sources into the energy strategy of our industry and enterprises. The Government on its part is giving special emphasis and incentives to generation of grid quality power from non-conventional and renewable energy sources. I therefore urge the scientific community to increasingly assist and partner industry to develop and deploy for their operations alternate and renewable sources of energy.

8. Global energy consumption has recorded more than a six fold increase in the past 55 years; from 1951, when the global population was around 2.6 billion and per capita coal equivalent consumption of slightly over 1 tonne to currently with a population of 6.5 billion and per capita coal equivalent consumption of around 2.5 tonnes. Of the global energy supply more than 75% has been met through fossil fuels. The extensive use of fossil fuels has two major

concerns namely, environmental impact and depletion of resources. A variety of stresses impacting the environment, emerge from the extraction and use of fossil fuels. Some of these have global implications, like global warming, while others impact human health and the ecology. Take the case of coal mining in India. This causes land degradation through subsidence and mine fires. The impact of mining, especially open cast, in forest areas is also of particular concern. Similarly, onshore oil and gas production generates drilling waste fluids and solids, produces water and volatile organics that contaminate surrounding water bodies and the air.

9. We have plenty of reserves of fossil energy sources – especially coal and lignite, which lie beyond the reach of conventional mining techniques. But, there are several serious problems in their exploitation, namely, relatively lower heat value, high ash content, difficulties in transportation and disposal of residues and last, but not the least, carbon dioxide emissions. Obviously, there are technology solutions to all of these. Take the case of surface gasification technologies for coal. These have been improved to significantly reduce emissions. With underground gasification, the problem of ash disposal is eliminated and the gaseous pollutants, primarily CO<sub>2</sub>, can be sequestered. Low pressure methane so generated can be used for power generation with reasonably high efficiency using the Integrated Gasification Combined Cycle (IGCC) route at the well-head or pit-head as the case may be. Also, underground gasification offers the additional advantage of complete conversion of coal into gas, eliminating the need to leave out considerable quantities as in conventional mining

processes. Thus, coal gasification to IGCC power generation to High Voltage Direct Current (HVDC) transmission can deliver clean, reliable, affordable electrical power. A mission, with adequate investments in R&D and its utilization, is needed for coal gasification and IGCC power generation. Another advantage of pursuing underground coal-bed gasification is that as and when Gas Hydrate recovery technology is mastered, we will be technologically prepared for exploiting a new source, as indications are, that it is almost entirely methane. India has an estimated gas reserve of 40 to 120 trillion cubic metre in gas hydrates located in water depths of about 2000 metres along our Exclusive Economic Zone (EEZ). When we are successful in exploiting this source, it can take care of India's energy needs for several decades. But we still need to fully understand the environmental implications in utilizing this source – a challenge for the scientific community to resolve.

10. But there are other options. Consider biomass. It is used today to produce liquid fuels, such as alcohol, by fermentation. In this process, there are no greenhouse gas impacts, because the carbon dioxide used to make the biomass comes from the atmosphere. However, only a fraction of the biomass becomes liquid fuel. Quantities of liquid fuels from biomass can be dramatically increased if we could convert all of the biomass into a hydrocarbon fuel. As biomass contains significant quantities of oxygen, it could then be thought of as partially oxidized hydrocarbon with its energy value per unit of carbon significantly increased. This approach to biomass utilization could help triple liquid fuel production per unit of biomass and also produce higher quality fuel.

I believe this is what the scientific community and energy industry should be striving for together as a short term solution.

11. We also have about 63 million hectares of wasteland, of which about half has been earmarked for tree plantation. Multi-purpose trees such as Jatropha can grow well in wasteland with very little water requirement. The plant has fifty years of life time and fruiting takes place as early as in two years to yield up to 5 tonnes per hectare of oil seeds that could produce 2 tonnes of bio-diesel. Presently, the cost of bio-diesel production is comparable to the cost from hydrocarbon sources. But this can be substantially reduced through optimization of process technology and using high yield variety plants. Thus, bio-diesel plants grown even on one-third of the wasteland for tree plantation can yield 20 million tonnes of bio-diesel. Not an insignificant contribution to our energy pool, especially to liquid fuels. But we need to do more R&D on developing genetically modified Jatropha varieties with still higher oil content and devise optimal processing technologies. This is what we should strive for in the medium term. Also, we have the ability to completely rewrite the geopolitics of oil if we ensure that the efficiency of transportation in the country – specifically diesel transportation is improved and bio-diesel substitution takes place on a war footing.

12. For us and for several other countries, nuclear power provides another viable alternative to fossil fuels. Life cycle analysis studies reveal that nuclear power is equal, if not better than other renewable energy sources in terms of carbon dioxide emissions. The bulk of

CO<sub>2</sub> emissions for nuclear power arises from mining, refining and preparing the fissile material and not from its operation. The Earth has inexhaustible raw material to power nuclear plants at present levels of consumption. But we are short of uranium resources. As a result, presently we are able to add a mere 4,000 mega watts capacity of nuclear power in a decade whereas we should be targeting around 20,000 mega watts capacity per decade if we are to continue with our high economic development pace and at the same time reduce overall greenhouse gas emissions.

13. What are the potential costs of cutting greenhouse gas emissions? Can these emissions be reduced without sacrificing economic growth or our standard of living? Any effort to significantly limit greenhouse gas emissions will require changes in behavior and investments in technology – in short, changes in economic activity that could impose costs on our society. The costs of climate change mitigation reflect the magnitude of the emissions reduction, the timing of these reductions, and the means of implementation. Of course, left unaddressed, climate change will impose costs on society as well – and so, the benefits of undertaking climate change mitigation must also be considered. Effectively understanding the potential costs and benefits of mitigating climate change will allow policy-makers to develop policies that achieve the greatest emissions abatement for the resources expended, secure greater participation and compliance, and maximize the environmental effectiveness of the mitigation effort.

14. The impact of global warming is already being felt. Crops in Haryana and Punjab which provide for bulk of our wheat production have faced spells of heat in the Rabi season for several years in the recent past. A few paddy-producing areas do face scarcity of rain in the monsoon season. At the same time, parts of Madhya Pradesh, Maharashtra and Karnataka, that earlier had marginal monsoon rains, now have abundance of water for irrigation. We all know that even a small increase or decrease in temperature could push down crop yields much further from what they are today. Rain-fed agriculture in marginal areas, in semi-arid and sub-humid regions is mostly at risk and we could lose as much as 125 million tonnes of rain-fed cereal production. This year itself it is estimated that floods have affected around 20-25 million people. More than 2 million hectares of cropland has been damaged, around 150,000 dwelling units destroyed and nearly 1500 people feared dead.

15. Once again you will ask me whether this is only on account of climate change. My answer is: no one knows for sure. But we know that increase in temperature can reduce crop duration, increase crop respiration rates, alter photosynthate partitioning of economic products, affect the survival and distribution of pest populations thereby altering the equilibrium between crops and pests, hasten nutrient mineralization in soils, decrease fertilizer use efficiencies, and increase evapo-transpiration. Indirectly, there may be considerable other effects on land use due to snow melt, availability of irrigation, frequency and intensity of inter and intra-seasonal droughts and floods, soil organic matter transformations, soil erosion, changes in pest profiles, decline in arable areas due to submergence of coastal lands, and availability of energy. All these

can have an adverse impact on our agricultural production and, hence, food security. Further in India, the poorest of the poor possess the most marginal land and depend heavily on climate-sensitive factors. They are vulnerable to flooding, soil erosion, drought and crop failure. If these occur more often and with greater intensity due to climate change as predicted, the burden will fall heavily on all those who are least able to cope. We have, therefore, to prepare ourselves for any such eventualities.

16. Fortunately, our economic rise is taking place at a time when crucial technological and organizational innovations are required for a sustained future; these could help to overcome the energy crisis that is likely to result from dwindling reserves and use of fossil fuels. The earlier we join the search for low-carbon development trajectories, the greater the chances of sustainability. Development patterns in India could opt for innovations away from the energy-intensive “new world” pattern exemplified by the United States, Canada, Australia, and New Zealand. In doing so, we could become an important actor in energy-related research and development, as the markets for their applications have enormous potential. The Clean Development Mechanism (CDM), one of the flexibility mechanisms incorporated into the Kyoto Protocol, offers great possibilities to India in helping mobilize foreign direct investment, by providing commercial incentives for the private sector to invest in mitigation projects and providing opportunities for the scientific community to team up with Indian industry for affordable and sustainable domestic solutions. I therefore believe that appropriate public–private incentives and linkages would be necessary in order to bring the CDM into full play. To this end, I feel that public funds

could be used to complement private investment via the CDM, thus enhancing market functions of such investments. But even more important to us is the challenge of carbon dioxide capture and storage especially from our coal based power plants. Several large experiments are under way the world over for geological storage of carbon dioxide. I feel that we too need to mount a major exploratory initiative in this direction. Another possibility for India is carbon sequestration by reforestation and afforestation.

17. Today, climate-related and environmental aspects are an integral part of our Eleventh Five Year Plan. However in most of the Plan projects, reduction of GHG emissions is a desirable by-product but not the primary objective. But we need to be doing more than that – we need to make conscious and deliberate efforts to move to a low carbon economy. For its effective implementation both the Central government and State governments need to together rein in local industries and enterprises. The degree of local political autonomy, together with our size and complexity, makes it difficult for the Central government to oversee the course of actions at the local level. State governments also face a conflict between economic and environmental aims. Priority to the economic development of their region, postpones environmental recovery for a future date. As a result, climate policy implications have not diffused much beyond central policy-making bodies. The core group of relevant policymakers and experts is quite small. There is also a large discrepancy between regulations and laws and actual implementation at the State and local levels. Responsible local institutions are not equipped with sufficient resources to meet their tasks, for example, monitoring and sanctioning. The decoupling

between local and central environmental administrations has created problems for policy coordination and implementation. Strengthening climate capacities in the environmental administration at all levels could help to improve policy formulation and coordination. Can the scientific community take up the role of advocacy and capacity building at the state and central government levels on climate change?

18. Structural systemic changes in the past fifteen years have facilitated, and sometimes even created, incentives for the development of climate-relevant capacities. Economic liberalization and openness have promoted enormous economic growth and provided economic, technological, and scientific resources to build up capacities to address the manifold causes and consequences of climate change. But it has also provided new constraints. On the positive side, economic growth has supplemented India's financial resources and widened the financial scope available for climate-relevant measures. Foreign companies and competition have brought with them technology and knowledge transfers which have enhanced productivity and efficiency and thus reduced the energy and resource intensity of production, with corresponding effects on relative emissions. With increased integration into competitive global markets, India has had to adopt high environmental standards required in certain sectors, for example, the automobile industry. Therefore, the opportunities for the participation of non-governmental actors in climate policy making and monitoring need to be enlarged to fully utilize their potential. India's reform process has had a strong impact on the economic system, but little on the political system. Public awareness of climate change is still low due

to the limited influence on non-governmental organizations and the media. We need to build on this aspect through the involvement of the scientific community.

19. Also, the present model of economic development the world over is based on concentrations of economic enterprises and people in cities because of the availability of relatively cheap fossil fuels. Concentrations of industry and population in cities are many times greater than what can be supported by the surrounding landscape. As fossil fuels become less available and cost more, cities have to diminish in size, eventually to the size compatible with their support area. Signs of this are visible in the West where a few industries and enterprises are already moving to areas where there is more space, cleaner air and water, and land. Reintegrating cities with their region of support and influence may also help solve the severe urban problems and lead to less-intensive fuel consumption life styles. Decisions on these issues will have to be made jointly by governments and the energy and transport industries worldwide. They will have to address the problems of growing pollution caused by continued use of fossil fuels and move towards solutions which will facilitate a smooth transition to a non-carbon-based global economy. Governments will be required to put in place mechanisms to finance and give economic incentives for promoting energy efficiency and conservation, more advanced energy technologies, and environmental clean-up. The global community will have to look for ways and means for a smooth transition away from fossil fuels. Energy research and development and investment strategies will need to be re-oriented with changing consumer preferences and government policies. The global community must

act quickly. Otherwise, the choices for delivering sustainability for future generations will be far more difficult and costly.

20. Sir, let me now turn to what we in the two Ministries that I have the privilege to head, commit to the Nation in this New Year. We are setting up a Group on Climate Change Adaptation cutting across departments in the two ministries to proactively prepare for providing technology required to comprehensively address issues related to climate change. A Centre for Climate Change, initially to be located within the campus of the Indian Institute of Tropical Meteorology (IITM), Pune will address the scientific issues related to Global Warming and Climate Change. Our steadfast efforts to modernize weather forecasting facilities in the India Meteorological Department (IMD) to a state-of-the-art system will commence bearing fruit from this year through the launch of a dedicated weather channel and agro-advisories at the district level. The Department of Biotechnology (DBT) will set up in the current year, the Biotechnology Industry Research Assistance Council (BIRAC), which will act as an effective interface between academia and private industry particularly tailored to the needs of the SME's and start-up's. To spur the arrival and to foster the growth of futuristic BT technologies, the DBT, again this year, shall implement a novel Biotechnology Industry Partnership Programme (BIPP). To further strength public-private-partnership initiatives, especially in new areas, we shall ear-mark 30% of the whole budget of the DBT for this activity. The present day cost of drug development is generally beyond the capacity of most Indian pharma firms. A novel initiative of open source drug discovery is being mounted by CSIR to address the problem and bring the cost of drug development to

manageable levels. To bring innovation at the centre stage of national consciousness, the Department of Science and Technology (DST) is mounting wide ranging multi-pronged initiatives to foster, nurture and promote inclusive innovation in the country including availing assistance from the World Bank and partnership of countries like UK. Sir, in our endeavour to involve the private sector in policy formulation, we have requested FICCI to help us draft an 'Innovation Law' which I hope to bring up for the consideration of the Government within this year itself.

21. Sir to conclude, I wish to say that given the unprecedented support that we have had from the Hon'ble Prime Minister and the confidence accorded by the Planning Commission to Science, Technology and Innovation in the 11<sup>th</sup> Five Year Plan, we in the scientific community resolve to contribute our mite to position India in the comity of nations as a formidable player.

Thank You!

Jai Hind.