GLOBAL CHANGE AND INDUSTRIAL ECOLOGY

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Global change refers to planetary-scale changes in the Earth system. The system consists of the land, oceans, atmosphere, poles, life, the planet's natural cycles and deep Earth processes. These constituent parts influence one another. The Earth system now includes human society, so global change also refers to large-scale changes in society.

More completely, the term "global change" encompasses population, climate, the economy, resource use, energy development, transport, communication, land use and land cover, urbanization, globalization, atmospheric circulation, ocean circulation, the carbon cycle, the nitrogen cycle, the water cycle and other cycles, sea ice loss, sea-level rise, food webs, biological diversity and more.

In the past, the main drivers of global change have been solar variation, plate tectonics, volcanism, proliferation and abatement of life, meteorite impact, resource depletion, changes in Earth's orbit around the sun and changes in the tilt of Earth on its axis. However, there is overwhelming evidence that now the main driver of planetary-scale change, or global change, is the growing human population's demand for energy, food, goods, services and information, and its disposal of its waste products. In the last 250 years, global change has caused climate change, widespread species extinctions, fish-stock collapse, desertification, ocean acidification, ozone depletion, pollution, and other large-scale shifts.

The scientific study of environment and its organisms with respect to their abundance, habitat, interaction, climate and distribution is referred to as *Ecology*. *Industrial ecology* thus, studies the physical, chemical and biological interactions and relations between the industrial processes and ecosystems. It evaluates the effects of industrialization on the environment. The study revolves around the flow of materials from industrial processes into the nature - the way in which industrial systems (for example a factory, an eco-region, or national or global economy) interact with the biosphere.

The objective of industrial ecology is to reduce the negative impact of industrial process on nature, thereby clearing off the threat posed to the environment, mainly in the form of Global Warming. It is concerned with the shifting of industrial process from linear (open loop) systems, in which resource and capital investments move through the system to become waste, to a closed loop system where wastes can become inputs for new processes.

The environmental impact of industries can be reduced through industrial ecology. Firstly, industrial ecology draws on and extends a variety of related approaches including systems analysis, industrial metabolism, materials flow analysis, life cycle analysis, pollution prevention, design for environment, product stewardship, energy technology assessment, and eco-industrial parks. All these invariably will provide a long-term perspective, encouraging consideration of the overall development of both technologies and policies for sustainable resource utilization and environmental protection into the future. It will emphasize opportunities for new technologies and new processes, and those for economically beneficial efficiencies. The outcome of these processes will be greater material efficiency, the use of better materials, and the growth of the service economy which would contribute to the "dematerialization" of the economy. Resources that are cheap, abundant, and environmentally beneficial may be used to replace those that are expensive, scarce, or environmentally harmful. Such a substitution can be seen in the many important changes in energy sources that have occurred over the past century. As the energy sources have shifted from wood and coal toward petroleum and natural gas, the average amount of carbon per unit energy produced has decreased significantly, resulting in the "decarbonization" of world energy use.

Secondly, another industrial ecology strategy is to use waste products as raw materials. These efforts often come into conflict with concerns about hazardous materials in the wastes, such as the concern that trace metals in ash from power plants recycled in fertilizer may contaminate soil. However, in some cases, such waste reuse can be successful. In the industrial district in Kalundborg, Denmark, several industries, including the town's power station, oil refinery, and plasterboard manufacturer, make use of waste streams and energy resources, and turn by-products into products. There are many examples of technological innovations that have had significant environmental benefits. An important example is the replacement of chlorofluorocarbons (CFCs) with new compounds in order to protect the stratospheric ozone layer. Other examples are the elimination of mercury in batteries, and the elimination of lead in gasoline, paint, and solder.

Thirdly, industrial ecology advocates the substitution of service for product as a way of reducing environmental impacts, meaning that customers do not seek specific physical products, but rather the services provided by those products. For example, an integrated pest management service might provide crop protection rather than selling pesticides. The service thus saves money and the ecosystem by using only as much pesticide as needed.

The challenge of industrial ecology is to understand how technological and social innovation can be harnessed to solve environmental problems and provide for the well-being of the entire world. Thus, effective implementation of the various methods of Industrial ecology as mentioned above will definitely help in combating the threat of global warming and help secure our environment. Each one of us can contribute to a safer world and save our planet by being a part of the revolution against global change through industrial ecology.