



UNEP

**Sustainable Buildings
and Climate Initiative**

Promoting Policies and Practices for Sustainability

GREENING THE BUILDING SUPPLY CHAIN

UNITED NATIONS ENVIRONMENT PROGRAMME

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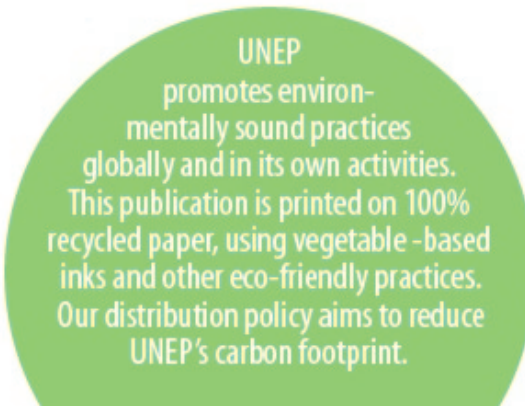
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The SKANSKA logo consists of the word "SKANSKA" in a bold, blue, sans-serif typeface.

Contents

Foreword	8
Executive Summary and Action Framework	9
1 Introduction to the Greening the Building Supply Chain initiative	16
1.1 The environmental impact of the construction and building sector	16
1.2 The development challenge	16
1.3 The construction sector	18
1.4 The opportunity for greening the building supply chain	19
2 The “Greening the Building Supply Chain” initiative	20
2.1 Introduction	20
2.2 Objective	20
2.3 Building typologies	21
2.4 Task Force process	22
2.5 The building delivery and management process	22
2.6 Green interventions	24
3 Greening the Building Delivery and Management Process	26
3.1 Introduction	26
3.2 Stage 1 - Concept Definition	26
3.2.1 Scope	27
3.2.2 Stakeholders	27
3.2.3 Relationships	28
3.2.4 Barriers	28
3.2.5 Green Interventions	29
3.2.5.1 More progressive public green building policies	29
3.2.5.2 Private sector green building policies	31
3.2.5.3 Favorable financing terms for green buildings	33
3.2.5.4 Alternative procurement models for green buildings	34
3.3 Stage 2 - Design	37
3.3.1 Scope	37
3.3.2 Stakeholders	38
3.3.3 Relationships	38
3.3.4 Barriers	39
3.3.5 Green Interventions	39
3.3.5.1 Green performance guarantees	39
3.3.5.2 Green incentives in permitting process	41
3.4 Stage 3 - Construction	44
3.4.1 Scope	44
3.4.2 Stakeholders	45

3.4.3 Relationships	45
3.4.4 Barriers	45
3.4.5 Green Interventions	46
3.4.5.1 Green/sustainable private procurement	46
3.4.5.2 Green/sustainable public procurement	48
3.5 Stage 4 - In use	52
3.5.1 Scope	52
3.5.2 Key Stakeholders	53
3.5.3 Relationships	54
3.5.4 Barriers	54
3.5.5 Green Interventions	54
3.5.5.1 Green facilities management	54
3.5.5.2 Benchmarking and follow-up	55
3.5.5.3 Green leases	58
3.5.5.4 Green criteria in asset valuation	59
3.6 Tools for Green Interventions	61
3.6.1 Building Level	61
3.6.1.1 Green building rating tools	61
3.6.1.2 Life cycle assessment and costing	63
3.6.1.3 (Green) BIM	67
3.6.2 Material, Product and Component Level	69
3.6.2.1 EPDs and product certification	69
3.6.3 Corporate Level	71
3.6.3.1 Reporting/disclosure	71
3.7 Discussion	75
4 Greening the Material and Product Supply Chains	76
4.1 Introduction	76
4.2 Stakeholders and barriers to green interventions	77
4.3 Materials groups considered	77
4.4 Intensity Analysis and Heatmap	77
4.5 Heat map	78
4.5.1 Heat map sample	78
4.6 Discussion	80
4.7 Recommendations	80
Conclusion	82
References	84

List of Figures

Figure 1. The most significant commercial relationships in the construction and building sector

Figure 2. Stakeholders and value.

Figure 3. The simplified building supply chain

Figure 4. The concept definition stage

Figure 5. Concept definition stakeholders

Figure 6. The design stage

Figure 7. Design stage stakeholders

Figure 8. The construction stage

Figure 9. Construction stage stakeholders

Figure 10. The in use stage

Figure 11. In use stage stakeholders

Figure 12. Supply chains

List of Tables

Table 1. Green priority aspects

Table 2. Indicative heat map of selected building materials

List of Case Studies

- Eco-reinforcement standard
- Vancouver Greenest City 2020 Action Plan
- Skanska's Journey to Deep Green
- Sumitomo Mitsui Trust Bank
- Houston Mayor's Office
- Seattle Green Building Incentives
- Saint-Gobain's responsible purchasing policy
- UNEP's Sustainable Public Procurement (SPP) Initiative
- The Green Building Information Gateway (GBIG)
- Soft Landings Framework
- Better Buildings Partnership Green Lease Toolkit
- RenoValue
- The wider impact of green building certification in South Africa and Australia
- CEN/TC 350
- BIM in practice
- EPDs at Saint-Gobain
- ENCORD Construction CO2e Measurement Protocol
- GRI CRESS
- WBCSD CSI Getting the Numbers Right

List of Info Boxes

- The impact of the global building and construction sector
- Challenges of future resource availability relevant to the building and construction sector
- Greening the Building Supply Chain and the 10 Year Framework of Programmes on Sustainable Consumption and Production
- The business case for green buildings
- Regulatory policies, fiscal policies and voluntary actions
- Integrated design
- Selected Life Cycle Assessment (LCA) Indicators for Green the Supply Chain
- Supply Chain Sustainability School
- Towards a Circular economy
- Alternative bids
- Open House and SuPerBuildings

Glossary

1-10

10YFP: 10 Year Framework of Programmes on Sustainable Consumption and Production

A

ADP: Abiotic Depletion Potential

B

BBP: Better Buildings Partnership

BCA: Building and Construction Authority of Singapore

BIM: Building Information Modeling

BRE: Building Research Establishment

BSI: British Standards Institution

BSRIA: Building Services Research and Information Association

C

C&D: Construction and Demolition

CASBEE: Comprehensive Assessment System for Build Environmental Efficiency

CCI: Clinton Climate Initiative

CDP: Carbon Disclosure Project

CH2: Council House 2

CIWM: Chartered Institution of Wastes Management

CO₂ eq: Carbon dioxide equivalent

CRESS: Construction and Real Estate Sector Supplement

CSI: Cement Sustainability Initiative

D

DB: Design and Build

DBFO: Design, Build, Finance and Operate

DBO: Design, Build and Operate

DECs: Display Energy Certificates

E

ENCORD: European Network of Construction Companies for Research and Development

EPC: Energy Performance Contracting

EPD: Environmental Product Declaration

EPG: Energy Performance Guarantee

ESCO: Energy Service Company

F

FIDIC: Federation of Consulting Engineers

FLEGT: Forest Law Enforcement, Governance and Trade

FM: Facilities management

FSC: Forest Stewardship Council

G

GBC: Green Building Council

GBIG: Green Building Information Gateway

GDP: Gross Domestic Product

GHG: Greenhouse Gas

GNR: Getting the Numbers Right

GPDA: Gypsum Products Development Association

GPP: Green Public Procurement

GRI: Global Reporting Initiative

GSL: Government Soft Landings

GWP: Global Warming Potential

H

HVAC: Heating, Ventilation and Air Conditioning

I

ICLEI: International Council for Local Environmental Initiatives

IEE: Intelligent Energy Europe

IPD: Integrated Project Delivery

IPMVP: International Performance Measurement and Verification Protocol

ISO: International Organisation for Standardisation

ITT: Invitation to Tender

L

LBC: Living Building Challenge

LCA: Life Cycle Analysis

LCC: Life Cycle Cost

LCI: Life Cycle Inventory

M

M&E: Monitoring and Evaluation

MEP: Mechanical, Electrical and Plumbing

MoU: Memorandum of Understanding

MTF: Marrakech Task Force

O

O&M: Operation and Maintenance

P

PCR: Product Category Rules

PEFC: Programme for the Endorsement of Forest Certification

PFI: Private Finance Initiative

POE: Post-Occupancy Evaluations

PPP: Public Private Partnership

PSP: Plasterboard Sustainability Partnership

R

RCA: Recycled Concrete Aggregates

RECNet: Global Network for Resource Efficient and Cleaner Production

RFQ: Request for Qualification

RICS: Royal Institution of Chartered Surveyors

RMC: Ready Mixed Concrete

S

SASB: Sustainability Accounting Standards Board

SCP: Sustainable Consumption and Production

SGBD: Saint-Gobain Building Distribution

SME: Small and Medium Enterprise

SPP: Sustainable Public Procurement

SPV: Special Purpose Vehicle

SUN: Sustainable United Nations

U

UBT: Usable Buildings Trust

UNEP-BIU: UNEP - Business and Industry Unit

UNEP-FI: UNEP - Finance Initiative

UNEP-LCI: UNEP - Life Cycle Initiative

UNEP-SBCI: UNEP - Sustainable Buildings & Climate Initiative

UNEP-SPPI: UNEP - Sustainable Public Procurement Initiative

V

VOC: Volatile Organic Compound

W

WBCSD: World Business Council for Sustainable Development

WGBC: World Green Building Council

WLC: Whole Life Cost

WRAP: Waste & Resources Action Programme

WRI: World Resources Institute

Foreword



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Much has already been done to tap the potential to reduce greenhouse gas emissions through greater energy efficiency in buildings with the co-benefit of improved energy security. More recently this potential has been reframed to take greater account of the social and economic benefits to building owners, tenants and society. While improvement of policy frameworks and the development of enabling market

conditions is still needed, wider societal challenges call for a more comprehensive view on reducing the environmental impact of buildings and the sectors operating therein.

Some 40-50% of total flow of raw materials in the global economy is used in the manufacturing of building products and components, adding significant amounts and energy and greenhouse gas emissions to the life cycle impact of buildings. In addition, scarcity concerns over mineral resources and especially water provide for an additional urgency to extend the narrow focus on energy use in buildings and the associated greenhouse gas emissions.

Consequently, the sectors making up the Built Environment need to work with stakeholders towards the widespread adoption of a simple life cycle framework - using Life Cycle Costing and Life Cycle Assessment as essential building blocks; allowing for holistic design decisions that will lower total life cycle environmental impacts, life cycle cost and weigh wider societal benefits and local context. Life cycle thinking will need to become mainstream. The challenge though, is to ensure a proper scientific basis, standardized methodologies, data transparency and quality, but above all a language that can be understood and spoken by all stakeholders.



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Across the world, countries face ever-increasing demands for resources. Driven by economic development, a growing middle class and rising populations, many countries are facing problems associated with rapid urbanization, resource depletion and scarcity, and more broadly, unsustainable patterns of consumption and production. As a key sector contributing to meeting needs for housing, schools, hospitals, public and commercial

developments, the building and construction sector is a large consumer of materials and natural resources. A critical objective therefore, is to further promote resource efficient throughout the system, fostering transformative changes at all levels, in the policies and practices of public and private sectors.

Sustainable consumption and production (SCP) promotes the concepts of doing more and better with less, decoupling economic growth from increasing resource use and environmental degradation, leading to low-carbon and green economies. Through individual initiatives and collective actions, the building and construction sector has made great strides in its delivery of more energy efficient buildings. Delivering zero-energy and even positive energy buildings is now well-established, but more remains to be done to realize greater resource efficiency throughout the sector, including efforts to reduce construction and demolition waste, achieve greater water efficiency in construction and manufacturing processes, increase awareness of material impacts, and attain greater understanding and application of Life Cycle approaches and tools.

The sector faces also institutional barriers to achieve greater efficiencies. Overcoming the sector's fragmentation and reaching to a multitude of stakeholders, including a large percentage of SMEs, will require stronger partnerships, enhanced collective actions, and greater leadership and responsibilities from public and private sector stakeholders. This report provides the basis for such actions, and UNEP-SBCI looks forward to establishing collaborations to help realize the necessary gains. UNEP-SBCI is pleased to have worked with its partners and Task Force on Supply Chain, who provided the practical experience and needed expertise to inform this dialogue. A special thanks to Skanska for their generous support and leadership in these efforts.

Executive Summary and Action Framework

As the building sector creates demand for construction materials, logistics and transport, packaging, and waste management, among others aspects, the sector and its supply chain contribute, at a large scale, to consumption and production patterns which impact on key environmental aspects such as carbon, energy, water and waste.

The business case for green building is largely established on tangible benefits associated with energy efficiency, which can now be easily measured and monetized. As the green building market matures so does the ability to understand the complexity of our sector and identify ways that we can improve our overall system efficiencies. However, while the need to understand and reduce energy consumption and greenhouse gas emissions from buildings during their operation has become increasingly recognized, efforts related to the resource use in the building supply chain appear to be less advanced. Few systematic attempts have been made to assess existing options to reduce the environmental impacts of a building and its components over its entire life-cycle. For this reason a Task Force on Greening the Building Supply Chain was established under UNEP-SBCI to identify opportunities for achieving greater resource efficiency in the building sector supply chain and contribute towards wider socio-economic goals, and to provide recommendations to UNEP-SBCI for a specific focus in development of future work programmes.

Consistent with the Task Force Mission and Goals, this Report was specifically produced to define prioritisation of green interventions for study by UNEP-SBCI and partners in future work programmes, and to support the development of a Sustainable Buildings and Construction programme under the 10 Year Framework of Programmes on Sustainable Consumption and Production. The Report also maps the interdependencies upstream and downstream of the construction site, allowing the various stakeholders to gain insight into their role and on how they impact on the overall system.

Given the large range of buildings' typologies and the associated distinctive supply chains, for this Report, a specific scope was chosen. It focuses on new and existing public and private offices as a representative building type. These buildings' delivery and management process (the way in which they are designed, delivered occupied and maintained) is divided in five stages: Concept Definition, Design, Construction, In Use and End of Life. For each stage of this process green intervention taken by stakeholders in the supply chain are described and linked with five core environmental aspects (energy, carbon, materials, waste and water). These aspects were selected as they are generally recognized by the industry to have the highest global impact over the life cycle of buildings. Four main green interventions categories are defined in the Report: Regulatory and control mechanisms, Economic or market-based instruments, Fiscal instruments and incentives and Support, information and voluntary action. For each green intervention case studies are presented to provide concrete and successful examples.

The building delivery and management process presented in the Report shows that challenges to greening the building supply chain begin with the complexity of the stakeholders relationships. A variety of stakeholders from materials suppliers to capital providers are involved at various stages of the process, each with their own specific role and at the same time with overlapping responsibilities. The barriers each stakeholder faces, ranging from lack of knowledge to financial or technological risk to lack of communication with other stakeholders, among others, are not easily overcome and require a systematic and comprehensive approach. Likewise, potential green interventions to address these barriers are also wide-ranging and include financial instruments, voluntary support programmes and regulatory actions, in addition to the required maturity of the market.

The Report also introduces an “Intensity Analysis Methodology” based on an LCA approach aimed at improving the understanding of environmental impacts of selected materials and providing indications about potential entry points for green interventions within the building materials supply chains. Aluminium, Brick, Cement, Flat glass, Mineral wool, Plaster board, Polystyrene, Polyurethane, Steel (rebar and structural), and Timber (structural) were selected for the resource intensity analysis. These materials groups have been considered based on the mutual specific resource use and environmental impacts associated with the product group and based on the current production and potential future production volumes increase. A heat map sample, looking at the relative environmental impacts of the selected construction materials, was also developed to visualize the results of the selected intensity analysis method.

The developed methodology shows that it is possible to analyze resource intensities in the form of a heat map that can be used to illustrate relative impacts from materials, based on specific impact resulting from material production in the EU for construction purposes. However, such a task is particularly challenging given multiple data quality issues, including differences between data sets stemming from different sources, data scarcity issues concerning materials production and consumption, as well as variable system boundaries regarding materials upstream processes, transport and manufacturing between different producers.

The Report provides general recommendations as well as detailed UNEP-SBCI specific recommendations for the development of actions linked with the different green interventions that can or could occur in both the building delivery and management process, and the material supply chains. These recommendations range from the promotion and facilitation of additional research on a precise green intervention previously identified in the Report, to the individuation of potential opportunities for collaboration both within and outside UNEP.

refine the intensity analysis method and the heat map approach tested in the Report identifying opportunities to better understand which materials contribute the most to a specific impact resulting from their supply chains, for example by overlaying heat maps with other relevant data such as scarcity and other risk maps that relate the heat maps to the selected material origin (e.g. combine heat maps information of freshwater use in the different stages in the supply chain with water scarcity maps).

Finally recommendations are provided to further

DELIVERY AND MANAGEMENT PROCESS	STAGE	STAKEHOLDERS	BARRIERS	GREEN INTERVENTIONS
	1 CONCEPT DEFINITION ↓	<ul style="list-style-type: none"> Public authorities Developers Capital providers Designers 	<ul style="list-style-type: none"> Lack of policy Financial risk Disregard for whole life costs Lack of knowledge and trust 	<ul style="list-style-type: none"> More progressive public green building policies Private sector green building policies Favorable financing terms for green buildings Alternative procurement models for green buildings
	2 DESIGN ↓	<ul style="list-style-type: none"> Public authorities Developers Designers/Engineers 	<ul style="list-style-type: none"> Lack of incentives Technological risk Lack of communication and leadership 	<ul style="list-style-type: none"> Green performance guarantees Green incentives in permitting process
	3 CONSTRUCTION ↓	<ul style="list-style-type: none"> Developers Contractors Material & equipment suppliers 	<ul style="list-style-type: none"> First mover risk Supply-chain relationships Tender process Lack of communication and leadership Lack of knowledge and trust 	<ul style="list-style-type: none"> Green/sustainable private procurement Green/sustainable public procurement
	4 IN USE	<ul style="list-style-type: none"> Owner Developer Facilities manager Tenants 	<ul style="list-style-type: none"> Lack of incentives Tender process Lack of knowledge and trust Lease structure 	<ul style="list-style-type: none"> Green facilities management Benchmarking and follow-up Green leases Green criteria in asset valuation

TOOLS FOR GREEN INTERVENTIONS

BUILDING LEVEL



- Green building rating tools
- Life cycle assessment and costing
- (Green) BIM

MATERIAL, PRODUCT
AND COMPONENT LEVEL

- EPDs and product certification

CORPORATE LEVEL



- Reporting/disclosure

General Recommendations

- More research is needed on good examples of effective collaboration models for public green building policies and more documented examples of effective case studies, including in rapidly developing regions where the greatest amount of construction activity will take place in the next years.
- The effectiveness of green performance guarantees in practice should be assessed, including the existing tools and technical monitoring systems (for water, energy and waste) that are applied.
- Further study the penetration of certification systems in value chain, and document successes and examples where pursuit of certification has had market impact and/or created transformation.
- Conduct mapping of life-cycle tools in combination with impact assessments and case studies, in order to improve the tools' application and help stakeholders more strategically implement them throughout the building sector supply chain.
- Facilitate the international up-scaling and implementation of life-cycle tools and initiatives to allow for use by SMEs and in developing countries.
- Determine the impact of life-cycle initiatives/tools, assess the real costs and benefits and how those could potentially be improved through standardisation and green interventions.

UNEP-SBCI Recommendations

1. More progressive public green building policies

- Document and highlight the impact of best practices, synthesize and disseminate information and advocate for better public policies through UNEP efforts with governments. The 10YFP programme provides a significant opportunity for mainstreaming sustainable building public policies.
- Promote and facilitate through the work of UNEP-SBCI additional research and identify which government policy instruments (procurement, labelling, standards, incentives) and support structures can encourage green improvements in the design and construction phase and also encourage the private sector to develop relevant initiatives.
- Promote and highlight in UNEP-SBCI's relevant work with governments and local authorities the benefits of model regional building codes that mandate high energy performance, materiality of low toxicity, and materiality of high regional content. These codes can offer climatological benchmarking and regional durability guidance.

2. Private sector green building policies

- Provide through the UNEP-SBCI a platform for stakeholders in the building and construction sector to engage in developing and implementing strategies for the systematic application of green interventions throughout the building supply chain. This platform can help to build consensus for the development of international metrics for resource efficiency and sustainability of materials.
- Facilitate through collaboration with UNEP-SBCI partners and other networks capacity building for private-sector resource efficient building practices. There is a significant opportunity to improve private/private knowledge transfer targeted at SMEs in the sector in collaboration with UNEP's Business and Industry Unit.

3. Favorable financing terms for green buildings

- Strengthen and increase collaboration between UNEP-SBCI and UNEP-Finance Initiative to develop strategies and approaches to address financing barriers for energy and resource efficiency in the building and construction sector and align relevant metrics.

4. Alternative procurement models for green buildings

- Engage UNEP-SBCI industry partners to document best practices including alternative procurement methods, and highlight results and lessons learned in relevant 10YFP programme activities.
- Identify and assess sector-specific approaches to procurement that result in improved resource efficiency through

UNEP-SBCI engagement with sustainable and green procurement initiatives, including UNEP-Sustainable Public Procurement Initiative.

- Encourage the adoption of standard contract types, or contractual frameworks, that have been proven effective, reasonable and legally robust in major world markets and document through relevant UNEP initiatives and partners.

5. Green incentives in permitting process

- Promote and highlight to governments and local authorities the benefits of incentives in the permitting process. UNEP-SBCI partners, including Green Building Councils are well positioned to support development of comprehensive policy packages to promote green buildings, and other policy instruments, including regulatory, economic/market based, fiscal instruments and incentives, and information/voluntary actions.
- Further examine and document benefits and results of incentive programmes during the permitting process. UNEP-SBCI partners can share experiences and case studies to document results and promote successful incentive programmes.

6. Green/sustainable private procurement

- Promote and facilitate through UNEP-SBCI partners the development of supporting criteria for private procurement policies that include green or sustainable standards.
- Engage with relevant international agencies, UNEP initiatives and building industry associations to assure that suppliers have the training and skills needed to meet green/sustainable procurement standards and improve their green performance through time.

7. Green/sustainable public procurement

- Support and promote through a collaboration between UNEP-SBCI and UNEP Sustainable Public Procurement Initiative the mainstreaming of sustainable public procurement (SPP) as a policy tool for sustainable buildings and construction in government policy at local and national levels.
- Facilitate through the activities of UNEP-SBCI and partners the development of supporting criteria for SPP, and align sector criteria with national and regional criteria (such as EU GPP) to provide harmonization and consistency across markets.
- Work in collaboration with other UNEP initiatives and building industry associations to assure that SMEs have the training and skills needed to gain access to GPP/SPP, and to measure the impact of GPP/SPP in the building sector through the development of specific building related indicators.

8. Green facilities management

- Develop a UNEP-SBCI watching brief and document best practices in green facility management and work with industry associations and relevant organizations (such as national Green Building Councils) to develop guidance and training to support green operations.
- Highlight and promote through UNEP-SBCI and partners the importance of best practice commissioning and encourage the adoption of standards for commissioning.
- Work with and through UNEP-SBCI partners to promote and demonstrate more sustainable facilities management policies and practices.
- Identify collaboration with UNEP-SBCI partners to update the “Energy Efficiency in Buildings – Guidance for Facilities Managers” to include resource optimization and wider efficiency gains.

9. Benchmarking and follow-up

- Support UNEP-SBCI partners and related networks in efforts to benchmark performance and conduct additional research and continuous data-gathering. UNEP-SBCI can play a significant role in the synthesis and dissemination of information, especially through the 10YFP programme, to promote adoption of performance standards.

- Engage with other non-governmental and multi-lateral organizations to accelerate the adoption of enabling protocols, conventions, and tools required to improve interoperability, thus supporting when needed national-scale market participants (e.g., national green building councils) and promote through UNEP-SBCI. Important issues include data specification (e.g., metrics), metadata, space and building identification, and harmonization of reporting protocols. These are pre-competitive issues that ultimately enable diverse, efficient markets by making it easier to identify and communicate about the performance of buildings and portfolios.

10. Green leases

- Identify and promote through UNEP-SBCI and partner networks best practices in facility management, including green leases and comprehensive policy toolkits in partnership with other organizations for industry uptake.
- Demonstrate leadership through UNEP-SBCI partner promotion and utilization of green leases, and share lessons and results through the initiative's network.

11. Green criteria in asset valuation

- Strengthen partnership between UNEP-SBCI and UNEP Finance Initiative (UNEP-FI) to develop financial tools and case studies evidencing the market value of high performing green buildings.
- UNEP-SBCI, UNEP-FI and respective partners, including RICS, to collectively promote the development of training materials aimed at valuation professionals that encourage the factoring of green criteria into valuation processes, through initiatives such as RenoValue. Collaboration should promote the development and update of standards to include green criteria and LCC approaches in asset valuation.

12. Green building rating tools

- Support continued UNEP-SBCI partner development and implementation of certification systems as one of various policy tools to guide delivery of green buildings, and work with GBC networks to identify measures that address resource efficiency in supply chain.
- Support efforts of the WGBC to harmonize rating tools and provide international consensus, while considering local context, and encourage UNEP-SBCI partners to support such efforts.

13. Life cycle assessment and costing

- Support the development of life-cycle based indicators that may be needed to facilitate measuring resource efficiency and performance in the building and construction sector. These indicators are also required to identify points of leverage and the areas of highest energy efficiency/energy/carbon mitigation potential in the supply chain, including how building developers and owners can influence the performance of construction materials producers and manufacturers. Attention should be given to indicators, which have reached already international consensus, for example those based on the Environmental Product Declarations (EPDs, CEN TC 350).
- Strengthen collaboration between UNEP-SBCI, its partners and the UNEP Life-Cycle Initiative and the International Resource Panel to adapt life-cycle design and de-materialisation models for implementation in building sector. There is a significant opportunity to assist countries to establish baseline data and support inter-operability of national life-cycle inventories of their building materials, as well as to adapt life-cycle modelling and design tools for use by designers and regulators. UNEP-SBCI to collaborate with Life Cycle Initiative on a sector-specific programme on LCA in building sector, with specific focus on access to data and interoperability of databases. The programme should develop policy tool-kits that will provide enabling frameworks, metrics and reporting protocols that can be delivered through the 10YFP programme.

14. (Green) BIM

- Promote the use of practical tools, such as BIM, to facilitate life cycle decision making and supply chain collaboration early in the design process, improve construction and procurement processes, but also facility management,

to maximize resource efficiency potential over the building life cycle.

- Engage with SPP and other relevant initiatives to promote and encourage Green BIM in procurement in appropriate circumstances.

15. EPDs and product certification

- Support through the UNEP-SBCI network the greater adoption and application of EPDs in the sector, and review efforts at the national and international levels related to EPDs to assure consistency in measurement and application.
- Support efforts to harmonize standards through collaboration among UNEP-SBCI, its partners and networks and standard organisations (e.g. CEN and ISO).

16. Reporting/disclosure

- Collaborate with reporting and disclosure organizations and with private sector organizations representing the target group of companies and its final audience to foster and coordinate development of the 'tools' allowing for greater transparency and harmonization with international standards and relevant benchmarks. Such cooperation is necessary to arrive at a less burdensome and more meaningful set of tools to measure, benchmark and consequently drive investments and action in green and sustainability.
- Elaborate with other concerned entities within UNEP and outside a reporting component for the building sector, notably in the context of corporate sustainability reporting.

Materials' Intensity Analysis Recommendations

- Compile life cycle data and EPD data for selected construction materials and product groups with a geographical coverage representative of the global production.
- Determine the most relevant energy and materials flows and processes (contribution analysis) in a cradle-to-gate perspective individually for (not between) the different materials and products before and after aggregation to impact categories independently for selected countries/global regions. The result would be one heat map per material/product group allowing to identify : i) the important aspects and life cycle stages in the production stage per country/region and ii) to what extent there are differences between the production processes in different countries/regions.
- Compare performance data of best available techniques and emerging techniques for determining specific room for improvements, e.g. from technology transfer.
- Overlay heat maps with other relevant data such as scarcity and other risk maps that relate these heat maps to material/component origin (e.g. combine heat maps information of freshwater use in the different stages in the supply chain with water scarcity maps).
- Develop heat maps of absolute national/regional resource uses/environmental impacts due to selected construction materials/product groups. This would indicate the absolute and relative importance of the selected materials/product groups for resource use/environmental impacts on a regional scale.
- Analyse tools that support the designers in performing environmentally conscious design decisions (e.g. guidelines and checklists, one-score screening indicators, full life cycle assessment, process simulation software, databases on materials, etc.) building upon life cycle data used in the construction sector to support the selection of construction materials/products and type of construction.
- Identify activities (i.e. green interventions) and actors with similar goals (cf. examples) and analysis of strategic partnerships.

Chapter 1

Introduction to the Greening the Building Supply Chain initiative

1.1 The environmental impact of the construction and building sector

The construction, use and regeneration of buildings generate many social and economic benefits. By 2025, the volume of construction output is expected to reach an annual US\$15 trillion worldwide (Global Construction Perspectives and Oxford Economics, 2013), and UNEP-SBCI has previously reported that the building and construction sector¹ typically provides 5-10% of employment at national level and typically accounts for 5-15% of the GDP (UNEP-SBCI, 2009a).

However these benefits can bring with them negative impacts, most notably those associated with the impact on the natural environment. Based on several measures, it is apparent that the global construction sector has an oversized environmental footprint. Whilst the most tangible aspects of this footprint often relate to buildings in use, a significant if less understood proportion results from the broader design and construction process and the choice of materials used.

1.2 The development challenge

From a development perspective, improvements to the built environment are widely acknowledged to be of vital importance. Done well, construction literally builds the foundations to support a growing population and increased urbanization. If planned and implemented properly, the building and construction sector is a crucial enabler of sustainable development, addressing the simultaneous needs for housing, workplace, public buildings and services, communications, energy, water and sanitary infrastructures. Again, if done properly, it enables cohesive social interactions and spurs economic development at the micro-level (UNEP-SBCI, 2009b). A relationship between the built environment and public health has also been demonstrated by numerous commentators (e.g. Rydin et al., 2012).

The impact of the global building and construction sector



Energy: Approximately one third of global energy end use takes place within buildings, while the manufacture of building materials consumes a further 10% of the global energy supply (UNEP, 2011)



Carbon: The sector is the single largest contributor to climate change (UNEP, 2011), with the use phase of buildings alone estimated to be responsible for 30-40% of total global greenhouse gas emissions (UNEP, 2007)



Materials: Each year, approximately three billion tonnes of raw materials – 40-50% of the total flow in the global economy – are used in the manufacturing of building products and components worldwide (Roodman, et al., 1995; Anink, et al., 1996)



Water: Buildings in use have been estimated to be responsible for 12% of global water use (UNEP, 2011), but can indirectly account for a much more significant proportion of total water demand through the production of building materials, construction and other supporting processes (Crawford, 2011).



Waste: Building construction and demolition waste contributes about 40 per cent of solid waste streams in developed countries (UNEP, 2011).

Yet there are significant and important differences between developed and developing countries in both the current building stock and projected building-sector growth (UNEP, 2011). In many developed countries, projected economic growth is modest and projected population growth flat or even negative. Here, an aging building stock, changing building regulations and demographic and societal changes – for example a significant increase in one-person households (UNEP, 2011) – maintain strong demand for new and refurbished buildings. Here also, the impacts of continued urbanization and changing patterns of migration influence the demand for buildings.

In contrast, developing countries are fast-growing, rapidly urbanising and are projected to add 2.3 billion people to the global population over the coming four decades (UN DESA, 2009). By 2030, there are predicted to be 3 billion more middle class consumers in the global economy (McKinsey & Company, 2011) and by 2050 70% of people are expected to live in urban areas (UN-HABITAT, 2010). It is acknowledged that India, already short of 24.7 million homes in 2007 (Roy, et al., 2007; NHHP, 2007), will need millions of new homes over several decades to accommodate

projected income growth and urbanisation. China is expected to add twice the amount of current US office space between 2000 and 2020 (WBCSD, 2009), and it is projected that in each year to 2020, an additional one billion m² of new buildings will be constructed there (Cheng, 2010).

These challenges have major implications for the building and construction sector that must be faced against a backdrop of ever-increasing resource scarcity. Material use increased eight-fold in the twentieth century (Krausmann, 2009) and commodity prices (based on food, agriculture raw materials, metals and energy) have already increased by an estimated 147% since 2000 (McKinsey & Company, 2011). Resource availability is expected to become an increasing constraint to future economic growth and a particular challenge to manufacturing industries.

Challenges of future resource availability relevant to the building and construction sector

- *Demand for steel is predicted to increase about 80% between 2010 and 2030, primarily driven by increasing demand from China, India, and other emerging markets (McKinsey & Company, 2011).*
- *Global cement production is estimated to increase by between 43% and 72% between 2006 and 2050, with much of the extra demand coming from China until 2030, then increasingly from India and other developing economies in Asia, Africa and the Middle East (WBCSD/IEA, 2009).*
- *Water use by industry is expected to grow to over 20% of global total demand by 2030, creating a potential water shortfall of 40% relative to expected demand, based on the maximum sustainable global supply (2030 Water Resources Group, 2009).*
- *Depletion of high quality metal ores (OECD, 2008), whilst not yet perceived as an immediate problem for most metals, will increasingly require substitution of lower grade ores and use of more energy to extract the useful metal content (UNEP, 2011).*

The challenge to meet the current and future demand in a way that is sensitive to an ever increasing resource scarcity is critically dependent on being able to ‘green’ the building and construction sector. This can happen only if the sector itself is better understood.

¹ In this context, ‘building’ describes the physical structure itself and ‘construction’ describes the many activities involved in its delivery and management.

1.3 The construction sector

The concept definition, design, construction and use of buildings are determined by a diverse and complex supply chain (Figure 1), both upstream and downstream of the construction site. Upstream, the building and construction sector is characterised by a proliferation of relatively small and local actors (by international business standards) with a high degree of fragmentation within, and non-integration between, its many

elements. Even the largest construction projects rely, to a large extent, on a myriad of small and medium enterprises (SMEs) as suppliers and subcontractors, contributing to aspects of the design, providing and transporting materials and offering specialist skills on site. The complexity of interaction among these participants is perhaps one of the greatest barriers to greening the building supply chain.

Figure 1. The most significant commercial relationships in the construction and building sector (modified, with approval, from WBCSD, 2007).



Downstream of the construction site, the building market is equally fragmented, with many small landlords, corporate property owners and public housing authorities managing multiple buildings typically in local or regional markets.

Coordination among all the stakeholders in the building and construction sector is uncommon. As a result, decisions taken during the concept definition, design and construction phases – which have the potential

to have a major influence on the overall environmental impact of a building during its use – tend to be made without consideration of life-time impacts or costs since these are often not seen as the responsibility of the property developer (UNEP-SBCI, 2009a). Similarly, the supply of materials is often done in isolation, with little or no incentive to pursue product development or alternative options, as many of the benefits of such actions are not realised by those directly involved in the process.

² Upstream is where a construction/building originates, i.e. property developer and planners. Downstream are contractors, suppliers and users.

1.4 The opportunity for greening the building supply chain

Whilst initially motivated primarily by individual examples of corporate and public sector leadership or altruism, and frequently focused on energy efficiency, the green building trend is now increasingly driven by a more extensive business case that is progressively more understood by developers, owners and tenants alike (WGBC, 2013a). The building sector has also been shown to provide the greatest potential for delivering significant cuts in energy consumption and GHG emissions at no cost (McKinsey & Company, 2009; UNEP-SBCI, 2009a). The industry now generally recognises that green buildings deliver far more than energy efficiency alone, including environmental benefits such as reduced water use and fewer hazardous materials, economic benefits such as return on investment and risk mitigation, and user's benefits such as higher employee productivity and health benefits (WGBC, 2013a).

Green building...

- ✓ Takes an intelligent approach to energy
- ✓ Safeguards our water resources
- ✓ Minimises waste and maximises reuse
- ✓ Promotes health and well-being
- ✓ Keeps our landscape green
- ✓ Creates resilient and flexible structures
- ✓ Connects us
- ✓ Considers all stages of a building's life-cycle

Source: WGBC (2013b)

Greening the building supply chain is seen as a necessary precondition for up-scaling delivery of green buildings and realising these opportunities on a commercially-viable and widespread basis. In its wider socio-economic context, greening the building supply chain has the potential to realise multiple environmental, social and economic opportunities, extending far beyond the walls of a green building itself. The transition to more resource efficient methods, materials and technologies can bring with it competitive advantage and permit new economies of scale for those businesses and territories that adapt fastest and most fully (European Commission, 2011). The new skills and organisational changes that will be required (UNEP, 2008) can create new jobs, stimulate economic growth and contribute to the emerging green and low-carbon economy.

Working towards greater resource efficiency in the building and construction sector will also ensure that the sector plays its part in addressing other global issues such as increasing energy security, curbing climate change and moving towards a circular economy. And due to its broad cross-sectoral impact, it can also play a central role in helping improve the resource efficiency of other sectors. In developing countries, in particular, greening the supply chain also has the potential to contribute towards improving other key developmental issues. For example, reducing water use in the building supply chain can help increase the availability of fresh water in parts of the world with severe or increasing water scarcity.

To date, considerable attention has focused on energy and greenhouse gas emissions from buildings during their operation. However, efforts to understand and minimise resource use in the building supply chain appear to be less advanced and few systematic attempts have been made to assess what opportunities exist to reduce the environmental impacts of a building and its components over its entire life-cycle embracing concept definition, design, construction, use and demolition. The ultimate aim should be to identify those options and actions that, over the whole building life cycle or throughout the entire building and construction sector, can realise environmental, social and economic benefits for both business and for society.

Chapter 2

The “Greening the Building Supply Chain” initiative

2.1 Introduction

The building and construction sector³ has an oversized environmental footprint, yet is faced with the twin challenges of global development and increasing resource scarcity. Greening the building supply chain can deliver important social and economic benefits that extend far beyond buildings themselves, and that can contribute towards wider developmental goals.

2.2 Objective

Despite its clear importance, there remains a relative lack of understanding about the ways in which the building supply chain could better deliver green buildings, achieve greater resource efficiency throughout the building and construction sector and contribute towards wider socio-economic goals. It is in this context that the Greening the Building Supply Chain initiative has been established by UNEP, to systematically assess opportunities for green interventions in the building supply chain as a whole. The Task Force on Greening the Building Supply Chain comprises members from within UNEP-SBCI and from companies that are involved in different aspects of the building and construction sector. It includes representatives from international industry associations and institutes, national governments and academia as well as industry participation from architects, engineers, contractors and materials manufacturers (see acknowledgements for full list).

The scope of the initiative extends far beyond the direct benefits associated with green buildings themselves (such as energy efficiency) and considers the wider range of opportunities that underpin the design and construction systems and processes that deliver buildings to market. The outcome of this work is a prioritisation of green interventions for study by UNEP-SBCI and partners in future work programmes, and to support the development of a Sustainable Buildings and Construction programme under the 10 Year Framework of Programmes on Sustainable Consumption and Production.

Greening the Building Supply Chain and the 10 Year Framework of Programmes on Sustainable Consumption and Production

The 10 Year Framework of Programmes (10YFP) is a global framework of action to enhance international cooperation to accelerate the shift towards Sustainable Consumption and Production (SCP) in both developed and developing countries. Its overall objectives are to:

- **accelerate the shift** towards SCP, supporting regional and national policies and initiatives;
- **contribute to resource efficiency** and decouple economic growth from environmental degradation and resource use, while creating decent jobs and economic opportunities and contributing to poverty eradication and shared prosperity;
- **mainstream SCP** into sustainable development policies, programmes and strategies, as appropriate, including into poverty reduction strategies;
- **support capacity building** and facilitate access to financial and technical assistance for developing countries, supporting the implementation of SCP activities at the regional, sub-regional and national levels; and
- **enable all stakeholders to share** information and knowledge on SCP tools, initiatives and best practices, raising awareness and enhancing cooperation and development of new partnerships – including public-private partnerships.

The UNEP-SBCI Greening the Building Supply Chain initiative contributes to the ‘Sustainable Buildings and Construction’ programme, one of the initial list of five 10YFP programmes adopted at Rio+20.

2.3 Building typologies

Buildings are crucial to how we live our lives. The characteristics of a building – its design, its aesthetic and its technical standards – influence our productivity, our well-being, our moods and our interactions with others (BPIE, 2011).

The term ‘building’ is used to cover a wide variety of structures that are designed for human occupancy, ranging from large commercial developments to single family houses. The majority (by number) of buildings worldwide are residential but non-residential buildings which, for example in the European Union account for 25% of the total building stock, are far more complex and heterogeneous (BPIE, 2011). Variations in usage patterns (e.g. hotels versus schools), energy requirements (e.g. surgery rooms versus storage rooms in hospitals), construction techniques (e.g. low-rise out-of-town supermarkets versus high-rise commercial buildings in urban settings), age (e.g. 1960s offices versus new-build offices) and ownership (owner-occupied versus leased) are some of the many factors that influence the ways in which green buildings are, or could be, realised.

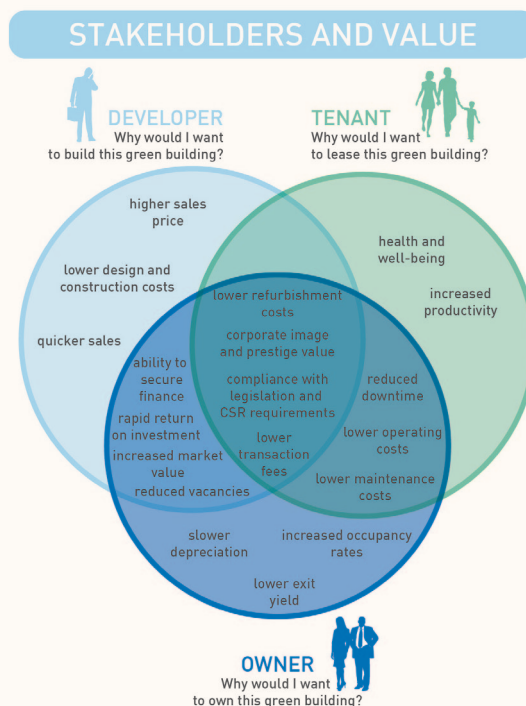
The sheer variety of buildings and the complexity of their different supply chains led, for the purposes of this study, to the need to prioritise specific building types. Hence, the scope of the Greening the Building Supply Chain initiative was limited to new and existing public and private offices. Where relevant, this scope was further limited to mid-rise offices.

Offices are one of the most significant types of non-residential building type, estimated to comprise 23% of non-residential floor space in Europe (BPIE, 2011) and 17% of commercial floor space in the USA (US Department of Energy, 2012). In its early days, the green building movement focused on the office building market as the business case and benefits were clear for both owners and occupiers of quality office space. As a result, most green building rating systems have certified more office projects than any other building type⁴. With a clear and increasing demand in the office sector for green building – as demonstrated by the use of non-governmental voluntary certification schemes – and a clearly established business case, offices are also regarded as being at the forefront of the green building trend. In turn, this means more exemplary case studies and quantitative evidence tend to be available than for other building types.

The business case for green buildings

In March 2013, the World Green Building Council launched its ‘Business Case for Green Buildings’ review – a first attempt to collate all credible evidence about the ‘business case’ for green buildings into one definitive resource. It shows how green buildings add value in different but overlapping ways for developers, owners and tenants.

Figure 2. Stakeholders and value.



Source: WGBC (2013a)

³ In this context, ‘building’ describes the physical structure itself and ‘construction’ describes the many activities involved in its delivery and management.

⁴ There are some notable exceptions. For instance the PassivHaus standard initially focused on residential buildings (www.passivhaus.org.uk).

2.4 Task Force process

The Greening the Building Supply Chain initiative has adopted the following process to systematically reveal and assess opportunities for green interventions within the building supply chain:

1. Simplification of the building supply chain into a two-dimensional representation, comprising the building delivery and management process and a limited number of priority materials supply chain.

2. Assessment of the building delivery and management process:

- (i) Description of the main stages - a description of the main scope of activities and deliverables within each stage of the building delivery and management process that potentially affect the environmental performance of the building.
- (ii) Identification of barriers within the delivery and management process - a review of stakeholders' motivations, relationships, knowledge of green buildings and market constraints was used to identify and describe barriers to green interventions within each of the stages of the building delivery and management process. This review necessarily only considered the key (or most significant) stakeholders, relationships and barriers.
- (iii) Review and prioritisation of green interventions - consolidation of information gathered to identify priority areas for green interventions in building delivery and management process.
- (iv) Gathering of case studies - collation of good practice examples of green interventions to support qualitative impact or opportunity assessment.
- (v) Recommendations – recommendations for further work by UNEP-SBCI, linked UN programs (with reference to 10YPF) and other non-governmental partners.

3. Assessment of the materials supply chains:

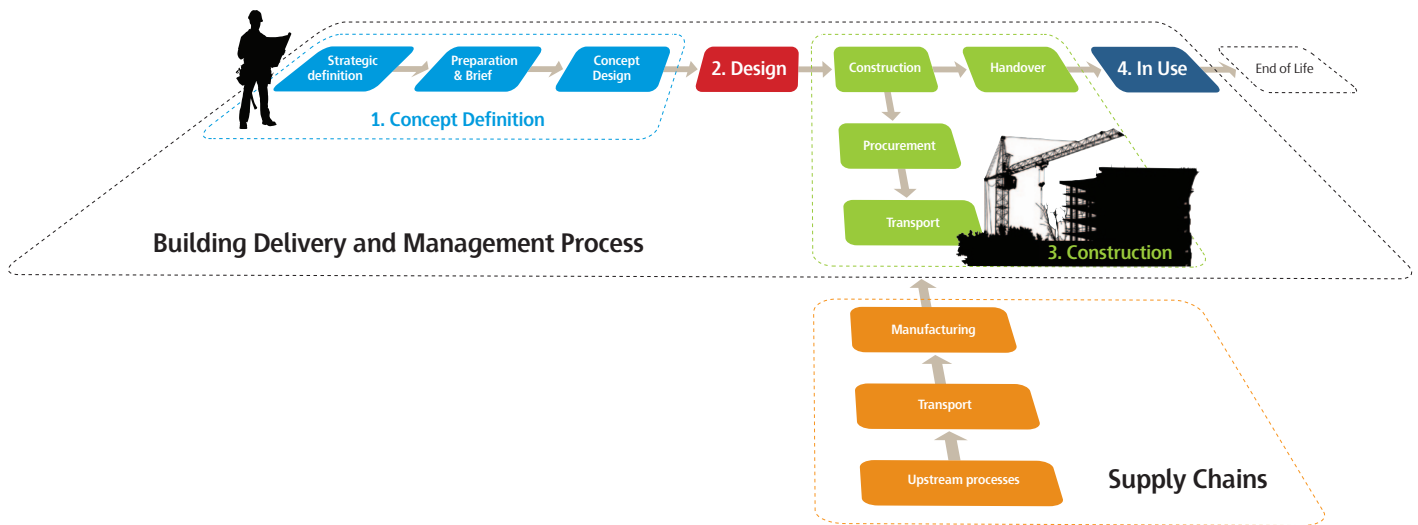
- (i) Overview of stakeholders and barriers within materials supply chains – description of the main, stakeholders, relationships and barriers associated with the materials supply chains.
- (ii) Prioritization of materials supply chains - a prioritization of materials groups supply chains to be studied based on the environmental impact of materials used in the construction process. The following materials were prioritised: Aluminium, Brick, Cement, Flat glass, Mineral wool, Plaster board, Polystyrene, Polyurethane, Steel (rebar and structural), Timber (structural).

- (iii) Indicative impact assessment - an order of magnitude impact 'green' assessment of the selected materials groups and a heat map to present core areas and sources for selected environmental aspects.
- (iv) Discussion and recommendations - discussion of the intensity analysis method and its challenges and recommendations for further work by UNEP-SBCI on materials supply chain assessment.

2.5 The building delivery and management process

For the purposes of the Greening the Building Supply Chain initiative, a high-level representation of the building supply chain was adopted (Figure 3). This characterisation inevitably simplifies the complex set of interactions and relationships that occur in real life, but does so in a way that is intended to capture the overall process and main flows of materials and information. The representation defines two main aspects of the building supply chain.

Figure 3. The simplified building supply chain



The first aspect, the ‘building delivery and management process’, describes the way in which buildings are designed, delivered and occupied. This process is preceded by development of masterplans or land use allocation plans (including the density allowance, type of use etc.) under responsibility of local authorities. For the purposes of this project, a conventional contract arrangement has been assumed though it is recognised in practice that many alternative procurement routes exist. The simplified process consists of five stages:

- 1. Concept Definition:** where the initial idea, scope and brief for a building is established and agreed.
- 2. Design:** translation of an initial idea for a building into a detailed design.
- 3. Construction:** covering all on-site operations including a building is handed over to the client. The procurement of materials and products is, for reasons of simplicity, characterised as occurring in the construction stage. In practice, it can occur throughout the delivery and management process.
- 4. In Use:** covering the operation and maintenance of a building for the duration of its useful life. Divestment and leasing is, for reasons of simplicity, characterised as occurring during the in use stage. In practice, it can occur throughout the delivery and management process.

5. End of Life: used to signify the point at which either a building is demolished or at which significant renovation occurs, but which in either case represent the end of the building’s useful life and prompts the building delivery and management process to restart.

The second aspect, the supply of materials, describes the process by which the materials and products required to satisfy a building design are extracted, transformed and supplied to site. The simplified material supply chain consists of three stages:

- 1. Upstream processes:** mineral extraction, energy production and manufacturing processes upstream of manufacturing process under consideration.
- 2. Transport:** all transport upstream and during manufacturing process, excluding waste transport during manufacturing under consideration.
- 3. Manufacturing processes:** production of product and co-products including production of ancillary materials or pre-products and packaging, including waste processing.

2.6 Green interventions

A central element of the Greening the Building Supply Chain initiative is the identification and exploration of green interventions that can or could occur in both the building delivery and management process and the material supply chains. For the purposes of this initiative, green interventions are defined as regulatory and control mechanisms, economic or market-based instruments, fiscal instruments and incentives, and

support, information and voluntary actions, taken by stakeholders in the supply chain, that lower the environmental impact of a building, its materials or building-related activities over the life-cycle of the building, and/or have a wider or legacy environmental, social or economic impact beyond the building itself.

Regulatory policies, fiscal policies and voluntary actions



Regulatory and control mechanisms are laws and implementation regulations that require certain devices, practices or system designs to green the buildings supply chain. Examples include appliance standards, building codes, procurement regulations, energy-efficiency obligations or quotas, mandatory audit programmes and utility demand-side management programmes.



Economic or market-based instruments are usually based on market mechanisms and contain elements of voluntary action or participation, although they are often initiated or promoted by regulatory incentives. Examples include energy performance contracting, cooperative procurement, efficiency certificate schemes and cap-and-trade schemes



Fiscal instruments and incentives usually adjust prices either by a taxation aimed at reducing negative impacts or by financial support to help overcome first-cost related barriers are to be addressed. Examples include green taxes, tax exemptions and reductions, public benefits charges, and capital subsidies, grants, subsidised loans and rebates.



Support, information and voluntary action are instruments aimed at persuading consumers to change their behaviour by providing information and examples of successful implementation. Examples include voluntary certification and labelling programmes, voluntary and negotiated agreements, public-leadership initiatives, awareness raising and education, as well as detailed billing and disclosure programmes.

Source: UNFCCC, 1999; IEA, 2005

It is also helpful to define ‘green’ in the context of this initiative. The definition of green has been taken to include the five environmental aspects (Table 1) that are generally understood by the industry to have the highest global impact over the life cycle of buildings. While it is recognised that other ‘green’ aspects are important in some cases, this prioritisation covers the major and most universal environmental impacts to which the building supply chain contributes.

Table 1: Green priority aspects

ASPECT	SCOPE	PURPOSE OF GREEN INTERVENTIONS
ENERGY	Primary energy consumed within material supply chains and in the construction, use and renovation of buildings.	<p>Green interventions seek to reduce the embodied energy of the building supply chain as a whole (Figure 3) – with specific focus on the materials supply and construction-related activities – to reduce the life cycle energy consumption of buildings.</p> <p>Plenty of studies and initiatives have assessed the energy demands of a variety of buildings across their lifetime. On average, the in use phase contributes around 80% of total life cycle energy, with construction accounting for a further 15-20% (UNEP-SBCI, 2009), most of which is embodied in the materials used. The energy use associated with end of life is, accordingly, less than 5%. However, the more energy-efficient buildings become in operation, the greater the relative significance of the energy embodied in their construction and materials. This means as low and near zero energy buildings become scaled up globally, and in use energy is reduced, emphasis will need to shift towards reducing the embodied energy of buildings.</p>
	The GHG emissions (expressed in CO ₂ e) emitted within material supply chains and in the construction, use and renovation and/or deconstruction of buildings.	<p>Green interventions seek to reduce the carbon emissions associated with buildings, beyond the effects of energy efficiency alone, by changing the source of energy supplies and reducing embodied carbon in the building supply chain.</p> <p>It has been estimated that in use emissions account for over 80% of the total life cycle carbon emissions of buildings, with a further 15% of emissions embodied in materials and around 1% resulting from the construction process itself (BIS, 2010; Deloitte formerly dcarbon8, unpublished). There are two main areas of green intervention. First, lowering carbon emissions through changing energy source following improvements of energy efficiency and, second, lowering carbon emissions associated with chemical production processes.</p>
MATERIALS	The use of depleting non-renewable mineral resources within material supply chains and in the construction, use and renovation of buildings.	<p>Green interventions seek to reduce the use of building materials in absolute terms, as well as increase the proportion of responsibly sourced green materials by promoting material transparency.</p> <p>It is estimated that over 10,000 different materials are used in the construction and use of buildings, many of which use depleting mineral non-renewable resources. Responsibly sourced green materials can be characterised as being non-hazardous materials that minimize the use of depleting mineral resources through the use of reused, recycled and renewable material content while, seeking to reduce the embodied impacts related to energy, waste, carbon and water. Responsibly-sourced green materials would furthermore provide for reuse or recycling options at the end-of-life.</p> <p>Declared material transparency should recognise product and material content, the chronological history of the entire supply chain, and the embodied environmental impacts of harvesting, extraction and manufacturing which, when used correctly, allow for informed decisions to be made about the relative greenness of different construction materials early in design.</p>
	The amount of solid waste going to landfill from the material supply chains and associated with the construction, use and end of life of buildings.	<p>Green interventions – supported by green interventions associated with selection and use of materials – seek to help the building and construction sector contribute towards a global circular economy. This will be achieved when material use and waste generation is minimised, any unavoidable waste is recycled or remanufactured, and any remaining waste is treated in a manner least harmful to the environment and human health, or even in a way which generates new value such as energy recovered from waste (UNEP, 2011).</p> <p>From a life cycle perspective, studies have shown, for example in Australia, that approximately 85% of construction and demolition waste is from the end of life stage of buildings (Terry and Moore, 2009) with renovation and refurbishment generating the highest volume of waste to landfill (CRC for Construction Innovation, 2005). Significant waste quantities also arise within the material supply chain (for example, through inefficient extraction or manufacture and packaging) and as a direct result of the building delivery and management process (for example, through design errors and changes, inaccurate definition of quantities, poor on-site material control, inefficient construction processes and low re-use of waste streams).</p>
WATER	The amount of freshwater used within material supply chains and in the construction, use and renovation and/or deconstruction of buildings.	<p>Green interventions seek to reduce the embodied water of the building supply chain as a whole – with specific focus on the material supply chain and construction-related activities – by increasing water efficiencies and decreasing the use of fresh water by selecting and maximising the (re-)use of water of alternative qualities.</p> <p>While water use in the operation of buildings is fairly well understood – and reductions of 80% in water demand and 90% in sewage discharge can be achieved for commercial office buildings (e.g. Chanan et al, 2003, Skanska 2013) – much less is known about the water embodied in construction processes, materials and products. A water footprint study of a new London office suggests that around 60% of total water use over a 30 year lifetime would be from its operation, with as much as 40% from water embodied in materials and products and less than 1% from construction processes (BIS, 2010; Deloitte formerly dcarbon8, unpublished). From this, and other international water use benchmarks (Bint et al., 2010), it can be estimated that embodied water in commercial office buildings is equivalent to their total water consumption over 30 to 100 years in use, and therefore a significant part of their total water impact.</p> <p>As water efficient buildings become more widespread, the relevant significance of embodied water will increase further still. Even where buildings are not located in areas of water stress, their supply chains might depend on or impact water scarce zones.</p>

Chapter 3

Greening the Building Delivery and Management Process

3.1 Introduction

The Greening the Building Supply Chain initiative is intended to uncover opportunities for green interventions in the fragmented and complex building supply chain (Figure 1). A process has been adopted to systematically reveal and assess opportunities for green interventions, based on a simplification of the building supply chain into a two-dimensional representation (Figure 3), comprising the building delivery and management process and a limited number of supply chains.

The building delivery and management process describes the way in which buildings are designed, delivered occupied and maintained. For the purposes of this project, a conventional standard form of contract arrangement has been assumed with design and supervision by consultants and a main contractor, which is likely to remain the most prevalent form of project procurement (e.g. RIBA, 2012). The simplified process consists of five stages (concept definition, design, construction, in use and end of life), the first four of which are covered in this chapter.

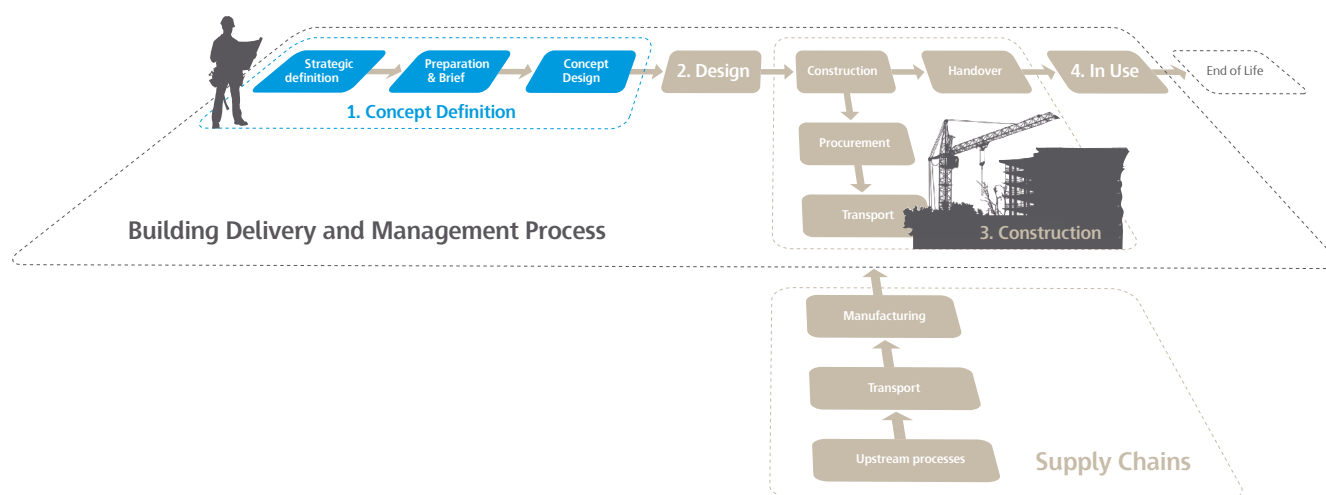
At each stage, green interventions are described that can or could occur in the building delivery and management process. For the purposes of this initiative, green interventions are defined as regulatory, economic, fiscal or voluntary actions, taken by stakeholders in the supply chain, that lower the environmental impact of a building, its materials or building-related activities over the, and/or have a wider or legacy environmental, social or economic impact beyond the building itself.

The definition of 'green' includes the five environmental aspects (energy, carbon, materials, waste and water) that are generally understood by the industry to have the highest global impact over the life cycle of buildings.

It is important to note that in many circumstances, especially in developing countries, there is often an active informal component within the overall building and construction sector. Such informal activities are by their nature difficult to structurally assess, and are thus excluded from the analysis in this report. Likewise, a main objective of this report is the identification of case studies for best practice, which are generally not found within the informal sector, as it does not follow conventional processes. However, further study and research should be developed to identify approaches to apply green criteria to the informal sector and to measure the resource impact of such activities.

3.2 Stage 1 - Concept Definition

Figure 4. The concept definition stage



3.2.1 SCOPE

The concept definition stage typically starts with the input of the developer being captured as a business case and strategic brief. In general, all developments are either speculative or non-speculative, and for non-speculative developments the strategic brief will include input from the (anchor) tenant. In some cases, owners act as developers, and capital providers (lenders and investors) may also add conditions to the development. The business case is the rationale behind the initiation of a new building project, and should include initial considerations of the desired outcomes for the project (for example, in the case of an office this might include a flexible working environment with improved workplace productivity).

The developer may appoint specialist consultants to undertake feasibility studies and options appraisals to establish whether the project is viable, to assist in the development of the project brief and to aid the identification of feasible options. These typically include consideration of relevant planning policies and aspects such as land-use zoning, which might involve dialogue with public authorities.

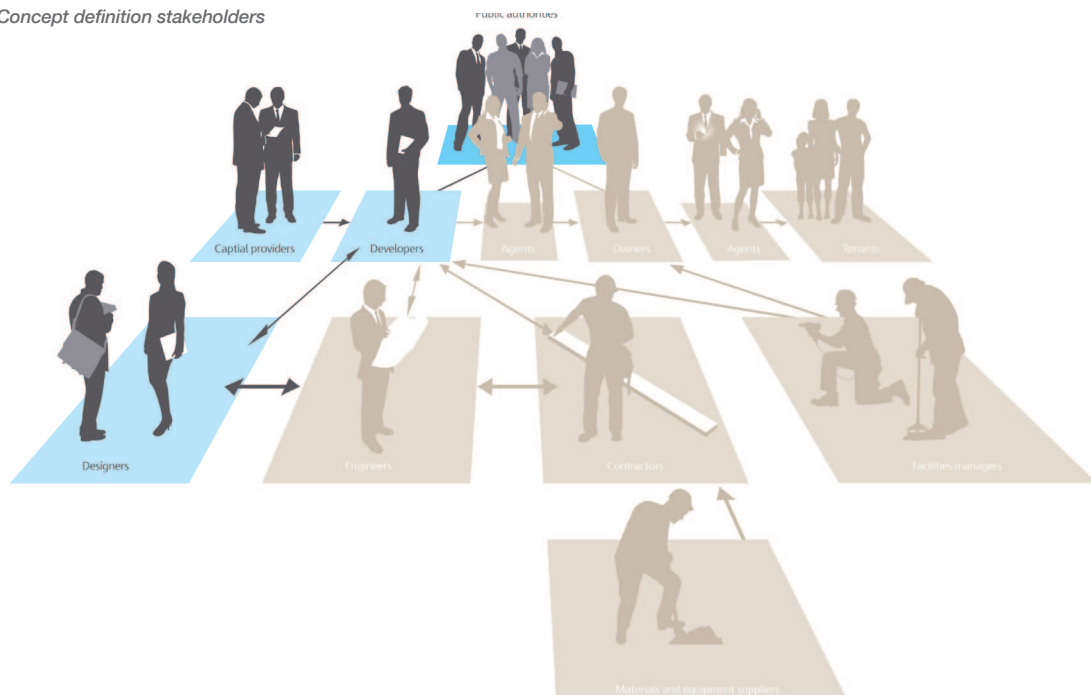
Following consideration of different financing alternatives offered by capital providers, the developer will define the project budget based primarily on the yield requirements and the developer's profit expectations. It is at this stage that the procurement strategy is also largely defined.

Designers then develop the preferred option into a concept design as a response to the project brief. The development of cost information is conceptualized at this stage to ensure that the rent or economics necessary from the user are sufficient to build the project.

The most important decision at concept phase affecting resource efficiency is regarded to be the capital budget available, and the fact that there is often little consideration given to operational budget (i.e. running costs) at this stage. Beyond that, the impact of the concept design stage on resource use greatly depends on the maturity of the design. In conventional contracts, its influence on building material selection is understood to be limited. However, the concept design may include building services and maintenance strategies (that ultimately determine in use resource efficiency) and architectural design features or material, technology and control recommendations that significantly influence resource efficiency. Some aspects of the concept definition stage however do have a more general impact on broader resource efficiency aspects; in particular the fundamental initial decision of whether to refurbish, extend or build new. In addition, the provision for flexibility of use will allow for less resource consuming interventions in the future, and a focus on build quality might influence durability and therefore future resource consumption.

3.2.2 STAKEHOLDERS

Figure 5. Concept definition stakeholders



3.2.3 RELATIONSHIPS

Public authorities ⇌ Developers

Public authorities influence and regulate building construction through regulatory and fiscal policies. Furthermore, land-use planning and zoning control places requirements on the type of development permitted at any given location, and impose specific conditions on the size, density and use of buildings. Also, fees imposed on developers by authorities change many decisions made in the design process (housing impacts, storm water, etc.). Local building codes are also enforced by Public Authorities, which often mandate specific building configurations and materiality.

Capital providers ⇌ Developers

The developer seeks to attract project financing and typically develops a prospectus including the business case in support of achieving a risk-adjusted return. Funding is obtained either through many variations of ownership structures (equity) or borrowing money (debt).

Developers ⇌ Designers

The developer procures concept design services, which in conventional contracts are provided by designers, and are coordinated by a lead designer. Conceptual design services are procured through public and company procurement policies. These policies usually require pre-qualification of designers (although this may happen outside the project life-cycle), and are followed by a request for proposals to qualified consultants, which at this stage may take the form of an idea/design competition.

3.2.4 BARRIERS

LACK OF POLICY Public policy that covers resource efficiency beyond energy consumption in the building and construction sector is often lacking and where it does exist, limited enforcement often hinders progress. Furthermore, policy is defined and revised according to national and local priorities and these are subject to political and economic cycles. Public authorities may not fully comprehend the benefits or lack the political will or the capacity to prioritize resource efficiency policies amongst competing priorities.

FINANCIAL RISK Capital providers are primarily motivated by maximizing yield or return on investment and the building's market value and risks associated with safeguarding them. Since building development is very capital intensive, nearly every lender and every investor looks to "benchmark" a proposed investment against

what has been done before. Deviations (for example, introducing resource efficient solutions) are perceived as high risk and therefore most stakeholders are reluctant or unable to do things differently.

DISREGARD FOR WHOLE LIFE COSTS Developers are the primary actors in commercial construction and developments are frequently speculative where markets are not constrained, which largely results in a short-term holding with focus on higher investment returns (to compensate for the risk) and minimizing construction cost (in an attempt to increase yield and development profit). Speculative developers are only interested in resource efficiency if tenants or investors also see value, though in most cases limited market demand from tenants and conservatism from financial institutions will prevent them voluntarily raising resource efficiency specifications beyond legal compliance. While designers and other consultants may be more motivated to address resource efficiency, they are often constrained by capital budgets and schedules influenced by developer yield requirements. Capital budgets are often independent of operational budgets, so design decisions are made without consideration for long-term savings during the in use stage.

LACK OF KNOWLEDGE AND TRUST Often, the key stakeholders in the concept definition stage are hindered by a lack of knowledge about the industry-accepted benefits of resource efficiency, the perceived cost and schedule impact, limited benchmarking data and no clear industry leadership. In addition, a lack of trust between stakeholders limits pursuit of more collaborative business models to achieve resource efficiency at little to no cost and schedule impact.

3.2.5 GREEN INTERVENTIONS

3.2.5.1 MORE PROGRESSIVE PUBLIC GREEN BUILDING POLICIES

TYPE OF GREEN INTERVENTION:



Regulatory and control mechanisms



Economic or market-based instruments



Fiscal instruments and incentives



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of policy
- Financial risk
- Lack of communication and leadership

Policies and legislation that encourage, facilitate or mandate the delivery of greener buildings can provide an important stimulus to action. Policy instruments can be effective mechanisms for improving resource efficiency in several ways including: (i) avoidance and reduction in the harvesting/excavation of resources; (ii) use of resources in the production process; (iii) efficiency of the operation of products; and (iv) reuse and recycling of resources.

A range of policies and incentive schemes can be implemented with little to no cost for governments and, if done thoughtfully, can stimulate local economies in the short term and increase their stability in the long term. They can also provide a means for mitigating capital restrictions and development risks, help define a (new) benchmark for financial institutions, encourage innovation, provide justification for adopting new technologies and establish a common goal to foster collaborative approaches.

Case study: Eco-reinforcement standard

Type of green intervention:



Regulatory and control mechanisms



Support, information and voluntary action

Aspects of green directly addressed:



Materials

In 2008, the UK Government published its Strategy for Sustainable Construction, which contained detailed commitments and targets to reduce the impact of construction activities. A key commitment aimed at construction product manufacturers was to ensure that, by 2012, 25% of all construction products supplied to government projects should be sourced from schemes recognised for responsible sourcing. This policy announcement helped trigger a succession of actions across the building and construction sector, which has helped avoid and reduce the harvesting/excavation of resources and promote reuse and recycling of materials in major infrastructure projects.

Initially, the construction industry committed to work with the Building Research Establishment (BRE) and the British Standards Institution (BSI) to finalise a framework for assessing whether a material or product was responsibly sourced. Following extensive dialogue, BRE published its BES6001 Framework Standard for the Responsible Sourcing of Construction Products. Subsequently, CELSA and several other UK manufacturers approached BRE to develop a BES 6001 compliant sector-specific standard and certification scheme called Eco-Reinforcement to implement, and potentially exceed, this standard for reinforcing steel products.

A key outcome is that steel products that meet the Eco-Reinforcement standard are now available at no extra cost, and suppliers can provide 100% responsibly-sourced steel to projects such as Crossrail – currently the largest construction project in Europe.

Case study: Vancouver Greenest City 2020 Action Plan**Type of green intervention:**

Regulatory and control mechanisms



Fiscal instruments and incentives



Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Waste

Progressive green building policies can also be effective instruments at regional and municipal level. With a suite of policies and by-laws focused on sustainable building, Green buildings are just one of ten focus areas in Vancouver's Greenest City 2020 Action Plan, which aims to make the city the greenest in the world by 2020. To achieve the green building goal, the action plan includes two specific targets:

- All new buildings to be carbon neutral in operations by 2020, and
- Existing buildings to reduce energy use and greenhouse gas emissions by 20% by 2020.

The city has introduced several programs and policies in its effort to meet these targets. A green building code has been introduced for all developments, as well as policies for re-zoning, large developments, higher buildings, and district energy use. A retrofit policy has also been implemented that applies to all buildings seeking a renovation permit which will see approximately 2,500 projects per year required to undertake energy efficiency upgrades during renovations. An incentives program is also in place, with more floors permitted in buildings designed to high standards that achieve a 50% reduction in energy use.

Vancouver's Greenest City 2020 Action Plan was announced as the overall winner of 2013 WorldGBC Government Leadership Awards for 'Best Green Building Policy'. The WorldGBC Government Leadership Awards, an initiative of the WGBC/UN-Habitat and ICLEI, honour local government leadership in green building and highlight policies that maximise the opportunity for buildings to mitigate environmental impact. The biennial award program aims to encourage the uptake of high-quality policies and practices worldwide.

While the uptake of green building is something that can happen without policy intervention, effective policy interventions are often essential to accelerate uptake and increase coverage. There are numerous excellent examples of effective green or resource efficiency policies around the world, and an increasing evidence of these policies leading to a green economy with associated benefits, such as employment (UNEP, 2008) and improved environmental performance (UNEP, 2011).

Yet while there is emerging evidence of the benefits of more progressive public policies, there is not sufficient progress in all regions and, even where there is, harmonization and support of holistic approaches is lacking. This might be attributed to the fact that policy is defined and revised according to national and local priorities. Public authorities may not fully comprehend the benefits, or lack the political will or the capacity to prioritize resource efficiency policies amongst competing priorities. Furthermore, a lack of comprehensive

planning, prescriptive regulations and codes and/or policy misalignment often stands in the way of holistic and cost efficient approaches to achieving resource efficiency in the building and construction sector.

Conversely, (over)ambitious attempts by public authorities are often met with resistance by a conservative and risk adverse industry unwilling to change and often lacking the knowledge on the long term benefits of proposed policies. This, combined with short political and economic cycles, may lead to public authorities relaxing regulation or abandoning incentives, consequently adversely affecting market certainty. Uncertainties about the durability of specific policies mean that the private sector is often unwilling to commit the investment or resources required to achieve market transformation.

Ultimately, harmonized, ambitious, and long term policies are needed to facilitate greater understanding and foster market certainty. Holistic approaches and the alignment of urban planning/zoning, development plans, district energy systems and investments, building codes and financial incentives, along with economic development, climate and sustainability strategies are necessary to maximize resource efficiency. Strengthening of building codes, in particular – coupled with greater enforcement – will result in increased rate of uptake in better performing buildings.

RECOMMENDATIONS

- More research is needed on good examples of effective collaboration models for public green building policies and more documented examples of effective case studies, including in rapidly developing regions where the greatest amount of construction activity will take place in the next years.
- Document and highlight the impact of, best practices, synthesize and disseminate information and advocate for better public policies through UNEP efforts with governments. The 10YFP programme provides a significant opportunity for mainstreaming sustainable building public policies.
- Promote and facilitate through the work of UNEP-SBCI additional research and identify which government policy instruments (procurement, labelling, standards, incentives) and support structures can encourage green improvements in the design and construction phase and also encourage the private sector to develop relevant initiatives.
- Promote and highlight in UNEP-SBCI's relevant work with governments and local authorities the benefits of model regional building codes that mandate high

energy performance, materiality of low toxicity, and materiality of high regional content. These codes can offer climatological benchmarking and regional durability guidance.

3.2.5.2 PRIVATE SECTOR GREEN BUILDING POLICIES

TYPE OF GREEN INTERVENTION:



Support, information and voluntary action



Economic or market-based instruments

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of knowledge and trust
- Lack of communication and leadership

Increasingly, private sector stakeholders, including building owners, investors and/or developers, are choosing to implement targets or standards on new or renovated buildings to achieve beyond legal compliance resource efficiencies. Such private sector policies or actions might include targets for resource use (e.g. energy, waste, water) or be aligned with recognised green building rating tools. Such policies are often motivated by both the financial and reputational benefits associated with operating or owning green buildings.

This green intervention primarily addresses the lack of clear sector leadership, which helps improve communication and understanding of the benefits of resource efficiency and the perceived cost and schedule impact. It also helps provide incentives for suppliers (including contractors) to alter their business-as-usual approaches.

Case study: Skanska's Journey to Deep Green™**Type of green intervention:**

Support, information and voluntary action



Economic or market-based instruments

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

Skanska AB is aiming to be the leading green project developer and contractor; an aim it has formalised through its Journey to Deep Green™ and related Environmental Policy. Deep Green projects are those where construction process and product performance have a near-zero impact on the environment – far beyond compliance with existing standards and voluntary certification schemes:

- Net zero primary energy for Buildings and net positive primary energy for Civil/ Infrastructure
- Near zero carbon in construction
- Zero waste
- Zero unsustainable materials
- Zero hazardous materials
- Net zero water for buildings and zero potable water for construction

Skanska's Color Palette™ is the strategic framework and communication tool for Green Business that has been developed to measure and guide the company's performance on its Journey to Deep Green™. For each priority opportunity (Energy, Carbon, Materials and Water), predetermined "Stepping Stones" across the "Green Zone" define where each project is mapped on the Color Palette™, scaling from Vanilla to Deep Green:

- Vanilla – The construction process and product performance is in compliance with law, regulations, codes and standards.
- Green – The construction process or product performance is beyond compliance, but not yet at a point to be considered to have near-zero impact.
- Deep Green – The ultimate destination, where the construction process and product performance have a near-zero impact on the environment. A Deep Green project must achieve at least three of the six Deep Green targets.

The Color Palette™ was used by all Business Units (BUs) to set Green Business targets and develop 2011-2015 Green Action Plans, an integral part of the 2011-2015 Profitable Growth Business Plan. For example, 50% of Skanska Commercial Development Nordic projects started after 2015 will target Deep Green.

Adopting innovative and stretching green building policies helps demonstrate sector leadership, which can bring with it benefits to the companies involved including first mover advantages, improved reputation and brand recognition. There are also indirect benefits including enhanced employee engagement, capacity building and improved recruitment and retention of employees; all helping sustain long term operations.

Clear leadership in the highly-fragmented building and construction sector is needed but difficult to achieve; therefore, examples of good practice are much needed to inspire replication. Other, wider, benefits include the creation of more examples of green building – which can potentially improve benchmarking and create higher demand – and improved public opinion about the reputation and motivation of the construction industry and its role in sustainable development.

There is, however, a risk of overstatement of positions and objectives, which can potentially lead to 'green wash', jeopardizing many of the benefits above and most notably the industry's reputation and progress. Furthermore, many private sector policies are accompanied by their own definitions of green. A maturing industry will require harmonization of the (existing) multiple, unaligned and individualized systems, using international definitions on resource efficiency.

RECOMMENDATIONS

- Provide through the UNEP-SBCI a platform for stakeholders in the building and construction sector to engage in developing and implementing strategies for the systematic application of green interventions throughout the building supply chain. This platform can help to build consensus for the development of international metrics for resource efficiency and sustainability of materials.
- Facilitate through collaboration with UNEP-SBCI partners and other networks capacity building for private-sector resource efficient building practices. There is a significant opportunity to improve private/private knowledge transfer targeted at SMEs in the sector in collaboration with UNEP's Business and Industry Unit.

3.2.5.3 FAVORABLE FINANCING TERMS FOR GREEN BUILDINGS

TYPE OF GREEN INTERVENTION:



Economic or market-based instruments



Fiscal instruments and incentives



Regulatory and control mechanisms

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Financial risk
- Disregard for whole life costs
- Lack of knowledge and trust

Property lending practices, credit risk assessments and the determination of financing/loan conditions all impact on property pricing, risk assessment and valuation, and ultimately on whether (and how much) capital is available for new building developments. Consequently, green building can be encouraged or facilitated through favourable or preferential financing terms, such as the loan amount, interest rate or other imposed conditions.

The significance of financing terms for green buildings

has emerged partly as a consequence of the further development and adoption of international banking capital adequacy rules. The so-called Basel II Accord (published in 2004 and subsequently adopted into national law in most developed countries except in the US) requires banks to take a more sophisticated approach with regard to the risks they take when lending, and specifically required banks to develop property rating systems for property financing. The recently introduced Basel III accord has not changed the basic mechanisms and rules.

Favorable financial conditions can help reduce the financial risk associated with constructing green buildings and, if implemented correctly, can help place greater importance on long term value rather than short term (upfront) costs.

In the last decade, banks have developed their own property rating systems which may include green and sustainability-related rating criteria. A strong (theoretical) case exists for the assumption of a twofold impact (UNEP-FI Property Working Group, draft). First, the increased consideration of green and sustainability issues within valuation practices can lead to higher/lower loan amounts granted for sustainable/unsustainable assets. Second, the inclusion of green and sustainability-related rating criteria within property rating systems can result in favourable/unfavourable interest rates for the financing of sustainable/unsustainable assets.

In practice, it is impossible to precisely quantify the actual impact of such factors on loan conditions, as banks do not publish historical credit data and the algorithms by which they transform borrower and property rating results into interest rates offered to their customers. However, it is clear that this green intervention has not yet fully developed its potential or led to tangible consequences in lending practices. (Text adapted from UNEP FI/RICS/IIGCC/PRI, 2014. Sustainability Metrics – Translation and Impact on Property Investment and Management).

Case study: Sumitomo Mitsui Trust Bank, Japan**Type of green intervention:**

Regulatory and control mechanisms



Fiscal instruments and incentives

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

Sumitomo Mitsui Trust Bank has recognised and acknowledges the risk reduction potential of more sustainable assets and therefore offers preferential loans for financing sustainable construction activities. The loan rate depends on the property project's sustainability assessment indicated through an application of the "CASBEE Kawasaki" model or the Condominium Environmental Performance Indication of the Tokyo Metropolitan Government.

CASBEE Kawasaki is a local version of CASBEE (Comprehensive Assessment System for Build Environmental Efficiency). Its assessment items are divided into 6 categories; functionality/durability, green/landscape, attention to local character, saving/recycling materials, energy saving, and indoor quality. The assessment results by category are summarized in the form of a radar chart and the comprehensive assessment result is shown by the number of stars (5 stars in maximum). Sumitomo Mitsui Trust Bank offers preferential loan rates according to the number of stars achieved.

Similarly, the Condominium Environmental Performance Indication of the Tokyo Metropolitan Government shows the assessment results of condominiums in 5 categories; insulation, energy efficiency, solar power systems, durability and greening. The assessment results of each category are shown by the number of stars (3 stars in maximum for each category, 15 stars in maximum in total). Again, Sumitomo Mitsui Trust Bank offers preferential loan rates according to the number of stars achieved. (Text adapted from UNEP FI/RICS/IIGCC/PRI, 2014. Sustainability Metrics – Translation and Impact on Property Investment and Management).

RECOMMENDATIONS

- Strengthen and increase collaboration between UNEP-SBCI and UNEP-Finance Initiative to develop strategies and approaches to address financing barriers for energy and resource efficiency in the building and construction sector and align relevant metrics.

3.2.5.4 ALTERNATIVE PROCUREMENT MODELS FOR GREEN BUILDINGS**TYPE OF GREEN INTERVENTION:**

Economic or market-based instruments



Regulatory and control mechanisms

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS (FULLY DEFINED IN THE CONSTRUCTION PHASE, SECTION 3.3.4):

- Financial risk
- Lack of knowledge and trust
- Lack of incentives
- Tender process
- Supply-chain relationships
- Lack of communication and leadership

The conventional procurement route for construction (sometimes called 'design-bid-build') – which involves the developer first appointing a designer and then, once the design is complete, appointing a contractor for construction – remains the most popular form of contracting in many parts of the world. In the International Federation of Consulting Engineers (FIDIC) Conditions of Contract for Construction Projects (the "Red

Book”), the developer is assumed to have full control in this type of construction. This construction delivery mode focuses the design criteria upon the developer initiated requirements of design (e.g. design brief) and regulatory mandates (e.g. building codes); both of which tend to rely upon design specification minimums due to market forces and legal frameworks. Although this should ensure green criteria are considered in the design phase, contractors tendering for the detailed design are not expected to provide or suggest alternative (potentially greener) approaches.

However, there are an increasing number of alternative ways in which the design and construction of buildings are procured, which can offer greater potential for the delivery of green buildings. Procurement strategies are determined in the concept definition stage, and a lack of stakeholder collaboration at this time is a key barrier to achieving resource greater efficiency.

Design and build (DB) is a procurement route in which the main contractor is appointed to both design and construct the works. This can appeal to developers as it gives a single point of responsibility for delivering the project. It is perhaps the alternative procurement model that is most appropriate to single office developments, and therefore with most potential to green the building supply chain.

In some cases the contractor is appointed to carry out all of the design work (“one stage design and build”). In FIDIC’s Conditions of Contract for Plant and Design-Build Projects (the “Yellow Book”), the contractor will propose a preliminary design as part of the tender, based on the conceptual design provided or an alternative approach which fulfils the requirements of the developer. Before execution of the contract, the contractor will make a detailed design for approval.

If the client wishes to have greater influence over the design, a concept definition is prepared by designers, and then a contractor is appointed to complete the design and carry out the construction (“two stage design and build”).

A key advantage of design and build for green building include that early contractor involvement enables green considerations and solutions – as far as they are understood by the contractor – to be incorporated into the design. It also permits improved communication and integration between designers, engineers and contractors throughout the project schedule.

There is also typically increased opportunity for project innovations as fashioned by project needs and contractor capabilities, and improved resolution of post-occupancy issues, as these can be resolved by the members of the design-build team. Experience from design and build contractors suggests that further advantages include time savings due to eliminating construction contractor bid stage, co-current design and construction activities and an early focus on constructability. Also, design and build projects generally involve fewer change orders and disputes.

Although increasingly used as an alternative to conventional procurement, the DB model does attract some criticism; most notably it can reduce competition for construction services by favoring large engineering and construction firms who are willing to take on additional risks and liability throughout the design and construction process. It also has the potential to undermine the checks between design and construction teams in the conventional delivery systems, with the design team no longer independent of the construction contractor. Another commonly heard disadvantage is cost transparency – developers like to rely on competitive tendering of construction to ensure they get a market competitive price, and even when design and build is used, they are likely still to work with a consultant to ensure market competitive prices are obtained.

Design, Build and Operate (DBO) describes where a single contractor is appointed to design and build a project, and then to operate it for a period of time. In some cases, the contractor – perhaps via special purpose vehicle (SPV) with design, construction and facilities management expertise as well as funding capability – additionally finances the project (Design, Build, Finance and Operate, DBFO) and leases it to the developer or owner for an agreed period (typically 20 to 30 years). Common forms of this procurement route include Public Private Partnership (PPP) and Private Finance Initiative (PFI), where private sector capacity and public resources are used to deliver public sector infrastructure and/or services according to a specification defined by the public sector.

DBO projects, as described in FIDIC’s Conditions of Contract for Construction for Design, Build and Operate Projects (the “Gold Book”), are intended for establishing entire process plants or infrastructure projects with design-build obligation and a long-term operation commitment, where: (i) a higher degree of certainty of final price and time is required; and (ii) the contractor

assumes total responsibility for the design including choice of technology construction and the long-term operation, with little involvement and influence of the customer.

The intention of this approach is that high quality infrastructure is delivered and managed effectively throughout its life. In both cases, tendering is typically based on performance, quality requirements and operation. The contractor typically will propose its own design solution which will fulfil the performance requirements established by the developer including green criteria. Unlike in other procurement routes, the contractor will additionally be incentivised to optimise the design and construction to minimise the cost of operation. This means it drives better whole life cost solutions and sustainable/green choices, and ensures that the cost of large infrastructure projects are not borne by public authorities. It can also accelerate the delivery of large public projects, and lead to agreed high standards of maintenance and operation.

The structure, complexity and transaction costs make this procurement model most applicable for large complex public sector projects such as hospitals and schools, and make it unlikely to be used for single office developments. However, it could be considered for procuring design and build services for the (green) renovation of multiple public buildings, though greener buildings are not achieved automatically and depend on conditions imposed by the developer

Collaborative contracting is an umbrella term given to procurement strategies (including alliance contracting and partnerships, and IPD (Integrated Project Delivery) in North America) that enable participants to work together in an open and non-adversarial environment. They enable the flexibility and incentive to work together to deliver optimal commercial, and potentially green, outcomes for all.

This approach developed as a method of procuring, and sometimes managing, major capital assets in which a public authority or agency works collaboratively with private sector parties to deliver a project. Consequently, it remains an approach that most widely adopted for public procurement in the utilities and infrastructure sectors (e.g. O&M of water utilities in the UK, delivery of large construction projects in Australia, increasingly popular in the U.S.), though it appears to be well suited to the use of integrated project design to deliver green buildings.

Alliance contracting requires all parties to work as an integrated, collaborative team to deal with key project delivery matters on a 'best-for-project' basis. It means that the contractor engages with the developer and material & equipment suppliers in a different way, benefitting from a diverse team with skills drawn from across the supply chain with collaboration a great enabler of innovation. It also means that all members of the alliance are able to influence design and specification of greener solutions – if prioritized by the developer – with long term relationships meaning that greater attention is paid to the whole life cost/impact. Furthermore, it avoids contractors singularly assuming all risks associated with green solutions as can occur under other procurement routes (such as DB or DBO/DBFO). In a collaborative-style delivery model – with its concentration on a mutual approach – risks and rewards are shared between all stakeholders.

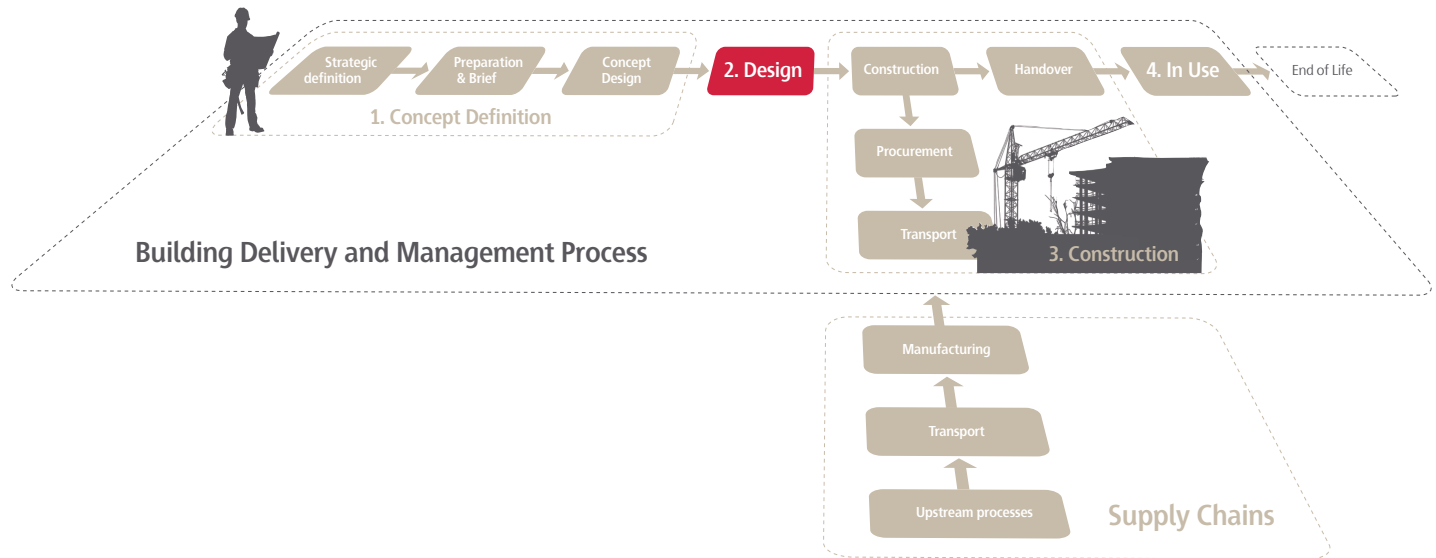
For alliance contracting to operate effectively it needs strong, committed leadership and requires compromise, and in some cases cultural alignment, from all stakeholders involved. Furthermore, long term alliance arrangements can become stale if not sufficiently ambitious or reviewed on a regular basis. Typical barriers to wider scale adoption include lack of trust and respect between parties, which may be due to competitive sensitivities and differing attitudes to risk. Such contracts are sometimes difficult to manage and cultural misalignment between parties may hold back performance.

RECOMMENDATIONS

- Engage UNEP-SBCI industry partners to document best practices including alternative procurement methods, and highlight results and lessons learned in relevant 10YFP programme activities
- Identify and assess sector-specific approaches to procurement that result in improved resource efficiency through UNEP-SBCI engagement with sustainable and green procurement initiatives, including UNEP-Sustainable Public Procurement Initiative.
- Encourage the adoption of standard contract types, or contractual frameworks, that have been proven effective, reasonable and legally robust in major world markets and document through relevant UNEP initiatives and partners.

3.3 Stage 2 - Design

Figure 6. The design stage



3.3.1 SCOPE

This stage involves designers and engineers developing and finalising a detailed design for the project on behalf of the developer. Design services are procured through public and private procurement policies. These policies usually require pre-qualification of design and engineering consultants, and are followed by a request for proposals to qualified consultants.

It is at this time that project strategies are developed – such as an acoustics, construction, fire engineering, health and safety, operations and maintenance and sustainability – and it is verified that the cost information is aligned to the project budget. This stage would also typically include making applications to relevant public authorities for planning and other statutory approvals, and the process of selecting and appointing a contractor for the main construction contract.

Once the work of the lead designers has been progressed to the appropriate level of detail, specialist subcontractors can progress their design work as required. During this stage, architectural, building services and structural engineers provide technical definition for the project. In conventional contracts, most aspects of the design are completed during this stage, prior to construction commencing.

The design stage has a clear role to play in establishing resource efficiency of a building project. At this stage, decisions about the majority of the priority materials are taken, and described in sufficient detail to allow cost information to be further detailed based on material quantities. This stage also identifies equipment and in many cases furniture requirements for the building, which also has a direct influence on overall resource efficiency (for example specification of energy efficient appliances or water efficient fixtures and fittings).

3.3.2 STAKEHOLDERS

Figure 7. Design stage stakeholders



3.3.3 RELATIONSHIPS

Public authorities ⇌ Developers

The relevant public authorities review and approve planning or building permit applications from the developer. Approval might be given subject to changes to the proposed development or subject to planning conditions. The process of obtaining permits can be lengthy, sometimes starting in the concept definition phase, and frequently involves a public consultation process.

Developers ⇌ Designers/Engineers

The developer procures, either directly or indirectly through the lead designer, further (complementary) services from designers and engineers based on the conceptual design and final brief. Design and engineering services are typically procured through public and company procurement policies. These policies usually require pre-qualification of designers and engineers (although this may happen outside the project life-cycle), and are followed by a request for proposals to qualified parties.

3.3.4 BARRIERS

LACK OF INCENTIVES Developers are often unaware of the benefits of green or resource efficient buildings. The common perception remains that green buildings increase costs, and potentially project schedule, adversely affecting profit and yield. With little to no clear tenant demand and insufficient examples of greener buildings attracting higher market values, the developer will have little incentive to entertain proposals that seek to improve resource efficiency from designers and engineers.

TECHNOLOGICAL RISK New technologies have risks arising from increased upfront costs, (the fear of) unintended outcomes from their use and associated claim from tenants and concerns about appropriate maintenance regimes (WGBC, 2013a). In addition, a lack of knowledge about, or capacity to react to market developments, means that some new technologies or material solutions are not addressed by policies or codes, making their approval by public authorities difficult and introducing the risk of delay and/or costly planning conditions for the developer. Consequently, developers, designer and engineers tend to specify the products they are most familiar with and have used before.

LACK OF COMMUNICATION AND LEADERSHIP Often, the lack of involvement of specialist material & equipment suppliers at this early stage is a constraint to achieving improved levels of resource efficiency. Similarly, the lack of early constructability reviews and knowledge transfer from designers and engineers to the lead contractor can create additional barriers downstream.

3.3.5 GREEN INTERVENTIONS

3.3.5.1 GREEN PERFORMANCE GUARANTEES

TYPE OF GREEN INTERVENTION:



Economic or market-based instruments



Fiscal instruments and incentives

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Financial risk
- Lack of knowledge and trust

Through performance guarantees, developers or owners can address the risk of not achieving a stated indicator of green performance, such as a level of certification according to a Green Building rating tool or a specified energy performance, with associated financial benefits. The most common performance guarantee addressing green or resource efficiency is the energy performance guarantee (EPG).

An energy performance guarantee is usually a clause or a set of clauses in the contract between the developer or owner and an energy service provider, supplier or contractor (energy service company, or ESCO⁵), that specifies the required energy performance with penalties for failing to deliver that performance. Penalties include the cost to make-good and/or a financial compensation for missed savings. Through such guarantees, the developer or owner in part or wholly transfer the risk to the service provider, supplier or contractor, thus providing more certainty of financial savings. Energy performance guarantees – due to the associated financial savings – have been the basis for the emergence of energy performance contracting (EPC), and has increasingly been used in renovation contracts allowing developers or owners to finance their energy efficiency upgrades through future energy savings rather than through equity.

According to Transparence, an Intelligent Energy Europe co-funded project, a typical EPC project consists of the following elements (Transparence, 2014):

- Turnkey service – The ESCO provides all services required to design and implement a comprehensive project at the customer facility, from the initial energy audit through long-term measurement and verification of projects savings.
- Comprehensive Measures – The ESCO tailors a comprehensive set of measures to fit the needs of a particular facility, include energy efficiency and, in addition, can include renewables, distributed generation and water conservation.
- Project financing – The ESCO arranges for long-term

⁵ An energy service company (ESCO) can be a commercial business such as a utility company, equipment supplier, contractor, a not for profit business, or may in some cases take the form a legal entity (SPE or SPV) established for the EPC contract to help achieve financing.

project financing that is provided by a third party company, typically in the form of a bank loan.

- **Project Savings Guarantee** – The ESCO provides a guarantee that the savings produced by the project will be sufficient to cover the cost of project financing for the life of the project.

Energy performance guarantees and contracting help address the commonly encountered issue that the actual performance of the buildings is not as it was designed for, as the performance guarantee will extend the responsibilities of service provider, supplier or contractor to ensure installed equipment is delivering the savings as agreed. In addition, it provides for clear targets from the outset of the project. Energy efficiency guarantees and future monetary savings have also attracted the interest from capital providers as they provide a means to secure cash flow and return on loans.

Case study: Houston Mayor's Office

Type of green intervention:



Economic or market-based instruments



Regulatory and control mechanisms

Aspects of green directly addressed:



Energy



Water

With the support of the Clinton Climate Initiative (CCI), the Houston mayor's office developed and implemented a large-scale energy efficiency retrofit program to address all city buildings using CCI's best practices energy performance contracting methodology. The city government has set a goal of reducing its energy demand from buildings by at least 25% through the program. In working with CCI, the city government decided to pursue an energy services performance contracting (EPC) model, worked with the city government to identify energy service companies (ESCOs) that could implement the retrofit project under CCI's energy performance contracting best practices, and helped the city government understand and consider the available financing alternatives.

The city ultimately chose to award its contract to two ESCOs, Siemens and Schneider Electric/T.A.C., based on the firms' experiences working with particular building typologies similar to Houston's building stock. Both Siemens and Schneider Electric/T.A.C. agreed to guarantee the energy savings resulting from the project over a period of up to 20 years; they also agreed to monitor savings in accordance with the International Performance Measurement and Verification Protocol (IPMVP).

In 2010, construction of the first nine buildings were completed in 14 months, with the two contracts delivering a 37.6% saving / 13 years (simple) payback time and 29% saving / 11.6 years (simple) payback time, respectively.

To date, ESCOs are most well developed in Europe and the US, but remain in a more formative state in Asia Pacific. The U.S. ESCO market reached a peak of \$5.6 billion in 2011, and despite a subsequent sharp decline, the market is expected to grow to \$8.3 billion by 2020 (Navigant Research, 2013,). In Europe, the European Investment Bank lent, on average, EUR 1.3 billion per year since 2007 for energy efficiency, with 43% going to buildings over the last 5 years. The binding measures contained within the EU Energy Efficiency Directive will require considerable investment by Member States (European Commission, 2014). Meanwhile, private investment funds focusing on energy efficient retrofits have also started to emerge, investing in worldwide energy efficiency and demand response markets.

In Asia Pacific, Japan and South Korea have the most advanced ESCO sectors but ESCOs are also active in China, India, and Australia. However, low market expectations for existing buildings, along with a lack of capital for ESCO services, have resulted in low market volumes to date (especially in China and the emerging economies).

According to Transperence (2014), the majority of surveyed ESCOs in the EU have experienced a slight growth over the last 3 years. However, the survey reveals that ESCOs in most EU countries experience similar barriers: the complexity of EPC, the lack of trust in the EPC industry, low demand and split incentives, and obtaining affordable financing. The reason given for the latter is the knowledge of the characteristics of EPC projects with the capital providers. The recent financial crisis and the tightening of lending requirements were also cited.

EPC does attract the criticism that it does not necessarily encourage a holistic approach towards achieving energy efficiency, but instead focuses on low cost system modifications to optimize (short term) returns on investments. In addition, EPGs and EPCs may limit innovation and encourage the selection of “off the shelf solutions” as ESCOs foremost look to minimise technology risks.

RECOMMENDATIONS

- The effectiveness of green performance guarantees in practice should be assessed, including the existing tools and technical monitoring systems (for water, energy and waste) that are applied.

3.3.5.2 GREEN INCENTIVES IN PERMITTING PROCESS

TYPE OF GREEN INTERVENTION:



Fiscal instruments and incentives



Regulatory and control mechanisms



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Financial risk
- Lack of knowledge and trust
- Technological risk
- Lack of incentives
- Lack of communication and leadership

Incentivizing the green building market through financial or structural incentives offered by public (typically regional or municipal) authorities. Such incentives reward developers or owners who support green building techniques, and can be used as a means for spurring innovation and demand for green building technologies.

Structural incentives work by encouraging developers to practice green building through rewards such as additional density bonuses or expedited permitting processes. In this way, green buildings can be made a more attractive option to developers at low or no cost to the municipality. Such schemes can help address several barriers to green building. Development is high risk and capital intensive business, and good incentives can help reduce development risk and improve the developer business case for green building with the intent to create momentum and benchmarks in the market. Incentives programmes can encourage developers to consider the benefits of green or resource efficient building, where that may not have happened without such schemes. Good incentive programmes also help mitigate the risks associated with the implementation of emerging technologies or practices and encourage developers (through designers, engineers or contractors) to collaborate earlier with suppliers.

Case study: Seattle Green Building Incentives**Type of green intervention:**

Fiscal instruments and incentives



Support, information and voluntary action



Regulatory and control mechanisms

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

The City of Seattle, through a range of Green Building Incentives, is helping to prioritise or accelerate new green developments within the city. At their most basic, they shorten the time it takes to get a new construction permit for buildings that meet the city's Priority Green thresholds (energy efficiency, water conservation and waste reduction) and that are certified (Built Green 4 star or 5 star, LEED Gold or Platinum or Alternative Path/ Passive House).

At their most challenging, the Living Building and Deep Green Pilot programs allow developers to increase the development yield by requesting departures from the Seattle Land Use Code for buildings attempting to meet the Living Building Challenge or its Seattle Deep Green Pilot. The Living Building Challenge (LBC) is a green building certification program that defines the most advanced measure of sustainability for buildings and landscapes currently in existence. Buildings must achieve 'petal recognition' in order to be eligible for the scheme, which means meeting at least three of the seven LBC petals (site, water, energy, health, materials, equity, and beauty), including at least one of energy, water and/or materials. In addition, total energy and water use must be reduced by 75%, and at least 50% of stormwater must be captured and used on site.

There is great potential in removing risk from (and increasing opportunity in) the permitting process and better/earlier alignment of developer and public authority objectives. Green incentives in the permitting process – as well as other incentive programmes more generally covered under public policies – provide useful vehicles to build exemplary green buildings.

The opportunity to achieve momentum at relatively low public expense is great. For an incentive programme to be successful it will need to be complemented by an extensive education/communication effort on the benefits of the programme and political will required for implementation. There must also be a common understanding of the benefits of such programmes, allowing for trust and collaboration to be the basis for implementation.

However, often the imposed need for increased transparency (such as additional reviews to justify incentives for the private sector), complexity of the prioritization/

qualification criteria, lack of knowledge of emerging technologies, availability of resources, and limiting building codes and regulations may prevent these programs achieving their full potential.

Public consultation, especially for projects that are subject to more controversy through departures from regular land-use codes, can add additional risk to the process and may lead to delays that offset any potential financial gains through programme incentives. Furthermore, where incentive programs include financial penalties for not achieving specified green criteria, the cost of financing the project often increases to cover this risk. The green specification can, in itself, become a barrier to participation by developers if over-ambitious specifications lead to the definition of buildings that deviate too much from convention, and for which financing can be difficult to obtain.

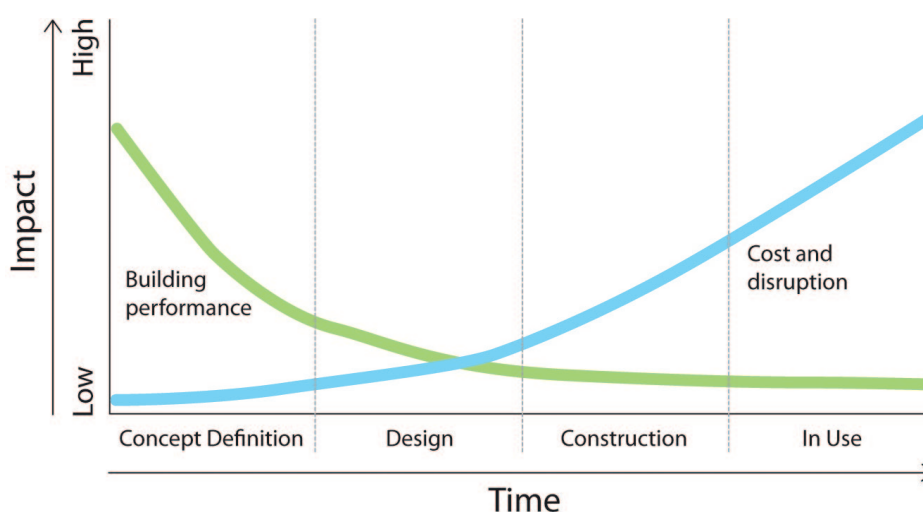
RECOMMENDATIONS

- Promote and highlight to governments and local authorities the benefits of incentives in the permitting process. UNEP-SBCI partners, including Green Building Councils are well positioned to support development of comprehensive policy packages to promote green buildings, and other policy instruments, including regulatory, economic/market based, fiscal instruments and incentives, and information/voluntary actions.
- Further examine and document benefits and results of incentive programmes during the permitting process. UNEP-SBCI partners can share experiences and case studies to document results and promote successful incentive programmes.

Integrated design

Characterising the building delivery and management process as reflecting conventional project delivery, which we have taken as a basis for defining green interventions, tends to underplay the opportunity for, and potential impact of, integrated design.

Integrated design involves multidisciplinary collaboration between stakeholders at all stages in the building supply chain. This means green design principles, incentives and benefits can be established at the outset, satisfying the needs, and clarifying the roles and responsibilities, of multiple stakeholders while achieving the overall project objectives. Furthermore, integrated intervention at an early stage has a large impact on building performance at relatively low financial cost. Interventions that occur later in the building delivery process generally result in higher cost due to the consequences (intended and unintended) on other aspects of the process, and may not result in optimum building performance.



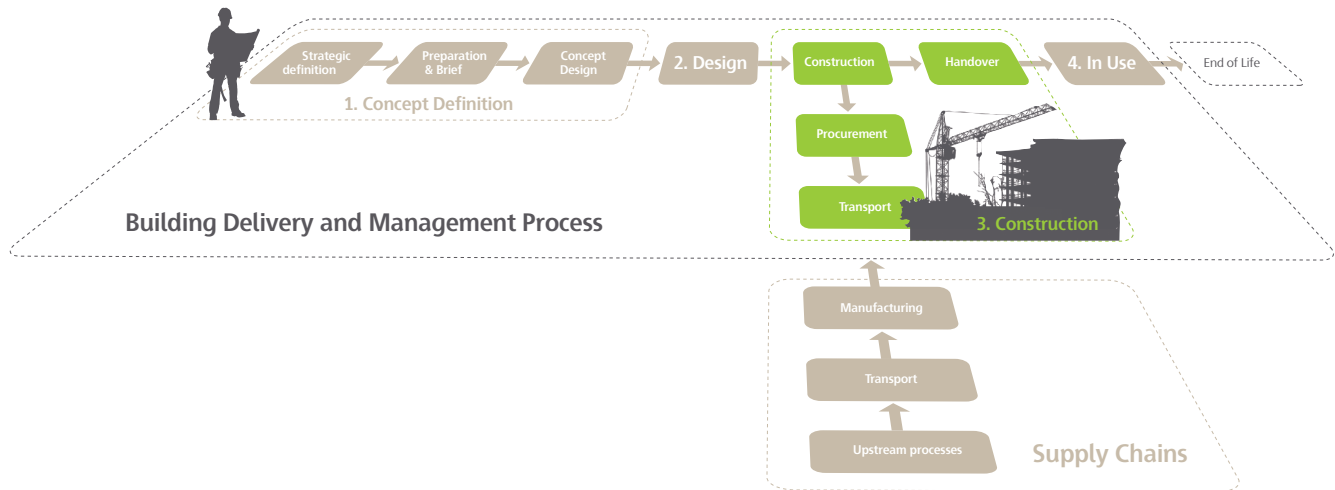
Source: Modified from WBCSD (2007)

Council House 2 (CH2) is a sustainable office building designed for the City of Melbourne, and the first six Green Star rated building in Australia. The process of designing CH2 was highly collaborative and innovative - challenging conventional approaches to sustainability and building design - which proved critical to the achievement of an integrated design.

Working collaboratively with Council's own designers and project managers, the CH2 project team began with by attending an initial two-week workshop followed by regular design sessions that ran for eight months. The initial workshop enabled 70% of the design and building systems to be resolved in the concept definition stage, improved communication and understanding between the stakeholders involved in the project, and resulted in design and tender time being six months less than originally predicted. While the integrated design process developed on CH2 led to many beneficial and unexpected design outcomes, the majority of these outcomes represented hybrid solutions between traditional industry solutions and customised adaptations. Furthermore, involving the lead contractor as early in the process - despite using a relatively conventional procurement process - enabled innovative decisions to be made with a degree of certainty in terms of constructability and cost.

3.4 Stage 3 - Construction

Figure 8. The construction stage



3.4.1 SCOPE

During the construction stage, the lead contractor, as appointed by the developer, manages the majority of activities typically through a competitive tendering process. Construction activities start with mobilisation, during which all the required contracts and arrangements, including procurement of most materials, equipment and services, are established prior to construction activities commencing.

On a conventional contract, construction would not normally commence until most of the design has been completed; however, the designers/engineers or the lead contractor and/or specialised contractors typically complete some aspects of the design, such as materials & equipment suppliers, during the construction phase.

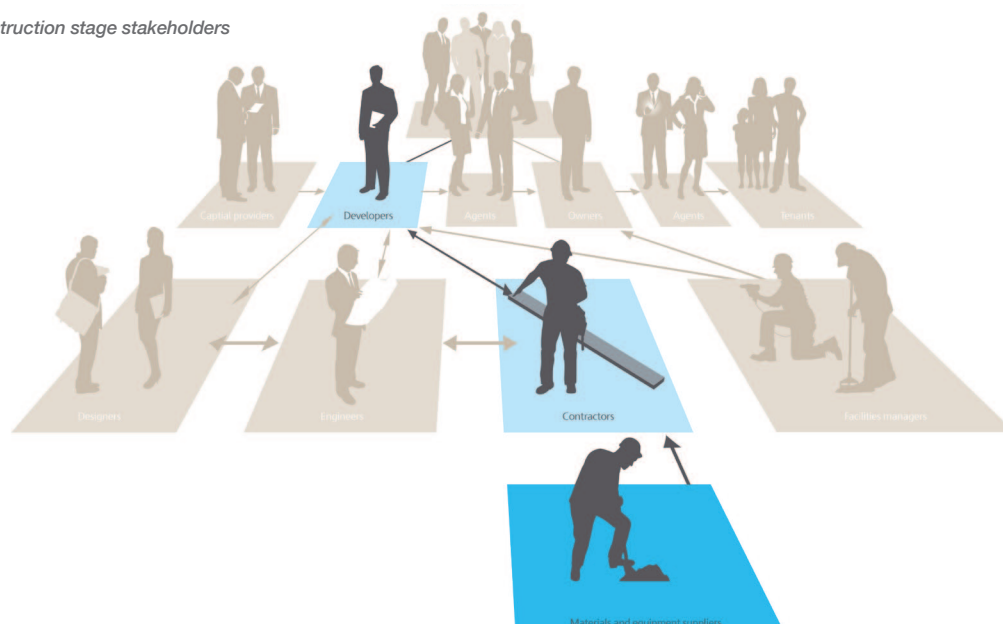
As construction commences and progresses on site, the lead contractor takes responsibility for site management and quality, schedule and cost control. At this stage, designers and engineers may be consulting about design queries and amendments. As buildings have become increasingly complex, it is less likely that any one stakeholder will have the required skills to carry out all of the works necessary. Increasingly therefore, specialist elements are sub-contracted such as piling, roofing, cladding, civil engineering, steelwork, plumbing and electrical services to specialised sub-contractors, which in some cases may include materials & equipment suppliers.

Unless guided by developer policies, the lead contractor selects material & equipment suppliers to meet the design specifications; decisions which directly impact on resource efficiency. Some non-architectural materials are typically specified during the construction stage, including plasterboard and formworks (e.g. timber). Other on-site decisions and processes that can have significant impact on resource use, and that are coordinated by the lead contractor, include material control and planning, efficiency of construction processes, waste management and plant and energy source selection.

Following appropriate inspections, commissioning and testing, the construction stage is widely understood to finish at the point when the contractor issues a certificate completion and the site is handed back to the developer. In practice, a defects liability period follows once the client has taken possession of the development when any defects are rectified, and the final certificate is issued signifying that the construction works have been fully completed. Other key tasks relating to the building handover include development of the building or O&M manual; tasks that require the involvement of the relevant designers, engineers and material & equipment suppliers.

3.4.2 STAKEHOLDERS

Figure 9. Construction stage stakeholders



3.4.3 RELATIONSHIPS

Developers ⇌ Contractors

The formal process of procurement typically starts with the developer issuing a request for qualification (RFQ) to prospective contractors (although this may be done outside of the project life cycle). Selected/qualified contractors subsequently receive an Invitation to Tender (ITT) or equivalent, and later submit a formal bid with cost. The terms are set by the developer and usually result in tendering for a fixed price contract, though other contract types are sometimes used such as unit rate or guaranteed maximum price. The developer selects a preferred bidder, usually based on pre-defined criteria and mostly influenced by cost, and engages in negotiations. Once chosen, the developer formalizes the relationship with the contractor through a contract. The developer and contractor also agree on formal change management criteria and process, through which changes to the design are managed.

Contractor ⇌ Material & equipment suppliers

The developer procures, either directly or indirectly through the lead designer, further (complementary) services from designers and engineers based on the conceptual design and final brief. Design and engineering services are typically procured through public and company procurement policies. These policies usually require pre-qualification of designers and engineers (although this may happen outside the project life-cycle), and are followed by a request for proposals to qualified parties.

3.4.4 BARRIERS

FIRST MOVER RISK For many suppliers, most notably SMEs, the innovation required to achieve greater resource efficiency requires too high a level of investment in knowledge, people, IPR, technology and equipment, with limited or unknown return and the risk of other suppliers following suit with much lower investment costs. Many prefer to be fast followers rather than first movers, and gain second-mover advantage.

SUPPLY-CHAIN RELATIONSHIPS Some suppliers are tied to certain manufacturers or contractors, which creates a relationship that does not inspire, challenge or incentivise manufacturers to innovate. Likewise, contractors primarily prioritize their procurement decision on capital cost - as opposed to life cycle cost - leaving little scope to offer more resource efficient solutions if available. In addition, in an immature and highly fragmented 'green' market, there is no clear leadership leading to a lack of a consistency or objectivity in the definition of "green". This often results in suppliers having to deal with multiple different requests for information or products, and receiving little or no guidance on how to focus often limited resources to the benefit of developing their products or services in the longer term.

TENDER PROCESS The majority of construction work involves competitive tendering by contractors on highly specified tender documents issued by the developer, with tight bidding deadlines and awarded primarily based on capital cost. This tender process leaves lit-

tle or no room for greening building projects – which might have higher upfront costs but lower operational costs – nor does it inspire stakeholders to work collaboratively towards greening the building sector. Upon award of the construction contract, the contractor focus will focus mainly on schedule, risk and change management to protect low available margins. ‘Green’ alternatives suggested at this stage typically attract higher costs than if the evaluation of equipment and material alternatives was done in earlier stages. Even where green alternatives are available with comparable cost to the specified solutions, limited knowledge and experience on behalf of the contractor and construction and/or warranty risks may mean the contractor is reluctant to incorporate the alternative.

LACK OF COMMUNICATION AND LEADERSHIP Construction is often characterized by a large number of participants working side by side, with a high rate of interdependency and complexity of tasks in varying collaborations for the duration of the project. There is also often a lack of alignment between the actors, each working with its own targets and motivations under pressure of deadlines and budget constraints. This often translates into fragmentation, poor levels of co-operation, lack of mutual respect, and lost opportunities for optimum use of resources (Pries and Janszen, 1995; Barlow, 2000, Lichtenberg, 2002; 2005). Even if undertaken, proactive improvement of construction processes not positively affecting the efficiency or the construction budget cannot be recovered and are at the expense of a low industry margin. Furthermore, the nature of construction as described above, and the fact that construction firms small or large are project-based organizations, provides significant barriers to replication and wider scale adoption of successfully applied innovations from previous or other projects. (Barlow, 2000; Tjandra and Tan, 2002).

LACK OF KNOWLEDGE AND TRUST The building and construction sector is characterized by fragmentation and many SMEs. Even the largest players are small and relatively local by international business standards, with the exception of some materials & equipment suppliers (WBCSD, 2007). Relevant knowledge is scattered amongst stakeholders but developer procurement strategy, lack of trust and large differences in profit margins at different points in the supply chain prevent more collaborative approaches.

3.4.5 GREEN INTERVENTIONS

3.4.5.1 GREEN/SUSTAINABLE PRIVATE PROCUREMENT

TYPE OF GREEN INTERVENTION:



Economic or market-based instruments



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- First mover risk
- Supply-chain relationships
- Tender process
- Lack of communication and leadership

Some large private sector stakeholders in the building and construction sector have started to develop and implement procurement policies that include green or sustainable criteria. Such programmes typically go beyond compliance and minimum expectations for green performance, and monitor supplier compliance using self-assessment and/or site audits. Sometimes, these policies are accompanied by a continuous improvement or training element, whereby the private stakeholder works with its suppliers to help them improve their green performance through time.

Green private procurement can improve communication of green expectations, provide a clear framework for leadership and collaboration and can help drive general improvements across the supply chain.

Case study: Saint-Gobain's responsible purchasing policy**Type of green intervention:**

Support, information and voluntary action



Economic or market-based instruments

Aspects of green directly addressed:

Materials

Saint-Gobain has implemented a responsible purchasing approach to extend its good business practices to its suppliers. Its Suppliers Charter explains the Group's requirements for suppliers and service providers in terms of human rights, business practices and environmental and social performance, and is distributed to all registered suppliers. It also includes responsible purchasing clauses in all framework agreements signed by the Group, to remind suppliers about Saint-Gobain's sustainable development requirements.

Compliance with its Suppliers Charter is monitored using a self-assessment questionnaire and a supplier audit program, launched in 2011 and designed to ensure that its suppliers meet their commitments concerning labor law, human rights, workplace health and safety, environmental protection and the implementation of an appropriate management system. Regular site audits are undertaken, with priority given to territories defined as 'high risk' in which Saint-Gobain has supplier operations. The audit process includes an initial audit and follow-up audit, and includes environmental criteria.

The supply of sustainable timber is of key importance to Saint-Gobain. Its Building Distribution sector (SGBD) has decided to engage closely with its chosen suppliers to go beyond compliance and help incorporate sustainability across the whole value chain. It introduced an Environmental Timber policy in 2007 to ensure the origin and traceability of timber products. The implementation of this policy since six years has led to certification of outlets, FSC or PEFC-certified products in joinery, and development of tools and training on the European Timber Regulation, Forest Law Enforcement, Governance and Trade (FLEGT).

In France, SGBD worked closely with Joubert, a major French supplier of Okoume plywood, to help them improve the traceability of their value chain and their own sustainability policy. SGBD has been able to help Joubert green their own value chain by, for instance, giving credit and value to their initiative in terms of certifications and responsible procurement, which has become for them a competitive advantage and helps benefit the whole market.

Private procurement policies provide business with an opportunity to provide leadership in building and construction sector, and help improve the capacity of the supply chain as a whole to deliver green solutions. In addition to addressing the critical need to comply with regulations, responsible purchasing helps create value for the businesses involved by providing a clearer picture of purchasing-related impacts and potential risks. In this way, it can deliver a meaningful competitive advantage.

However a lack of consistency and validity between approaches adopted can lead to suppliers being faced with multiple – potentially conflicting – requests from different customers. There are also concerns about the potential exclusion of SMEs and the additional costs of meeting green expectations. Ensuring compliance by suppliers can be a challenge, especially for large businesses with operations in different territories, where varying environmental legislation and standards are expected. Introducing such programs can also be a significant expense, and since it remains a cost-focused market, few in the building and construction sector would be willing or able to prioritize green criteria ahead of financial cost.

RECOMMENDATIONS

- Promote and facilitate through UNEP-SBCI partners the development of supporting criteria for private procurement policies that include green or sustainable standards.
- Engage with relevant international agencies, UNEP initiatives and building industry associations to assure that suppliers have the training and skills needed to meet green/sustainable procurement standards and improve their green performance through time.

3.4.5.2 GREEN/SUSTAINABLE PUBLIC PROCUREMENT

TYPE OF GREEN INTERVENTION:



Regulatory and control mechanisms

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Technological risk
- First mover risk
- Supply-chain relationships
- Tender process
- Lack of communication and leadership

Green or sustainable public procurement (GPP/SPP) is a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured. In this way, GPP/SPP contributes to creating markets for appropriate green technologies and innovative solutions, reducing environmental impacts, driving social improvements (such as the support of fair trade) and achieving financial efficiency.

For most public authorities, the construction of new and renovation of existing buildings represents a major share of annual expenditure – in some cases over 50% (ICLEI - Local Governments for Sustainability, 2008). Additionally, the running costs of publicly owned buildings including heating/cooling, electricity, waste, hot and cold water, are significant drains on public finances. Furthermore a large proportion of all construction works are publicly financed, with authorities therefore able to exert considerable influence on the market as a whole.

Green or sustainable public procurement explicitly takes into account the main social and environmental impacts associated with construction, and considers the overall life cycle of a building. It covers many different issues, ranging from types of building materials used to different approaches to achieving high resource efficiency. It also provides a clear framework for leadership and collaboration, helping mitigate the risk of specifying green (alternative) solutions, and ensures a consistent approach (at least for all work covered by each GPP/SPP agreement). It can also help reduce technological risk, by ensuring green criteria are considered earlier in the project life-cycle.

Case study: UNEP's Sustainable Public Procurement (SPP) Initiative

Type of green intervention:



Regulatory and control mechanisms

Aspects of green directly addressed:



Energy



Waste



Water



Carbon



Materials

UNEP has long supported SPP by facilitating global consensus on the integration of sustainable development considerations in public procurement, fostering information exchange and providing practical tools for implementation.

In 2008, the Swiss government and UNEP established a partnership to implement the methodology developed by the Marrakech Task Force on Sustainable Public Procurement to implement SPP (MTF Approach to SPP). UNEP subsequently rolled out the MTF Approach to SPP between 2009 and 2012 in 7 pilot countries (Chile, Colombia, Costa Rica, Lebanon, Mauritius, Tunisia and Uruguay), with the support of the European Commission, the Swiss Government and the Organization of Francophone Countries.

The project produced a number of key outputs:

- Guidelines of what has now become the UNEP's SPP Approach, which incorporates the lessons learnt drawn from the pilot countries;
- Study on the Impacts of Sustainable Public Procurement on Sustainable Development, which is a first attempt to provide a methodology for measuring the sustainable development impacts and market changes of SPP;
- Training toolkit for decision-makers, suppliers and procurers.

The Sustainable Public Procurement and Ecolabelling Project started in April 2013 with the support of the European Commission, China and the Republic of Korea. The project seeks to combine Ecolabelling and SPP to achieve maximum synergies and to better deliver the common goal of stimulating the demand and supply of sustainable products.

With a view to addressing the many barriers facing SPP implementation, UNEP also launched an International Sustainable Public Procurement initiative (SPPI) at the Rio+20 Summit in June 2012. This international collaborative effort seeks to promote worldwide implementation of SPP through increased cooperation between key stakeholders and a better understanding of its potential benefits and impacts.

The SPPI is backed by the Global Sustainable Consumption and Production (SCP) Clearinghouse, an online platform for communication and cooperation among different actors involved in the promotion of SCP. The platform provides SPP stakeholders with the possibility to access key services such as an evolving database of initiatives or policies related to SPP.

Similar, parallel, activities have been undertaken by the European Commission through its Green Public Procurement (GPP) program. GPP has specific construction criteria and a Training Toolkit for construction has been developed by the EU Commission and ICLEI. Since January 2010, the European Commission has collected examples of GPP in practice to illustrate how European public authorities have successfully launched 'green' tenders, and provide guidance for others who wish to do the same (GPP brochure of good practice examples, available online at http://ec.europa.eu/environment/gpp/case_en.htm).

Through such programs, the public sector has a great opportunity to steer and lead the building and construction sector, and using objective, transparent green award criteria will create green competition and build knowledge and experience

However a lack of cooperation and integration between different public authorities may lead to an inconsistent approach to, and application of, sustainable procurement, and inability to achieve full market impact. There also remains uncertainty around verification of sustainability claims of products, and inconsistent standards across different product categories, meaning there is a clear opportunity to better align with or refer to product labelling tools. There is often a lack of political will to invest the resources necessary to implement SPP/GPP, as the benefits as compared to other policy areas, are not fully understood by politicians or the public. There are also concerns from suppliers about the potential exclusion of SMEs and the additional costs of certification.

RECOMMENDATIONS

- Support and promote through a collaboration between UNEP-SBCI and UNEP Sustainable Public Procurement Initiative the mainstreaming of sustainable public procurement (SPP) as a policy tool for sustainable buildings and construction in government policy at local and national levels.
- Facilitate through the activities of UNEP-SBCI and partners the development of supporting criteria for SPP, and align sector criteria with national and regional criteria (such as EU GPP) to provide harmonization and consistency across markets.
- Work in collaboration with other UNEP initiatives and building industry associations to assure that SMEs have the training and skills needed to gain access to GPP/SPP, and to measure the impact of GPP/SPP in the building sector through the development of specific building related indicators.

Supply Chain Sustainability School

Launched in 2012, the UK Supply Chain Sustainability School is a free, virtual learning environment that aims to help construction suppliers and sub-contractors develop their organisations' sustainability knowledge and competence. In what is thought to be a first for the industry, the School was jointly founded by some of sector's largest contractors and materials & equipment suppliers in the UK (Aggregate Industries, Kier, Lend Lease, Morgan Sindall, Sir Robert McAlpine, Skanska, Willmott Dixon), and represents a common and collaborative approach to addressing sustainability within the supply chain. The School is part publicly funded, with match funding being provided in-kind by the partners.

The School provides material & equipment suppliers with a common approach to addressing the sustainability challenges facing the industry. It addresses the frequently-heard view that suppliers are faced with many different sustainability information and requirements but that, as SMEs, they typically do not have the financial or staffing resources to be able to investigate or address these issues.

The School is open to any supplier in the construction industry, with the goal to widen the initiative to any construction supply that want to develop its sustainability credentials and help to build a more sustainable supply chain for the industry.

Although primarily an online resource, via e-learning modules and other web-based resources, the School also provides face-to-face learning including regional supplier days and training workshops. Supplier days are free to attend, and give all suppliers the chance to hear from industry experts on a range of topics including the future of sustainability, the aims and objectives of leading UK contractors and how they want to engage with their supply chains.

In its first year, the School gained 2,400 registered members – exceeding the original target of 800 – who represent more than 1,300 companies, three quarters of which are small to medium sized businesses (under 250 employees). Initial feedback from across the construction industry, indicates that the potential long term impact of the School should be significant.

Towards a Circular economy

The concept of zero waste to landfill – a requirement of the ‘circular economy’ framework – is seen as a way of transforming the building industry from industrial to sustainable capitalism (e.g. Construction Resource Initiatives Council of Canada, 2012). In accordance with the waste hierarchy, the first step towards achieving a circular economy approach in the building and construction sector is to prevent waste occurring at source. Failing this, options for material re-use and recycling should be implemented.

Actions can be taken at all stages in the building delivery and management process that help eliminate waste at source:

- Owners and developers committing to green purchasing and/or zero waste operations policies;
- Designers using their guiding and design principles to influence material selection and the quality of their specifications
- Material & equipment suppliers choosing to lead and engage in ongoing research and development; and
- Contractors committing to respect and implement green building design and practices.

Typically, surplus construction materials are perceived to have no value and to be the sole responsibility of the contractor. To achieve zero waste to landfill, all stakeholders and influencers need to work together to improve resource efficiency and to redefine excess (waste) materials as valued resources.

Some construction materials, such as steel, are capable of long-term re-use. Re-use of steel products without melting potentially offers a very low-energy supply of components, with energy required only for dismantling and reassembly. For example, steel sheet piling – used on construction sites as a temporary structure to hold back water or earth – can be re-used 5 or 6 times, after which the main UK manufacturer will buy the sheets back at a pre-determined rate if in good condition (Allwood and Cullen, 2011). There are also numerous cases where structural steel from existing or demolished structures has been re-used in new or renovated buildings.

Many construction materials are able to be recycled. Typically, surplus or recovered materials are melted and/or crushed to either be combined with virgin materials (to increase recycled content) or to create new (sometimes lower grade) entirely recycled materials. In general, recycled materials can be used in construction provided that they meet relevant technical standards and, if not specified at the outset, are approved by the developer as a material change in the construction.

Initiatives and schemes that are leading the way in finding new and innovative ways of re-using and recycling construction waste include:

- The WBCSD Cement Sustainability Initiative issued a study that shows that concrete is recyclable and is being recycled. Its “Recycling Concrete” report (WBCSD, 2009b) – based on the knowledge and experience of CSI members and a stakeholder consultation process – argues that the recycling of concrete can reduce natural resource exploitation and waste going to landfill, and asks for an ultimate goal of “zero landfill” of concrete. It recommends that governments and key stakeholders publicize data on construction and demolition waste and develop reliable and consistent statistics;

that they develop economic incentives and legislation to allow infrastructure that promotes concrete recycling (particularly green building schemes); and that they set targets for the use of recycled concrete in both road construction and building industries. The CSI hopes that raising awareness of concrete recycling will promote discussion among all relevant stakeholders and lead to an increase in recycling of concrete. Cement producers can indirectly support this through the work of subsidiaries in the concrete, aggregates and construction industry.

- The Building and Construction Authority of Singapore (BCA) has developed a strategy on recycling and reuse of concrete aggregates based on improved integration among key stakeholders in the construction supply chain. With BCA's coordination, demolition contractors, construction and demolition (C&D) waste recyclers, ready mixed concrete (RMC) suppliers, building contractors and developers worked together to increase the supply of building materials by maximising resource recovery of concrete waste and to drive demand by increasing the usage of recycled concrete aggregates (RCA). To increase the supply and ensure quality of RCA, BCA partnered with key stakeholders to develop the demolition protocol and quality protocol. To drive the adoption and increase the demand for RCA, BCA targeted contractors, designers, engineers and developers with a reward scheme to recognise the use of these materials in their building projects and a capability development fund to increase capacity through, for example, supporting technology and plant upgrades and building competencies through education and training.
- In the UK, WRAP (Waste & Resources Action Programme) started a programme in 2005 to address the issue of plasterboard waste, working closely with the related industry sectors to identify and develop solutions. In 2006, the GPDA (Gypsum Products Development Association) proposed that their members enter into a binding voluntary agreement which would provide measurable contribution to the setting of targets to drive specific changes in working practices which would lead to increased diversion of plasterboard waste from landfill. The resulting Ashdown Agreement on Plasterboard Recycling, in 2007, set out shared objectives for the diversion of waste plasterboard from landfill. Subsequently, as an output of a UK government programme to develop a Plasterboard Roadmap identifying the environmental impacts of plasterboard throughout its lifecycle, the Plasterboard Sustainability Partnership (PSP) came into existence in 2009. The PSP is a non-profit making, voluntary initiative by stakeholders across plasterboard manufacturing, distribution, installation, regulation and end of life to work towards improvement in every aspect of plasterboard sustainability. A key output is the development of the Plasterboard Sustainability Action Plan, which includes actions on designing out waste where the greatest opportunity can be realised for waste reduction, and for which an online training module has been developed. The existence of concerted and cross-sector action has provided the basis for the development of new practical solutions to eliminate waste, such as the growing trend for plasterboard recycling services, which sees manufacturers take back and recycle unused or surplus plasterboard from construction sites.

Alternative bids

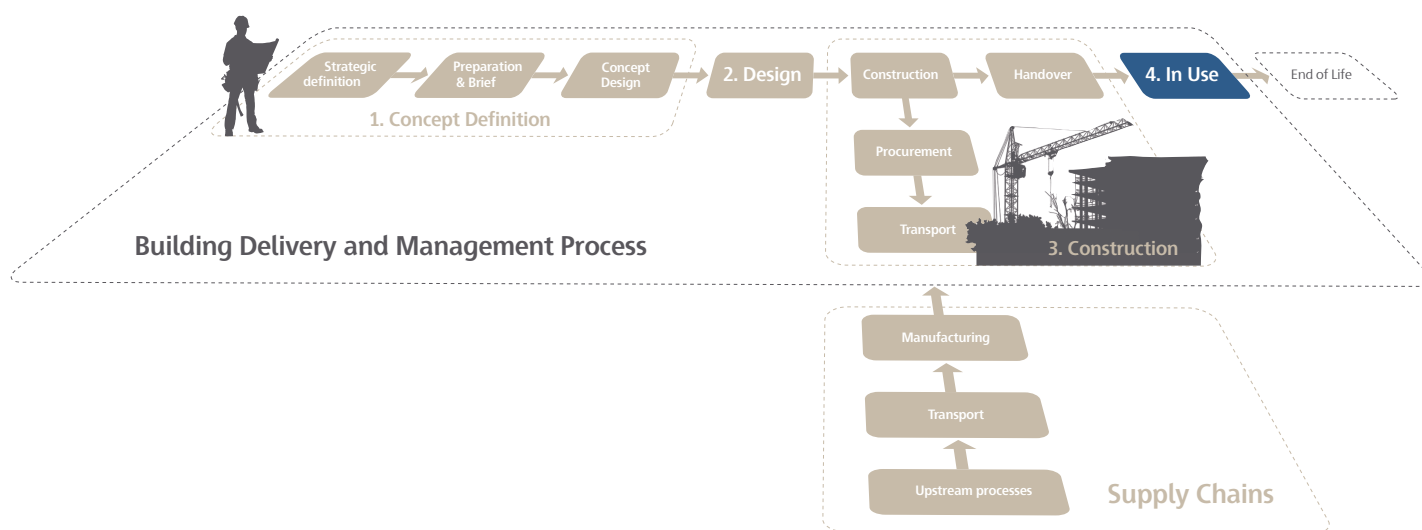
An alternative bid is a voluntary or unsolicited response to an Invitation to Tender, offering the owner, developer or contractor a different or modified product or service than specified. An alternative bid may be developed to address a number of issues related to construction and building delivery, including voluntary green interventions through the conventional procurement process, however one that is not without risks. In both public and private procurement, the alternative bid is submitted in addition to a fully compliant bid to ensure the bidding contractor or supplier is not disqualified. In addition, the owner, developer, contractor or the representing agent may not have the resources or the incentive to review the alternative bid.

Some procurement policies – mostly notably public procurement policies – may prevent or limit bidders submitting, or owners, developers or contractors being able to consider, and an alternative bid. For example, most public policies only allow consideration of alternative bids by sharing key aspects of the alternative bid with other bidders. This puts competitive or commercial information at risk, and may prevent bidders from pursuing alternative bids. In addition, submission of an alternative bid may result in delays in the tendering process due to added response and review time and/or increase the risk of disputes after award.

However, under facilitating procurement policies, with the right resources, and where trust is gained, alternative bids can lead to significantly increased resource efficiency of projects and improved tender specification going forward.

3.5 Stage 4 – In use

Figure 10. The in use stage



3.5.1 SCOPE

The in use stage describes the period during which a building is occupied by a user, typically either an owner-occupier or tenants through a lease agreement. Responsibility for the ongoing management of a building (e.g. operations, maintenance and repairs) is often contracted to a facilities manager; a procurement process that is often carried out by a property manager acting on their behalf of the developer or owner (investor).

During the in use stage, resource efficiency is largely governed by the operations & maintenance of the building, as specified in the building or O&M manual. This includes the use of equipment and appliances by the tenant and the maintenance and repairs schedule as followed by the facilities manager. Between them, operations and maintenance typically account for the majority of life-cycle use for several green aspects of buildings, such as energy, carbon and water.

This means facilities managers play a critical role in the operation and maintenance of a building, and achieving or improving on defined resource efficiency specifications.

Decisions about renovation or demolition are also of key importance to the overall resource efficiency of a building. Once deemed not be able to perform the functions for which it was designed and constructed, a decision must be made about the future of a building by the owner, often informed by the tenant. This might entail a programme of renovation and refurbishment, representing a return to the concept definition stage and in effect restarting the building life-cycle, or could result in demolition.

When sufficient lease commitments have been secured to provide a stable cash flow for new owners (investors), and market conditions are favourable,

the developer will seek to divest. While divestment is described during in use, this may already happen earlier but typically not before planning and other statutory approvals have been obtained.

Some owners (investors) pursue short term gains, while others buy to lease or occupy banking on long term value increase. The last group is most likely to consider investments addressing emerging trends/risks around resource efficiency. An important investor category are real estate funds, whose motivation differ and are largely affected by the debt/equity ratio, the holding period and the risk profile set forth in the fund strategy. The green knowledge of fund managers and (real estate) agents largely determines whether resource efficiency is considered.

The role of agents (including valuation professionals) is also important, though their financial interests are usually short-term and transaction driven (WBCSD, 2007).

3.5.2 KEY STAKEHOLDERS

Figure 11. In use stage stakeholders



3.5.3 RELATIONSHIPS

Owner/developer ⇄ Facilities manager

The owner and/or developer procures hard (e.g. façade, landscape, plant and equipment, HVAC, lighting, lifts) and soft (e.g. security, reception, catering, waste) management services from a facilities manager. Often a lead facilities manager (or managing agent) is sought who will then procure the hard and soft services required, leading to a chain of sub-contractors.

Owner/developer ⇄ Tenants

Owner/developer seeks tenants for the office development. This typically includes the involvement of representing real estate agents and the terms are agreed and formalized through a lease agreement. Tenants most often prioritize location, lease price, functionality, and terms such as the length of the lease and termination when selecting office space.

Developer ⇄ Owner

Divestment of property by developer to owner (investor), through agents. This is typically as a result of negotiations between the developer, owner (investor) and/or representing agents based on the valuation of the market value as assessed by both parties.

3.5.4 BARRIERS

LACK OF INCENTIVES Facilities management (FM) is not ordinarily seen as a core business to owners (investors) for reasons including the limited holding time of the investor, an insufficient understanding of the benefits for the owner and agents and, in many cases, a lease structure that creates no incentive for the owner (investor) to prioritize FM.

TENDER PROCESS FM services are procured based on a number of core and general criteria – which typically do not consider the local context or specific building - and which do not include incentives to improve resource efficiency.

LACK OF KNOWLEDGE AND TRUST There is a broad consensus that (green) buildings in operation do not perform as well as they could. This ‘performance gap’ between predicted and achieved performance is exacerbated by the often complete separation of, and hence poor communication between, the designer/contractor and owner/tenant/facilities manager. Tenants and/or FM services companies often do not have sufficient information on the building from the design and construction stage, or knowledge and experience how to operate and maintain the building to optimise resource

efficiency. Awareness and understanding amongst agents (including valuation professionals) of their role with regard to considering resource efficiency in valuations also remains low. Consequently, advice is based on analysis of recent past transactions and a notion of the future continuing to be ‘business as usual’ - mitigating speculative interpretation of new and emerging trends [WGBC 2013a].

LEASE STRUCTURE Barriers introduced by the lease structure are often referred to as split incentives, where the benefits of investments made by the owner (investor) (e.g. renovation) are realised by the tenant, or where a fixed lease does not provide the tenant with incentives to improve on resource efficiency. Similar barriers exist when the developer still owns the building. The developer is in a pivotal position to drive change, however, there is a lack of knowledge or trust to engage FM earlier, and change contractual terms of FM and tenants.

3.5.5 GREEN INTERVENTIONS

3.5.5.1 GREEN FACILITIES MANAGEMENT

TYPE OF GREEN INTERVENTION:



Economic or market-based instruments



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of incentives
- Tender process
- Lack of knowledge and trust

A closer involvement in, and recognition of, the opportunities that exist in engaging the facilities management (FM) profession for delivering improved resource efficiency during the design, construction and in use stages was defined as a priority green intervention. However, few examples of early involvement of FM, tendering of green FM, and/or green contractual terms and incentives were found to illustrate the effectiveness of such green interventions.

RECOMMENDATIONS

- Develop a UNEP-SBCI watching brief and document best practices in green facility management and work with industry associations and relevant organizations (such as national Green Building Councils) to develop guidance and training to support green operations.
- Highlight and promote through UNEP-SBCI and partners the importance of best practice commissioning and encourage the adoption of standards for commissioning.
- Work with and through UNEP-SBCI partners to promote and demonstrate more sustainable facilities management policies and practices.
- Identify collaboration with UNEP-SBCI partners to update the “Energy Efficiency in Buildings – Guidance for Facilities Managers” to include resource optimization and wider efficiency gains.

3.5.5.2 BENCHMARKING AND FOLLOW-UP**TYPE OF GREEN INTERVENTION:**

Regulatory and control mechanisms



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of knowledge and trust

Although green buildings are becoming more widespread, there remains little in the way of available baseline or reference information to objectively benchmark the extent to which a new green building meets or exceeds expectations. Comparison with benchmark data provides owners, developers and tenants of green buildings with information on relative building performance.

Benchmarking has two main dimensions. First, benchmarking of buildings to address the lack of knowledge about existing green buildings in a given location in order to help guide and inform the delivery and management of new green buildings (“what can be achieved”). Second, benchmarking of performance, coupled with appropriate follow-up, to ensure that the actual performance of green buildings in use matches or exceeds what would be expected (“what has been achieved”). Performance benchmarking can assume

many forms, including comparison with the expected or designed performance of a building, comparison before and after renovation or comparison with a reference building.

To fully understand the benefits and performance of green buildings, data and information is needed on building specifications and performance. This should include qualitative information (such as what buildings have attained, which green certification scores, and the green solutions adopted) as well as quantitative measures of environmental impacts and resource use, such as energy use, water consumption and waste generation. Measures might also include less tangible aspects of building performance such as tenant well-being and productivity, and other co-benefits of green buildings.

Used in this way, benchmarks (and the wider dissemination and sharing of building information) can promote green buildings and help accelerate market transformation. Consistent and systematic evaluation of building performance, so as to inform future building design, can also help ‘close the loop’ in the building delivery and management process.

Case study: The Green Building Information Gateway (GBIG)**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

GBIG (<http://www.gbig.org>) is a global platform, developed by the USGBC, for exploring and comparing the green dimensions of the built environment. Acting as a search engine for green building data, GBIG provides insights that enable better buildings and communities. It is designed to provide asset-level transparency, market context, and a platform for analytical insights for a wide variety of stakeholders in the building delivery and management process. Information in GBIG is aggregated from many sources to provide multiple lines of information, including activities (projects at or within a building), buildings, places, and strategies (e.g., projects that earned specific LEED credits). Projects and buildings can be assembled into customized collections (portfolios of green buildings that share a common theme) which can be used for reporting or connections to other databases via Application Programming Interfaces and other mechanisms.

GBIG is based on the premise that the lack of actionable information about building attributes and performance contributes to pervasive market failures. Consequently, the provision of timely, relevant but historically “invisible” dimensions of building information can help stakeholders value green performance, more rationally allocate limited resources, and, ultimately, increase the supply of high performing green buildings.

GBIG helps users answer a range of questions about green buildings:

- Why it's green? GBIG allows users to “unpack” green building labels to understand the basis for certification and examine individual dimensions of energy efficiency, transportation, water efficiency or indoor environmental quality
- How does a project or building compare to others? GBIG puts projects and buildings into context with respect to local, regional, and global market activity.
- How has a building performed over time? GBIG provides rich, multi-source aggregations of information about building attributes and outcomes. This includes tools to help users understand how an asset performed before or after an intervention, such as certifications, management strategies, or applications of specific technologies.
- How do professionals interpret data about projects and markets? GBIG recognizing that the data provide the foundation for decision-making, but require skilled interpretation is always required to create knowledge from information. GBIG includes the Insight technical forum to help communicate technical findings linked to specific projects, buildings, or places.

GBIG currently includes information on over 300 different types of green building interventions, including rating systems, disclosures, and instance of products and services from around the world. As more data is incorporated globally into GBIG from the various rating systems, users will have access to more benchmark information specific to local and regional markets.

Case study: Soft Landings Framework**Type of green intervention:**

Regulatory and control mechanisms



Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

The Soft Landings Framework is a joint initiative in the UK between BSRIA (Building Services Research and Information Association) and UBT (Usable Buildings Trust). It is an open-source framework available from BSRIA that is intended to “...smooth the transition into use and to address problems that post-occupancy evaluations (POEs) show to be widespread”.

The Soft Landings Framework enables designers and contractors to improve the performance of buildings and generate feedback for project teams. This requires involvement in the project for the first three years of occupation and so will have budgetary implications and may affect appointments.

The framework includes 5 key stages:

1. Ensuring that the client's needs and required outcomes are clearly defined in the strategic brief.
2. Reviewing comparable projects and assessing proposals in relation to facilities management and building users during the design development and review.
3. Ensuring operators (owners/tenants/facilities managers) properly understand systems before the construction phase is completed and the building occupied.
4. Stationing a soft landings team on site to receive feedback, fine tune systems and ensure proper operation during initial building use.
5. Resolving outstanding issues and undertaking post occupancy evaluations once the building is in use, and making sure outcomes are fed-back for future projects.

The UK Government Soft Landings (GSL) policy, published in 2011 and aligned to the Soft Landings Framework, is used in public construction projects to ensure the “golden thread” that exists between the reason for the creation of an asset and its intended business purpose is not lost during construction, and to safeguard its continuation into the building's operative stage.

Understanding how a building is performing allows an organisation to identify where savings (resource and financial) can be made most effectively. Significant savings can be made in the running costs of many buildings simply by understanding when plant and equipment is (and is needed to be) operational and adjusting timing settings accordingly. The outcomes of performance follow-up can provide essential feedback for future projects, potentially providing opportunities for competitive differentiation. Meanwhile, performance data can be used to set and report against targets as well as benchmark performance, over time, against industry benchmarks or comparable buildings.

There are emerging legislative trends on performance assessment and labelling of buildings. Rating systems (tools) are increasingly being extended to include in use performance (e.g. LEED EBOM, BREEAM IN-USE, Green Star Performance). In the EU, Display Energy Certificates (DECs) focus on operational energy use and are designed for prominent display in buildings. Widely seen as a vital tool in driving energy efficiency in buildings, DECs have, to date, only been required in buildings over 500m² and occupied by the public sector. Yet evidence is already emerging of the value of DECs in those buildings, with many achieving substantial year-on-year reductions in energy costs and improvements to their ratings. There is an opportunity for actual performance to be included in a greater number of (private) property transactions, rather than designed performance.

Increased availability of data and data transparency can help build knowledge and demand for green buildings, not least if data is combined with details on consumption costs and payback periods. However, there is currently a lack of common languages and modes of communication, meaning that consistent data specification, interoperability, and quality are essential going forward.

RECOMMENDATIONS

- Support UNEP-SBCI partners and related networks in efforts to benchmark performance and conduct additional research and continuous data-gathering. UNEP-SBCI can play a significant role in the synthesis and dissemination of information, especially through the 10YFP programme, to promote adoption of performance standards.
- Engage with other non-governmental and multi-lateral organizations to accelerate the adoption of enabling protocols, conventions, and tools required to improve interoperability, thus supporting when needed national-scale market participants (e.g., national green building councils) and promote

through UNEP-SBCI. Important issues include data specification (e.g., metrics), metadata, space and building identification, and harmonization of reporting protocols. These are pre-competitive issues that ultimately enable diverse, efficient markets by making it easier to identify and communicate about the performance of buildings and portfolios.

3.5.5.3 GREEN LEASES

TYPE OF GREEN INTERVENTION:



Regulatory and control mechanisms



Economic or market-based instruments

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of incentives
- Lack of knowledge and trust
- Lease structure

Given that a significant proportion of the commercial building stock that will exist in 2050 has already been built (ICCA, 2012), reduction targets cannot be met by simply improving the efficiency of new buildings. Substantial carbon reductions are required from the whole sector – meaning the owners and tenants of all buildings have a part to play. Green leases and MoUs are useful tools to support both owners and tenants by setting out provisions for the efficient environmental management and improvement of their buildings.

A green lease is a standard form lease with additional clauses included to provide for the management and improvement of the environmental performance of a building by both owner and tenant(s). Such a document is legally binding and its provisions remain in place for the duration of the term. Green leases tend to be relevant only in the context of leases of commercial buildings. A Memorandum of Understanding (MoU) can be used to provide owners and tenants with a non-legally binding written agreement setting out how a building's environmental performance will be managed and improved by both parties.

Green leases and MoUs help to overcome split responsibilities/incentives by providing a framework for engagement on environmental issues. They enable the parties to better understand each other's environmental aspirations, identify where opportunities for collaboration exist and develop an understanding of how improvements can best be undertaken.

Case study: Better Buildings Partnership Green Lease Toolkit**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

The Better Buildings Partnership (BBP; <http://www.betterbuildingspartnership.co.uk>) has produced a comprehensive toolkit for green leases to enable owners and occupiers of commercial buildings to work together to reduce the environmental impact of their buildings.

The guidance is non-prescriptive, helping owners and occupiers to agree carbon, energy, waste and water reduction strategies which best fit with the circumstances of individual properties. The Toolkit helps owners and tenants to positively engage in developing practical ways to effect significant positive change, ultimately accelerating the process of making commercial properties more sustainable.

The Toolkit includes the following:

- Non-prescriptive best practice recommendations by which, through a partnership approach, owners and tenants can agree appropriate arrangements to best fit with the circumstances of individual properties.
- A model MoU, which can be used in full or in part and which parties can enter into at any stage of a lease.
- Model Form Green Lease Clauses which the BBP believes should be included in new and renewal leases as a minimum as best practice. The extent to which these clauses are used will depend on the parties' ambitions and what is appropriate for individual circumstances.
- Case studies to illustrate how green leases and MoUs can be used to establish environmental aspirations for the management and operation of a building.

The main opportunities associated with green leases are that they help align building management objectives and financial incentives so that both owners and tenants benefit from adopting green measures. They also typically require (improved) collection of environmental data, improving transparency about building performance and enabling stakeholders (owners and tenants) to measure success against agreed goals.

The fact that green leases are legally binding can, itself, be a barrier to adoption with some organisations reluctant to take on additional legal burdens or raise green leases with potential tenants for fear of driving them away. Consequently, non-legally binding MoUs might provide greater opportunity for widespread adoption. They generally provide a faster route to agreement than is possible with a green lease, can be updated without amending the lease and can remain in place for any chosen length of time.

RECOMMENDATIONS

- Identify and promote through UNEP-SBCI and partner networks best practices in facility management, including green leases, and develop comprehensive policy toolkits for industry uptake.
- Demonstrate leadership through UNEP-SBCI partner promotion and utilization of green leases, and share lessons and results through the initiative's network.

3.5.5.4 GREEN CRITERIA IN ASSET VALUATION**TYPE OF GREEN INTERVENTION:**

Economic or market-based instruments



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Disregard for whole life costs
- Lack of knowledge and trust
- Financial risk

The use of property valuation is an essential aspect of the property life cycle, particularly at the point of transaction when buildings are being sold (divested) or rented. Incorporating green aspects such as energy efficiency into valuation practices is essential to raise awareness on the value of investing in green buildings amongst prospective capital providers, developers and owners. Being able to demonstrate the business case to stakeholders is a necessary prerequisite to accelerating the market transition towards a green and resource efficient building stock and building construction sector.

There is an emerging body of evidence that high performing green buildings do not only perform better in terms of energy efficiency but also in terms of commanding higher rents or resale prices (WGBC, 2013a).

Therefore, harnessing the expertise of agents – or valuation professionals – to advise developers/owners in the drive towards a greener building stock and building construction sector is pivotal as valuation professionals are well placed to comment on financial impacts of asset specific and wider market factors.

Wider use of green criteria in asset valuation would help demonstrate to developers and owners (investors) the real market value of green buildings by introducing extra – green – dimensions in discussions about cash flow, construction cost and market value (yield and development profit). It would also help address limitations on knowledge about the benefits of resource efficiency and help reduce the (perceived) risk associated with green buildings. Valuation professionals typically base their advice on analysis of recent past transactions, so having more valuation professionals who are aware of and can include green aspects in valuations – leading to a larger evidence base – should help create and reinforce a positive feedback whereby green criteria are considered as part of a ‘business as usual’ approach.

Case study: RenoValue**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy

There are more than 70,000 valuation professionals in Europe (TEGoVA, 2014). While they have a duty to reflect the market (rather than ‘make’ a market for green buildings), they can offer their clients (developers and owners) evidence-based advice about the value of green buildings. If this practice became more widespread, in addition to their customary reporting services during the transaction of buildings, it could have a significant market impact. Therefore, harnessing the expertise of valuation professionals is thought to be essential in achieving market transformation.

To this end, RenoValue is a new European Commission project (funded by Intelligent Energy Europe (IEE)) that aims to develop tailored training material for valuation professionals from across the EU. The training material will increase expertise and develop a knowledge-base regarding the latest energy efficiency and renewable energy technologies, their impact on building performance and methodological and theoretical guidance. This will mean valuation professionals are better able to factor green criteria into the valuation process and advise their clients accordingly. It is intended that this will ultimately lead to increased levels of investment in green buildings, contributing to achieve the EU’s Nearly Zero Energy Building and 2020 strategic climate and energy targets.

The project will commence by assessing the needs of valuation professionals (and other stakeholders) with respect to including green criteria in asset valuation, followed by the delivery of bespoke training material to 350 valuation professionals in 7 target countries.

Consideration of green issues should play a role in any valuation assignment, including the valuation of conventional buildings, because such buildings are already associated with higher risks (e.g. faster obsolescence and shorter remaining economic lifespan) which must be considered and priced today.

Crucially, the use of green criteria in asset valuation has the potential to break the “viscous circle of blame” (Cadman, 2000; Keeping, 2000), where different stakeholders in the commercial property market are ready to take action but depend on, or say they depend on, other stakeholders to take action before they can respectively demand, build, commission or fund sustainable buildings. Valuation professionals – by recognising green and sustainability-related benefits and risks, and reflecting this in their estimates of market and value and worth provided to other stakeholders – are able to facilitate the breaking of the viscous circle of blame, instead creating “virtuous loops of feedback and adaptation” (Lorenz, 2008).

However, there are at least three major issues to overcome when addressing the key market barrier of professional knowledge and skill gaps amongst valuation professionals. First, awareness and understanding amongst professionals about their own roles with respect to consideration of green criteria in valuation remains low. Second, a key challenge for valuation professionals is access to good quality data on both true cost and savings of green buildings and on potential future differential. They face a difficult situation when assessing ‘market value’ as they must reflect current market demand, but without existing market evidence they are not in a position to consider green building features in their standard valuation practice.

Third, there is a lack of dedicated direction and guidance for valuation professionals. Whilst current valuation techniques have the capacity to reflect green features, such as energy efficiency, there is a lack of understanding with valuation professionals about user needs and the possible value impact of existing and emerging green technologies. Many valuation professionals may not be able to assess them objectively, as this type of expertise usually falls in the domain of building designers and engineers.

RECOMMENDATIONS

- Strengthen partnership between UNEP-SBCI and UNEP Finance Initiative (UNEP-FI) to develop financial tools and case studies evidencing the market value of high performing green buildings.

- UNEP-SBCI, UNEP-FI and respective partners, including RICS, to collectively promote the development of training materials aimed at valuation professionals that encourage the factoring of green criteria into valuation processes, through initiatives such as RenoValue. Collaboration should promote the development and update of standards to include green criteria and LCC approaches in asset valuation.

3.6 Tools for Green Interventions

3.6.1 BUILDING LEVEL

3.6.1.1 GREEN BUILDING RATING TOOLS

TYPE OF GREEN INTERVENTION:



Economic or market-based instruments



Regulatory and control mechanisms



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of communication and leadership
- Lack of knowledge and trust

Green building rating tools provide third-party validation of the design and/or performance of a building. Certification systems are vital as they provide an independent assessment of the green performance of projects; increasingly a key consideration for owners, tenants, agents and capital providers. Certification systems have been particularly successful in raising awareness of green buildings, resulting in greater market demand and industry response.

By defining what is considered ‘green’ in a particular market, rating tools are able to recognize and reward best practice and thereby help move the entire market beyond simple code compliance. In more mature green building markets, building codes often become more stringent as the baseline for what is considered standard performance – at least as defined by ratings tools – increases.

Green building rating tools also help create demand for green buildings. There are currently 31 different certi-

fication systems currently supported by Green Building Councils; the most widely used examples include LEED, GreenStar and BREEAM. The systems often serve as a guideline from the first day of planning and throughout the construction phase, and increasingly focus on life cycle analysis and the in use phase of the building life-cycle.

Ratings tools create a common language around green building by providing definitions and performance benchmarks, which can provide verification for capital providers and developers. They have expanded the understanding of green building beyond simply energy or water efficiency in operations. Areas of building design and operation that were previously overlooked, such as indoor environment quality and the life-cycle of buildings materials, have gained attention in the market and in policy.

Meeting a certification standard can be a means for contractual agreement between all players in the design and construction process, as well as potential policy targets for the public and private sectors. For example, many public authorities are adopting certification as a requirement, primarily in public buildings.

Case study: The wider impact of green building certification in South Africa and Australia

Type of green intervention:



Support, information and voluntary action

Aspects of green directly addressed:



Materials

The introduction and use of the Green Star certification scheme in South Africa and Australia has had an impact much wider than the individual buildings assessed, by helping bring about industry change.

In South Africa in 2008, the Nedbank Phase II project chose to target the Green Star low VOC (Volatile Organic Compound) credit, but up to that date such paints were not manufactured within the country. Dulux decided to change their manufacturing process on a few products so that they could produce a selection of their paints to meet the low VOC (Volatile Organic Compound) standard at only a small financial premium. Following this, other South African companies are now manufacturing low VOC paints, and they can be bought at the same price as standard paint products.

In both South Africa and Australia, the Green Star requirement for FSC chain of custody certified timber is helping transform the timber supply chain. Chain of custody is essential in a supply chain to understand where a product comes from. This is critically important for timber, where responsible stewardship of forest plantations is vital. In South Africa, FSC certificates have previously typically been only available for pine, but slowly awareness is growing in the industry. In Australia, the desire to achieve the first 6 Star Green Star rating for the Melbourne Convention Centre led to FSC Timber Veneer Panels being specifically developed by Laminex Group for the project. The resulting panels are Australia's first FSC Chain of Custody certified timber veneer decorated panels in the commercial building industry, and have been produced to be suitable for a range of other interior joinery applications.

Worldwide, green building certification is increasingly understood as a tool to prove environmental performance and associated benefits. Many international and national systems exist, with widespread and increasing uptake demonstrating their potential. Certified buildings typically cost less to operate and maintain, are more energy and water efficient, have higher occupancy rates than conventional buildings in the same market, are healthier and safer for occupants and are a physical demonstration of the values of the organizations that own and occupy them.

The area of certified green buildings recorded by the World Green Building Council's annual survey almost doubled between 2012 and 2013, and numbers of certified buildings rose by 50% in the same time. Whilst these figures do not include every country, and some of the increase may be due to more countries responding to the second survey or reporting their buildings more accurately, it is clear that the quantity of certified buildings globally is growing rapidly.

In more mature green building markets (particularly some urban areas), new commercial office buildings that are not certified are now not considered Class A space. From an investor's perspective, green building certification is increasingly seen as a factor in competitive positioning and in risk mitigation.

While ratings tools have great value, they also attract some criticism. They do not always drive a truly holistic design that takes the local context into consideration, particularly where the rating tool used is not customized to the local market. Some rating tools assess buildings only at the design stage or at construction completion and do not ensure ongoing green performance (though this has, in turn, driven the rise of ratings tools that include building operations). Finally, they create additional expense for projects, particularly where the markets are new to green buildings and do not have experience and capacity within the industry in delivering a new model of design and construction. Furthermore, the adoption of certification as a requirement by public authorities can sometimes be seen as a shortcut to achieving green building; it means they are effectively relying on an external body using evolving national or international standards rather than embedding local and context-specific standards into their own policy.

So, despite their maturity, some barriers preventing mass adoption remain. These include: a lack of har-

monization among different ratings tools, perceptions of the cost of certification (which are shown to be much higher than actual costs); a lack of understanding around the benefits of green building and how they are applicable to owners, tenants and the wider community; and perceptions that supply chain barriers make delivery of green buildings too difficult, time-consuming or expensive.

Whilst green building rating tools cannot be fully consistent, reference to recognised environmental assessment frameworks (e.g. life cycle analysis) would allow them to complement a standard methodology with national and regional context; increasing impact and allowing supply chains to develop independently of the individual systems. Incorporation of the necessary material and product transparency should consider international standards for life cycle analysis such as LCC and LCA, where applicable.

RECOMMENDATIONS

- Support continued UNEP-SBCI partner development and implementation of certification systems as one of various policy tools to guide delivery of green buildings, and work with GBC networks to identify measures that address resource efficiency in supply chain.
- Support efforts of the WGBC to harmonize rating tools and provide international consensus, while considering local context, and encourage UNEP-SBCI partners to support such efforts.
- Further study the penetration of certification systems in value chain, and document successes and examples where pursuit of certification has had market impact and/or created transformation.

3.6.1.2 LIFE CYCLE ASSESSMENT AND COSTING

TYPE OF GREEN INTERVENTION:



Support, information and voluntary action



Regulatory and control mechanisms

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Disregard for whole life costs
- Lack of knowledge and trust

Life cycle assessment (LCA) is a tool for the systematic evaluation of the environmental aspects of a product (e.g. building) or service through all stages of its life

cycle (which in the context of this report represents concept definition, design, construction, in use and end of life). LCAs allow businesses in the building and construction sector to understand and assess how they can improve product or building performance by adopting a cradle-to-grave approach. For special purposes more restricted scopes are possible, such as cradle-to-gate (if extraction and product manufacturing processes are of interest) or gate-to-gate (if the focus is on the production process within company or production site boundaries).

The International Organisation for Standardisation (ISO) has standardised the framework for undertaking an LCA in ISO 14040 and 14044, developed at the request of industry which wanted to ensure consistency when different products are compared. These two ISO standards provide general advice for the steps and structure of an LCA, comprising of four phases (i) goal and scope definition, (ii) life cycle inventory, (iii) life cycle impact assessment and (iv) interpretation and communication.

Life cycle costing (LCC) is an economic evaluation of the total cost of a product, asset (e.g. building) or process throughout its life cycle. Whole life cost (WLC) is often used interchangeably with LCC but specifically includes wider costs which in the content of buildings might include land acquisition costs and income generated from leases.

LCA and LCC provide the fundamental building blocks of a framework to support whole life thinking, which takes into consideration environmental, economic and social aspects and impacts. A life-cycle framework provides a simple, modular and standardized concept that can support the self-assessment or provide the basis for a third-party assessment of every kind of building and construction unit, giving stakeholders a clear perception of costs, benefits, impacts, challenges and successes implied in the process.

Adopting a life cycle approach helps provide one consistent green language for all stakeholders, and may lead to more holistic decision making to achieve lower life cycle impacts. The use of LCC means that cost-optimal solutions can be pursued both for individual buildings and for the construction and building sector as a whole. Life cycle thinking and calculations are also derived from objective (scientific) principles with limited scope for interpretation or industrial and/or political lobbying. They can provide a consistent definition of green and resource efficiency, potentially reducing the burden for suppliers and providing a basis for industry transparency and trust.

Case study: CEN/TC 350**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

The CEN/TC 350 technical committee is an initiative of the European Committee for Standardization. It aims to develop standardized methods for the assessment of the sustainability aspects of new and existing construction works, and has developed several standards providing frameworks for the assessment of environmental, social and economic performance of buildings. Four, in particular, are relevant to green buildings, and all are based on a life cycle approach.

The EN 15643-1 standard establishes very general principles and requirements for the development of the following standards. The methodological framework defined is applicable for all kinds of buildings and is based on a life cycle approach. The EN 15643-2 standard establishes specific guidelines for the assessment of the environmental performance of buildings. The EN 15804 standard provides a structure for the development of product category rules (PCR) for construction products so that environmental product declarations (EPD) produced using these PCRs are harmonized. PCRs for different construction products in compliance with the EN 15804 standard are currently in development. Finally, the EN 15978 standard provides calculation rules for the assessment of the environmental performance of buildings based on EN 15643-1 and EN 15643-2 guidelines, and using data for construction products coming from EN 15804 compliant EPDs when available.

Similar activity is underway by the ISO/TC 59/SC 17 technical committee, an initiative from the International Organization for Standardization. This technical committee aims at developing international standards for sustainability in buildings and civil engineering works. Like for the European standards, the ISO standards are based on a life cycle approach, however, they are less prescriptive in terms of modelling rules such as system boundaries or end of life scenarios.

Green building certification system and green public procurement initiatives refer to and benefit from a life cycle approach (LCC and LCA). For example, the European Commission GPP product sheet states that “more action should be undertaken to make life cycle costing a standard procedure on which decisions relating to construction work are based”.

Open House and SuPerBuildings

Open House The OpenHouse project is a European research project under the FP7 framework of the European Commission. The objective of the OpenHouse project is to develop and implement a common European transparent assessment methodology for sustainable buildings, with the CEN/TC 350 and ISO/TC 59/SC 17 initiatives as well as other sustainable buildings assessment methodologies as a baseline.

SuPerBuildings The Sustainability and Performance Assessment and Benchmarking of Buildings (SuPerBuildings) project is another European research project under the FP7 framework of the European Commission. The goals of the project were to develop and select sustainability indicators for buildings, to study performance levels of new and existing buildings of different types, to develop methods for the assessment of sustainable buildings, and to make recommendations for the effective use of benchmarking systems. The outputs of the CEN/TC 350 and ISO/TC 59/SC 17 standardization processes were considered. The SuPerBuildings initiative worked in collaboration with the OpenHouse project to avoid duplication.

Many LCI (Life Cycle Inventory) databases are already available to help practitioners perform LCAs without collecting data for every involved process, especially for upstream processes for which specific data would not be accessible. Furthermore, various software packages exist to support LCA and LCC analyses. However, there remains confusion on how to use LCA and what information is needed, and the availability, relevancy and transparency of data can still be an issue. Its (perceived) complexity, cost and time required are also barriers to adoption, and the most effective way of communicating results to facilitate and demonstrate industry improvement has largely yet to be established.

While some leading building designers and contractors do aim to include LCA and/or LCC, their experience shows that few developers or owners are willing to pay for the extra work involved for little or no perceived (additional) financial return. LCA also introduces additional time pressures in the design stage. Consideration of all the different M&E (Mechanical and Electrical)

systems, facades and constructional materials, and ensuring completeness of all elements, can be time-consuming, yet no extra time is typically allocated.

RECOMMENDATIONS

- Support the development of life-cycle based indicators that may be needed to facilitate measuring resource efficiency and performance in the building and construction sector. These indicators are also required to identify points of leverage and the areas of highest energy efficiency/energy/carbon mitigation potential in the supply chain, including how building developers and owners can influence the performance of construction materials producers and manufacturers. Attention should be given to indicators, which have reached already international consensus, for example those based on the Environmental Product Declarations (EPDs, CEN TC 350).
- Strengthen collaboration between UNEP-SBCI, its partners and the UNEP Life-Cycle Initiative and the International Resource Panel to adapt life-cycle design and de-materialisation models for implementation in building sector. There is a significant opportunity to assist countries to establish baseline data and support inter-operability of national life-cycle inventories of their building materials, as well as to adapt life-cycle modelling and design tools for use by designers and regulators. UNEP-SBCI to collaborate with Life Cycle Initiative on a sector-specific programme on LCA in building sector, with specific focus on access to data and interoperability of databases. The programme should develop policy toolkits that will provide enabling frameworks, metrics and reporting protocols that can be delivered through the 10YFP programme.
- Conduct mapping of life-cycle tools in combination with impact assessments and case studies, in order to improve the tools' application and help stakeholders more strategically implement them throughout the building sector supply chain.
- Facilitate the international up-scaling and implementation of life-cycle tools and initiatives to allow for use by SMEs and in developing countries.
- Determine the impact of life-cycle initiatives/tools, assess the real costs and benefits and how those could potentially be improved through standardisation and green interventions.

3.6.1.3 (GREEN) BIM

TYPE OF GREEN INTERVENTION:



Support, information and voluntary action



Regulatory and control mechanisms

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Disregard for whole life costs
- Lack of knowledge and trust
- Technological risk
- Lack of communication and leadership
- Supply-chain relationships

Building Information Modeling (BIM) is a process for developing and using a computer generated three-dimensional (3D) parametric model to facilitate the planning, design, construction and use of a facility (Azhar et al., 2008). It allows the physical and functional characteristics of a facility to be maintained as a digital portrayal of a building that can be shared by the various stakeholders involved throughout the whole lifecycle of buildings. It can be continuously updated to ensure that owners, designers, engineers, surveyors, contractors and facilities managers can work with the same information. Visualization of the model means that stakeholders can better understand solutions and alternatives available for the project.

Building information models characterize building component properties and quantities, define the geometric, spatial and geographic attributes of the project, and support cost estimations, project scheduling, monitoring of material utilization and in use applications (Bazjanac, 2006). This provides a reliable and efficient basis for making informed decisions throughout the project's lifespan, from concept definition and construction, through to its use and eventual demolition.

Its benefits are realized across every aspect of the development process, including improved visualization of proposals, faster and more effective processes, better design and improved production quality, facilitation of automated prefabrication and assembly and support for using life cycle data. The use of BIM tools to help achieve sustainability and/or improved (green) building performance objectives on a project is referred to as "Green BIM" (McGraw-Hill Construction, 2010).

Green BIM can be used throughout the building delivery and management process (Sharif, 2012), with applications in concept definition (through visualization of alternative designs), design (through optimized design including implications of different design solutions), construction (through supporting efficient construction methods and quality/quantity controls) and in use (through monitoring building performance and supporting decisions about periodic maintenance, renewal and renovation). It provides a platform for information sharing that encourages and facilitates communication across the building and construction supply chain. It improves information transparency and trust, leading to better design due to improved collaboration with the supply chain and customer, facilitating green innovations, holistic solutions and better integration of supplier products, also reducing errors and risk. It also helps address knowledge and performance gaps at different stages on the building delivery and management process, particularly the in use stage.

Case studies: BIM in practice**Type of green intervention:**

Support, information and voluntary action



Regulatory and control mechanisms

AT DESIGN STAGE: POWERHOUSE KJØRBO, NORWAY**Aspects of green directly addressed:**

Energy

Powerhouse Kjørbo, in Bærum, Norway, will be the world's first, refurbished positive energy office building. BIM models created from laser-scanning were used to analyze the effects of shade from trees on the planned solar panel placements. This scan was used to develop the structural as-built model, allowing for more efficient collision-detection of the architectural and mechanical, electrical and plumbing (MEP) models.

TRACKING MATERIALS: NYA KAROLINSKA HOSPITAL, SWEDEN**Aspects of green directly addressed:**

Materials

At Nya Karolinska Hospital (NKS) – an ultra-modern university hospital in Solna, Sweden – materials are being evaluated on their sustainability and hazardous properties. BIM is being used to track the final location of materials once built-in to provide the client with a log-book for future renovation, demolition and decontamination thereby making it easier to identify appropriate actions.

EMBODIED CARBON: CITY GREEN COURT, PRAGUE, CZECH REPUBLIC**Aspects of green directly addressed:**

Carbon

In Prague, Czech Republic, BIM was used to calculate the embodied carbon of the City Green Court office building, the first time this had been done for an office building in the country. The project's embodied carbon footprint, including construction materials, on site activities and transportation, were calculated using Skanska's internal carbon footprinting tool. Skanska will use the City Green Court's footprint as a benchmark with which to perform value engineering and realize embodied carbon savings on future projects in the Czech Republic.

REDUCING WASTE: ST BARTHOLOMEW'S AND THE ROYAL LONDON HOSPITALS, UK**Aspects of green directly addressed:**

Waste

For the redevelopment of St Bartholomew's and the Royal London Hospitals in London, BIM has been used to reduce waste plasterboard, brick and flooring materials. The project waste management strategy won the CIWM (the Chartered Institution of Wastes Management) award in 2009.

EXISTING BUILDINGS: RICS HEAD OFFICE, PARLIAMENT SQUARE, LONDON**Aspects of green directly addressed:**

Energy



Carbon



Materials



Waste



Water

At RICS head office in London, a building information model has been created primarily to enhance the organization's facilities management process, but also as a learning and demonstration exercise to help the industry understand the challenges and benefits of using BIM in existing buildings. The process for BIM followed a standard route, with a 3D model produced from a laser scan of the building, but with the additional challenges of inaccessible services, ornate architectural detail and small rooms typical of historic buildings, building elements of unknown origin and the need to conduct the survey whilst the building was being used. To conform with best practice, the BIM model is also tied into the UK National Grid using external Total Station measurements.

BIM supports faster and more effective design processes as information is more easily shared and reused, allowing for early technical and cost evaluation of multiple design options including material selection in less time. It also has the potential to support life cycle assessment (LCA) of environmental impacts and life cycle costing (LCC) throughout the different stages of the project life cycle, though further development in this area is required.

There are already requirements in the UK, the Netherlands, Denmark, Finland and Norway to use BIM on publicly-funded building projects by 2016. The European Parliament has voted to support a package of reforms to the EU Public Procurement Directive, which includes clauses designed to encourage all European countries to recommend the use of electronic tools, including BIM, on public works contracts. Reforms must be implemented into national law within two years.

Green BIM is poised for great growth. In the US, industry-wide BIM adoption had risen from 28% in 2007 to 71% in 2012 and is still growing (McGraw-Hill, 2012), and 78% of BIM users who were not currently using it for green projects in 2010 expected to be doing so within 3 years (McGraw-Hill Construction, 2010). The expected increased customer demand was the main driver for adopting BIM that was mentioned by contractors, with public and governmental customers requiring the use of BIM in their projects.

Though BIM is widely regarded as an essential tool, the use of technical software does require an upfront, and sometimes additional, financial investment. This can be problematic for businesses when they are tendering for a project and do not want to make a risky investment at that stage. However, earlier investments and analyses will generally create cost reductions later on in the project life cycle, for example in the operations period. Such investments also help to fully optimize the building and its use, resulting in significant life cycle savings.

Although the focus for BIM is predominantly on new buildings, it can equally be applied to, and benefit, existing buildings. BIM is expected to increasingly become part of the retrofit and refurbishment process. The key advantage for owners and tenants is that they can see how changes to an existing building will impact them, meaning improved engagement and happier tenants. Also, as with new buildings, the use of BIM promotes collaboration, resulting in preparation of O&M schedules that can be quickly created and shared with all parties involved.

However, the use of BIM for existing buildings provides practical measurement challenges (see above). Furthermore, few organizations can afford to immediately commission and populate a new building information model for an existing building. Moving from a predominantly paper-based environment to an electronic one is likely to present further challenges (Pickford, 2013)

RECOMMENDATIONS

- Promote through the use of practical tools, such as BIM, to facilitate life cycle decision making and supply chain collaboration early in the design process, improve construction and procurement processes, but also facility management, to maximize resource efficiency potential over the building life cycle.
- Engage with SPP and other relevant initiatives to promote and encourage Green BIM in procurement in appropriate circumstances.

3.6.2 MATERIAL, PRODUCT AND COMPONENT LEVEL

3.6.2.1 EPDs AND PRODUCT CERTIFICATION

TYPE OF GREEN INTERVENTION:



Support, information and voluntary action

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of knowledge and trust

To assess the environmental performance of a building over its entire life cycle through the application of LCA, it is necessary to rely on consistent environmental data for the incorporated construction products, materials and systems. To allow calculation at building level, the detailed data must be made available according to common standards.

Environmental Products Declarations (EPDs) communicate the environmental performance of construction products, resulting from the use of LCA. EPDs are usually developed by manufacturers to inform their consumers on the environmental performance of their products using selected indicators. The EN 15804 and the ISO 21930 standards provide general guidelines for the development of EPDs for building materials. For the EN 15804, these guidelines must then be used to build product category rules (PCR) for different types of materials.

EPDs usefully provide a transparent, objective language that applies to all materials, at all stages of the building delivery and management process. They provide a consistent definition of green and resource efficiency, potentially reducing the burden for suppliers and providing a basis for industry transparency and trust.

Case study: EPDs at Saint-Gobain**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

Saint-Gobain uses Life Cycle Assessment to assess the green credentials its construction products, and communicate credible, fact-based information about them. It provides the results of LCAs to its employees and customers through third party verified Environmental Product Declarations (EPDs).

Saint-Gobain first carried out LCAs in the early 1990s, through its insulation business. Since then, it has chosen to use Life Cycle Assessment (LCA) as the main tool for measuring the environmental footprint of its products and has conducted systematic LCAs for all its major product lines. It also promotes the use of LCAs and EPDs in the building industry more widely.

Externally, designers, contractors and materials & equipment suppliers (Saint-Gobain's customers) rely on EPDs to assess the environmental performance of a building over its entire life cycle, based on the construction products and materials specified. Internally, EPDs are used by Saint-Gobain to gain a better understanding of where a given product's environmental impacts are situated. They are also used to identify priority avenues for improvement, especially under its eco-innovation policy.

Currently, few EPDs for buildings material are available. However, the recognition of EPDs in Green Building Rating Tools is a driver for wider uptake and in France (with HQE) and Germany (with DGNB) EPDs are requested and used to assess the building performance. Similar developments in BREEAM and LEED V4.0 are likely to reinforce the global trend towards more EPDs publications.

Generally, use of EPDs remains voluntary, meaning it is the decision of individual suppliers whether or not to support this kind of product labelling. In countries such as France, where it is possible to find references to EPDs in laws or official documents, then the move towards EPDs becomes stronger and faster.

The most difficult and expensive aspect of carrying out LCAs and publishing EPDs is setting up the system (i.e. the first EPD is expensive; expertise and software is required; data must be collected from production sites and suppliers). For large suppliers, initial costs can be

amortised over the next LCAs and EPDs, leading to economies of scale. However, this is not always possible for the large group of SMEs that operate within the building and construction sector or in emerging countries.

Another barrier against wide scale adoption of EPDs is the lack of harmonization between countries or EPD programme operators. It means companies have to adapt to different national systems with different requirements, thus leading to additional costs and slowing down the move along the experience curve. Harmonisation of the requirements between countries could encourage more companies to start investing in EPDs and to publish EPDs for all their products (and not only to limit themselves to one unique EPD, used mainly as a marketing argument). Uptake would be further encouraged if system operators mutually recognized their EPDs, and if a state of interoperability of databases could be achieved, with increased data transparency.

The complexity of LCA and EPDs is also a barrier. They are often criticised as difficult to understand and communicate, and for not allowing a direct comparison between products. However, this reflects that they are not produced for mass communication (business to consumer) purposes, but rather to be used by architects, engineers and contractors to design buildings and evaluate alternative options. They are also not meant to directly compare construction products.

The use of EPDs in the building delivery and management process would be facilitated by an increased number of available EPDs for all products, and an increased availability of tools calculating easily buildings environmental impacts. The integration of these tools and EPDs into the BIM systems is an opportunity to facilitate use of LCA in the future.

RECOMMENDATIONS

- Support through the UNEP-SBCI network the greater adoption and application of EPDs in the sector, and review efforts at the national and international levels related to EPDs to assure consistency in measurement and application.
- Support efforts to harmonize standards through collaboration among UNEP-SBCI, its partners and networks and standard organisations (e.g. CEN and ISO).

3.6.3 CORPORATE LEVEL

3.6.3.1 REPORTING/DISCLOSURE

TYPE OF GREEN INTERVENTION:



Support, information and voluntary action



Regulatory and control mechanisms

THIS GREEN INTERVENTION ADDRESSES THE FOLLOWING BARRIERS:

- Lack of knowledge and trust
- Lack of communication and leadership
- Supply-chain relationships

Corporate extra – financial reporting has become increasingly commonplace, and most large companies now provide an account of their non-financial performance including resource use. This is often in the form of a corporate sustainability or responsibility report that provides information on economic, environmental, social and governance performance. For organisations

in the building and construction sector, annual reporting can form the basis of a transparent and balanced appraisal of the impacts (both positive and negative) of their activities and how they are managing the associated risks and opportunities (for example, how they can profit from new commercial opportunities associated with greening the building supply chain).

Progressively, third party frameworks are used to increase the consistency of and trust in corporate extra – financial reporting. This is most commonly in the form of voluntary guidelines, such as the Global Reporting Initiative (GRI) sustainability reporting guidelines and the Integrated Reporting framework; as well as in the form of sustainability accounting standards, such as the ones proposed by the Sustainability Accounting Standards Board (SASB). Some organisations are now seeking formal assurance, with the most widely used being the AccountAbility AA1000 Assurance Standard and the International Standard on Assurance Engagements (ISAE) 3000. Some assurance schemes apply to specific aspects of resource use, such as the Certified Emissions. Measurement And Reduction Scheme (CEMARS) for carbon emissions.

In addition to formal reporting, many companies choose to disclose information about resource use through voluntary ratings and disclosure schemes. Some of these schemes require information about a range of non-financial performance (e.g. Dow Jones Sustainability Index, UN Global Compact) while others focus on specific aspects of environmental or, less frequently, social impact. For example, CDP (formerly the Carbon Disclosure Project) request detailed information from the world's largest companies about carbon, water and (forest) materials use, including both from its direct operations (scope 1 and 2) and, in the case of carbon, increasingly including quantification of indirect (scope 3) greenhouse gas emissions. Various sector-specific initiatives have also been developed to help improve the consistency, comparability and utility of disclosures.

Non-financial reporting can improve transparency, knowledge-transfer and trust along the supply chain, as dedicated non-financial reports are aimed at a wider audience (including customers and suppliers) than a traditional annual/financial report (intended primarily for investors).

Case study: ENCORD Construction CO2e Measurement Protocol**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Carbon

Founded in 1989, the European Network of Construction Companies for Research and Development (ENCORD) is Europe's forum for industry-led research, development and innovation in the construction sector, with members including many of the world's largest construction companies and suppliers.

The ENCORD Construction CO2e Measurement Protocol was developed by the members of ENCORD, along with partners from other construction organisations, to detail the method to be used when measuring the Scope 1 and 2 greenhouse gas (GHG) emissions of an organisation within the construction sector.

The protocol is built on (and follows the methodology of) the Greenhouse Gas Protocol (GHG Protocol) March 2004 revision, which was originally developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The ENCORD protocol carries the WRI quality mark, only the 2nd sector tool to gain this recognition. It is formally supported by both the CDP and the WGBBC, and is referenced in the Global Reporting Initiative (GRI) construction and real estate sector supplement (CRESS).

The supporting guidance identifies the intended users of the protocol, the main sources of emissions over which a construction company may have some influence, and the method of measuring these emissions. Guidance is also provided on reporting methods at a company and project level, with a view that companies will report their emissions publicly. It is also intended to assist current and future work undertaken to reduce emissions from specific construction related activities and operations.

Case study: GRI CRESS**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon



Materials



Waste



Water

The Global Reporting Initiative (GRI) produces a comprehensive Sustainability Reporting Framework to enable greater organizational transparency. The Framework sets out the Principles and Indicators organizations can use to measure and report their economic, environmental, and social performance.

The Construction and Real Estate Sector Supplement (CRESS) – launched in 2014 – is a tailored version of the GRI G4 Guidelines intended for companies that invest in, develop, construct, or manage buildings and infrastructure. It was developed by a multi-stakeholder, geographically diverse Working Group, formed by volunteers from construction and real estate companies, investors, labor, non-governmental organizations and research organizations.

Case study: WBCSD CSI Getting the Numbers Right**Type of green intervention:**

Support, information and voluntary action

Aspects of green directly addressed:

Energy



Carbon

The Getting the Numbers Right (GNR) system is a sector-wide global information database that provides accurate, verified data on the cement industry's CO₂ emissions and energy performance. It was initiated by the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI), which is a voluntary global effort by 24 major cement producers who believe there is a strong business case for the pursuit of sustainable development.

In addition to CSI members, CEMBUREAU, the European Cement Association, and FICEM, the Latin-American Cement Association, collect information from non-CSI cement plants in Europe and Central and South America. The database is independently managed by PricewaterhouseCoopers (PwC), who provide data security to manage antitrust and confidentiality concerns. Participants and interested parties can only see aggregated data on global and regional performance, with a one-year delay in the data available to comply with anti-trust legislation.

GNR is based on the CSI's Cement CO₂ and Energy Protocol, which was derived from the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, developed by WBCSD and the World Resources Institute. This protocol is the most relevant guidance document for the measurement and reporting of CO₂ emissions in the cement industry worldwide providing a common language, set of definitions and harmonised methodology for calculating CO₂ emissions, with the aim of reporting them transparently.

The database currently includes data for the years 1990, 2000, and 2005 to 2011. Program participants from the CSI began independent third-party assurance of their CO₂ emissions information with 2006-data. The latest (2011) data comprises 55% of cement production outside of China spanning 967 individual facilities, with 96% coverage in Europe and two-thirds coverage in North and South America. Four new country reports were released for the first time (Thailand, Morocco, Philippines and Egypt) and improving the participation of cement companies in China and other emerging economies is a high priority for GNR.

In 2013, extra – financial reporting was undertaken by 93% of the world's largest 250 companies and 71% of the 4,100 companies surveyed in the KPMG 2013 Corporate Responsibility Reporting Survey (KPMG, 2013). The high rates of reporting in all global regions means that non-financial reporting can be considered standard business practice for large businesses. However, the survey also revealed that the quality (as defined by the reports' authors) of non-financial reporting varies between sectors, with the construction & building materials sector producing, on average, the lowest quality reports of any sector.

Whilst some schemes are initiated or backed by investors (e.g. GRI, CDP) it is not clear to what extent and how resource use issues currently influence investors' decisions. Some investors have started embedding extra – financial considerations into all their investment decisions, and expect improvements in extra – financial reporting and performance as a pre-condition for investment. However, there is also a growing belief that (long term) risks and opportunities associated with social and environmental impacts such as resource availability (e.g. the “carbon bubble” as described by the Carbon Tracker Initiative) remain largely overlooked by investors, and therefore over- or undervalued by markets (WBCSD/ UNEP-FI, 2010).

Whilst the benefits of extra – financial reporting are well established for individual businesses, including enhanced reputation and increased resource efficiency (EY/Boston College Center for Corporate Citizenship, 2014), it is far harder to evaluate the extent to which this results in tangible improvements in resource use for the building and construction supply chain as a whole.

There is an increasingly strong legislative driver for non-financial reporting, with mandatory reporting requirements already in place in some countries (e.g. Denmark, France, South Africa and UK). A draft directive being discussed in the European Parliament and the Council of Ministers would require all large companies in Europe (organisations with more than 500 employees and either a net turnover of €40m or a balance sheet total of €20m) to disclose non-financial information in their annual reports.

While an increase in reporting and disclosures should, in principle, improve transparency across the building and construction sector, the sheer range and variety of reporting and disclosure frameworks and schemes

can create confusion and inconsistency. While some schemes try to cover all economic, social and environmental issues in the same way, others are focused on single issues. The motives for such schemes might also be important, with some run for profit by third parties or backed by ‘consultancy’ services, and others industry-led or voluntary. As a result, non-financial reports tend to vary hugely in content, validity and style, making it hard to assess comparative performance.

Reporting and disclosure increasingly represent a growing burden in terms of time and resources, and frequently require communication or other specialist expertise, which, perhaps unlike in other sectors, was not previously required in the building and construction sector. Furthermore, large contractors typically have numerous projects ongoing at different locations with different timescales, involving an even larger number of suppliers, which is not well suited to baselines, fixed (annual) reporting or global statements about non-financial performance or aims.

A key area for improvement is reporting on suppliers and the value chain; reported to be a weak aspect in existing reporting (KPMG, 2013) and disclosures (e.g. CDP, 2013).

RECOMMENDATIONS

- Collaborate with reporting and disclosure organizations and with private sector organizations representing the target group of companies and its final audience to foster and coordinate development of the ‘tools’ allowing for greater transparency and harmonization with international standards and relevant benchmarks. Such cooperation is necessary to arrive at a less burdened and more meaningful set of tools to measure, benchmark and consequently drive investments and action in green and sustainability.
- Elaborate with other concerned entities within UNEP and outside a reporting component for the building sector, notably in the context of corporate sustainability reporting.

3.7 Discussion

The building delivery and management process illustrates well the inherent complexities in the building and construction sector. The large number of stakeholders involved at various stages of the process, each with unique and/or overlapping roles and responsibilities, creates challenges to greening the building supply chain. The barriers each stakeholder faces, ranging from lack of knowledge to financial or technological risk to lack of communication with other stakeholders, among others, are not easily overcome and require a systematic and comprehensive approach. Likewise, potential green interventions to address these barriers are also wide-ranging and include financial instruments, voluntary support programmes and regulatory actions, in addition to the required maturity of the market.

To achieve a significant impact in the building delivery and management process, key stakeholders must adopt and develop best practices, and further develop consensus on use of green interventions. More importantly, improved relationships and coordination among stakeholders is critical to green the system.

UNEP-SBCI, working with its partners and with other UNEP initiatives, is well positioned to facilitate engagement with stakeholders involved in the building delivery and management process, and to foster the required transparency and uptake of harmonized tools and green interventions. A key element of these efforts would be the development of indicators against which progress can be measured. Given the wide variety of interests and stakeholders identified, development of such indicators will require a multi-stakeholder approach and coordinated activities

The series of recommendations identified throughout this chapter and summarized in the Action Framework provides a roadmap for advancing the building delivery and management process well beyond progress made previously through existing practices and policies. Collectively, the engagement of stakeholders to further green the building concept definition, design, construction and in use activities, greater uptake of green interventions and tools, and the implementation of further actions identified here can all assist in transforming the building and construction sector, to help realize the significant potential that exists for greater resource efficiency.



Chapter 4

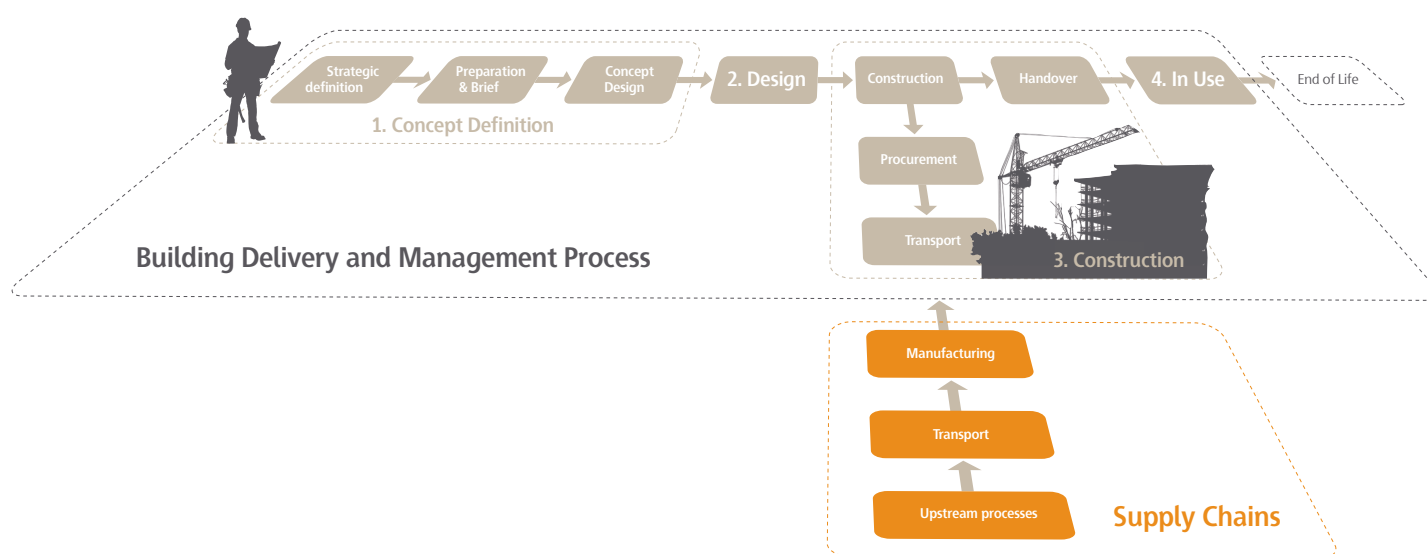
Greening the Material and Product Supply Chains

4.1 Introduction

The Greening the Building Supply Chain initiative is intended to uncover green interventions in the fragmented and complex building supply chain and to provide recommendations to define prioritisation of actions for UNEP-SBCI and partners in future work programmes. Chapter 3 reviewed potential green interventions within the Building Delivery and Management process. This chapter focuses on a limited number of supply chains supplying construction (see Figure 12). Whilst in Chapter 3 a systematic process to surfacing green interventions was followed, Chapter 4 rather describes a methodology to focus future dialogue on the development of green interventions within selected supply chains. This approach was taken as only a limited number of case studies of green interventions in subject supply chains were found in the time available for the Taskforce.

The methodology introduced is a so-called “Intensity Analysis Methodology” and was developed with Karlsruhe Institute of Technology and University of Kassel and following recommendations in Chapter 3 is based on an LCA approach. The intensity analysis method is not developed to compare the materials in terms of their environmental impact, as the selection of materials should be done considering the function of the materials and the products following a whole building life cycle assessment. The supply chain intensity analysis is carried out only to improve understanding of environmental impacts of those materials selected, providing indications about potential entry points for green interventions within the building materials supply chains.

Figure 12. Supply chains



4.2 Stakeholders and barriers to green interventions

Material (and equipment) suppliers can influence resource consumption and unwanted environmental impacts by selection, sourcing and haulage of input materials and precursors, selection and sourcing of energy, and the selection of technologies and processes, inter alia for efficiency improvements, releasing opportunities for virtuous circular economy loops within the whole building sector. An important role is played by contractors, which in a conventional contract select the suppliers, sometimes influenced by developer's procurement policies and define material quantities. Contractors also influence resource efficiency by site management activities such as waste and water management and the selection of energy sources. Chapter 3 introduced first mover risk, supply chain relationships and the tender process as major barriers to greening material supply chains (see 3.4.4.)

Furthermore, developers impact the extent to which resources are used and environmental impacts are provoked or mitigated by defining the demands related to the building, influenced by public sector (public authorities) planning policies and building codes. Designers and engineers, can contribute to improving resource efficiency and reducing environmental impacts by selecting methods of construction optimization and proposing materials and combinations of materials, which contribute to realizing construction parts with otherwise identical or sufficiently similar use characteristics and show a reduced resource consumption or lower environmental impacts. Contractors with involvement of the relevant designers, engineers and material & equipment suppliers will develop the Operations and Maintenance Manual that is the basis maintenance and replacement activities during the in use phase. In Chapter 3 lack of policy and incentives, financial and technology risks, lack of knowledge, trust, communication and leadership have been identified as the main barriers to greening the building supply chain (see 3.2.4 and 3.3.4).

During the in use stage facilities managers, which are responsible for the ongoing management of a building and are acting on the behalf of the developer or owner, can influence resource consumption and unwanted environmental impacts related to ongoing maintenance and replacement actions. Decisions about renovation or demolition/disassembly are also of key importance to the overall resource efficiency of a building and are often prompted by tenant (decisions). Chapter 3 summarizes lack of incentives, the tender process, lack of knowledge and trust and lease structure as major barriers.

4.3 Materials groups considered

The materials groups that have been considered for the resource intensity analysis have been selected taking into account the following:

- the mutual specific resource use and environmental impacts associated with the product group (these can differ from one manufacturing process to another and between countries);
- the current production volume of the product group in Europe as mass or volume;
- possible strong increases of production volumes in the future.

Considering these aspects the following materials have been considered for the intensity analysis:

- | | |
|--------------------------------|-----------------------|
| • Aluminium | • Brick |
| • Cement | • Flat glass |
| • Mineral wool | • Plaster board |
| • Polystyrene | • Polyurethane |
| • Steel (rebar and structural) | • Timber (structural) |

4.4 Intensity Analysis and Heatmap

The decision support for the different actors along the supply chain can come from tools that help understanding the environmental aspects of a material through all stages of its life cycle. Based on recommendations in Chapter 3, Life Cycle Assessment (LCA) was selected as a tool to develop the intensity analysis and help achieving the Task Force goal of improving our understanding of the building supply chain. In particular, LCA was chosen because it allows key stakeholders to understand the entire life cycle environmental impacts associated with the building materials they select to use on their projects.

To develop a sample heat map cradle-to-gate LCA data⁶ from the Ökobaudat⁷ database published by the German Federal Ministry of Construction were used. For weighting, LCA data were combined with production and consumption records in the EU-27. In the analysis preference was given as far as possible to consumption data and a variety of data sources were consulted to deduce production or consumption data of the different materials. Main data sources were the PRODCOM statistics by EUROSTAT providing detailed production volume statistics for EU-27 for 2011 and statistics of industrial associations.

⁶ These data represent values considered by the developers as LCA average values for Germany. The LCA values can differ strongly within a country but also from one country to another, e.g. due to a different energy mix. One example is aluminium, which is in some countries produced using electricity generated by hydropower affecting inter alia the value for Global Warming Potential.

⁷ <http://www.nachhaltigesbauen.de/baustoff-und-gebaeuedaten/oekobaudat.html>

Selected materials used in the construction sector were covered. Materials' production and consumption figures have been multiplied with per kg impacts from the Ökobaudat database. Summing up all materials for each impact category gave the total impacts from these materials in that specific impact category and the relative share of each of the selected materials, which was then translated into a heat map with a three color coding (high, moderate and low relative importance).

It has to be noted that the selection of adequate LCA data is challenging and can introduce a number of uncertainties as some of the materials families contain a number of different products for which LCA data is available.

4.5 Heat map

The purpose of a heat map is the identification and presentation of core areas and sources for selected environmental aspects. Heat maps present findings graphically with the temperature of the color representing the importance of the area or contribution. They are therefore mainly suitable if results are presented in a qualitative or semi-quantitative manner, irrespective if results are based on quantitative information or individual qualitative assessments, and they are developed for the purpose of identifying priority areas for green interventions. In this chapter the principle of a heat map is explored as a tool to visualize the qualitative (semi-quantitative) results of the selected intensity analysis method.

4.5.1 HEAT MAP SAMPLE

Based on a methodological feasibility study developed by experts from the Karlsruhe Institute of Technology and University of Kassel, a heat map approach was selected which looks at the relative environmental impacts of specific construction materials in Europe. This heat map approach is particularly useful for selecting materials for a more detailed analysis, in case the environmental performance of the construction sector as a whole in that region should be improved. In a following detailed analysis, potentials for a reduction of the environmental impacts can be identified and assessed regarding technical feasibility, cost-effectiveness and side effects.

The relative contribution of each material to each impact category was calculated and translated into the heat map with a three color coding (high, moderate and low relative importance). The proposed heat map allows no comparisons between different impacts and should not be understood or used for any conclusions in the sense that one material has a lower environmental impact than another. This would require a full life cycle analysis accounting for all life cycle stages and would also require a similar function for the selected materials. In addition, for such a comparison, far more indicators would have to be considered.

Selected Life Cycle Assessment (LCA) Indicators for Green the Supply Chain

As we have seen in Chapter 3, Life cycle assessment (LCA) is a tool for the systematic evaluation of the environmental aspects of a product (e.g. building) or service through all stages of its life cycle (which in the context of this report represents concept definition, design, construction, in use and end of life). LCAs allow businesses in the building and construction sector to understand and assess how they can improve product or building performance by adopting a cradle-to-grave approach.

In an LCA, an inventory of energy and material flows related to the product being analyzed is built. These are transformed into mid-or endpoint categories. Midpoint impact categories, translate energy and material flows into environmental categories such as climate change, acidification, human toxicity, etc. Endpoint impact categories translate the midpoint impact categories to their final impacts on human health, natural environment, and natural resources.

For the heat map the following four mid-point impact categories were chosen based on the definition of green given in Chapter 2 and including the five environmental aspects that are generally understood by the industry to have the highest global impact over the life cycle of buildings.

- **Primary energy:** the sum of total renewable primary energy and total non-renewable primary energy.
- **Freshwater:** use of freshwater resources as in GaBi 5
- **Disposed waste:** discharged non hazardous waste as in GaBi 5⁸
- **GWP:** Global warming potential in kg CO₂ eq, based on CML2001⁹









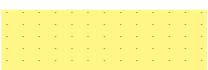



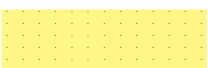


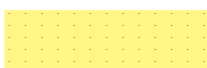
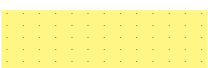
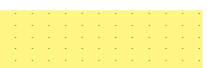
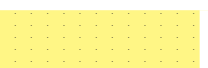
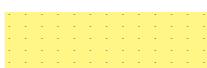
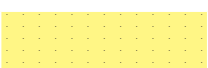
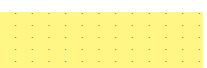
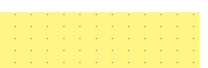
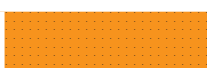
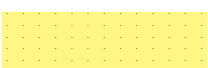
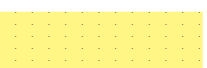
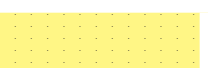

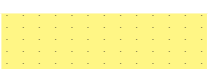
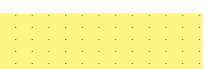
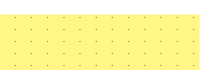

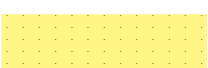







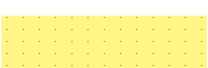


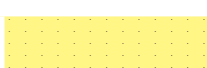
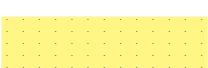
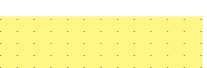
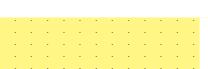
Tests with the impact category Abiotic Depletion Potential (ADP) were also conducted, but resulted in implausible results. This is related to the fact that ADP has been developed for internationally traded mineral resources whereas (with the exception for metals) mineral resources for the construction industry are mainly sourced locally or regionally.

⁸ GaBi 5 is a Life Cycle Assessment Software that models every element of a product or system from a life cycle perspective.

⁹ Based on method for impact assessment: CML2001 – November 2010. CML 2001 is an impact assessment method developed by the Institute of Environmental Sciences of the Leiden University, which restricts quantitative modelling to early stages in the cause-effect chain to limit uncertainties.

Table 2: Indicative heat map of selected building materials

The heat map is based on LCA data for Germany of 2013 and EU production/consumption data of mainly 2011. The heat map does not address all environmental impacts including, for instance, raw material depletion and abiotic depletion potential. The colour is indicative of the contribution a material has on the total impact of the analysed materials in that particular impact category in the EU. Consequently, colours may not be interpreted as indicative of the severity of the environmental impact. This would require a weighting between different impact categories, which was not possible to develop here due to the heterogeneous impact categories selected.

INDICATIVE RELEVANCE OF A MATERIAL (OR MATERIAL GROUP OR GROUP OF CONSTRUCTION MATERIALS) FOR THE TOTAL IMPACTS OF THE CONSTRUCTION MATERIALS ANALYSED (BASED ON GERMAN LCA DATA IN "OKOBAUDAT" AND ESTIMATED EU PRODUCTION AND CONSUMPTION DATA RESPECTIVELY)				
	HIGH RELATIVE IMPORTANCE $\geq 20\%$ of the impacts provoked by the selected materials used in construction in EU27			
	MODERATE RELATIVE IMPORTANCE 5 to 20% of the impacts provoked by the selected materials used in construction in EU27			
	LOW RELATIVE IMPORTANCE $< 5\%$ of the impacts provoked by the selected materials used in construction in EU27			
Material	Primary energy consumption (total)	Freshwater use	Disposed waste	Global warming potential (GWP)
ALUMINIUM INDUSTRY				
BRICKS INDUSTRY				
CEMENT INDUSTRY				
FLAT GLASS INDUSTRY				
MINERAL WOOL INDUSTRY				
PLASTER BOARD INDUSTRY				
POLYSTYRENE INDUSTRY				
POLYURETHANE INDUSTRY				
STEEL INDUSTRY: REBAR				
STEEL INDUSTRY: STRUCTURAL				
TIMBER INDUSTRY: STRUCTURAL				

The proposed heat map allows no comparisons between different impacts and should not be understood or used for any conclusions in the sense that one material has a lower environmental impact than another.

4.6 Discussion

The results of the intensity analysis method in the form of the heat map can be used to illustrate relative impacts from materials, based on specific impact resulting from material production in the EU for construction purposes (it has to be noted that the underlying LCA data represent average German conditions and that production data are subject to strong cyclic changes). Structural steel, aluminium and cement have a high relative importance in the selected categories (or for the LCA indicators selected) and rebar, brick and polyurethane a modest relative importance. It needs to be stressed that a high contribution is not necessarily equivalent to a high reduction potential. The identified materials could then be analysed in more detailed studies to identify and assess reduction potentials, e.g. in the case of Global-warming potential GWP in the areas: process optimization, low carbon energy sources and alternative suppliers for pre-products with lower GWP.

The developed methodology showed that it is possible to develop heat maps highlighting the main environmental impacts associated with the production stage of single building materials. A further differentiation into A1 to A3¹⁰ while useful for providing better focus for policy action is, however, challenging and require a very detailed analysis. The main challenge is to clearly define the system boundaries between A1 and A3 as these might vary between different producers.

For the development of heat maps for the building materials data quality is a particularly challenging issue. Considerable differences between data sets stemming from different sources were detected and production/consumption data is in some cases scarce. The extent of this study did not allow to gather own data or to make a broad comparison between different data sets. As a consequence of uncertainties and gaps in the underlying data, and different options of interpreting the results. It cannot be excluded that other authors making use of other data sources or a different methodology would achieve different results.

4.7 Recommendations

- Compile life cycle data and EPD data for selected construction materials and product groups with a geographical coverage representative of the global production.
- Determine the most relevant energy and materials flows and processes (contribution analysis) in a cradle-to-gate perspective individually for (not between) the different materials and products before and after aggregation to impact categories independently for selected countries/global regions. The result would be one heat map per material/product group allowing to identify : i) the important aspects and life cycle stages in the production stage per country/region and ii) to what extent there are differences between the production processes in different countries/regions.
- Compare performance data of best available techniques and emerging techniques for determining specific room for improvements, e.g. from technology transfer.
- Overlay heat maps with other relevant data such as scarcity and other risk maps that relate these heat maps to material/component origin (e.g. combine heat maps information of freshwater use in the different stages in the supply chain with water scarcity maps).
- Develop heat maps of absolute national/regional resource uses/environmental impacts due to selected construction materials/product groups. This would indicate the absolute and relative importance of the selected materials/product groups for resource use/environmental impacts on a regional scale.
- Analyse tools that support the designers in performing environmentally conscious design decisions (e.g. guidelines and checklists, one-score screening indicators, full life cycle assessment, process simulation software, databases on materials, etc.) building upon life cycle data used in the construction sector to support the selection of construction materials/products and type of construction.
- Identify activities (i.e. green interventions) and actors with similar goals (cf. examples) and analysis of strategic partnerships.

¹⁰ A1 – Raw materials supply, A2 – Transport, A3 – Manufacturing.

¹¹ Note that here for example Portland cement produced in the EU is compared to those produced in the USA, Latin America and China.



Conclusion

Many significant challenges remain for the building sector- one of the most resource intensive sectors - to overcome the numerous barriers to achieving greater resource efficiency. While there has been considerable progress in creating better performing buildings, the sector still faces issues including among others: fragmentation; a lack of awareness; associated risks; and a need for simple and effective tools and policies. And, despite the efforts of many public and private players, the sector is still responsible for an important share of global GHG emissions, energy consumption, use of non-renewable materials, water use and waste generation. Through greater understanding of the environmental impacts of the sector, individual and collective actions of multiple stakeholders to promote sustainable consumption and production patterns, and development of effective policies, strategies, and tools, including the means to quantify impacts, significant progress can be realized in transitioning the building sector towards improved resource efficiency.

Greening the building supply chain is a necessary precondition for up-scaling delivery of green buildings and realising the associated sustainability opportunities on a commercially-viable and wide-spread basis. The building sector is fragmented, both at the upstream level, where a construction/building originates, and at the downstream level, where contractors, suppliers and users are. This fragmentation associated with the complexity of the interaction among the different stakeholders represent one of the greatest barriers to greening the building supply chain.

Greater awareness of stakeholder roles and understanding the impact of decisions made by various stakeholders throughout the building delivery and management process can help provide the basis for collective action.

There are many benefits to be derived from greening the elements of the supply chain and implementing green interventions, and cases studies illustrate that there is considerable potential for improving the overall environmental performance of the building supply chain. Despite multiple data availability and data quality challenges, methods are available to identify the relative impacts of various materials, and focus attention on policies or practices which may reduce the impacts.

To achieve a significant impact in the building delivery and management process, key stakeholders must improve coordination, implement best practices, and

further develop consensus on metrics and reporting and further develop Life Cycle approaches, and refine green interventions to maximize potential for greater resource efficiency. Within this context, actions by UNEP-SBCI, its partners and by other organizations are necessary to promote progressive policies and resource efficient practices, facilitate necessary research, and to develop consensus for tools and approaches to measure impact.

More specifically, UNEP-SBCI can play a leading role in greening the building supply chain by providing to stakeholders in the building and construction sector a platform for long-term engagement in developing and implementing strategies for the systematic application of green interventions throughout the building supply chain. UNEP-SBCI, working with its partners and with other UNEP initiatives, is well positioned to facilitate a harmonized documentation of the impact of green interventions in the building supply chain, synthesize and disseminate information and advocate for green interventions, such as sustainable building public policies with governments and local authorities.

The Report also shows that the results of the intensity analysis method in the form of the heat map can be used to illustrate relative impacts from materials, providing preliminary guidance to stakeholders on where actions to reduce impacts or intensities might be focused. To fully explore the environmental impact reduction potential of the building supply chain UNEP-SBCI and its partners should further refine the impact assessment methodology as well as the ways to overcome data challenges so to be able to development heat maps of absolute national/regional resource uses/ environmental impacts due to selected construction materials. This would provide a more solid basis for stakeholders to identify actions to reduce environmental impacts and assess their technical feasibility, cost-effectiveness and side effects.

Through greater understanding and collective action, the building sector can realize significant change. This report identifies a number of actions and potential entry points that will assist in the transition to a resource efficient building sector, through the leadership and responsibility of multiple stakeholders.



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About the UNEP Division of Technology, Industry and Economics

Set up in 1975, three years after UNEP was created, the Division of Technology, Industry and Economics (DTIE) provides solutions to policy-makers and helps change the business environment by offering platforms for dialogue and co-operation, innovative policy options, pilot projects and creative market mechanisms.

DTIE plays a leading role in three of the six UNEP strategic priorities: climate change, harmful substances and hazardous waste, resource efficiency.

DTIE is also actively contributing to the Green Economy Initiative launched by UNEP in 2008. This aims to shift national and world economies on to a new path, in which jobs and output growth are driven by increased investment in green sectors, and by a switch of consumers' preferences towards environmentally friendly goods and services.

Moreover, DTIE is responsible for fulfilling UNEP's mandate as an implementing agency for the Montreal Protocol Multilateral Fund and plays an executing role for a number of UNEP projects financed by the Global Environment Facility.

The Office of the Director, located in Paris, coordinates activities through:

- **The International Environmental Technology Centre** - IETC (Osaka), promotes the collection and dissemination of knowledge on Environmentally Sound Technologies with a focus on waste management. The broad objective is to enhance the understanding of converting waste into a resource and thus reduce impacts on human health and the environment (land, water and air).
- **Sustainable Consumption and Production** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- **Chemicals** (Geneva), which catalyses global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- **Energy** (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies. This branch is also charged with producing green economy reports.

DTIE works with many partners (other UN agencies and programmes, international organizations, governments, non-governmental organizations, business, industry, the media and the public) to raise awareness, improve the transfer of knowledge and information, foster technological cooperation and implement international conventions and agreements.

For more information,
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The buildings sector supply chain is a complex network of manufacturers, suppliers, vendors and users through which our built environment is constructed, maintained, renovated and demolished. Due to the complexity of interaction among these participants and to a series of financial, technical and economic barriers, the supply chain is responsible for high levels of energy consumption, carbon emissions, water use and waste generation.

This report, developed through the work of UNEP-SBCI's Task Force on Greening the Building Sector Supply Chain, addresses stakeholders' interaction, barriers and green interventions to enhance sustainability in the supply chain operation, and identifies best practices using international case studies. The report also presents an intensity analysis method carried out to improve understanding of the building supply chain and the factors that influence its environmental performance, providing indications about potential entry points for interventions within the building project life cycle and building materials supply chains.

Based on the stakeholders, barriers, green interventions assessment as well as on the proposed intensity analysis method, recommendations are provided to develop a work program under the auspices of UNEP-SBCI to green the building sector supply chain by focusing on five key criteria: energy, carbon, water, materials and waste.

The United Nations Environment Programme's Sustainable Building and Climate Initiative (UNEP-SBCI) is a partnership of major public and private sector stakeholders in the building sector. We work in cooperation with other international organizations to promote sustainable building policies and practices worldwide. The Initiative provides a common platform, develops tools and strategies, establishes baselines, and demonstrates through pilot projects.