Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

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THIS PRESENTATION WAS SHARED BY

Prof. Ashok B. Lall

Principal Architect,
A.B. Lall Architects, New Delhi

FOR THE SESSION:

"Affordable and Sustainable Development: Priorities for India"

DURING ANGAN 2019

Knowledge Partner

teri The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

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Urbanisation and Sustainable Development: The DNA of Sustainable Urban Morphology

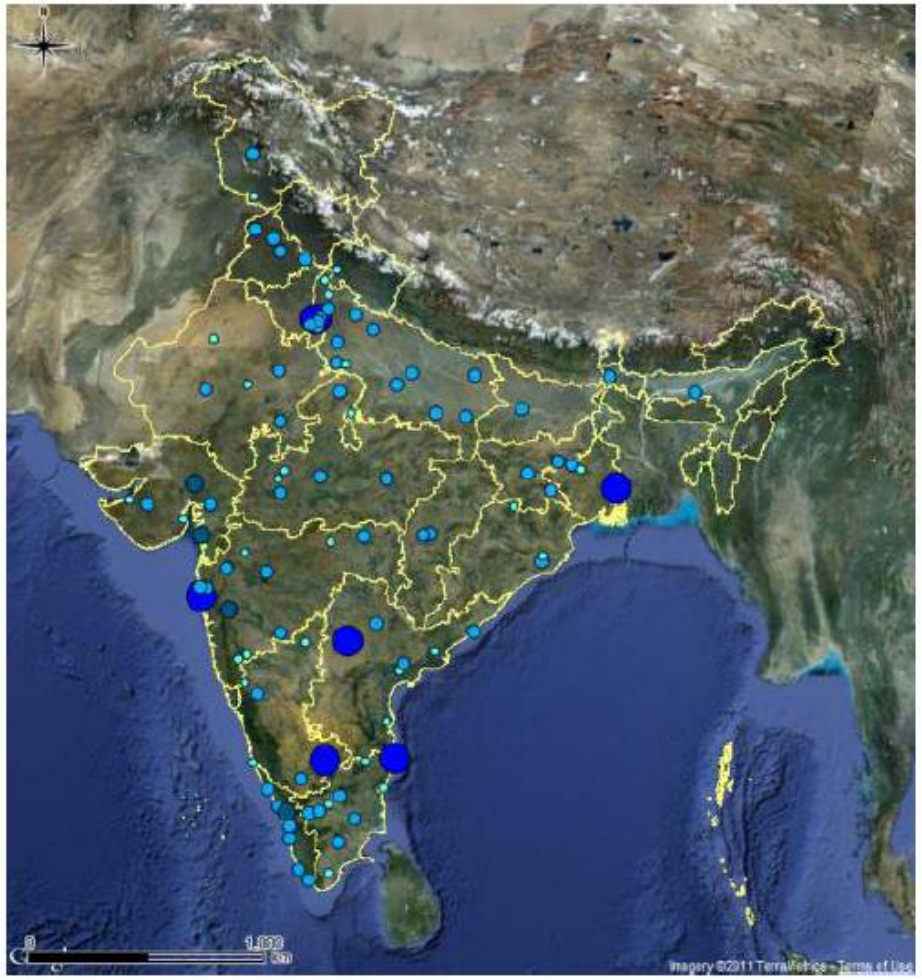
ANGAN

New Delhi , September 2019

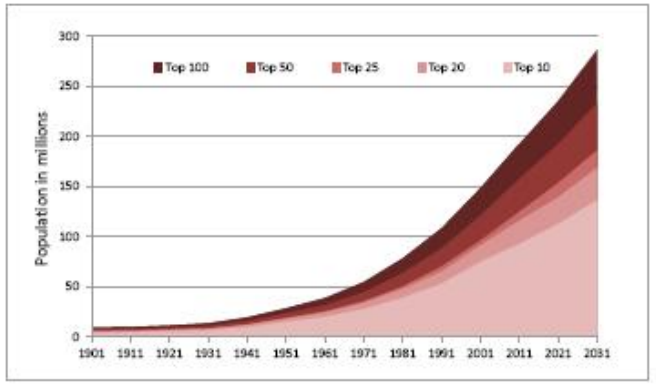
Ashok Lall

URBANISATION TRENDS IN INDIA

Urban India: 2031



By 2031, it is projected that there will be 6 cities with a population greater than 10 million. A key question is how many Indians would live in how many medium and small towns - the bridge between a transforming rural and urban India?



Cities Size Class by Population
- 0 - 0.1 million
- 0.1 - 1 million
- 1 - 5 million
- 5 - 10 million
- 10 - 30 million

Source: IIHS Analysis based on Census of India. (Satellite Map, Google Inc.)

POLICY IMPERATIVES

Affordable homes at locations of employment and economic opportunity with access to public transport and social amenities. Livelihoods in an inclusive construction economy

Resilience of urban living in cases of infrastructure breakdown and disasters, with sufficiency of habitable space and environmental security – water, air, recycled waste.

Use of low-carbon and resource-efficient modes of production for construction of housing and selecting building types for minimum operational energy.

Build-in resilience against extreme events, shade and green for a habitable outdoors against heat waves, aggregate rain harvest and water efficiency, minimize hard ground and motor vehicles for low UHI

Housing for all
Ministry of Housing & Poverty Alleviation

SUSTAINABLE DEVELOPMENT GOALS

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

PURPOSE OF URBAN DEVELOPMENT ?

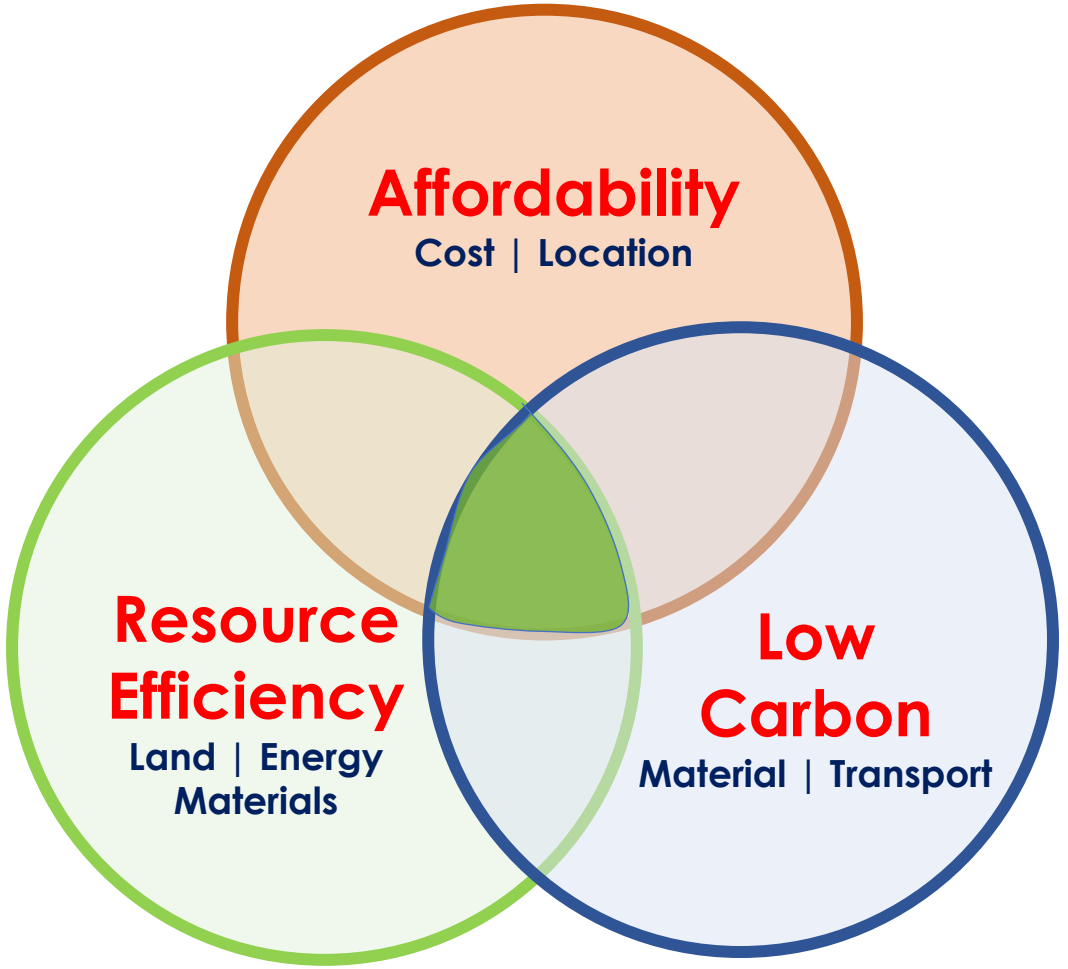
The purpose of urban development, which encompasses the regeneration of existing cities and their expansion, must be to use these very processes as levers for distribution of the wealth and knowledge generated by the urban economy.

Urban Development must produce greater equity along with economic growth. It must benefit all citizens

OPPORTUNITY OF URBAN DEVELOPMENT ?

To adopt that DNA of urban morphology in seeding the city's regeneration and expansion which will make the city affordable, accessible as well as environmentally secure and sustainable.

This DNA will make will enable the Nation to fulfil its promise to the world of following the Sustainable Development Goals and Reducing the Carbon Intensity of GDP



"A combination of resource-efficient and low-carbon construction with compact urban morphology and low-carbon city transport produces low carbon and affordable urban systems. "

Low Carbon Affordable City

LOW RISE -HIGH DENSITY

DU/Ha – ***400***

Open Space/DU- **15m²**

Construction Cost- Rs.**9000-11000**/sqm

80% Solar Potential *for renewable energy from rooftops*

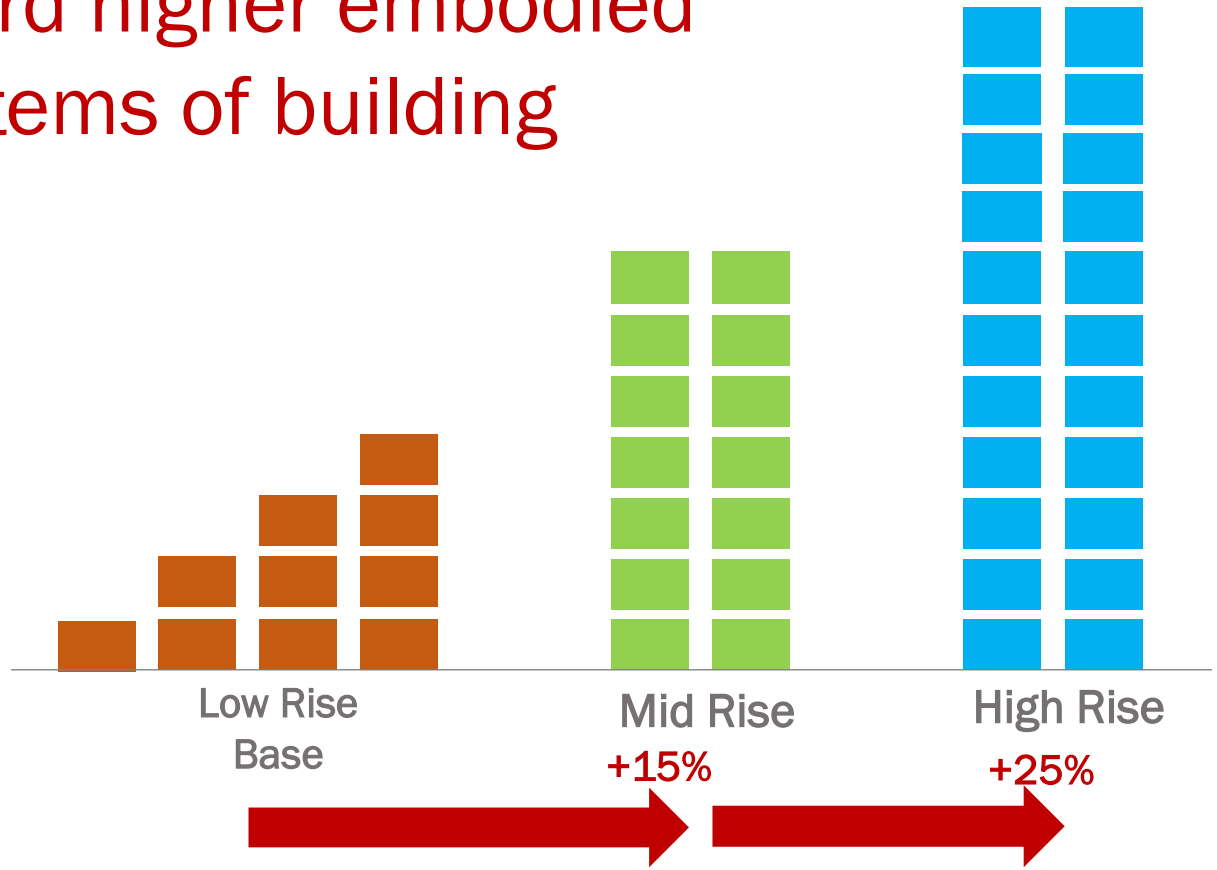
3 million tonnes less of CO_2 emissions, if Low-rise format is used in Gujarat State instead of High-Rise in the next decade

Quick construction time *with rationalized simple building technologies*

Best opportunity for wealth distribution through the construction process

BUILDING TECHNOLOGY & CARBON EMISSIONS

Trend toward higher embodied energy systems of building



Housing comprises 70% of the city's Built Space

The Multiplier Effect of Embodied Energy in Construction Materials and Methods

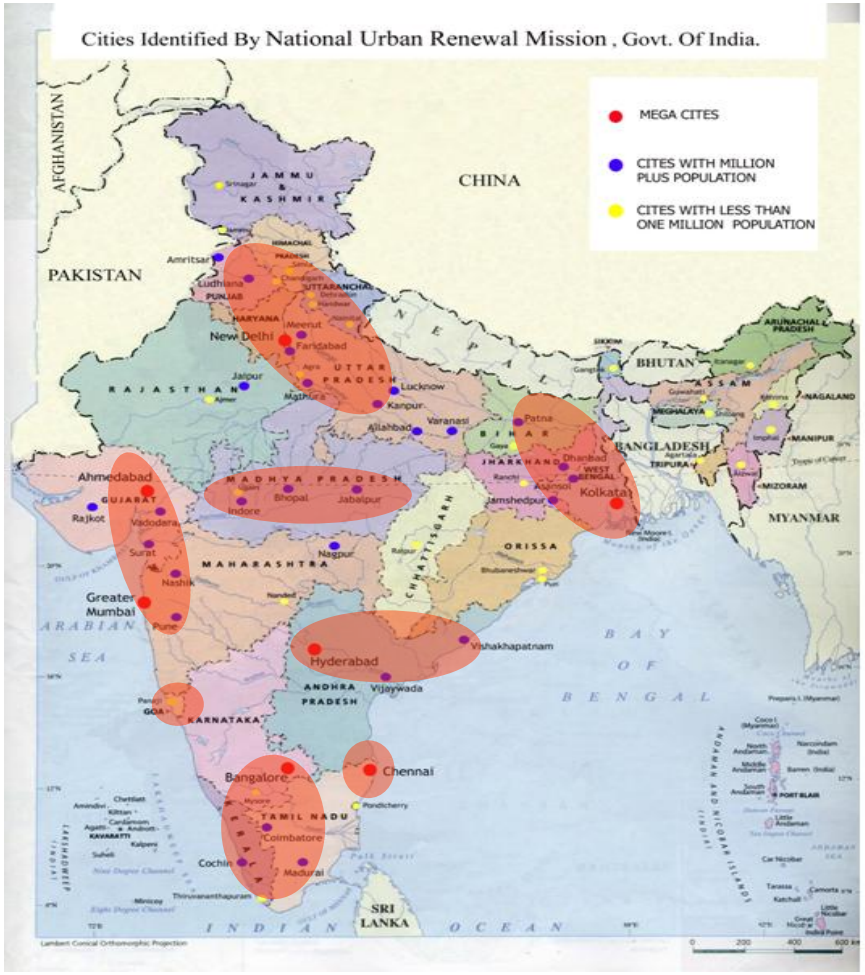
50% addition of built-space to existing stock

X

50% increase in embodied energy per unit area

X

over 63 cities of 1 million plus population today



COMPRESSED INTO ONE DECADE!

WE HAVE AN EXPLOSION OF CO2 EMISSIONS ON ACCOUNT OF THE EMBODIED ENERGY OF CONSTRUCTION – WHICH CANNOT BE THEORETICALLY AMORTIZED OVER THE LIFE OF THE BUILDING.

Next 5 years' projection

20 million dwelling units

↓

10 sqm Floor Area/ dwelling unit
(for air conditioning)

↓

@ 90 watts/ Sqm

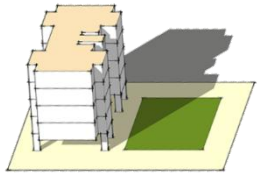
↓

18000 MW
Additional summer peak load

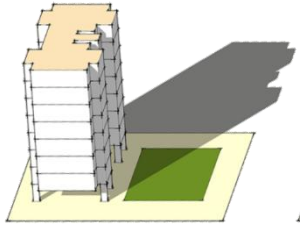
This is a mere tip of the iceberg if we were to also take into account the existing housing stock, and future growth that might plateau by 2030.

Methodology for Evaluation

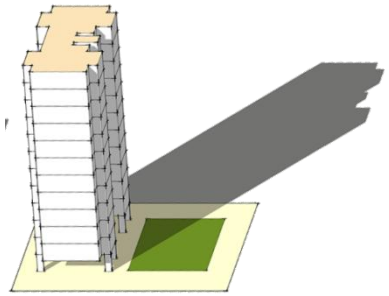
In this study, the buildings are classified in 3 typologies :



Low rise(<16.5m),



Medium rise(16.5-25m)



High Rise(>25m)

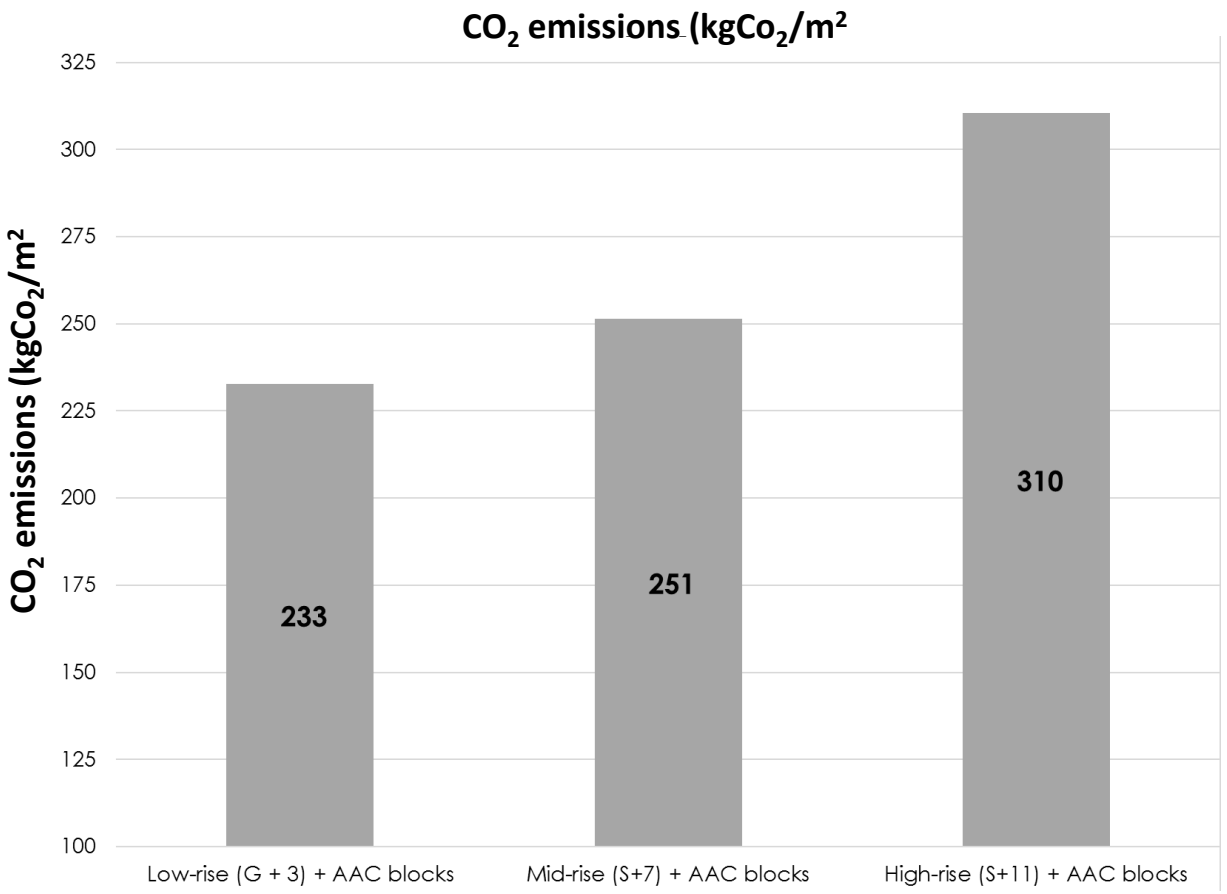
This study has evaluated the potential of Low Carbon resource-efficient affordable housing on various parameters over 3 scales:

Building Level

Neighbourhood Level

City Level

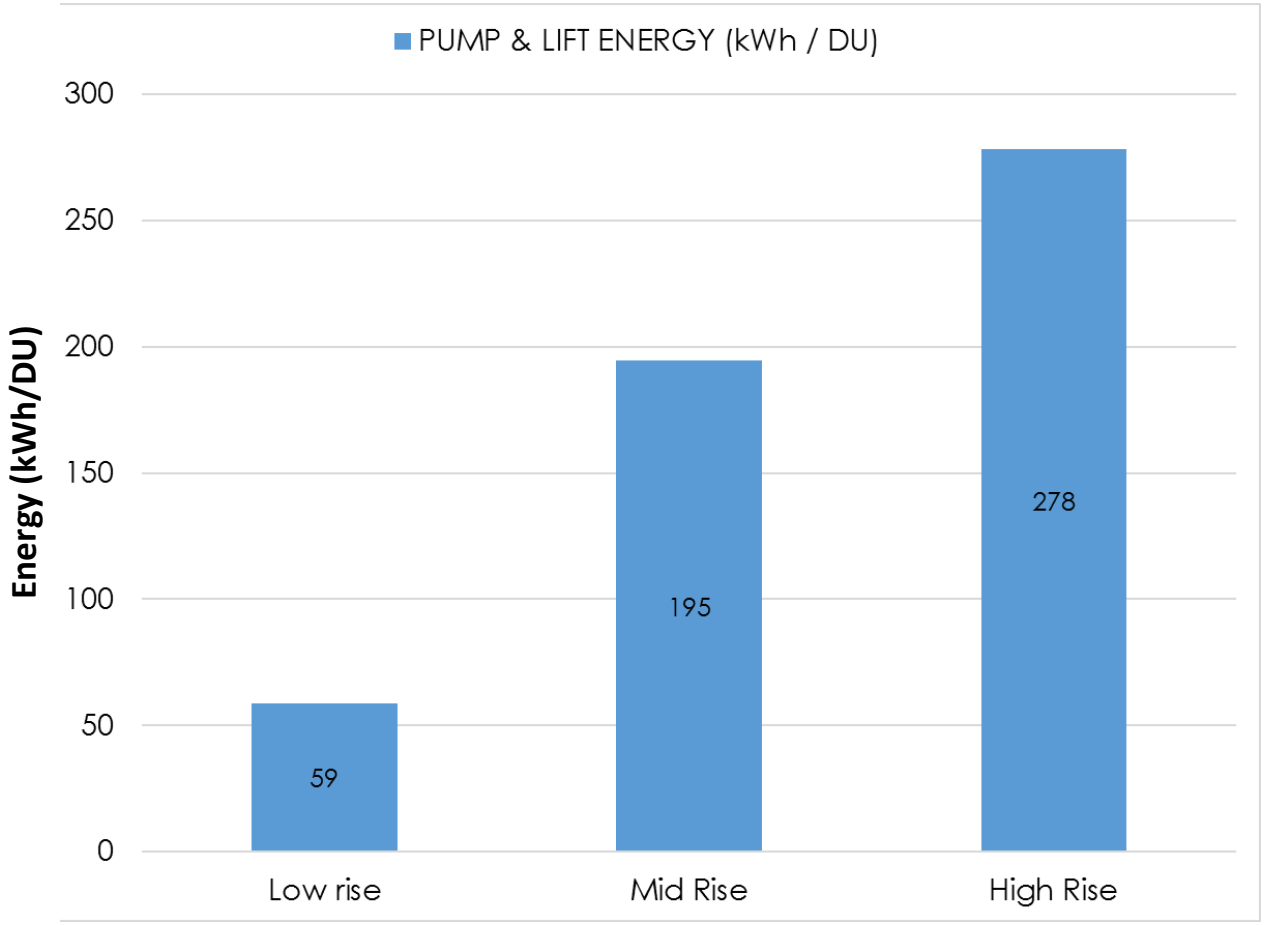
Embodied Energy Efficiency

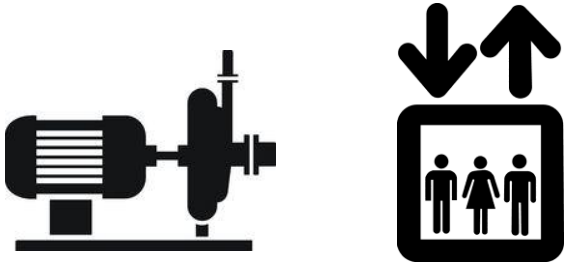


- Given the same walling material, the taller our buildings are, greater will be the CO_2 emissions, due to higher steel and cement content.
- As we go from low-rise to mid-rise and high-rise buildings, CO_2 emissions will increase around 15% and 35% respectively.
- The CO_2 emissions are higher if we use brick and monolithic concrete. Use AAC/Hollow-core/Fly ash bricks/ Hollow-core/ Hollow burnt- clay brick instead

Hollow Core Blocks | AAC Blocks | Flyash Bricks | Hollow burnt-clay brick

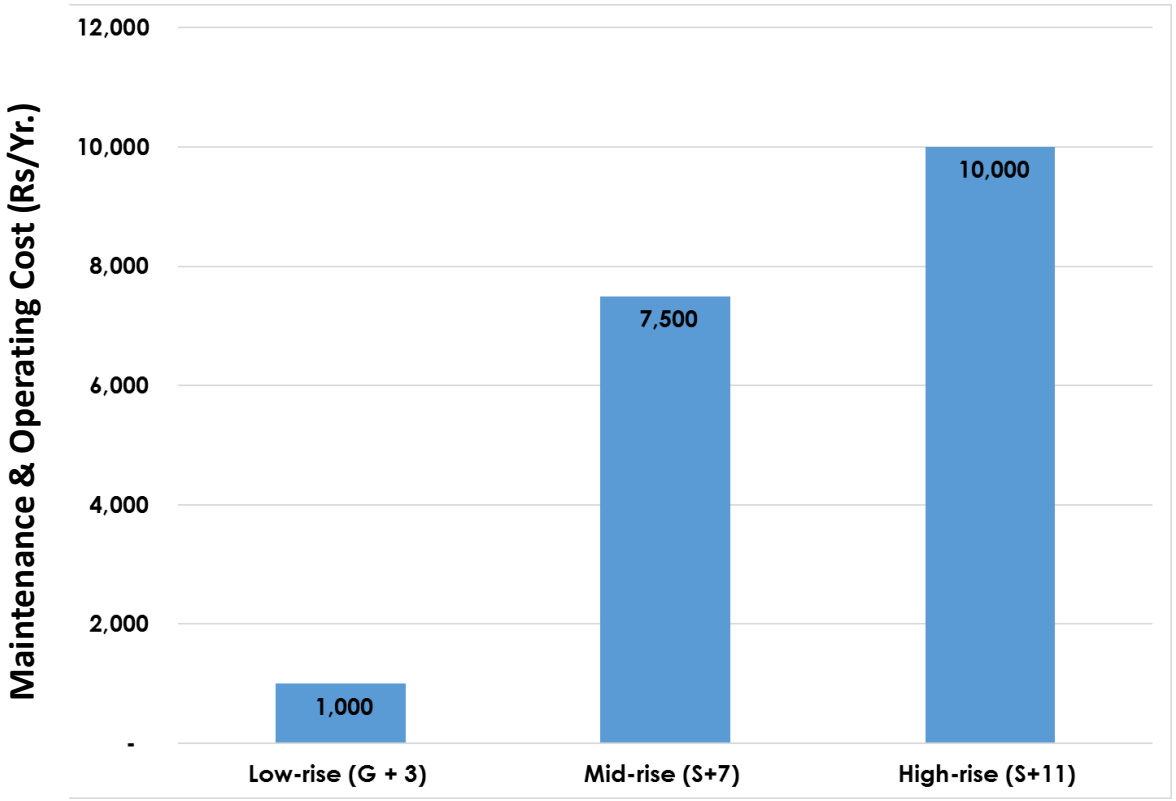
Operational Energy Efficiency

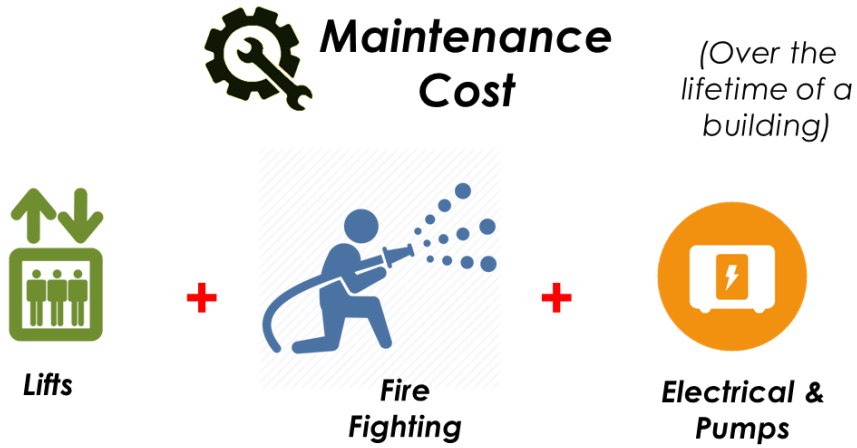




- **Increase in common service energy (pump + lift) by 4 to 5 times as we go from low-rise to high rise**

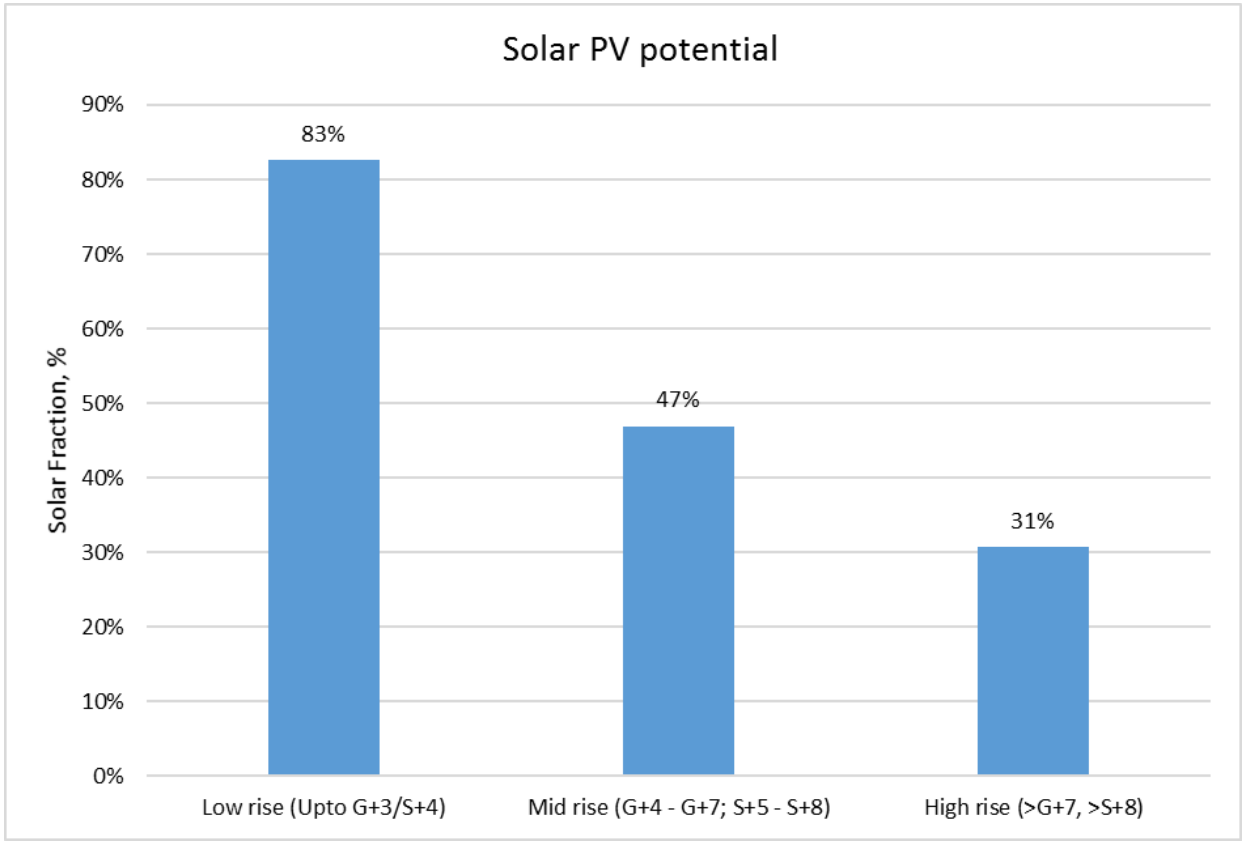
Maintenance Cost Comparison

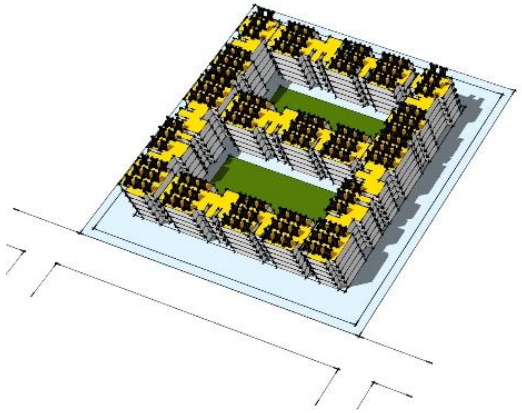




- **The maintenance costs of High rises is 10 times the cost incurred in Low rises.**

Rooftop Solar Potential

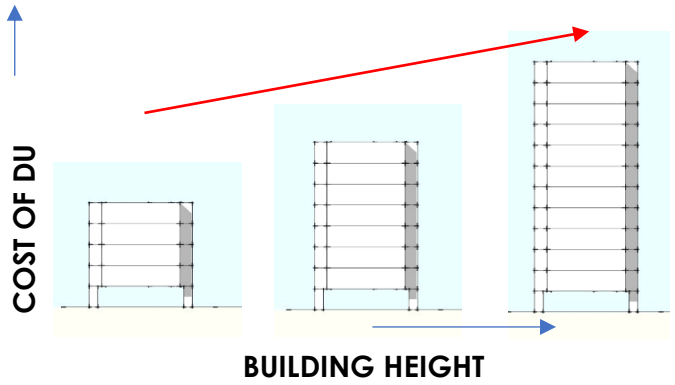


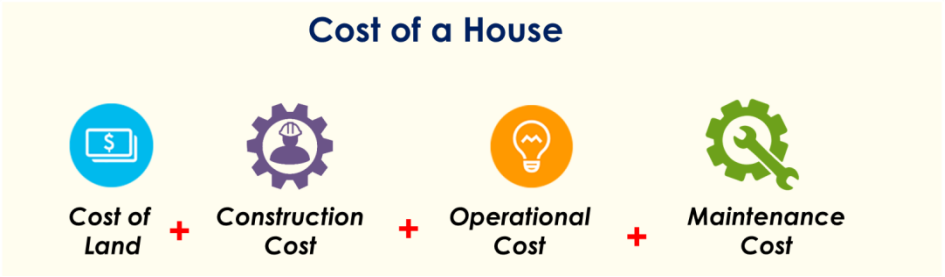


- **80% of the energy requirement in a low-rise building can be met by rooftop solar energy. Low rise buildings have the potential to be Net Zero due to better Rooftop Area to Electricity Demand Ratio.**

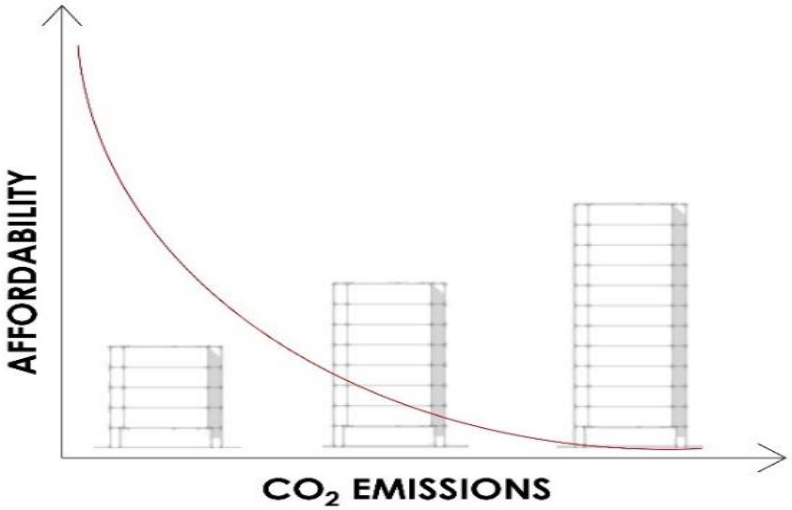
- **Building higher decreases Solar potential.**

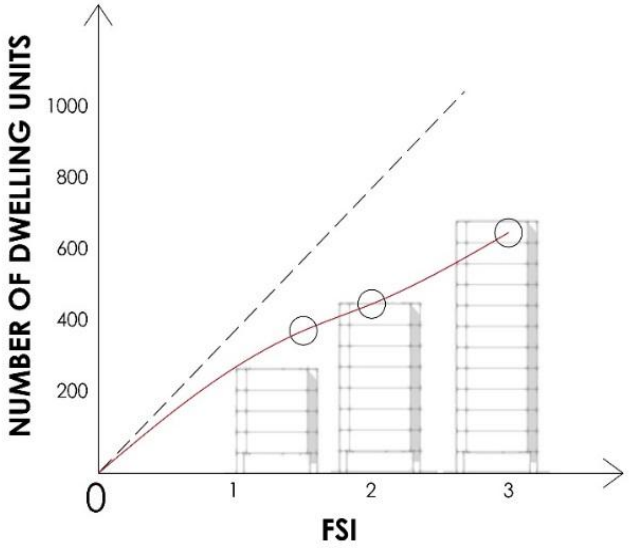
Land Cost, FSI and Density



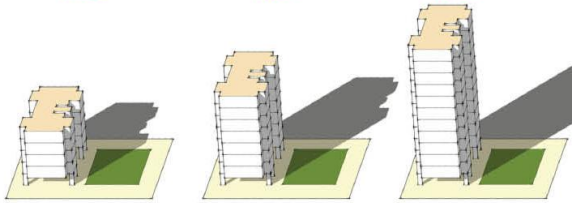


Increase in FSI does not yield proportionate increase in number of houses
Land cost increases with the increase in FSI





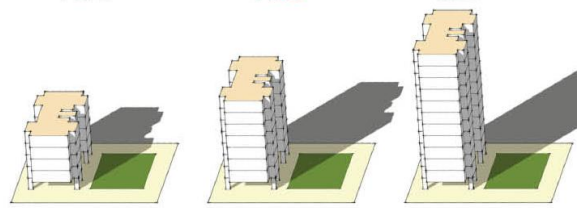
Comparison of Building Typologies



Criteria of Comparison	Low Rise	Medium Rise	High Rise
Sustainability	**High**	**Medium**	**Low**
Environmental Impact	**Low**	**Medium**	**High**
Suitability for Housing Category	**EWS/LIG** (<50m²)	**LIG/MIG** (50-90m²)	**MIG/HIG** (>90m²)
Demand	Maximum ***70%***	Moderate 20%	Least 10%

The high rise development is least suitable from a Low Carbon perspective and thus should be avoided.

The preferred typology should be Low rise but if Land Cost are very high one may go for a Medium Rise.



Criteria of Comparison	Low Rise	Medium Rise	High Rise
Affordability	**Most**	**Less**	**Least**
Open Area per Person	●	●	●
Embodied Energy efficiency	●	●	●
Operational Energy efficiency	●	●	●
Solar-Roof Potential	●	●	●
(Carpet Area)/ (Built Up area)	●	●	●
Construction Cost affordability	●	●	●
Quick Construction Time	●	●	●
Maintenance affordability	●	●	●
Disaster/ Breakdown resilience	●	●	●

LOW CARBON - AFFORDABLE CITY

LOW RISE -HIGH DENSITY

DU/Ha – ***400***

Open Space/DU- **15m²**

Construction Cost- Rs.**9000-11000**/sqm

80% Solar Potential *for renewable energy from rooftops*

3 million tonnes less of CO_2 emissions, if Low-rise format is used in Gujarat State instead of High-Rise in the next decade

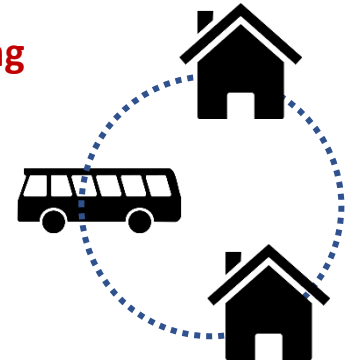
Quick construction time *with rationalized simple building technologies*

Best opportunity for wealth distribution through the construction process

CITY LEVEL

Transit & Location

Locate **maximum affordable housing within 500m of the mass transit routes** like the proposed BRT route and **200m from the major roads**, allow ing easy access to affordable public transport.



This locational advantage for affordable housing helps ensure:

a) Reduced need and dependence on private transport, therefore **reduction in the carbon footprint of mobility in the city.**

b) **Spatial equity** for all citizens.

c) ***Quick economic integration and progress for the new migrant and the young aspirant.***

PEDESTRIAN FRIENDLY URBAN GRID

Ensure **walkability** (<500m) to the **Public Transit Routes.**

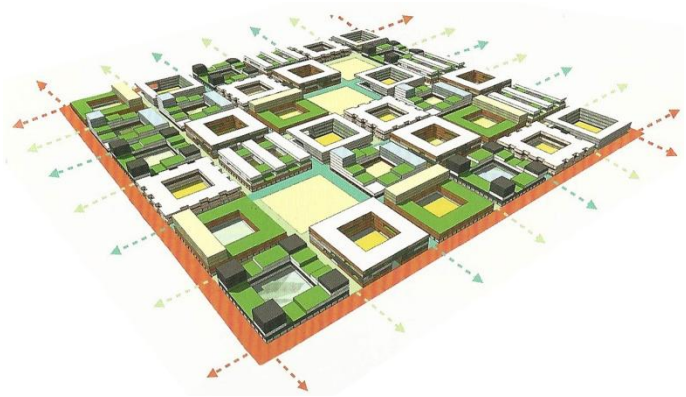
Frequent **pedestrian connections** at every 50m in the city blocks **encourages walkability** and **enhances liveability**.

PEDESTRIAN FRIENDLY URBAN GRID

Ensure **walkability** (<500m) to the **Public Transit Routes.**

Frequent **pedestrian connections** at every 50m in the city blocks **ensures walkable access to Public Transport Routes**, **encourages walkability** and **enhances liveability**.

TOWN PLANNING AND DEVELOPMENT CONTROLS DETERMINE THE SUSTAINABILITY AND QUALITY OF LIFE OF THE CITY



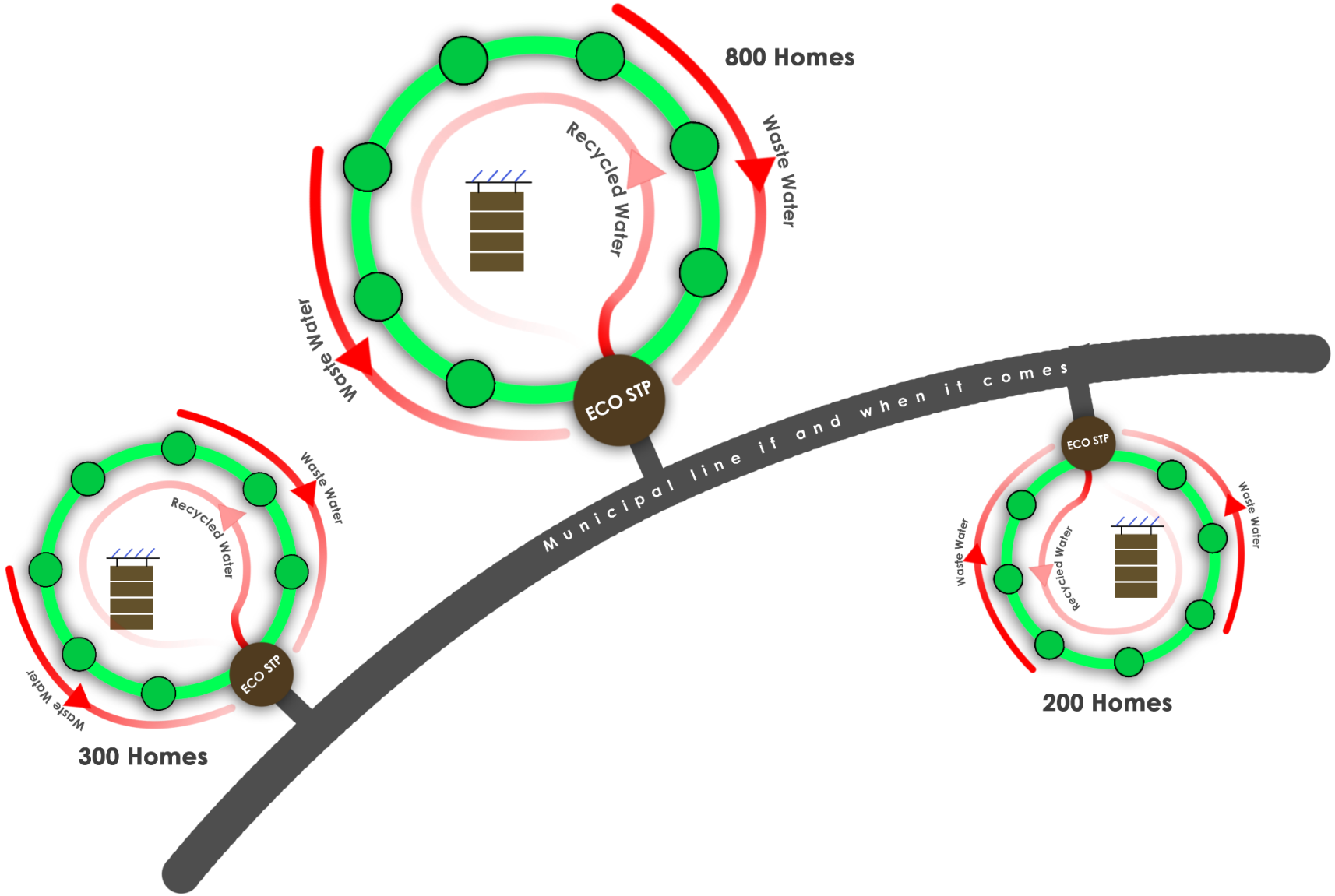
MOTOR CAR FRIENDLY URBAN GRID

PEDESTRIAN FRIENDLY URBAN GRID

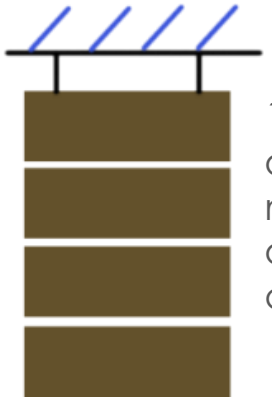
DECENTRALIZED AFFORDABLE UTILITY SYSTEMS

For a slum free city

- Water Supply
- Sewage Treatment
- Recycling
- Electricity Supply

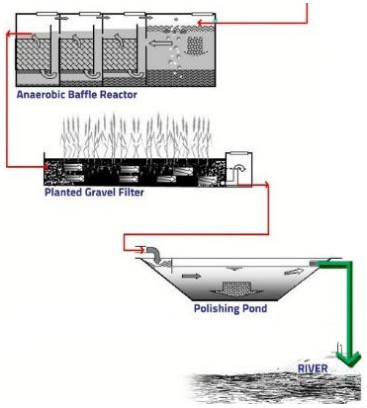


DECENTRALIZED AFFORDABLE UTILITY SYSTEMS



1/3rd roof area of Solar PV meets 4 floors of electricity demand.

Solar PV for essential functions - grid connected



COMPACT COMMUNITY DEWATS SEWAGE TREATMENT AND COMPOSTING

Water testing kit

COMMUNITY WATER FILTER

A variety of low cost – low energy sewage treatment technologies are now available.

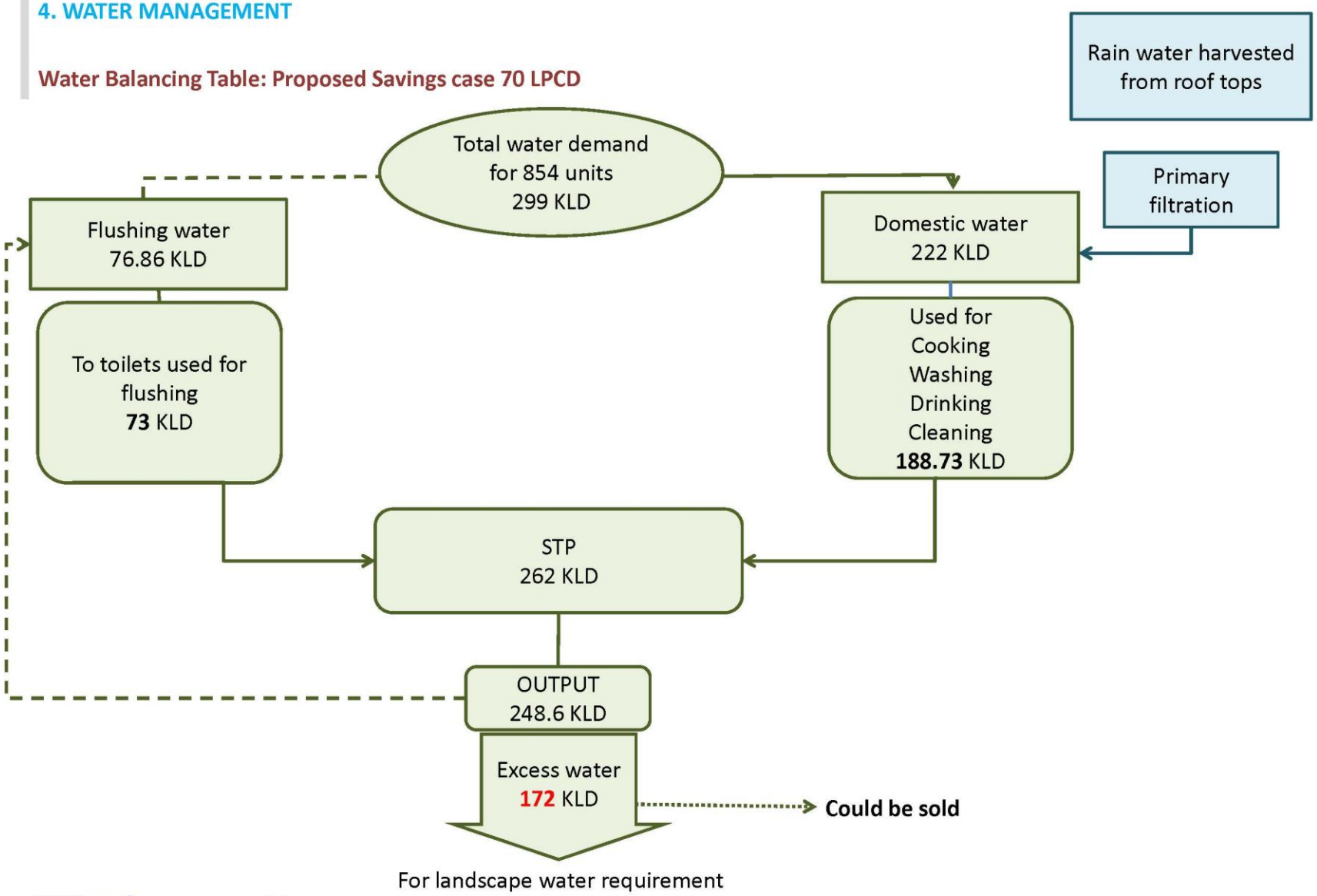
Cost
Rs. 300 – Rs. 500 per sqm of building area.

PROMOTE ECO BUSINESSES UNDER REGULATORY REGIME

INCENTIVIZE DECENTRALISED WATER MANGEMENT EMBOD

4. WATER MANAGEMENT

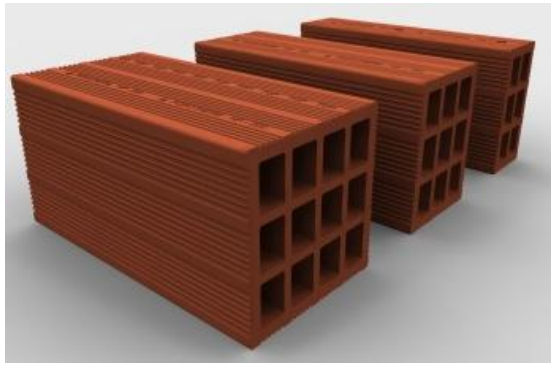
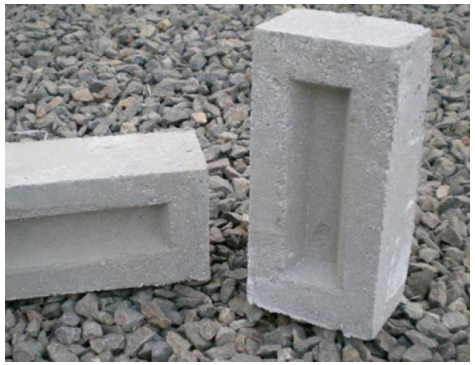
Water Balancing Table: Proposed Savings case 70 LPCD



INCENTIVIZE LOW EMBODIED ENERGY WALLING MATERIALS

Parameters	Common burnt clay brick- Fired in FCBTK	Burnt clay REBs (hollow)	Autoclaved Aerated Concrete (AAC) Block	Cement concrete block	Fly ash bricks	Compressed stabilized clay blocks
Energy for Manufacturing (excluding transportation) MJ/m^3	~ 2000	~1300	~1300	~1000	~800	~600
CO_2 emission for manufacturing (T CO_2/m^3)	~ 0.2	~0.15	~0.13	~0.15	~0.16	~ 0.06

Sales Tax and Excise Exempted

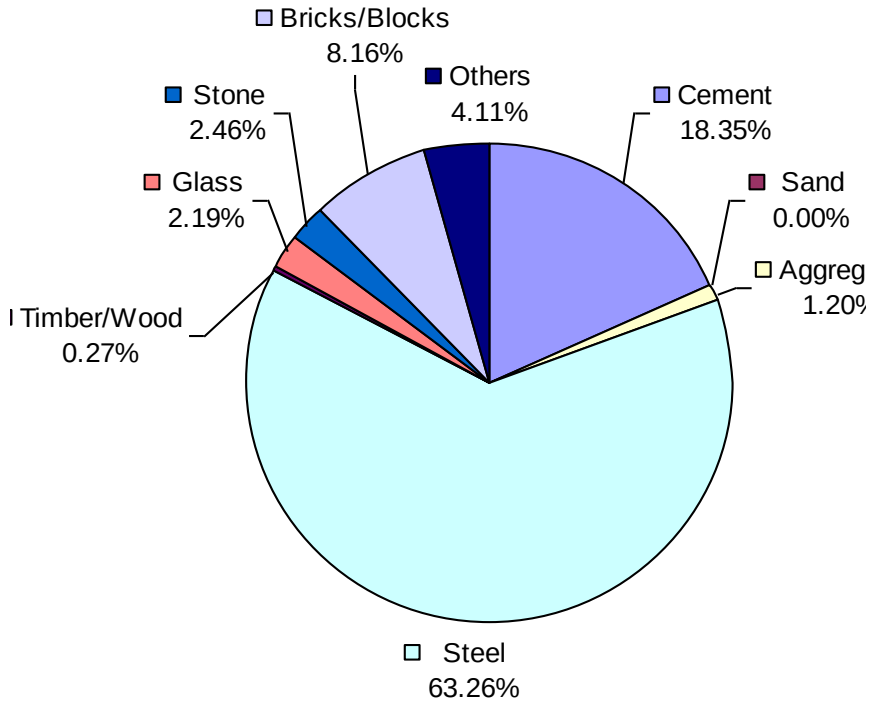





INCENTIVIZE LOW CARBON TECHNOLOGIES

Housing comprises 70% of the city's Built Space

Build low rise high density for low carbon urban futures

	Embodied Energy		Carbon Emissions	
	MJ/sqm	GJ/sqm	$KgCO_2$/sqm	tCO_2/sqm
Low Rise				
DDA (typical)	2028.91	2.03	229.43	0.23
IIPH	1374.43	1.37	177.43	0.18
High Rise				
HEWO (typical)	2367.40	2.37	260.03	0.26
IIT - D	2615.40	2.60	290.60	0.29



Consumption of Steel is a chief contributor in CO_2 emissions in building construction

Steel consumption < 25 kg/ sqm of built area
– claim 5% property tax rebate!

Steel consumption > 35 kg/ sqm of built area
– pay additional 5% property tax!

CITIZENS MUST KNOW – SUSTAINABILITY METRICS

Which way is my city going ?

- **Carbon emissions from electricity consumption per capita per month**
- **Solar Access Potential at the Local Level : Solar access roof /per unit floor area**
- **Carbon emissions from consumption of fossil fuels – petrol, diesel, gas - per capita per month**
- **Dependence on distant water sources per capita per month**
- **Self-sufficiency quotient for water**
- **City's GINI Index on Republic Day**

SOLAR ACCESS FOR SOLAR CITIES – PUBLIC SPACE

SOLAR ACCESS FOR SOLAR CITIES – PUBLIC SPACE

Presidential Estate – 5 MW S P P P The Energy And Resources Institute Ashok B Lall Architects

SOLAR ACCESS FOR SOLAR CITIES – PUBLIC SPACE

Photovoltaic trees for shade and electricity