Energy, Climate & Sustainability

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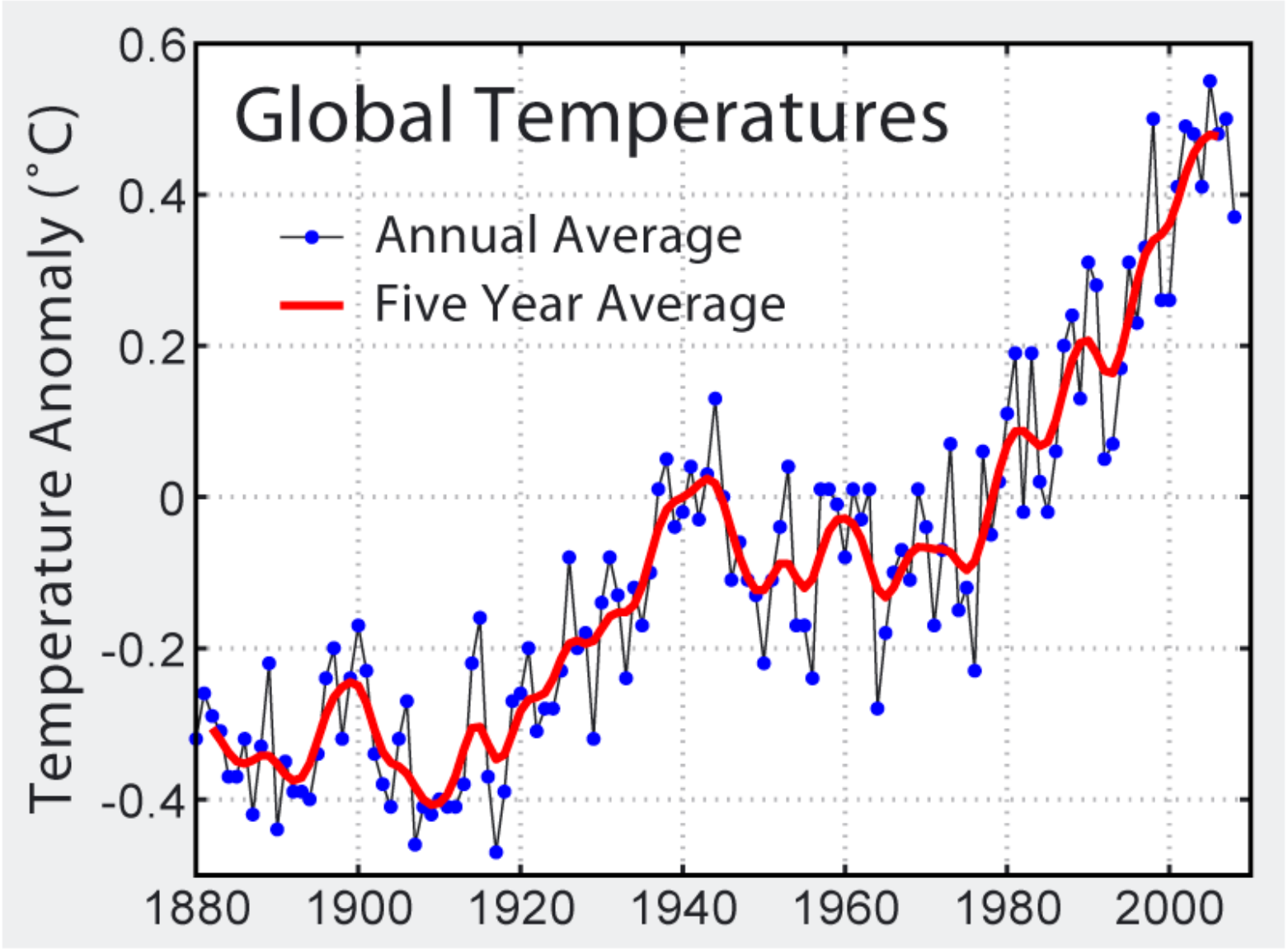
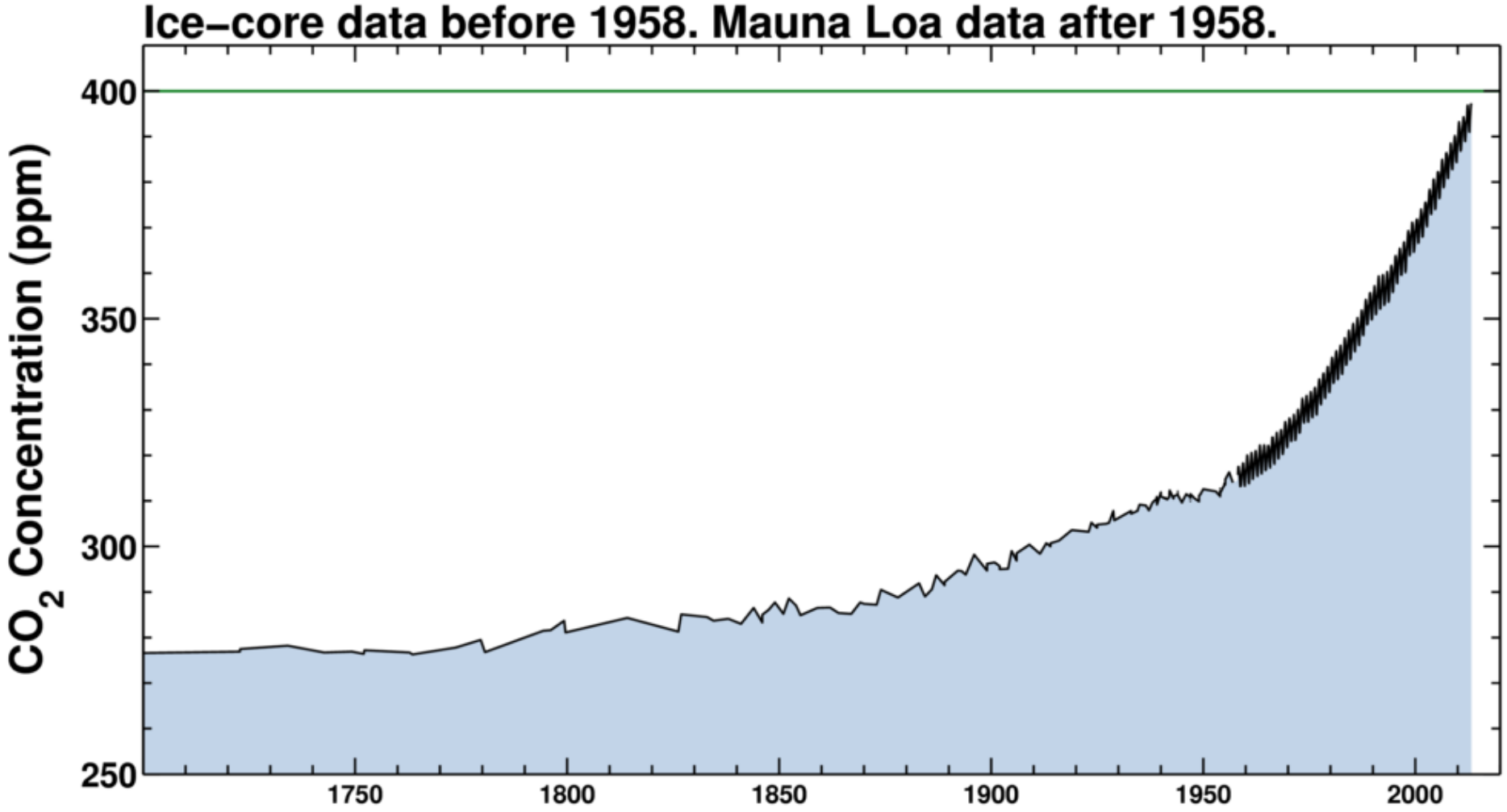
Do you believe in climate change?

Climate change in real



Climate change in driven by greenhouse gases (mainly CO_2)



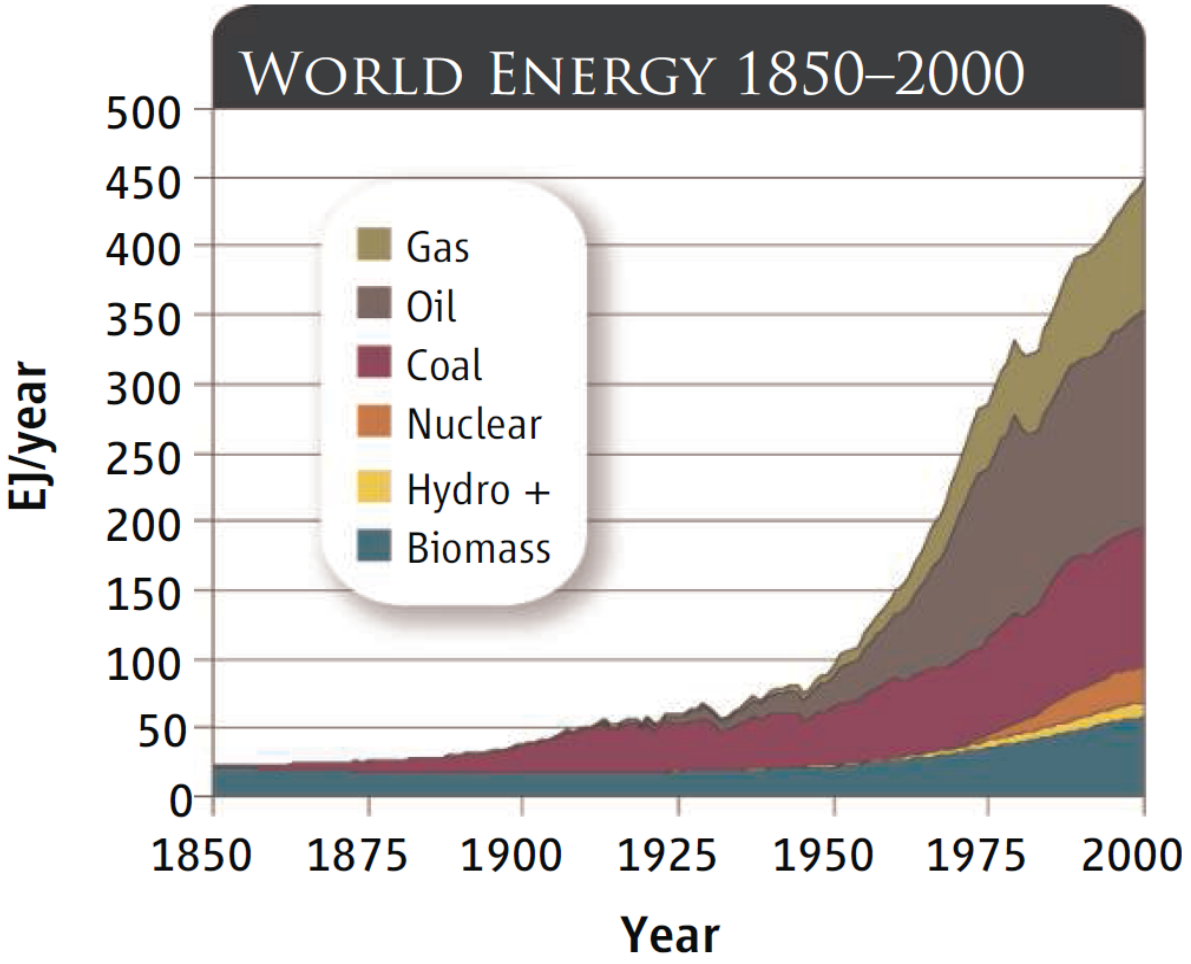
Climate change is more than global warming and melting polar ice caps

QUARTZ
India

India's vital monsoon rains are changing—and not for the better

er 1,000 people died and tens of thousands were left
fter early monsoon rains in the northern Indian state of
d triggered flash floods and landslides. The year before, late

Energy consumption has played a crucial role in climate change/CO_2 emissions



- Energy use increased 20-fold
- Fossil fuel use increased more than
- By 2005, fossil fuels were contributing 81% of the world primary energy supply, 82% in China, and 88% in the United States

Energy plays a crucial role in the development of the society

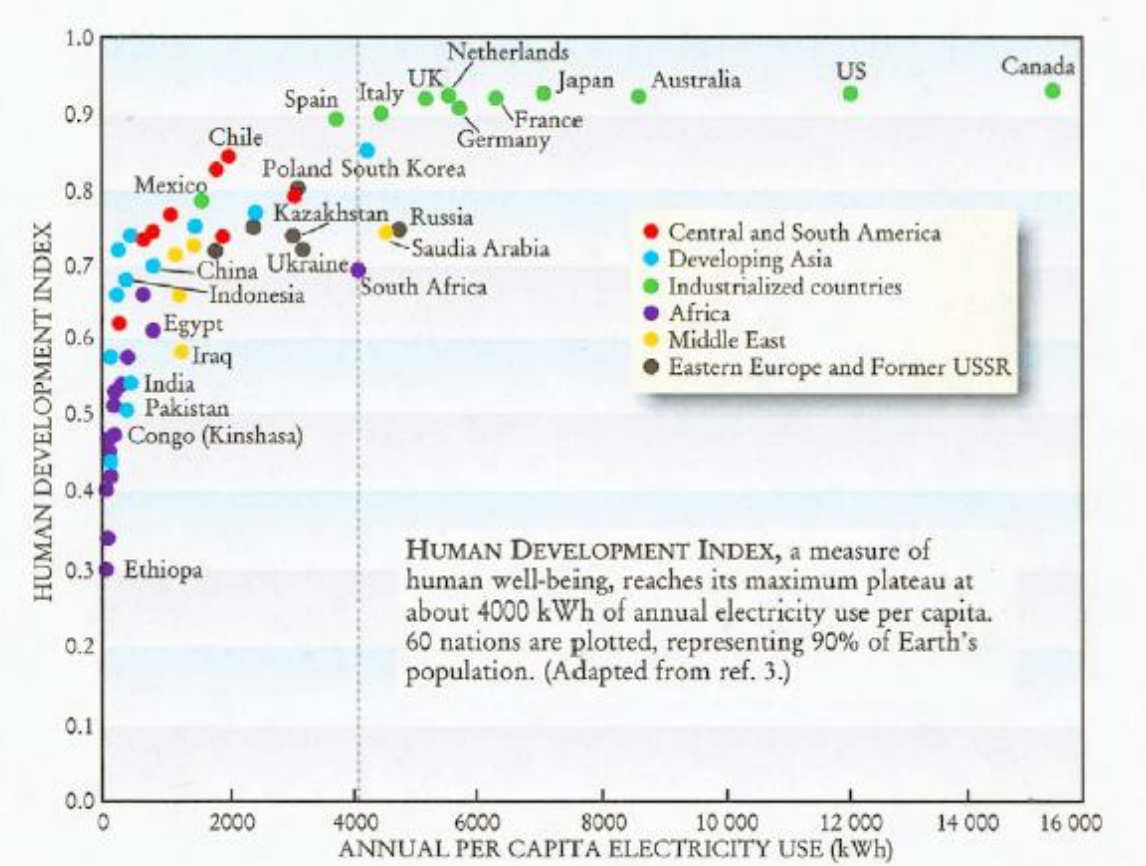
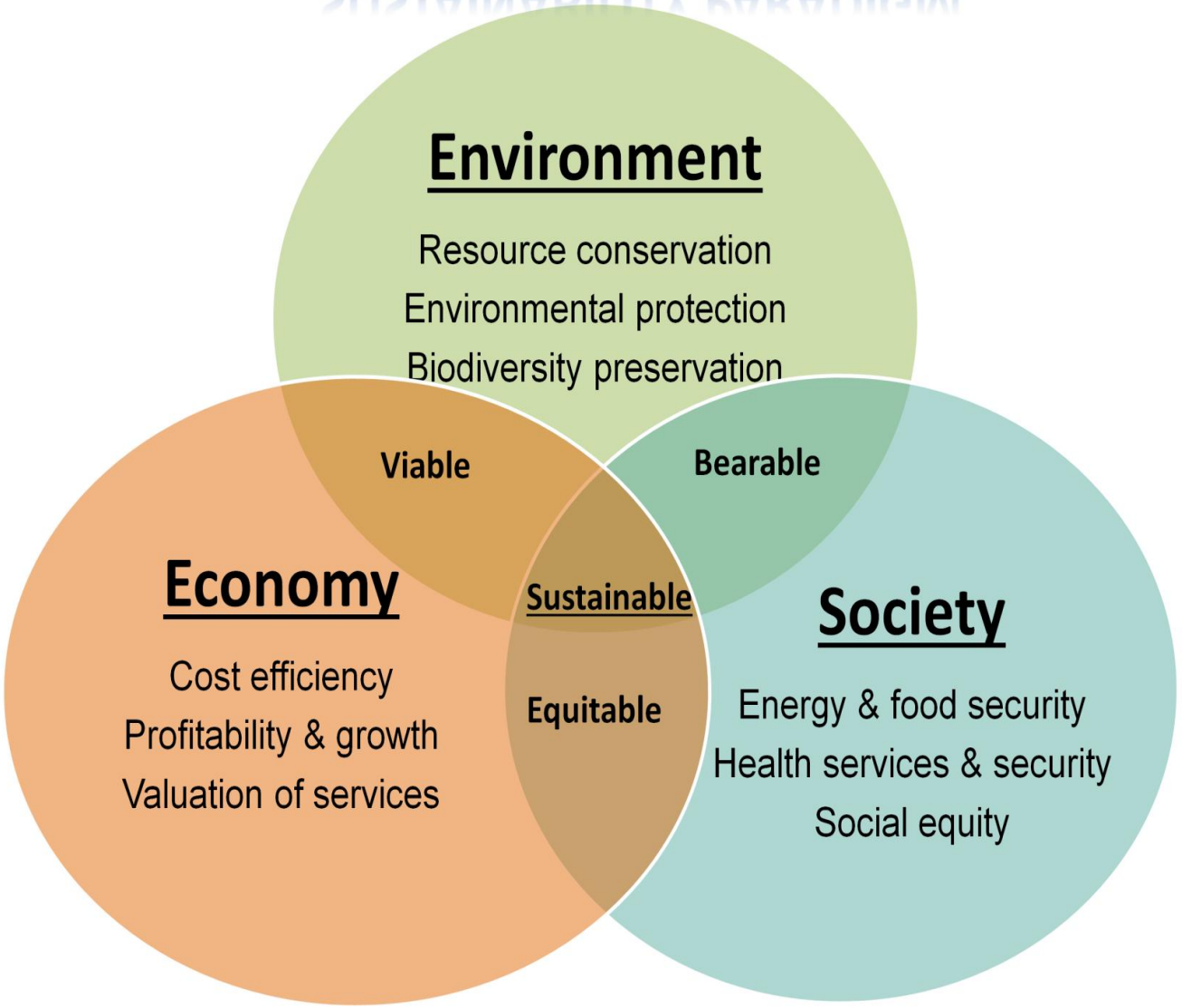


Figure 1.2. Human development index vs. per capita electricity use for selected countries. Taken from S. Benka, *Physics Today* (April 2002), pg 39, and adapted from A. Pasternak, Lawrence Livermore National Laboratory rep. no. UCRL-ID-140773.

Plenty of clean, affordable, and accessible energy required (especially for India)

We need ***sustainable*** energy!



Sustainability concerns go beyond global warming/climate change

So what “sustainable” energy options do we have?

- Solar
- Wind
- Hydro
- ***Biomass***
- ***Electrochemical***
- ***Nuclear***
- ***Coal????? (clean coal/advanced coal technologies)***

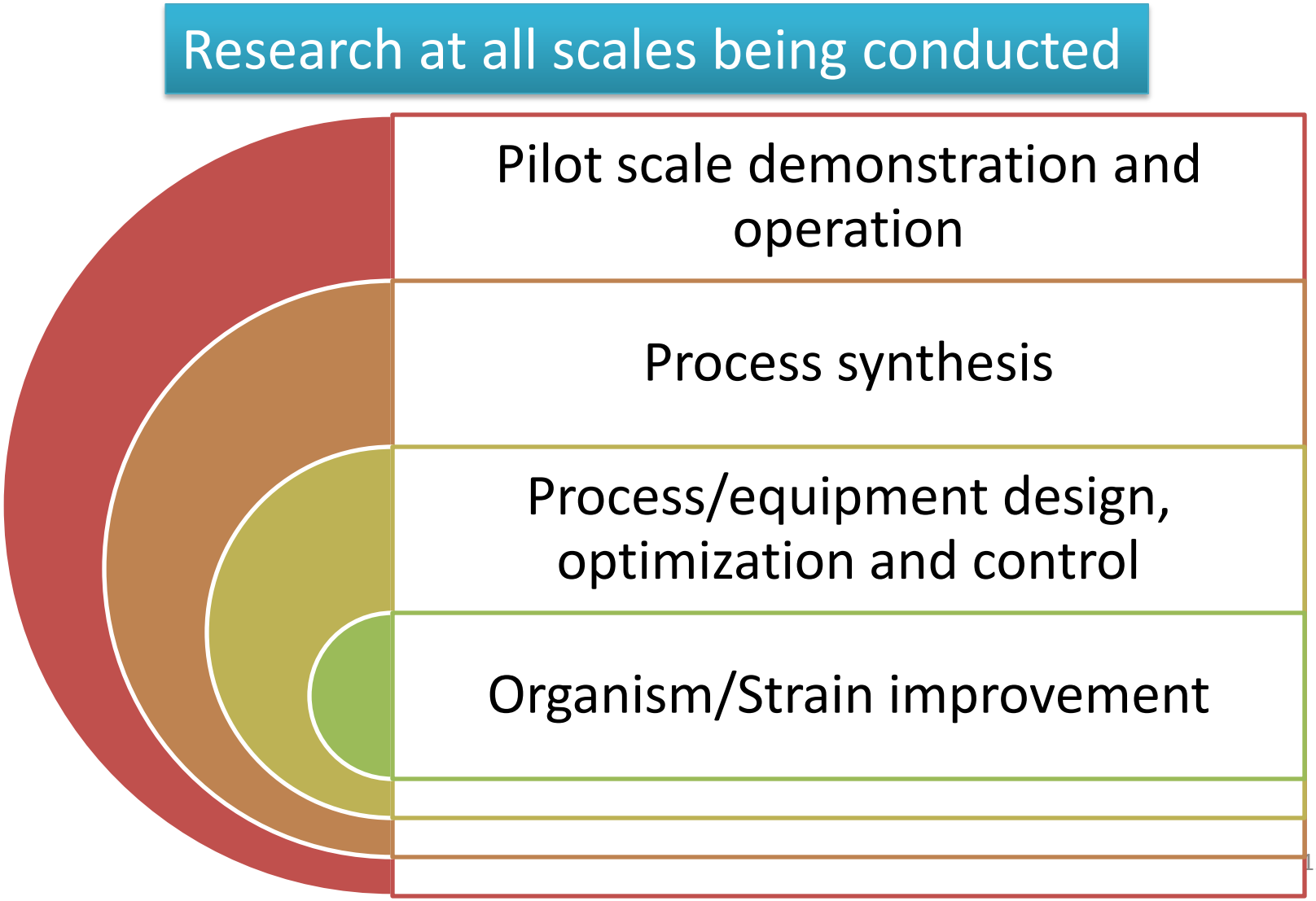
Focus in Chemical Engineering @IITB:

Improve cost-efficiency and reduce emissions by applying chemical sciences and engineering

Energy: Focus Areas

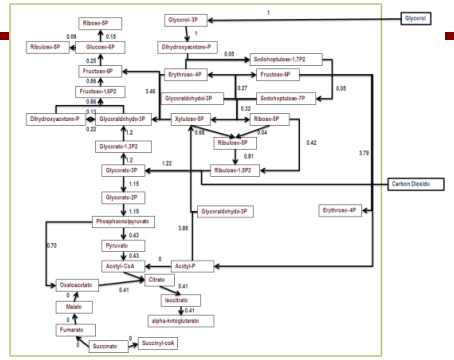
- Biomass and biofuels
  - Micro-algal biofuels
  - Lignocellulosic biofuels
- Clean/advanced coal technologies
- Fuel cells
- Solar thermal power
- Municipal solid waste

Biomass and Biofuels: Algal and Lignocellulosic Biofuels



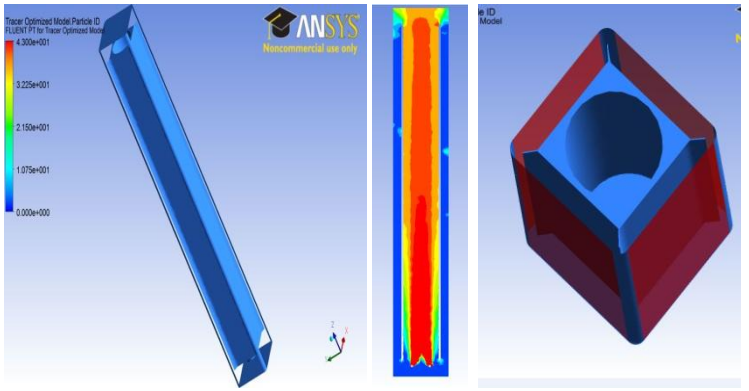
Algal Biofuels: Strain Improvement and Process Design

- Improved photosynthetic efficiency and high cell density cultures of cyanobacteria (P. Wangikar)
- Algal and cyanobacterial expression systems for improved biofuel production (S. Nohonha)



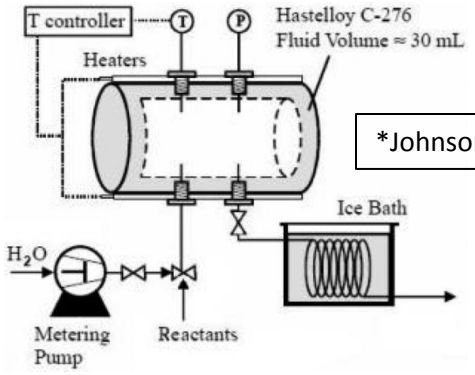
CFD modeling and optimization of photobioreactor (Y. Shastri)

- Conceptual development of novel PBR design
- Simulation based optimization of PBR performance



Hydrothermal liquifaction of algal biomass (Y. Shastri & S. Bhartiya)

- Development of a comprehensive reaction kinetic model
- Experimental validation on a laboratory scale reactor



*Johnson and Tester (2013)

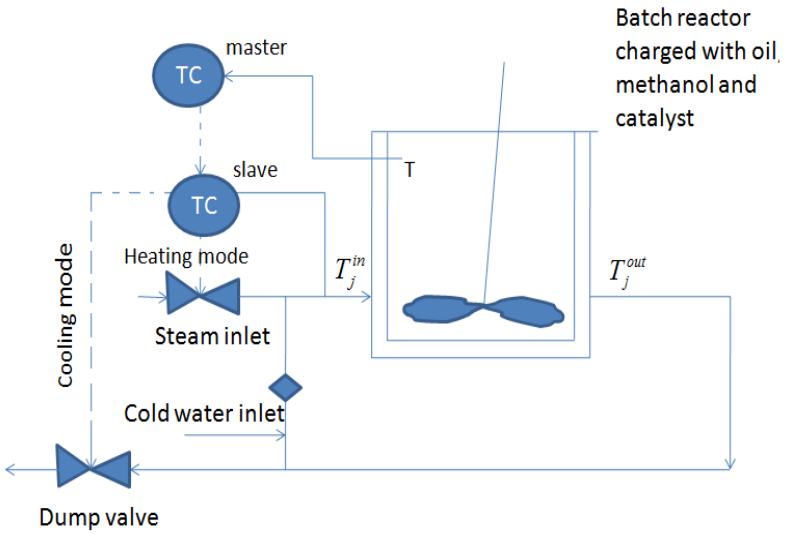
Algal Biofuels: Process Control and Synthesis

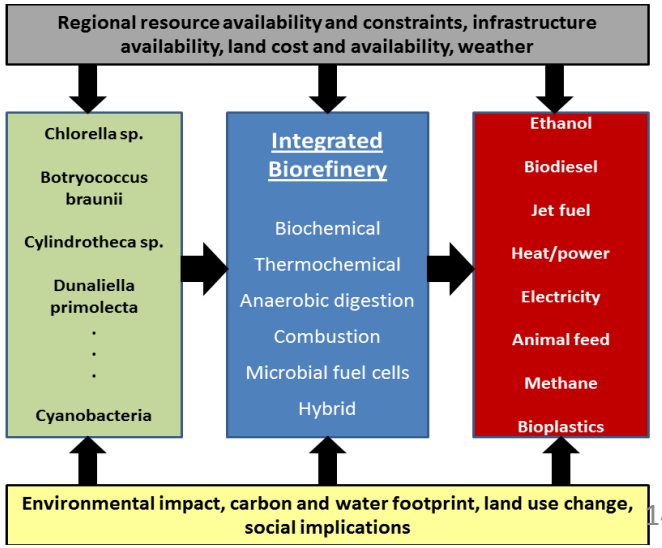
Advanced control and validation of trans-esterification (Y. Shastri & S. Bhartiya)

- Development of advanced model based control of batch operation
- Experimental validation on a laboratory scale reactor

Model based optimal algal biorefinery synthesis (Y. Shastri & S. Bhartiya)

- Optimal strain, process, and product selection
- Optimal scheduling of bath operations
- Co-production of biofuel and value added products





Lignocellulosic Biofuels: Process Optimization and Control

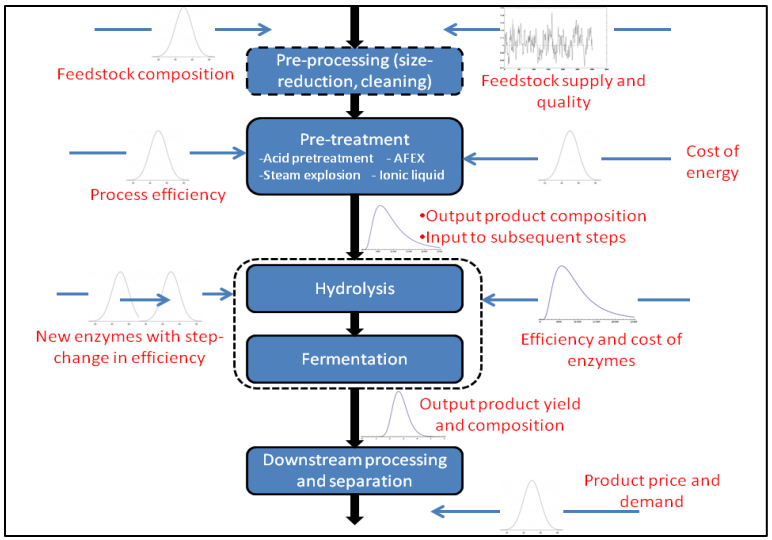
Stochastic optimization of lignocellulosic biofuel production processes (Y. Shastri)

- Characterization and quantification of uncertainties
- Focus on pre-treatment and enzymatic hydrolysis
- Robust process design and optimization

Control design for the simultaneous saccharification and fermentation process

(S. Noronha & S.C. Patwardhan)

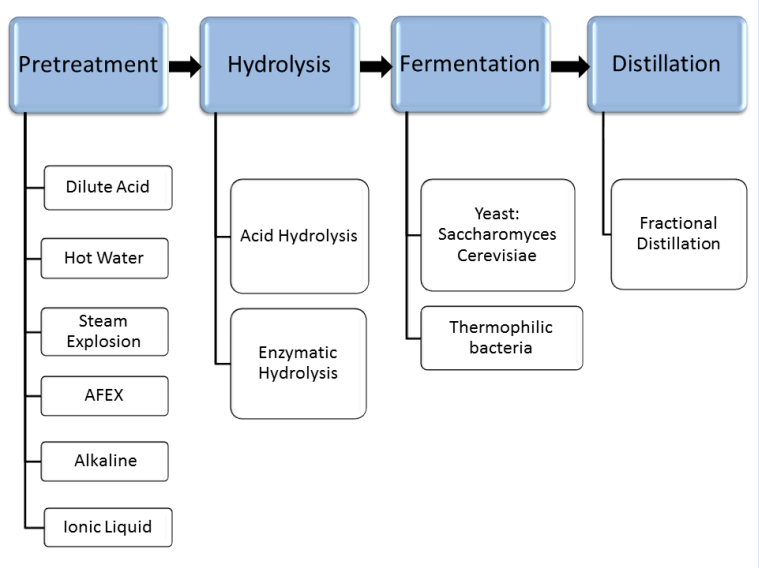
- An adaptive model predictive controller for the SSF process
- A framework to incorporate multi-rate sampled data into an existing control scheme.



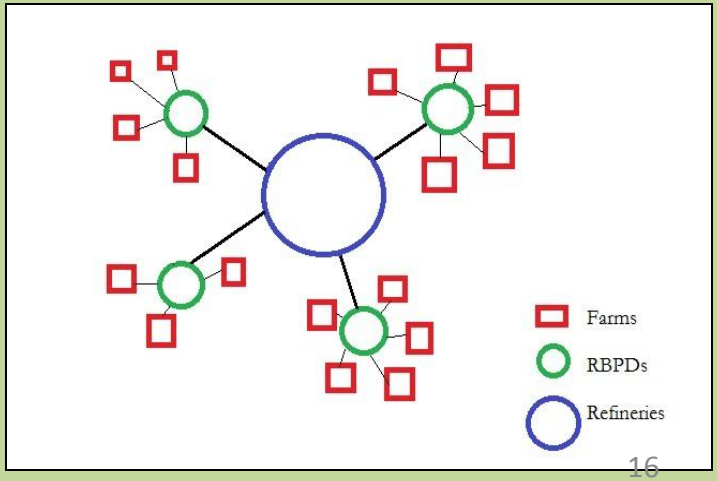
Lignocellulosic Biofuels: Process Synthesis and Integration

Model based optimal lignocellulosic biorefinery synthesis (Y. Shastri & S. Bhartiya)

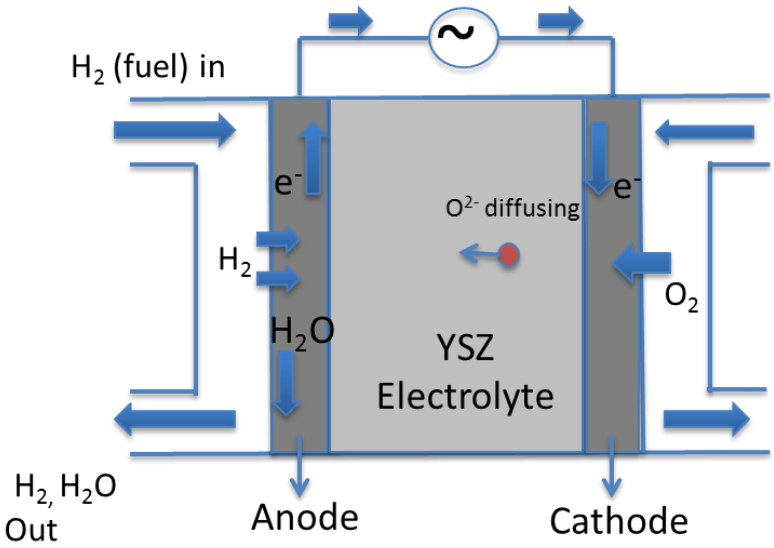
- Optimal feedstock, process, and product selection
- Co-production of biofuel and value added products
- Studying the impact of scale

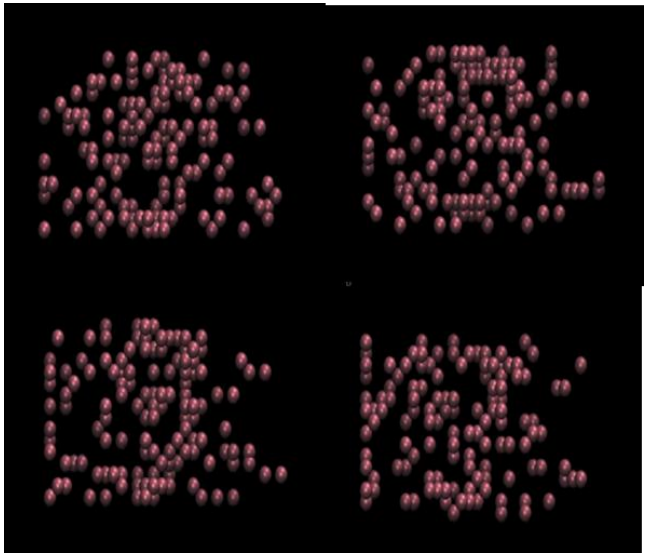


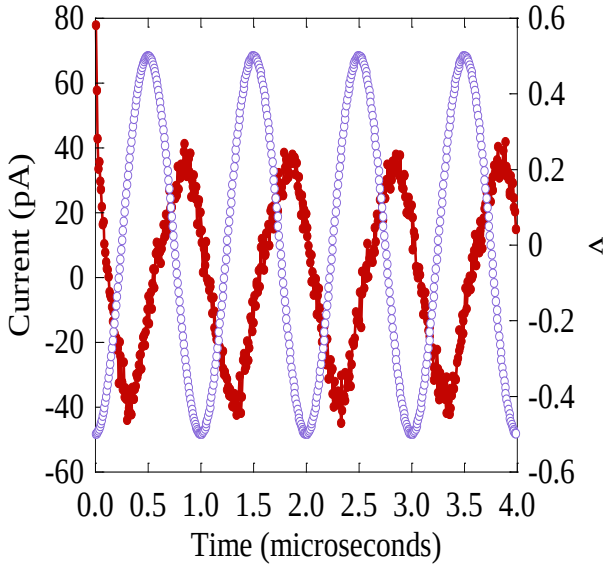
- Integration of first and second generation processes in a sugar refinery (Y. Shastri)
- Development of a resilient biomass to biofuel supply chain (Y. Shastri)



Fuel Cells: Electrochemical Impedance Spectroscopy Studies of Fuel Cells (A. Chatterjee)



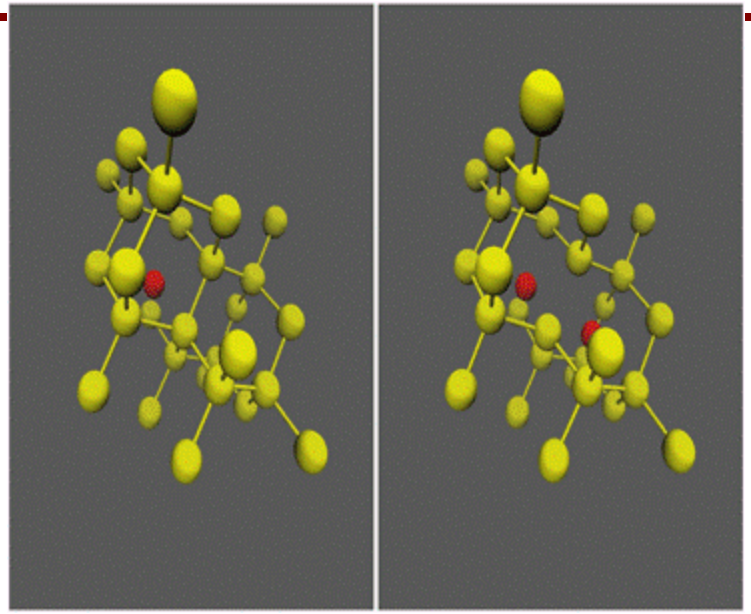


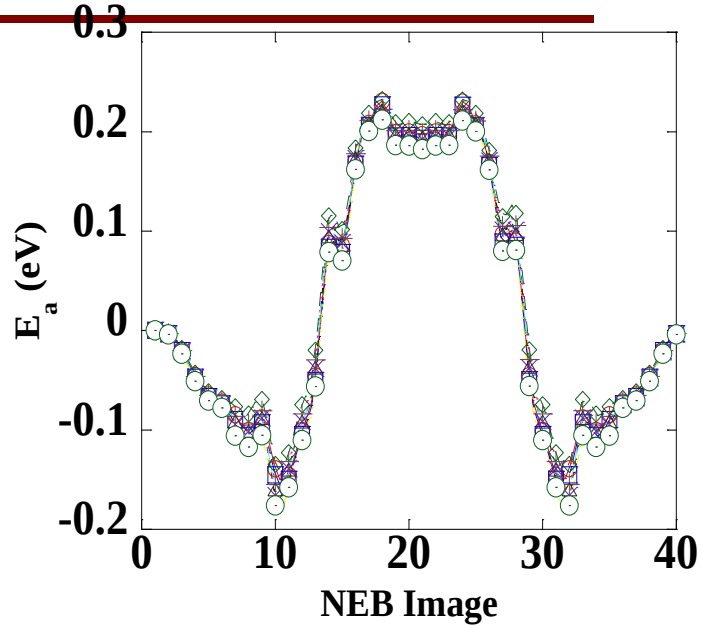


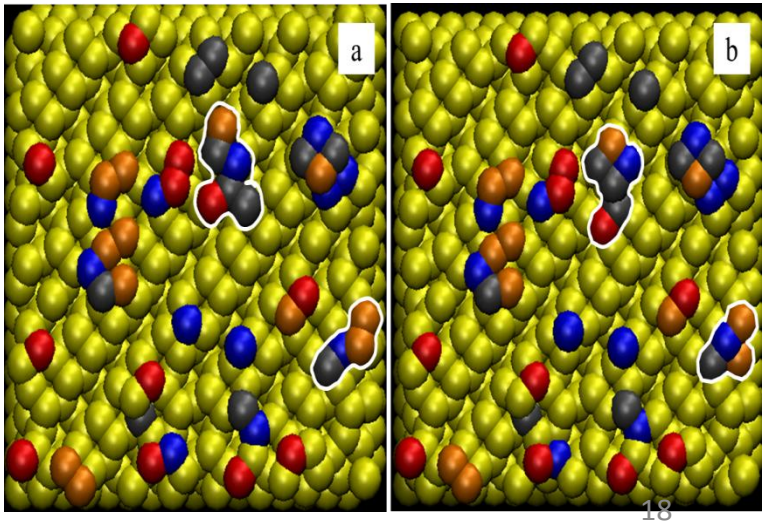
Top: Schematic of solid oxide fuel cell studied, Top-right: Diffusion of oxygen vacancies inside the electrolyte (only vacancies are shown). Right: Typical plot showing the ionic current against time.

ComRaDe
Computer-aided Rational Design of Materials

Batteries and Photovoltaic: Molecular Simulation of Silicon (A. Chatterjee)







Top-left: Two applications being explored – lithium ion battery and photovoltaics, Top: Bond-stretching and compression events during diffusion of Li in bulk Si, Top-right: Minimum energy path as Li hops from one site to a neighboring site, Right: Diffusion of Si atoms on reconstructed Si(100) surface

ComRaDe
Computer-aided Rational Design of Materials

Solar Thermal Power Plant

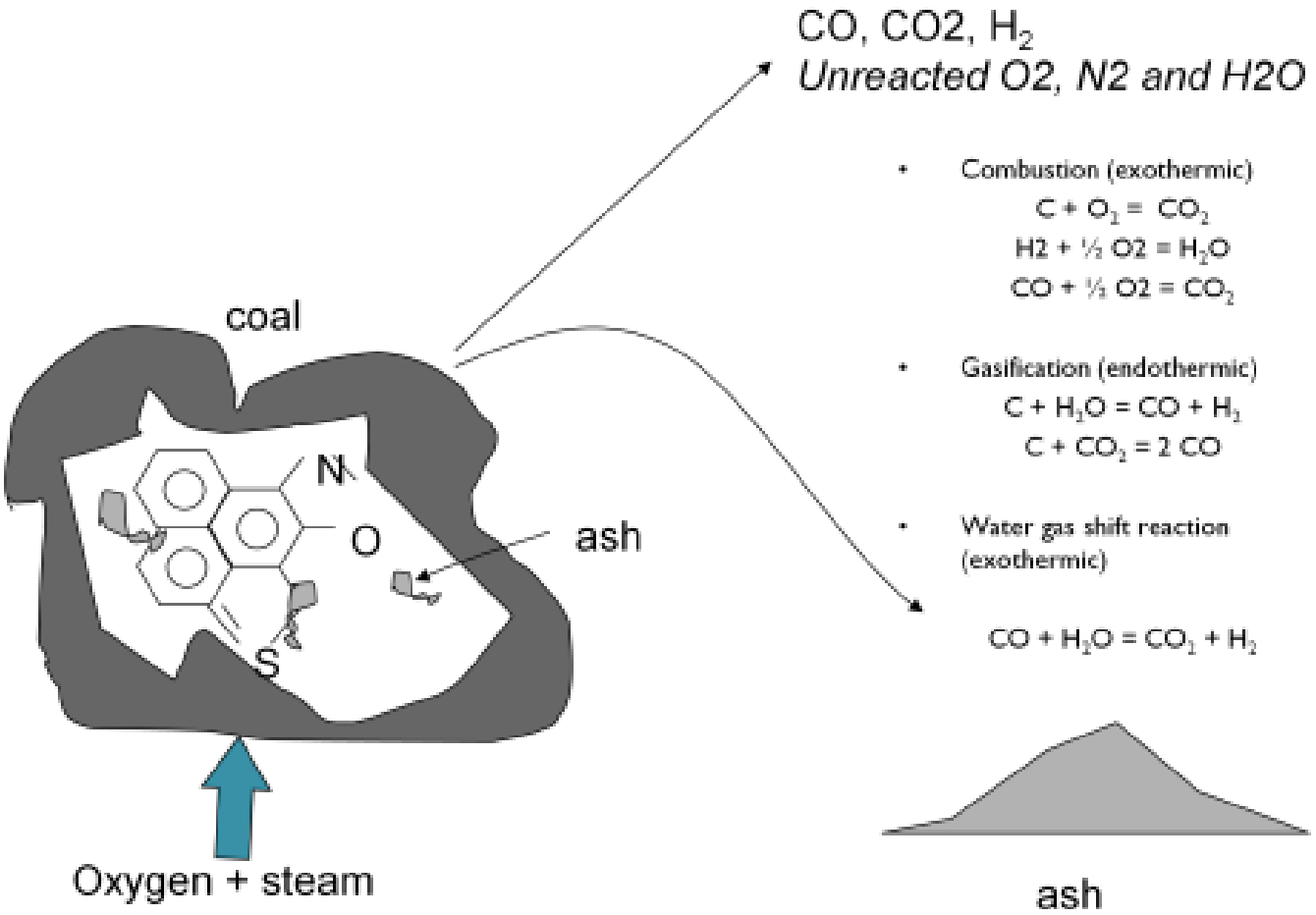
(M. Bhushan and S. Bhartiya)

- A grid-connected 1 MWe Solar Thermal Power Plant
- Designed and Commissioned at Gurgaon by an interdisciplinary team from IIT Bombay (sponsor: MNRE) (http://www.ese.iitb.ac.in/~NSTPP)
- Integration of two different fields: PTC and LFR, without fossil-fuel backup

- **Focus:**
  - Design and implementation of instrumentation and control systems
  - Development of first principles model
  - Design of daily operating strategies

Underground (in-situ) coal gasification (S. Mahajani)

Subject coal to oxygen and steam (gasification)

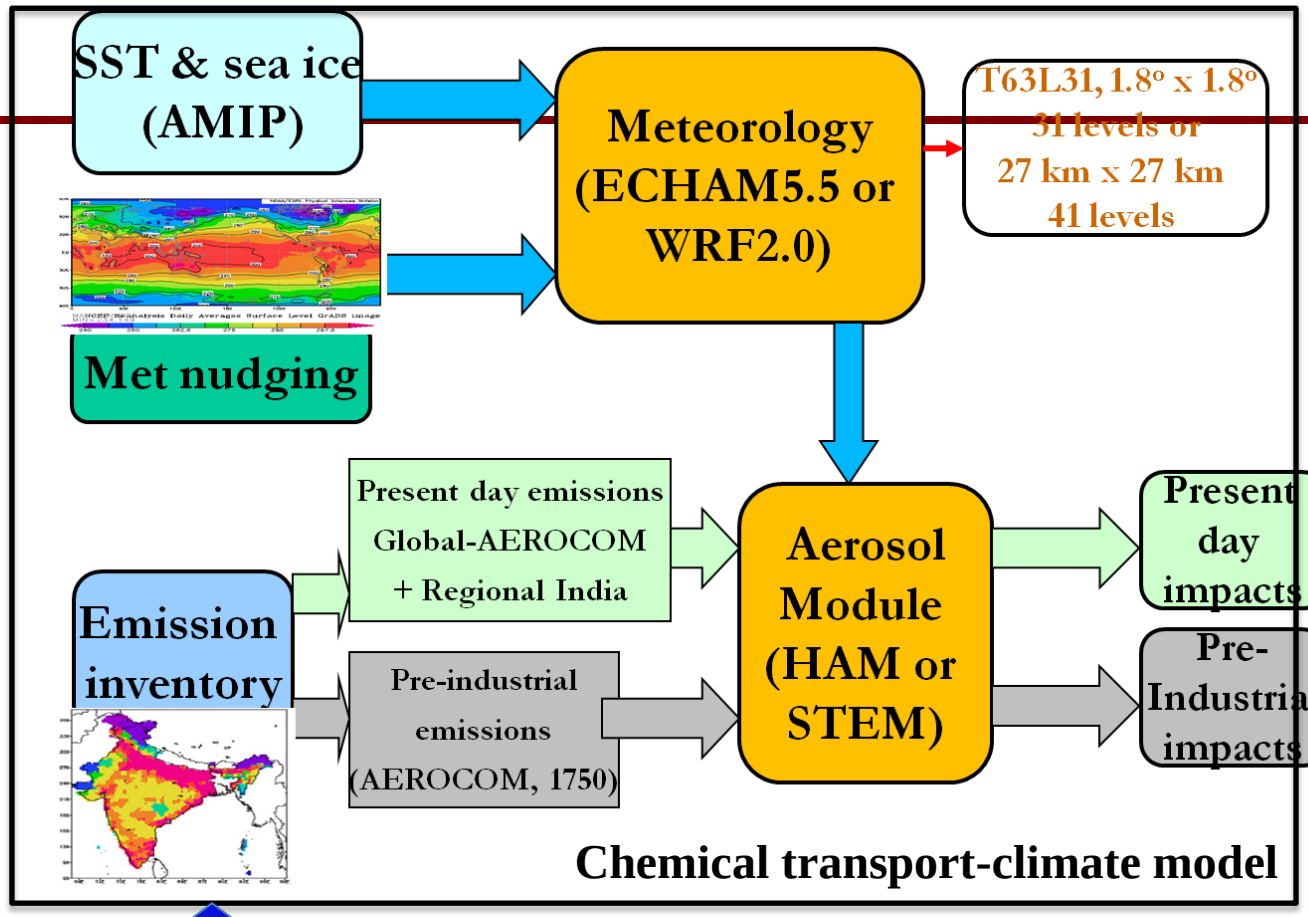


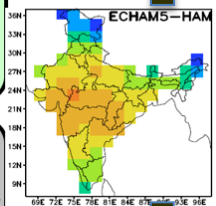
MSW Management: Waste to Energy

- Landfill
- Incineration
- Gasification
- Pyrolysis
- Biogas
- Composting

Focus: Process development, improvement, optimization, and environmental impact assessment (S. Mahajani & Y. Shastri)

Climate and air-quality effects of energy-use emissions





Process understanding: Aerosol induced changes in radiation, temperature and rainfall over India

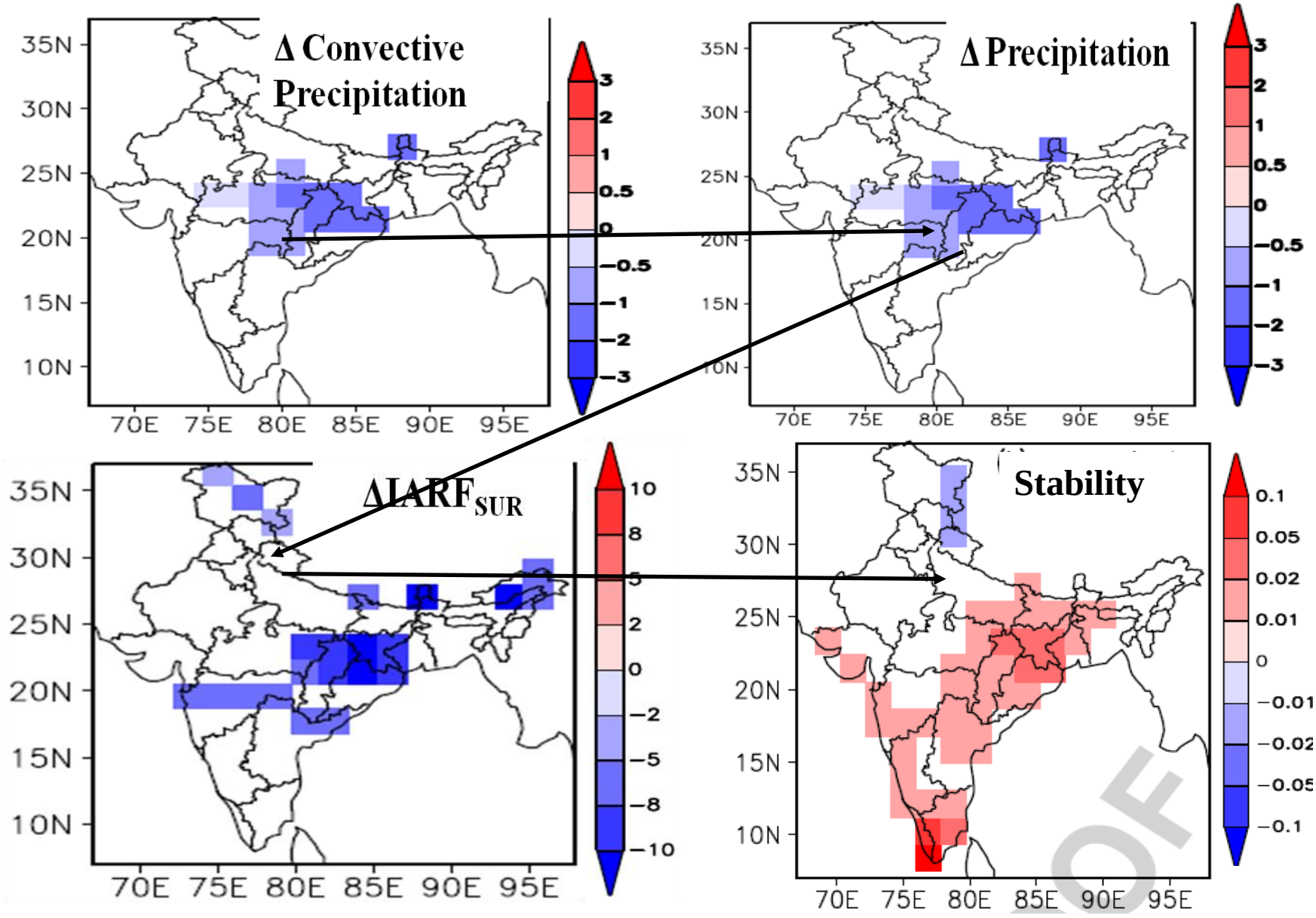
Impacts: Mitigation strategies yielding benefits to both climate and air-quality

Fundamental studies: Measuring chemical, micro-physical, optical properties of emission particles

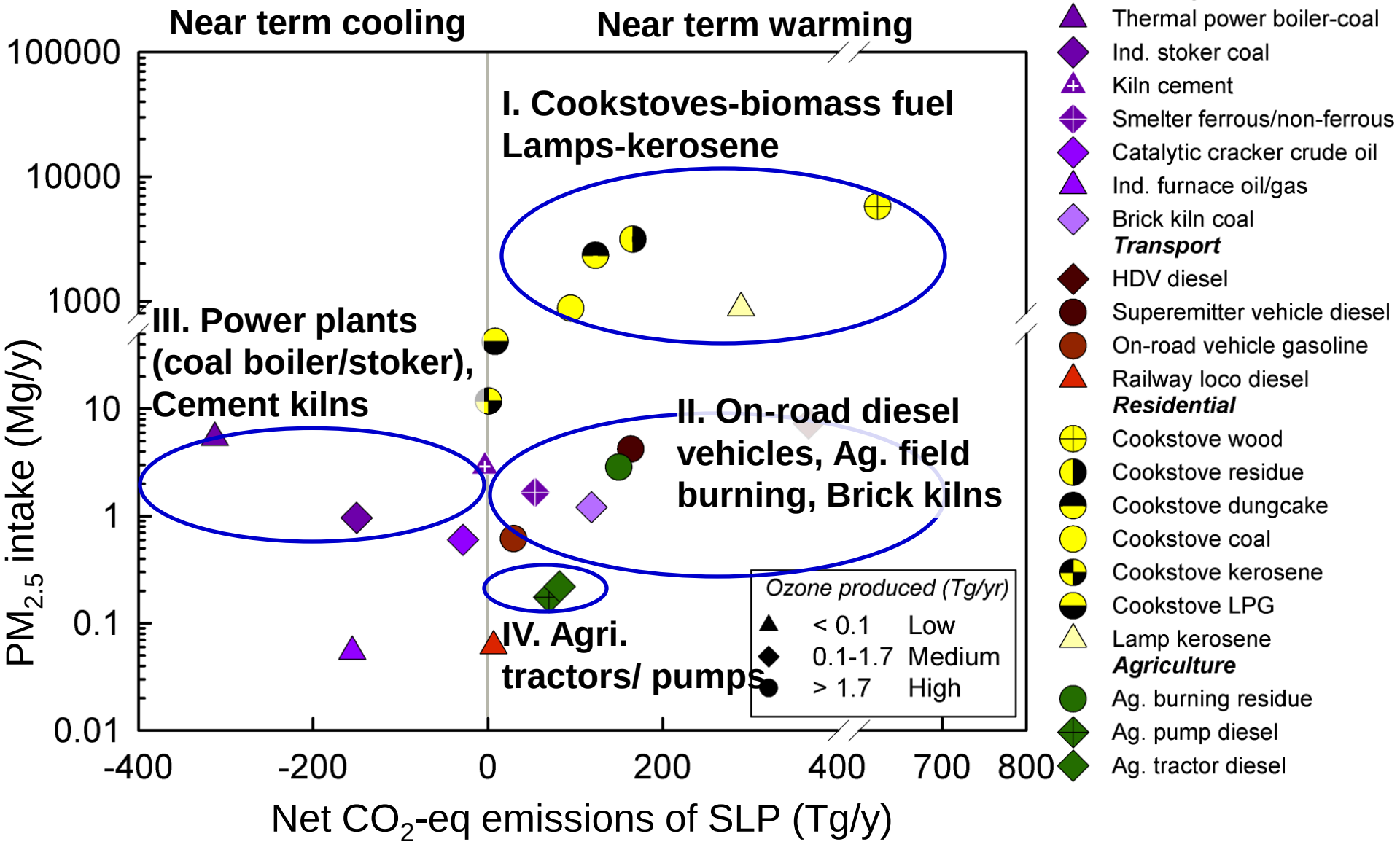
Modeling energy-use emissions: Spatial and temporal resolution

C. Venkataraman

Identification of mechanisms of atmospheric aerosol induced rainfall changes (C. Venkataraman)



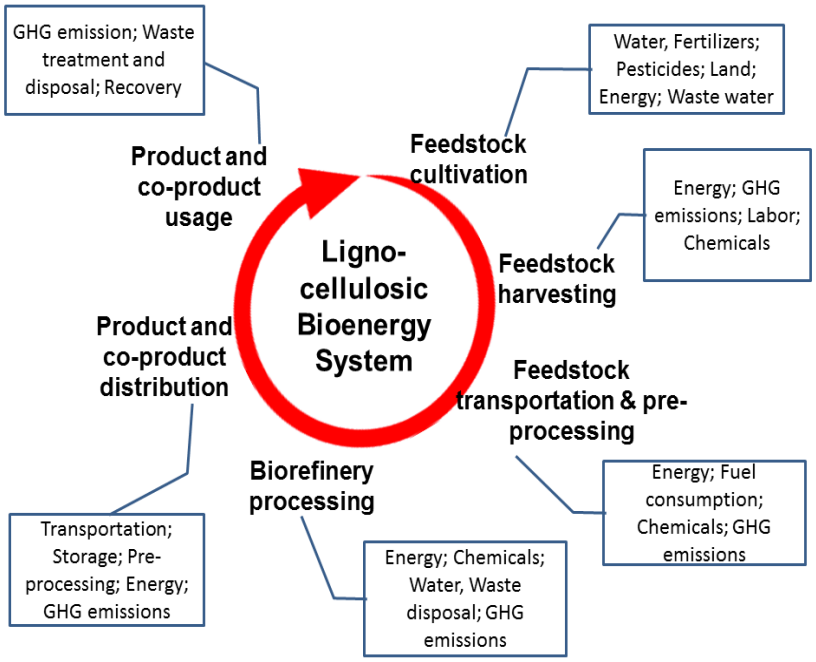
Frameworks using emission metrics for combined impact of energy technologies (climate, health, air-quality) (C. Venkataraman)



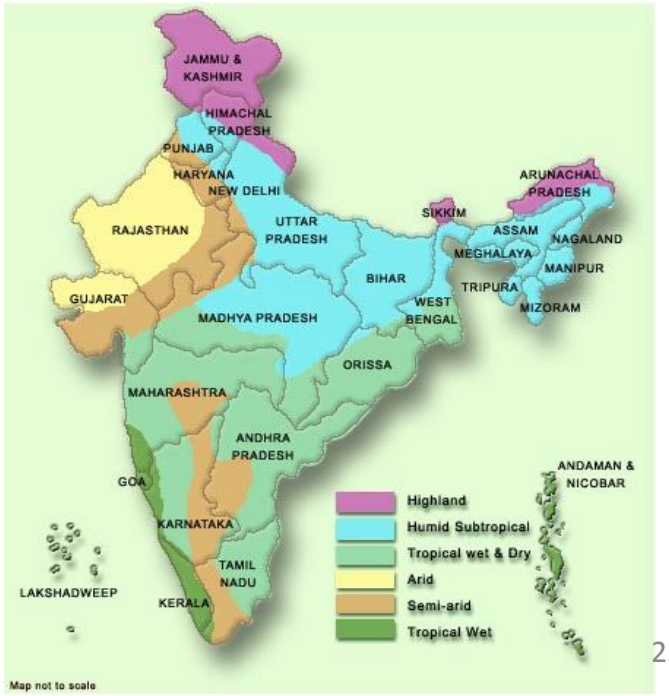
Sustainability: Life Cycle Impact Assessment of Energy Systems (Y. Shastri)

- Incorporation of data uncertainties in the LCI analysis
- Focus on Indian scenario with goal to develop region specific recommendations

Lignocellulosic biofuel systems



Energy alternatives for India



Sustainability: Socio-economic and Cultural Aspects in Process Safety

- Incorporating risk parameters in socio-economic indicators:
  - Classical economic development indices (HDI, LQI etc) do not embody risk indicators associated with the development
  - Ongoing research projects are exploring incorporation of risk parameters (Individual Risk, Societal Risk) into classical economic parameters for holistic assessment of development
- Cultural determinants of process safety management systems
  - Building a framework for analysis of role of local (i.e., national) cultural factors on process safety management systems
  - Investigating global accident statistics and questionnaire-based survey of worker and management attitudes

Highlights

Key facilities

- Supercritical Fluid Micronizer
- Pressurized Hot water Extraction System
- Supercritical Fluid Processing Systems (Laboratory and Pilot Scale)
- Fixed bed coal gasification and combustion system
- Biomass pyrolyzer
- High performance computer cluster

Publications in:

- Environmental Science and Technology
- Bioresource Technology
- Biotechnology and Bioengineering
- Biofuels, Bioproduct, and Biorefining
- European Journal of Industrial Engineering

Energy, Climate & Sustainability: Faculty involved


Sharad Bhartiya


Mani Bhushan


Abhijit Chatterjee


Ravindra Gudi


Sanjay Mahajani


Ranjan Malik


Arun Moharir


Santosh Noronha


Sandip Roy


Yogendra Shastri


A.K. Suresh


C. Venkataraman


Madhu Vinjamur


Pramod Wangikar

How to choose a research topic?

Home › India › India News › Six changes after Paris climate deal: How the new global pact could affect your life

Six changes after Paris climate deal: How the new global pact could affect your life

The fight against climate change began in 1992 at the Earth Summit in Rio de Janeiro that gave birth to the UN Framework Convention on Climate Change. And culminated with a global agreement in Paris

Home › Business › Business Others › An internal Carbon Price to invest in energy efficient, renewable technologies

An internal Carbon Price to invest in energy efficient, renewable technologies

While it became the first Indian firm to do so, the company's carbon price is in line with its commitment to reduce its Green House Gas emissions by 25 per cent over the next three years.

In Deonar, kin of many ragpickers still looking for alternative jobs

A survey conducted on the families of the 108 waste segregators indicated that at least 72 per cent of the families currently have no other alternative source of income.

How India sees the coming crisis of water — and is preparing for it

Two draft laws and the report of an expert committee have recently framed the core principles of India's future water management policy.

Thank You!

Contact me at

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for any questions

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http://www.che.iitb.ac.in/ys/Resources.html