Position paper on:
Low Carbon Resource-Efficient Affordable Housing

Based on the context of urbanization in Gujarat, particularly that of Rajkot

Commissioned by:
Swiss Agency for Development and Cooperation

18/12/2017
This paper seeks a strategy to achieve affordable Housing for All, in tune with Sustainable Development Goals and Climate Change agenda of COP21.
Sustainable Development Goals

10. Reduced Inequalities

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

11. Sustainable Cities and Communities

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

12. Responsible Consumption and Production

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

13. Climate Action

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.
Urbanization in India

Urban population (Million)

- 1991: 220
- 2001: 290
- 2008: 340
- 2030: 590

Total population (Million)

- 1991: 856
- 2001: 1,040
- 2008: 1,155
- 2030: 1,470

Urbanization rate (1)

- 1991: 26%
- 2001: 28%
- 2008: 30%
- 2030: 40%

1 Defined as the ratio of urban to total population based on the census definition of urban areas; population >5,000; density >400 persons per square kilometer; 75 percent of male workers in nonagricultural sectors; and other statutory urban areas.

SOURCE: India Urbanization Econometric Model; McKinsey Global Institute analysis
### Urbanization in India

#### Five states are likely to be more than 50 percent urbanized

<table>
<thead>
<tr>
<th>Urbanization rate, 2008</th>
<th>Urban population</th>
<th>Urbanization rate, 2030</th>
<th>Urban population</th>
</tr>
</thead>
<tbody>
<tr>
<td>%, total population</td>
<td>Million</td>
<td>%, total population</td>
<td>Million</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>53</td>
<td>67</td>
<td>53.4</td>
</tr>
<tr>
<td>Gujarat</td>
<td>44</td>
<td>66</td>
<td>48.0</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>44</td>
<td>58</td>
<td>78.1</td>
</tr>
<tr>
<td>Karnataka</td>
<td>37</td>
<td>57</td>
<td>39.6</td>
</tr>
<tr>
<td>Punjab</td>
<td>36</td>
<td>52</td>
<td>19.0</td>
</tr>
<tr>
<td>Haryana</td>
<td>31</td>
<td>45</td>
<td>15.2</td>
</tr>
<tr>
<td>West Bengal</td>
<td>29</td>
<td>40</td>
<td>41.5</td>
</tr>
<tr>
<td>Kerala</td>
<td>28</td>
<td>41</td>
<td>15.8</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>28</td>
<td>46</td>
<td>45.5</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>25</td>
<td>32</td>
<td>29.9</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>25</td>
<td>31</td>
<td>12.0</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>24</td>
<td>33</td>
<td>29.5</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>24</td>
<td>40</td>
<td>11.7</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>21</td>
<td>26</td>
<td>68.9</td>
</tr>
<tr>
<td>Orissa</td>
<td>18</td>
<td>24</td>
<td>11.0</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>12</td>
<td>20</td>
<td>1.8</td>
</tr>
<tr>
<td>Bihar</td>
<td>9</td>
<td>17</td>
<td>21.3</td>
</tr>
</tbody>
</table>

**SOURCE:** India Urbanization Econometric Model; McKinsey Global Institute analysis
“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.”
EVALUATING BUILDING OPTIONS
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**
Empirical data from the following projects of Rajkot was collected from RMC and analysed on the parameters of embodied energy, operational energy, maintenance costs, space efficiency, solar roof potential etc. The data was then compared and recommendations for a low carbon, resource efficient and affordable scenario are suggested.

<table>
<thead>
<tr>
<th>Type</th>
<th>Project Name</th>
<th>Name Of Scheme/Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Rise G+3</td>
<td>Kittipara, NR. Refyuji Colony</td>
<td>RAY</td>
</tr>
<tr>
<td></td>
<td>MMGY 22A, Popatpara Rajkot</td>
<td>MMGY</td>
</tr>
<tr>
<td></td>
<td>Raiya Dhar 17A, 17B, 34A</td>
<td>BSUP-III</td>
</tr>
<tr>
<td>S+4</td>
<td>Nr. Bishop House FP 95B</td>
<td>MMGY</td>
</tr>
<tr>
<td>Medium Rise S+7</td>
<td>MMGY 30B</td>
<td>MMGY</td>
</tr>
<tr>
<td></td>
<td>MMGY 3B</td>
<td>MMGY</td>
</tr>
<tr>
<td></td>
<td>Nr. Bharat Nagar, TP 28 Mavdi, FP 12A</td>
<td>PMAY PPP</td>
</tr>
<tr>
<td>High Rise S+10</td>
<td>Bharat Nagar, 7A</td>
<td>SMART GHAR I, PMAY</td>
</tr>
<tr>
<td>S+11</td>
<td>Nr. Bharat Nagar, TP 28 Mavdi, FP 49/A (Smart GHAR I)</td>
<td>SMART GHAR III, PMAY</td>
</tr>
</tbody>
</table>
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 instead use AAC/Hollow-core/Fly ash bricks/ Hollow-core/ 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

 Evaluated over their lifecycle the maintenance & operation costs of High rise buildings is **10 times** the cost incurred in Low rise buildings.
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.
BUILDING UNIT LEVEL
Quality of Life and High density living

Lack of Space inside a House

Spill over space

Dearth for open Space

Space inside a house is a direct indicator of quality of life.
### Quality of Life and High density living

#### Space within a House

<table>
<thead>
<tr>
<th>Size of DU (sqm) (Carpet Area)</th>
<th>Low-Income Housing</th>
<th>Middle-Income Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25-30</td>
<td>70-75</td>
</tr>
<tr>
<td></td>
<td>40-45</td>
<td>105-110</td>
</tr>
<tr>
<td></td>
<td>55-60</td>
<td></td>
</tr>
<tr>
<td>Space (sqm)/Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.1</td>
<td>16.1</td>
</tr>
<tr>
<td></td>
<td>9.4</td>
<td>23.8</td>
</tr>
<tr>
<td></td>
<td>12.7</td>
<td></td>
</tr>
</tbody>
</table>

#### People/DU 4.5

If the number of people increases, as some houses even have 8-10 people per house, then the per person size decreases even further.

Greater Need for **Compensatory Open/Spill over Spaces** in immediate proximity of the home

- **Open Spaces on Ground**
- **Accessible Rooftop Spaces**
The recreation space requirement for Affordable Housing Schemes with DU size less than 45sqm, needs to be determined by People Density rather than Plot Area.
- Building higher increases the area taken by Circulation (Corridor, Stair etc.) and the Structure also becomes thicker.

- Thus for getting the same Carpet Area the Built Up area increases, thus decreasing Space Efficiency and making the per sqm Construction Costlier.
### Comparison of Building Typologies

<table>
<thead>
<tr>
<th>Criteria of Comparison</th>
<th>Low Rise</th>
<th>Medium Rise</th>
<th>High Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Suitability for Housing Category</td>
<td>EWS/LIG (&lt;50m²)</td>
<td>LIG/MIG (50-90m²)</td>
<td>MIG/HIG (&gt;90m²)</td>
</tr>
<tr>
<td>Demand</td>
<td>Maximum 70%</td>
<td>Moderate 20%</td>
<td>Least 10%</td>
</tr>
</tbody>
</table>

#### Criteria of Comparison

<table>
<thead>
<tr>
<th>Affordability</th>
<th>Low Rise</th>
<th>Medium Rise</th>
<th>High Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Area per Person</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Embodied Energy efficiency</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Operational Energy efficiency</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Solar-Roof Potential</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>(Carpet Area)/(Built Up area)</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Construction Cost affordability</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Quick Construction Time</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Maintenance affordability</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
<tr>
<td>Disaster/Breakdown resilience</td>
<td>Most</td>
<td>Less</td>
<td>Least</td>
</tr>
</tbody>
</table>

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**.
NEIGHBORHOOD LEVEL
1. **Reduce front Margin** from 4.5m to 1.5m. Promote Build to Line typology. This helps in:

   a) **Increasing Buildable area** and thus ground coverage.

   b) Creating **safer neighbourhood**, with ‘eyes on the street’
Promote Mixed-use,

a) Reduces need for motorised travel - basic amenities & livelihoods integrated with housing

b) Ensures Pedestrian friendly streets and vibrant streetscape.

Optimizing Land by promoting Mixed Use

Existing

Proposed
Sustainability at Plot level

‘Maximize Soft ground’* in order to:

a) Have Maximum Water percolation.

b) Provide space for plants and vegetation.

c) Minimize Urban Heat Island Effect.

* The S+4 typology, accommodates all the required parking under the building footprint, and thus gives maximum soft ground.
Optimizing Land and density
Land and development policy needs to aggressively address the causes of high Land Cost*:

• Speculation and investment of unaccounted wealth in real estate markets
• Land hoarding
• High stamp duty

And fast-track
• Allocation/release of public land for affordable housing

* Source: Three year Action Agenda 2016-17 to 2019-2020, NITI Aayog, GOI
CITY LEVEL
Locate *maximum affordable housing within 500m of the mass transit routes* like the proposed BRT route and *200m from the major roads*, allowing 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**.
RUDA GDCR
Recommendations
GDCR Recommendations

OBJECTIVE
Development Control Regulations must be designed to promote a low-carbon urban fabric considering a 50 year perspective. This is imperative to meet the commitment made by India to reducing carbon intensity of development by 30% by 2030.

Synergies have to be found between the quantitative demand for shelter, demand for land and urban fabric that is affordable and sustainable.

The research shows that the solution lies in low-rise high density urban fabrics for ‘affordable housing’ for majority of our citizens.

Land policy and development controls need to INCLUDE AND ADDRESS these priorities.
**DNA of Low Carbon Affordable Cities**

250-600 DU/Ha

**LOW RISE - HIGH DENSITY**

DU/Ha – 400

Open Space/DU - 15m²

Construction Cost - Rs. 900-1100/sqft

80% Solar Potential for renewable energy from rooftops

3 million tonnes less of CO₂ emissions, if Low rise format is used instead of High Rise

Quick construction time with rationalized simple building technologies

Best opportunity for wealth distribution through construction process
Low-Carbon Affordable City

Best* Case Scenario for Affordable Housing:

LOW RISE-HIGH DENSITY

For all Tier 2 and Tier 3 towns and urban extensions of Metros the preferred typology is Low rise.

Where land cost is very high the Medium rise option may be an acceptable compromise.

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

* Optimising Affordability, Resource Efficiency, Sustainability and better quality of Life