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Addressing Sustainable Development Goals and Tackling Climate Change:
Scientific Realities and Options

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Abstract

The paper traces the history of the global dialogue on sustainable development including the outcome of the historic Rio Summit of 1992. It identifies climate change as a driver of and an important part of the unsustainable record of development pursued worldwide. There is now scientific evidence going back at least a century and quarter on the scientific basis of climate change, culminating in the work of the Intergovernmental Panel on Climate Change (IPCC) which brought out its latest comprehensive assessment in the form of the 5th Assessment Report completed in 2014.

The paper then brings out the equity dimensions of climate policy and how these need to address the challenge of sustainable development, particularly as they are embedded in the Sustainable Development Goals (SDGs) adopted by the UN General Assembly in 2015. The trends in emissions of greenhouse gases (GHGs) are alarming and the current concentrations of carbon dioxide, methane and nitrous oxide are unprecedented in at least the last 800,000 years. As a result, the impacts of climate change hold major risks to all forms of life.

Extreme events, including heat waves and extreme precipitation events are on the increase both in frequency and intensity. Projections for the future show that without adequate and timely mitigation measures, the risks from impacts of climate change would become progressively more serious and beyond the ability of human society to adapt to.

The paper lays out the critical policy imperatives of mitigation of GHG emissions and adaptation to the impacts of climate change, and including a process of sustainable development in growth strategy and policy.

The world has been through diverse trends, which have dominated policies and actions, before arriving today at the realization that economic development across the globe must be sustainable, a concept voiced by many, but understood by very few. On September 25, 2015 the UN General Assembly adopted 17 Sustainable Development Goals (SDGs), which essentially provide the building blocks of development strategies to be implemented globally in an effort to make economic development sustainable during the period extending up to 2030. The 17 SDGs were adopted as the culmination of an intensive and remarkably inclusive process followed actively since the 2012 Summit in Rio entitled "UN Conference on Sustainable Development". But, in actual fact the articulation of what would constitute sustainability in development goes back a long period of time including what is contained

in the report of the World Commission on Environment and Development (WCED), more popularly known as the "Brundtland Commission". The landmark Rio Summit of 1992 which was held with high expectations under the title "UN Conference on Environment and Development" also provided a turning point in thinking on issues of sustainability. While sustainability is a complex subject that goes considerably beyond protection of the environment, its genesis lies undoubtedly in concerns emanating from the degradation of the environment, which many distinguished thinkers and pioneering activists highlight as lying at the core of unsustainable development. However, acceptance of knowledge and scientific facts in this general field has been rather slow, and, therefore, even slower has been the practice of sustainability in development actions.

"Clearly, the contribution of these pioneering thinkers and visionary intellectuals provided the world with logic and evidence to show that the expanding production and consumption of some goods and services as being pursued by human society were clearly not sustainable, based on existing patterns."

If we look at the problem of human induced climate change, we can certainly identify the work of Svante Arrhenius, a Swedish scientist, who towards the end of the 19th century highlighted the risks that the world would face with growing emissions of carbon dioxide, as a consequence of industrial growth and the widespread use of coal as a source of energy in industrial enterprises and in steam locomotives for transportation which expanded rapidly in that period, followed by even greater expansion of road transport using hydrocarbons as a fuel. Arrhenius used the term 'Cosmic Physics' while assessing physical theories that linked scientific phenomena related to the seas, the atmosphere and land. He was perhaps the first scientist to have constructed a climate model in which the influence of atmospheric carbon dioxide on the earth's climate was assessed. His work was published in 'The Philosophical Magazine' in 1896, and it brought out on the basis of the model constructed by Arrhenius, that as the quantity of CO_2 increases or decreases in geometric progression, the temperature will increase or decrease in arithmetic progression. He was, therefore, able to find that the burning of fossil fuels which would lead to emissions of carbon dioxide would result in climate change. In his estimate, a doubling of CO_2 due to fossil fuel burning was expected to take 500 years, leading to a temperature increase of 3 to 4 ^{o}C. In actual fact, the world is on a trend by which doubling would take place in less than 200 years from the time that Arrhenius carried out his study and his modeling exercise.

Later in the 1960s pioneering environmental crusaders like Rachel Carson brought to the attention of society in the US the growing hazards from extensive use of a range of chemicals and pesticides, etc., which were polluting the soil, many water streams and the air in cities and industrial sites with the rapid growth of the US economy. This remarkable person faced formidable challenges and opposition from vested interests and industry leaders, who were solely concerned with maximizing profits without regard to consequences that society would face with growing use of harmful chemicals and other substances. For them the welfare of

human society, both for the present and future generations, was irrelevant—the very antithesis of sustainability as a goal or criterion in business.

This was followed by visionary economic thinkers like Nicholas Georgescu-Roegen and Kenneth Boulding who saw the reality of a closed economic system, wherein you could not wish away the growing volume and impacts of waste material being produced in the modern production system. Their major contribution, in very simple terms, was to show the world that producing waste material resulted in negative externalities, which were hardly ever considered by decision makers and were certainly not assessed and included in economic metrics for their negative economic and ecological impacts on the welfare of society. They also brought out the inevitable threat in the production of goods on an increasing scale which would lead to an equally large, if not larger, production of what was termed as "bads". Clearly, the contribution of these pioneering thinkers and visionary intellectuals provided the world with logic and evidence to show that the expanding production and consumption of some goods and services as being pursued by human society were clearly not sustainable, based on existing patterns.

The work of the Intergovernmental Panel on Climate Change (IPCC), which was established in 1988 and which brought out the latest of its comprehensive assessments, the Fifth Assessment Report (AR5), in 2014 has provided complete scientific assessment of the serious extent to which human actions are resulting in changes in the earth's climate. The IPCC, particularly in its AR5, has highlighted the growing risks associated with climate change, and how actions to deal with this challenge would also require sustainability in development strategies and their implementation.

Human induced climate change should be considered as symptomatic of the breakdown of sustainability criteria in development, as we see it worldwide today. Climate change is essentially the consequence of what constitutes unsustainability of growth and development, particularly because human-induced climate change is the result of growing concentration of greenhouse gases (GHG) in the atmosphere. And, climate change in all its forms is impacting adversely on all forms of development, sustainable or otherwise. At the same time, inaction on dealing with climate change would restrict the ability of society to develop in a sustainable manner. In its unmitigated extent climate change could lead to abrupt and irreversible impacts, which would leave no room for redressal of the problems that are being caused by today's path of development. Sustainable development also involves the principle of equity, and climate change has impacts which are largely inequitable both from the geographical as well as the social perspective.

Climate policies need to be assessed on the basis of sustainable development and equity. Limiting the effects of climate change is necessary to achieve sustainable development and equity including the eradication of poverty. If we evaluate the historical contribution of different societies to the accumulation of GHGs in the atmosphere, we see a vast range of diversity, because there are some societies which have hardly emitted anything more than a very small fraction of the total cumulative emissions of GHGs, but in several cases these are also societies which are most vulnerable to the impacts of climate change. Furthermore, it is a fact that different countries face varying challenges and circumstances and possess very different capacities to address mitigation and adaptation. These issues of mitigation

and adaptation raise questions related to equity, justice and fairness. There is also the issue of intergenerational equity which needs to be considered when evaluating a global response to climate change. Delaying mitigation shifts the burden from the present to the future generation. As it is, insufficient adaptation responses to impacts that are becoming commonplace are already eroding the basis and available space for sustainable development. In its very basic characteristics, climate change is a risk management problem, and an increase in risk to people, property, livelihoods and economic opportunities would render any pattern of development unsustainable. Mitigation and adaptation are complementary approaches for reducing risks of climate change impacts over different timescales. As the IPCC concludes, mitigation in the near-term and its continuation through the century can substantially reduce climate change impacts in the latter decades of the 21st century and beyond. Adaptation can provide substantial benefits both by addressing current risks as well as dealing with emerging risks that would occur in the future.

The IPCC AR5 has identified five Reasons For Concern, which aggregate climate change risks and illustrate the implications of warming and adaptation limits for people, economies and ecosystems across sectors and regions. It has been assessed that without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risks of severe, widespread and irreversible impacts globally.

In order to evaluate the nexus between human induced climate change and unsustainable development, it would be useful to look at the historical assessment of climate change as it has occurred since the beginning of industrialization. The IPCC AR5 has found that human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history, and that recent climate changes have had widespread impacts on human and natural systems. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. It also found that the period from 1983 to 2012 was perhaps the warmest 30-year period of the last 1400 years in the Northern Hemisphere, where such assessment is possible. The globally averaged combined land and ocean surface temperature data, based on calculation by a linear trend, show a warming of 0.85 ^{o}C during the period 1880 to 2012. Further, it found that ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 and only 1% of this was stored in the atmosphere. Ocean warming was found to be largest near the surface, and the upper 75m warmed by 0.11 ^{o}C per decade over the period 1971 to 2010. Since the beginning of the industrial era, the uptake of CO_2 in the oceans has resulted in their acidification. In this period, the pH of ocean surface water has decreased by 0.1, corresponding to a 26% increase in acidity. In the period 1992 to 2011, the Greenland and Antarctic ice sheets have been losing mass, likely at a larger rate over the period 2002 to 2011. With glaciers continuing to shrink worldwide, Northern Hemisphere snow cover has continued to decrease in extent, and there is also growing evidence to show that Northern Hemisphere permafrost temperatures have increased in most regions since the early 1980s. The annual mean Arctic sea ice extent decreased over the period 1979 to 2012 with a rate that was very likely in the range of 3.5 to 4.1% per decade. Projections for the future indicate that in a scenario which involves no mitigation actions, Arctic sea ice during September in the middle of this century would be existent.

Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with other drivers for which human beings are responsible, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century. The AR5 clearly stated that it is extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by increase in human induced GHG concentrations and other anthropogenic forcings together. Overall, human induced forcings have likely made a substantial contribution to surface temperature increases since the mid-20th century over every continental region except Antarctica.

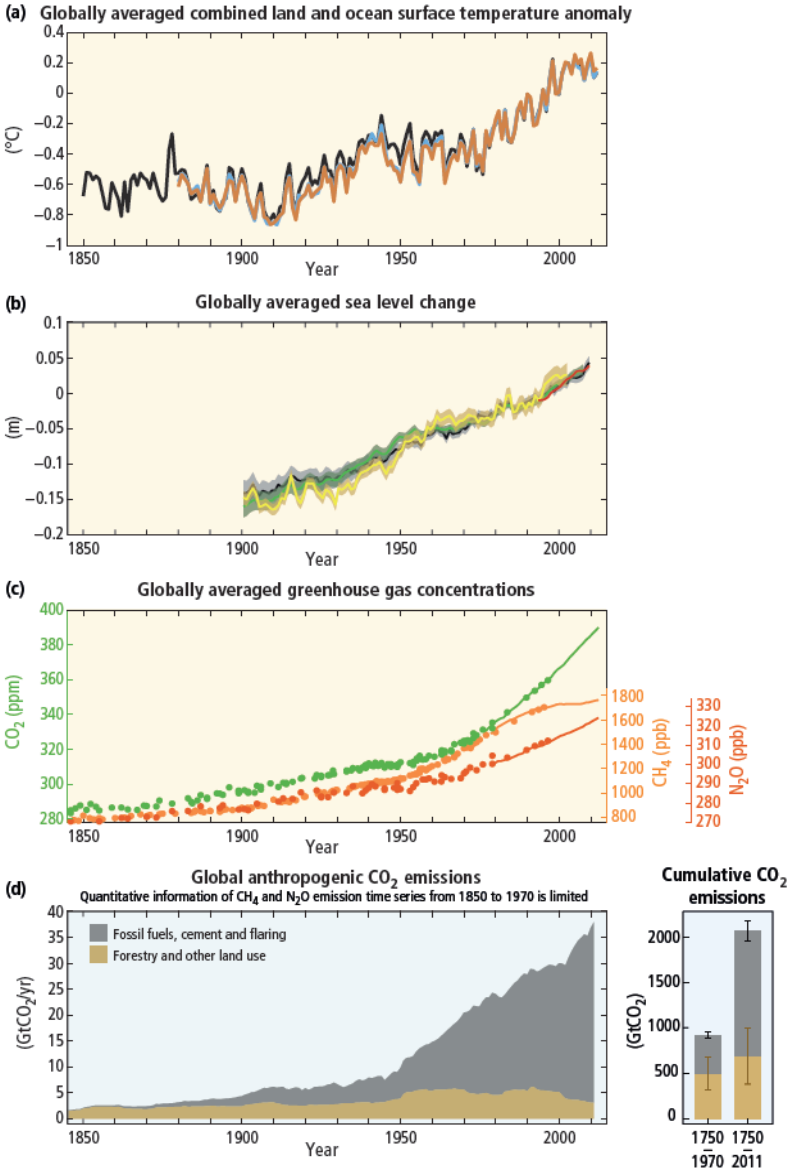
The extent of changes that have taken place since the beginning of industrialization, including changes in temperature, sea level, greenhouse concentrations and global anthropogenic CO_2 emissions are shown in Figure 1.

The impacts of climate change extend to natural as well as human systems on all continents and across the oceans. The AR5 states that the evidence is the strongest and most comprehensive in respect of impacts on natural systems. In many regions of the world changing precipitation or melting snow and ice are impacting on hydrological systems and affecting water resources in terms of both quantity and quality. These impacts exacerbate existing scarcity of water in several locations, which are the result of population growth, income increases and over-exploitation of groundwater resources as well as lakes and rivers. There are several terrestrial, freshwater and marine species which have shifted their geographic ranges, seasonal activities and migration patterns, etc. in response to ongoing climate change. Some impacts on human systems are also attributable to climate change. In the case of agriculture, several studies referred to in the AR5, covering a wide range of regions and crops show that negative impacts of climate change on crop yields have been more common than positive impacts. Ocean acidification and its impacts on marine organisms have also been attributed to human influence. As a result, food security for the world as a whole is likely to undergo adverse changes.

The IPCC brought out a report in 2011, entitled "Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)", which found that the number of cold days and nights has decreased and that warm days and nights have increased on the global scale. It also found likely that the frequency of heat waves had increased in large parts of Europe, Asia and Australia. Further, it assessed that human influence had contributed to the observed global scale changes in the frequency and intensity of daily temperature extremes since the mid-20th century. Human influence had more than doubled the probability of occurrence of heat waves in some locations, and there was also evidence that observed warming had increased heat-related human mortality and decreased cold-related human mortality in some regions. Significantly, this report found that it was likely that more land regions had increased in the number of heavy precipitation events than those where it had decreased. Increasing trends in extreme precipitation and discharges in some catchments implies greater risks of flooding at a regional scale. Also, it is likely that extreme sea levels (for example, as experienced in storm surges) have increased since 1970, being mainly a result of rising mean sea level. The IPCC in its AR5 found that continued emissions

of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.

Figure 1: The extent of changes that took place since the beginning of industrialization



Source: IPCC AR5

The AR5 used four specific scenarios for projecting the future, and the one that represents no targeted mitigation can result in very high temperature increases, with an average temperature increase by the end of this century within a range of 2.6 °C to 4.8 °C. The scenario which includes stringent mitigation efforts is projected to lead to a temperature increase by the end of this century of 0.3 °C to 1.7 °C relative to the beginning of this century.

"Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond."

The AR5 assessed that a large fraction of species faces increased extinction risk due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors. Most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes. Marine organisms will face progressively lower oxygen levels and high rates and magnitudes of ocean acidification, with associated risks exacerbated by rising ocean temperature extremes. It is also projected that coral reefs and polar ecosystems would be highly vulnerable. At the same time, coastal systems and low-lying areas are at risk from sea level rise, which will continue for centuries even if the global mean temperature is stabilized. Global marine species redistribution and marine biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystems services. For wheat, rice and maize in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2 °C or more above late 20th century levels. However, some individual locations may benefit. Global temperature increases of around 4 °C or more above late 20th century levels will pose large risks to food security globally, particularly since demand for food is likely to increase with growth in population and income. At the same time, projections indicate a reduction in renewable surface water and groundwater resources in most dry subtropical regions. This would intensify competition for water among different sectors. Climate change is also projected to increase displacement of people. Populations that lack resources for planned migration would experience higher exposure to extreme weather events, particularly in developing countries with low income. In a world where conflicts between groups of people as well as between nations create various threats to human society, the AR5 assessed the impacts of climate change in this respect as well. Climate change can also indirectly increase risks of violent conflicts by amplifying well-documented drivers of these conflicts such as poverty and economic shocks.

The Paris Conference of the Parties which arrived at an agreement on climate change reaffirms the earlier target which had been set for 2 °C as being the limit of temperature increase that the world should treat as a goal till the end of this century. However, the Paris Agreement also requires the IPCC to produce a special report to assess the impacts of climate change at a temperature increase of 1.5 °C. This decision reflects the growing concern that 2 °C may be accompanied by impacts and climate change risks that would be unacceptable. Indeed, in the Fourth Assessment Report (AR4) of the IPCC it had been assessed that sea level rise by the end of this century resulting from thermal expansion of the oceans alone

could lie anywhere between 0.4 to 1.4m. The current debate at the global level also includes the subject of loss and damage, wherein several developing countries are highlighting the moral and possibly legal claims of the most vulnerable countries being compensated for loss and damage as a consequence of climate change by countries that are essentially responsible for the largest share of cumulative GHG emissions.

Mitigation actions would require consideration of a number of important actions and policies. The AR5 has clearly stated "Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation". Since GHGs mix freely in the atmosphere, irrespective of their geographical sources of emission, international cooperation is critical for effective mitigation. Of course, mitigation can also have local co-benefits, such as improved air quality, higher energy security, higher agricultural yields and, in several cases, other economic benefits and higher employment. Adaptation measures on the other hand focus primarily on local to national level outcomes. The Kyoto Protocol provides useful experience in respect of the political aspects of international cooperation, the evolution of flexibility mechanisms such as the Clean Development Mechanism and the effectiveness of a global agreement with targets set for each country and monitoring of implementation measures.

The IPCC also found that mechanisms that set a carbon price, including cap and trade systems and carbon taxes, can achieve mitigation in a cost-effective way, but these have been implemented with varying effects, because national circumstances and variations in policy design are a critical determinant of outcomes. It has been found that the short-run effects of cap and trade systems have been limited because the caps specified were generally loose. In some countries, tax-based policies specifically aimed at reducing GHG emissions, along with policies focused on technology and other aspects have been instrumental in weakening the link between GHG emissions and GDP. In many countries, fuel taxes have also had effects which are similar to sectoral carbon taxes. Regulatory measures and information dissemination can also be effective. Appropriate regulatory approaches could include energy efficiency standards, information programmes including labelling of devices and equipment, which facilitate the consumers making better-informed decisions.

In general, sector-specific mitigation policies have been used to a greater extent than economy-wide policies. Economic instruments in the nature of subsidies are also sometimes applied across sectors and take the form of tax rebates or exemptions, grants, loans and credit lines. An increasing number and variety of renewable energy policies, which in several cases includes subsidies, have brought about rapid growth of RE technologies in several parts of the world in recent years. There are also in existence subsidies in sectors which contribute to GHG emissions, and reduction of these is also an important measure. There are varying estimates of existing subsidies on fossil fuels, and it is well-known that these remain very high at the global level, and in some countries are a determinant of high levels of consumption of fossil fuels.

As stated earlier, mitigation carries a large range of co-benefits which are linked with human health, food security, conservation of biodiversity, improvement of local

environmental quality, greater energy access, and generation of livelihoods and equitable sustainable development. Some mitigation policies could raise the prices of some energy services and could act as barrier in the ability of specific societies to expand access to modern energy services, particularly for under-served populations. These side effects can be offset through the adoption of complementary policies such as income tax rebates or other mechanisms for providing direct benefits to the consumer. Long term mitigation strategies would also involve the articulation of appropriate technology policy. Substantial reductions in emissions would require large changes in investment patterns, but with appropriate enabling policies and a facilitating environment, the private sector, along with the public sector, can play important roles in financing mitigation and adaptation. Climate change is a threat to sustainable development. However, the AR5 found that there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses. Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond.

"Change in behavior, lifestyles and values would have to be an important consideration in adopting and implementing policies for the future."

If we evaluate the nexus between climate change action and the 17 SDGs, there is clearly a substantial overlap in the actions required to meet the SDGs and those required to deal effectively with climate change. SDG 13 specifically mentions climate change actions, but many of the other SDGs are an important part and closely connected with climate action. For instance, the very first SDG, which targets the removal of poverty, would require both mitigation as well as adaptation measures by which the risks associated with the impacts of climate change, and which are disproportionately harmful for the poorest sections of society would require mitigation at the global level and adaptation to the impacts of climate change at the local level. The other SDGs, such as the 2nd, 3rd and the 6th, deal with the removal of hunger, good health, clean water and sanitation respectively, are areas in which the impacts of climate change would make the achievement of these SDGs far more difficult. For instance, given the growing adverse impacts of climate change on agriculture and with the prospects of the global population stabilizing above 9.5 billion and with higher incomes across the globe, food security would be affected adversely if climate action is inadequate or delayed. That would make it much more challenging for the world to meet all the SDGs. SDG 7 which focuses on renewable energy is an important part of mitigation action, as is SDG 9 which involves innovation and infrastructure. Some of the other SDGs which involve good jobs and economic growth, reducing inequality, sustainable and resilient cities and communities, responsive communication and partnerships for the goals are clearly linked very closely with actions to deal with climate change. The 14th SDG which focuses on life below water is also linked with climate change, because increased emissions of GHGs would lead to further acidification of the oceans and warming not only at higher levels of temperature but also at greater depth in the oceans. Hence, if the ecosystems and marine life existing in the oceans are to be protected and conserved, then the emissions of greenhouse gases and the consequent warming would need to be limited.

Action to deal with climate change and the attainment of the SDGs both have to be seen within the framework of ethics, intra-generational and inter-generational equity. Consequently, change in behavior, lifestyles and values would have to be an important consideration in adopting and implementing policies for the future. As the IPCC states climate change exacerbates other threats to social and natural systems, placing additional burdens particularly on the poor. Consequently, aligning climate policy with sustainable development requires attention to both adaptation and mitigation. On the other hand, delaying global mitigation actions may reduce options for climate-resilient pathways and adaptation in the future. Opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time, particularly if limits to adaptation are exceeded. Strategies and actions can be pursued now which would move towards climate-resilient pathways for sustainable development, while at the same time helping to improve livelihoods, social and economic well-being and effective environmental management. In some cases, economic diversification can be an important element of such strategies. The academic community has to come up with analysis of policies which are suitable and relevant at the local level, but which must now increasingly focus on the global imperatives of dealing with climate change and meeting the SDGs.

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