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Managing the Material Supply Chain for the Kigali Housing Sector

City of Kigali Housing Symposium
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2. City of Kigali material and energy balance
3. How local and how green can construction materials be?
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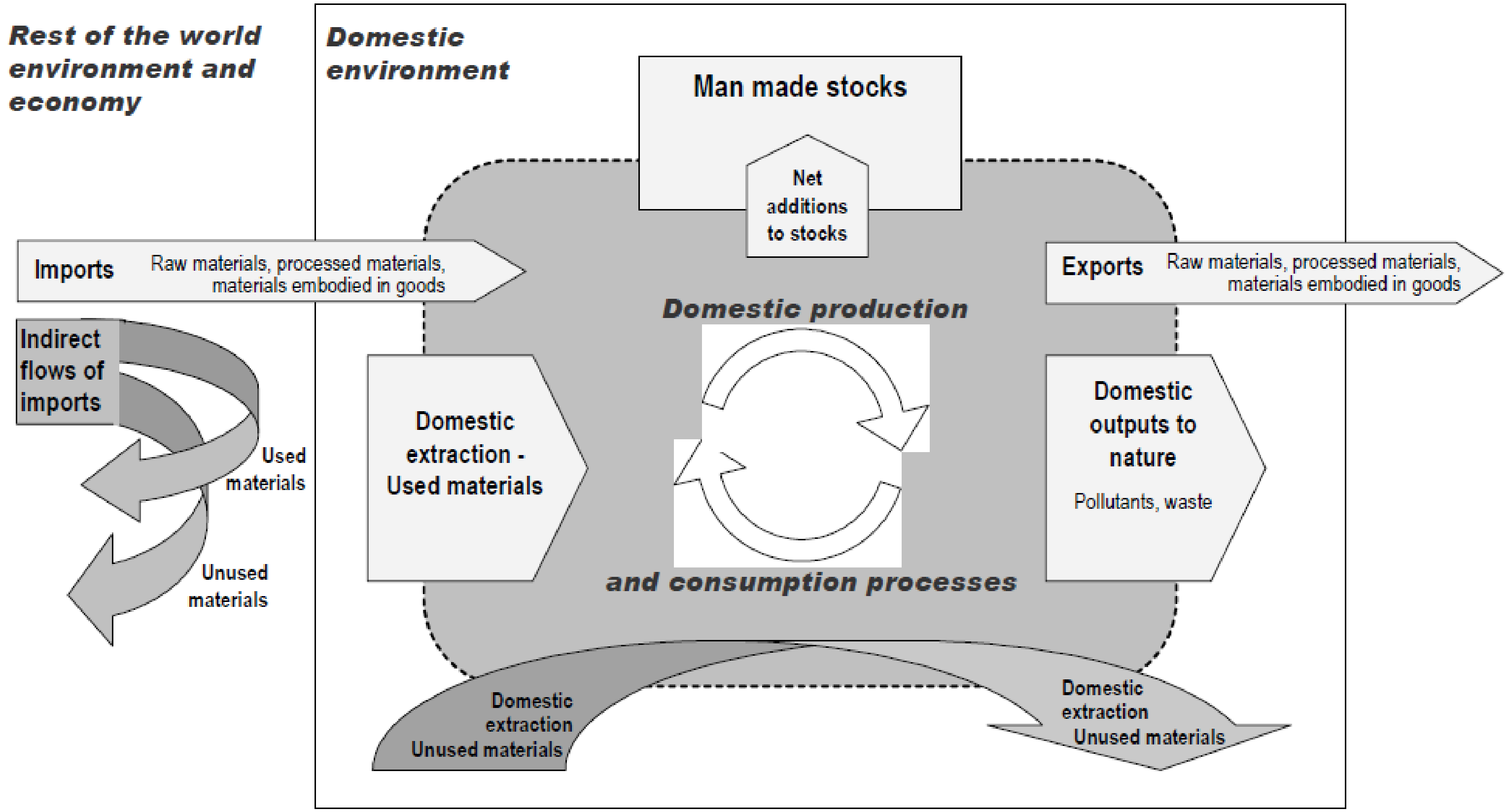
6. Conclusions

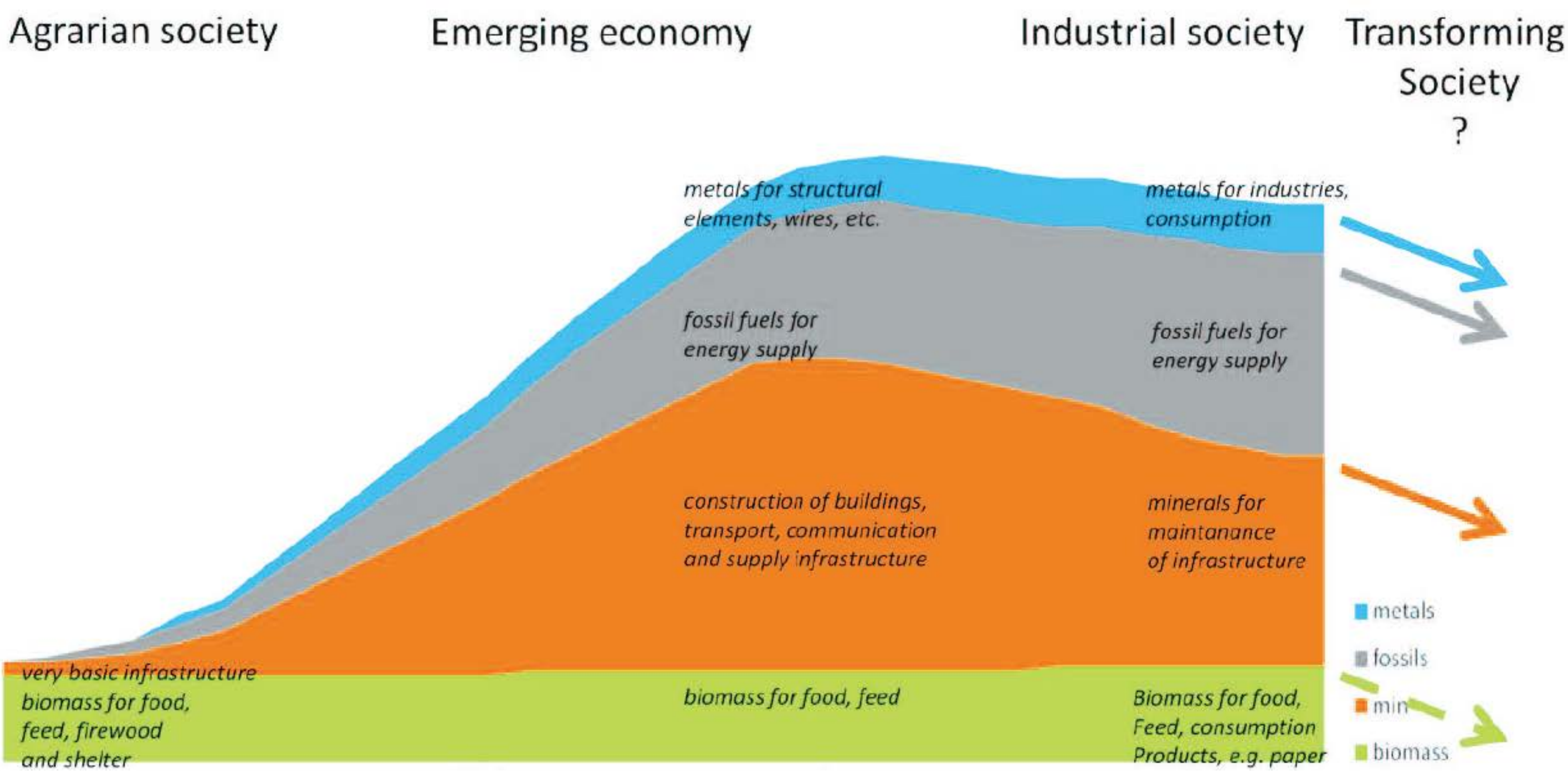
1. COUNTRY-WIDE MATERIAL FLOWS FOR CONSTRUCTION MATERIALS

ECONOMY-WIDE MATERIAL BALANCE SCHEME

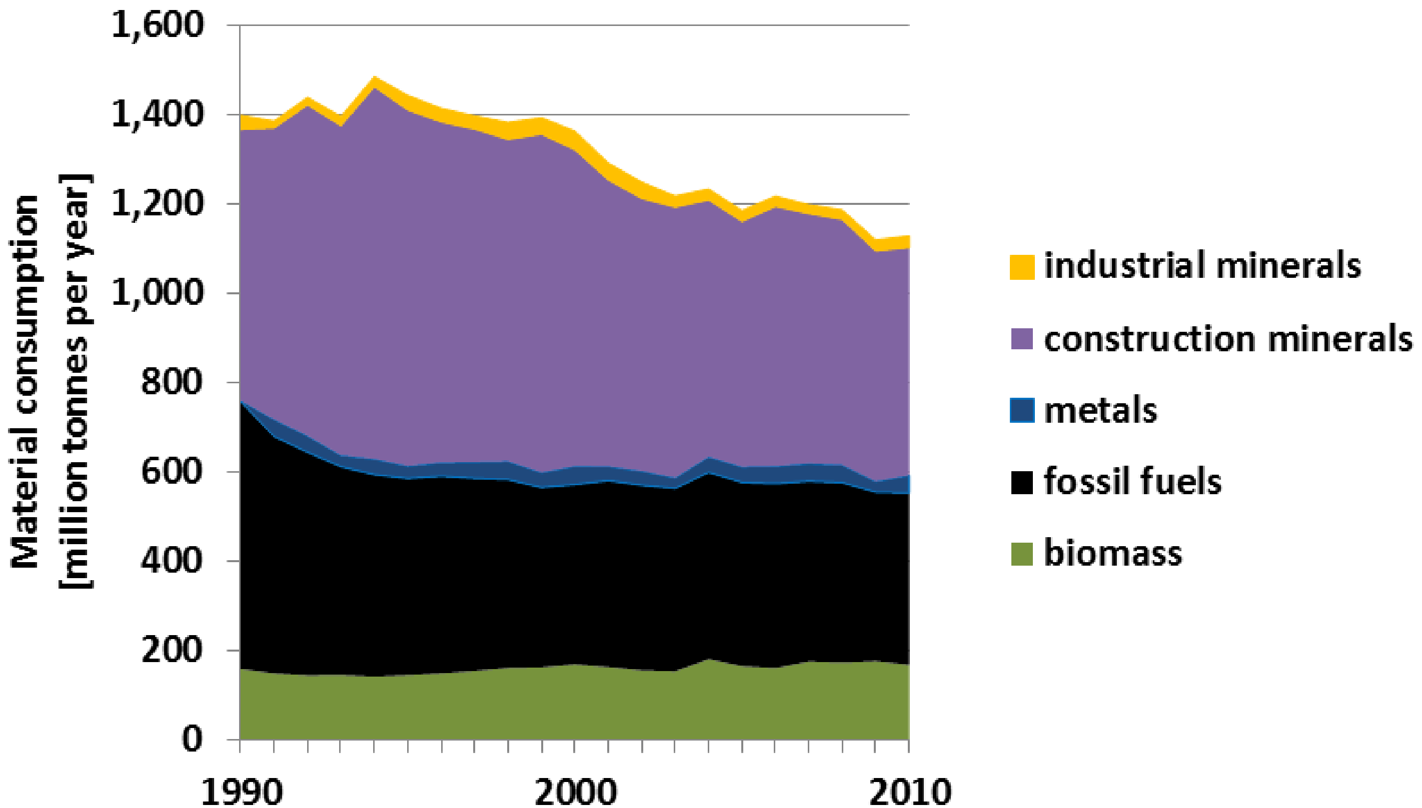


Source: OECD 2007

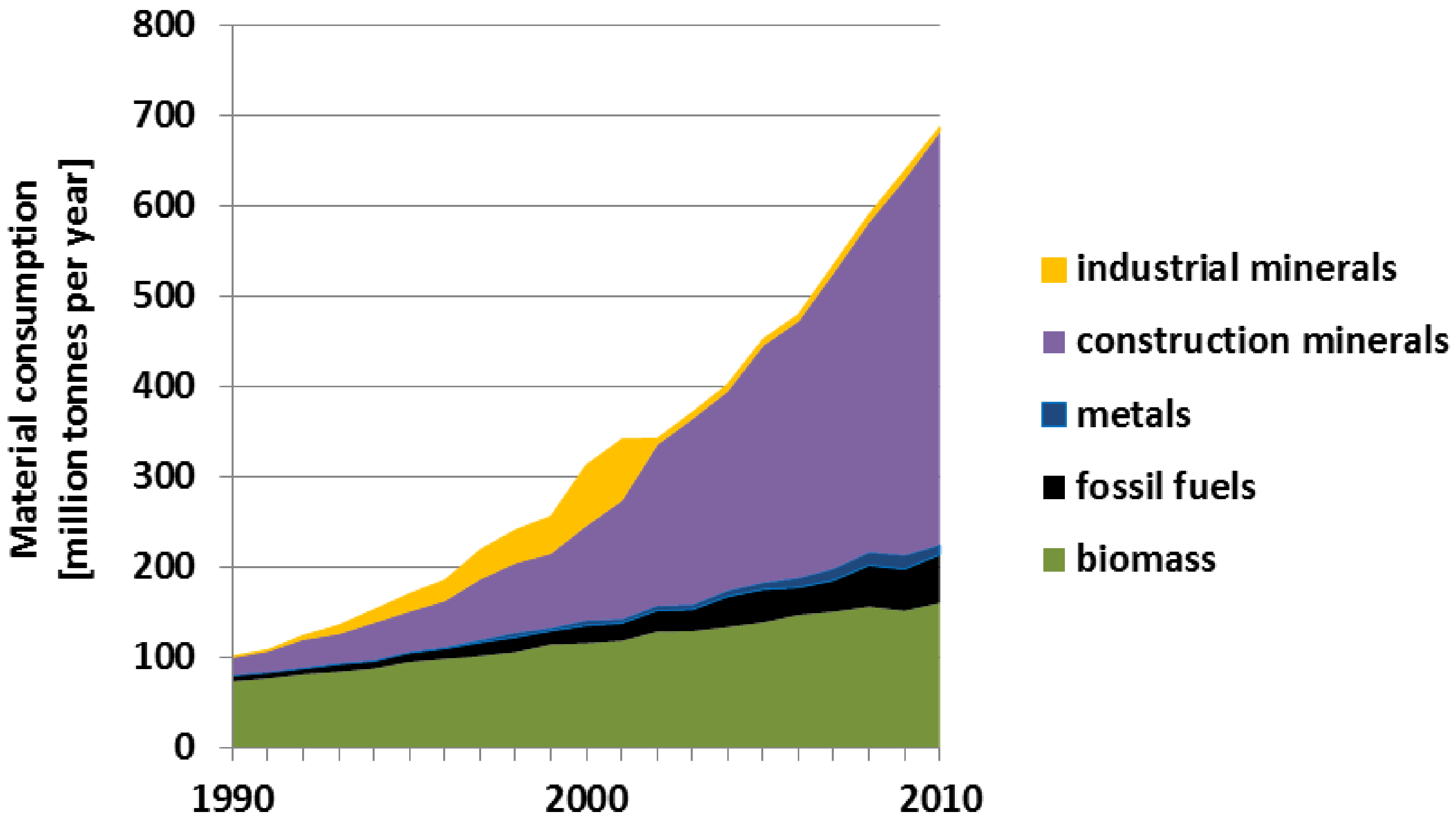
TYPICAL MATERIAL CONSUMPTION PATTERN DURING A DEVELOPMENT PROCESS



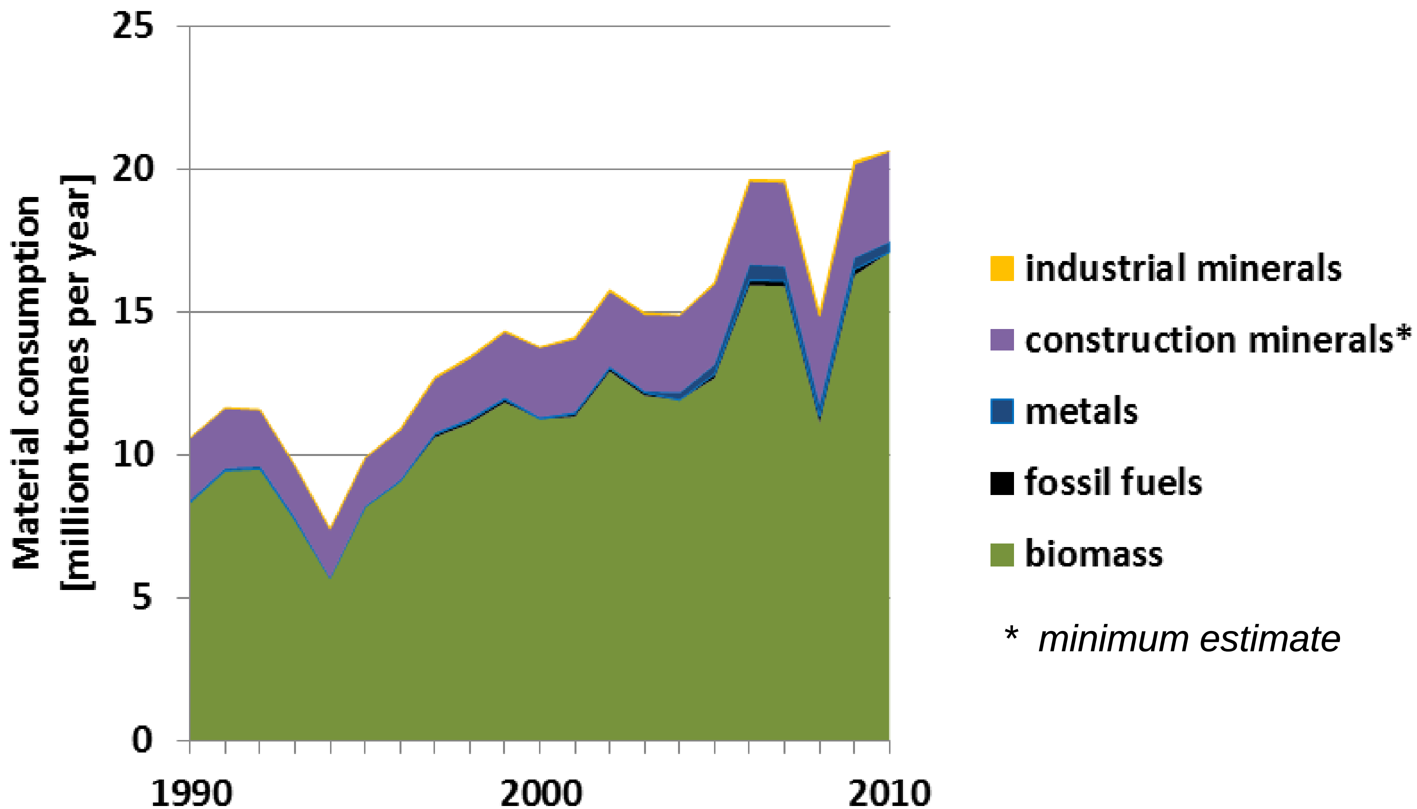
MATERIAL CONSUMPTION FLOW FOR GERMANY 1990-2010



Material consumption flow for Vietnam 1990-2010



MATERIAL CONSUMPTION FLOW FOR RWANDA 1990-2010

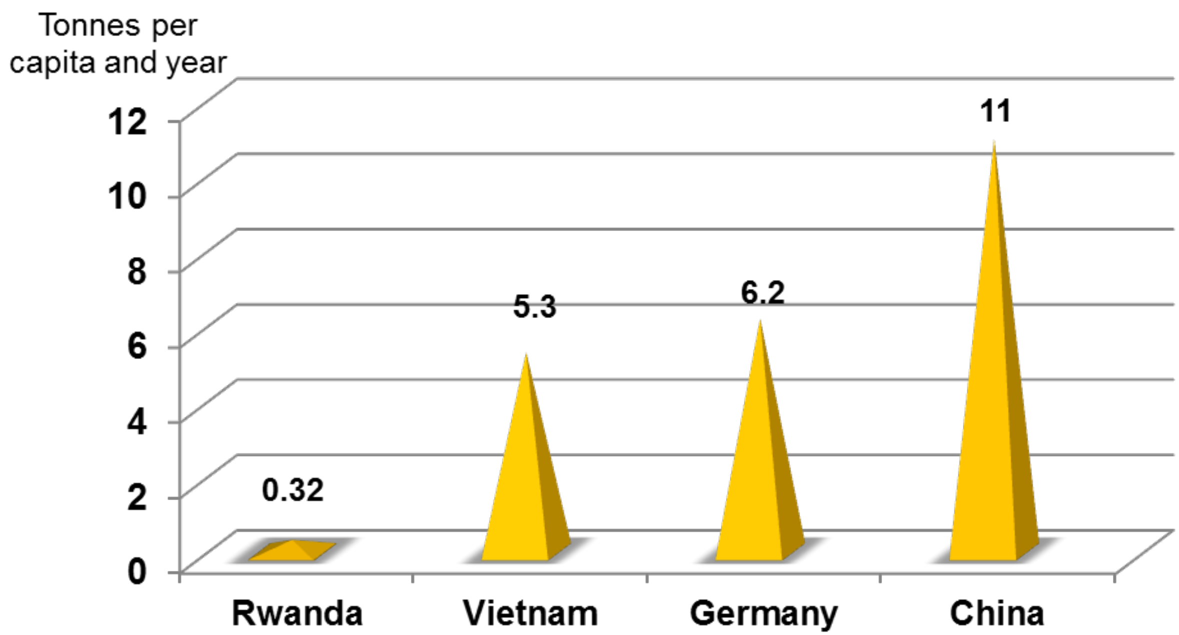


Material consumption in Rwanda, Vietnam, Egypt and Germany, 2010 [tonnes per capita]

	Rwanda	Egypt	Vietnam	Germany
Biomass	1.7	1.8	1.8	2.1
Fossil fuels	0.023[a)]	0.82	0.62	4.7
Metals	0.036	0.13	0.12	0.49
Construction minerals	0.32 [b)]	5.2	5.3	6.2
Industrial minerals	-0.000077	0.0021	0.057	0.32

(a) data for 2009; b) minimum estimate

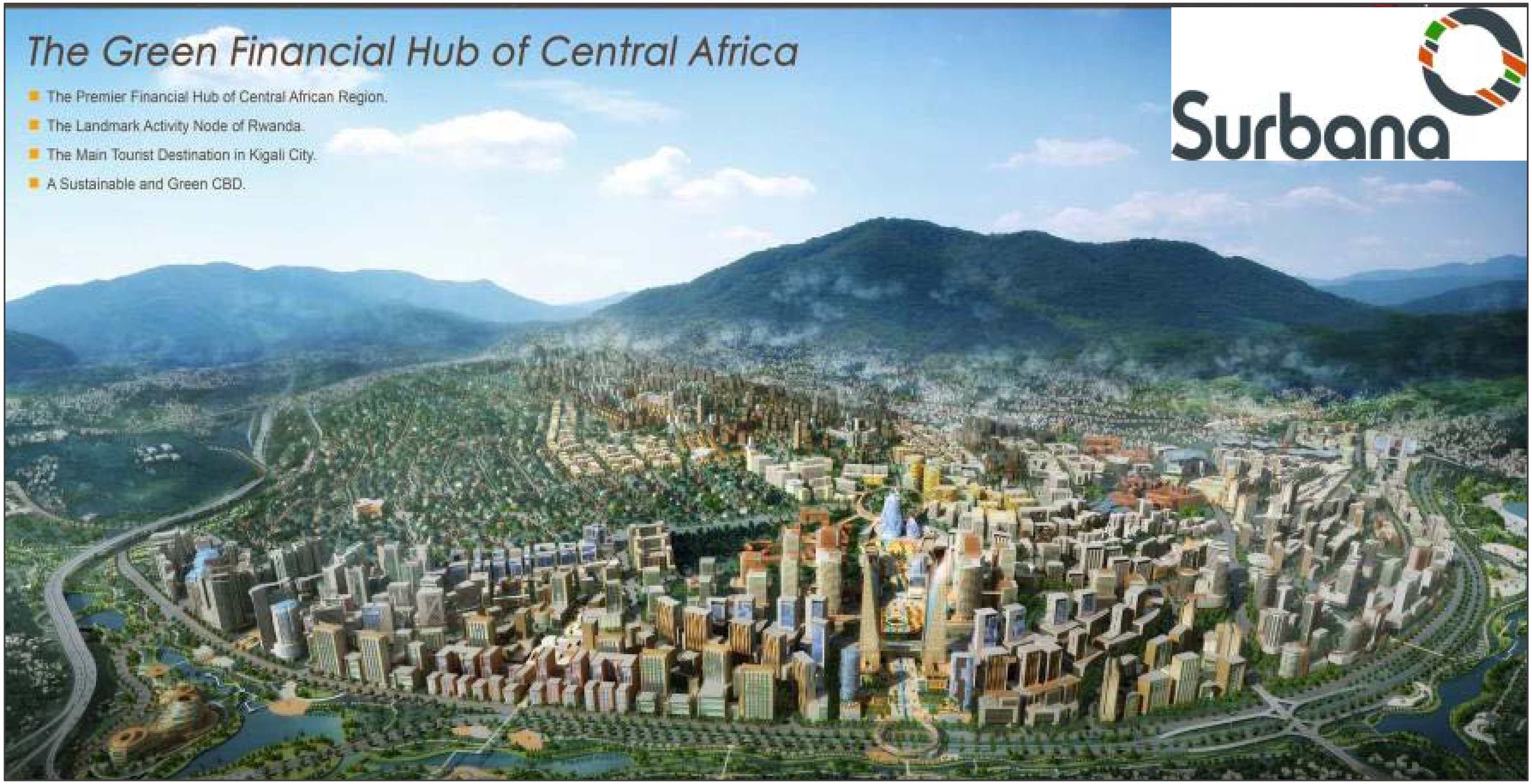
CONSUMPTION OF CONSTRUCTION MINERALS (2010)



Source: http://www.materialflows.net

2. CITY OF KIGALI MATERIAL AND ENERGY BALANCE

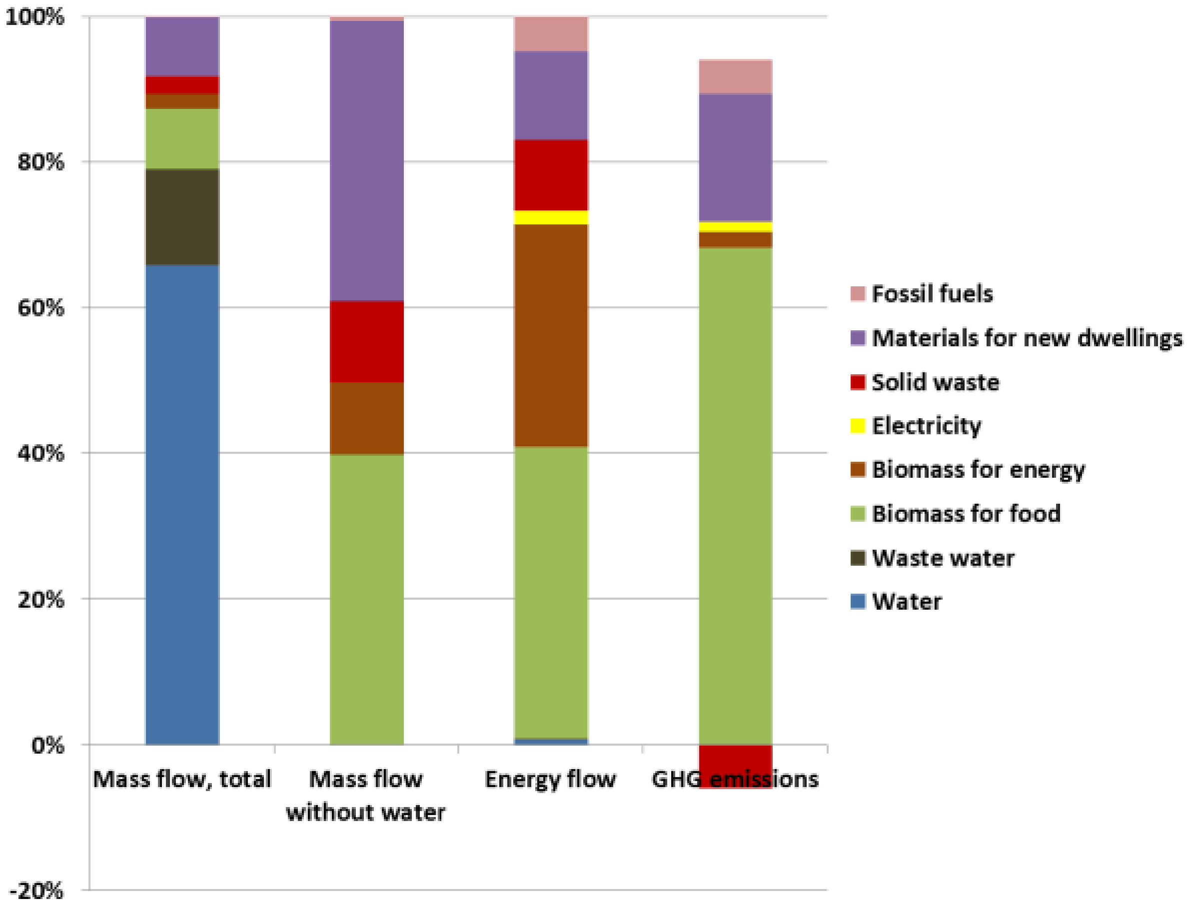
THE VISION: KIGALI CONCEPTUAL MASTER PLAN



CITY OF KIGALI MATERIAL AND ENERGY BALANCE

- Preliminary assessment
- Population: 1.3 million residents
- Water, energy and waste data for 2010
- Construction sector: 30,000 dwelling units per year (50% concrete and 50% bricks)
- Standardized GHG emission factors (need to be tailored to Rwanda conditions)

KIGALI FLOWS OF MASS, ENERGY, GHG EMISSIONS [% OF TOTAL]



Construction of 30,000 dwellings per year would account for 40% of the mass flow for solids matter in Kigali, demanding 12% of the energy flow and account for 20% of the GHG emissions.

Potential for improvement:
- use of biomass-based building materials,
- light-weight and
- high-density building designs,
- optimizing infrastructure.

3. How local and green can and should construction materials be?

RWANDA HOUSING POLICY, 17 MARCH 2015

REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

NATIONAL HOUSING POLICY

Final Draft 17/03/2015

Pillar 2: Resource-Efficient Planning, Green Technology and Professionalism

Policy Statement # 7
Building concepts shall adopt energy efficiency building standards, grey and rainwater recovery, and ICT facilitation

- Develop energy efficient building standards
- Establish regulations for grey and rainwater recovery, water treatment, and waste management
- Establish ICT building facilitation

RWANDA HOUSING POLICY, 17 MARCH 2015

4.8.1 Local construction materials

This policy supports the use of local construction materials. Emphasis should be on an increase of quantity of material produced in Rwanda, its quality, and on competitive costs of locally produced products.

- Competitive costs will be achieved through larger production and high efficiency in production.

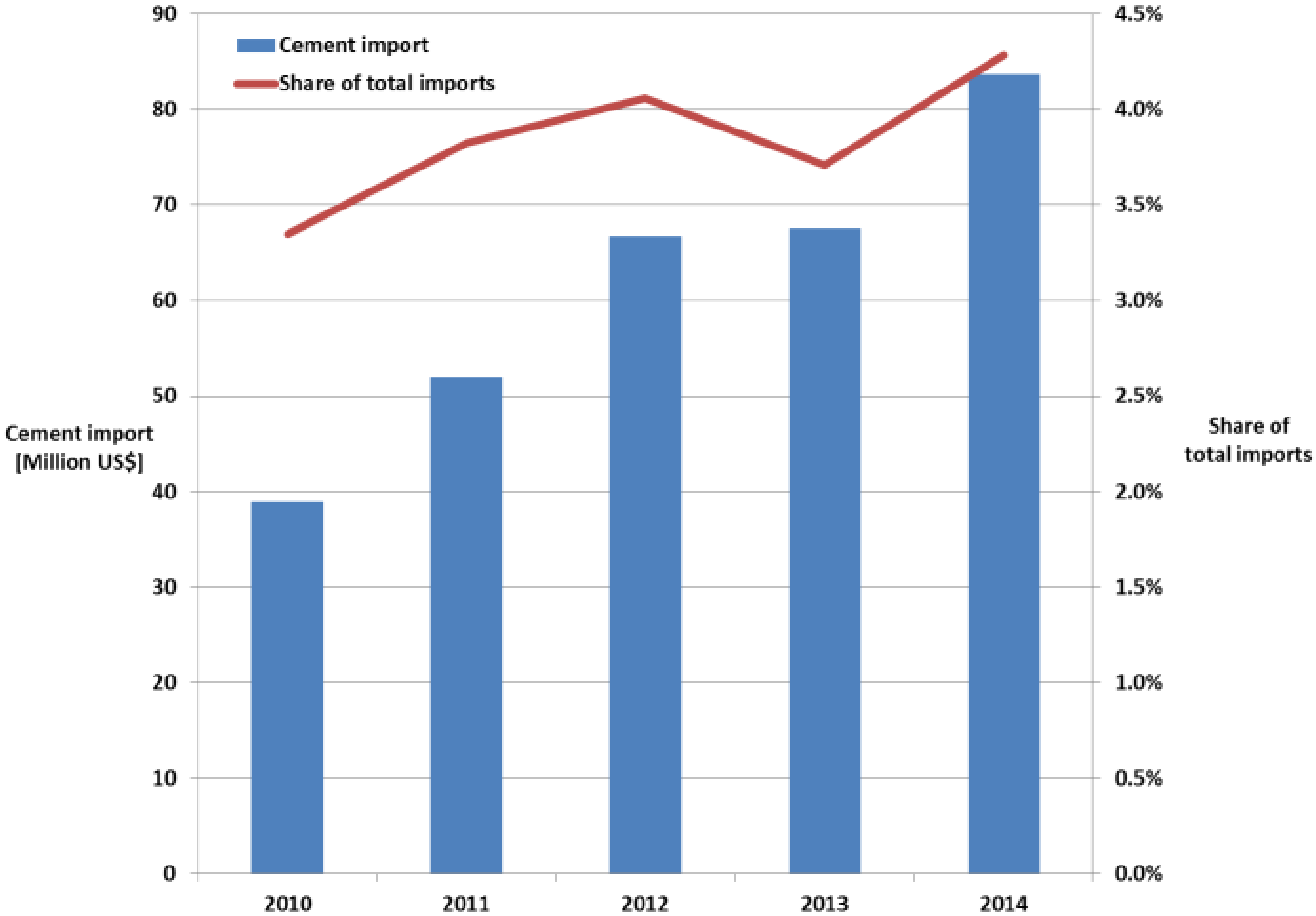
- The production of construction materials shall be “green”, considering any energy input required, carbon dioxide output reduction, labor creation, and ensuring no cause of reduction in food production.

PROPOSED INDICATORS FOR LOCAL AND „GREEN" CONSTRUCTION MATERIALS

- Cumulative energy demand (CED)
- GHG balance (CO_2-eq)
- Import quota
- Land use competition with food production
- Speed of construction
- Prices
- Other…

4. CASE STUDY: CEMENT AND SAND

IMPORT OF CEMENT INTO RWANDA



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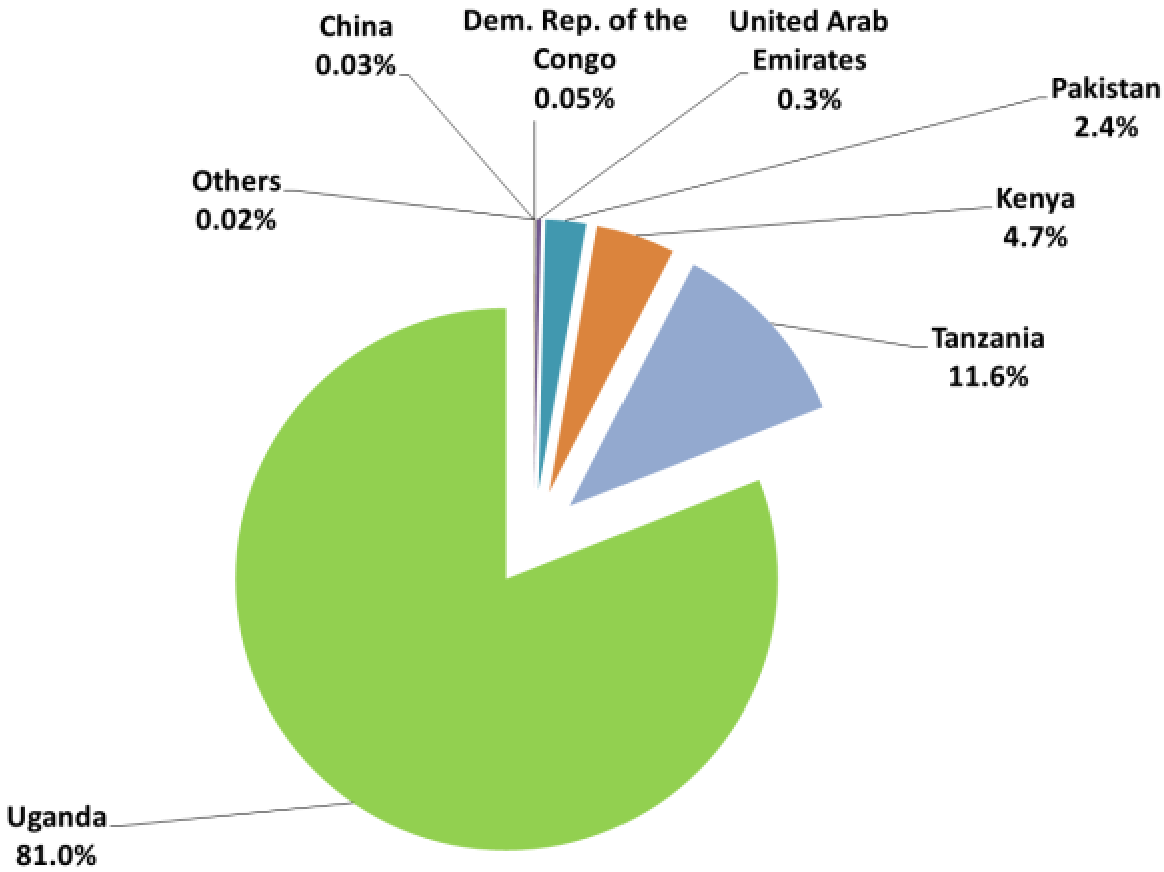
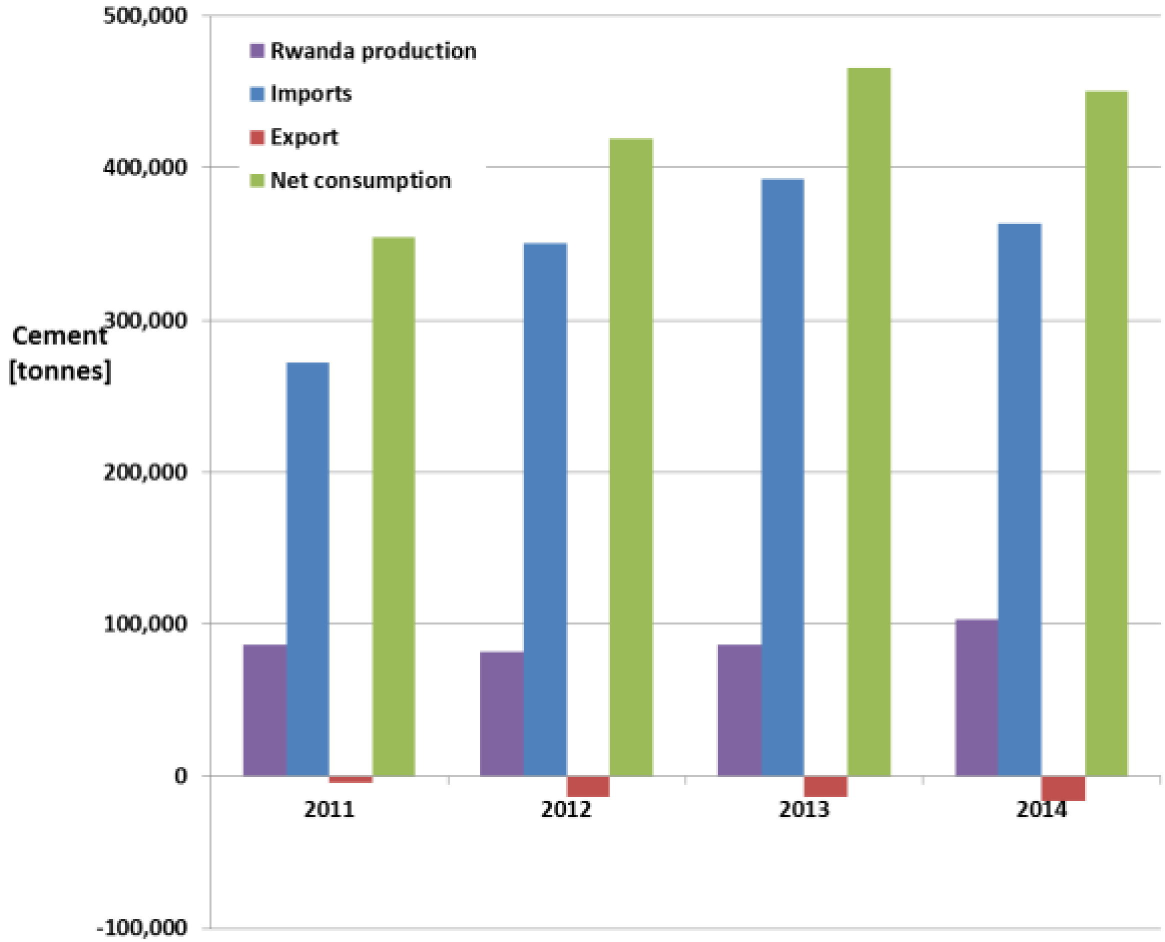
ORIGIN OF CEMENT IMPORTS INTO RWANDA, 2014



CEMENT CONSUMPTION, RWANDA, 2011-2014



CASE STUDY SAND

Sand mining at Mukunguri river,
(25 km SW of Kigali)

Cost for 15 m³ truck of sand:
- wages for miners: 15,000 RWF (18 €)
- purchase prices at site: 50,000 RWF (60 €)
- sale price in Kigali: ~300,000 RWF (360 €)

Cost per tonne for 25 km transport :
Kigali/Rwanda: 16,500 RWF (20 €)
Heidelberg/Germany: 4,500 RWF (5.50 €)

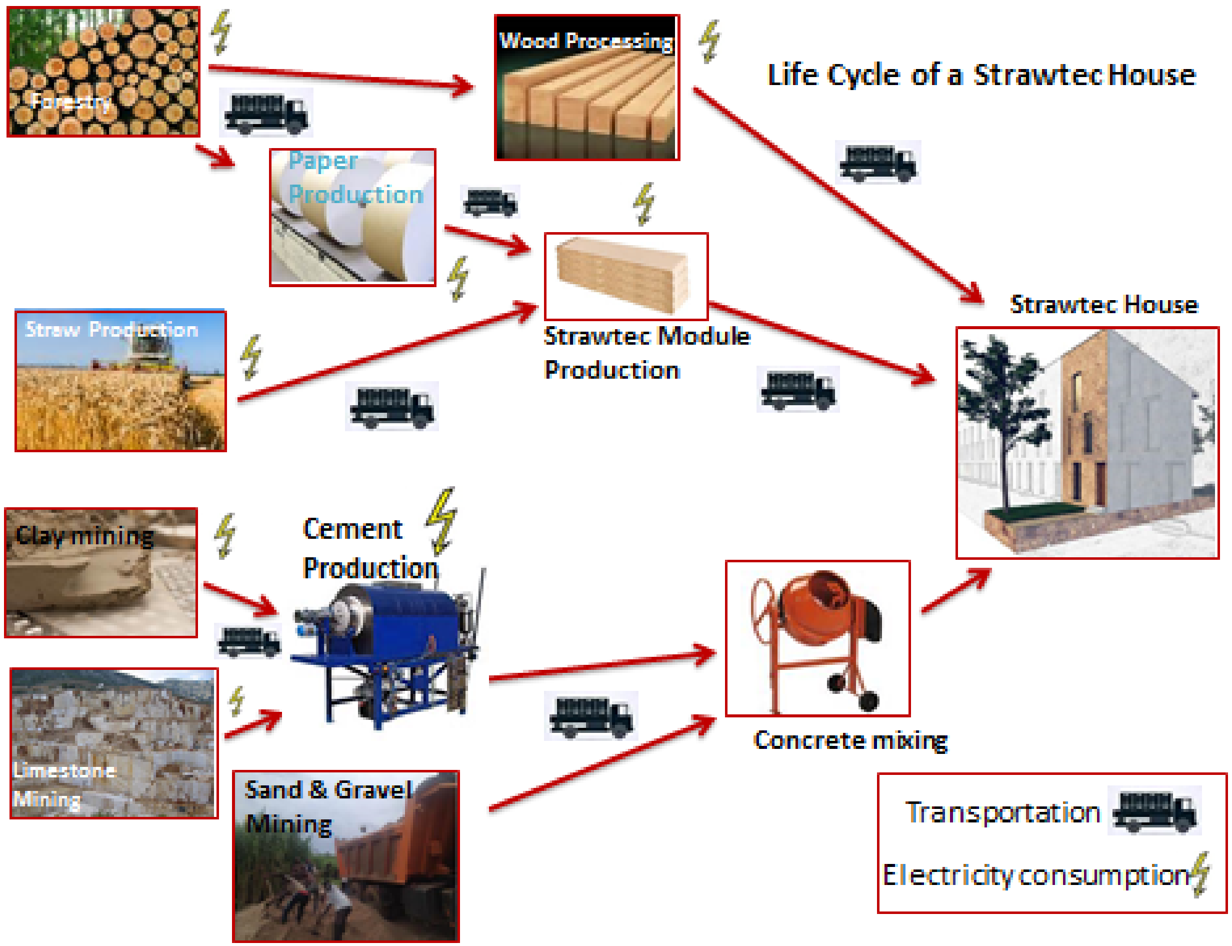
ROAD CONDITIONS IMPACT TRANSPORT COSTS

Research questions

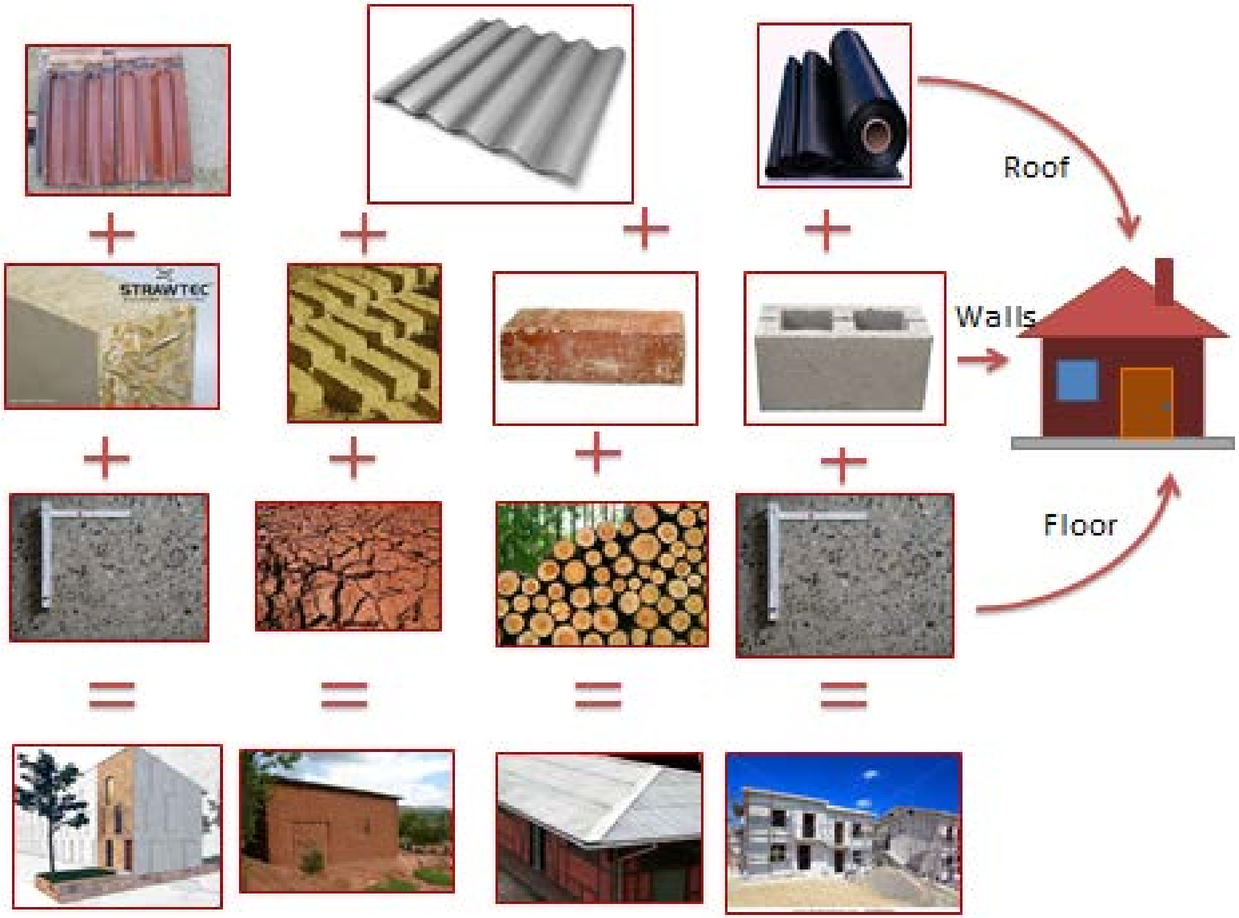
- Cost factors for building materials (salaries, taxes, fees, transport, profit)
- Cost cutting options (e.g infrastructure improvement (roads)
- Price setting mechanisms

5. LIFE-CYCLE ASSESSMENT (LCA) FOR BUILDINGS: STRAWTEC PANELS VS. CONCRETE BLOCKS

LIFE-CYCLE ASSESSMENT (LCA)



LIFE-CYCLE ASSESSMENT (LCA): COMPONENTS



LIFE-CYCLE ASSESSMENT: SYSTEM BOUNDARY

House Type A STRAWTEC

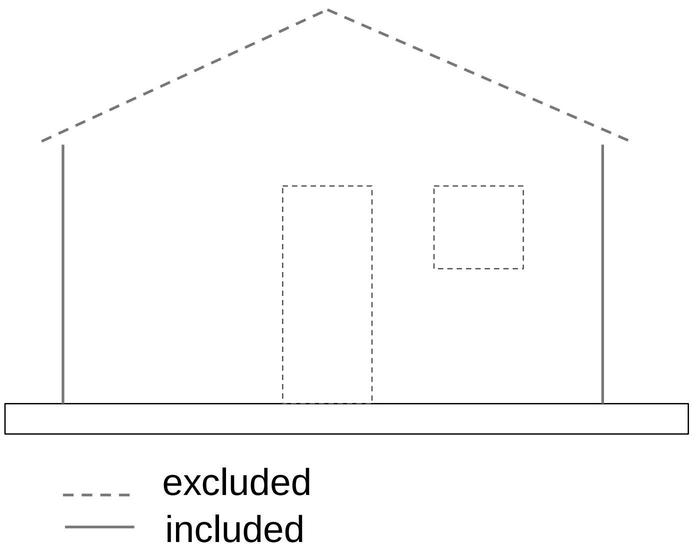
- exterior walls — Strawtec
- columns — -
- foundation slab — concrete

House Type B CONCRETE

- exterior walls — concrete hollow blocks
- columns — reinforced concrete
- foundation slab — concrete

House Type C HYDRAFORM

- exterior walls — hydraform bricks
- columns — -
- foundation slab — concrete



Functional Unit: 45 sqm house

Cradle-to-Gate LCA

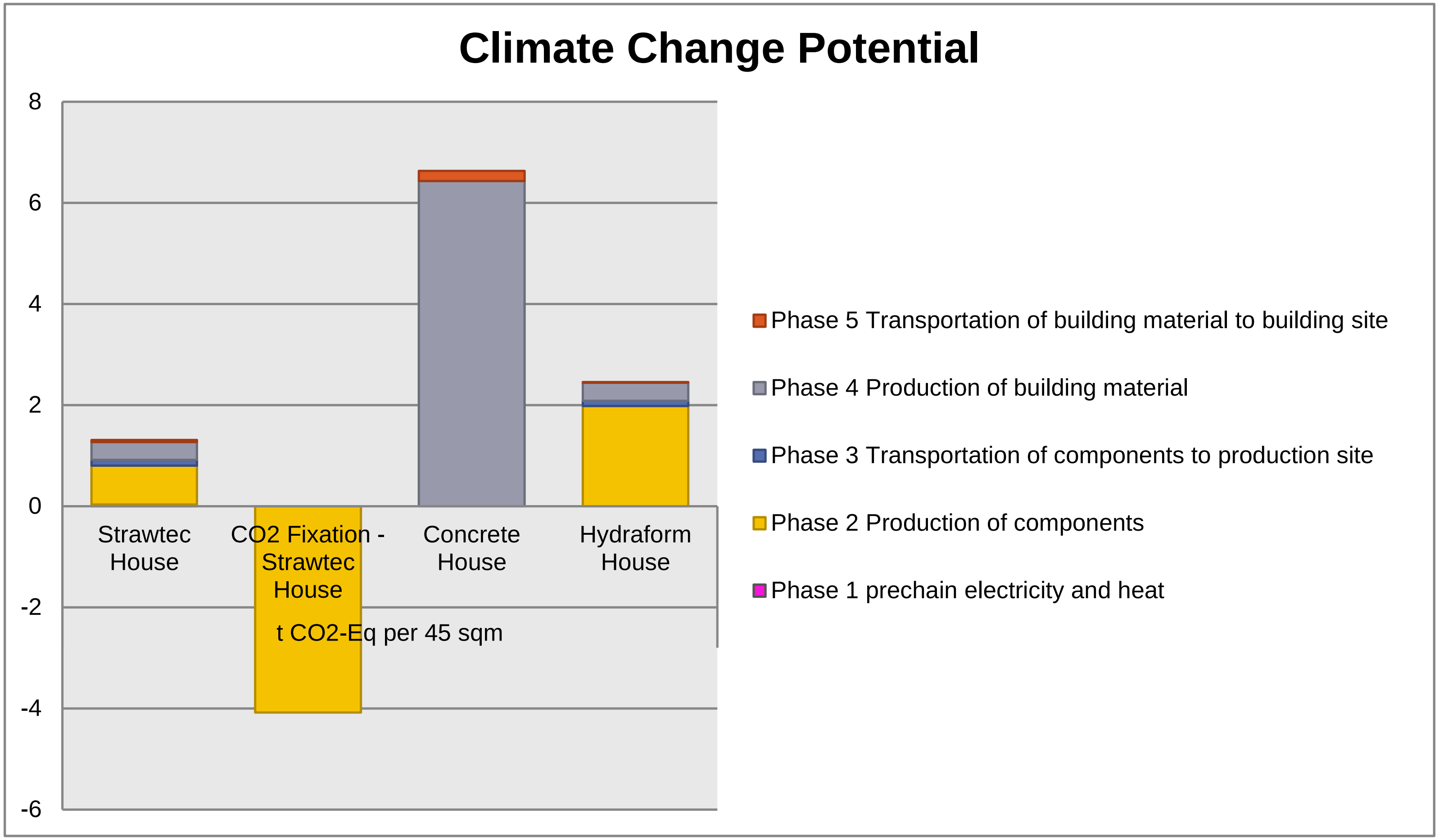
LIFE-CYCLE ASSESSMENT: DATA

Process data	Data source	Reference area
straw & strawtec	Strawtec Group AG**	Rwanda
paper	ecoinvent 3*	Europe
glue	ecoinvent 3*	Europe
concrete	ecoinvent 3*	World
concrete hollow block	ecoinvent 3*	World
reinforcing steel	ecoinvent 3*	World
hydraform	Hydraform**	South Africa
cement CEM II/A-P 42,5N	ecoinvent 3*	World
laterite (soil)	ecoinvent 3*	World

Transportation data	km to production site	km to building site
Strawtec (straw+paper+glue)	(70+13500+14500*)	50
concrete	*	50
concrete hollow block	*	50
reinforcing steel	*	50
cement CEM II/A-P 42,5N	350*	0
laterite (soil)	0*	0

* Rwanda-specific adjustments planned, ** background data ecoinvent 3

LIFE-CYCLE ASSESSMENT: RESULTS



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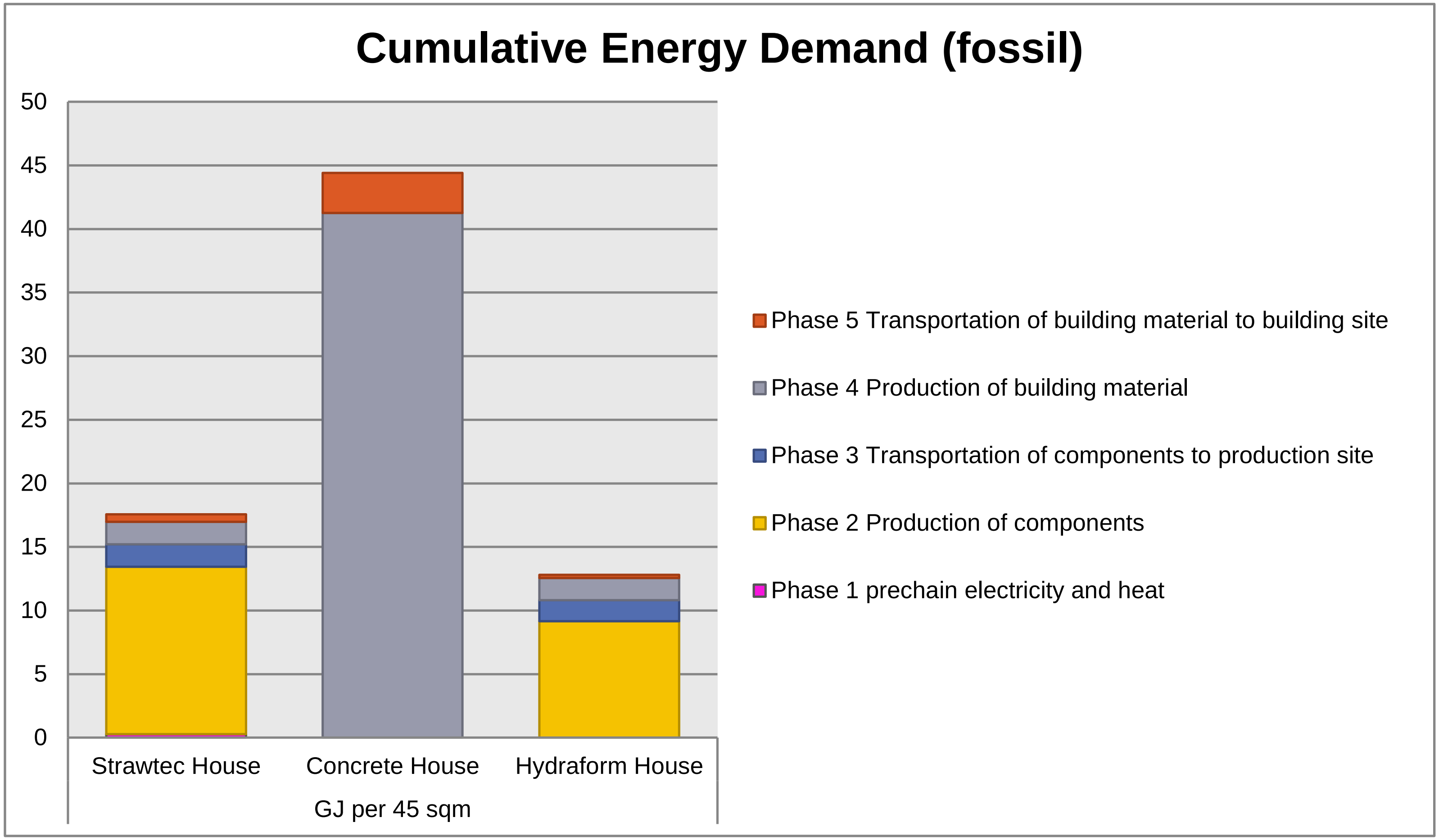

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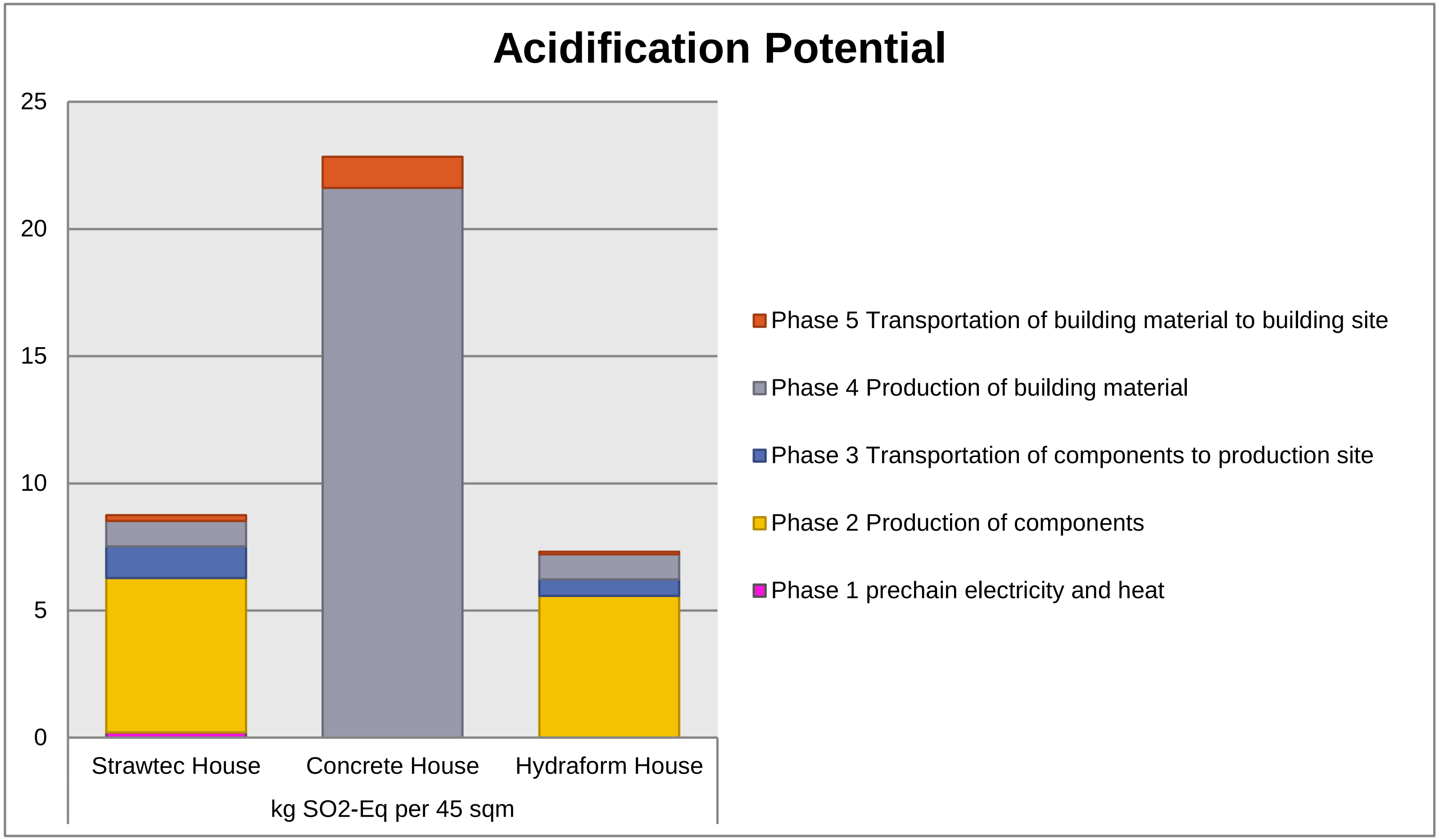

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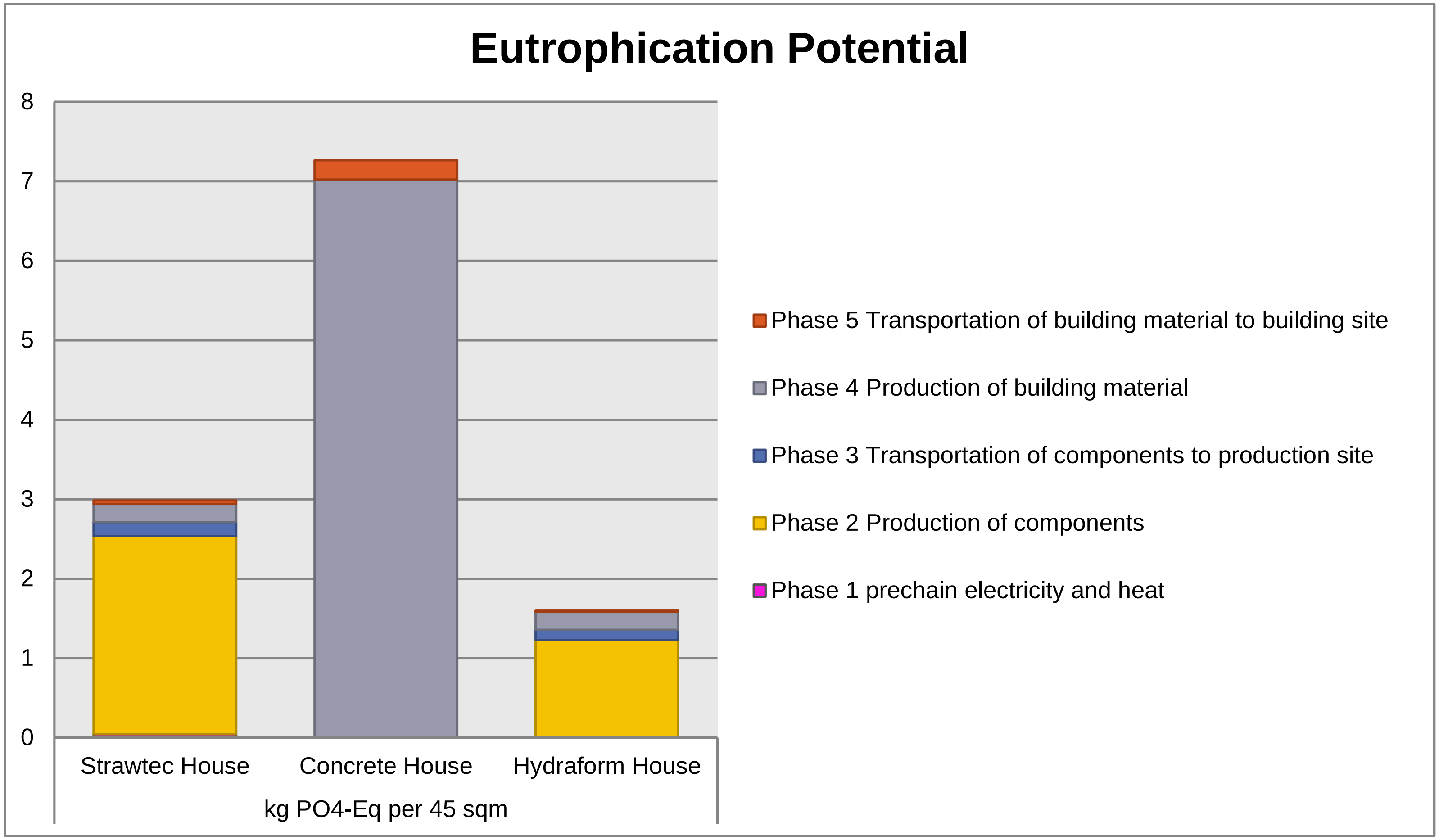
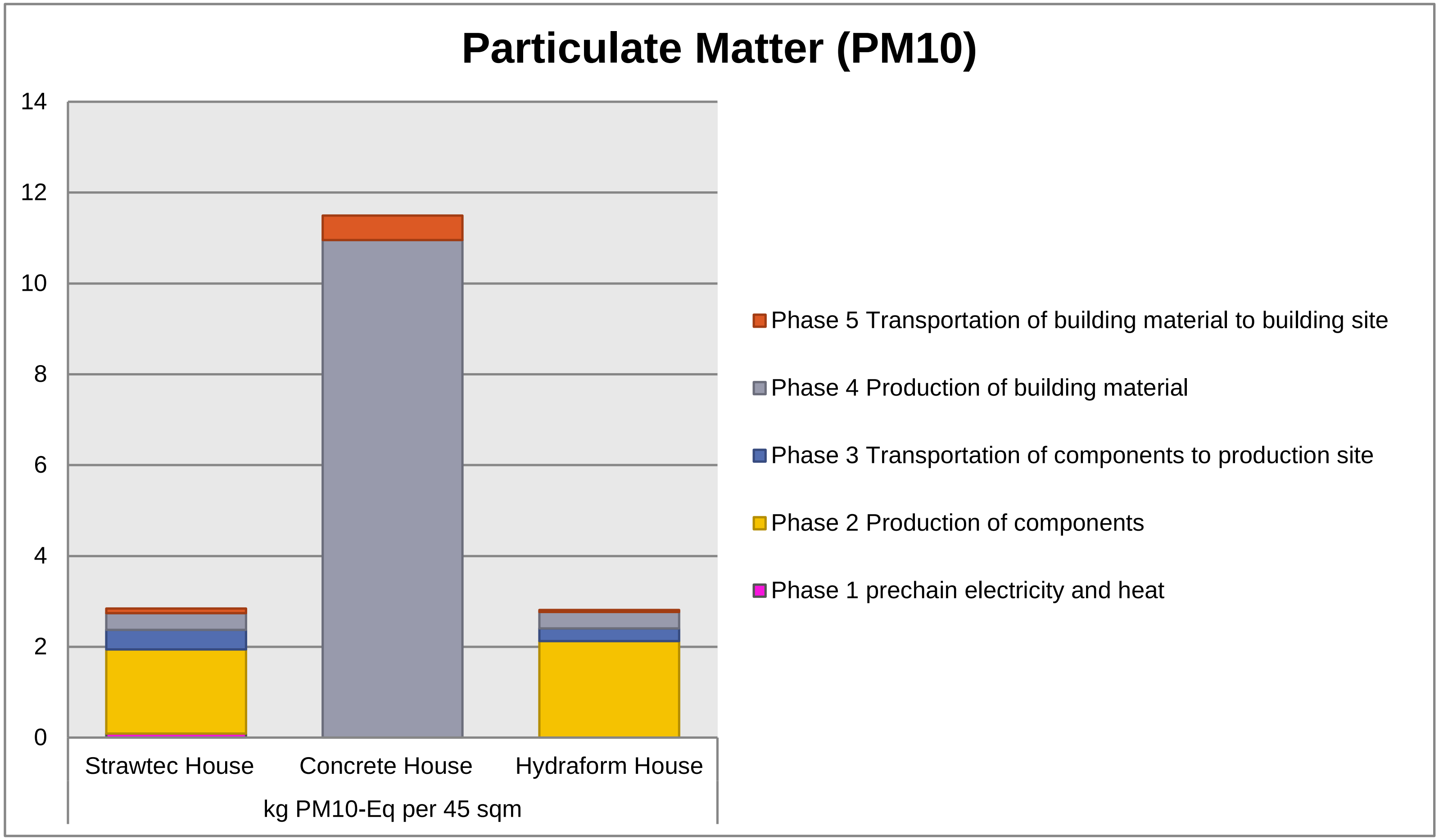
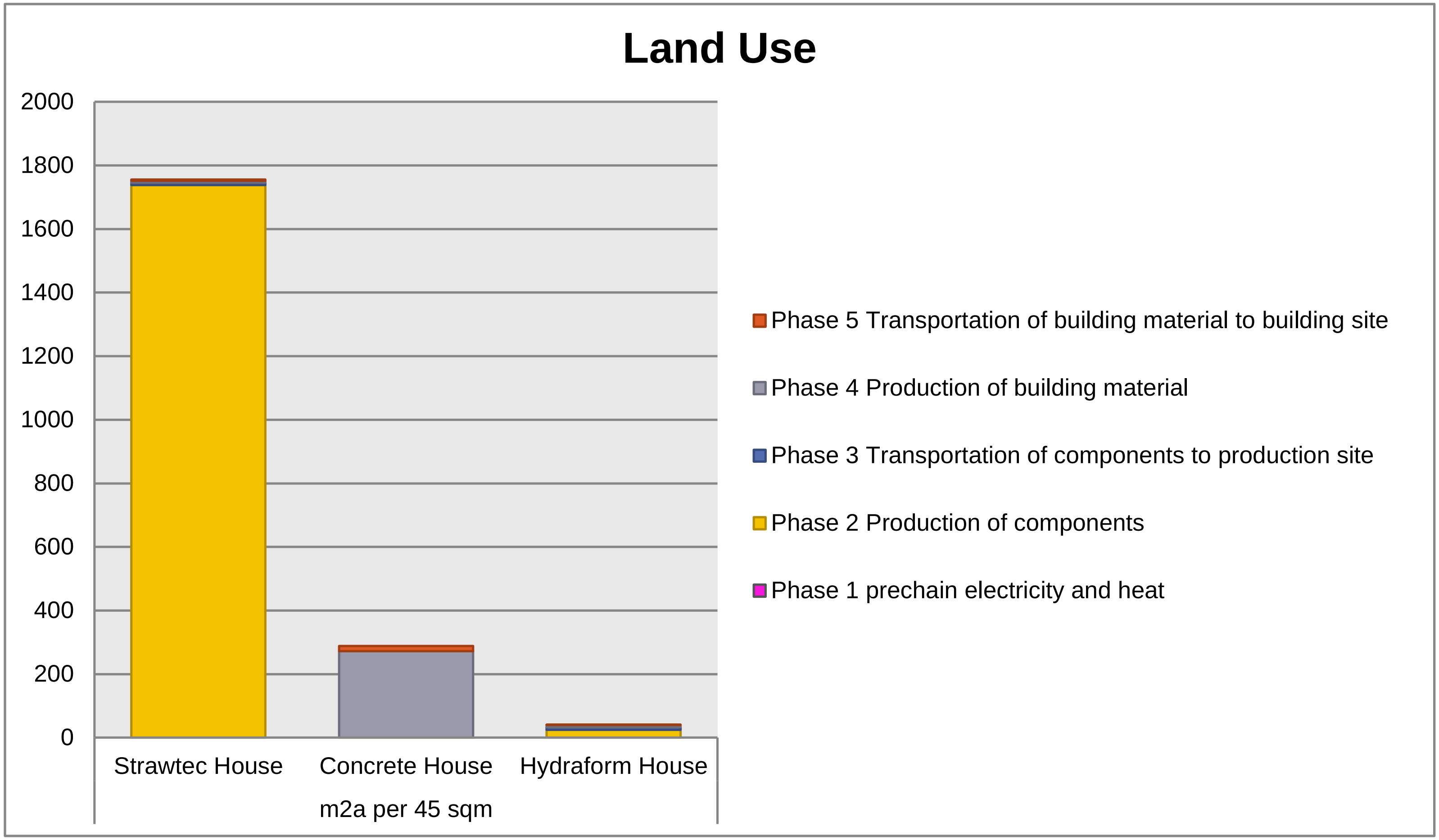


LIFE-CYCLE ASSESSMENT: RESULTS



Life-cycle Assessment: results



BUILDING MATERIALS CALCULATOR

Web-based / Excel-based tool to determine the sustainability of buildings

- Allows easy entry of material options for buildings
- Using LCA to quantify impacts
- Qualitative results for other indicators
- Cost data if possible

Construction materials for Rwanda conditions

- Traditonal mud & wood houses
- Prefabricated concrete blocks
- Fired brick
- Strawtec
- Can be expanded to other components (windows, plumbing et.)

6. CONCLUSIONS

1. The construction sector is likely to dominate the material flows in Rwanda in the coming decades.
2. Extraction and production flows for cement, sand/gravel, wood, straw and other materials need to be monitored carefully.
3. Transparent material supply chain data can help identify cost-cutting (choice of materials, logistics etc.).
4. The LCA suggests the significant advantage of bio-based building materials; potential land-use conflict need to be monitored closely.
5. Rwanda needs easy-to-use indicators for local and green construction materials. A Building Materials Calculator can facilitate the sustainability assessment.

Thank You!
[English]

Cảm On!
[Vietnamese]

Danke!
[German]

Murakoze!
[Kinyarwanda]

Shukran!
[Arabic]

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