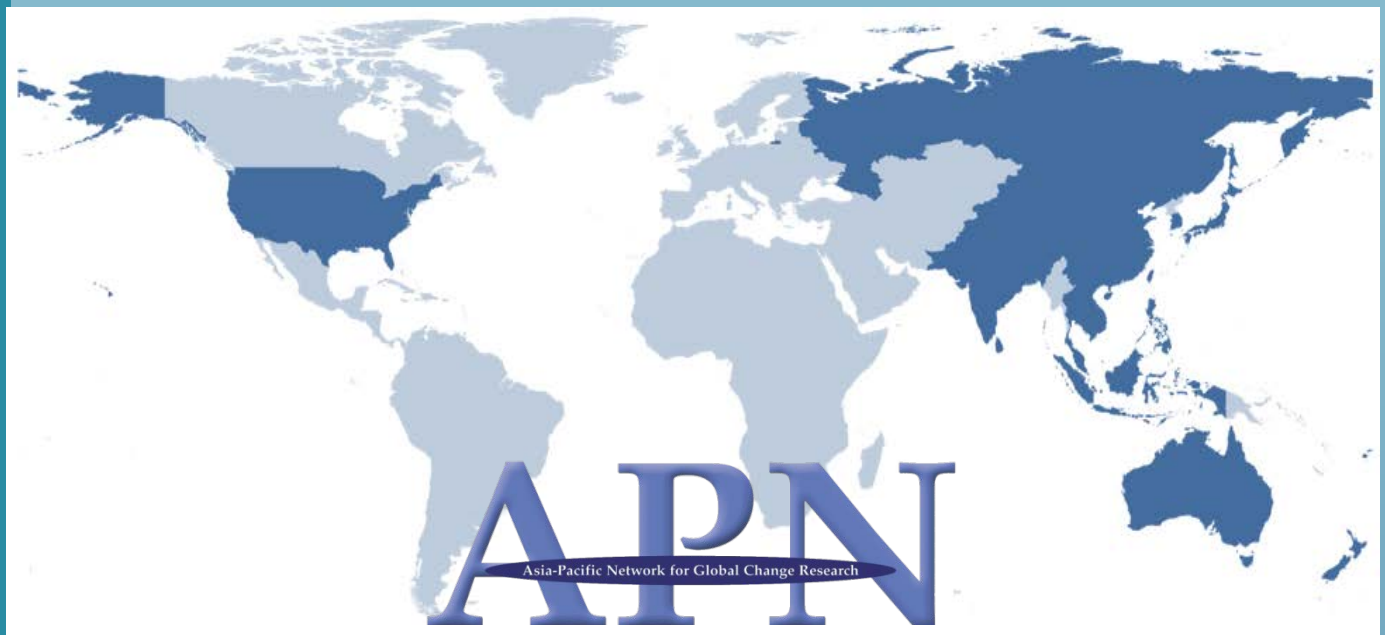
Final Report for APN LCI PROJECT

Project Reference Number: LCI2013-01CMY(R)-Vashist

Identification of Policy and Institutional Gaps, Drivers and Strategies to Scale-up Low Carbon and Energy Efficient Technology Application in the Construction and Infrastructure



Low Carbon Initiatives Framework

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Identification of Policy and Institutional Gaps, Drivers and Strategies to Scale-up Low Carbon and Energy Efficient Technology Application in the Construction and Infrastructure Sectors of South Asia

Project Reference Number: LCI2012-01NMY(R) - Vashist/ LCI2013-01CMY(R)- Vashist

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

The construction sector of India, Nepal and Pakistan are currently seeing a boom in the construction sector owing to growing economy and rapid urbanisation. The growth of the sector has critical environmental implications. It has been estimated that buildings are responsible for more than 40% of the total global energy used, and contribute to approximately one third of the global greenhouse emissions, both in the developed and the developing countries (UNEP SBCI, 2007). Apart from the energy footprint, it also has a high resource footprint.

With is understanding of the status of the construction sector in South Asia and the increasing demand for housing in these respective countries, the project aimed to focus on the housing sector especially social housing in small and peri-urban areas. Thus in order to build a narrative on use of low carbon technology options in South Asia, case studies on the application of such technology options were documented in the 3 selected countries, namely India (Fly-ash bricks, prefabrication, bamboo), Nepal (Hollow Concrete Blocks, Compressed Stabilised Earth Blocks, Bamboo) and Pakistan (Vertical Shaft Brick Kilns, Hydraulic Lime and Earth and Bamboo).

The project further focused on deriving lessons from the case studies, technology and institutional maps and the policy analysis to prepare a country report. The report identified strategies employed to successfully mainstream low carbon options both within the sector as well as it drew lessons from other sectors. This was further collated into a regional report. The regional report looked at economic, technological, and regulatory and policy frames in the different country situations.

Overall, the case studies on low carbon and energy efficient materials and technologies from across South Asia, revealed that the construction sector as a whole is these countries is disaggregated with complex interlinks among both the public and private stakeholders. While low carbon materials and technologies do exist, their adoption and mainstreaming of these materials and technologies continues to be an uphill task. While policies and markets need to be strengthened, capacity building and more importantly awareness generation is crucial for the successful adoption of these technologies. Thus attention needs to be paid to all stakeholders in the value chain, their coordination and cooperation in mainstreaming the use of these materials and technologies, which will thus result in the transition towards more green and inclusive economies.

Keywords: Construction, low carbon, energy efficient, reconstruction, affordable housing

Objectives

The research project caters to the urgent need to increase awareness about the environmental consequences of a massive development of current building practices. It aims to show the way forward for the generalization of clean technologies to the social housing space, and ultimately, to the housing sector as a whole.

Key policy questions that the study seeks to answer are:

- How can regulatory and financing frameworks create an enabling environment for the proliferation of low carbon technologies across the region in public and private construction and infrastructure development?
- What kind of institutional capacity gaps need to be filled (and how) for accelerating low carbon construction and infrastructure?
- What kind of partnerships are required to ensure a robust eco-system for the accelerated application of low carbon construction and infrastructure technologies.

Amount received and number years supported

The Grant awarded to this project was:

US$ for Year 1: USD 40,000

US$ for Year 2: USD 43,600

Activity undertaken

- Technology and institutional mapping was undertaken to understand the current status and gaps in capacities at different levels
- Case Studies of India
  - Low Carbon and Resource Efficient Technology: Scaling up of Fly Ash Brick Technology in India
  - Bamboo: Use in Structural Applications
- Case Studies of Nepal
  - Bamboo: Value Added Market for Engineered Housing
  - Public Acceptability of Hollow Concrete Block: Overcoming Policy and Market Barriers
- Case Studies of Pakistan
  - Bamboo Construction: Low Carbon and Disaster Resilient Alternative
  - Energy Efficient Brick Production: Vertical Shaft Brick Kilns
- Use of Hydraulic Lime and Earth in Disaster Risk Management
- Country report produced on Low Carbon Construction: Drivers and Barriers

- Regional report on Low Carbon Construction: Drivers and Barriers
- Policy briefs:
    1. Towards Upscaling the Application of Low-Carbon and energy-efficient technology in the Construction Sector- India.
    2. From Gray to Green: Driving Low carbon and energy-efficient housing- Nepal.
    3. Low-carbon, Energy-efficient and disaster-resilient construction alternatives- Pakistan

Results

Results from the regional case studies reveal that pathways to sustainability in construction do exist. The analysis of the case studies have thus helped in identification of all the stakeholders that play an essential role in creating an enabling environment for the adoption of low carbon and energy efficient materials and technology.

In the case of Vertical Shaft brick kilns in Pakistan, it was found that there was a 30-50% reduction in energy consumption (SKAT EEBP, 2010). While the VSBK is an example of an efficient use of technologies, the use of fly ash bricks is an example of resource efficiency, where the residue of thermal power plants is used to produce building bricks. Further, alternative building materials, like micro-concrete roofing tiles, stabilised concrete earth blocks and prefabricated roofing elements can reduce the resource consumption by 25-30% (DA-CDKN, 2013).

Relevance to the APN Goals, Science Agenda and to Policy Processes

APN's scientific agenda as per the Third Strategic Plan (3SP) aims to foster the understanding of global environmental change by conducting regional research through collaboration and capacity development. The project was a collaborative study between three developing countries (India, Nepal and Pakistan). The collaboration and communication between the APN member countries for this shared research initiative has feed into APN's Institutional Agenda. The project focus is on change drivers for clean technology in the construction and infrastructure sector which is aligned to 3SP's thrust area on Resources Utilisation and Pathways for Sustainable Development. The present project has aimed to strengthen global change research and provide insights into capacity gaps via syntheses and assessment work, focusing on sustainable development in the construction sector. A multi-stakeholder study, it includes the involvement of all communities of technology developers, supplies, market players, industry, civil society, public and decision makers.

The research has built upon the rationale that the construction sector at 9% annual growth rate is one of the fastest growing sectors in the region and after energy is the second highest contributor to national GHG emissions at 22%. The case studies from the identified countries have highlighted the

possible use of low carbon construction technologies like Vertical Shaft Brick Kilns (Pakistan), Bamboo(India, Nepal, Pakistan), Fly-ash (India), Hydraulic lime (Pakistan), Hollow Concrete Blocks(Nepal) and Compressed Stabilized Earth Block (CSEB).

The outcomes of the project thus are in line with APN's thrust on climate change mitigation through enabling regional collaborative research in Asia and encouraging a dialogue between researchers and national/local policy makers in the developing countries. The results from the regional case studies reveal that pathways to sustainability in construction do exist. Cleaner and alternate technologies have been developed that can substantially reduce the ecological footprint of the sector.

In the case of Vertical Shaft brick kilns in Pakistan, it was found that there was a 30-50% reduction in energy consumption (SKAT EEBP, 2010). While the VSBK is an example of an efficient use of technologies, the use of fly ash bricks is an example of resource efficiency, where the residue of thermal power plants is used to produce building bricks. In India, 163.56 million tonnes of fly ash was generated in 2012-2013 (Central Electrictiy Authority, 2014). Fly ash is now increasingly being used as a resource material rather than a waste. In this regard, fly ash has gained popularity in the manufacture of building materials like bricks, blocks, tiles etc, thus acting as an appropriate alternative to clay based conventional building materials. Fly ash bricks have a low environmental footprint as compared to the clay bricks produced by conventional technologies as greenhouses gases are not emitted during their production as well as conserve top soil. Further, alternative building materials, like micro-concrete roofing tiles, stabilised concrete earth blocks and prefabricated roofing elements can reduce the resource consumption by 25-30% (DA-CDKN, 2013). Energy consumption can also be reduced by 30-80% in new and existing buildings by commercially viable technologies (UNEP SBCI, 2007).

Further what has been key to this study is the role of stakeholders. In the case of Nepal as seems to be the case for both India and Pakistan as well, it has been evident that policy and regulatory frameworks play a vital role in the mainstreaming of low- carbon construction materials and technologies. For example, compressed stabilized earth blocks (CSEB) are made from a mix of dry inorganic soil, non-expansive clay, aggregate and sometimes a small amount of cement, thus making them a viable alternative to fired bricks. Attempts have been made to introduce CSEB in Nepal since the past decade; however lack of awareness among the end-users has been the main reason for its failure. Hence, strategies for adoption of this material include financial incentives like subsidies, voluntary green building certification systems, building codes etc.

Given the results of this study, the overall study has aimed to identify the barriers and drivers to the adoption of these technologies, thus moving towards trying to create a dialogue between the researchers and national/local policy makers in the selected South Asian countries through the policy briefs.

Self-evaluation

The progress in the project has been satisfactory. A lot of time was dedicated on conducting in depth research on the drivers and barriers in the scaling up of low carbon technologies in the affordable housing sector. In order to have uniformity in the mapping studies, a common framework was designed in the first year of the project. The partners contextualized this framework in their research. Based on the analysis frame, the country as well as the regional report, have attempted to highlight the key drivers and barriers that exist for the up-scaling of low carbon and energy efficient technologies.
The APN Global Change Perspectives policy brief on the 'application of low carbon and energy efficient technologies in the construction sector' was an outcome of the case study analysis of the identified countries. This policy brief showcased significant insights into the commonalities that the countries share and the future potential for interactive research in South Asia.

Further, another output of the study was a collaborative research paper titled, 'Upscaling the Application of Low-Carbon and Energy-Efficient Technology in the Construction Sector.' Having undergone revision, the paper was published in the APN Science Bulletin in April, 2016. Since it is a collaborative research, coordination between partners is essential to the smooth progress of the project. There have not been any major road blocks on this account.

Potential for further work

The overall project has provided considerable insights into the construction sector within each country as well as at the regional level, and the roles that the stakeholders play in acting as barriers or drivers in the mainstreaming of these low carbon technologies into the construction sector.

Given this context, the next step would be for greater interactions with Governmental agencies and research and development organizations, in attempting to bridge the knowledge and policy gap, for greater awareness and market generation of these technologies. An important intervention for governmental agencies would be for formulation of 'Sustainable Public Procurement' schemes, which would provide for greater awareness and demand for the application of low carbon and energy efficient technologies.

Publications (please write the complete citation)

- Development Alternatives (2015). *Low Carbon and Resource Efficient Technology: Scaling-up of Fly Ash Brick Technology in India*
- Development Alternatives (2015*). Bamboo: Green Construction Material in India*
- LEAD (2015). *Bamboo Construction: Low Carbon and Disaster Resilient Alternative in Pakistan*

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We would like to thank Asia-Pacific Network for Global Change Research for their support. Increasing environmental impact of the construction sector is a growing concern for developing countries like India, Nepal and Pakistan, and this study afforded us the opportunity to explore and understand the issue.

We would like to thank all our stakeholders who took time to share with us their initiatives in the application of low carbon construction technologies, that has reflected in the comprehensive study conducted in the report.

TECHNICAL REPORT

Preface

Construction, one of the fastest growing sectors, is a significant contributor to the development process of South Asia. However, it is one of the highest contributors to greenhouse gases (GHG) emissions and accounts for massive resource consumption. The need for improvement of construction sector is obvious. However, despite continuous efforts, examples of successful initiatives can be observed only in a few clusters. It is extremely necessary to mainstream low carbon technologies in order to mitigate the impacts of increased GHG emissions. With this background, Climate Action Network – South Asia and their collaborators, undertook research on studying the rapidly growing construction sectors in India, Pakistan and Nepal with a focus on social housing in small towns and peri-urban areas.

The regional comparative research looked at economic, technological, and regulatory and policy frames in the different country situations to strengthen regional global change research by identifying key gaps and areas for integrative research. The idea was to define the critical elements of the eco-system for promoting low carbon development pathways in the identified sectors.

1.0 Introduction

The construction sector is crucial component and indicator of a country's development. It is the second largest employer after agriculture in India, and accounted for 8.2% of its GDP in 2011-2012 (Planning Commission, 2013). The sector grew at a rate of 18% per annum from 2004-07 in Pakistan (Neilson, 2010). Along with the social and economic implications; the construction sector has a critical role to play in the environmental implications as well. Being an energy intensive sector, it contributes to around 10–24% of total national greenhouse gas (GHG) emissions in India and Pakistan (Parikh et al., 2009). Besides energy, this sector is also very resource intensive. Cement, concrete and bricks are the most sought after materials in construction. They are produced using inefficient technologies that consume large amounts of coal and release high carbon emissions. The sector has an adverse impact on agricultural yield exerting pressure on food security due to conflicts of use of fertile top soil between agriculture and brick making, aggregate mining and sand dredging of rivers for concrete, mortars and plasters.

Economic growth and the geographic reconfiguration of the demands for housing and infrastructure towards urban and peri-urban areas have fueled the growth in construction activities. However, the urbanisation process has occurred rather rapidly and haphazardly, bringing South Asia to the forefront of an enormous socio-economic shift without adequate thought and planning for defining its environmental future.

There are viable opportunities for greening the sector, however, in order to translate the opportunities to tangible benefits, several interventions in the form of public policies, awareness generation, capacity building and skill development, and appropriate financial tools are imperative.

Thus the key policy questions that the study attempted to answer are:

- How can regulatory and financing frameworks create an enabling environment for the proliferation of low carbon technologies across the region in public and private construction and infrastructure development?
- What kind of institutional capacity gaps need to be filled (and how) for accelerating low carbon construction and infrastructure?
- What kind of partnerships are required to ensure a robust eco-system for the accelerated application of low carbon construction and infrastructure technologies?

2.0 Methodology

The research study caters to the urgent need to increase awareness about the environmental consequences of a massive development of current building practices. It aims to show the way forward for the generalization of clean technologies in the social housing space, and ultimately, in the housing sector as a whole.

With a focus on low carbon, resource and energy efficient options, a literature study and technology and institutional mapping and profiling has been done for each selected country, namely India, Nepal and Pakistan. A case study approach has been adopted to analyse good practice applications and of conventional applications in each country situation, so as identify the drivers and barriers in the mass scale adoption of these construction materials and technologies (see table 1).

In addition, a stakeholder mapping process was conducted to identify the key gaps that hinder the adoption of these technologies, thus helping in the formulation of conclusions on the push and pull factors that are essential for the mainstreaming of these materials and the technologies in South Asia.

Table 1: Selected case studies on low carbon &energy efficient materials and technologies

Country name	Prevalent Low Carbon &Energy efficient Materials & Technologies		
India	Fly Ash Bricks	Bamboo	Prefabricated concrete slabs
Nepal	Hollow Concrete bricks	Bamboo	Compressed Stabilised Earth Blocks
Pakistan	Vertical Shaft Brick Kilns (VSBK)	Bamboo	Hydraulic Lime

The regional research also looked at economic, technological, and regulatory and policy frames in the different country situations and attempts to strengthen regional global change research by identifying key gaps and areas for integrative research. While the country situations differ, a common analytical frame binds the overall study.

Analysing policy thrusts and national commitments towards transformation of the sectors helped in identifying the drivers for change within the institutional mechanisms, financing systems, incentives and partnership arrangements and define the critical elements of the eco-system for promoting low carbon development pathways. It also examined barriers with respect to technology know-how, regulatory mechanisms, capacities of stakeholders and market promotion. The analysis resulted in identifying strategies that can be employed to successfully mainstream low carbon options both within the sector as well as draw lessons from other sectors.

Analysis Frame for each country:

- Policy guidelines and regulatory frameworks
- Institutional Mechanisms and synergies across institutions
- Partnerships
- Investments/ Financing
- Capacities

3.0 Results & Discussion

The results from the regional case studies reveal that pathways to sustainability in construction do exist. Cleaner and alternate technologies have been developed that can substantially reduce the ecological footprint of the sector.

In the case of Vertical Shaft brick kilns in Pakistan, it was found that there was a 30-50% reduction in energy consumption (SKAT EEBP, 2010). While the VSBK is an example of an efficient use of technologies, the use of fly ash bricks is an example of resource efficiency, where the residue of thermal power plants is used to produce building bricks. In India, 163.56 million tonnes of fly ash was generated in 2012-2013 (Central Electrictiy Authority, 2014). Fly ash is now increasingly being used as a resource material rather than a waste. In this regard, fly ash has gained popularity in the manufacture of building materials like bricks, blocks, tiles etc, thus acting as an appropriate alternative to clay based conventional building materials. Fly ash bricks have a low environmental footprint as compared to the clay bricks produced by conventional technologies as greenhouses gases are not emitted during their production as well as conserve top soil. Further, alternative building materials, like micro-concrete roofing tiles, stabilised concrete earth blocks and prefabricated roofing elements can reduce the resource consumption by 25-30% (DA-CDKN, 2013). Energy consumption can also be reduced by 30-80% in new and existing buildings by commercially viable technologies (UNEP SBCI, 2007).

Further what has been key to this study is the role of stakeholders. In the case of Nepal as seems to be the case for both India and Pakistan as well, it has been evident that policy and regulatory frameworks play a vital role in the mainstreaming of low- carbon construction materials and technologies. For example, compressed stabilized earth blocks (CSEB) are made from a mix of dry inorganic soil, non-expansive clay, aggregate and sometimes a small amount of cement, thus making them a viable alternative to fired bricks. Attempts have been made to introduce CSEB in Nepal since the past decade; however lack of awareness among the end-users has been the main reason for its failure. Hence, strategies for adoption of this material include financial incentives like subsidies, voluntary green building certification systems, building codes etc.

Similarly in the case of fly ash bricks a policy push has been the major driver for the accelerated uptake of the technology in India. The notification numbered S.O. 763 (E) of Ministry of Environment, Forests and Climate Change and the Fly Ash Mission of Department of Science and Technology, Government of India, have played a crucial role in the uptake of the technology through technology demonstration, easy access to fly ash and mandatory use of fly ash bricks in construction.

A broad analysis of all the case studies has helped in the identification of all the stakeholders that play an essential role in creating an enabling environment for the adoption of low carbon and energy efficient materials and technologies.

The table below provides a clear understanding of the key stakeholders; their roles as facilitators in adopting low carbon construction materials and their mainstreaming into the construction sector.

Table 2: Analysis of stakeholders and their roles in upscaling low carbon and energy efficient construction materials and technologies

Stakeholders	**Role**
Government	• Streamlining policies to promote the use of low carbon and energy efficient construction technologies • Introduce low carbon materials and technologies in the Schedule of Rates • Encourage preferential procurement by Government departments • Ensure quality of materials through eco-labelling / rating systems • Strengthening implementation processes and mechanism • Increased coherence and integration among departments
Private Sector	• Partnerships for strengthening supply chain through aggregation • Enhanced access to finance to provide an impetus to micro-entrepreneurs

	• Incubation services for commercialisation of technologies • Encourage PPP for commercialisation of technologies
Civil Society Organisations	• Awareness • Training and capacity building

Given that the role of all stakeholders is crucial, the study through the analytical frame seeks to further highlight the key drivers that result in up scaling low carbon and energy efficient materials and technologies in South Asia.

4.0 Conclusions

In conclusion, it is evident that the construction sector is a disaggregated sector with complex interlinks among both the public and private stakeholders. But at the same time, one is able to identify the key agents of change whose cooperation as well as coordination can bring about a paradigm shift in the construction sector from a carbon intensive and resource inefficient sector to a more sustainable construction sector.

On one hand, the Government agencies need to work towards streamlining policies to include the 'green' mandate, strengthen the implementation processes and mechanisms and increase coherence and integration among departments. On the other hand, the private sector needs to build partnerships so as to strengthen the supply chain as well as enhance access to finance to provide an impetus to micro-entrepreneurs. Finally, the civil society organizations also have a crucial role to play in generating awareness as well as building capacities towards the use of green construction materials. Thus the coming together of all these stakeholders with a universal goal of mainstreaming the use of low carbon and energy efficient construction materials and technologies will result in the transition to a green and more inclusive economy.

5.0 Future Directions

The overall project has provided considerable insights into the construction sector within each country as well as at the regional level, and the roles that the stakeholders play in acting as barriers or drivers in the mainstreaming of these low carbon technologies into the construction sector.

Given this context, the next step would be for greater interactions with Governmental agencies and research and development organizations, in attempting to bridge the knowledge and policy gap, for greater awareness and market generation of these technologies. An important intervention for governmental agencies would be for formulation of 'Sustainable Public Procurement' schemes, which would provide for greater awareness and demand for the application of low carbon and energy

efficient technologies. Therefore is a need for strong engagement among all stakeholders in order for successful upscaling of low carbon and energy efficient technologies in the overall construction sector.

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Appendix

Conferences/Symposia/Workshops

Development Alternatives (DA), Clean Energy Nepal (CEN), LEAD Pakistan and Climate Action Network South Asia (CANSA) organised a regional consultation on **"Low Carbon Options for South Asian Countries and Sectors"** at Hotel Soaltee Plaza, Kathmandu, Nepal on August 26-27, 2014 in association with PGVS and Christian Aid. This event was supported by Heinrich Boell Foundation (HBF), Oxfam and Asia Pacific Network (APN). The major objectives of the workshop were:

- Create awareness on low carbon development
- Share country and sectoral case studies
- Develop a long-term regional low-carbon development strategy

Funding sources outside the APN

Not applicable

List of Young Scientists

1. Anshika Wahi, DA (awahi@devalt.org): Research on drivers and barriers, bamboo case study.
2. Kriti Nagrath, DA (kriti.nagrath@gmail.com): Kriti Nagrath has played a crucial role in the selection and development of case studies. She has been involved in drafting the case studies through detailed research and consultations with different stakeholders. Represented India in the regional workshop. She also contributed to research on the country report.
3. Sanghamitra Misra: Sanghamitra undertook research on the various technologies and materials available for construction in India as well as the challenges in technology adoption. She was involved in developing case studies for the project.
4. Dandapani Varsha: Selection and development of case studies. Drafting of fly ash and prefab case study, policy brief and article. She attended regional workshop and contributed to the research on the country report.
5. Achu Shekhar: Achu contributed to research on drivers and barriers of low carbon technologies.