EU-REI
Creating a Resource Efficient India

Fostering Resource Efficiency in the Indian Building and Construction Sector

September 2018

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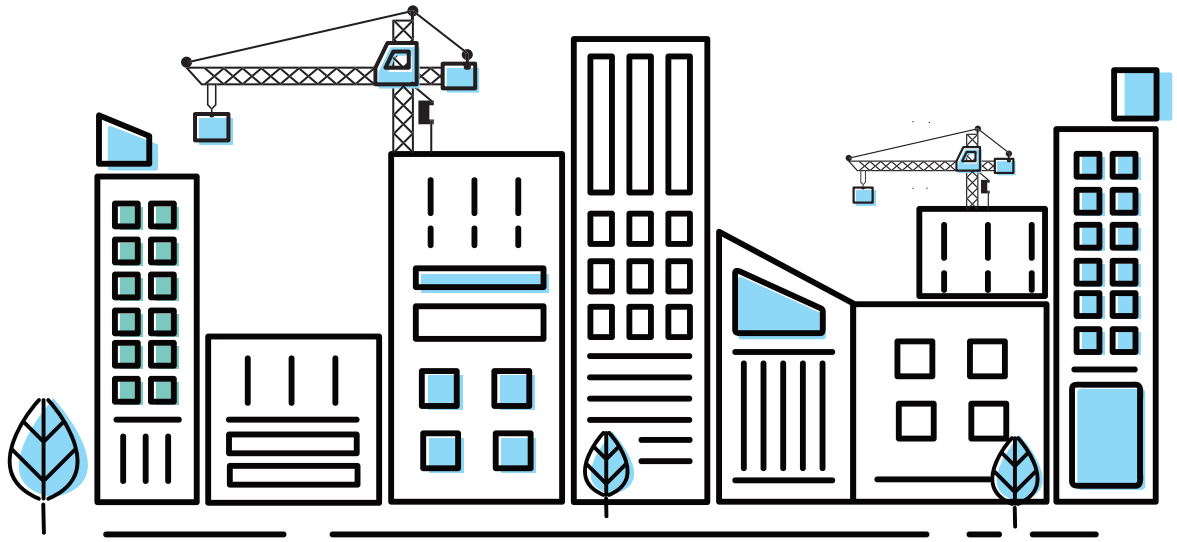

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Executive Summary

The study at hand demonstrates the urgency of effectively tackling resource efficiency in the Indian building and construction sector. An analysis of current and future material flows has shown that depletion of five of the most important resources for the building and construction sector (sand, soil, stone, limestone, iron & steel) is critically high and that a radical shift towards usage of different and more sustainable materials and building practices is needed. However, a closer look at the existing policy landscape and interviews with Indian key experts have made it clear that there is less demand for formulating new policies and regulations but rather for tangible measures and effectively implementable initiatives that can have a real impact and receive buy-in from key players.

Based on the analysis of the wider context, a large number of interviews, and three stake-holder consultation workshops with key players from the Indian construction sector, we have identified three main fields of action that could be addressed through policy innovations and tangible interventions to drive resource efficiency in the building and construction sector:

1) The use of more sustainable resources as building materials needs to be increased. Particular focus areas should be locally sourced resources and vernacular architec-ture concepts as well as demolition waste and recycled products as building materi-als. Key priority activities in this regard should be the development of local material inventories and databases as well as the development of a comprehensive set of norms and standards for locally sourced and recycled materials. This further needs to be supplemented by awareness raising, capacity building, and promotion cam-paigns.

2) The second recommended field of action is closely related to the first category and covers the promotion of transparency tools. Key elements of this are the abovementioned inventories and material catalogues as well as norms and standards as standalone activities. For the inventories, the close connection to the local level, their easy accessibility as well as their comprehensive and up-to-date information are crucial needs. For the norms and standards, key requirement are their comprehensive coverage of building materials as well as the balance between local context-specificity and national harmonisation. Further, we discuss Environmental Production Declarations (EPDs) as transparency tools and how their uptake and recognition can be increased. It is recommended to create momentum through an initial focus on larger firms and the stronger recognition of EPDs in public tender processes. Furthermore, more harmonisation across issuers and a more streamlined approach through a regulatory body seem to be needed.

3) A third focus area is indicator frameworks and green rating schemes. The greater use and uptake of green rating schemes could be key for providing more transpar-ency and comparability between building concepts with regards to their environmen-tal impact as well as facilitates systems for rewarding positive behaviour. Two key elements in this regard are a) the general promotion of green rating schemes through showcasing efforts, market leaders, and tangible incentive systems and b) the inclusion of circularity aspects in existing indicator frameworks.

Based on these key fields of action and the specific recommendations for required next steps, we propose three tangible initiatives and policy packages that could be viable ways of making the

recommended changes happen. The most important suggestion in this regard is to tackle the desired changes across all areas of action through a soft-launch approach. In a soft launch approach, the government announces that after a set timeframe, specific regulations and rules will kick in. The regulatory requirements and rules can then incrementally be increased up to that point. In the meantime the government needs to create buy-in and momentum in the sector and actively support players in adapting to the new rules as well as reward early movers. While regulations are being scaled up, the incentive and active support system should be front-heavy and scaled-down over time.

In addition to the soft-launch approach, it is recommended as a tangible next step to develop a task force that supports the respective public authorities in developing the abovementioned inventories and material catalogues as well as norms and standards and drives this process in the initial phase. Lastly, the importance of identifying and building up market leaders and best practice examples has been demonstrated. We therefore recommend actively choosing and subsidising visible pilot projects with larger private sector players for the different fields of action and use them for awareness raising and showcasing.

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List of Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
B&C	Building and construction
BEMPs	Best Environmental Management Practice
BIS	Bureau of Indian Standards
C&D	Construction and Demolition
CAGR	Compound Annual Growth Rate
CDW	Construction and Demolition Waste
CEP	Circular Economy Package
CPR	Construction Products Regulation
CREDAI	Confederation of Real Estate Developers Association of India
EFTA	European Free Trade Association
EIA	Environmental Impact Assessment
EPBD	The Energy Performance of Buildings Directive
EPDs	Environmental Production Declarations
FAR	Floor Area Ratio
FISSAC	Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extend Construction Value Chain
GDP	Gross Domestic Production
GIZ	Deutsche Gesellschaft für internationale Zusammenarbeit
GoI	Government of India
GRIHA	Green Ratings for Integrated Habitat Assessment
GST	Goods and Service Tax
IGBC	India Green Building Council
IGEP	Under the on-going Indo-German Environment Partnership
InRP	Indian Resource Panel
JRC	Joint Research Centre
LCI	Lowest Concentration of Interest
MoEFCC	Ministry of Environment, Forest and Climate Change

MoHUA	Ministry of Housing and Urban Affairs
MoUD	Ministry of Urban Development
NBSS	National Bureau of Soil Survey
NIC	National Insurance Contribution
NOx	Nitrogen Oxides
PMAY	Pradhan Mantri Awas Yojana
R&D	Research and Development
RCC	Reinforced Cement Concrete
SCP	Sustainable Consumption and Production
SEAC	State Expert Appraisal Committee
SEIAA	State Environment Impact Assessment Authority
SHPSC	State High Power Steering Committee
SPM	Suspended Particulate Matter
TERI	Innovative Solutions for Sustainable Development
ULB	Urban local body
UNEP	United Nations Environment Programme
UNFC	United Nations Framework Classification for Resources
UT	Union Territory
WRI	World Resources Institute

1. Introduction

Economic growth of the 20th and early 21st century has contributed to widespread alleviation of absolute poverty across India. However, the modus operandi of the country's economy is still rested upon a linear "take-make-dispose" logic which extracts resources, transforms them into products and simply discards them at the end of life. Following such linear consumption and production patterns is highly resource intensive and represents a waste of valuable materials. In the light of increasing resource scarcity, promoting resource efficiency (RE) and circular economy principles becomes imperative and can contribute to the long-term availability of resources and inclusive economic development in India.

Towards an International Resource Efficiency Agenda

Having recognised the urgency of the issue, the Indian government actively engages in international collaboration to implement global resource efficiency strategies, e.g. in relation to the 2030 Sustainable Development Goals (SDGs) which recognise the potential of resource efficiency in resolving trade-offs between economic growth and environmental degradation. In fact, resource efficiency strategies form a key part of Goal 12 (sustainable consumption and production) and Goal 8 (decent work and economic growth), but also links to sustainable cities and communities (Goal 11), industry, innovation and infrastructure (Goal 9), climate action (Goal 13), and affordable & clean energy (Goal 7).

Other important activities are carried out under the ambit of the G20 Resource Efficiency Dialogue which was launched in July 2017 by G20's Hamburg Declaration. According to the Declaration, the Dialogue has three core objectives: 1) exchange knowledge on policy options to increase resource efficiency; 2) sharing of best practices on resource efficiency along the entire product lifecycle; and 3) spread awareness on solutions and options to strengthen countries' national policies which reduce overall resource consumption. In addition, resource efficiency strategies can make substantial contributions to reaching the 2°C target and fulfilling countries' Nationally Determined Contributions (NDCs) as part of the Paris Agreement signed in 2015.

At the European level, the transition towards resource efficient economic model is reflected by the European Commission's (EC) Roadmap to a Resource Efficient Europe in 2011. Therein, a key component is the development of policies which encourage management of waste as a resource by means of reuse and recycling. In May 2018, the EC renewed its commitment to aim for more sustainable production and consumption practices by adopting the Circular Economy Package. Mobilising more than six billion EUR in funding under Horizon 2020 and EU structural funds, the Package defines several priority areas to improve the utilisation of critical raw materials.

Indo-European Collaboration on Resource Efficiency and Circular Economy

At the national level, the Indian government seeks to strategically foster resource efficiency on a broader scale, e.g. as reflected by the publication of a national resource efficiency strategy paper by the India's policy think tank NITI Aayog. In the context of these recent developments, the European Union (EU) is

providing support through its Resource Efficiency Initiative (EU-REI) in India which aims to facilitate the implementation of the UN global sustainable consumption and production (SCP) agenda by adapting international standards and best practices to the Indian context. More specifically, the project seeks to support the Indian government to identify and implement measures which can foster resource efficiency across four priority segments, including waste from plastic packaging and electrical and electronic equipment (WEEE or e-waste), the buildings and construction sector, electric mobility and renewable energies.

Being implemented over the course of three and a half years (01/2017 to 7/2020), the EU-REI project will focus on assessing the production and consumption trends in selected sec-tors which are congruent with Indo-European interests and experiences in the above mentioned priority sectors. The project is implemented on behalf of the EU by a consortium led by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH with The Energy and Resources Institute (TERI), Confederation of the Indian Industry (CII) and adelphi.

Being home to about 1.3bn people, **India's construction market is projected to grow at a rate of 7-8% through the next ten years and is likely to become the world's third largest by 2022** (Betts et al. 2013). As of today, economic activities in this sector are still rested upon a linear take-make-dispose logic, that extracts raw materials, transforms them into goods and, once these reach the end of life, simply disposes them to landfills or incineration plants. Following, such linear production patterns will put an enormous pressure on the country's resource base.

Enhancing Resource Efficiency and Circular Economy in the Building and Construction Sector in India

In contrast to linear economic systems, a circular economy is "restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times" (Ellen MacArthur Foundation 2017). In essence, the concept envisions an economic system which produces neither waste nor pollution and is based on the premise that all materials are either circulated at a high quality within the production system or, whenever possible, are fed back into the biosphere at the end of life. More than ever, the circular economy is being perceived as an alternative to business as usual across many sectors. Lately, the concept has received increasing attention across international fora. This is illustrated by the European Union where the above mentioned **Circular Economy Package (CEP) was adopted in December 2015.** The CEP aims at creating new jobs, boosting the competitiveness of European industries, preserving precious and scarce resources, reducing environmental impacts of resource use and injecting new value into waste products (European Commission 2015a). According to the Circular Economy Action Plan, **construction and demolition of the built environment is considered a priority area** (European Commission 2015b).

The paper at hand particularly focuses on increasing resource efficiency and integrating circular economy thinking in the Indian building and construction sector. Previously, papers have been published on resource efficiency (Sekhar et al. 2015) and material consumption patterns in the Indian construction sector (Satpathy et al. 2016) and a sequence of policy briefs was published. The sequence is comprised of a baseline study (Caleb et al. 2017a), a potential analysis (Caleb et al. 2017d), and policy recommendations (Caleb et al. 2017b). These papers have provided a plethora of data and important theoretical inputs. The study at hand integrates their findings but goes far beyond their scope and shifts focus. Firstly, it adds a European lens to the Indian perspective, is partly based on interviews with European experts, and **includes examples for best practices from the EU for interventions and policy instruments.** Secondly, the study at hand puts greater emphasis on **comprehensive, integrated policy packages and tangible recommendations** and suggests how these can be implemented. Also, this paper follows a stricter focus on **different stakeholder perspectives, incentive structures, and feasibility** of recommendations. A particular emphasis is laid on the development and transfer of

policies, standards and guidelines which could lower resource consumption while maintaining high economic productivity and meeting the long-term demands of the Indian economy.

1.1 Methodology

1.1.1 Objectives

In order to drive resource efficiency in the Indian building and construction sector, a lot can be learned from case studies and best practice examples from the European Union and be transformed into comprehensive context-specific policy packages tailored to the needs of the Indian economy. Hence, the purpose of this study is to assist the Government of India (GoI) by suggesting feasible policy interventions for increasing resource efficiency in the Indian buildings and construction sector. To fulfil this purpose, the study uses a number of research questions for guidance.

Table 1: Summary of research questions

Research Question	Which policy interventions are most suitable to foster resource efficiency in the Indian building and construction sector?
Sub-questions	• What are institutional context factors for resource consumption and resource efficiency in the buildings and construction sector in India? • What are key drivers for resource consumption and efficiency in the buildings and construction sector in India? • What are potentials for improvements in resource efficiency in the buildings and construction sector in India and how can they be unlocked? • What strategies can be adopted to better manage different input materials for the buildings and construction sector in India from a resource efficiency perspective? • Which strategies should be chosen in order to secure buy-in from relevant stakeholders and achieve compliance with new policies? • Which policies can strike a balance between feasibility, effectiveness, and ambition? • How can different policy innovations and options be packaged in tangible and comprehensive intervention/policy packages? • What concrete steps need to be taken in order to drive resource efficiency in the building and construction sector through the proposed innovations?

1.1.2 Methods

The integrated research design uses a triangulation approach, thus combining a set of different methods to develop robust policy recommendations to the GoI. In a first step, a broad **literature review** was conducted. The literature review was particularly important for the analysis of the baseline situation in India, covering material flows, economic developments, and the policy and regulatory environment. In a second step, the literature analysis was complemented by **15 in-depth interviews** with recognised European and Indian experts with a professional background in resource efficiency in building and construction, civil engineering, architecture, and policy formulation. The interviews provided insights regarding the feasibility of previously identified policy options and provided inputs to the formulation of additional interventions suggested. In parallel to these methods, a sequence of **three stakeholder consultation workshops** was organised in India to facilitate interactions with a broader audience and develop a more fine-grained understanding of contentious issues. Through this methodology, it was possible to gather opinions of a very wide set of Indian stakeholders and key experts on suggested policy options and gather very valuable inputs for the design of additional policy recommendations from

the focus groups and working sessions in the consultation workshops. A list of experts interviewed is provided in Annex I.

In a nutshell, the background analysis and groundwork for this paper are mostly based on the literature review whereas the development of policy innovations and recommendations primarily builds on expert interviews and stakeholder consultation workshops.

1.1.3 Limitations and Scope

Despite extensive research efforts undertaken for this study, it should be highlighted that the research design is inherently qualitative in nature and inferences should be drawn carefully on a case-by-case basis. This applies to all policy recommendations provided in this study. While this limitation does not undermine the general validity of the findings, it surely emphasises the need for a process of due diligence prior to implementation of the presented policy options. Each policy would require a dedicated planning process, including a thorough feasibility study, budgeting process, and development of an implementation plan before roll-out. For the development and selection of recommended policy innovations, we roughly followed a set of theoretical evaluation criteria. A plethora of potential ex-ante evaluation criteria for environmental policies can be applied (Mickwitz 2003). Yet, to keep the evaluation criteria within a manageable scope, a pre-selection was conducted in close coordination with GIZ and EU. The assessment of policy options analyses the **relevance, expected impact**, and **cost-effectiveness** of a suggested policy option. Further, **political feasibility** is considered as an additional criterion. Together with the research questions presented above, these criteria form the analytical framework of the study. It is important to note that the research questions as well as the evaluation have been considered as overarching guiding principles rather than as rigid tick box criteria.

Table 2: Criteria for the evaluation of policy options explained

Evaluation criterion	Description
Relevance	Determines whether the goals of the policy option facilitate a transition towards a resource efficient building and construction sector.
Expected impact	Examines the expected results of the policy options with regards to resource efficiency in the building and construction sector
Cost-effectiveness	Analyses whether the expected impact justifies the costs for implementation of a policy option; costs can be valued in both monetary and non-monetary (i.e. staff, administrative burden) terms.
Political feasibility	Explores whether the implementation of a policy option is feasible from a political point of view; low political feasibility is indicated by strong opposition, either by lobbying efforts from industries or civil society. Receiving buy-in from private and public stakeholders is perceived as fundamentally important.

1.2 Disposition

In Chapter 2, the paper describes the economic baseline situation in India and analyses material flows of five key resources as well as current economic developments with rele-vance for the building and construction sector in India. A rough overview of the existing policy landscape and a brief presentation of some key government policies and initiatives that are relevant for the sector are covered in Chapter 3. Chapter 4 provides an overview of the policy landscape and best practice examples in Europe. The core of this paper is Chapter 5: In this section, we firstly present different available generic policy tools, before outlining our recommended options for specific policy innovations in more detail and including required next steps for each innovation area. In the final chapter (6), we describe concrete policy and activity packages based on the recommended innovation options, present opportunities for Indo-European cooperation and provide an outlook on how the key players can proceed from here.

2. Baseline Assessment of India's B&C Sector

2.1 Economic Assessment

India's massive **urbanisation and its demographic structure are two of the main megatrends** that will significantly shape not only the nation's construction sector, but also its future development at large. Due to its unique demographic structure, almost half of the nation's working population will belong to the most productive group of 30–49 year olds within the next years. Combined with relatively low wage levels and the fact that India has the world's largest employable graduate population, these demographic trends constitute a significant advantage for the Indian economy (Deloitte Touche Tohmatsu Limited 2014). In view of this development, urbanisation as the second megatrend does not come along surprisingly. From its 2008 level of 340m, urban population is projected to grow to an estimated 590m by 2030 (Sankhe et al. 2010). Along with this massive urbanisation, India's economic structure is about to change. While the ratio between the urban and rural economy was almost equally balanced in 1995, urban GDP accounted already for 58% of overall GDP in 2008 and is projected to further grow to nearly 70% by 2030 (Sinha 2018).

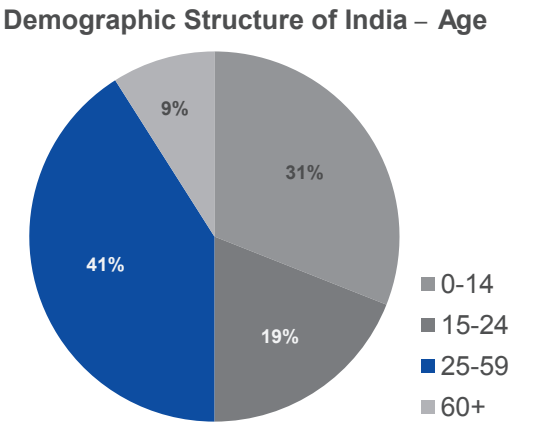


Figure 1: Demographic (age) structure of India (adapted from Deloitte Touche Tohmatsu Limited 2014)

Significance of the Construction Sector

The construction sector and its related manufacturing activities contribute as much as **25% to India's carbon emission** – a figure likely to further rise in the future. Apart from energy use, the sector is also responsible for roughly **12% of fresh water use** and the generation of a significant share of the country's wastewater, most of which goes untreated to the very sources of water-rivers, streams and oceans. After agriculture, the construction sector is the **second largest contributor to the GDP** with **currently 7.5% and a projected contribution of 9.5-10% by 2022.** Futhermore, it yields the **second highest inflow of FDI**, thus playing a pivotal role in the economic growth of the nation

The described demographic developments and urbanisation will have noticeable consequences across many sectors, particularly the construction sector. As more and more people move to India's cities, the demand for affordable housing and infrastructure will rapidly increase. 70% of buildings supposed to be constructed in India by 2030 still have to be built. To meet urban demand, between 700m and 900m m² of residential and commercial space have to be built each year along with 350-400km of metro lines. Additionally, between 19,000 and 25,000km of new roads will need to be built every year, almost equalling the number of road kilometres constructed over the past decade (Sankhe et al. 2010).

Spurred by significant investments in urban infrastructure, housing, roads, and railways, the Indian construction sector is growing by an annual rate of 7-8% and is set to become the third largest construction market in the world by 2025 with a size of USD 1 trillion. It employs more than

35 million people directly and generates further employment by providing growth impetus to its various sub-sectors such as iron and steel, cement, brick manufacturing, etc. (Deloitte Touche Tohmatsu Limited 2014). Moreover, it accounts for up to 45% of steel, 85% of paint, and up to 70% of glass consumption in India as well as significant shares of the output from the automotive, mining and excavation equipment industries (Maier Vidorno 2017).

In order to address the pressure on the housing market and urban infrastructure caused by the rapidly growing urban population, the Indian government started implementing different schemes in recent years - most prominently the **Smart Cities Mission** (see Chapter 3) and **Housing for All 2022** under which is it envisioned to build 12 million urban and 30 million rural houses by 2022. The mission supports construction of houses with up to 30m² of carpet area and basic civic infrastructure like water, sanitation, sewerage, road access, electricity, etc. There are four components under the urban missions: "in situ" slum redevelopment, credit linked subsidy scheme on housing loans, affordable housing in partnership with state agencies or the private sector, and subsidies for beneficiary-led construction (PMINDIA 2016). However, out of the 1,630,000 endorsed units only 41,000 houses have been built by March 2017. Some of the major challenges in meeting the mission's target include lacking participation of organised real estate developers due to low profit margins. Despite being a national mission, state governments play a leading role in implementing the Housing for All mission which often leads to confusion over the scope of responsibilities during the execution, negatively impacting the mission (Deloitte Touche Tohmatsu Limited 2014). Furthermore, current levels of investments in housing and accompanying infrastructure are far from meeting the set targets for a successful programme implementation (KPMG 2014). Beyond residential housing, it is estimated that the commercial office stock is going to surpass 55.7m m² by the end of 2018, constituting a 20% rise in two years.

Besides real estate development, India is expected to see a large growth impetus from the infrastructure sector as GoI is expected to highly invest in the sector, mainly in highways, renewable energy, and urban transport. The announcements in the 2018/19 Union Budget include USD 92bn for the sector, out of which railways receive the highest budgetary alloca-tion with USD 23bn. As urbanisation is calling for the construction of modern transport links that connect major population centres, USD 18bn of investment for scaling up India's national highway network were announced in March 2018, an increase of 44% compared to the previous year. As part of its USD 106bn Bharatmala infrastructure development plan, the government plans to build more than 80,000km of new roads by 2022, creating 50 national corridors as opposed to the 6 currently existing ones (Pandya 2018). It will link around 550 districts to national highways (currently 300) and will enable 70-80% of freight to move over highways as opposed to 40% at present. It is estimated that demand created by the Bha-ratmala plan has the potential to add 3% to the national GDP and provide up to 10 million jobs (Rajat 2017).

2.2 Material Flows

The resource needs of the building and construction sector are immense. Estimations range from 30% to 40% of all global material flow. An estimated growth of the domestic construc-tion market by 7-8% over the next 10 years is likely to further aggravate this situation in India (Caleb et al., 2017a). Fuelled by an increasing population, a growing middle class and a wave of urbanisation, the majority of this growth is expected in the residential sector where construction demand is predicted to increase more than fourfold by 2030 from its 2005 level.

To meet the expected growth of the construction sector, huge volumes of material will be required. Sand (concrete and mortar), soil (bricks), stone (aggregates), limestone (cement) and iron and steel (bars and rods) are the most intensively used materials for building and construction purposes. Some of these materials are already facing scarcity issues. The extraction and use of these materials also have associated environmental and social impacts. Therefore, it is important to understand the flow of these materials in the market in order to identify competing users of these materials and points where interventions can be made. The following section on material flows demonstrates the severity

of the situation and shows that radical measures and new ways of thinking about resource efficiency in the building and construction sector are needed. Without introducing circular economy thinking and strategies for reusing or recycling building materials as well as identifying alternative, more sustainable material sources and strategies for greater resource efficiency in the building and construction sector the pressure on natural resources will become critically severe in India.

2.2.1 Sand

Sand is a natural aggregate formed by rock erosion over thousands of years (Gavriletea 2017). Its sources can be classified as marine or terrestrial deposits. The two most common marine sources are the deposits on the shore and offshore whereas most common terrestrial sources are river channel deposits, floodplain alluvial deposits and residual soil deposits (Gelabert). Sand is the main component in various construction materials such as cement, mortar, tiles, bricks, and glass which makes it an indispensable resource for every industrialised economy. The importance of sand as a resource is demonstrated by the fact that according to the United Nations Environment Programme (UNEP) sand and gravel nowadays represent the highest volume of raw material used on earth after fresh water with extractions greatly exceeding their natural renewal rates. Of all mined materials every year, sand and gravel account for both the largest share (68-85%) and the fastest extraction increase. However, the absence of reliable data makes specific environmental assessments very difficult and has contributed to a lack of awareness about this issue (Peduzzi 2014).

To calculate and analyse the material flow of sand, its major usage in concrete, fly ash bricks, and backfilling must be used as a proxy due to insufficient official data of sand demand itself in India. Ignoring gaps, current sand demand from these uses amounts to about 751m tons/annum (Satpathy et al. 2016).

With rapidly growing demand, sand exploitation is increasingly becoming an environmental issue leading to major changes in local flora and fauna, depletion of groundwater and the destruction of agricultural land. Mining of sand in India is largely informal and unorganised as the process does not require sophisticated infrastructure and is thus attractive to small players. This makes it difficult for government authorities to monitor the sand mining industry and limit its negative environmental impacts. Recycled, secondary and other aggregates currently represent only 3% of all aggregates sales. But this segment is growing at a rapid pace, increasing at 7% per annum from 2005 to 2010 (Sekhar et al. 2015).

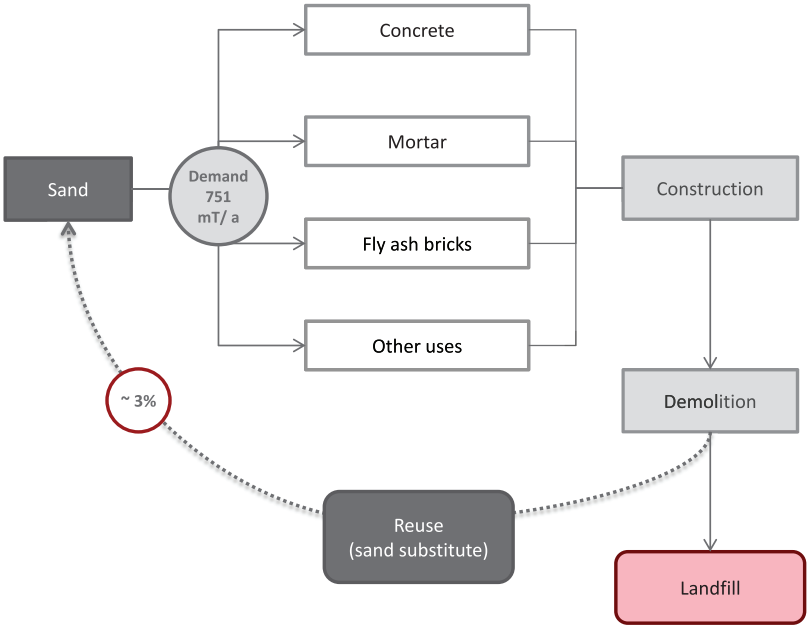


Figure 2: Material flow: Sand (adapted from Satpathy et al. 2016)

2.2.2 Soil

Soil is the primary resource for the brick kiln industry to produce clay bricks, one of the most important building materials in India, making soil one of the most exploited resources in India today (Satpathy et al. 2016). India is the second largest producer of bricks, accounting for over 10% of the global production (Lalchandani and Maithel 2013). However, the industry is largely unorganised and follows traditional, labour-intensive processes and practices, with minimal use of mechanisation (TERI 2017). Unlike European countries which utilise mined clay and shale for brick making, Indian brick manufacturers mostly rely on surface soil. The production process begins with excavating top soil from nearby agricultural fields which is then mixed with other types of soil depending on requirements (Maithel 2013). It is estimated that about 250bn bricks are being produced this way annually in more than 150,000 brick kilns throughout the country. For brick production, about 350m m³ of soil are required per year. As the alluvial soil of the Indo-Gangetic plains is best suited for brick production, a large number of brick kilns can be found in this region. While black and red soil can also be utilised for brick production, they need to be amended with stabilisers. Taken together, these three types of soils cover almost 89% of India's land area. As bricks are one of the most important walling materials used in India, the annual 6.6% growth rate of the construction sector would increase the annual demand to around 500bn bricks by 2030 (Maithel 2013), equalling a doubled demand for soil of about 700m³ of soil.

The extensive exploitation of soil for brick making has increasingly become an environmental and social issue across the country. As brick kilns are mostly situated on fertile agricultural land, there are competing uses of soil for agricultural purposes and brick making. The removal of topsoil for brick production directly translates into reduced fertility and decreased land productivity. Although there have been regulations put in place by GoI to streamline this largely unorganised industry, existing regulations for soil extraction are rarely being followed. As the depth of extraction exceeds the legal limit of 2 metres below ground level in most cases and mined pits are not backfilled, the area suffers from land degradation, creating long term impact on the land (Sekhar et al. 2015). Large areas of land are deteriorated every year due to these practices. Furthermore, with an annual consumption of roughly 35m tons of coal, brick kilns are amongst the largest industrial consumers of coal in India, emitting an estimated 66m tons of CO^2.

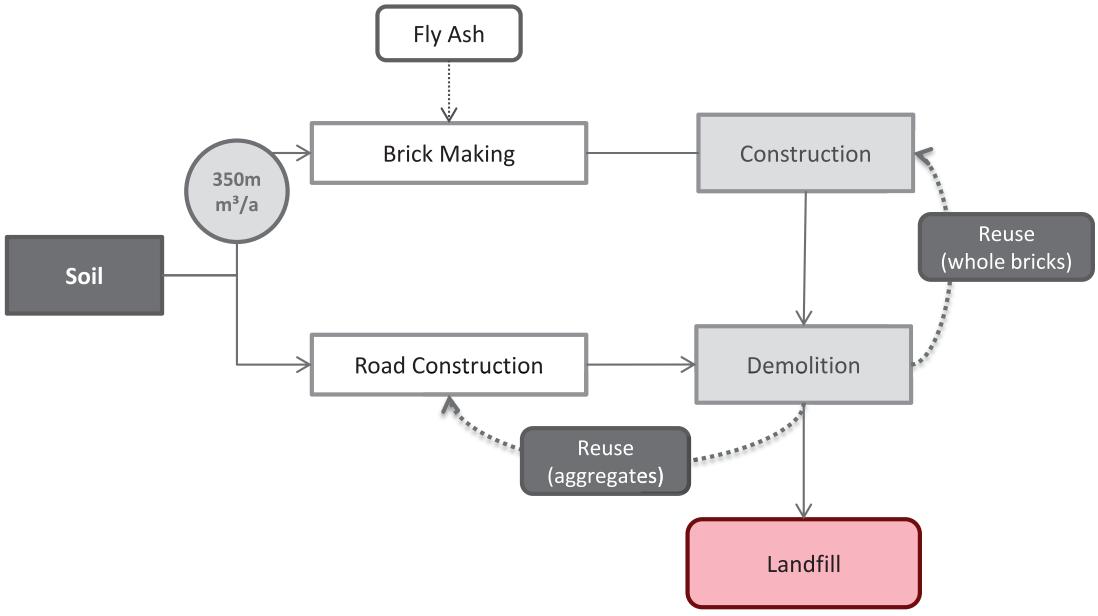


Figure 3: Material flow: Soil (adapted from Satpathy et al. 2016)

2.2.3 Stone (Aggregate)

Stones as coarse aggregates are most widely used by the construction industry for making concrete and road construction. Because of their massive texture, low porosity and stable minerals, basalt and granite are the most popular rocks used as coarse aggregates. Except for northern, north-eastern and western parts of India, granite deposits can be found almost throughout the entire country whereas basalt deposits are limited to eastern and central In-dia. (TERI et al. 2016). As concrete will remain the mainstay of construction, the demand for coarse aggregates is expected to increase to more than 2bn tons by 2020. An additional capacity of 1bn tons must be generated by 2027 to meet the demand for road infrastructure and housing according to estimates from the 12th Five Year Plan. Due to various mix ratios used for concrete, coarse aggregates range from 2 to 10 parts per unit of cement. Bearing this in mind, the coarse aggregate demand will range between 2-10.3bn tons.

Since modern techniques which curb the pollution emitted from mining and crushing stones have not been adopted at a large scale in India, the process still has significant negative impacts on the environment, including major impacts on air, noise, and soil quality. Destruc-tion of natural ecosystems and disruption of hydrological resources are further impacts that can be attributed to stone mining (Lad and Samant 2014).

To mitigate the negative environmental impacts of aggregates and to reduce reliance on natural stones, using alternative materials for aggregates could be a way forward. Recycled aggregates from CDW have been successfully established and can be readily used in con-struction of low rise buildings, concrete paving blocks, tiles, flooring, retaining walls, ap-proach lanes, sewerage structures, subbase course of pavements, drainage layers in high-ways, dry lean concrete, etc. With a total amount of approximately 726m tons/annum, there is huge potential for CDW to be used as a substitute for natural stones (TERI et al. 2016).

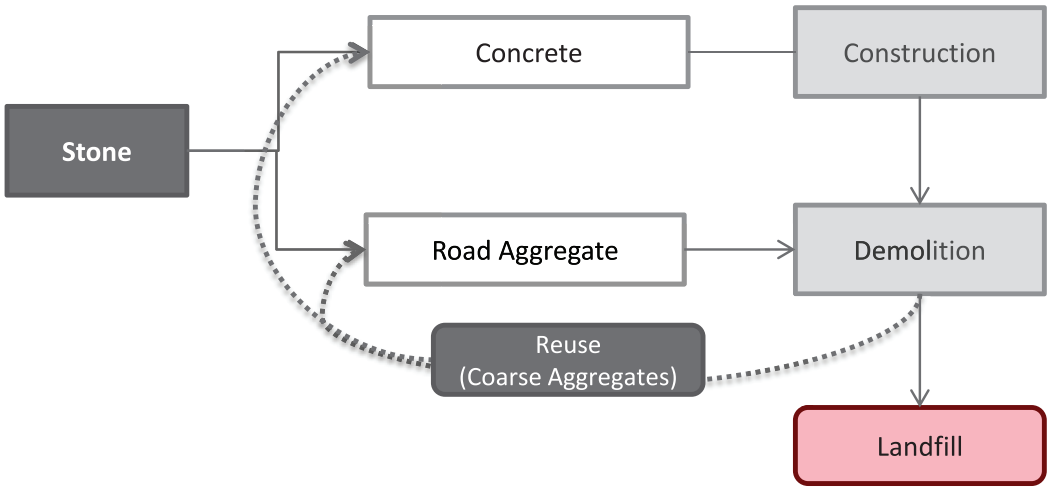


Figure 4: Material flow: Stone (adapted from Satpathy et al. 2016)

2.2.4 Limestone

Limestone is an umbrella term for any sedimentary rock consisting of calcium carbonate ($CaCO_3$). It is most used as a raw material for clinker in the cement industry and by the steel and iron industry to remove impurities from iron ore and to lower the melting temperature. The majority (69%) of limestone reserves in India are cement grade, followed by iron and steel grades (12%), and chemical grades (3%). Total reserves including all categories and grades have been estimated at 203bn tons based on the United Nations Framework Classification for Resources (UNFC) system. Because of its vital importance for the construction sector, limestone is one of the most extracted resources in India today.

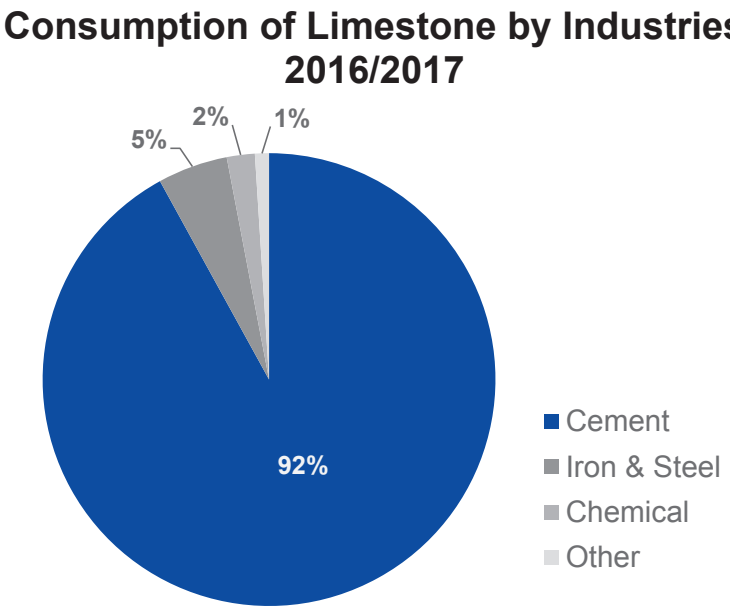


Figure 5: Consumption of limestone by Indian industries in 2016/ 2017 (adapted from IBM 2018)

In the year 2016-17, it was reported that 771 mines have produced a total of 313m tons of limestone which represents a 2% increase compared to the previous year. The total con-sumption of limestone amounts to 242.45m tons in 2016-17. As India is the second biggest cement producer after China, the majority of limestone was consumed by the cement in-dustry. The installed capacity of all cement plants in India amounts to 421m tons. Overall, production reached 283.5m tons in 2015-16, representing an increase of 6.52% compared to the previous year. Propelled by a growing construction and infrastructure sector, the cement industry is expected to reach 550-600m tons/annum in production by 2025 (IBEF 2018).

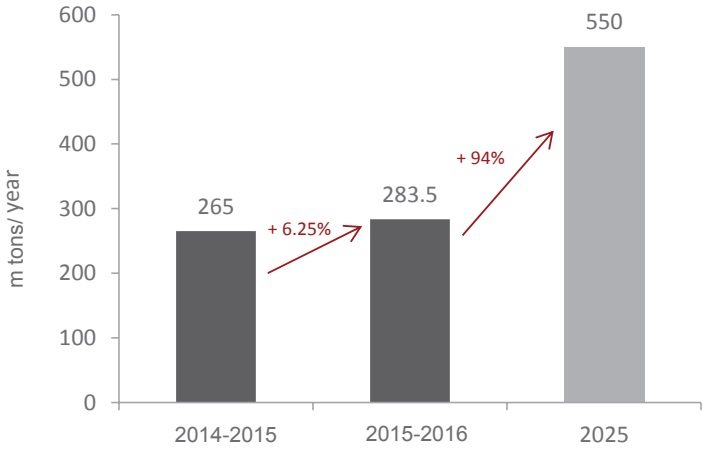


Figure 6: Development of production capacity of Indian cement industry (in mT per year) (adapted from IBEF 2018)

As limestone extraction is carried out with open cast mining methods it affects the environ-ment in its various stages of mining, processing, and utilisation. Among the major concerns associated with limestone mining are denudation of forest, depletion and pollution of water, erosion, and reduction in biodiversity (Lamare and Singh 2016). In addition, CO^2 emissions from limestone mining in India can be estimated at approximately 0.5m tons in the year 2016-17. Communities living close to limestone mines often suffer from contaminated water as well as dust and noise from mechanical processes used for crushing limestone to appro-priate sizes for transportation (TERI et al. 2016).

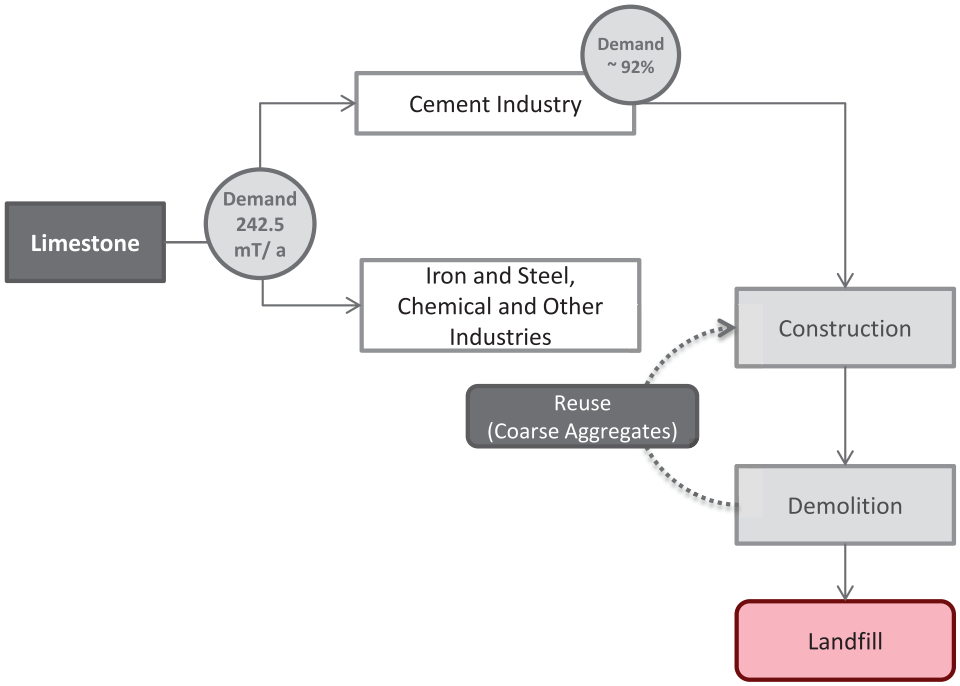


Figure 7: Material flow: Limestone (adapted from Satpathy et al. 2016)

2.2.5 Iron and Steel

Iron and steel are an essential driving force behind industrial development in any country. The same is true for India where a strong correlation with the growth of domestic GDP and employment rates can be seen (Ministry of Steel 2017). The booming construction and in-dustrial manufacturing sector caused a significant increase in steel demand over the past decades that will most likely continue in the near future. Over 55% of India's steel demand is coming from the construction and infrastructure sector. As urban construction is increasingly moving from traditional masonry load-bearing structures towards Reinforced Cement Concrete (RCC) framed structures, the primary use of finished steel in the construction sector is in bars and rods for these structures. As for the infrastructure sector, steel use is dominated by national highway construction, railways, and power transmission lines (Satpathy et al. 2016).

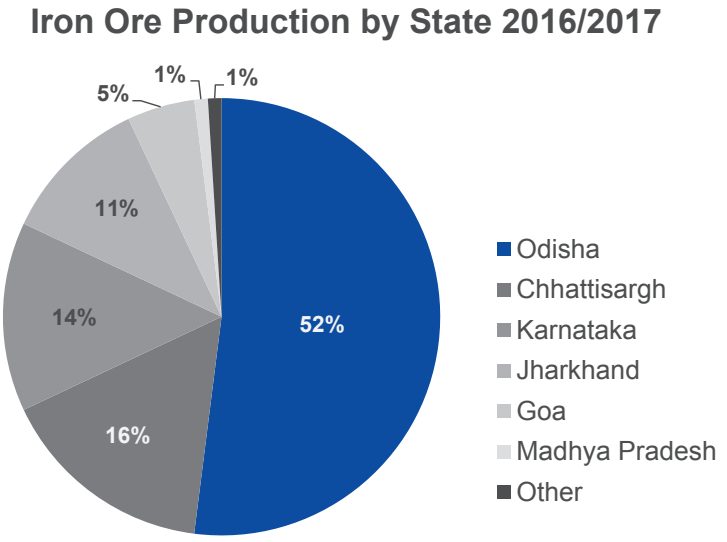


Figure 8: Iron ore production in India (by state) (adapted from Indian Bureau of Mines 2018a)

With total reserves of Haematite and Magnetite ores being estimated at over 33bn tons, India is among the leading producers of iron ore in the world. Across India, there are 296 reported mines that generated a total output of 192m tons in the year 2016-17 (Indian Bureau of Mines 2018a). Finished steel production grew to 101.8m tons in 2016-17. Domestic con-sumption of finished steel stood at 84m tons in 2016-17, representing a CAGR of 3.4% during the last five years (Indian Bureau of Mines 2018b). However, per capita steel consumption in India is relatively low at 61kg compared to the global average of 208kg, thus underlining the huge expected increase in the long term. According to the Ministry of Steel, domestic steel demand is expected to grow to 230-240m tons/annum by the year 2030-31, significantly driven by the construction and infrastructure sector (FICCI 2017).

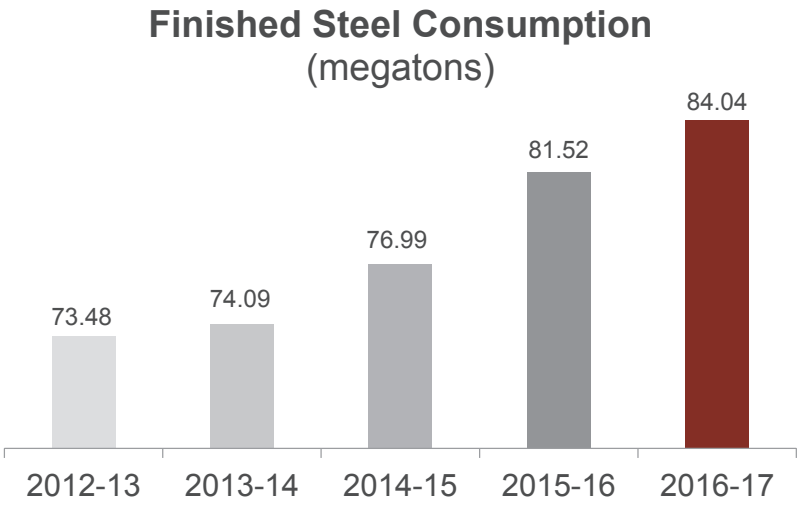


Figure 9: Finished steel consumption (in megatons) (adapted from Indian Bureau of Mines 2018a)

As steel production relies on coking coal as fuel, it is highly energy intensive and contributes 8% to India's overall CO^2 emissions. Considering the entire production process from mining of ore to end use, steel production causes severe negative environmental impacts. The negative impacts of ore mining are similar to the impacts discussed in previous sections and include land degradation, disturbances of natural watersheds, air pollution, noise, and vibrations due to blasting (Satpathy et al. 2016).

Demand for recycled steel in India is currently ca. 25MnTPA which is mostly generated from domestic scrap (6MnTPA are imported). Due to policy impact and increasing investments in infrastructure and manufacturing the domestic scrap supply is expected to grow at 6-8% CAGR from FY15 to FY30 (TATA Steel n.d.).

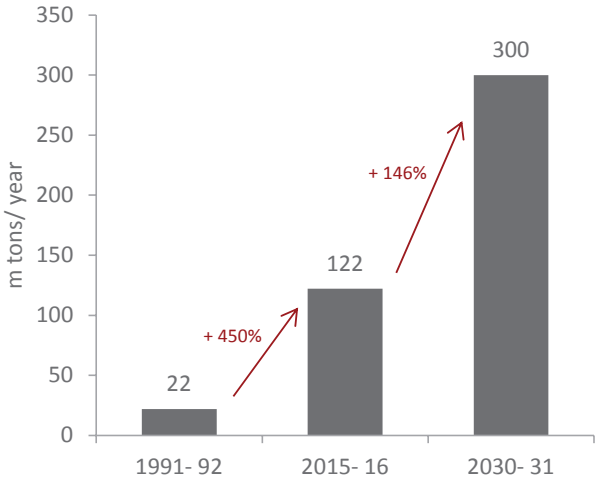


Figure 10: Development of Indian production capacity of crude steel

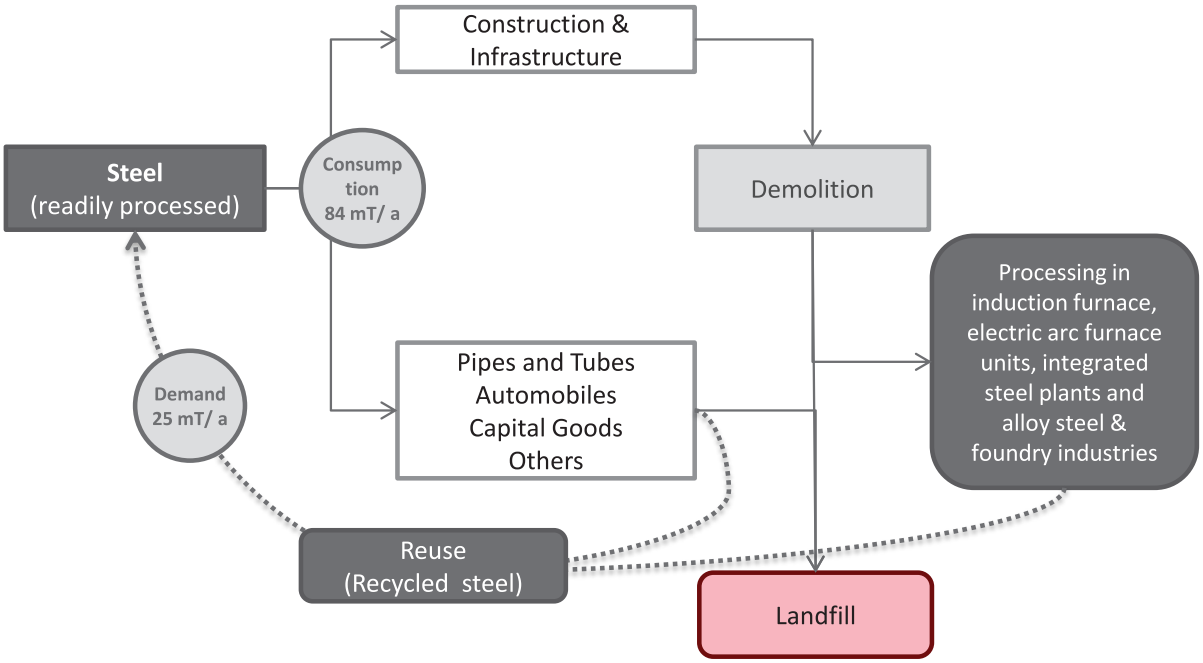


Figure 11: Material flow: Steel (adapted from Satpathy et al. 2016)

3. Resource Efficiency in the Indian B&C Sector: Policy Developments

To address increasing resource scarcity and negative environmental impacts, **Indian legislators have introduced several laws and guidelines** in recent years to **encourage resource efficiency and green building practices on both federal and state levels.** For orientation purposes, the most prominent ones of these policies are briefly outlined in the following chapter. It should be noted that although there are numerous regulations in place to enhance resource efficiency, it is often unclear to which extent they are enforced and implemented.

Fly Ash Notification

First issued by the MoEFCC in 1999, this notification aims to **promote the use of fly ash** instead of soil or limestone as the primary raw materials for building materials such as bricks and cement. As a **by-product from coal combustion** in thermal power plants, fly ash can be **utilised in cement and brick production as a substitute for limestone and soil.** Even though it is not possible to replace limestone and soil entirely, it is certainly capable of reducing their use as primary materials. The notification requires builders to use at least 25% of fly ash in clay bricks and 50% of fly ash by weight in fly ash bricks if the construction site falls within a 100km radius of coal and lignite based thermal power plants. It further stipulates that at least 20% of dry fly ash should be provided for free and on a priority basis to manufacturers producing fly ash and clay fly ash bricks, blocks, and tiles (Caleb et al. 2017c). An amendment to the notification in 2016 increased the 100km radius to 300km and made it mandatory for power plants to provide fly ash to manufacturers within the 300km radius for free. In addition, the use of fly ash bricks is promoted by some states in government construction and is already mandatory in Odisha, Madhya Pradesh and Bihar (Chakravartty 2016). Since the notification was introduced, the market responded positively to the government efforts but there still is great room for improvement as only 12% of fly ash generated in India are currently used for the production of bricks and tiles (Satpathy et al. 2016).

Construction and Demolition Waste Management Rules

Introduced by MoEFCC in 2016, the C&D Waste Management Rules are designed to **improve the process of recovering and reusing waste generated through construction and demolition activities.** Under these rules, large waste generators who generate more than 20 tons/day or more than 300 tons/month are **obliged to segregate their waste into different streams** such as concrete, soil, steel, wood, plastics, bricks, and mortar which are then deposited at a collection centre or authorised processing facilities. In addition, large generators **need to submit a waste management plan and an environment management** plan to local authorities prior to construction or demolition work that outlines environmental issues that are likely to occur from construction, demolition, and disposal of CDW. If respective plans are not presented to local authorities they can withhold permission for construction. Cities with a population of more than one million are supposed to establish necessary facilities within 18 months from the date of notification of these rules, whereas smaller cities shall establish them within

2-3 years. To finance these facilities **large generators of waste will have to pay charges for waste collection and transportation as well as for processing and disposal.** To enforce these rules the State Pollution Control Boards are responsible for regularly monitoring the disposal sites. Furthermore, the rules provide that local authorities should utilise 10-20% of CDW in their public procurement (MoEFCC 2016a). Additionally, Rajasthan State Pollution Control Board has launched a so-called **Start-up Policy focused on Waste to Resources.** This policy aims to push the utilisation and minimisation of various types of waste. It includes promoting entrepreneurship as well as providing investments in the waste sector for reducing, recycling, and recovering waste. The policy focuses on projects converting industrial and municipal waste into resources such as energy and building materials (Rajasthan State Pollution Control Board, 2017).

Environment Impact Assessment Notification

Based on the 1986 Environment Protection Act, the process of Environmental Impact As-sessments (EIA) was made mandatory under the act through its amendment in 1994. Since then, several amendments have been introduced to the EIA. This included an amendment in 2004 that expanded EIA to large construction projects including new townships and industrial estates, having influence on resource efficiency in the construction sector. Additionally, small-scale mining projects are under its ambit since 2006 **making environmental clearances mandatory for mining of minor minerals in areas less than or equal to five hectares.** Within the notification, an **institutional framework for giving clearances, evaluations required as well as mechanisms for monitoring and enforcement are defined.** Based on the potential impact on its area, human health and natural resources, projects are grouped in Category A or B projects. Category A projects are required to undertake a public hearing before an environmental clearance can be issued by the Union Environment Ministry. Category B projects are evaluated and approved by state level authorities such as the State Environment Impact Assessment Authority (SEIAA) and State Expert Appraisal Committee (SEAC) (Banerjee 2016).

Sustainable Sand Mining Management Guidelines

Since sand is classified as a minor mineral in India, sand mining falls under the 2006 EIA amendment and requires environmental clearance. However, **to ensure that sand and gravel mining is done in a sustainable and socially responsible manner** the MoEFCC issued the Sustainable Sand Mining Management Guidelines in 2016. Besides providing guidelines and policies for sustainable extraction of sand, the guidelines aim to **improve the effectiveness of monitoring mining as well as the transportation of extracted material.** By establishing these guidelines, the MoEFCC aims to e**nsure sustainable availability of adequate quantities** of aggregate for India's booming construction sector while simultaneously ensuring the **conservation of rivers and their natural environment** by protecting and restoring their fragile ecosystems. To do so, it also encourages the use of renewable and recycled materials such as quarry dust, incinerator ash, and manufactured sand (M-sand) as substitutes. Although executing these guidelines requires detailed surveys of sources of sand by state governments they are a promising approach to containing illegal mining and creating national inventories based on which informed decisions for sand management can be made (MoEFCC 2016b).

Legislation at national level is a fairly recent development as **each state formulates its own guidelines for sand mining under the Minor Mineral Concession Rules.** In the face of **dramatic increase in illegal sand mining,** serval states such as Karnataka, Tamil Nadu, Kerala, and Rajasthan have fully or partially banned sand mining, putting pressure on the construction sector to look for alternatives. While some states try to solve the issues of illegal sand mining with bans, states such as Maharashtra, Andhra Pradesh, Telangana, and Rajasthan move towards legalisation with provisions for online tendering and monitoring of sand mining operations. In Maharashtra, the Revenue Department has implemented an online mining approval and tracking system that enables contractors to order sand through their mobile phones. Alongside this service, the Maharashtra government also enacted the Maharashtra Minor

Mineral Extraction (Development and Regulation) Rules in 2013 to ensure scientific mining of sand and other minor minerals in the state (Government of Maharashtra 2015). A similar approach can be found in Andhra Pradesh and Telangana where the data of sand availability and its sale is maintained on a central portal. This ensures that the sale of sand is regularised and data on the amount of sand traded is readily available online (TNN 2014). Increasing efforts for legalisation are also driven by substantial revenue losses from sand sales that state governments suffer from due to illegal sand extraction. However, di-verging policies in different states and black markets created by bans and restrictions cause significant price fluctuations across different regions.

In order to shift the market focus to alternatives, the MoEFCC promotes the use of M-sand. M-sand is derived from stone quarries and can also be produced from CDW and other con-struction products like aggregates. This makes it an ideal substitute for natural sand. The market has begun to slowly respond to this alternative. By now, there are around 100 operat-ing M-sand manufacturing units in Karnataka and the first units began their operations in Tamil Nadu and Kerala. Complementing the Sustainable Sand Mining Management Guide-lines, the 2015 amendment to the Mines and Minerals Development and Regulation Act puts stringent punitive provisions for combating illegal mining. For enforcement, provisions have been made for setting up special courts for the purpose of providing speedy trials of offences related to illegal mining (Govind 2015).

AMRUT

Launched in June 2015, the Atal Mission for Rejuvenation and Urban Transformation (AM-RUT) aims to **upgrade urban living conditions by providing basic services primarily to poor and disadvantaged households.** The scheme does so by **extending urban water supply and improving sewerage networks** as well as **improving public transport services** and creating green public spaces. 500 cities and towns are going to benefit from this scheme until 2020 and possibly beyond as the MoUD might continue the scheme after its success is evaluated. The project fund makes up the biggest share with 80% of the annual budgetary allocation. It is divided between the states each year with equal weightage given to the urban population and the number of statutory towns in each state. Another purpose of the AMRUT mission is to improve governance by implementing a set of eleven reforms. In contrast to previous missions, the AMRUT scheme is shifting from penalties to incentives by keeping apart 10% of the annual budget as an incentive for achieving reforms. The use of the incentive amount is decided by the State High Power Steering Committee (SHPSC) and the incentive award can only be used in cities under the AMRUT scheme (Govind 2015).

Smart Cities Mission

Smart Cities Mission was launched in 2015 with the aim to **drive improved quality of life and inclusive and sustainable development across 100 cities.** The total number of 100 Smart Cities has been distributed across the states and Union Territories (UTs) giving equal weightage to urban population and the number of statutory towns in the state/UT. Each state/UT has a certain number of potential Smart Cities. The cities were selected through a Smart Cities challenge – a national competition designed for municipal authorities to develop smart proposals to improve cities through citizen centric development. Unlike AMRUT's project-based approach, the Smart Cities Mission follows an area-based development approach, requiring cities to upgrade a selected area in the city. The idea is to create a replicable model that can then be extended to other parts of the city as well as other cities in the country. The strategic components of area-based development in the Smart Cities Mission are **city improvement (retrofitting), city renewal (redevelopment) and city extension (greenfield development).** The Smart Cities Mission is a centrally sponsored scheme with financial support of Rs. 480bn over five years, i.e. on an average Rs. 1bn per city per year. An equal amount has to be contributed by the state/ ULB (urban local body) on a matching basis (National Portal of India 2016, 2015).

4. Resource Efficiency in the B&C Sector in Europe: Lessons Learnt

Providing more than 18 million direct jobs and contributing about 9% of the EU´s GDP, the construction sector is of great relevance to the European economy (European Commission 2016c). After the economic crisis of 2008, the sector suffered from sudden decline of growth rates. First signs of recovery were noticeable after 2013 and 2014, when construction activities started to increase again. Now, the forecasts for the next years predict continuous growth of the sector. New agendas and programmes, like **the initiative for greener buildings,** contribute significantly to this development. The EU recognises the important role of the sector in strategies to ensure resource efficiency and adapt to climate change which is reflected in the European policy developments (Building radar 2017; European Commission 2018g). A comprehensive framework with legislative and regulatory tools for increasing resource efficiency is in place, including European standards, information platforms and labelling instruments (European Commission 2016c).

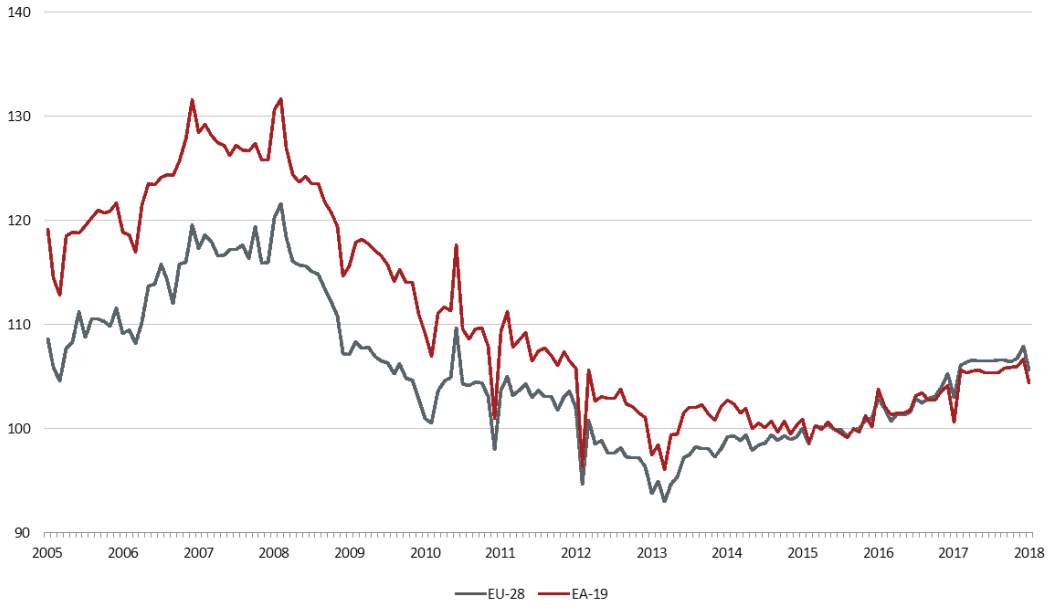


Figure 12: Index of construction production of EU member states (adapted from European Commission 2011b)

4.1 Policy Developments

Circular Economy is one main principle guiding European policy makers across industries, including the building and construction sector. The **Circular Economy Package was presented by the European Commission in 2015.** The action plan has a particular focus on improved construction and demolition waste management. The use of recycled material at a large scale is another objective (European Commission 2011; European Parliament 2016). Implementation and performance standards are set

across the member states and incentives are created to push companies towards new innovations and approaches. Core elements of the package are the legal acts:

- Waste Framework Directive
- Landfilling Directive
- Packaging Waste Directive
- Various specific sectoral Directives

(European Parliament 2016)

Additional tools are used to promote the agenda of the Circular Economy Package across all technical areas, beginning with product and building design. One of these tools is the voluntary reporting framework Level(s) (explained in detail in Chapter 4.2.2.).

The "Europe 2020" goals, as part of the EU growth strategy for the current decade, promote smart, sustainable, and inclusive growth and are closely linked to the construction sector. The goals directly influence the safety of workers as well as buildings infrastructure and products used in the sector with a significant impact on resource efficiency and the fight against climate change (European Commission 2016c).

The **Roadmap to a Resource-efficient Europe** emphasises the impact of construction activities on natural resources, the environment, and climate change. Several targets for the construction sector have been set for 2020 and a number of strategies and legislations have been brought on the way by the European Commission to reach them. One of these is the **EU Strategy for the Sustainable Competitiveness of the Construction Sector** which sets major objectives for the sector in the future. Improved resource efficiency and environmental performance are in focus alongside stimulating investments and creating jobs. The lack of resources directed towards research and innovation, particularly in comparison to other sectors, was identified as one of the main obstacles to reach the objectives of the European Commission. The high demand for materials and the massive waste generation of the sector are key challenges that require a shift in behaviour patterns. Progress on the development of resource and energy efficient construction will contribute to the goals described in umbrella regulations and programmes, such as the Roadmap to a Resource-efficient Europe and the **Roadmap for Moving to a Competitive Low Carbon Economy in 2050,** and will strengthen international competitiveness for European businesses. To ensure well-functioning internal markets, harmonisation measures, such as indicators, codes, and standards are being established by the European Commission and further initiatives support the harmonisation efforts (European Commission 2012).

Another focus of European legislation is **construction and demolition waste.** In terms of volume, it is the largest waste stream in the EU (European Commission 2016b). A number of guidelines, policies, and standards address this massive flow of material and are embedded in trans-sector strategies, such as the **Waste Framework Directive and the Circular Economy Package.** For the construction and demolition sector, the European Commission specifically targets the recovery of valuable resources, adequate waste management, and assessments of environmental performance of buildings. **Pre-demolition guidelines** shall enhance high-value recycling, further supported by voluntary recycling protocols to improve quality and transparency of recycled construction materials (European Commission 2018a). The latter receives further attention through the **EU Construction and Demolition Waste Protocol** which is embedded in other European policies: the **Construction 2020 Strategy, the Communication on Resource Efficiency Opportunities in the Building Sector,** and the Circular **Economy Package**. Its main objectives are to improve the waste management system and to build trust in the quality of recycled materials made of demolition and construction waste (European Commission 2018a).

70%

Recycling rate for Building and Construction Waste

(European Commission 2016a)

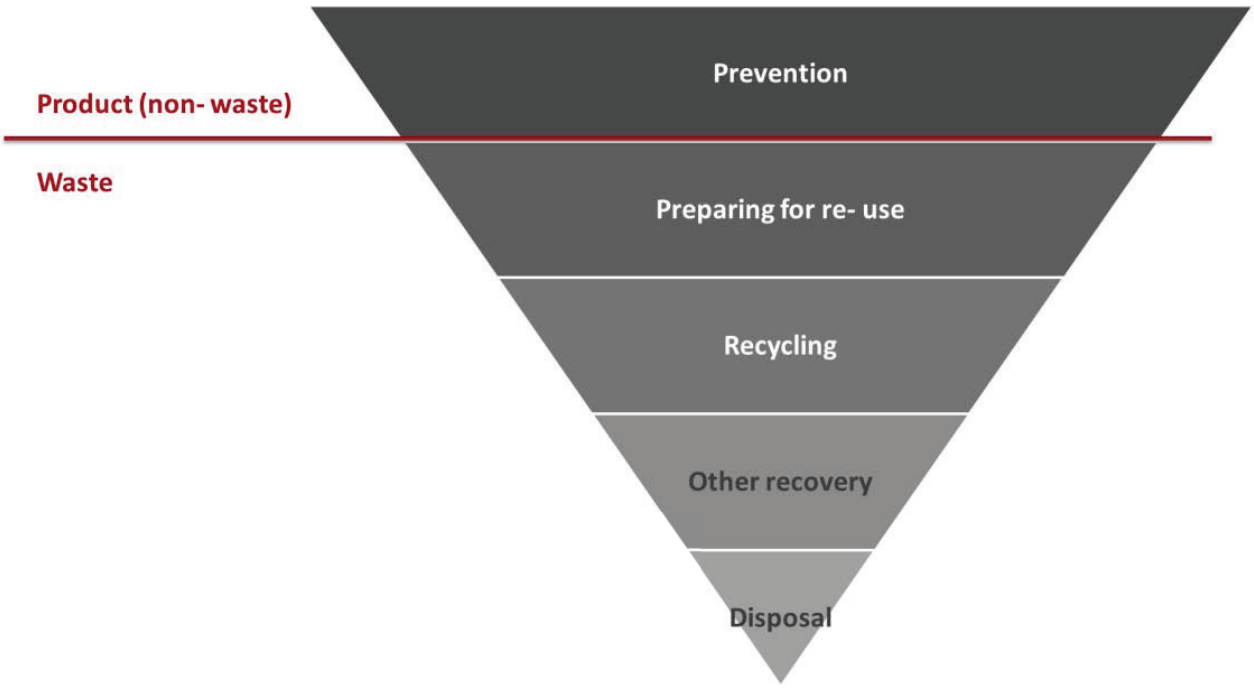


Figure 13: The EU waste hierarchy (adapted from European Commission 2016a)

Overview of relevant policy tools:

Waste Framework Directive (2008):

- Centrepiece of European waste legislation; promoting the five-step waste management hierarchy (see Figure 13)
- Pushes European policy towards increased resource efficiency
- **Target:** 70% of construction and demolition waste prepared for reuse, recycling and other forms of material recovery

(European Commission 2016a)

EU Construction and Demolition Waste Protocol:

- Embedded in the Construction 2020 Strategy, the Communication on Resource Efficiency Opportunities in the Building Sector and the Circular Economy Package
- Aims to improve trust in and knowledge on recycled materials to strengthen recycling infrastructure in Europe
- Tools:
  - o Waste identification, source separation, and collection
  - o Improved waste logistics and processing
  - o Quality management
  - o Policy framework and conditions

(Basuyau 2017)

Energy Efficiency Plan (2011):

- Setting plans to promote an economy with focus on saving resources, implementing a low carbon system and the security and independence of Europe's energy supply
- Focus on construction sector (agendas for eco-design etc.)

- **Targets:**
  - 3% of all public buildings to be renovated per year until 2020
  - After 2020: all new buildings must be carbon-neutral (for EU-27 countries)

(Building radar 2017)

The Energy Performance of Buildings Directive (EPBD):

- Together with the Energy Efficiency Plan the main legislative instruments for energy performance improvement (of buildings)
- Supported by a set of European standards (e.g. for thermal performance of buildings, ventilation, and lighting)
- **Targets:**
  - All new buildings as zero-energy buildings by end of 2020
  - Certification system for energy performance of buildings (energy rating and recommendations for cost-effective improvements of performance)

(European Commission 2011)

Overview of tools and instruments supporting European policies:

European Standards are crucial for the assessment of and reporting on the performance of buildings, covering the entire lifecycle. Over 450 harmonised standards were developed for construction products, including technical standards that cover mechanical resistance and stability, safety in case of fire, energy economy and heat retention as well as sustainable use of natural resources. Aiming to harmonise various certification schemes, **Eurocodes** are a series of European standards targeting the structural design of buildings and other civil- engineering works. They are used within EU and EFTA member states. The Eurocodes are in continuous development (European Commission 2011).

The **EU Building Stock Observatory** is an implementation tool of the EPBD that provides data on the energy performance of the EU building stock. It includes a database, a data mapper, and factsheets (European Commission 2018d).

European Best Practice Example: *Eurocodes*

An **example of norms and standards** are the Eurocodes which are a set of 10 European standards (EN 1990 – EN 1999) providing a **common approach for the structural design of buildings** and other civil-engineering works**.** Beyond the 10 main codes, there are about 60 sub-norms as well as context- and country-specific national annexes to each code**.** The Eurocodes have been developed by scientists, engineers and other practical experts in the *European Committe for Standardization (CEN)*

They include:
- *Basis of structural design (EN 1990);*
- *Actions on structures (EN 1991);*
- *The design of concrete (EN 1992), steel (EN 1993), composite steel and concrete (EN1994), timber (EN 1995), masonry (EN 1996) and aluminium (EN 1999) structures;*
- *Geotechnical design (EN 1997);*
- *Design, assessment and retrofitting of structures for earthquake resistance (EN 1998)*

The European Construction Sector Observatory provides analyses and comparative assessments of the market conditions and information about policy developments to European policy makers and stakeholders. It focuses on the implementation, monitoring and assessment of the impact of policy measures regarding competitiveness of construction enterprises, and sustainable development objectives (European Commission 2018f).

The EU-LCI Working Group, established in 2011, is focusing on EU-wide harmonised health-based reference values for the assessment of product emissions and operates as part of the EC Advisory Group on Construction Products. The multi-stakeholder expert consortium established EU-LCI values in a transparent and scientific manner, mainly focusing on potentially harmful emissions from building materials (European Commission 2018e).

Construction Products Regulation (CPR) provides harmonised rules and technical tools for the marketing and trading of construction products in the EU. It helps to assess the performance of construction products and provides reliable information to all stakeholders.

The NANDO database is an information system that provides the names of all bodies designated to carry out conformity assessments (for relevant harmonised European standards) for construction products (European Commission 2018c).

The **CP-DS database** provides information on all construction product regulations on dangerous substances. The information comes from public authorities from all European countries and aims to support stakeholders in identifying relevant regulations. The database is maintained by the European Commission. Currently, there is only little information available as the platform is still in the development stage (European Commission 2018c).

4.2 Implementation of the European Framework: Lessons Learnt

4.2.1 European Rules & Regulations on National/ Regional Level

The comprehensive European legal framework for the building and construction sector leaves details of the implementation to the member states. Within Europe, a wide range of progress and success stories can be observed. Critical in most cases seems the early and continuous involvement of stakeholders. As the construction industry is a critical player in Europe's economy, it is of great importance to include its perspective and interests (Dri et al. 2018). This is achieved through:

1.) Consultation, communication and involvement of users

2.) Participatory and inclusive planning (local steering committees)

3.) Inclusivity at all levels (local waste platforms)

For waste prevention and management, numerous local and regional plans have been developed. Many offer economic benefits through incentives and tax alleviations for waste reduction and sustainable planning. Another key driver for environmentally sound and sustainable activities in the sector is regulations and mandatory schemes. However, it has to be noted that increased waste management fees and other economic instruments as well as higher requirements for waste sorting were followed by a rise in illegal dumping of CDW. Stricter enforcement of regulations and increased awareness are measures to target this problem at the local level (Dri et al. 2018).

An assessment of the best environmental management practices for the waste management sector pointed out several specific measures. An adequate building design can help to minimise waste by preventive design measures such as the use of prefabricated elements and modern construction techniques. A design that considers deconstruction and includes elements for easy disassembly can be another way of waste prevention. During the construction stage, careful waste management and -prevention are critical (waste management plans for sites are even mandatory in several EU member states). This includes monitoring of waste generation and the establishment of waste separation and collection strategies. Efficient use of material (incl. storage) is also fundamental and reuse of materials can reduce waste generation on site even further (Dri et al. 2018).

The integration of European rules and regulations in national standards and legislation is closely monitored by the European Commission. The most relevant EU policies and the status of their implementation on the level of the member states are presented in Annexes II and III. The impact of **the Circular Economy Package** on national policies with respect to the building and construction sector can best be measured by looking at the implementation of the Waste Framework Directive of 2008. This states that the EU member states are required to adopt the national waste prevention programmes by December 2013. The annual review of the implementation of the framework is monitored by the

European Environment Agency. Selected results of the 2016 evaluation are shown in the case studies on Austria and Denmark (see below). In all European countries, waste prevention programmes are in place. An overview of the adopted waste prevention programmes is given in Annex II and III.

Status of Waste Prevention Programmes in Europe (2016)

Case study: Austria

Overall waste management plan contains:

- Abfallvermeidungsprogramm 2017
  Waste Prevention Programme
- Bundesabfallwirtschaftsplan
  Federal Waste Management Plan

Sectors covered:

- construction and infrastructure;
- manufacturing;
- retail and transport;
- households;
- private service activities and hospitality;
- public services.

Objectives:

- decoupling economic growth from the environmental lifecycle impacts of Austrian waste and its upstream material flows;
- reducing emissions;
- minimising pollution;
- conserving resources, focusing on raw materials and energy carriers.

Specific measures targeting the B&C sector:

- standardisation of a building pass, an instrument that provides information on the use and location of raw materials and pollutants, and collects this core data for entry into a centrally held register of buildings and apartments
- pilot projects for selective demolition and reuse of construction materials
- prolonging the use of buildings; pilot projects for low-waste buildings
- development of teaching materials for low-waste construction
- evaluation of the waste management concept for strengthening the integration of waste prevention into a system of permits
- regulations for on-site separation of demolition waste

(European Environment Agency 2016a)

Case study: Denmark

Overall waste management plan contains:

Waste Prevention Strategy:

- Waste II (continuation of the Resource Strategy for Waste Management - Denmark without Waste)
- Danmark uden affald II - udkast til strategi for affaldsforebyggelse
  Denmark without waste II – a waste prevention strategy

Sectors covered:

- agriculture;
- construction and infrastructure;
- manufacturing;
- retail and transport;
- households;
- private service activities and hospitality;
- public services.

Objectives:

- enable the building and construction industry to act in a more resource efficient way and shift to safe and environmentally sound substances, and improve knowledge sharing across the sector
- improve the resource efficiency of Danish enterprises
- make it easier for consumers to buy products and services that require fewer resources and fewer problematic substances and that generate less waste
- reduce food waste at all stages of the value chain
- support textile companies to reduce environmental impacts in the production phase and make it easier to reuse and recycle textiles, in part by reducing the use of hazardous substances in textiles
- simplify the reuse and recycling of electronics and electronic waste, so that
- the life of these products is extended and they are better integrated into the circular economy
- reduce the environmental impact of packaging

Specific measures targeting the B&C sector:

- prevention of the generation of construction and demolition waste
- increasing the lifespan of buildings that have lost their functions and identifying new functions for them;
- creating a national coordinating body (to align supply and demand, support the development of technical guidelines and standards, and support research and development);
- promoting the practice of selective demolition;
- transforming the construction materials' classification system;
- creating a waste handover system;

- determining an obligatory percentage for the incorporation of reused materials in construction for Green Public Procurement,
- drafting a specific regulation for construction and demolition waste
- creating a coordinating body for the prevention of construction and demolition waste that would, among other things, support research and development in the field
- supporting research and development, eco-innovation and eco-design
- transferring knowledge on waste prevention
- encouraging more pronounced incorporation of prevention into vocational training and corporate policies
- encouraging the development of networking among the relevant experts

(European Environment Agency 2016b)

Integrated construction and demolition waste plans

Integrated construction and demolition waste plans are one of the so called best environmental management practises (BEMPs) described by the Joint Research Centre (JRC) of the European Commission. They aim to support local authorities in optimising waste management and direct activities towards a more circular economy. Plans for CDW are developed by local authorities and involve relevant local stakeholders, like the established construction industry. One focus area is waste prevention, using instruments like a demolition code of practice. To enhance reuse and recycling, minimum requirements for waste sorting and documentation of material flow are suggested. Regional plans quantify collection and recycling needs necessary to achieve national targets. Urban development plans take those into account and specify measures and required capacities. The set targets can exceed the EU or national objectives of recycling rates of at least 80%. While the waste authorities of local, county or regional governments are responsible for the development and enforcement of plans and strategies, activities of CDW management are mostly driven by private companies. These activities can be enhanced by regulations and standards or incentives like tax relieves or the promotion of certain material.

Regional implementation: the Basque Country

Regional CDW plan, objectives:

- Promotion of prevention and reuse
- Environmentally sound recovery
- Minimising landfilling and treatment of CDW

Study/estimation for every activity that requires a permit:

- Demolition of an existing building: study on material and recycling possibilities
- Segregation of waste when given limits are exceeded (e.g. +10 tons of concrete)
- Waste management studies for licensing: estimated amount of waste, measures for waste prevention, inventory of potential hazardous waste
- Construction of a new building: the use of secondary material is highlighted
- Ratios of waste generation for various building types

4.2.2 Transparency Tools

There are several options for tools that can be used to increase transparency in the building and construction sector related to resource efficiency and circular economy. It can be distinguished between tools and instruments directly introduced by the European Commission (like the NANDO database) and tools implemented by national and regional authorities or private initiatives (European Commission 2018c). Many of the latter receive funding from European programmes. The FISSAC project for example is funded by the Horizon 2020 research and innovation programme (FISSAC n.d.). Voluntary certification schemes are another option. One of the most advanced approaches is the Cradle to Cradle Certification (C2C) that promotes circular economy and product design for a wide range of products, including the building and construction sector.

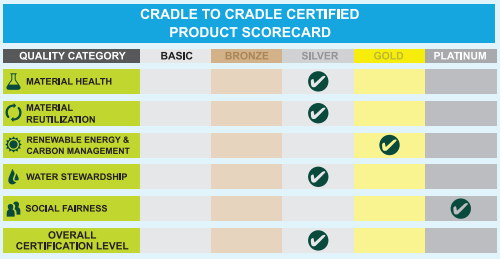
European Best Practice Example: *Cradle to Cradle*

Cradle to Cradle Certification (C2C) is considered the **most advanced rating scheme in the context of circular economy.** The C2C certification **assesses circularity performance for a wide range of products, including construction components.** C2C assesses products across five categories on a five step scale from Basic to Platinum: 1) material health, 2) material reutilisation, 3) renewable energy & carbon management, 4) water stewardship, 5) social fairness

As reasons for getting their products C2C certified, European companies name:

- Ambition to drive change in the sector
- Minimising future risks (e.g. waste management costs in future)
- Retaining value of products (potential for resale)
- New business segment and new opportunities
- Preempt regulatory changes
- Marketing reasons

Across EU member states, C2C is most coveted in the Netherlands, examples are the C2C inspired city hall and sports center in Venlo. For these particular projects, a circular economy concept was a mandatory requirement in the public tender. Even though C2C might currently be too ambitious for the Indian context, it demonstrates the logic of how circularity can be integrated in rating schemes



FISSAC

Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extend Construction Value Chain

FISSAC is a project involving stakeholders at all levels of the construction and demolition value chain that aims to develop a methodology and software platform to facilitate information exchange in order to support industrial symbiosis across the sector.

The 3 sustainability pillars of the project are:

1) Environmental (with a lifecycle approach)
2) Economic
3) Social (taking into consideration stakeholder engagement and impact on society).

(FISSAC n.d.)

Level(s) – Buildings sustainability performance

- Tools to promote the targets of the Circular Economy Package: lifecycle thinking at the whole building level
- Voluntary reporting framework to improve the sustainability of buildings;
- Linked to existing standards, EU-wide approach to assess the environmental performance of buildings
- Tool to design and construct sustainable buildings (low energy and resource consumption
- Assessment and certification scheme

(European Commission 2018h)

4.2.3 Market-based Policy Instruments

Taxes on aggregates can help to save resources and promote the use of recycled products. Taxes on the extraction or use of raw material can make recycled material financially more viable. Waste taxes are another option to support this development. Several countries in Europe have tax systems based on this concept (ECOTEC 2001). Examples from multiple European countries show that environmental taxes can have a positive effect on resource use and domestic economic development but have to be used with caution and only after detailed market analysis.

The use of recycled aggregates from construction and demolition waste can be **encouraged by levies or taxes** on natural materials.

The **Netherlands** and **Germany** successfully implemented standardised approaches on the use of recycled materials

Dri et al. 2018

Overview of environmental taxes

UK: Aggregates Tax

- **Objectives:**
  - to address environmental costs associated with quarrying operations
  - reduce demand for aggregates and encourage the use of alternative materials (e.g. recycled construction materials)
- Tax revenues are earmarked and transferred back to the sector via reduction of the employers NIC´s (National Insurance Contribution) and via a specific fund
- Tax levels gradually increased over time:
  - 2002: 1.9 €/ton; 2010: EUR 2.5 €/ton
  - About 20% of the price of aggregates
- **Results:**
  - Reduced demand for low quality crushed rock
  - Slight increase in demand for recycled aggregates

Sweden: Tax on Natural Gravel

- Objective: to close the price gap between gravel and crushed rock (the closest substitute)
- Tax levels increased over time:
  - 1996: 0.6 €/ ton; 2003: 1.2 €/ ton; 2006: 1.7 €/ ton
  - main contribution by consumer
- Revenues are incorporated in central state budget
- **Results:**
  - Decreased share of natural gravel of all aggregates (1984: 80%; 2008: 19%)
  - Increased energy demand of the sector for the extraction of crushing rock
  - Higher use of cement to produce concrete based on crushed rock
  - Decreasing transport distances

Denmark: Close linkage of tax on raw materials and waste disposal tax

- Objective: reduced use of resources and increased use of recycled materials
- **Tax levels:**

- 0.67 €/m³ for selected raw materials, commercially extracted or imported and consumed in Denmark, no exports
- 38 €/ton of waste landfilled
- Tax burden mostly transferred to end consumer (price increase up to 33%, depending on material)

- **Results:**
  - Only small effect of tax on raw material extraction
  - But: Tax on raw material combined with waste disposal tax: strong economic incentive to use recycled aggregates
  - Increased recycling rate of CDW: 1985 12%; 2004 94%

(Söderholm 2011)

5. Enhancing Resource Efficiency in the B&C Sector: Recommendations for India

5.1 Suitable Policy Tools

Irrespective of the specific policy innovations and strategies for driving resource efficiency in the building and construction sector, there are different options of generic policy tools and instruments that can be considered by Indian policymakers in adapted forms for the suggested specific interventions. They differ in how restrictive they are, what incentives they use, and whether they are of regulatory or voluntary nature. The most promising strategy will most likely be one that combines different approaches and accompanies restrictive regulations with positive incentives.

Sector-wide hard regulations are the most restrictive policy instrument available. This affects the entire building and construction sector, no matter whether public or private investors and developers are leading a construction project. This tool is most appropriate for fundamental standards that are non-negotiable and for restricting the use of certain materials or practices that create significant negative externalities. Beyond hard regulations, **setting positive financial incentives** such as tax rebates or exemptions for building in a resource efficient way can be one of the most powerful tools for changing practices in the construction sector. Even if investors and construction firms might not yet understand the long-term benefits of building in a more resource efficient way and the impact it has on lifecycle costs beyond the construction phase, creating additional financial incentives in an initial phase makes it economically rational for them to abide by these principles. A further incentive-based policy tool works with setting negative incentives for environmentally undesirable behaviour by **pricing negative externalities**. In many cases, construction companies and investors bear only a smaller portion of the full costs of unsustainable, resource inefficient constructions. A large part of the wider societal and environmental impact is not properly accounted for. Policymakers can thus put stronger emphasis on putting price tags on these externalities when setting taxes and fees for public services such as waste management.

Given the magnitude of public construction projects, changing the **requirements for public tenders** can have a real impact without having to introduce and monitor sector-wide regulations. The requirements and selection criteria could be changed in a way to reward proposals that suggest the use or avoidance of certain materials and practices by favouring them against others. In order to appear credible and to convincingly convey the message of how crucial resource efficiency is for the Indian economy and society, it is essential that the **public sector leads by example**. All new public construction projects should be built with a sustainability and resource efficiency focus. Making this visible might help to instigate wider change of practice in the construction sector and encourage private investors and developers to go down the same route. A last but very important policy tool concerns the aspect of spreading knowledge about resource efficiency in the private and public sector through **education, capacity building, and information**. It is fundamentally important to ensure that local government officials, investors, developers, architects, and construction companies fully understand the importance of the issue as well as the financial and non-financial cost implications of resource inefficiency over

the lifecycle of a building. Furthermore, architects and construction firms need to know what the eco-efficiency characteristics of different materials are and be informed about possible ways of how resource efficiency can be increased and what support they can get for this.

5.2 Recommended Areas for Policy Innovation

Building on the presented analysis of the baseline situation and the mentioned available general policy tools, a set of specific areas for policy innovation and recommended next steps is presented below. The development of these recommendations mainly builds on the input from the 15 expert interviews and the three stakeholder consultation workshops. At the end of the chapter, specific, tangible policy packages and project ideas that could follow this report are suggested based on the policy recommendations.

5.2.1 Use of Sustainable Building Materials

A key area for policy innovation that can drive resource efficiency in the building and construction sector is increasing the use of sustainable resources as building materials. In this regard, it is useful to consider a set of criteria that are the basis for defining a certain material as sustainable. The three most important factors are: **1) What materials are available locally? 2) What materials can ensure resource efficiency in maintaining the building? 3) What materials are easily degradable / recyclable?**

Looking at these three criteria can ensure that the entire lifecycle of a building from the construction until the demolition phase is considered when selecting building materials. This should not only include increasing the use of new, more sustainable building materials but also making conventional resources more sustainable. In order to effectively drive resource efficiency through material usage, it is fundamentally important to provide tools that help understanding the impact of different materials throughout the different lifecycle stages of a building and to build awareness in the entire building and construction sector, primarily among architects and developers.

Beyond awareness, incentive structures are a key pillar for changing behavioural patterns in the private sector. It will not be enough to just inform investors and the private sector about available options and their environmental impacts but they need to see tangible incentives for using certain materials and not using others. Pricing of materials at point of purchase is the most obvious aspect of this consideration. However, this can also include cost implications further down the line such as maintenance and waste management costs. Indirect incentive structures beyond pricing of products are advantages that companies gain in tenders by using certain materials. Performance based material codes are crucial in the respective legislation and legislation needs to be material neutral – i.e. construction firms should be able to make material choices independently as long as functional requirements are met.

Either way, for any of these options to be effective, it is essential that there is sufficient supply of affordable sustainable resources and that distribution channels are accessible. Currently, many sustainable or recycled materials are only available in larger bulks even though smaller private home-builders might not have sufficient liquidity to buy an entire house or all required materials at once. Hence, modular perspectives should be considered to reach these client levels and retailing of smaller amounts of materials should be incentivised.

A) Vernacular architecture/locally sourced resources

Despite a commonly seen tendency to focus on new materials and innovations in the narrower sense when thinking about resource efficiency, in the Indian context it is important to put more effort into exploring traditional approaches and commonly used local materials that could be adjusted to the functional requirements of modern day constructions. This area has been widely discussed at stakeholder consultations and interviews with key experts and was generally perceived as a highly

promising approach. Increasing the adoption of vernacular architecture approaches and primarily using locally sourced resources has great advantages from a resource efficiency perspective. In most cases, such approaches have been continuously tested and improved over a long time and are perfectly fitted to the local context and the respective geographic and climate conditions, often more so than modern materials and concepts that are imported from very different contexts. With regards to material usage, it is essential to keep transport costs low and stick to materials that are available locally in abundance and can be used for construction without significantly harming the environment and the natural resource endowment of India. It is fundamentally important to look at locally available resources from a disaggregated local level perspective rather than from a national angle as differences between states are significant. International studies show, that the use of local materials, like stone, can reduce the embodied energy in the building material by 33%. The global warming potential can be decreased by 29% (Mendonça and Martins 2015). Locally available materials can significantly reduce CO2 emissions and traffic congestions due to reduced transport and logistics efforts. Examples of sustainable materials that are available locally in different Indian regions and should thus be considered in construction projects in the respective areas include solid wood (north east India), coconut wood (south west India), and brick clay and straw (Rajasthan). Increasing the use of locally available resources necessarily needs to go hand-in-hand with policies ensuring sustainable consumption and regeneration of respective resources, e.g. through sustainable forestry and reforestation policies in case of solid wood.

Best Practice Example:
Kamath Design Studio
contemporary Indian vernacular architecture

Kamath Design Studios is a **pioneer in using vernacular architecture** principles and **sustainable resources** for a wide range of buildings in northern and central India. The key resource and **building material** used by Kamath is **mud.** It aims to use mud in the most efficient way possible in line with traditional building approaches but **adapted to the requirements of use in modern day India.** The buildings designed and built by Kamath include residential houses, hotels and guesthouses, schools and education centres, work spaces, religious and cultural centres, and many more.

Best Practice Example:
Bamboo Products for Construction

An option for **replacing steel and cement** for construction is using a combination of **locally sourced bamboo** and rammed earth. Treated bamboo has great durability and can last for more than 30 years if used in external construction and more than 50 years for interior use.

Using locally sourced bamboo has not only the advantage that the extraction of iron ore and production of steel can be limited but also ensures that locally available material can be utilised and local communities benefit from local construction projects. Bamboo represents a **non-carbon-intensive natural solution** as an alternative to less sustainable carbon intensive materials. As such, it also helps to reduce waste during construction and demolition. One exemplary company dealing with bamboo products for construction in India is *Jans Bamboo Products*

Suggested key actions:

- In many cases, there is a significant lack of knowledge amongst players in the building and construction sector and the wider public regarding what building materials are locally available, where they can be purchased and what functional criteria they fulfil. It is therefore fundamentally important to raise awareness and make information about these materials publicly available. One of the most important tools that we recommend to be pushed by local authorities is the **development of specific inventories of all locally available building materials.** The inventories should be publically available and inform architects, builders, and construction firms about locally available (within a certain radius) products and their functional characteristics. In each region, there should be a central go-to office where these inventories are stored publicised and updated. (Further elaborated below in Chapter 5.2.2.)
- Beyond knowledge dissemination and information, trust in quality is a key ingredient to driving better uptake of traditional building practices and local materials. It is therefore essential to

ensure that **norms and standards exist for all locally available materials** that are included in the inventories. Without strengthened quality assurance systems and verified standards, it will be very hard to convince investors and builders of their suitability and value for construction projects. (further elaborated below in Chapter 5.2.2)

- Another recommended step is to dedicate significant **research and development (R&D) resources to upgrading locally available resources and traditional construction practices** and working on making them more suitable for modern use and requirements. Despite proven qualities of vernacular architecture concepts, changing framework conditions and climatic circumstances require updating and adjusting traditional building practices in order to make them credible alternatives to more modern approaches and ensure trust and uptake from the construction sector and wider public. Investing in research and capacity building with a focus on vernacular architecture and traditional local material are hence important steps in making these practices and products fit for purpose in modern times.
- If the steps above are successfully taken, it is recommended to force greater demand for locally sourced materials and vernacular building concepts through **public procurement** in a next step. Strong **local procurement of materials** could be implemented through tenders that include quotas for locally sourced materials, give bonus points for their use, or use mandatory rules that the availability of locally available alternatives that fulfil functional requirements needs to be thoroughly assessed for each construction concept. Exemptions should be granted if no adequate local alternatives are available according to the developed inventories.

European Best Practice Example:
Thoma Holz
building with locally sourced solid wood

A European best practice example for **building with sustainable, locally sourced materials** is the **Austrian company *Thoma Holz***. *Thoma* builds a huge variance of buildings across Europe and beyond with **100% locally sourced solid wood** without using any chemicals and metals. Through careful analysis of local contexts, solid knowledge about the functional characteristics of different kinds of wood and research on developing wood-based building concepts for modern day requirements, Thoma has built over 1000 solid wood buildings globally in various climatic zones and latitudes. Currently, Thoma aims to implement solid wood techniques and build up local production capacities in Asian target markets through its subsidiary *Thoma Eurasia.*

Thoma's approach shows that building with local wood can help to implement circular economy principles with a range of benefits if sustainable wood use and adequate forestry policies are given. Wood offers excellent insulation for buffering heat peaks without the use of ACs. Full deconstructability and recyclability at the end of life are given.

More generally, this proofs that exploring locally available, sustainable construction materials can be very promising if research effort goes into adapting the building concepts to specific regional, climatic, and functional requirements of modern day use.

Best Practice Example:
Laurie Baker
energy & resource efficient vernacular architecture

The work of the **architect Laurie Baker** has been groundbreaking for the use of **vernacular architecture principles** in modern **India**. His philosophy was to develop **sustainable, energy efficient, affordable buildings based on traditional building concepts using locally sourced materials**. He worked across regions in India and managed to spearhead a new movement and architectural school of adopting vernacular architectural principles and adapting them to the requirements of the 20th century.

Laurie Baker's approach of combining modern and traditional building concepts enabled him to design architecturally appealing structures for a wide range of purposes, including universities, churches, and residential buildings. One of his most famous "re-inventions" was a cooling system for large buildings based on natural airflows without the use of ACs. Despite his death in 2007, his achievements remain proof of the feasibility to build resource and energy efficient buildings in India with local materials and without heavy dependence on imported concepts and resources.

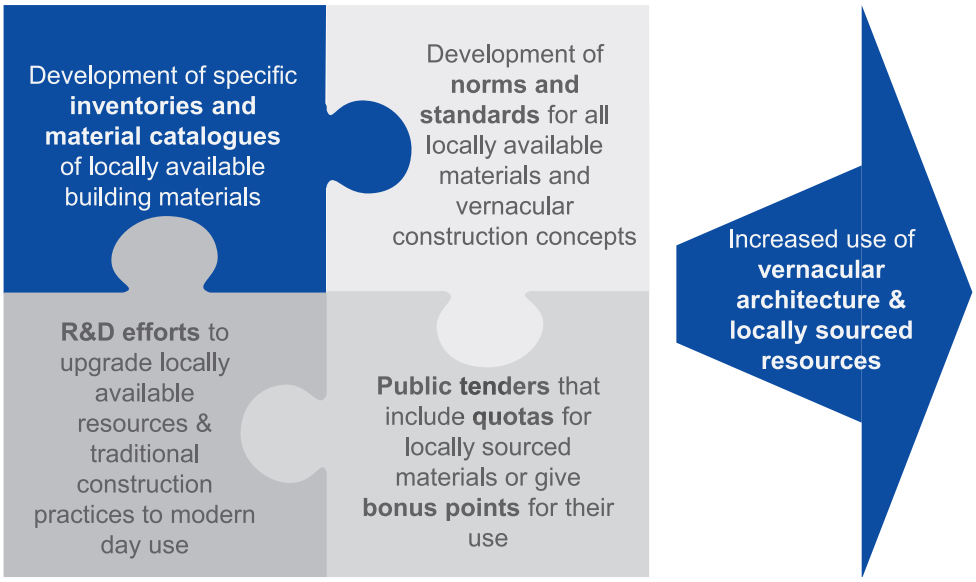


Figure 14: Visualisation of increasing use of vernacular architecture/locally sourced resources

B) Demolition waste as building material

Apart from sourcing locally available materials, encouraging the stronger use of demolition waste as a building material is an option for sustainable building materials that should be pushed further. The opportunities and challenges are fairly similar to those described above for locally available resources. A crucial advantage of using demolition waste as construction material is that it combines using less new resources and addressing waste management problems at the same time. Both aspects are key issues the Indian economy and the building and construction sector are struggling with. Indeed, there are several formal recycling facilities for demolition waste already and there is a lot of informal recycling happening. However, despite this and the existing Construction and Demolition Waste Management Rules (see Chapter 3) uptake and usage of recycled building materials remain very limited. The aim should be to include not only demolition waste but also waste created during the construction process. A technical solution for this has been developed by the Austrian expert Mr. Thomas Romm who has developed mobile recycling units which are able to reuse construction and demolition waste (mainly concrete) but also natural resources (aggregates such as gravel and sand) which are extracted right at the construction site. By managing mass flows from construction sites and using on-site materials, inner-city transport of material and heavy traffic can be reduced by two-thirds. In principle, this can result in up to 90% less fuel (diesel), CO2 emissions and traffic. A key necessity is to create tangible business models that further incentivise the usage of recycled materials in new building projects as well as the stronger engagement of private players in the recycling business and the respective retailing. Currently, demand is mostly driven by public projects and the level of awareness of the availability of recycled products, their price competitiveness, and trust in their functional characteristics as well their

European Case Example:
Recycled Concrete

The **usage of recycled concrete in Baden-Württemberg (South West Germany) and Switzerland** is an example of the **importance of a comprehensive approach** to increasing the use of recycled building materials. Even though very positive and crucial steps have been taken and the respective **DIN Norm and regulation allow the usage of recycled concrete** as an alternative to normal concrete, uptake in building and construction projects remains very low.
The main reason appears to be limted knowledge in the sector about this option and the functional characteristics of recycled concrete (very similar to normal concrete). This shows the **need for awareness raising, pilot models, market leaders, and promotion campaigns** that should go hand-in-hand with the development of norms and standards. Furthermore, the local government could have made a difference early on through **leading by example and explicitly requesting recycled concrete in public tenders**. Experts assume this could have created larger demand and momentum and eventually driven down prices as the production of recycled concrete would have been encouraged.

accessibility for private players are rather limited. The uptake of private players is further aggravated by the fact that there are very limited distribution channels for recycled building materials, especially for individual homeowners and smaller firms. The abovementioned on-site recycling approach could be one way of overcoming the distribution channel constraints.

Suggested key actions:

- Similarly to locally sourced materials, there is a severe lack of knowledge among the wider public and in the construction sector with regards to what recycled products are available on the market, what they could be used for, and what qualities they have. A **policy intervention should thus include an inventory and catalogue of available recycled building materials** in a certain area. The approach should be closely aligned with the one for locally sourced materials and could thus be part of a combined integrated initiative. (Further elaborated in Chapter 5.2.2.)
- Another parallel that might be even more significant for demolition waste than for locally sourced resources is the need for norms and standards. Given the low level of trust of many players in the building and construction sector in recycled materials, it is important to develop a **comprehensive system of norms and standards for recycled building materials.** These should provide full transparency with regards to the functional characteristics and certifies quality standards of suitable products. BIS, NBSS, CREDAI, private sector representatives, and related ministries should all be involved in the process of formulating a wide variety of standards for recycled materials.
- Following the development of standards, investing in **branding and labelling of recycled materials** should be another part of the strategy in order to increase trust in recycled products. It is important that these materials and products are not perceived as cheap, low quality products which often still is the case. Even though the private sector should have primary responsibility for this, government-run campaigns could provide support.
- **Technical guidance and advisory on functional characteristics of recycled materials** are additional essential ingredients to increase the usage of recycled building materials. The key target groups for this training should be architects, developers and construction firms in order to influence their choice of materials in the concept phase.
- Lastly, the **creation of a functional market for recycled building materials** is important. Whereas this requires private suppliers of recycled materials to invest in distribution channels that are easily accessible, the public sector could play a crucial role in **developing positive framework conditions** for this. This could consist of two elements: Firstly, the role of sustainable material usage could be

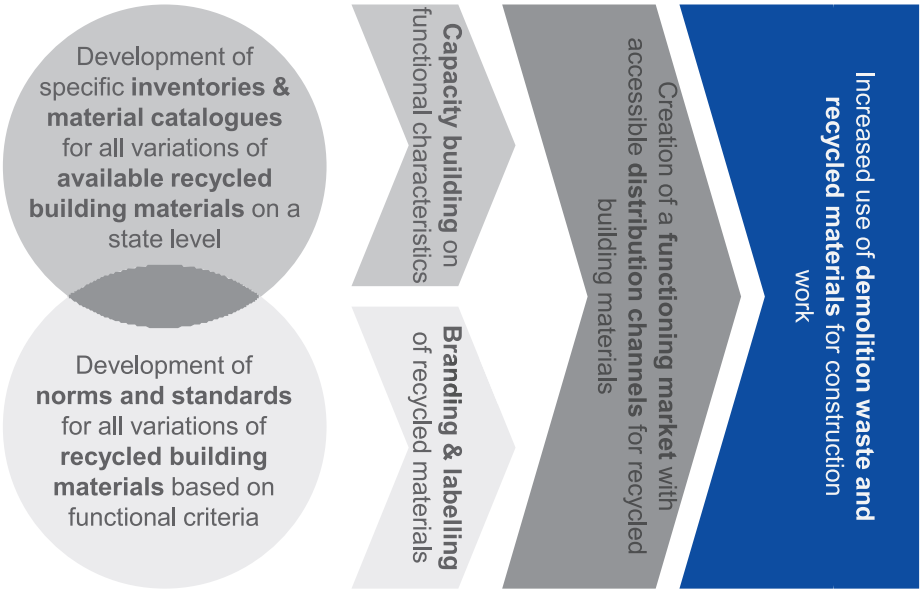


Figure 15: Summary of increasing use of demolition waste as building material

strengthened in tender scorings for public construction processes. This creates tangible incentives for bidders to think about options of using recycled construction materials and eventually creates greater demand. Secondly, it could be considered to even set stronger mandatory quotas for recycled materials in building concepts with exemptions if such materials are not sufficiently available. However, mandatory rules need to be very carefully designed as there always is a risk of being counterproductive measures. If this option is considered then a soft launch would be the most promising approach to increasing effectiveness and secure buy-in from the private sector (see Chapter 6).

C) Fly ash

Fly ash is a by-product of burning pulverised coal in electric generation power plants. It serves as a secondary raw material for soil in brick making and limestone in cement production. As described in Chapter 3, the MoEFCC mandates its use for construction projects falling within a 100km radius of coal or lignite based thermal power plants through the Fly Ash Act. There are exemptions for projects outside this radius. Due to its chemical similarity to limestone, fly ash is also used in cement production where almost 42% of fly ash generated in India is utilised. The uptake of Fly Ash is fairly high and the respective policies are seen as successful examples of driving resource efficiency in the building and construction sector. Building materials based on fly ash are now widely considered as acceptable, sustainable materials. Therefore, only very few policy adjustments seem to be needed in this regard. Two key concerns related to the use of fly ash remain: Firstly, fly ash is closely linked to the use of coal based power plants and is therefore a by-product of an industrial process that is contrary to a sustainability and resource efficiency approach. Potential changes towards more sustainable energy sources in the long-term thus need to be factored into fly ash strategies for the construction sector. Secondly, quality of fly ash products varies widely. A comprehensive system of quality standards and norms is lacking.

Suggested key actions:

- Given the fairly comprehensive uptake of fly ash products as building materials, **no significant policy changes seem to be required**
- However, in order to create more trust in fly ash products and ensure more consistent and reliable quality across India, a **more comprehensive set of norms and standards is recommended for fly ash based construction materials.**
- There is further scope for innovation by exploring options of using bottom ash and pond ash as well

5.2.2 Transparency Tools

Another option of how resource efficiency in the building and construction sector can be strengthened in India is through promoting ecological transparency of construction materials and buildings. This is important for raising awareness for such issues and addresses the challenge of insufficient information and knowledge about different materials and their ecological impacts. Even though several transparency tools exist in the Indian context, there is a lack of consistency and barely any of them are used comprehensively. Transparency refers to different aspects and stages in construction processes such as availability and features of materials as well as environmental impact of used materials or processes in a building. Often, smaller manufacturers of building materials are worried about transparency tools and certifications that require a lot of time, information, and financial resources from them. Therefore, it is important to focus on tools that are able to secure buy-in from the private sector and are not too complex for a wider uptake and roll-out.

A) Product inventories/databases

One fundamentally important transparency tool that has been widely discussed at the workshop, the focus groups, and interviews are inventories and indexes for locally sourced and recycled materials. As mentioned above (Chapter 5.2.1), such inventories could play a crucial role in driving the use of

sustainable materials. It has been shown that a large part of the reason why not more sustainable resources are used in the building and construction sector in India is that construction firms and end consumers are often unaware of what sustainable material options are available and what functional features and characteristics they have. Apart from just informing local firms and consumers about options, such inventories can also be the basis for further policy options such as mandatory material quotas or bonus points for tenders. Having a reliable source of information of what is available locally will enable public entities to take better informed, transparent decisions about tender requirements as well as about exemptions that need to be granted for mandatory quotas.

Suggested key actions:

- It is crucial for the **inventories to be developed on a local level**. In each defined region there should be a central inventory that architects, construction firms and end consumers can consult before developing a building concept. The inventories need to be easily accessible at the local authorities.
- It is important for the inventories to be **developed as one stop shops**. This means that inventories for locally sourced materials and vernacular architecture concepts should be at the same place as inventories for recycled products
- The indexes should contain **comprehensive information about the different materials.** This needs to include functional characteristics, price, distribution channels where they can be purchased as well as potentially what conventional materials they could be a substitute for.
- The local authorities responsible for the inventories need to make sure that they get f**ully updated in regular intervals.**
- Lastly, public entities and local authorities need to **actively promote and publicise the inventories** to make the sector and the wider public aware of them. Furthermore, before any public tender is issued, the **responsible agency should be obliged to consult the inventories** before. The information should then be actively used for structuring tender requirements.

B) Environmental Product Declarations (EPDs)

A **more elaborated transparency tool** that is widely used in European countries is EPDs. EPDs are **environmental disclosure tools that provide information on environmental impacts of different products.** In Europe, they are applied extensively to compare construction components of buildings. They enable users to compare different elements and products that are used in a building with regards to their environmental impacts and other aspects. The purpose of EPDs is to incentivise more sustainable and resource efficient constructions through transparency and information about building materials. EPDs are issued by certified organisations based on information provided about the products and assessments. EPDs in Europe are aligned with different international and European norms that set the rules according to which the ecological assessments for the EPDs for certain product groups are conducted. Beyond ecological data, EPDs also include technical data that enables the comparison of the ecological performance of products with similar functional qualities. EPDs can be used as a source of information for building rating schemes. A product-specific approach for EPDs should initially focus on components with the largest material throughput, e.g. concrete or steel.

EPDs exist in the construction sector in India but their uptake is currently very low. In Europe, one key incentive for firms to get EPDs issued for their products is that many tenderers set this as a formal requirement. Furthermore, once key players start having EPDs for their products, there is an incentive for other firms to follow in order to not appear as the ones not willing to provide transparency.
In Europe, 10 national EPD platform operators provide databases for a vast range of construction components. These include Bau-EPD (Austria), ICMQ (Italy), EPD International AB (Sweden), unified under ECO Platform (EU umbrella).

Suggested key actions:

- Steps to push the uptake of EPDs should initially **focus on larger firms** as they have the capacities and resources for EPDs and have the potential to **trigger a sector-wide movement**. In a later step, smaller and medium-sized companies could be incentivised to declare resource efficiency of their products and to be integrated in the EPD network.
- There is need for more **harmonisation of standards across different EPD issuers**. It is important for the sector to know which agencies can issue EPDs and to have confidence in a standardised system.
- In addition to that, a wider roll-out of EPDs could be supported by a **dedicated regulatory body for EPDs** and EPD issuers. This could help to ensure alignment of all issuers with set standards and give companies trust in the system and a central point of contact that oversees the landscape of issuers.
- The most crucial measure for increasing the recognition and uptake of EPDs is to **make use of EPDs in public tender processes**. EPDs could be made obligatory for bidding firms above a certain size or could qualify for bonus points in the tender system. Even though EPDs do not include a rating per se and are no ecological certificates, a requirement or bonus system could effectively drive a change towards more ecological transparency which may eventually lead to more resource transparency.

C) Norms and Standards

The most formalised system and step towards more resource efficiency recommended by almost all stakeholders that were consulted for this study is the **development of a more comprehensive set of norms and standards for building materials** and a significant extension of the existing system. This would increase transparency and information about available building materials and could thus be one of the most crucial steps to push the use of sustainable resources mentioned above. Only through an urgently needed wide-reaching system of reliable and consistent Indian norms and standards can trust in new or currently less used materials be increased. The system of Indian norms and standards needs to strike the balance between harmonisation and universality across regions on the one hand and context-specificity and alignment with local framework conditions on the other hand. The **two priority areas should be recycled building materials and locally sourced materials/ vernacular architecture**. Norms and standards also form the basis for pushing alternative sustainable resources through tender processes as they enable the tenderer to set functional requirements that are covered by a system of standards rather than providing recipe-like instructions. On that basis, the use of sustainable materials that fulfil the functional requirements of a building concept but have better environmental impacts than conventional materials can be encouraged.

Suggested key actions:

- The various Indian **institutions that deal with standards** for the building sector **should cooperate with each other and with further key stakeholders** to work on the development of a more comprehensive set of standards. This should include BIS, NBSS, CREDAI, private sector representatives, related ministries, and various local players, particularly for locally sourced materials and vernacular architecture.
- As norms and standards are often not known by the wider public, informal builders and smaller firms, the extension of the system of norms and standards should **go hand in hand with publicising them and raising awareness.**
- It is important to **align the norms and standards with the process of developing inventories** of available recycled building materials and locally sourced materials. The respective norms should then be integrated in these databases that are kept by local the administration (see above).
- The **starting point** for this process should be **materials with the largest local availability, throughput, or potential as sustainable alternatives** to conventional materials. The abovementioned inventories can be a good source of information for these criteria.

- The focus of the system of standards should be on **functional criteria and characteristics** of materials and products as this will be key in making them comparable to more unsustainable commonly used building materials.

5.2.3 Indicator Frameworks and Circular Economy

Another way of driving resource efficiency in the Indian construction sector could be through the further establishment, promotion, and strengthening of indicator frameworks for monitoring ecological building performance. Indicator frameworks build on the suggested measures to increase transparency but go beyond that and provide more qualitative information and ratings on the ecological impact and performance of building concepts. This creates transparency and comparability and can thus be a main driver for promoting sustainable construction practices in India. Collaboration with practitioners, experts and auditors from the construction industry is crucial to the long-term success of rating schemes. Several such schemes already exist in India (e.g. IGBC, GRIHA) as voluntary options but uptake is still relatively low, circular economy aspects are mostly not sufficiently covered in the existing schemes, and the value of getting buildings certified is still perceived as limited by many private firms.

A) Promotion of indicator frameworks and creation of incentives for uptake of indicator frameworks

In this context, it is important to ensure that using such schemes for new building projects of a certain size becomes the norm. For this, it is essential to increase awareness of their existence and tangible value for the developers and construction firms. A shift in the general perception of existing green rating schemes can only be created if the public and private sector cooperate and understand the importance of reliable green ratings. This will be essential for eventually pushing the uptake and for transforming the ratings into meaningful tools that can drive resource efficiency in the building and construction sector in India.

European Best Practice Example:
DGNB
green rating schemes for buildings

The **German Sustainable Building Council (DNGB**) was founded in 2007 by 16 initiators from various subject areas within the construction and real-estate sectors. To **promote sustainable building practices**, DGNB **offers building certifications** for buildings with labels ranging from bronze to platinum. The comprehensive certification system follows a very transparent scoreboard approach and assesses the performance of buildings over six categories & qualities: 1) ecological, 2) economic, 3) technical, 4) process, 5) sociocultural and functional, 6) location quality. In each category, certain thresholds need to be achieved to receive the certificate. EPDs are partly the basis of the ecological assesments and provide valuable information for the ratings.

As of 2008, topics related to resource efficiency and circular economy have been anchored within the certification, especially in technical and ecological categories. Currently, **circular economy is a focus area** of the DGNB scheme. If circular economy aspects are considered during construction, additional bonus points can be awarded in the evaluation.

DGNB certifications provide transparency and comparability and bring signifiicant benefits for the respective certificate holders in public and private tender processes. In public tenders a positive DGNB rating can be a significant part of the selection criterias. As the DGNB certificate is highly recognised in the German construction sector, a positive rating can increase the value of a building and is thus welcomed by private investors and developers in tenders as well.

Suggested key actions:

- It is crucial to **create pull factors, set examples, and find positive market leaders** that use rating schemes. Therefore, **incentivising market leaders to make use of rating schemes** is a key step. This requires **showcasing and promoting efforts** through close cooperation between public authorities and leading private sector players in the market that could trigger a new movement and encourage other players to follow. A first step could include **roadshows as well as co-financing pilot projects** and making respective schemes more visible. Collaboration with respective certifiers such as GRIHA and IGBC will be key for this.
- The **awareness raising efforts should initially focus on the demand side** of building projects as well as on architects and developers. The biggest pull-factor comes through market demand and tangible incentives. A faster and wider uptake of indicator frameworks can be ensured if

public building projects and private investors reward positive green ratings in tender processes. **Government should thus lead by example** and create a momentum in which private construction projects see marketing and reputational benefits if their buildings are officially and visibly labelled as "sustainable" through prestigious ratings.

- Beyond the soft reputational and marketing incentives, there could be even stronger pull factors through **tangible financial rewards and mandatory rules**. On the government side, it could be considered to make it **mandatory that all public tenders above a certain value should take green building ratings into account** as binding criteria in the bidder selection. In order to not disadvantage local bidders versus international firms, this could be coupled with rules on local content requirements.
- For private investors and construction projects, it should be considered to set-up a **stronger incentive system**. Many experts express that the current practice of gaining 5-10% floor area ratio (FAR) bonus through building according to green standards (e.g. positive IGBC rating) might be insufficient. Further incentives to be considered could include **property tax or GST rebates** for owners/buyers of green-rated properties. Extending the range of stakeholders that benefit financially from green ratings to end consumers could significantly impact the market demand and create a stronger market pull.
- As there are cost implications involved in green ratings, it should be considered to **subsidise the uptake of ratings in an initial promotion phase**. It is important to lower the barriers for uptake at the beginning until crowding-in and peer effects start kicking in and subsidies can incrementally be decreased.
- Lastly, **harmonisation of ratings** between state and central level as well as different certifiers should be pushed to ensure planning certainty for companies without sacrificing necessary regional context specific variations.

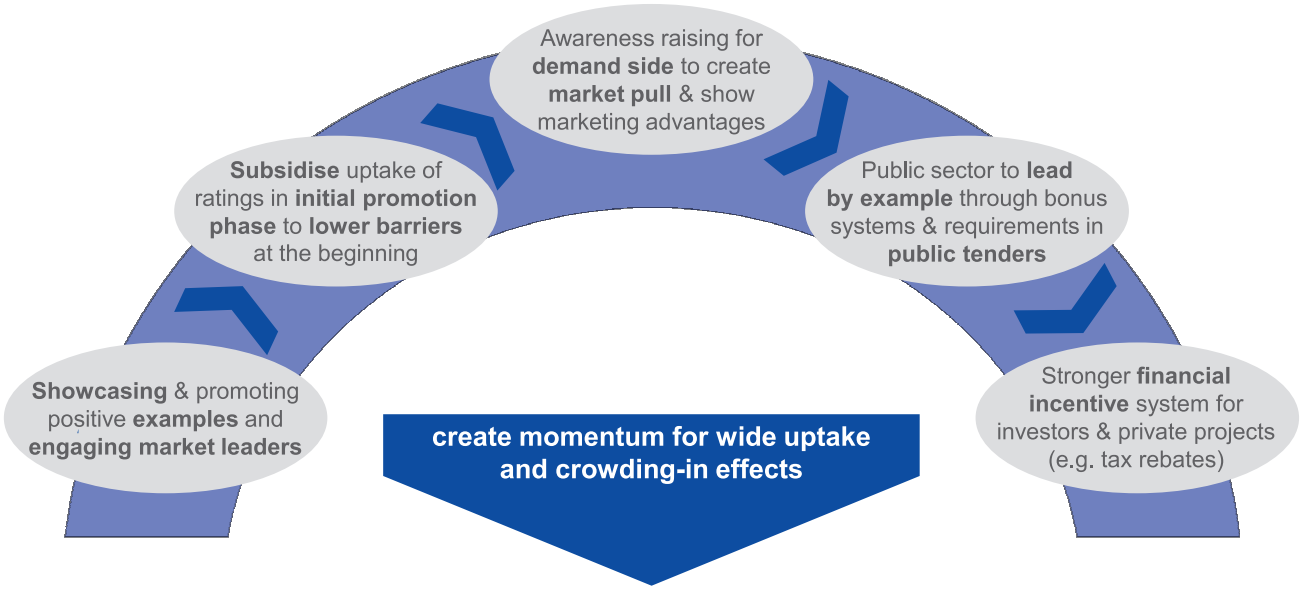


Figure 16: Visualisation of promoting uptake of indicator frameworks

B) Integration of circular economy in indicator frameworks

A second aspect that is important in the context of indicator frameworks and green rating schemes in India beyond uptake is **strengthening their validity in terms of measuring ecological impact throughout the entire building lifecycle**. Lifecycle aspects are currently insufficiently covered in the existing schemes and the ecological impact is thus not fully reflected and measured. It is fundamentally important to change the thinking in these aspects and push a perspective amongst developers, architects, investors, end consumers, and the public sector that considers a longer time horizon than just the construction stage. In the current form, usage of recycled materials gets recognised and rewarded in green rating systems whereas usage of recyclable materials is not adequately covered. If rating schemes do not properly consider these lifecycle aspects and circular economy principles they eventually only provide a snapshot that is not sufficiently meaningful for really impacting resource efficiency in the Indian building and construction sector.

European Best Practice Example:
Schüco
integrating circularity &C2C in business model

A **market leader and driving force** in the **European construction sector** with regards to **circularity aspects** is the **private company Schüco.** Schüco is a provider of ready-made construction materials based in Germany that provides high-end production materials for European markets. Schüco has an office in Mumbai and is expanding activities in India.

In 2012, Schüco started implementing Cradle to Cradle (C2C) certifications for its products. The integration of C2C and circularity principles is seen as a **long-term competitive edge which provides added value to customers.** According to Schüco, C2C and circularity offer **economic advantages when considering costs over the entire lifecycle** of buildings, including use phase and deconstruction. Covered product groups include aluminum façades, doors, and window elements.

Suggested key actions:

- Before indicator frameworks can be supplemented by circular economy aspects, open access to scientifically backed data and the capacities of key personnel in the buildings and construction sector need to be strengthened. **Training and capacity building on lifecycle assessments and circular economy principles** should therefore be widely offered to architects, developers, builders, and auditors. It is very important to not only target auditors and rating specialists but also those who design and build the buildings. Beyond training, the different rating providers should **improve and update manuals for the rating systems** that can help users to better understand the impact of different categories and help understand lifecycle assessments
- In a second step, **additional dimensions and categories should be added to existing rating schemes that specifically evaluate circularity** and lifecycle aspects of the buildings. It is advisable to keep this as a separate category rather than integrating a stronger circularity perspective in existing categories. By doing so, greater visibility of these specific aspects can be insured to instigate a wider change in the perception of them.
- It is recommended to **incrementally increase the impact of circularity aspects in indicator frameworks** on the final ratings rather than having a sudden shift in the practice. Otherwise, there is a risk of creating negative impact on buy-in from the construction sector if positive ratings are perceived as unachievable in existing rating schemes.
- The stronger integration of lifecycle aspects into indicator frameworks should be taken as an opportunity to push for **wider promotion of the circular economy idea in the general public.** Creating awareness of circular economy principles and lifecycle impacts through large scale campaigns can be instrumental in pushing the idea beyond a small circle of specialists and creating understanding among end consumers and smaller firms as well. Apart from the ecological impact, this campaign should include awareness raising regarding potential cost-savings further down the line if a lifecycle perspective is chosen.

- Lastly, **improving capacities for external monitoring** is crucial. All steps above can only be meaningful if this goes beyond voluntary initiatives and if public officials really buy into the idea and push for it in public tender processes. Due to these significant economic implications, validity and reliability of the ratings need to be insured and capacities among government staff to assess, monitor, and fully understand the rating systems is essential.

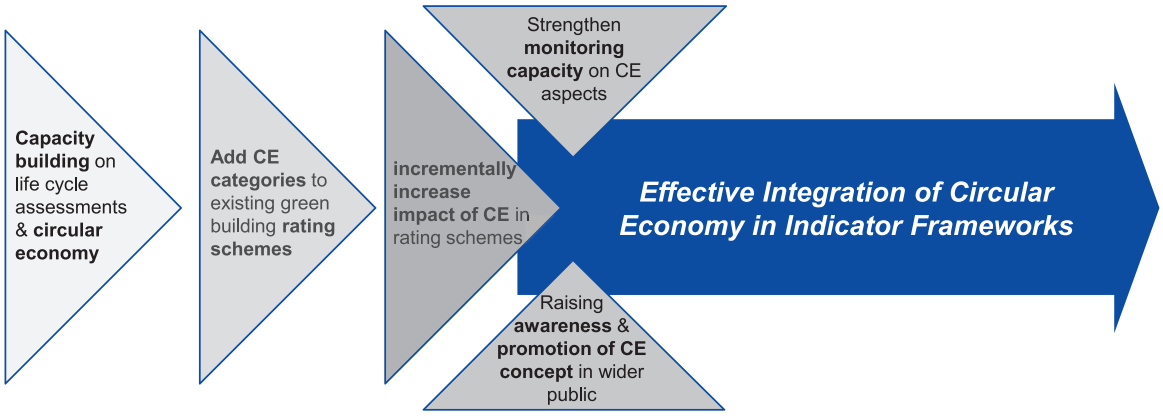


Figure 17: Visualisation of integrating circular economy in indicator frameworks

6 Outlook and Next Steps

6.1 Recommended Concrete Policy Packages and Pilot Projects

Building on the recommended areas for policy innovations above and the suggested next steps, there are a few tangible options how these could be addressed with concrete policy packages. Rather than only focusing on one of the areas presented above, the policy packages provide the opportunity for a combined approach.

Soft Launch

One of the most promising tangible approaches for the Indian context is a so-called soft launch approach. This approach follows the logic of combining positive incentives and support with a clear time horizon after which the active support will be scaled down and hard rules kick in. In the case of resource efficiency in the Indian building and construction sector, this strategy could be suitable for pushing the greater use of locally sourced materials and vernacular architecture concepts, demolition waste as a building material, and green building schemes or indicator frameworks.

In a first step, it needs to be **communicated that at a certain point in time**, several years down the line, **specific quotas or mandatory rules will be implemented**. It is essential that this communication is credible, provides a clear time horizon, and allows planning certainty for all market players. Examples could be quotas for recycled materials in all new building projects, requirements for always considering local resources and vernacular architecture concepts first in 50% of new public tenders, higher taxes on unsustainable building materials, or making positive ratings in certified green building schemes mandatory for all bidders in public tenders. After credibly announcing these policy changes for a specific point in time, a process of incremental steps and positive support should be initiated. It is important that the time frame is long enough to allow all market players to adapt and the supply side to scale up, but at the same time close enough in the future to create some level of urgency.

Further, it is crucial to create awareness, **buy-in and positive incentives early on**. This could be done through a **combination of knowledge creation and promotion efforts** with active financial support. The first part could be achieved through campaigns, roadshows, or **high profile lighthouse projects** that raise awareness and showcase the advantages of using certain building materials or rating schemes. This also involves getting market leaders on board to create a momentum and influence others. The second part could include **specific funding windows for innovative approaches and positive pilot projects as well as tax benefits or subsidies** for the use of sustainable materials or certifications. These benefits need to aim at particularly rewarding early movers. They should therefore be incrementally scaled down as soon as a critical mass of players has been reached and the desired behaviour gets closer to being the norm in the market.

In parallel with incentivising market players, creating awareness, and sharing information, **active capacity building and training opportunities** should be offered for architects, construction firms, and

developers. For example, a strategy on increasing the use of locally sourced materials and vernacular architecture should be coupled with offered trainings and workshops on these materials in different regional centres.

As support programmes, pilot projects, and subsidies get slowly scaled down, quotas, legal requirements, and public tender requirements should incrementally be increased and tightened. Through the **soft launch logic of starting with active support and then reversely scaling down financial rewards and scaling up rules and requirements**, an effective momentum can be created that allows for initial buy-in from key market players, can lead to desired practices becoming the norm, and ensures that the market is prepared for new regulations once they are eventually implemented. Making mandatory rules the very last step and getting the private sector on board early on are key success factors for this strategy.

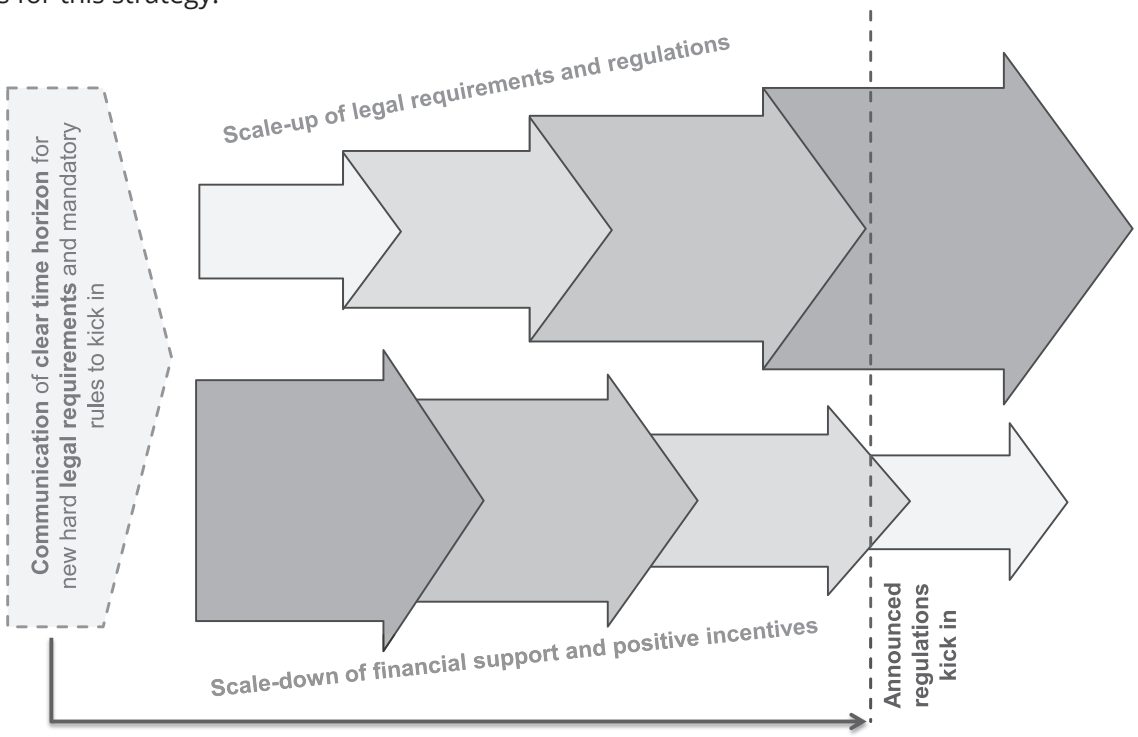


Figure 18: Visualisation of soft-launch approach

Leading Example Pilot Projects and Awareness Raising

Another concrete package could **focus on awareness raising and pilot projects**. This can either be seen as part of the soft launch approach or as a standalone measure. This initiative follows the logic that it is crucial to get key market leaders on board with new building practices and lead the movement by example. It is fundamentally important for the private sector, especially smaller and medium sized companies, to see and know inspirational role models and local success stories.

The most effective way of showcasing such local success stories and creating leading private sector examples is through **lighthouse projects run by larger companies and visible local pilot projects.** Such pilot projects could be actively supported through **subsidised demos and pilot sites in different regional centres and model cities**. The pilot projects might have to be **partly financed and coordinated by public authorities**. This initial trigger phase should be coupled with broad promotion campaigns, awareness raising efforts, and roadshows across the respective regions to maximise visibility of pilot projects and market leaders and reach as many parts of the private sector as possible. Apart from construction firms, it is particularly crucial to reach architects as they are responsible for building concepts and design as well as investors, public tender agents, municipalities, and developers who can drive change through demand creation by requesting the use of certain materials and concepts.

Task Force on Developing Norms, Standards and Inventories

As a third concrete initiative, it is recommended to create a **task force consisting of public authorities as well as experienced domestic and international consultants** with a mandate to drive two of the key areas of action recommended above (Chapter 5.2.2.):

a) **development of norms and standards** for recycled building materials and locally sourced materials

b) **development of inventories**, databases, and material catalogues of locally available building materials and recycled materials.

The task force should be **split into regional teams** looking after different states and their specific needs on the one hand **and a central umbrella unit** that takes care of country-wide coordination on the other hand. The task force should then support local authorities, BIS, NBSS, CREDAI, and partners in **identifying key materials and prioritising them** for the purpose of developing norms and standards as well as including them in the material catalogues.

Following this initial mapping and prioritisation exercise, it is important to provide **assistance in the actual process of developing the catalogues and sets of norms.** In close cooperation with all crucial stakeholders, information gathering about the different materials and processes must be the first step. The task force's role could be to **support in the facilitation and moderation of this process**. For the development phase, the task force should support in managing the process, setting clear milestones and managing workplans. A fundamental part of its mandate should be to **ensure coordination across states** and at the same time sufficient representation of the different states and regions to ensure a **harmonised but context-specific approach**. Lastly, the task force should liaise with various stakeholders and authorities to ensure that the process of developing norms, standards and inventories is aligned with other interventions aiming at resource efficiency in the building and construction sector and synergies can be created.

6.2 Scope for Indo-European Cooperation

The suggested policy recommendations offer a range of opportunities for cooperation between Indian and European public and private sector players to facilitate collective learning, technology transfer and exchange of lessons learned.

With regards to increased use of sustainable building materials, particularly vernacular architecture and locally sourced resources, there is scope for bringing together firms working according to these principles in the European context with Indian firms that have an interest in this field and know the specific local context. This offers scope for knowledge exchange and developing partnerships or joint ventures to tackle this issue together. The Indian partners could bring in solid understanding of locally available resources and construction techniques as well as specific climatic or cultural requirements in the building sector. The European partner firms could supplement this by contributing their technological expertise and knowledge on how the use of sustainable materials and vernacular architecture principle can be upgraded to fit the purpose of modern day use in buildings. An example of a European firm that could be a valuable partner for an Indian firm in this regard is the abovementioned Austrian firm Thoma Holz with its subsidiary Thoma Eurasia (see 5.2.1).

Similarly, European and Indian firms could work together on driving the increased use of demolition waste as building materials. European and Indian firms could primarily work together on two dimensions: a) the development of distribution channels and a functioning market for recycled building materials; as well as on b) the upgradation of recycling technologies to make recycling of demolition waste more efficient and enable on-site recycling. The partnering firms could create joint ventures and cooperate in finding suitable context-specific business models for marketing and distributing recycled building materials based on experiences and best practices from Europe and knowledge about the

specific context of the Indian building and construction sector. For on-site recycling Indian construction and recycling firms could work on an exchange with European experts such as the Austrian specialist Mr. Thomas Romm (participant of EU-REI Study Tour 2017) who developed the technology for mobile recycling units which are able to reuse construction and demolition waste right at the construction site. This can massively reduce transport costs and logistics efforts with regards to managing construction waste and overcome constraints with regards to distribution channels. Particularly in Indian cities with heavy traffic congestions, this can be a promising opportunity.

With regards to the integration of circular economy principles in existing indicator frameworks and the promotion of such, cooperation between GRIHA or IGBC and European providers of indicator frameworks such as DGNB or C2C certifying agencies is a promising opportunity. GRIHA has already started to integrate circular economy principles in its indicator framework. Cooperating with its more advanced European counterparts could thus allow GRIHA to upgrade its existing system and make it more ambitious while taking into account specific requirements of the Indian construction sector.

The opportunities for cooperation presented above are just a selection of potential examples. It is worth to further explore this area as the scope for collaboration between Indian and European firms goes far beyond what can be covered in this study.

ANNEX I

List of Individual Expert Interviews

Name	Organisation
Gaurav Bhatiani	IL&FS India
Dr. K Vijaya Lakshmi & Shruti Issar Issar	Development Alternatives India
Anita Kietzmann & Frank Grootens	IBU (Institute for Construction & Environment)
Christine Ruiz Durán	DGNB (German Sustainable Building Council)
Raju Amardeep	MOEF&CC India
Praveen Kumar Soma	IGBC (India Green Building Council)
Souvik Bhattacharjya	Teri
Suki Kler Young	EPEA (Environmental Protection Encouragement Agency)
Christian Donath	ECO Platform
Henning Ellermann	DENEFF (German Network for Energy Efficiency) Expert for resource and energy efficiency in the building sector
Valentin Brenner	Previously circular economy expert at Drees & Sommer; now CEO Brenner & Ebert Architects
Thijs Maartens	Cradle to Cradle Products Innovation Institute
Prof. Erik Serrano	Expert for structural mechanics at Lund University
Erwin Thoma	Thoma Holz (wood construction firm)
Stefan Rohrmus	Schüco

ANNEX II

State-level implementation of EU policies and overarching strategies

overarching strategies			EU policies	Content	State-level implementation	Case Studies
			Construction Product Regulation	Harmonised rules for marketing of construction products in the EU (including CE marking and <2,000 standards) -> free circulation of goods -> reliable information on performance of products (European Commission 2018b)	- National Standards - National Technical Assessment Bodies (TABs) (using the Commission electronic tools) (European Commission 2018b)	Ireland: - Notifying authority: Department of the Environment, Community and Local Government - Accreditation and monitoring: Irish National Accreditation Board - Product contact point for construction: Department of Housing, Planning and Local Government (Department of the Environment, Community and Local Government 2013)
Circular Economy Package	Construction 2020	Roadmap to a Resource-efficient Europe	Waste Framework Directive	Centrepiece of European waste legislation; promoting the five-step waste management hierarchy. Pushes European policy towards increased resource efficiency Target: 70% of construction and demolition waste prepared for reuse, recycling and other forms of material recovery (European Commission 2016a)	National Waste Prevention Programmes - revised and evaluated every six years - function individually or integration in other waste management plans - waste prevention objectives (quantitative and qualitative targets) - description of existing prevention measures and evaluation of their usefulness - targeting environmental impacts and enhancing economic growth (European Commission 2016d)	Sweden: Swedish national waste prevention programme under the Swedish Waste Ordinance (2011:927) - prepared by the Swedish Environmental Protection Agency - setting waste prevention objectives, measures and targets - using indicators to determine the success of implementation - describes existing waste prevention measures - aim: reduction of waste, promotion of sustainable product design (without hazardous substances), regardless of the extent of economic growth - 8 long- term objectives and 167 measures - long- term objectives for construction: by 2020, less waste is generated per m² of construction compared to 2014 (Naturvårdsverket 2013)

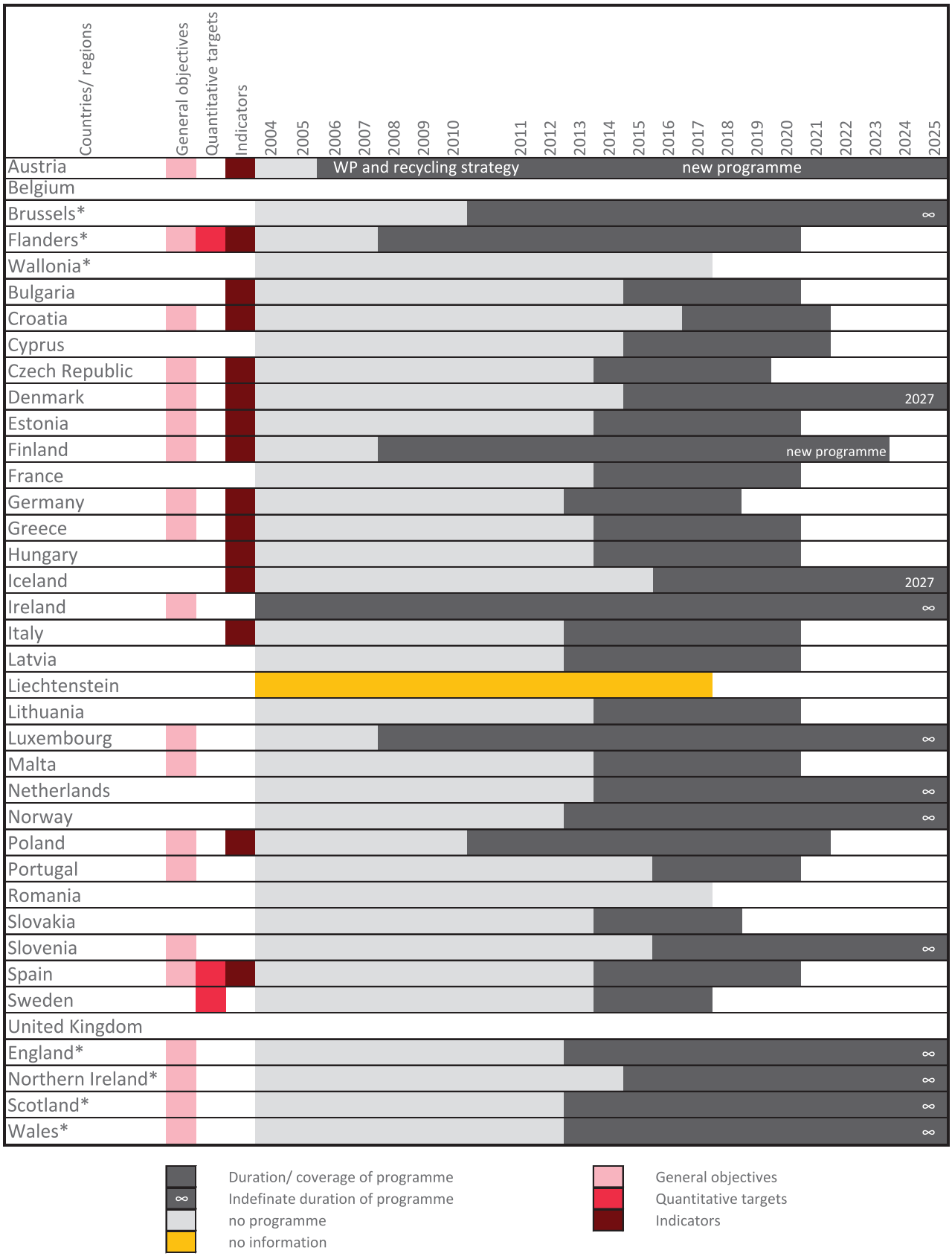
			EU Construction and Demolition Waste Protocol	Non- binding guidelines to increase confidence in the construction and demolition waste management process and trust in the quality of recycled materials. -> improved waste identification, source separation, and collection -> Improved waste logistics -> Improved waste processing -> Quality management -> Appropriate policy and framework conditions (European Commission 2016b)	- National standards - in cooperation with principles in national legislation (VTT et al. 2016)	Austria: selection of standards and ordinances Standards: - Dismantling of buildings as a standard method for demolition (ÖNORM B 3151: 2014 12 01) describes the measures needed for the planning and execution of the dismantling of buildings and specifies separation principles for different materials with regards to recovery or disposal - Demolition work - Works contract (ÖNORM B 2251: 2006 08 01) contains procedural and contractual provisions for the execution of demolition work on buildings or parts thereof. In case of suspicion of harmful substances, an additional standard is to be applied - Investigation of pollutants in buildings before demolition (ONR 192130: 2006 05 01) describes the requirements for the investigation of building components, in particular of building components contaminated with pollutants, the sampling of suspected areas, and the estimation of quantity and types of hazardous substances. The results of the exploration are used for a risk assessment which forms the basis for the preparation of concepts for demolition work National legal texts: - Recycling Baustoff Verordnung (BGBl. II Nr. 181/2015 : 2015 06 29 - 2016 01 01 & BGBl. II Nr. 290/2016:2016 10 27 - 2016 10 28)

						Ordinance on the obligations for construction and demolition activities, the separation and treatment of waste arising from construction and demolition activities, the production and end of waste from recycled building materials - Deponieverordnung (BGBl. II Nr. 39/2008:2008 01 30 - 2008 03 01) Ordinance on landfill regulations (Austrian Standards 2018a, 2018b, 2018c)
			Energy Performance of Buildings Directive	Latest revision from 2018: - requires member States to set minimum energy performance requirements for buildings and building elements - Cost- effective renovation of existing buildings - promotes the use of smart technology in buildings - supports electro-mobility infrastructure deployment in buildings' car parks - vision: decarbonised building stock by 2050 - mobilisation of investments (European Commission n.d.)	Member states need to integrate the provisions in national law by May 2020 - National minimum energy performance requirements should not be more than 15 % lower than the outcome of the cost-optimal results of the calculation taken as the national benchmark. (European Commission n.d.)	Denmark: Danish Building Regulations 2018 (BR18 introduced 1. January 2018) (Aggerholm S. 2018)

ANNEX III

Coverage of waste prevention programmes adopted in European countries and regions in line with the Circular Economy Package

(adapted from European Environment Agency 2018)



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