Ramanujan labs

Air Water Earth Energy

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Sustainability researcher and policy entrepreneur

Roshan Shankar

Sustainability & Academia
Sales & Marketing
Government & Bureaucracy
Software & Statistics

Co-Founder

Princeton Ph.D. (on long leave), MS/MPP (Stanford), B.E. (NSIT)
Advisor to Delhi Government Ministers and Punjab MPs (2014-2021)
Made unique friendships and connections in 202 districts
At ease with policymakers and academics from Panchayat-Parliament
Nominated as US State Department Fellow (ACYPL)
Was RA to ex-US Defense Secretary William Perry
Bloomberg C40 Cities City Expert

Emissions: A Global And National Perspective

2023: World is at 55 Gt/yr for CO2.

2055: Projected to reach 80 Gt/yr

Need is to get to 0.

Zero CO2 means large changes for the present coal and oil based industries.

India's annual emissions: 1 Gt/year (4% global) in 2001 to 2.6 Gt/year (7%) today.

Carbon intensity of energy production grows from 0.24 kg/Kwh (1970) to 0.28 kg/Kwh

China dropped from 0.33 kg/Kwh to 0.26 kg/Kwh, UK from 0.26 kg/Kwh to 0.17 kg/Kwh.

Net Zero Carbon Strategies and Pathways

Key mitigation strategies	Pathway
Reduce demand	1. Integrated spatial planning
	2. Single-sector efficiency, conservation, and lifestyle changes
	3. Cross-sector urban industrial symbiosis
Switch supply	4. Decarbonize electricity
	5. Electrify heating and mobility
	6. Carbon valorization
Enhance carbon uptake	7. Enhance carbon uptake and stocks

Source: Seto et al (2021)

Carbon Analytics Gains Importance and Relevance

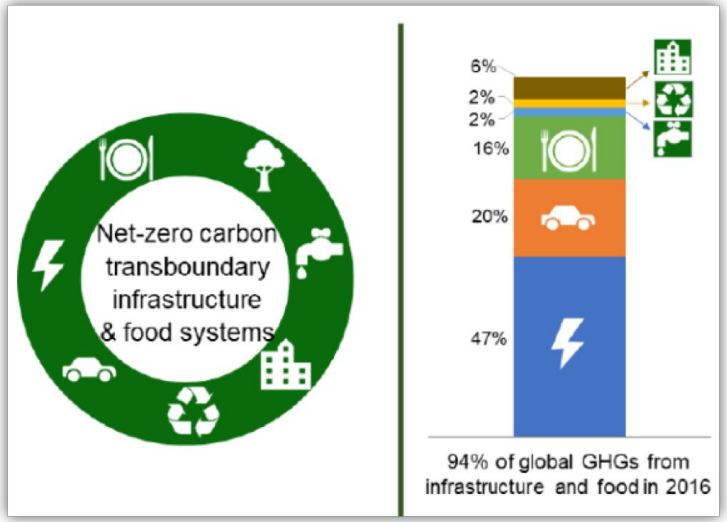
Carbon analytics for net-zero emissions sustainable cities

Anu Ramaswami, Kangkang Tong, Josep G. Canadell, Robert B. Jackson, Eleanor (Kellie) Stokes, Shobhakar Dhakal, Mario Finch, Peraphan Jittrapirom, Neelam Singh, Yoshiki Yamagata, Eli Yewdall, Leehi Yona & Karen C. Seto

Nature Sustainability (2021) | Cite this article

358 Accesses | **42** Altmetric | Metrics

Consensus on carbon accounting approaches at city-level is lacking and analytic frameworks to systematically link carbon mitigation with the Sustainable Development Goals are limited. A new accounting approach anchored upon key physical provisioning systems can help to address these knowledge gaps and facilitate urban transitions.



Source: Ramaswami (2021)

The Evolution of City Nomenclature

Table 1 Precursor urban initiatives and concepts related to net-zero carbon city

Concept/movement	Key ideas	Relevance to net-zero carbon cities
Sanitary reform (1840s)	Removal of filth and eradication of disease, especially cholera Innovations to remove and dispose sewerage and waste and deliver clean water lead to development of water and sewage infrastructure.	Physical infrastructure is fundamental to healthy city functioning.
Garden City (1890s)	Reclaiming nature in city planning, leading to New Town movement in the United Kingdom and colonies and, in turn, low-density, car-dependent suburbs (23) New design principles call for cities and towns to be surrounded by greenspace: gardens, agriculture, recreation area. Within the town, land uses—commercial, residential, industrial, etc.—are spatially differentiated.	Planning paradigms can change the layout of cities but can also have unforeseen implications.
City Beautiful (1890s)	Beautification of cities through construction of parks, grand boulevards, and monuments, with emphasis on street layout and a strong modernist suburban style (23)	Ideas for cities can move around the world and be given different expressions.
Eco-city (1990s)	Well-being of citizens and society through integrated urban planning and management that harness benefits of ecological systems Designing cities on ecological principles and keeping them in balance with nature (24)	Fundamentally questioned modernist planning and set out to transform cities to meet global and local ecological needs such as lower carbon.
Sustainable city (1990s)	Built on ecology but with emphasis on reducing the metabolism of cities, reducing car dependence, and enabling integrated economic and social outcomes (16)	Enabled a model for reducing energy use for global and national sustainability goals.

Source: Seto et al (2021)

Urban Sustainability: Net Zero Carbon City

Water sensitive city (2000s)	Urban water management approach that emphasizes circular design of water systems, such as rainwater harvesting and recycling, green roofs, rain gardens, and bioswales (25)	Water and energy use in cities are closely connected.
Smart city (2000s)	A digitally connected city that uses information and communication technologies (e.g., sensors, Internet of Things) to measure, manage, and improve quality of life and efficiency of urban activities (26, 27)	Reducing energy use and integrating local solar and wind systems into cities is made easier by smart systems.
Low-carbon city (2000s)	Decouples urban economy and activities from fossil fuel use and emphasizes energy efficiency, renewable energy, and green transportation (7, 28, 29)	Focused on carbon as the primary outcome that must be addressed but also with other goals.
Net-zero carbon city	Goes further than low-carbon city to remove all fossil fuels in a bigger system boundary and to regenerate urban and regional landscapes with carbon sequestering landscapes and circular economy strategies (30–33)	All of the above need to be integrated into urban regions.

Source: Seto et al (2021)

Global Energy Goes Local

Russia-Ukraine war

Countries search for Energy Independence

Multiplier inflation on prices

Covid 19

Broken Supply Chains

Deficit in International trust

Climate action

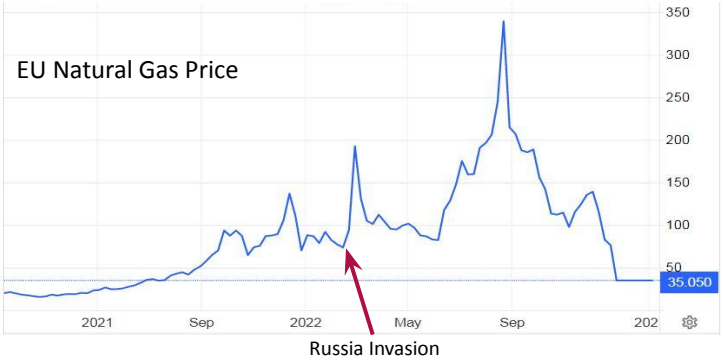
Governmental focus on emission reduction

Exponential Growth in alternative fuels

ESG & Net Zero

Companies moving towards sustainability

Additive Branding potential



Source: Statista/Wikipedia

Emissions Factors and Municipal Waste

Municipal Solid Waste

The EF from waste landfilling is estimated using IPCC's default methodology (IPCC 2006c):

$$CH_4 = MSW_T \times MSW_F \times MCF \times DOC \times DOC_F \times F \times \left(\frac{16}{12} - R\right) \times (1 - OX), \quad (1)$$

where MSW_T is the total waste generated; MSW_F is the fraction sent to landfills; MCF is the CH_4 correction factor; DOC is the degradable organic carbon; DOC_F is the fraction of DOC dissimilated; F is the fraction of CH_4 in landfill gas, with a default value of 0.5; R is the recovery of CH_4; and OX is the oxidation factor, with a default value of 0. For the variables requiring specific data relating to Delhi's waste composition, namely MCF, DOC, and DOC_F, we turn to the literature. Both Sharma and colleagues (2002b) and Kumar and colleagues (2004) estimate MCF and DOC at 0.4 and 0.15, respectively. Their estimates of DOC_F differ, however; where Sharma and colleagues (2002b) report 0.5, Kumar and colleagues (2004) report 0.77. Upon substituting these variables into equation 1, we estimated the range of Delhi's EF from landfilling as 0.4 to 0.6 kg CO_2-eq/kg of landfilled waste, and used the average of the two.

Industrial Process Benchmarks

The Delhi Pollution Control Committee (DPCC) estimates Delhi generates 7,310 tonnes of municipal solid waste (MSW) daily (DPCC 2010),[10] amounting to about 0.16 tonnes per resident per year (t/resident/yr), which compares to 0.14 t/resident/yr nationally (Sharholy et al. 2008). About 7% of Delhi's waste is diverted in the form of compost. Additionally there are three ongoing waste-to-energy projects in Delhi that promise to divert close to 15% of today's MSW (DPCC 2010).

Releases of untreated wastewater can also be a source of considerable GHG emissions. Rivers, lakes, lagoons, and the like provide anaerobic conditions for untreated wastewater, resulting in methane (CH_4) and nitrous oxide (N_2O) production. It is estimated that Delhi captures and treats 63% of its total wastewater produced (MUD 2010). Noting that Delhi treated 1,584 million L of wastewater per day in 2009 (MUD 2010), we estimate the 2009 releases of untreated wastewater total 339,633 million L.

Among the other industrial processes recognized by the Intergovernmental Panel on Climate Change (IPCC) as contributors to GHG emissions, cement production is the most prominent (IPCC 2006a). The Cement Manufacturers Association (CMA) reports no cement production within the boundaries of Delhi, thus providing a basis for incorporating cement as a relevant scope 3 item. No other industrial process emissions were readily identified within Delhi boundaries.

Chavez, Ramaswami 2012

Urban Risk Management for Municipal Waste

Raw Material	Price and availability of municipal waste
Pollution	Environmental concerns of WTE and Coal Power Plants
Operations	Difficult political economy with policy actors
Governance	Municipal corporations are not empowered

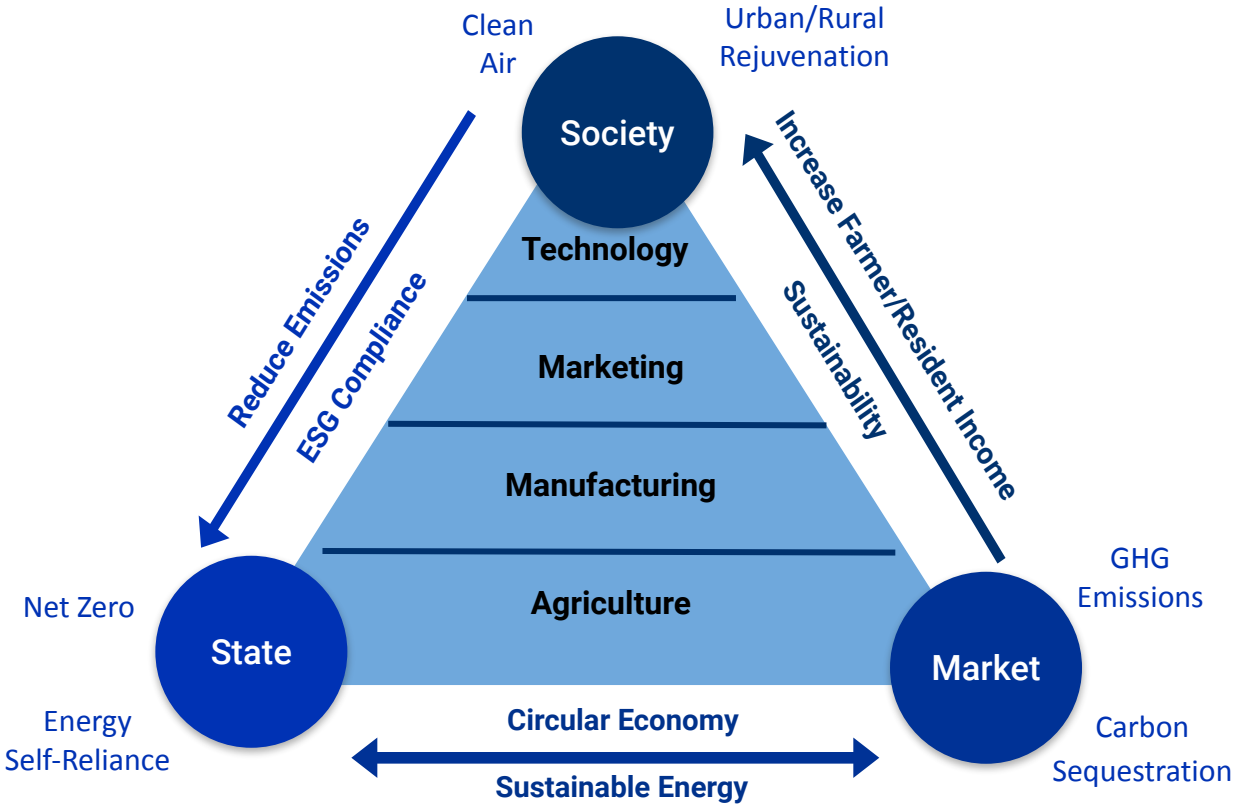
Many Efforts and Some Gaps in India's Stubble Management

Segment	Type	Who	People	Key Insights
State (Union, Delhi, Punjab, Haryana, Bihar, Uttar Pradesh)	Legislature	Public representatives (MPs, MLAs, MCs)	14	• Low knowledge of techno-commercial aspects of biomass and boilers • Slow industrial adoption of government mandates for biomass co-firing • Risk averse bureaucracy copies EU regulation without localization • Politicians have no skin in the game
	Executive	Union/State Government Ministers/Technocrats	12	
	Judiciary	Judges and lawyers at NGT, SC and HCs	7	
	Bureaucracy	Officers at state, district, tehsil and village level	21	
Market	Businesses	Corporates, MSME and village enterprises	36	• Working capital hard to find for sole proprietors to kickstart projects • Market making and buyer interest created by state of economy + war. • Vendors overcommitted to form factors, and types of residues • Parali startups focus on product/D2C rather than B2B sales/energy
	Industries	PSU's, Conglomerates, Manufacturers	23	
	Startups	Startups, incubators, accelerators	16	
	Financial institutions	Banks, NBFCs and money lenders	7	
Society	Farmers	Farmer Collectives and Farmer Producer Organizations	17	• Farmers need residue cleared in 25 days • Unpredictable yields and pricing for crops that aren't rice or wheat • Academia doesn't pursue industrial research to productize solutions • Media uninformed, social media uninterested, NGOs ineffective
	NGOs and Civil Society	Charitable organizations and faith based institutions	19	
	Academia	Scientists, researchers and practitioners	15	
	Media and Digital Media	Journalists, influencers, social media experts	9	
Total			190+	

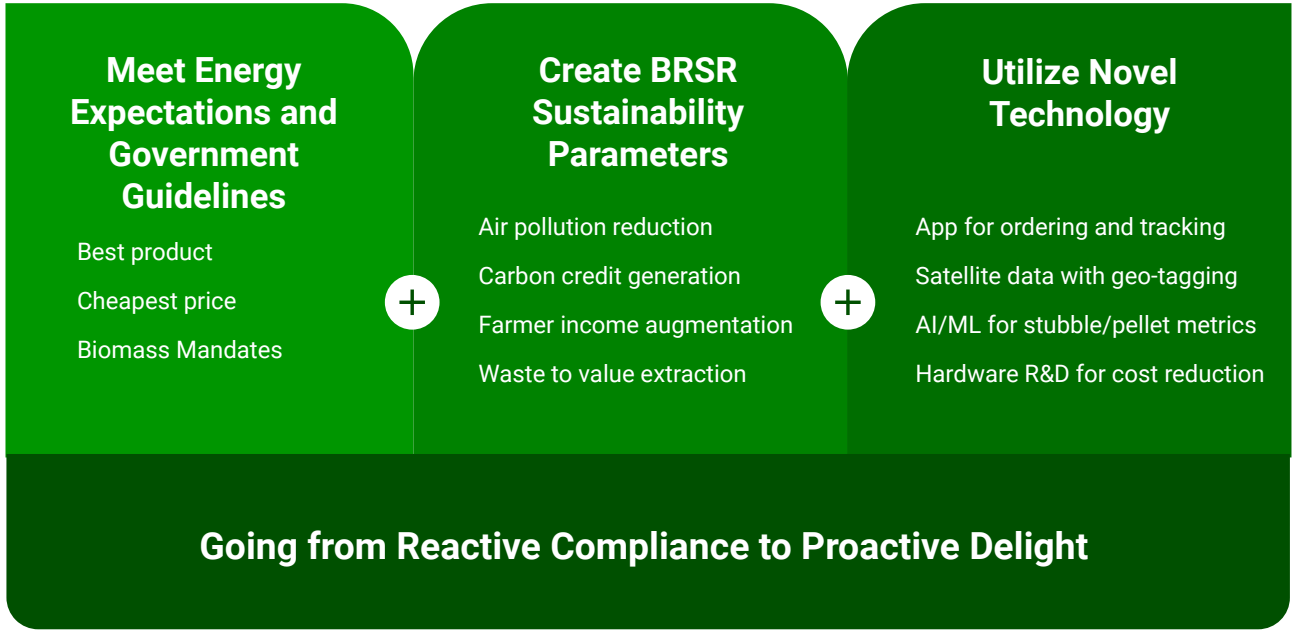
Rural Risk Management for Rice Straw

Price	Price and availability of input biomass vs. coal
Product	Physical and chemical properties of rice parali
Operations	Rural economy with decentralized collection
Marketing	Provenance and certification of carbon credits

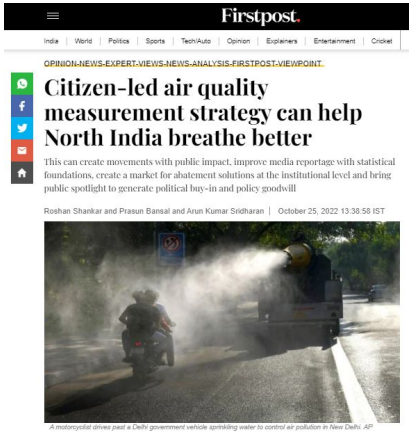
Sustainability => People, Profit and Purpose



Recommended Strategy for Power Plants



Writings on Improving Air Quality and Securing Energy Security



[Citizen-led air quality measurement strategy can help North India breathe better]

[Collaborative state can curb north India's stubble burning]

[An organised, robust response to stubble burning is need of the hour]

[Parali To Power Plants: PPP To Improve North India's Air Quality]

Thank you

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