IICHE-MRC E-NEWSLETTER

MUMBAI REGIONAL CENTER

INSIDE

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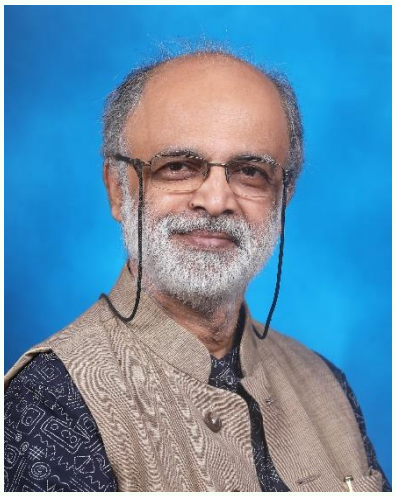

FROM CHAIRMAN'S DESK

Prof. Aniruddha B. Pandit
Chairman IIChE-MRC

My Dear Friends

Greetings for 2023! Time is perpetual, and persistent. We put blocks on it what has happened in 2022 and what is going to happen in 2023. As the year 2023 is already rolling, there is optimism in the air.

India has now become the 3rd biggest start-up nation and we are seeing a growing start-up eco system. World bank estimates India one of the fastest growing economy in 2023. India handled pandemic better than the west in 2022. India has managed inflation better than most countries. The country captured attention by its first private rocket launch and multiple other satellite launches. Indian banking sector has staged a dramatic turnaround from a huge loss in FY19 to record profit of Rs. 1.82 lakh crore in FY22, accompanied by a cleaning up of NPAs. India holds the Presidency of the G20, a premier forum for international economic cooperation, with a theme of Vasudhaiva Kutumbkam, One world, One family, One future. New education policy has promised to bring changes in the society as it emphasised on awakening the creative potential of human being.

With regards green hydrogen, the pros outweigh the cons. The National Green Hydrogen Mission, recently approved with an incentive plan of Rs. 17,490 crores by Union Cabinet, envisages making India a global manufacturing hub for clean energy source with huge potential for reduction of CO2 emissions. Resilience is the word being used to describe India's current economic footing**,** even as the developed world faces major headwinds. PM rightly mentions that India is going through Amrit Kaal, an auspicious time to start important assignment in astrological parlance, for reasons like witnessing cultural resurgence, social transformation, assertive foreign policy, courage to take decisions, economic prosperity and our young population.

In view of above, Chemical engineers have vital role to play with regards to not only eco-friendly and safe manufacturing of HHCs but also for development of clean energy resources. IIChE-MRC continues to conduct and support many online & hybrid events in line with these objectives. I wish this issue of e-Newsletter with two contemporary articles proves beneficial to the member community to encourage them to collaborate and rededicate ourselves for a better world.

Wishing all our readers a happy, healthy, and wealthy 2023.

Prof. Aniruddha B. Pandit

EDITOR'S CORNER

Dear Readers, Greeting !

I am happy to share yet another issue of IIChE-MRC E-Newsletter with very contemporary and thought provoking two technical articles. It is my pleasure to present glimpses of recent events including Chemcon-2022, SChemcon-2022, Chemergence-2022 etc. The respective events are also available on website and U-tube. We would like to thank readers for their honest feedback on previous issues of E-Newsletter. Looking forward to your valuable comments and contributions.

Over the decades of reading, thinking, it is felt that one should not pay attention to only mysterious macro factors. For country or individual, decisions are not made only on macro factors which is normally not our control but based on basic fundamentals, our needs and our preferences. Green hydrogen is produced by powering an electrolyser using renewable electricity. The hydrogen thus obtained is burnt to manufacture carbon-free power. One of the present disadvantages is the higher cost of production of green hydrogen. As we progress, these costs are likely to come down. Transportation is another hindrance. The electrodes manufactured using scarce rare earth materials is yet another as it may be subjected to supply chain disruptions and higher costs. Government has announced an ambitious project of coming up with a green hydrogen train soon. Yes, Technology is advancing, and its scalability is also being addressed.

There is one more change happening in the automotive industry to attain carbon neutrality. India's carmakers have set the tone with the launch of quite a few battery electric vehicle (BEV). Alternate variant is plug-in hybrid electric vehicles, in which the battery can be charged through charging equipment. Additional variant is self-charging hybrid electric vehicles with flex-fuel having good blend of renewable fuel like ethanol. The vehicle can switch between the engine and battery, or both. The ideal case would be a BEV running on 100 per cent renewable energy.

Some carmaker that has shown its technological prowess in cars running on hydrogen. Carmaker claims that it not only just emits water but also performs like an air purifier - purifying air equivalent to 150 adults breathing in just one hour of driving. It also claims that the fuel cell system can be used not only in heavy trucks but also in passenger cars,. Because of major cost constraint, hydrogen currently is under commercial vehicle application.

In light of above, Chemical engineers have big role to play in repositioning of Chemical engineering itself. I take the opportunity to thank editorial team, advisory committee, Chairman IIChE-MRC and specifically Prof. Vinay Srivastava Sir for publication of the newsletter. Let us grow and evolve as we undertake this journey together in 2023.

Happy reading! Take Care, Stay Safe !!

Jagdish Nageshri
Editor, IICHE-MRC e-Newsletter

'Why we need the Circular Economy model in Chemical Engineering

- LALIT VASHISTA

A circular economy involves the sharing, reusing, repairing, refurbishing, redesigning, and recycling of materials and products for 'as long as possible' to reduce our use of the world's resources, cut down waste generation, and ultimately diminish carbon emissions.

The world may be progressing super-fast, but the pace has led to an extraordinary number of challenges: soaring inflation, geopolitical tensions, supply issues, climate change, and untenable resource consumption.

The last is something we all really need to do something about. For we have only one Mother Earth. A Bain and Company study reveals that humans are currently using the "equivalent of 1.75 times the earth's natural resources each year".

The Circularity Gap Report 2022 puts things into better perspective – the global use of materials has outstripped the growth of population in 50 years.

- Consumption was 28.6 billion tonnes in 1972
- It rose to 54.9 billion tonnes in 2000
- Consumption surpassed 100 billion tonnes in 2019

Continued…

ABOUT THE AUTHOR

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The company operates in the field of Wastewater and Effluent Treatment, Process Filtration, Solvent Dehydration by pervaporation, Precious Metal Catalyst Recovery, R&D Projects, Ultrasonication, Sonochemistry, Hot gas filtration and Membrane processing for Biologicals and Chemicals –Ceramic, Polymeric – RO/NF/UF and MF, MBR - mainly process applications

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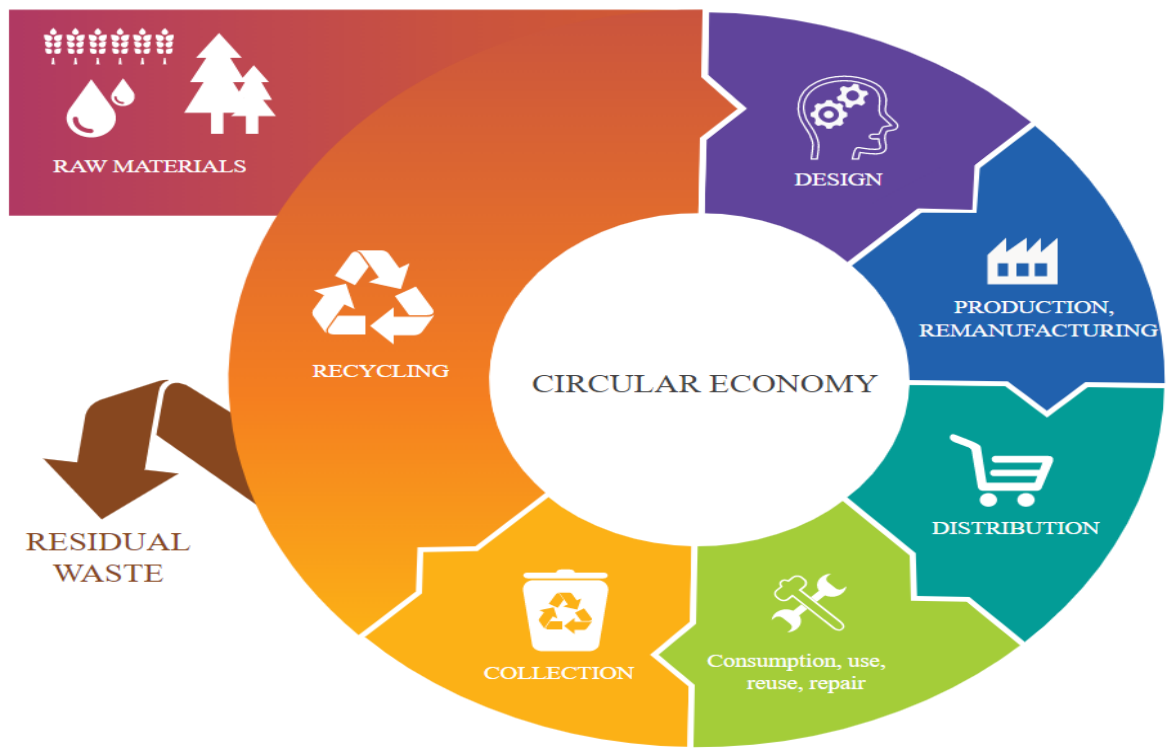

The Bain study offers further frightening statistics: "Our take-make-waste economy consumes 100 billion tonnes of materials a year and wastes over 90%."

"Rising waste levels are accompanying the rapid acceleration of consumption: ultimately, over 90% of all materials extracted and used are wasted. Or, on the flip side, only 8.6% make it back into our economy. And it's getting worse: in only two years, global circularity wilted from 9.1% in 2018 to 8.6% in 2020," it says.

What is the solution? Experts around the world are united in their answer: a circular economy.

As opposed to the linear economy model of production and consumption we have lived with so far, a circular economy involves the sharing, reusing, repairing, refurbishing, redesigning, and recycling of materials and products for "as long as possible".

This aims to reduce our use of the world's resources, cut down waste generation, and ultimately diminish carbon emissions. Also known as circularity, this way of life envisages decoupling economic growth from resource consumption.

Companies can work towards a circular economy in many ways: they can open the loop by conserving materials, using sharing economy platforms, offering products as a service, increasing the lifetime of a product by repair and reuse, and closing the loop by recycling.

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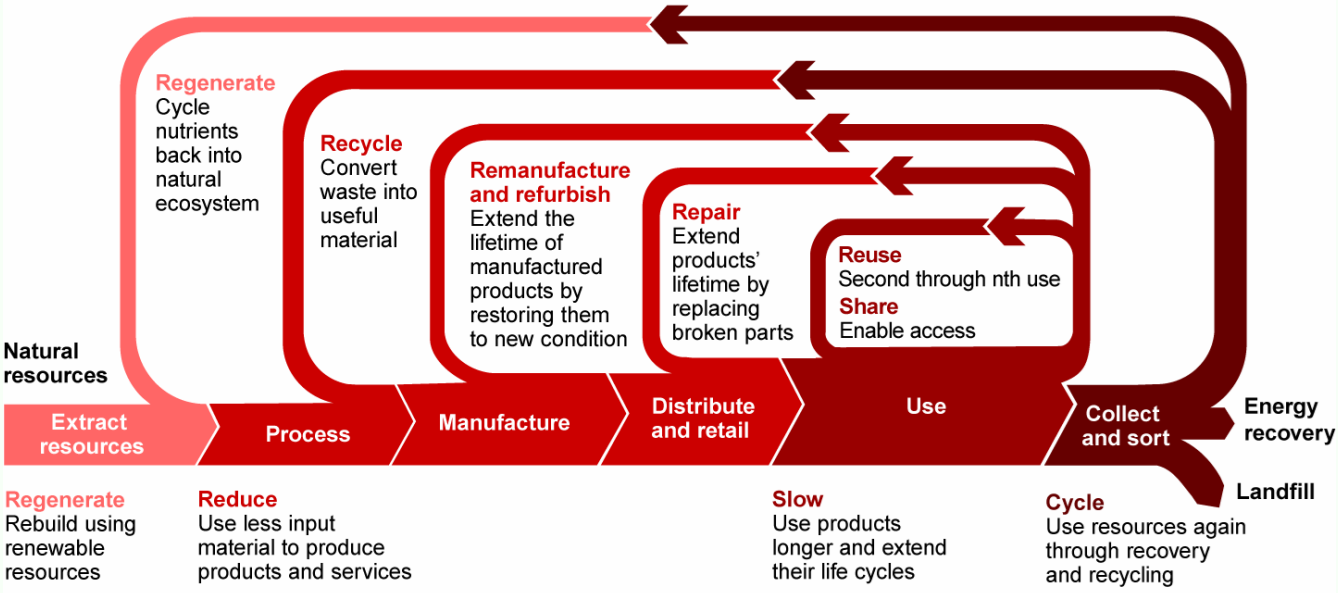
Circular opportunities across a product life cycle



Source: Bain & Company

The chemical engineering connection

Chemical engineering works with raw materials to ensure their transformation into final useful products. It manages flows and transformations of materials and energy in industrial plants. This is the engineering discipline used in all process industries, including chemicals, petrochemicals, energy, water, pharmaceuticals, food, and plastics. Materials provided by the industrial chemical sector are used in almost 95% of all manufactured products. The sector also plays a huge role in all kinds of recycling, be it mechanical, organic, or chemical, which further enmeshes it into the circular economy.

It is natural that the sector, which helps make materials and products more durable to extend their lives and reduce waste and demand for new products, must play a starring role in helping the world transition away from the unsustainable "take-make-use-waste" model to the "grow-make-use-restore" one.

In *Perspectives on circular economy in the context of chemical engineering and sustainable development*, a paper published on *Science Direct*, the authors write that the aim of the circular economy is to make "production processes more sustainable, maintain materials in a useful state in products for as long as possible, and avoid material losses, dissipation or hibernation, and emissions to the environment".

How can we get there? By making use of efficient technologies, effectual use of resources, and minimising waste/emissions.

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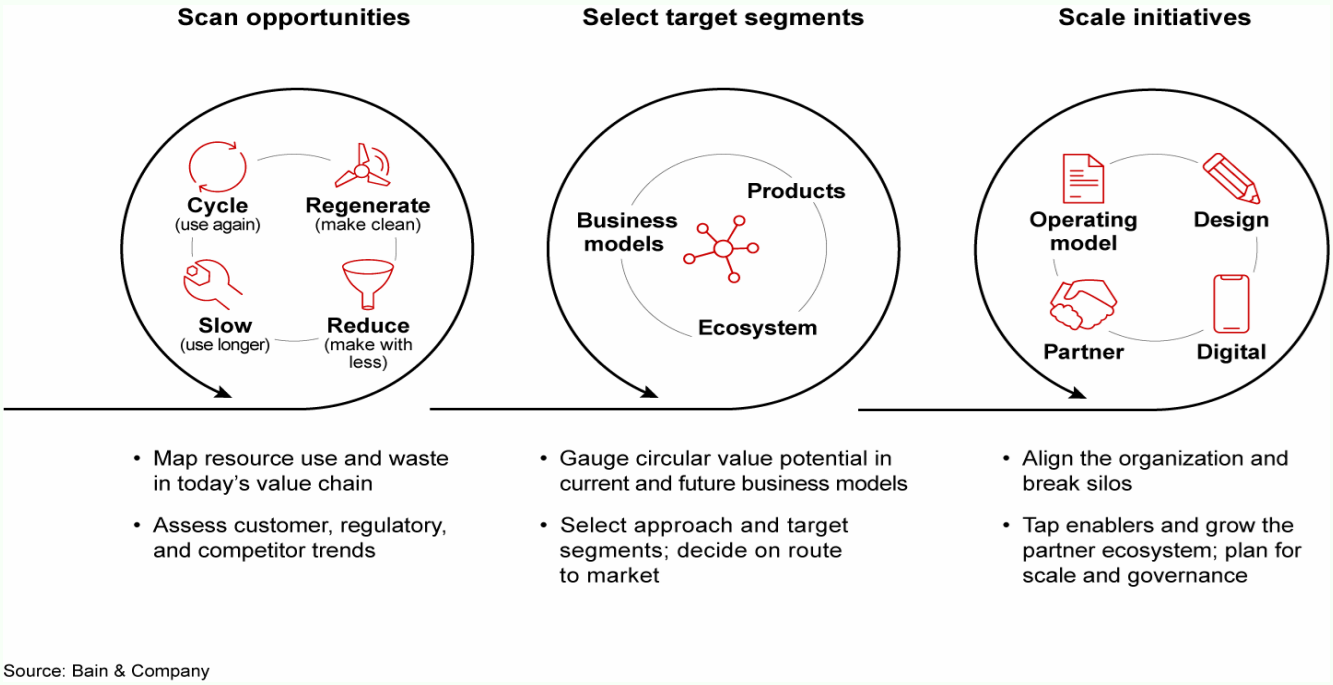

Source: Bain & Company

What can we do to achieve this? The paper puts forth a few pointers:

- Keep the circular loop in mind while designing processes and regenerative systems. This means minimising inputs, energy leaks, emissions, and waste, by narrowing and closing energy loops, by encouraging reusing, remanufacturing, refurbishing, and recycling.
- Convert waste streams into value-added products such as food, feed, bioenergy, and bio-based products. Select the best-in-class process technologies to cut consumption of water and energy.
- Promote the use of renewable sources and use strategies to increase efficiency and recycling of non-renewable resources.

The path ahead: Sector leaders and thinkers have responded to the challenges, with the chemical industry now rethinking and reworking models to bring change.

There is no fixed path to reaching a circular chemical economy. It will involve a network of innovators, businesses, companies, policymakers, financiers, and consumers, who come together with a new approach and work to meet circular economy targets. The collaboration will be key to creating and sustaining circular ecosystems, and stakeholders must keep the Triple Bottom Line - environment, economic, and social sustainability – in mind.

The time for everyone to work towards a circular economy is NOW. Early movers will gain substantial and strategic advantages and will be poised to disrupt industries and markets. World and business leaders believe that companies with pioneering experience in circularity will be in strong position to meet customer needs sustainably.

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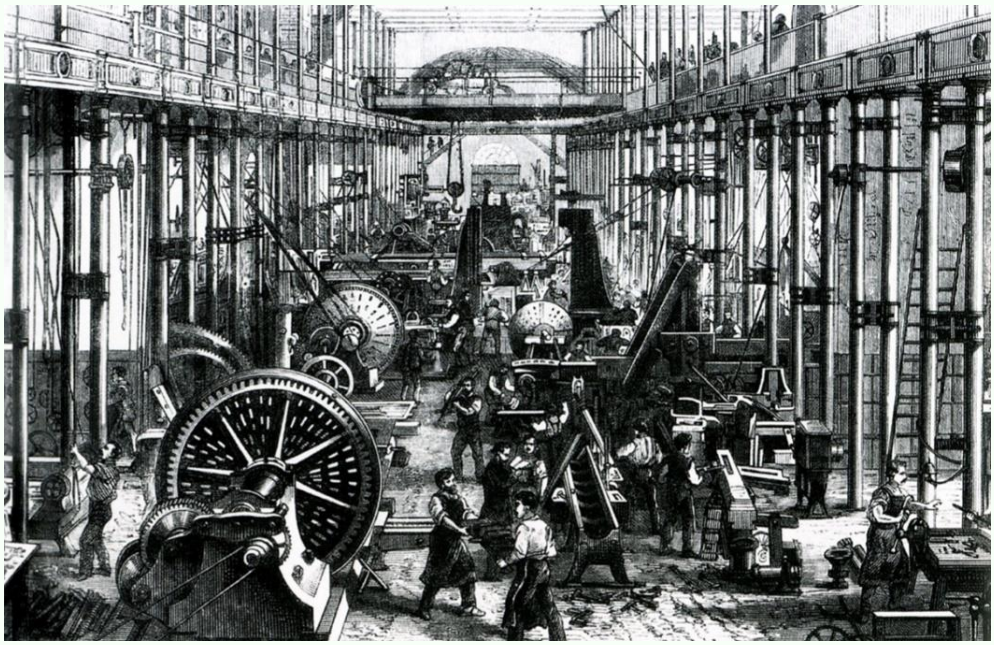
Progress & Nature

- PROF. ANIRUDDHA B. PANDIT

Industrial Revolution marks a key step in the definition of progress, where the machines did the work of animals (including humans), reducing physical efforts. In fact, the development of tools was the first step in that direction, followed by mass or large-scale production of tools and then the arrangement, organization and functioning of these tools, sequentially or simultaneously, termed as Machines. Industrial revolution started, when machines were made on a large scale, concentrated at any one location, resulting into factories or industries. The concentration of these activities at anyone location coincided with a significant change in the local environment, due to the usage of energy and water and the discharge of gaseous and aqueous effluents along with the collection of wasteful solid discard. The scientific community is in near consensus about the climate change and people of my generation has experienced it in their own lifetime. These experiences are becoming severe and more intense in nature and too frequent to be ignored as one-off anymore.

The question, to be posed to the scientific community, is how long could it go on? What can bring about the paradigm shift in the thinking. How long, this so-called progress & growth can continue? What are the limits of growth i.e., population and resources. The first articulation of growth (in population) can be attributed to Reverend Thomas Malthus, who talked about the difference in the growth patterns i.e., Geometric for population and linear in food resources, predicting 'doomsday' where population growth will overtake the growth rate in the food resources.



A Typical factory and machinery and equipment.

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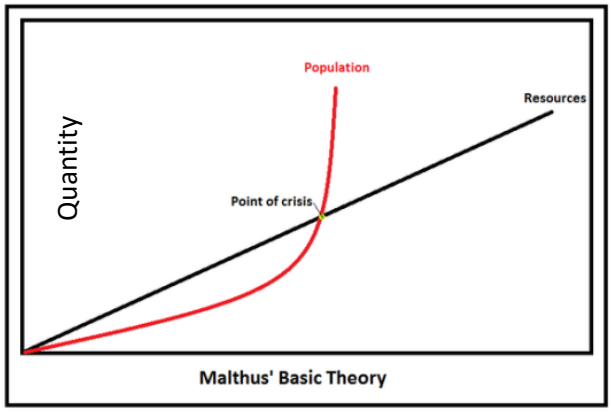
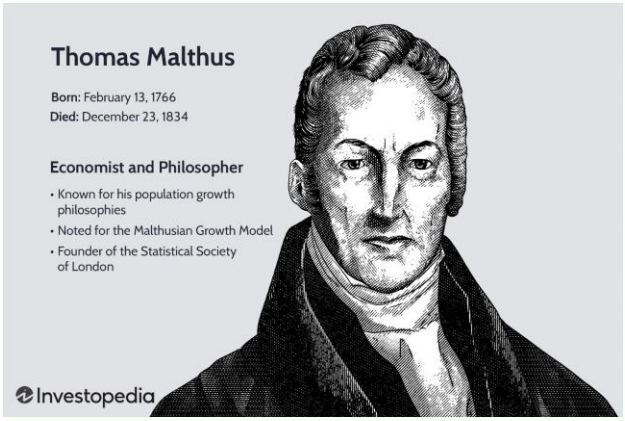


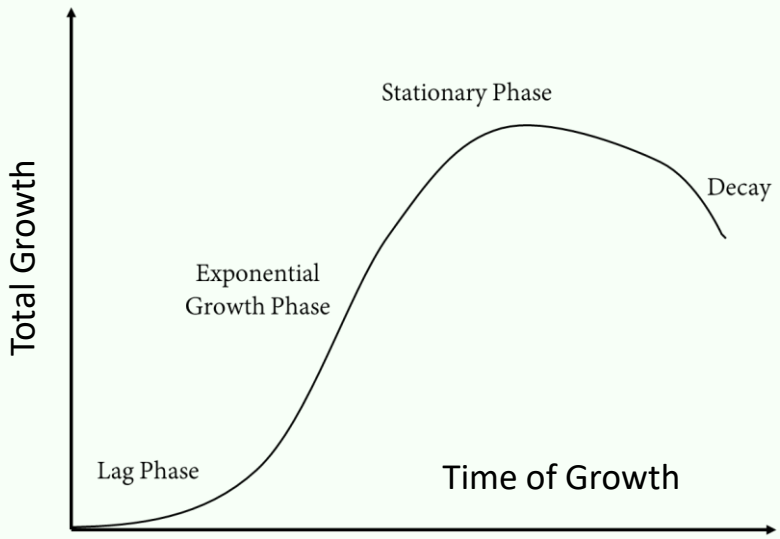


Malthus Basic Theory

This has not happened so far; thanks are due to the scientists and their innovations leading to Engineers & machines and industries staying ahead of the population growth curve.

These growth in the materials usage (resources) require two key inputs i) Energy and ii) water. The former is theoretically unlimited, considering solar energy & its manifestations in different form such non-renewable (long term renewable) and renewable (Biomass, Wind, Tidal, Direct Solar etc.), however the water, though available in plenty on our planet, the directly usable is only 0.3% of the total. To convert non-usable saline water into usable water, once again needs Energy.

The application of the geometric on exponential growth pattern to all the resources, which has been observed since the last five decades, however, conveys an apocalyptic end to the human civilization, which is consistent with any of a typical biological cycle or 'S' curve, lag phase, exponential growth phase, stationary phase, and decay or destruction.



Typical Biological Cycle

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It is not exceedingly difficult to understand this similarity, if we accept the hypothesis, that our planet like all others is a living entity and is expected to follow the same pattern. Thus, the modern-day questions and challenges faced by the humanity are simple in terms of progress.

i) Is this limitless growth, possible? Does it violate the principle of second Law of thermodynamics? And
ii) What are the ecological impacts of these exponentially growing Anthropogenic Activities, in simple words termed as, "Climate change"

I will try to answer the first question with all its reasoning, logic, mathematical models etc., while briefly touching about the second question of Climate Change occasionally.

The first hypothesis, which we can arrive, when we look at the second Law of Thermodynamics is,

"If disorderly available (highest state of Entropy) resources are used to make / convert them into orderly organized material (Products sold in the market), the degree of disorder in the remaining unexploited / not used resources (environment) must increase."

This increased disorder in the environment manifest itself into extreme natural events such as excess/heavy local rains, draught in other places, extreme temperature variations, earthquakes etc. This is the hypothesis proposed here, which is consistent with the second Law of Thermodynamics of Entropy maximization.

To quantitatively validate this hypothesis, we need the following information.

a) Quantitative data covering spatio-temporal variation over the scale of the planet itself.
b) Comprehensive mathematical models, phenomenological to start with & then data driven when sufficient data is available as these models are mathematically extremely complex.

The question, which requires an immediate answer is whether this change will be catastrophic, or it would be gradual? Again, with the hypothesis of our planet being a living entity, we can refer to the 'S' shape curve. Living entity with the realization of the limiting resources starts adapting to the changing environment as it tries to hit a balance between growth & sustainability.

This is the same debate, which is being discussed and elaborated in this article.

So, what is a sustainable progress?

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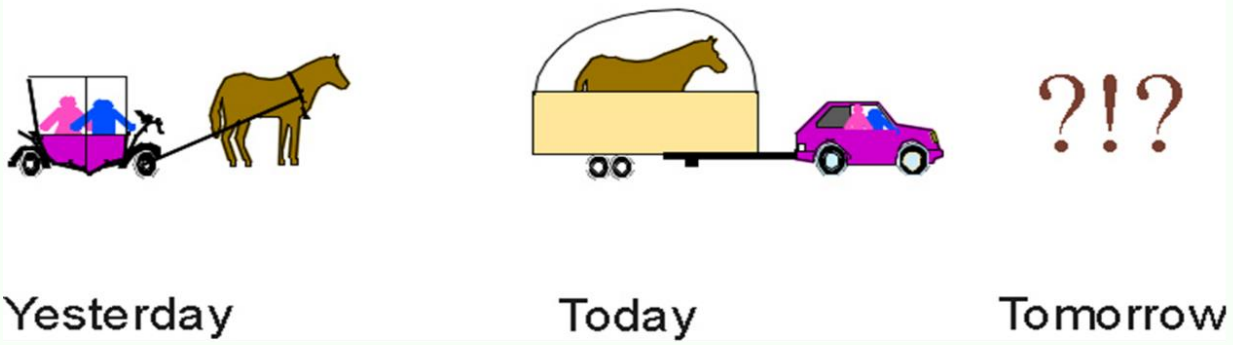
Technology for Sustainability

What is Sustainable Progress?

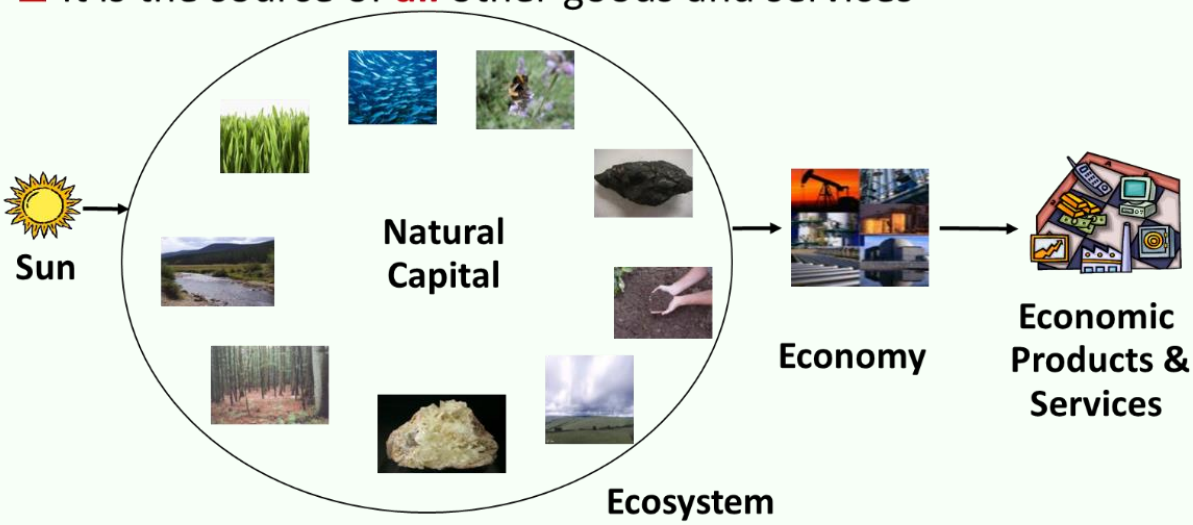


- **Can technology lead to sustainability?**

Courtesy of Dr. Steven Doherty, Slippery Rock Univ., PA

Sustainability and Natural Capital

- Availability of ecosystem goods and services (Natural Capital) is essential for sustainability
- It is the source of **all** other goods and services



Sustainable Progress and Natural Capital

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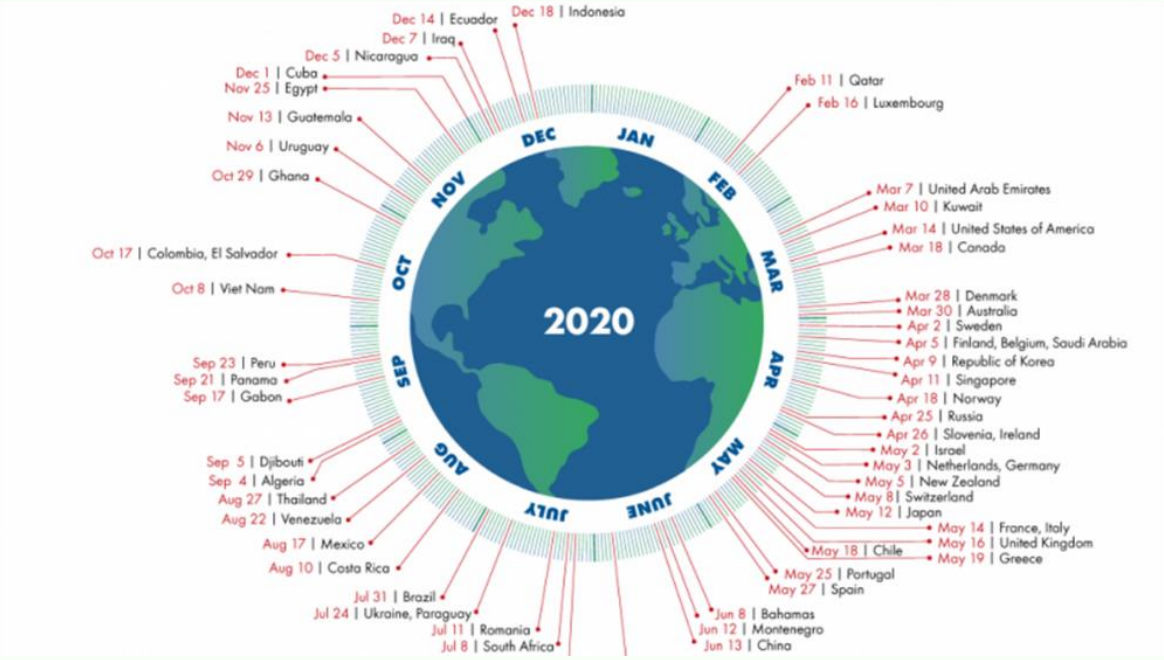
Earth Overshoot Day

India 22nd August2021, World 29th July 2021



Earth Overshoot Day

Is Progress as defined by the economist in terms of 'GDP' growth sustainable? To answer this question, I will put one Figure in front of you. Here we define "Earth Overshoot Day".

The figure shows the overshoot day of different countries in the world. It is defined as the day, when we have utilized all the possible renewable resources, which can be renewed in a matter of one calendar year based on the land mass occupied by that country. If you see the countries, whose economy relies totally on fossil fuels (Gulf Countries), the overshoot day is in the month of January itself, whereas, the countries, which are agriculturally dominated & have a large forest cover, show overshoot day in the month of December, indicating the sustainable leaving. Invariably one can see the developed countries have an overshoot day much earlier whereas the developing or less industrialized countries show the overshoot day much later in the year. Country like India lies somewhere, in between. It Clearly indicates that developed countries are "borrowing resources from future" risking the sustainability of the coming generation.

So, how much from future can we afford to borrow from and does the future generation (not born yet) has any say in our rate of resource consumption?

Unfortunately, there is no single answer to this question, and it depends on, who do you put this question to

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If you ask individuals, the following answers are expected.

a)	Poor and Marginal:	Today at the most tomorrow
b)	Medium Income:	Self and children, maximum one generation
c)	Rich:	Self, children & may be 5 to 10 generations

If you put the same question to an 'Enterprise', again the answers will vary

a)	CEO:	"One quarter" must show the progress
b)	Company Board:	Their appointment term 3 to 5 years
c)	Government:	Till the next election

Thus, with multiple time spans of sustainability defined as above, who is thinking of 500 and 1000 years in future? If you see the lifespan of any kingdom it has varied from 50 to 200 years, thus it is safe to assume at this stage, that 100 to 150 years is the period of sustainability, we should be considering in our assessment.

Thus, whatever anthropogenic activities which we undertake or practice needs to look over at least 100-year horizon to arrive and decide sustainable practices. There have been organizations and enterprises in India, who has run sustainably (without naming any) over the past one hundred years, but the constraints faced by them to sustain for the next one hundred years are significantly different. It is nice to see and notice that the younger generation, is very serious and is using all the modern tools to make the enterprise sustainable.

What are the modern tools to assess the sustainability of an activity / product & also the enterprise involved in the same?

The following tools, which are quantitative in nature and thermodynamically consistent, can be adapted.

The proposed method is called as 'LEEF', full form '**L**CA (Life Cycle Analysis) **E**mergy analysis and **E**cological **F**ootprint (LEEF)'.

This is a very comprehensive method. It is necessary to understand the definition of these terms and how they are used in practice.

The next part of the article shows and elaborates the method of 'LEEF' implementation with an example. LCA stands for Life Cycle Analysis. This involves a comprehensive estimation of resources used to conduct an activity and / or to make a product arising out of this activity.

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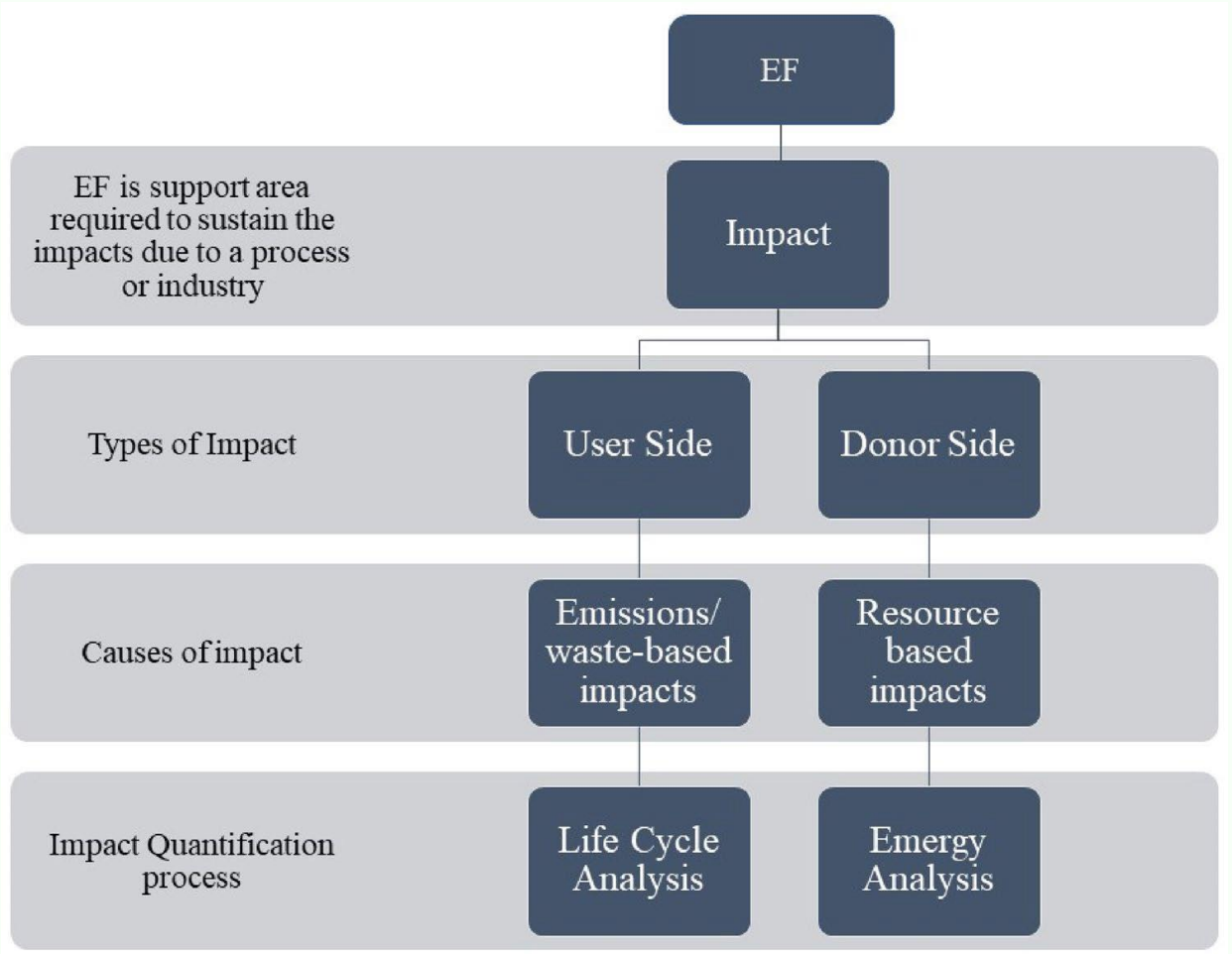

Flowchart explaining approach while calculating ecological footprint in proposed methodology (LEEF)

'LCA' can be performed over well-defined boundary i.e., limited to the Enterprise or industry location or also to include the resources arriving from distant places at that location, transportation of the same and then, the transport of the product to the consumer. The industry specific LCA includes, material Energy balance, the quality of energy used (classified as Exergy, discuss briefly) to conduct the activity and the final product obtained. If the boundary of LCA is limited to the industry, then what happens to the product, once it moves away from the predefined location (industry location) is not generally included. These look & gives guidelines related to the optimization & minimization of resources including energy to make this activity profitable to the enterprise on industry.

Obviously, this type of industry specific 'LCA' does not give any indication & directions towards Global sustainability of this activity. For the later to be assessed, one is required to enlarge the boundary of the analysis and go beyond the industry location.

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One can easily understand and imagine that expanding system boundary makes the analysis more complex and the data requirement is not limited to the industrial location but also the (i) locations of the various resources used, (ii) their transportation and the resources used for that transportation, (iii) the movement of the product to the consumers & the resources used for the same and finally after the product has been used (exhaustion of the product life), (iv) what happens to the remnant of the product. This technique is termed as “Cradle to Grave” (Birth till Death) approach. As you can see from the above, significantly larger amount of quantitative data is required and in the absence of the same the conclusions could be misguided or ambiguous and in worst case erroneous.

This is where “Emergy” & “Ecological Foot-Print” inclusion tries to remove this ambiguity and brings in a degree of certainty. Considering the fact that the ultimate source of energy is solar radiations, its different forms in terms of “solar Energy Equivalent Joules” used for every activity is estimated and accounted for such as use of solar Electricity with 15% energy conversion, Biomass with 0.3% conversion, fossil fuel with significantly higher amount of Solar energy equivalent Joules puts all the activities on a common footing.

Table below shows the Solar Equivalent Energy in Joules used for different energy forms used in performing any industrial or anthropological activity.

Sr. No.	Item	Raw data	Solar Transformation (SEJ/year)
Renewable Resources			
1	Sunlight	J/year	1
2	Wind, kinetic energy	J/year	1.5×10^3
3	Rain, Geopotential	J/year	1.04×10^4
4	Rain, Chemical	J/year	1.82×10^4
5	Water taken from local river	J/year	3.72×10^4
Non - Renewable resources			
1	Net topsoil	J/year	7.40×10^4
2	Soil	J/year	1×10^4
3	Water used by Cement	J/year	3.72×10^4

Energy Evaluation

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One can see from the table, this accounts for every form of energy and resource and on an average 1 x 10^6 Joules of solar incident energy results into approximately 10 Joules of usable form of energy.

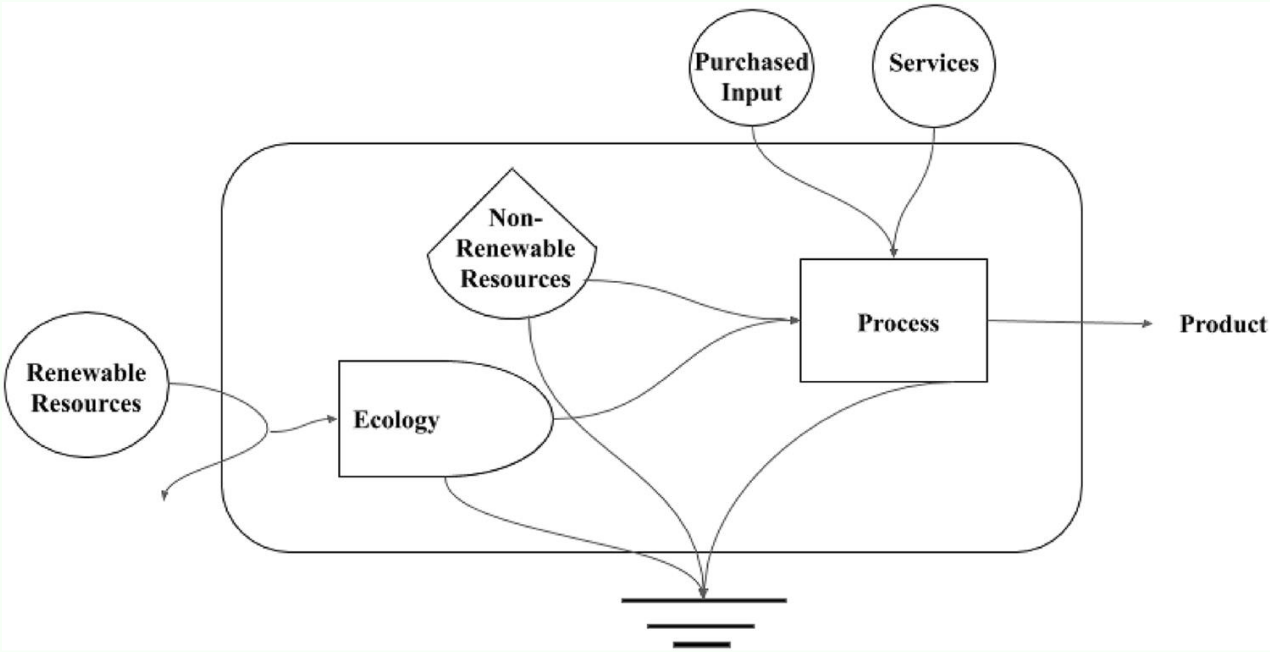
Methodology to be adapted for the estimation of Emergy Analysis resulting into estimation of the ecological foot-forint.

The steps involved are as follows

a) Selection of system boundary & estimation of Life Cycle inventory (LCI) by incorporating renewable energy flows from eco-system & other economic flows like labor, machinery etc.
b) Categorization of inputs into renewable, non-renewable, and purchased inputs
c) Emergy diagram as indicated in figure below
d) Collection of Unit Emergy Values
e) Total emergy input estimation
f) Estimation of Emergy indices

The Global Emergy baseline includes total annual emergy input, which includes total geo-biosphere, having solar radiation, tidal energy & deep earth heat input expressed in solar equivalence. Brown & Ulgiati (1997), introduced a Set of indices linking Emergy indices to sustainability. Only economically viable process cannot be considered as sustainable.

Optimum solution thus indicates economic efficiency, low use of non-renewable sources & minimum load on the environment.



Emergy Flow Diagram

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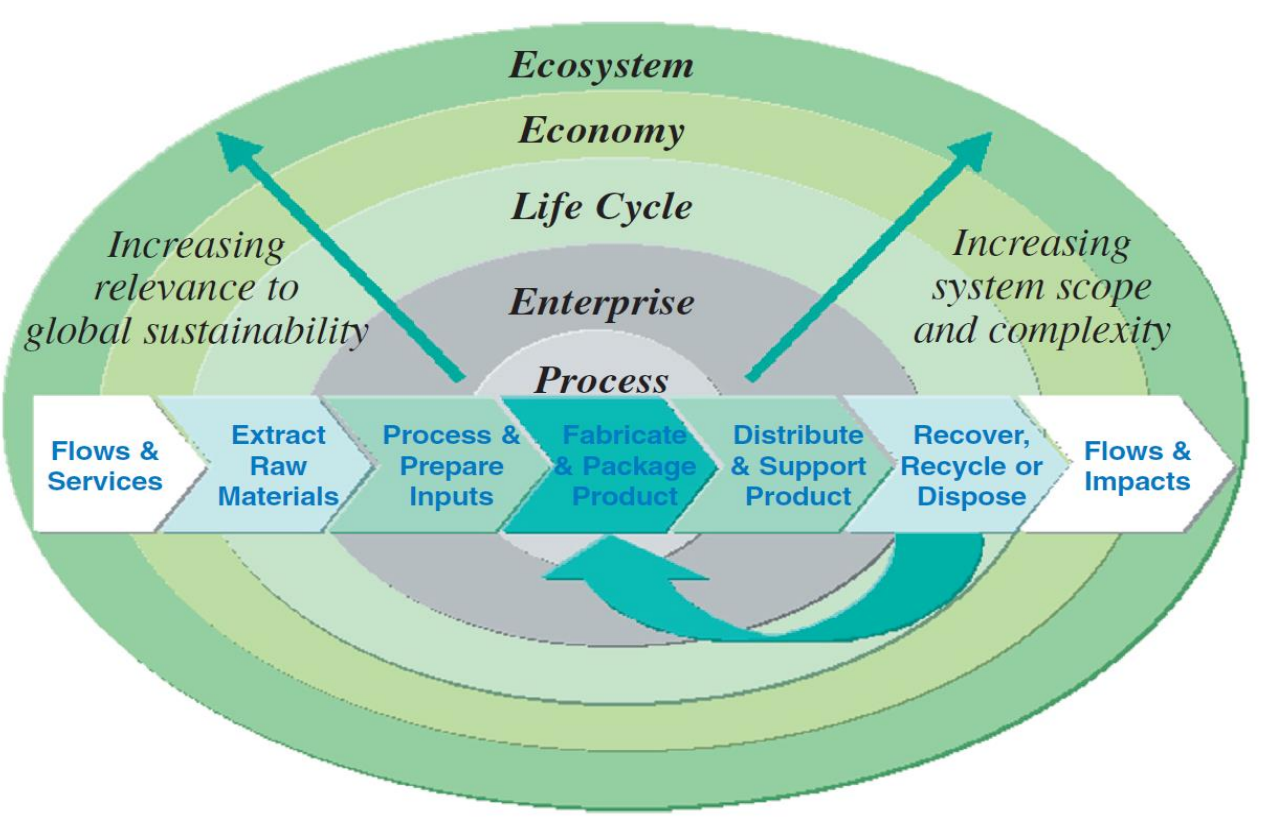
Estimation of Ecological Footprint:

It accounts for the provisioning of the resources consumed in the process and assimilation of waste and emissions generated by the process in terms of Biological Productive land. LCI, Life Cycle Inventory or compound method is used to assess the ecological footprint of a process/product for the industry location, region, or nation whereas LEEF uses component methodology. Both are essential to assess the Global impact, deciding the Global sustainability of the process or the product, which has a different time horizon.

Example of Sustainability Analysis: We start this sustainability analysis by first defining system boundaries. Each successive oval encompasses a broader set of life cycle steps. Gray areas represent existing Process System Engineering (PSE) techniques. Green ovals represent new frontiers for PSE.

As we can see from the figure, that as we keep expanding the system boundary, the complexity of analysis increases and the required data to meaningfully develops predictive models exponentially goes up. The uncertainty associated with the prediction increases. Socially this leads to controversial decision in terms of national policy and frequent changes & rectifications are required, which aggravates the matter further. This is where AI or artificial learning or neural network “emulating the working of brains” comes to our rescue.



Hierarchy of sustainable process systems engineering.

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Process System Engineering (PSE) is defined here looks at the phenomena and the possible interactions between the various phenomena and their interplay leading to more robust and reliable predictions.

The figure indicates the logical steps to be taken incorporating economic and ecological considerations & its impact and possibilities of minimizing the same through connective actions.

Accounting of responses can be done in a manner which not only considers the absolute value of the energy but also the quality of energy, termed as Exergy

- Is a twinkie equivalent to two medium sized bananas?
- Both have equal energy content, but
  - Quality of their energy is different
  - They are not substitutable
- Need to consider quality and substitutability of resources before aggregation or comparison
- A joule each of sunlight, wood, coal, oil and electrical energy are very different
- Exergy value
  - They should not be added without quality correction

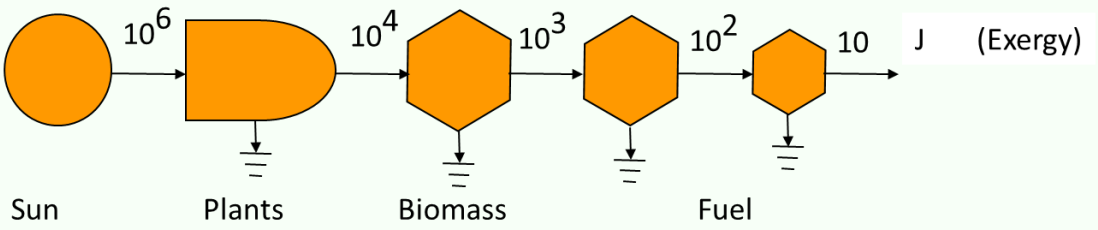
Twinkie and Banana.

This clearly indicates that the type of energy must be accounted for while doing the balance. On an average the incident solar energy by the time it is put to use reduce by six orders of magnitude when used in the form of fossil fuel & hence it is imperative to use energy of an appropriate form to derive maximum benefit & efficiency leading to it sustainable way, leading to least destruction of exergy as it is the final limiting parameter.

Continued…

Resource Accounting in Eco - LCA

- May account for quality and substitutability by considering life cycle of resource
- 10 J of fuel is equivalent to 10^6 joules of sunlight
- Must consider exergy flow in industrial and ecological systems
- Adopted by Ecological Cumulative Exergy Consumption (ECEC) analysis



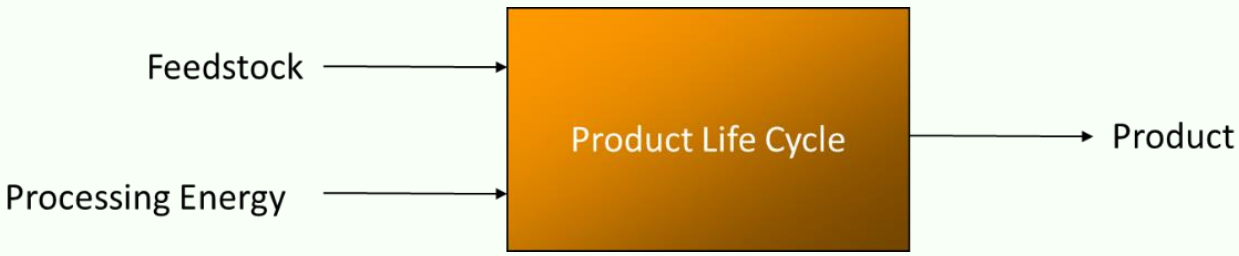
Energy required to convert raw materials into product

Odum, 1996; Hau & Bakshi, 2004

Here EROI: Energy Return on Investment can be used to assess the sustainability of the conversion process. It is simply defined as,

$$EROI = \frac{\text{Energy in the Product}}{\text{Processing energy}}$$

If the above value is greater than one, the conversion processes are sustainable & higher the value, better it is.



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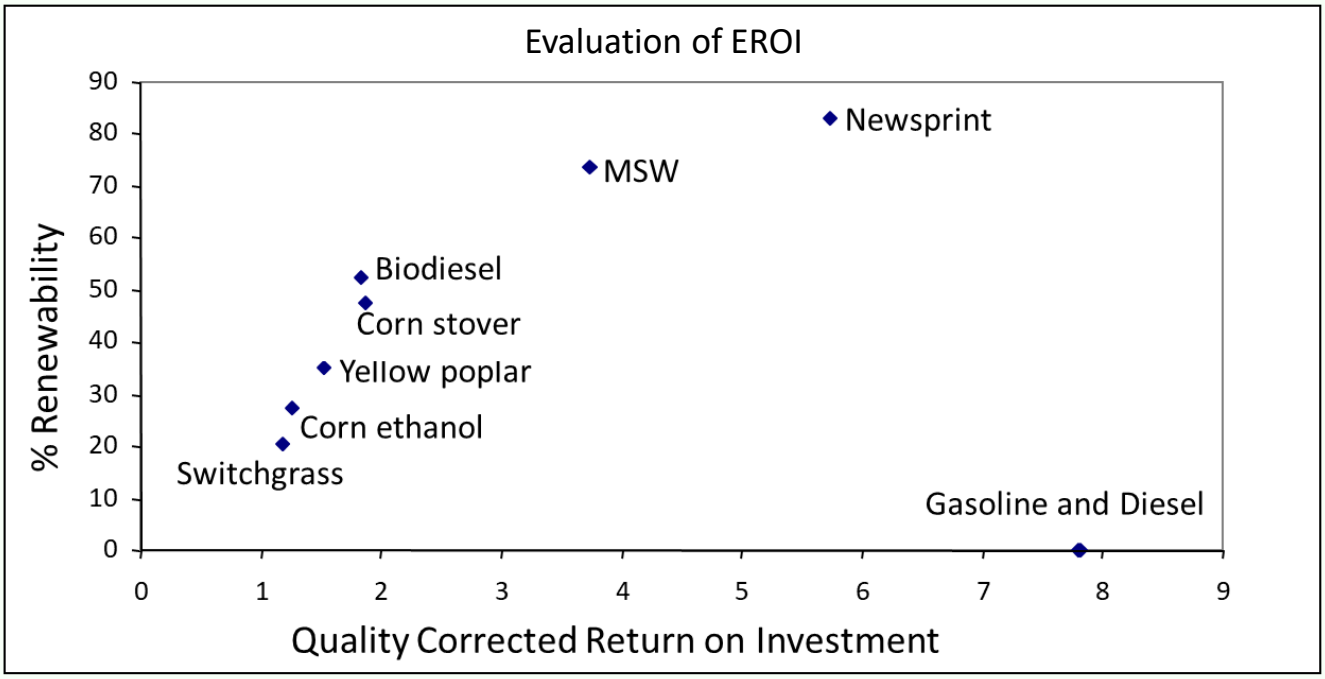


If one looks at all the natural processes employed by microbes using a variety of enzymes, we can conclude that all the natural processes are sustainable and hence need to be adapted in our regular practice whenever applicable, possible, and feasible. A simple example of cultivating and growing biomass, as a fuel, it is better to allow it grow naturally, rather than having farms (especially mechanized energy farms) cultivating these.

So, the question, we must ask ourselves is “Can we replicate natural systems”.

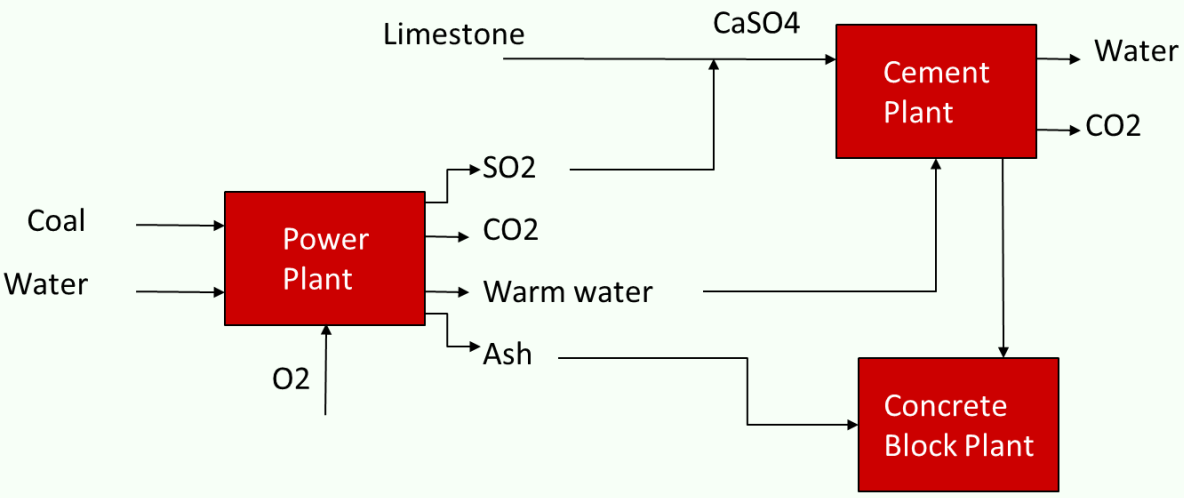
The answer to the above question is a definite yes. It is not easy though, some processes can be easily mimicked (replicated) for example the "Ant Colony", which is self-sufficient & completely balanced, Global elemental cycles of carbon, sulfur, phosphorus, nitrogen etc. and also the hydrological cycles.

Over exploitation and hurry in implementation leads to the disturbance in these ecologically sensitive cycles and hence before we embark on any new anthropological activity the Life-Cycle analysis and sustainability assessment is must. The more we move away from nature and our lifestyle becomes more synthetic & un-natural, more un-sustainable it is.

I am concluding this article with the final 2/3 figures. First Fig shows a network of Industrial system, where the products and emissions are used as a resource to make another product, but all are synthetic in nature.

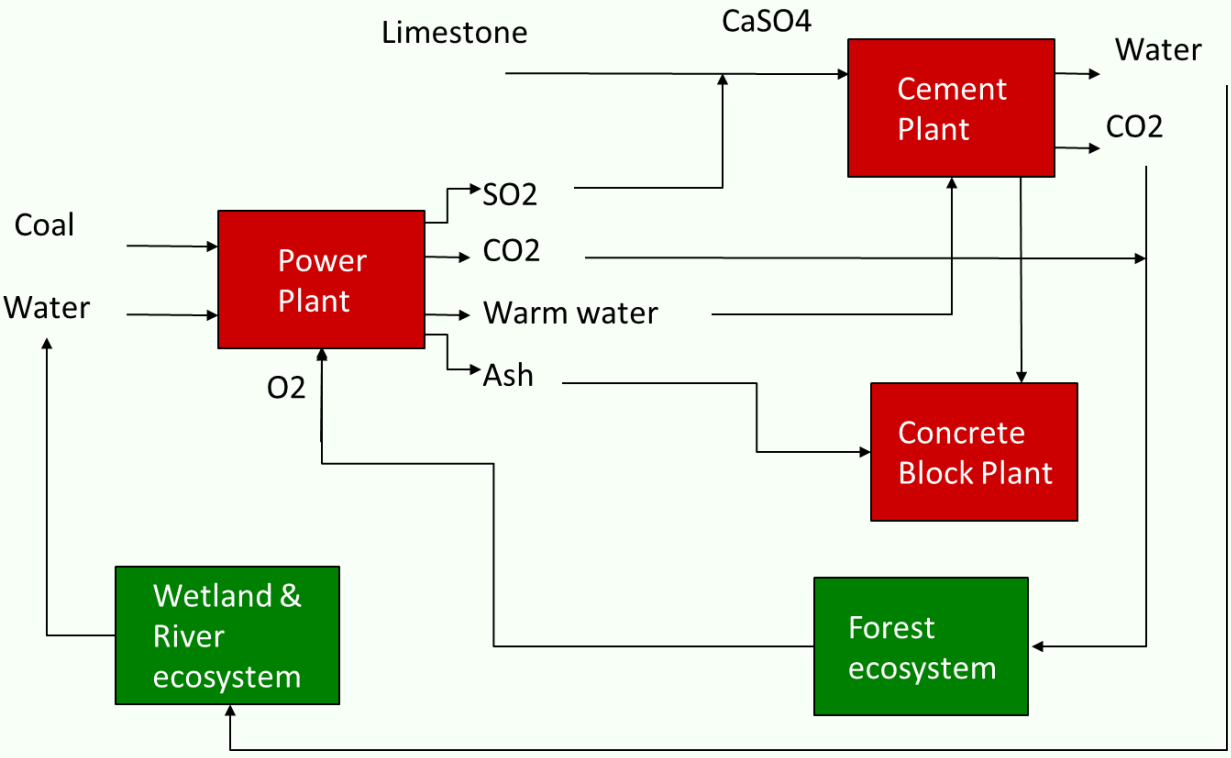
Continued…

Network of Industrial Systems



- **Will such efforts for "sustainable business decision making" lead to global sustainability?**

Network of Industrial – Ecological Systems (NIES)



Industrial-Ecological Networks

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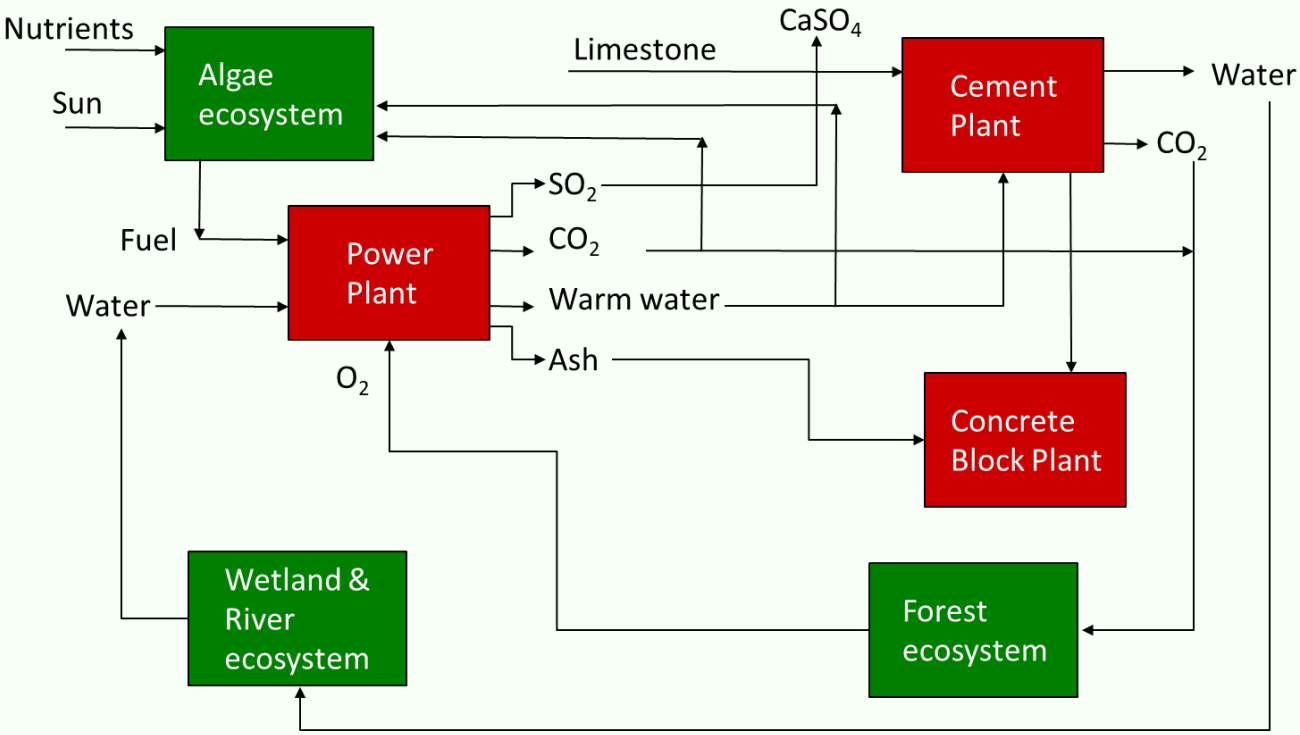
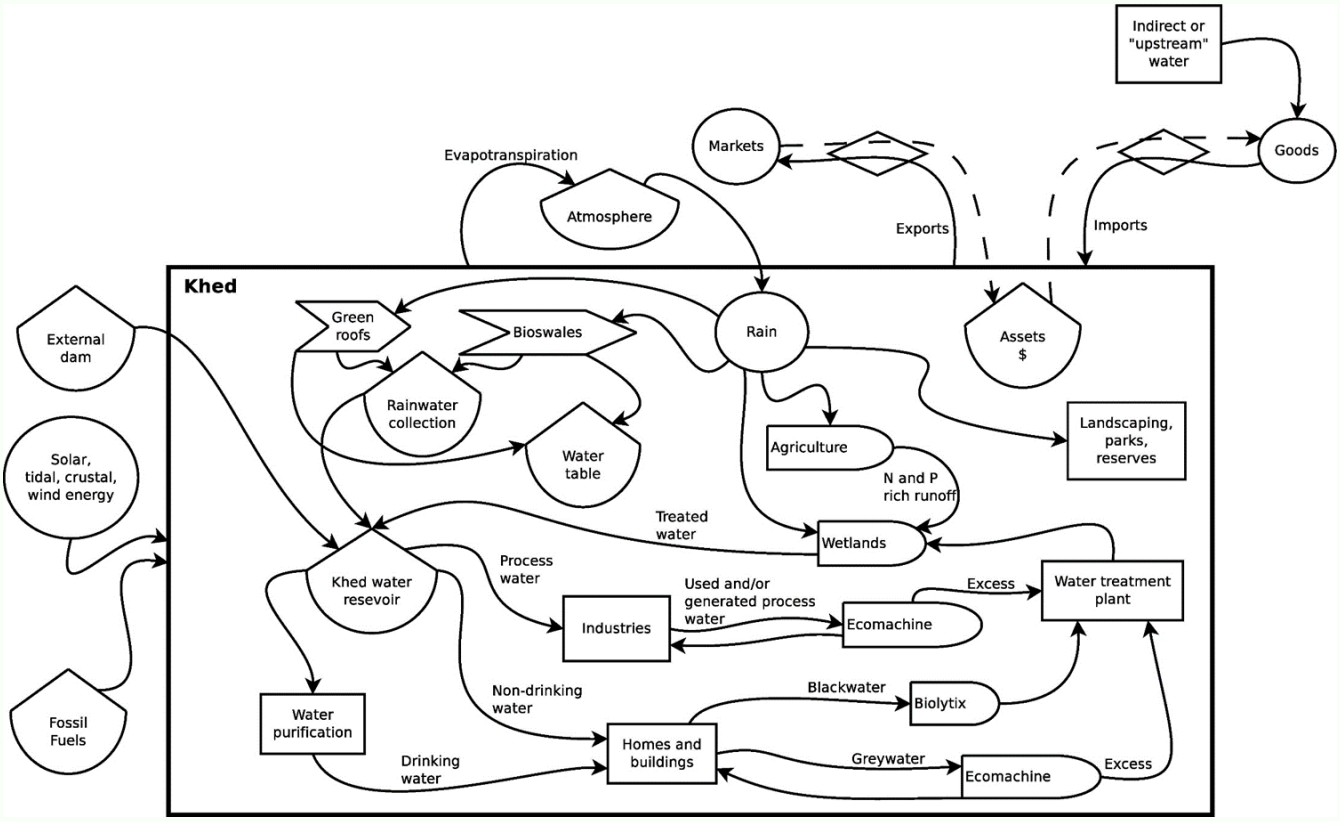


The next figure shows how some of the emissions can be used to support already existing natural and ecologically sustainable systems, leading again to aiding or complimenting the natural processes leading to a sustainable product manufacturing



Continued…

Yet, this is not always an easily possible depending of course on the product being made, as is shown in the last figure. The complexity associated with this “Network of Industrial Ecological System” NIES, is the challenge which requires tackling.

Thus, finally, we can say the following "Emulating Ecological Systems may lead to sustainability. Network of Industrial Ecological System 'NIES' is the possible path forward.

****

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2. Laxmi A. Zadgaonkar, Sachin A. Mandavgane, Framework for calculating ecological footprint of process industries in local hectares using emergy and LCA approach, October 2020, 2207–2221, Clean Technologies and Environmental Policy, Springer.

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ABOUT THE AUTHOR

Prof. Aniruddha B. Pandit earned his B. Tech degree from Institute of Technology, Banaras Hindu University in 1980 and joined for his Ph.D. (Tech) degree in UDCT (now UICT), under the guidance of Prof. J. B. Joshi. From 1984 till 1990 he worked in University of Cambridge, United Kingdom as a Research Associate with Prof. J. F. Davidson. He has developed many novel designs of gas-liquid contactors and also developed new impeller designs.

After returning to India in 1990, he joined UICT and was instrumental in starting a program in the area of Hydrodynamic Cavitation. His involvement in the ICT ENERGY group has resulted into many energy efficient patented processes for cooking, solar steam generation and mathematical modelling of smokeless Solid Fuel Stoves. In addition to his research contribution, Prof. Pandit has contributed to innovation in teaching the physical principles of chemical engineering operations.

He is actively involved in the area of harnessing solar energy and with tribal population in extending the chemical engineering principles for drying of farm / forest product & water disinfection for potable water. He is currently involved in setting up ICT-DAE Center for Chemical Engineering Education and Research to exploit the principles of chemical engineering in nuclear and allied energy engineering technologies.

IIChE Recent Events at a Glance

Glimpses of CHEMCON 2022

Harcourt Butler Technical University, Kanpur
December 27th to 30th, 2022

Chemical Engineering Congress &
75th Annual Session of Indian Institute of Chemical Engineers

Sustainability in chemical processes
through Digitalization, Artificial Intelligence and Green Chemistry

Continued …

Glimpses of CHEMCON 2022

Indian Institute of Chemical Engineers (IIChE) was instituted on 18th May, 1947 on the eve of the Indian Independence. Dr. Hira Lal Roy, the great visionary and pioneer of Chemical Engineering Education in India, along with few other senior colleagues felt the need for a platform to spread education of Chemical Engineering in India. Self-reliant and confident India will eventually ensure a sustained movement of Chemical Engineering profession through academic excellence, research, development, and industrial revolution.

Today with around 30,000 members on its roll, Institute has emerged as the apex body of Chemical Engineering Professionals in India. The activities of the Institute are spread across the country through its 42 Regional Centers and more than 168 student chapters. The Regional Centers promote and complement the activities and objectives of the Institute – within their respective territorial limits by organizing seminars, conferences, workshops, refresher courses, counseling sessions, and guiding career planning etc. The institute is recognized by the Department of Science & Technology, Govt of India as a Scientific and Industrial Research Organization and has 150 organizational members.

Ever since its foundation, the mission of IIChE has been to contribute to the Nation building through dissemination of knowledge and enhancement of skill in the field of Chemical Engineering and its allied areas. In spite of a challenging path, IIChE has been always steadfast in its role. Today the Organization has emerged as a premier professional platform for Chemical Engineering Education and Profession in India, having a Pan India outreach. IIChE spreads the message and movement of Chemical Engineering by conducting classes and conferences throughout the year at regular interval.

However, its annual event which is known as Chemical Engineering Congress (CHEMCON) stands out tall owing to its wide reach across National and International forum. CHEMCON provides an opportunity for all senior students of Chemical Engineering, research scholars, professors, industry experts to come together ensuring four days of intensive interface of knowledge and experience. These exchanges of thoughts and theories help all delegates to constantly update and equip themselves in a fast-changing scenario which calls for research and development in Chemical Engineering applications.

CHEMCON 2022 was 75th Annual Session of IIChE and was organized by Kanpur Regional Centre. CHEMCON 2022 has presented a host of events, like memorial lectures, plenary lectures, seminars, panel discussions, international symposium, industrial exhibitions etc.

Continued …

Glimpses of CHEMCON 2022

Inaugural Ceremony

Release of Souvenir

Address by Chief Guest Shri Yogi Adityanath

Address by Chief Guest, Shri Yogi Adityanath, Chief Minister of Uttar Pradesh: Inaugural Ceremony of CHEMCON 2022@HBTU, Kanpur

Shri Dhirubhai Ambani Commemoration day

Shri Dhirubhai Ambani Commemoration Day Celebration on 28th December 2022 during CHEMCON 2022

Continued ...

Glimpses of CHEMCON 2022

Dr Nadir Godrej with guests above and delivering HL Roy Memorial lecture.

Glimpses of S-CHEMCON 2022

Students' Chemical Engineering Congress (SCHEMCON), is an annual event organized by the Institutes having Students' Chapter of Indian Institute of Chemical Engineers (IIChE) under one of its Regional Centres. Chemical engineers interested in innovation and professional growth will meet with academic and industry experts to cover wide range of topics relevant to cutting-edge research, new technologies, and emerging growth areas in chemical engineering. It provides a platform for the Chemical Engineering Students to interact, learn and gain exposure to the expanding arena of Chemical Engineering.

Continued ...

Glimpses of S-CHEMCON 2022

Glimpses of ChEMERGENCE 2022

The student chapter of IIChE-TSEC provides a platform to nurture and display talents of students from across the country, through its annual event ChEMERGENCE. ChEMERGENCE, since its inception in 2007, has grown leaps and bounds to become one of the biggest student run festivals in the engineering arena. With events covering almost every aspect of Chemical Engineering and Applied Chemistry, ChEMERGENCE grows bigger and better every year, gaining popularity exponentially and hosting participants from all corners of the nation.

Glimpses of ChEMERGENCE 2022

Chemic-con Event

Closing Ceremony

IIChE Recent Events at a Glance

One day International Symposium on 'Sustainability through Technology' (Environment & Energy) was organized by UPL University on 26 September 2022 to bring the various professionals, researchers, and academicians working in the field of Environment & Energy on a common platform. The plenary lecture on Exergy analysis was delivered by the chief guest of the symposium, Dr. Aniruddha Pandit, Vice Chancellor, ICT, Mumbai, UGC Professor. University president, Shri Ashok Panjwani inaugurated the symposium with the lighting of the lamp. Other sessions were delivered by eminent experts including Dr. N. K. Verma, Dr. Vivek Dua, Shri Deepak Gadhia, Dr. Sanjay Patil, and Shri Prasad Gangavkar. This symposium provided a platform to exchange knowledge about the latest scientific trends and developments in the area of Environment and Energy.

IIChE Recent Events at a Glance

MOU between IICHE and SCE, Japan

CHEMCON 2022: MoU signing between Indian Institute of Chmical Engineers (IIChE) and Society of Chemical Engineers, Japan (SCEJ)

IICHE Executives with Lt. Governor of J&K.

Meeting of IIChE Officials with His Excellency, Honorable Lt.Governor - Shri Manoj Sinha (at Middle), Union Territory of J&K (From Left: Prof. M.K. Jha, Prof. G. D. Yadav, Mr. D. M. Butala, Mr. Praveen Saxena, Dr. Avijit Ghosh)

Inaugurations of IIT Patna Reg. Centre

Inauguration Ceremony of IIT Patna- Regional Centre@IIT Patna (From Left: Mr. S.K. Roy, Dr. S.K. Samanta, Dr. Avijit G
Mr. Praveen Saxena)

Inauguration of IIT Patna Reg. Centre

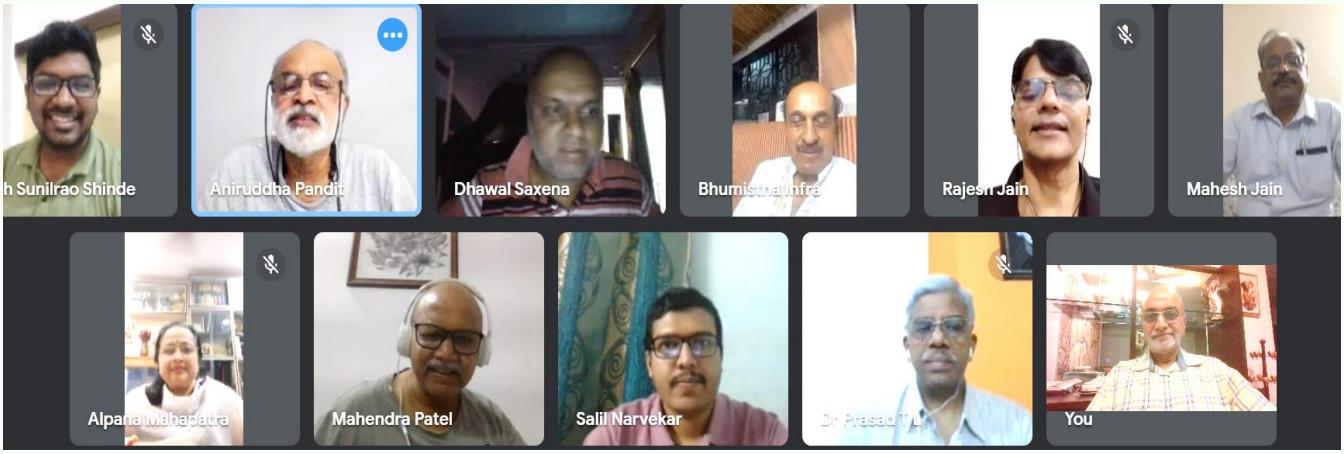
Regional Centre opening ceremony@IIT Patna

Continued ...

IIChE Recent Events at a Glance

IICHE-MRC EC meeting on 23rd July 2022

IICHE-MRC EC meeting on 4th December 2022



2nd National Council meeting at IICHE-HRC

IIChE Recent Events at a Glance

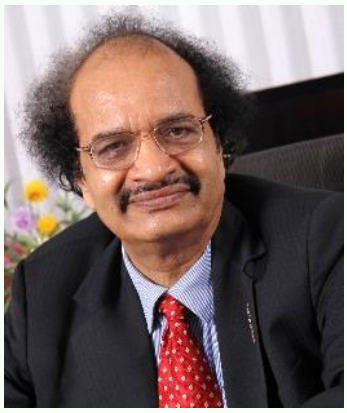
IICHE-MRC AGM meeting on 17th Sept 2022

Networking Visit IICHE-MRC 8th Sept 2022

Congratulations !!!

Prof. G.D. Yadav inducted to the US National Academy of Engineering (NAE)

Heartiest congratulations to Prof. GD Yadav!!!



Padma Shri Prof. (Dr.) G.D. Yadav, Emeritus Professor of Eminence, former Vice Chancellor, Institute of Chemical Technology, Mumbai and Past President, IIChE has been inducted on 2nd October 2022 to the **US National Academy of Engineering** (NAE), **USA** at Washington by President Prof. John Andersen and Chair Donald Winter, for his contributions to research, innovation, and teaching in Green Chemistry, Catalysis, Nanotechnology and Chemical Engineering. Till date, only 21 Indian nationals have received this prestigious membership.
Prof. Yadav, Madam Vasanti Yadav and President of the Academy Prof John Andersen are seen in photo.

International Honours to Prof. Ganapati D. Yadav It is a matter of great pride for India that Professor Ganapati D. Yadav, National Science Chair of Govt. Of India and Emeritus Professor of Eminence, and Former Vice Chancellor of the Institute of Chemical Technology (ICT) Mumbai is elected as the Fellow of the US National Academy of Inventors (INA). He is the only second Indian to be so honored. The NAI was founded in 2010 to recognize and encourage inventors with patents issued from the U.S. Patent and Trademark Office. Professor Yadav is the inventor of 120 patents and his recent work on green hydrogen production from water splitting with cost of hydrogen of less than a dollar, carbon dioxide valorization into fuels and chemicals such as methanol, dimethyl ether, methane and higher hydrocarbons, and waste biomass into 14 different value added chemicals has caught the attention of the world. His green hydrogen work is supported by ONGC Energy Centre. He was conferred Padmashri in 2016. He is also inducted as the Honorary Fellow of the Biotech Research Society India (BRSI) at IIT Guwahati. Recently MIT ADT University bestowed on him the first Bharatratna A. P. J. Abdul Kalam Award for Science and Technology with a cash prize of Rs. 2.5 lakh and citation and medal. Professor Yadav also holds another record for Indian engineering professor of guiding 107 PhD, 135 masters and 48 post-doctorates with 509 original papers and over 900 orations or lectures all over the world. He has been serving on a number of central government committees and policy making bodies. He is an independent director of 5 renowned listed companies and a consultant to industry for 4 decades. He is an elected fellow of all Indian Science and Engineering Academies and The World Academy of Sciences and many other professional bodies. He is currently the President of the Maharashtra Academy of Sciences, Indian Chemical Society and ACS India International Chapter.

Congratulations !!!

Prof. GD Yadav bestowed with the first Bharat Ratna Dr APJ Abdul Kalam award for Science and Technology with a gold medal, citation and a cash prize of Rs 2.50 Lakh.

Prof. Vinay K. Srivastava former President IIChE and Scientist BARC
Receiving CHEMCON 2022 CDS award at HBTU, Kanpur on 29/12/2022
Heartiest congratulations to Prof. Prof. Vinay Srivastava !!!

Heartiest congratulations to Shri Dhawal Saxena !!!

IIChE Forthcoming Events at a Glance

IIChE Forthcoming Events at a Glance

CALL FOR PAPERS

CHEMCON 2023

Indian Institute of Chemical Engineers

December 27 - 30, 2023, HIT, Kolkata

Theme: Energy Transition: Challenges and Opportunities

We are cordially inviting Faculty/Research Scholars/Scientists/PG & UG students to submit abstracts on the following

Topics

- Energy and Environment (EE)
- Transformation for Energy Transition (TET)
- Advanced Nano-Materials & Nanotechnology (ANN)
- Water and Wastewater Treatment (WWT)
- Advanced Chemical Engineering (ACE)*
- Advanced Polymer and Composite (APC)
- Biochemical and Bioscience Engineering (BBE)

*includes Applications of Machine Learning & IoT in Chemical Engineering and Process Modeling Simulation and Optimizations

Submission

Submit your abstract at the link below:

https://forms.gle/Q9oT2CBgQakbyHBP9

The abstract template is available on the website

Special technical session for UG/PG students

Key Dates

Abstract submission (200 words) by: March 30, 2023
Acceptance notification: April 15, 2023
Full paper submission: June 30, 2023
Last date of registration: August 30, 2023

Please visit website: iiche.org.in/chemcon2023

For enquiries, mail us at: chemcon2023@iiche.org.in

More information

All the presented papers at the conference will be considered for publication in any one of the following journals/book chapters as special issues subject to the peer review process.

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Jadavpur University, Kolkata

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Indian Institute of Chemical Engineers
Dr. H. L. Roy Building, Jadavpur University Campus, Kolkata - 700032

Contact
Dr. Avijit Ghosh
Organizing Secretary, CHEMCON 2023
& Assistant Professor, Department of Chemical Engineering, HIT, Kolkata
+91 983075211

IIChE Forthcoming Events at a Glance

Estd : 1984

Transform Yourself

First Announcement

19th Annual Session of

Student Chemical Engineering Congress

SCHEMCON 2023

SUSTAINABLE FUTURE

September 22-23, 2023

Organized by

Indian Institute of Chemical Engineers

KEC Student Chapter

Department of Chemical Engineering

KONGU ENGINEERING COLLEGE,

Perundurai

&

Coimbatore Regional Centre

Indian Institute of Chemical Engineers

Website: www.kongu.ac.in

Contact No: +91-98428 23432, +91-97503 83957

E mail : schemcon2023@gmail.com

Become IIChE Member

The Indian Institute of Chemical Engineers (IIChE) is the apex professional body of chemical engineers in India. It has a membership of about fifteen thousand including Corporate Members and Student Members. There are forty-one Regional Centers and forty-seven Student Chapters of the Institute in different parts of India. The Institute represents the chemical engineering profession in India. Many members of the Institute serve on various technical committees of the Government of India and of chemical and allied industries. Here are some of the benefits that a member of the Institute enjoys.

- Since IIChE is the recognized forum, membership of the Institute itself is considered as a professional accomplishment of a person.
- Member can join numerous seminars, symposia, workshops, training programme, special lectures, industry visits and other professional activities. Participation in such programme is either free or may involve a subsidized fee.
- Corporate member is eligible to contest in the annual election to the 25-member Council, which is the highest policy-making body of the Institute.
- IIChE has an active consultancy programme. An interested member may seek and get help from the Institute in his endeavor to offer consultancy services to potential industrial customers.
- Member can join the four-day Annual Professional Meet called CHEMCON at a subsidized fee. Various professional meets organized by IIChE acts as a forum for interaction and networking of the professionals
- The student members may join as member of seminars specifically meant for them and can participate in a number of competitions. One of such popular seminar is SCHEMCON which is organized by one of the IIChE Student Chapters.
- Corporate member may be nominated to various government and non-government bodies in different areas, if found suitable.

Details about types of membership, membership fees & subscriptions, membership card etc. are available on IIChE website.

https://www.iiche.org.in/joiniiche.php

Online Application forms for Life Fellowship, Life Membership, Life Associate Membership, Student Membership, Organisational Membership are also available on IIChE website.

CONGRATULATIONS !!!

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Prof. G. D. Yadav	Former VC, ICT & Former President, IIChE
Prof. Vinay K. Srivastava	Former President IIChE
Shri R.G. Rajan	Ex CMD, RCF & former Chairman IIChE-MRC
Dr. Sanjeev Katti	Director General, ONGC Energy Centre
Dr. Sanjay Mahajani	IIT-Bombay
Shri Praveen Saxena	Fellow IIChE & Vice President Indian Carbon Society.
Dr. D. Mandal	BARC, Mumbai
Shri Jayesh Master	Consultant
Prof. S.S. Bhagwat	ICT, Mumbai
Dr. S. Ganeshan	Ex Toyo and Former president IIChE
Shri D. P. Misra	Former President IIChE
Shri K. Venkatramanan	L&T and Former President, IIChE
Shri Sushil Kumar	Ex Reliance & Former President, IIChE

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