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DEVELOPMENT ALTERNATIVES

Monthly newsletter on issues of sustainable development

JK Lakshmi Cements, Sirohi, Rajasthan

Alternative Green Technology Solutions

Contents

The views expressed in the articles in this newsletter are those of the authors and not necessarily those of Development Alternatives.

Editor: Zeenat Niazi

Editorial Team: Shaila Sam, Bharti Kapoor, Payal Choudhary and Binu K George

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B-32, Tara Crescent, Qutub Institutional Area, New Delhi-110016

Tel: +91(11) 2655 4100-200

Fax: +91(11) 2685 1158

Email: library@devalt.org

Website: www.devalt.org

Technology Innovation – Disruptive Technologies for South-South Cooperation

Workers at a traditional brick kiln in East London, South Africa

There has been a wide variation in the definition of 'technology Innovation'. Going by theory, technology innovation is the process of developing a new process or a new product that alters the dimensions of our lives by bringing in disruptive changes in the way we do our work. Various constituents define 'technology innovation' as their own way of preference. An academic institution defines it as a disruptive product or process of producing a product. An engineering company will define technology innovation as a product or a process that improves the profitability of the company. The service sector defines it as an innovation that brings in a systematic change in people's lives.

At Technology and Action for Rural Advancement, we believe in technology innovation as the 'profitable implementation of creative ideas'. This not only changes the work that we do but also the very dimensions of our lives. We believe that innovations must be creative to bring about a disruptive change in everybody's life and it must be profitable. At TARA, we develop technologies for both scaling up and scaling out to ensure that the benefits reaches across the planet. If a product that is developed is not cheaper than the conventional product available in the market then it will not be accepted, and the innovation will remain in scientific journals. This theory is the backbone of our belief at TARA, and we strive on 'there is a little bit of TARA in the lives of rural India'.

TARA works in three areas of innovation:

1. **Product innovation:** Emerges from the need to develop a new product assisted

by the rapidly changing technologies of the world.

2. **Technology innovation:** Emerges from the rapidly changing environment of manufacturing the product, mainly looking at how to deliver it at scale in a lesser amount of time and at an affordable cost.

3. **Value innovation:** Increasing the value of a product or service in the search for a new un-tapped market.

For example, the most important value innovation of the decade is the services provided by Uber, Ola, Swiggy, Zomato, Groww or similar companies. These companies do not own any materials or capital but aggregate services and provide value to customers by improving the ease of doing business, including improving their lives.

TARA was set up in 1985 with the idea of exploring the interface between technology and people. Thus, most of the work we do involves close association with people. Over the past couple of decades, our focus on technology innovation has primarily been to benefit the people and planet across the world and not limiting only to India. Thus, our technology and technology development initiative is based on the following axioms:

1. **Climate friendly:** Technologies that we develop must save greenhouse gas emissions so that our future can breathe a healthy life.

2. **Resource efficient:** Our products are based on the use of waste materials so that the impact on virgin natural resources is minimised.

3. **Fulfil circular economy principles:** Our products and technologies provide economic value to non-commercial-grade raw materials that are not used much or for which the cost of use is not commercially feasible. Our technologies recycle a company's waste into a profitable product, causing a paradigm shift in the valuation of the material.

4. **Create jobs and enterprises:** Our technologies create jobs and enterprises across the value chain that are decent and provide dignity to people's lives. Thus, these enterprises operate throughout the year in a socially just way, providing jobs and decent income security.

5. **Socially acceptable and relevant:** Our technologies produce products that are not futuristic but relate to the market and where there is a demand for the same.

6. **Profitable and affordable:** All our products are affordable compared to similar products available in the market, and the technologies used to produce them have a bankable rate of return.

At Technology and Action for Rural Advancement, through a span of four decades, we have developed a repository of more than 40 technologies that cater to the needs of both SMEs and large companies. Most of our technologies are based on creating Wealth from Waste with a primary focus on their large-scale utilisation. Some of the flagship technologies are the use of stone crusher dust in building materials, e.g. Micro Concrete Roofing Tiles, Paving Blocks, Door and Window Frames, Kerb Stones, Planks and Joists, Floor Tiles and a wide range of other products. These are durable, use waste and can be customised based on designs and requirements. Technologies have been developed to produce walling and flooring building materials from construction and demolition wastes, sandstone dust, marble dust, kota stone dust waste and other varieties of wastes. Products have strengths of more than 80 MPa based on the need and can be usedin both structural and non-structural applications. To reduce the use of fossil fuels, technologies have been commercially developed and disseminated for producing pellets and briquettes from waste biomass, municipal solid wastes, packaging wastes, plastic and paper wastes. These can help partially replace coal as a fuel in all types of thermal applications, ranging from commercial cooking to cement plants to thermal power plants. ❐

Dr Soumen Maity
smaity@devalt.org

Asia's First Limestone Calcined Clay Cement Plant in 2025

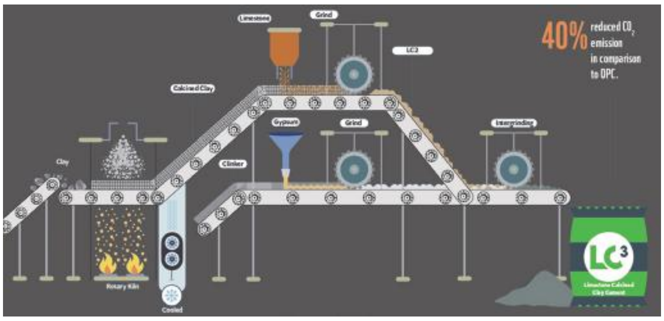
With a consumption rate of 30 billion tonnes annually, concrete is still the world's second most consumed substance. Cement, a major ingredient, is responsible for about 90% of the emissions in concrete and accounts for 8% of global anthropogenic CO_2 emissions.

One of the most trusted innovation in reducing CO_2 emmitions is Carbon Capture, Utilisation and Storage (CCUS). It has been proven that CCUS is not only capital intensive but also lacks any replicable on-ground example in any of the significant clinker-producing countries of the global south. Thus one of the most feasible option is to reduce clinker content. Developing alternative cementitious materials, plays a significant role in reducing emissions in the immediate future. Historically, the cement industry has utilised industrial by-products such as fly ash and slag to reduce the consumption of raw materials and decrease environmental impact; however, recent insights predict that the availability of these SCMs (supplementary cementitious materials) will be constrained in the next four decades.

Numerous studies by institutes and multilateral agencies have reviewed Limestone Calcined Clay Cement (LC^3) to reduce carbon emissions by 40%. It has been a parallel and a different journey to incubate the innovation out of university labs and transfer it profitably, efficiently and most importantly in a climate-friendly way to the industry.

LC^3 technology, a significant breakthrough in the cement industry, has found its roots in the global south, particularly in India. Spearheaded by a consortium of institutes and cement manufacturers like Ultratech Cement Ltd, JK Lakshmi Cement Ltd, JK Cements Ltd, Star Cements Ltd, and others, this technology blends clinker with calcined clay and raw limestone to reduce carbon emissions. With the technical support of the Indian Institute of Technology, Madras, the Indian cement industry's adoption of LC^3 and the publication of IS standards signify a pivotal shift towards eco-friendly practices, strongly driven by the Government of India's initiatives of a net zero emission target by 2070.

TARA Applied Research Centre, in partnership with Promac Engineering, has been instrumental in enabling the possible emergence of standalone rotary kiln-based Calcined Clay (CC) and Limestone Calcined Clay (LC^2) plants in Asia and Africa. This innovative approach leverages a blend of limestone and calcined clay as a new product, proving to be an alternative for economic viability. Previously, due to complex logistics in dense countries of the global south, cement plants found themselves distant from raw clay resources, making an investment in a new low-carbon cement financially unattractive. However, proposing equal proportions of Ordinary Portland Cement/CEM1 to be blended with an equivalent LC^2 mix at a satellite plant to formulate twice the amount of LC^3 has now gathered fresh appeal to most cement and concrete manufacturers to produce low carbon cement and concrete blends. This recent development has led to a mature ecosystem where an actual commitment to profitable environmental stewardship in the construction sector can be showcased.



LC^3 produces 40% less emissions compared to OPC*

The rise and demand of calcined clay-based cement feasibility surveys conducted by TARA Applied Research Centre in recent years bring focus to regions including the Middle East, Southeast Asia and the Indian Subcontinent, wherein the commercialisation of the technology may herald Asia's first LC^3 plant in 2025.

The study will highlight why searching for alternative SCMs must focus on the most widely available material given the circumstances: calcined kaolinitic clay.

The global urbanisation trends are creating a growing demand for low-carbon cement, particularly in Asia, Africa and Latin America, as cities expand and infrastructure projects multiply. The construction of roads, bridges, buildings and other infrastructure requires large quantities of cement and concrete. Adapting to this evolving demand with an equally robust and low-carbon technology like LC^3 will be necessary. It is imminent that before the decade is over, cement manufacturers in the global south will need to invest in LC^3 and comply with evolving regulations, collaborating with various stakeholders to meet their sustainability and business goals. ❐

Dr Debojyoti Basuroy
dbasuroy@devalt.org

* Ordinary Portland Cement

Policy Innovations for Accelerating a Green Transition

Fly Ash brick making at Ghitorni, Delhi

Policy innovation refers to driving and implementing effective policies that address diverse environmental imperatives and societal challenges to help achieve specific targets and goals. Notwithstanding its growing need for energy to meet aspirations, India has committed to achieving net zero carbon emissions by 2070 and implemented a reform process to transition to green energy. Green initiatives, rapid acceleration of solar energy production, biofuels, electric mobility and green hydrogen production dominate the energy sector. By 2030, India has committed to reducing the emission intensity of its gross domestic product by 33% and has a target of 30% penetration of electric vehicles. Policy innovation has formed the backbone of this transformation process, and some of the key drivers merit special mention:

- **Evolving standards and norms for regulation of air pollutants:** Bharat Stage (BS-VI) emission standards are for internal combustion engines and spark-ignition equipment, including motor vehicles. The implementation of the BS-VI norms has transformed the automobile industry in India.
- **Bureau of Energy Efficiency (BEE) rating system for electric appliances:** BEE ratings show how much electricity your appliance consumes. With one to five-star ratings, 5 stars mean your appliance is highly energy efficient.
- **Performance-linked incentive (PLI) scheme:** The PLI-Auto scheme aims to boost domestic manufacturing of advanced automotive technology products, including electric vehicles and their components.
- **Strategic intervention for the green hydrogen transition (SIGHT) programme:** This initiative provides a financial incentive budget outlay for green hydrogen production and electrolyser manufacturing to enhance the utilisation of green hydrogen in the transportation sector.
- **Interest subvention for solar application:** The KVIC provides an 8% interest subvention ceiling under Mission Solar Charkha. The interest subvention is for working capital requirements.

These and other policy innovations have been very effective in accelerating the adoption of green technologies by providing incentives and mitigating risks for producers and consumers. The cement sector in India is currently witnessing a boom with rapid expansion of production capacity to meet the growing needs of housing, infrastructure and other sectors of the economy. The cement sector, recognised as a 'hard-to-adapt' industrial sector, has undertaken the challenge to reduce carbon emissions drastically. Various studies of future trends in cement production have established the role of enhancing the share of blended cement in India's total production. This strategy minimises the use of limestone and increases the share of other raw materials, primarily Kaolinitic clays.

- **Limestone Calcined Clay Cement (LC^3): A case for supporting** LC^3 has emerged as one of the potentially viable solutions

XRD machine testing mineral content

for addressing climate risk and resource crises. LC^3 is an innovative cement variety comprising a blend of Portland Cement Clinker, calcined clay, low-grade limestone and gypsum. The Bureau of Indian Standards has published the standards and specifications for Portland Calcined Clay Limestone Cement, IS 18189: 2023, paving the way for leading cement companies in India to commence production and marketing of LC^3. Policy initiatives can surely accelerate the green transition in the cement sector by lending support for the preferential use of LC^3.

- **Rationalisation of applicable GST:** The current applicable GST rate for cement is 28%. LC^3 cement will demonstrably reduce carbon emissions in production, significantly reducing the consumption of high-grade limestone and diversifying the consumption of widely available Kaolinitic clays and low-grade limestone. Wide-scale usage of LC^3 with associated environmental benefits can benefit from a lower applicable GST rate of 12% or even 18%.

- **Mandatory use of LC^3 in housing for all schemes:** Beneficiaries of the economically weaker section, low-income group (LIG) and middle-income group (MIG) are eligible for interest subsidies ranging from 6.5% to 3.0% on the loan amount. The mission of green, affordable housing can mandate the use of LC^3 cement in all such schemes where interest subsidies and grants are made available.

- **Green finance for producers of LC^3:** Cement producers in India are driving carbon emission reduction through initiatives, captive solar energy and wind energy installations, waste heat recovery systems and energy efficiency measures. The production of LC^3 cement would accelerate this process. The government must define low-carbon pathways with immediate milestones and an enabling policy framework that includes domestic and international finance mobilisation.

The way forward is challenging but full of opportunities! ❐

Endnote

Environmental and Resource Assessment for Uptake of LC^3 in India's Cement Mix, by Kranav Sharma, Dr. Arun Kumar and Dr. Soumen Maity, 2020

Dr Arun Kumar
akumar@devalt.org

Potters of Asharikandi Showcase Sustainable Pottery Through TARA Tech

Green finished wares kept for drying at Asharikandi, Dhubri district, Assam

Located 190 kilometers west of Assam's capital city, Guwahati, lies a small village of Asharikandi sandwiched between two rivers. This village serves as an excellent example of eco-friendly products that not only align with the United Nations Development Program's target of reducing carbon footprint but also generates mass employment in the terracotta pottery sector. Asharikandi is home to over a hundred potters, renowned for their traditional artistic terracotta-making skills. In fact, terracotta and pottery are the major sole sources of income for the village.

Plastic clay is sourced from nearby areas for making the final products. It is one of the most sustainable sources of using natural resources. Since it gets replenished each and every year during the monsoons. The clay is processed manually, and the products are manufactured traditionally on a potter's wheel or by hand displaying exquisite skills. Afterwards, they are burned in a traditional kiln, and the final products are sold through a well-established retailing system. Products are also exported. However, due to the highly laborious and manual process involved, more people, especially the young generation, are gradually losing interest in this traditional business. The government is making efforts to support the ancient terracotta culture with state-of-the-art technologies.

To ensure that a balance between SDG targets and employment is met, Technology and Action for Rural Advancement (TARA) supported by NECTAR introduced modern and scientific techniques that do not compromise on traditional skills but enhance productivity without harming the environment.

Thus, TARA primarily addresses two key areas. First, the introduction of the de-airing pugmill was a significant intervention in clay processing. This machine reduced the labourious task of manually processing clay, thereby improving the productivity of the potters. The quality of the pugged clay also improved making further processing unnecessary. The pugged clay is of uniform quality and free from air voids, which ensures a higher quality of finished products. This meant that the clay procured from the clay pit areas could be directly fed into the de-airing pugmill for processing.

Secondly, TARA introduced improved firing techniques through both wood- and oil-fired furnaces. The firing downtime in wood-fired furnaces was reduced from 72 hours to 24 hours. These wood-fired furnaces were used to fire small, daily-use items. The oil-fired shuttle kiln, on the other hand, was used to fire high-value items. Sixteen local artisans from the pottery community were trained in these techniques. It was proved through testing and simulation that the overall efficiency of the production system increased by almost two times and the quality of the products improved significantly. This helped to strengthen the livelihood of local artisans, resulting in more income and higher profitability.

Installation of Pugmill

After the successful installation of the pugmill and kilns, a cost-benefit analysis was carried out based on technical data derived from the operational point of view, both from qualitative and quantitative aspects. After successes at a community level, the technological interventions were simulated to cluster level at commercial scales of production. The people who received the new technology to carry forward their traditions were excited about the latest development and expressed their interest in creating of central processing facilities amongst the potter community.

Traditional method of pottery

The efficiency and benefits of the wood- and gas-fired ovens were appreciated, and the potters saw the opportunity to reap the benefits from the machine. They have also expressed the need for both manual (hand-operated), semi-mechanised (foot-paddled operated) and mechanised (electrically-operated) potter's wheels. Since the machines installed promise good returns on investments, the potters are willing to own the above-mentioned machines and even pay for them.

The potter's families have requested the establishment of showrooms and centralised marketing facilities, along with incentives proposed by the community. After conducting visits and focus group discussions, it was discovered that the potter community in Asharikandi is content with the intervention. They also expressed interest in adopting it and contributing towards the initiative in both cash and kind. Therefore, it is recommended that such initiatives may be taken to scale up the demo initiative into a larger support programme involving new processes, technologies, training of self-help groups in service delivery systems and business sustainability, including marketing support. ❒

Anindya Dasgupta
adasgupta@devalt.org

Advancing Sustainability and Equity in Bihar's Brick Industry

Brick kiln workers at work in Bihar, India

The brick production industry in Bihar is currently experiencing a significant transformation. This change is marked by a noticeable shift towards more eco-friendly technologies and improved energy efficiency. This shift highlights the sector's commitment to sustainability and its efforts to reduce its environmental footprint. The adoption of zigzag kilns, particularly those with high draft, is leading the way in this transition. These advancements reflect a conscious effort within the industry to embrace eco-friendly practices and mitigate environmental impacts. However, despite these strides, challenges still exist, mainly due to the continued use of low-grade coal and suboptimal production processes.

The brick manufacturing industry is responsible for a significant amount of air pollution in the Indo-Gangetic plains, also known as the 'Brick Belt' of India. Bihar's brick industry alone contributes to 14% of the state's pollution, with an annual production of 23 billion bricks, making it the second-largest consumer of coal in the state. This sector also extracts a substantial amount of fertile topsoil. The industry's emissions, which include greenhouse gases and harmful pollutants such as carbon dioxide, black carbon, sulphur dioxide and nitrogen oxide, significantly contribute to climate change and environmental degradation[1].

Although the brick kiln industry is a major employer, the workforce is predominantly male, highlighting gender disparities within the sector. Creating safer and more inclusive working conditions can help to increase female participation and promote gender balance. Many kiln workers, who are often migrants from marginalised communities, face harsh working conditions and health risks. Making the industry more sustainable can be a solution to improve labour conditions and ensure the well-being of workers.

Development Alternatives in association with UNDP-Accelerator Lab and University of Nottingham is actively involved in implementing the GeoAI platform, which is a valuable tool for monitoring and regulating the brick industry. The platform collects data on worker demographics and labour conditions, which allows stakeholders to strategically target interventions in order to improve working conditions, provide

Key Insights

- Across the 12 states in India, 96% of brick kilns were located along Indo-Gangetic plains.
- In Bihar, 1680 kilns across five districts were inspected to verify brick kilns technologies, production capacity, fuel utilisation and labour-working conditions.
- Two-thirds of brick kilns were found to be operating with Zigzag technology.
- About 64% of brick kilns have medium production capacity of 15,000-30,000 bricks per day. About 33% have a small capacity of less than 15,000 bricks per day.

Finished bricks at a klin in Bihar

Mapping of brick kiln using GeoAI tool

better access to social security schemes and facilitate educational opportunities for workers' children. Furthermore, transitioning towards time-based wages and regulating labour practices can bolster economic security and empower workers within the industry.

To support the Government of Bihar's initiative in achieving "net zero" by 2070, Development Alternatives (DA) has been associated with Bihar State Pollution Control Board (BSPCB) for more than a decade. Major emphasis has been to support the brick sector to be carbon neutral and resource efficient. Thus, while the initiative advocates the promotion and use of fly ash bricks across the state, it also works with the Government of Bihar in easing the availability of fly ash exclusively for brick making activity. On the other hand efforts are also been taken to improve the performance of existing burnt brick technologies and reduce the use of coal and soil through introduction of advance technologies. ❐

Endnote

1 https://www.undp.org/india/publications/geoai-brick-kilns-bihar-learnings-and-recommendations

Prisha Singh
psingh1@devalt.org

Limestone Calcined Clay Cement (LC^{3}®)

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Contact us at
smaity@taratarc.com
dbasuroy@taratarc.com

TARA APPLIED RESEARCH CENTRE
www.taratarc.com
A UNIT OF DEVELOPMENT ALTERNATIVES GROUP

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Owner and Publisher: Dr Ashok Khosla on behalf of Development Alternatives

Development Alternatives
B-32, Tara Crescent, Qutub Institutional Area, New Delhi - 110 016
Tel: 91 (11) 2654-4100, 2654-4200, Fax: 91 (11) 2685-1158
Email: library@devalt.org, Website: www.devalt.org