URBAN CLIMATE CHANGE RESILIENCE STRATEGY
SUSTAINABLE URBAN HABITAT

Green and Resilient Development: A case study of ZED Homes in Bangalore

The objective of documenting this initiative is to create a better understanding of how sustainable housing development can lay the foundation for city resilience – cities that can better withstand climate change driven shocks.

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ACCCRN
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Context

There is an increasing recognition amongst urban planners and builders that climate change is a reality we must plan for. Urban areas contribute 60-70 per cent of India's GDP and any disruption to economic activities in urban areas due to climate change events (such as high intensity rainfall, floods, heat waves, etc.) could impact the country's economic growth adversely. With a little more than 40 per cent of India's urban population concentrated in 52 metropolitan cities (cities with million plus population), it is important that these cities take into account the climate change impacts while planning. It is essential to build resilience of cities to climate change.

With the projected climate change scenario for India, the problem of water supply, sanitation and power availability will only get worse, particularly in urban areas. There will be greater demand for water when there are heat waves, greater demand for electricity when there are heat and cold waves, and there will be general breakdown of most services when there is high intensity rainfall and flooding.

So how can cities plan new developments that are less dependent on the resources of the city and more dependent on local resource? Can new residential developments become self-sustaining and green – developments that not only don't use the resources of the city, but are resource efficient and are zero emission developments?

Problems related to urbanisation in Bangalore

Bangalore is a metropolitan city located in the southern part of India and is the capital of Karnataka state. The population of Bangalore has grown from 1.6 million in 1971 to 8.7 million in 2011. The city has grown rapidly in the last few decades as a large number of information technology offices have located themselves in Bangalore, because of which the city is also known as the 'Silicon Valley' of India.

Urbanisation has led to a boom in the real estate sector in Bangalore with an estimated 200,000 apartments coming up in the last decade. To meet the water needs of these apartments, a huge number of borewells have been dug up, which has adversely impacted the groundwater level in the city. The city is extracting more groundwater than is being recharged. An estimate puts the current average utilisation of groundwater in the city at 142%. The average depth at which groundwater is available is upto 45 meters, but this is increasing with time.

Large parts of the city face water crisis, especially in summer, as the demand for drinking water goes up and river Cauvery, from where the city draws water, dries up. The city gets water supply on alternate days. Many areas in the city have to depend on tankers for water. With climate change and average temperatures rising, the situation will only get worse.

Bangalore also faces floods during monsoon period. This was not the case earlier, since Bangalore was dotted with 261 lakes and tanks till 1961, which were gradually encroached upon and today the number of lakes is reduced to 85 (within municipal area). Construction over lake beds includes bus terminals and sports stadia, amongst others. Expansion of urban spaces reduces the buffer of these lakes, consequently the lake dries up and further expansion of built environment follows[1] . This encroachment on lakes makes urban spaces susceptible to floods, as more built-up area increases run off.

Therefore, Bangalore suffers from both water scarcity due to drop in water table as well as urban floods during heavy rains as the city has gradually lost its capacity to hold and discharge water safely. The solution to such problems is sustainable and green development.

Over the years, Bangalore has seen a rise in green and low carbon real estate developers, i.e. developers who are committed to reducing the ecological footprint of development. These real estate developers have included the following elements in their development projects:

- Rain water harvesting and ground water recharge
- Local sewage treatment and wastewater recycling
- Local solid waste management
- Solar energy and low power consuming fixtures
- Green construction practices

The present case study of ZED homes in Bangalore is one such example of sustainable residential development that can be replicated across the country.

Green and Resilient Housing Development – Case study of Bangalore's ZED Homes

Zero Energy Development (ZED) is an eco friendly housing development initiative of Biodiversity Conservation India Pvt. Ltd. (BCIL). The ZED housing projects focus on providing all amenities and services to residents with minimal ecological footprint. Their housing projects (ZED Earth, ZED Woods, ZED Collectives and T ZED) in Bangalore are sustainable developments which also have resilient features. The sustainable elements in water and energy use also make ZED homes resilient to climate change.

Earth	Projects avoid using bricks, as it uses precious top soil and baked at 400°C.
Energy	ZED's zero energy work strategies are sensitive to 'embodied energy[2] and 'active energy' use on consumption.
Water	ZED homes help residents manage their own water and wastewater. It reduces fresh water demand by as much as 70%.
Waste	Solid waste, wet waste, chemical waste, recyclable waste and every type of waste generated by residents is managed within the residential development itself.
Air	Focus on passive and active cooling systems that are energy-efficient and ozone-friendly.
Biomass	Emphasis is on native plant species. It helps in cooling the ambient air, providing shade and absorbing toxic emissions. Native species are well adapt to the local climate.

Source: www.zed.in/about

1 http://www.thenewsminute.com/article/lost-lakes-bengaluru-majestic-bus-stand-stadiums-they-all-have-one-thing-common-44005

2 Embodied Energy is the sum of all the energy required to produce any goods or services, considered as if that energy was incorporated or 'embodied' in the product itself.

ZED projects aim at minimising dependence on city networks and systems for water, energy and waste disposal (both solid and liquid). These residential developments consume less electricity, use sustainably produced timber for furniture, and also recycle and re-use materials, thus reducing demand for fresh construction materials (e.g. using left over wood and construction waste).

ZED EARTH

The ZED Earth project is located on the Yelahanka – Doddaballapur road, 14 km north of Yelahanka, Bangalore city. This Project is being developed on 25 acres and has mainly villas for higher income groups.

This project is located away from the city of Bangalore - it is outside the municipal limits, but within the jurisdiction of Bangalore Development Authority and Bangalore International Airport Area Planning Authority.

The project site has an advantage of a gentle gradient from one side of the site to the other. This feature helps in designing services like water, sewerage, drainage and ground water recharge points.

ZED COLLECTIVE

ZED Collective is located on Yelahanka – Doddaballapur road, 6 km north of Yelahanka, Bangalore city. This Project has been developed on 1.75 acres and has apartment blocks.

This project is also located away from the city. The site falls within the jurisdiction of the municipal body. The site is connected by a feeder road to the main Doddaballapur-Yelahanka road.

ZED Collective is adjacent to other ZED projects, namely Townsend and ZED Woods. Townsend caters to high income group and has villas, while ZED Woods caters to the middle and upper middle income groups.

Green and Resilient Features of ZED Housing Projects are:

Water Supply

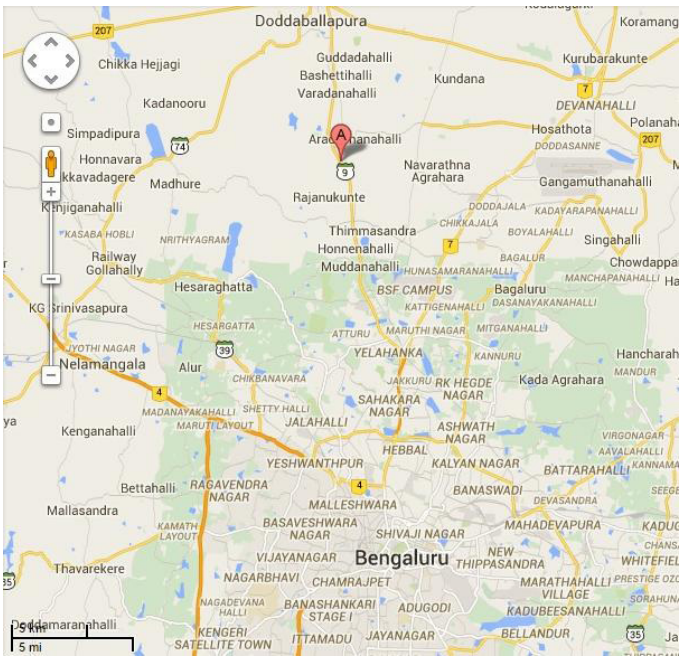
The ZED housing projects ensure 24x7 water supply to its residents. This is an achievement in Bangalore where water is supplied only for a few hours a day, the supply is on alternate days, and only 51% of the population is covered by water supply.

The salient features of water supply system in ZED developments:

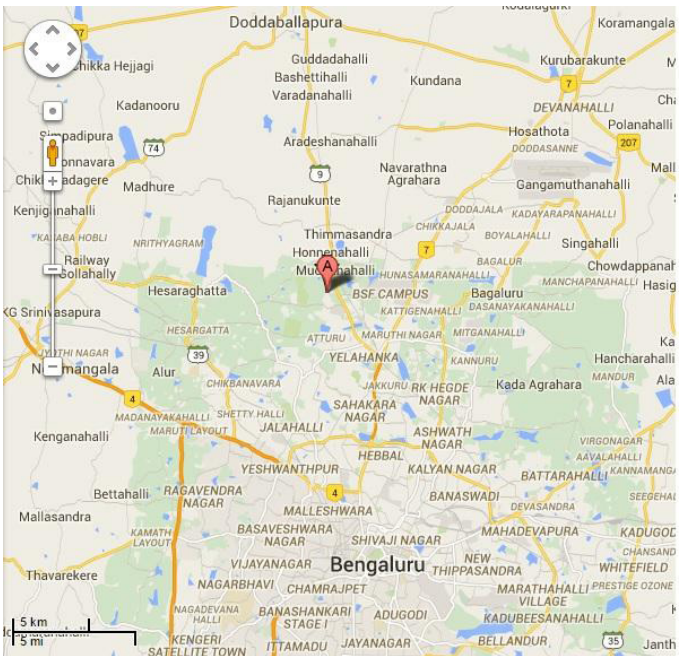
Water Source: All projects use only ground water and do not use municipal water supply network for water. Bore-wells are dug at different depths reaching different aquifers, and not all aquifers are exploited at the same time. For example, twelve aquifers have been identified at ZED Earth site, of which only two aquifers are being used for extracting water at present. The aquifers are recharged by rainwater harvesting systems like trenches and recharge wells. The land cover within the housing area has open and green spaces, and the design of streets is such that it increases the ground water recharge potential.

Water Treatment: After drawing water from ground through borewells, water is treated in three stages (see Picture-1). It passes through dual media filter (sand and carbon), then nano filter (UV filter) and resin based water softener. The three stage treatment treats the raw water for TDS, Ph

Picture 1: Water treatment plant at ZED Earth *Source: NIUA*



Map 1: Site location of project ZED EARTH



Map 2: Site location of project ZED COLLECTIVE

and ecoli, and the treated water is stored in a tank. Regular testing and checking of water quality pre and post treatment is done at the project sites.

Demand Management: Reducing demand for water is essential to conserve water. Therefore, the water faucets provided in the houses are water efficient, with aerators, which save water. ZED projects use taps and showers that save 35,000 litres of water annually per household.

The demand for fresh water is reduced by reusing treated waste water for landscaping. The water for landscaping is supplied twice a day (morning and evening) and is auto regulated through a timer (see figure- 1).

Drainage

ZED projects handle storm water in a non-conventional way. The projects are designed in a way that not a single drop of rain water goes outside the site. Rain water is harvested from rooftops, from green open spaces, and other non-paved green areas within the site which recharges the aquifer. This helps in arresting the run off.

Different means are deployed for rain water harvesting on site. An illustration below of street profile from the project ZED Earth depicts these elements (see figure- 2).

Essential features of storm water management in ZED projects are:

- Land cover: The ratio of open and unpaved area to built-up paved area in the projects favours rain water percolation into the ground instead of run-off.
- Roofs: Roofs in ZED projects capture rain water or are designed in a way which channelizes rain water towards recharge pits or recharge trenches.
- Streets: Only middle section of the right of way is made of concrete, while the sideways have recharge pits integrated in the landscape design in front of villas.
- Recharge pits: Rain water is channelized towards different recharge pits and trenches. This system has been integrated in the site plan. Water collected from roofs and streets reaches these recharge pits / recharge wells.

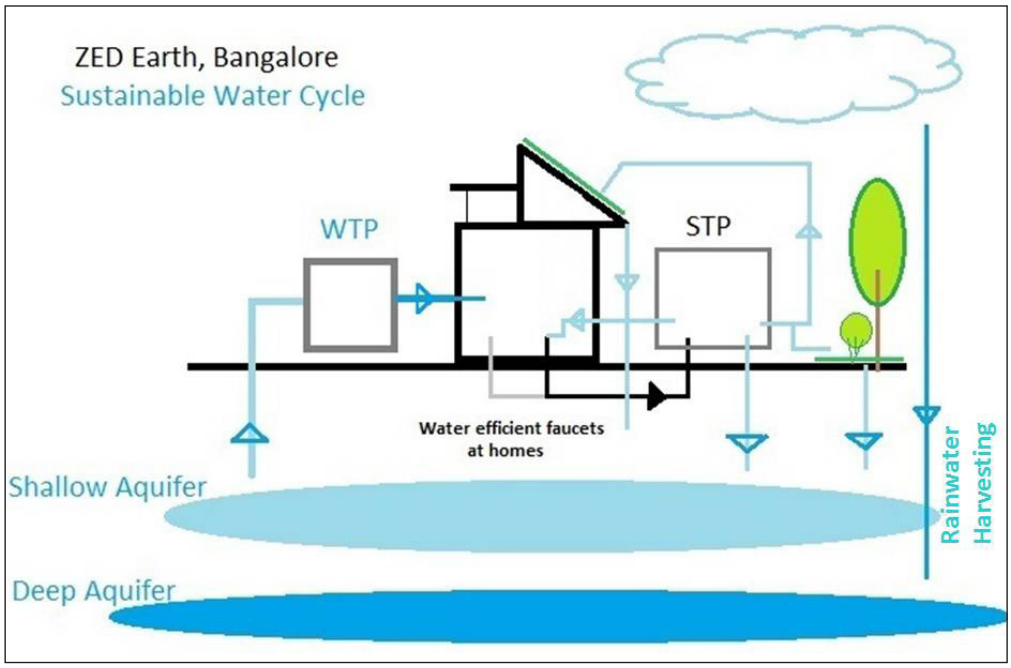


Figure.1: Illustration of water flow at ZED EARTH (Closed water loop) *Source: NIUA*

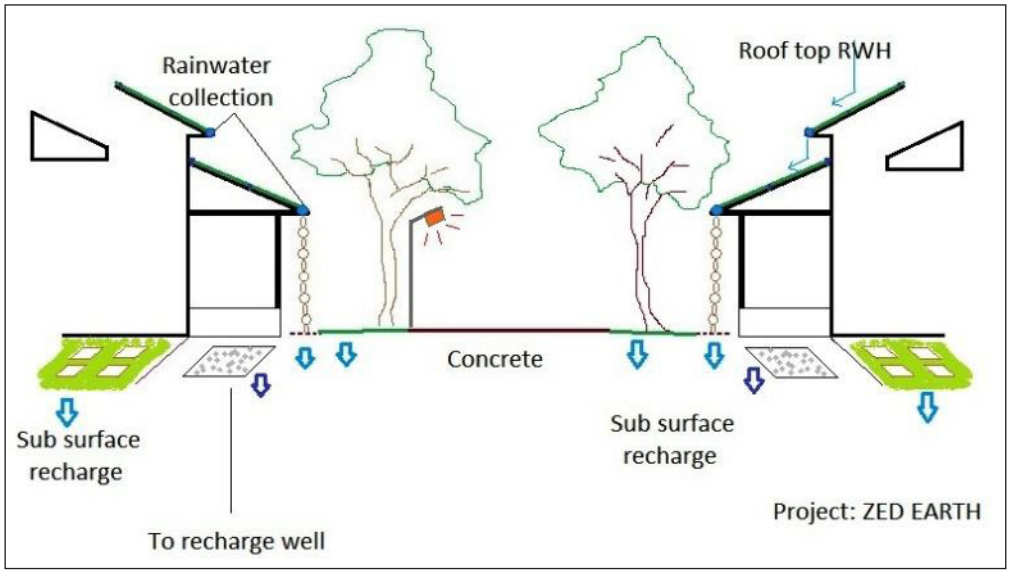


Figure 2: Street profile at ZED Earth *Source: NIUA*

Waste Water

To reduce the ecological footprint, ZED projects discharge zero wastewater into the city's sewer network and the projects are self reliant in this regard. There is a mini sewage treatment plant within each project site and the treated wastewater is recycled for non-potable purposes (see picture-2). This reduces the demand for fresh water.

In case of breakdown of STP, an underground retention tank holds 3 days of waste water. This has been provided as a part of the design. The maintenance staff of the housing complex has also been trained to take care of any emergency or break down.

Picture 2: Sewerage treatment plant at ZED Collective *Source: NIUA*

Solid Waste Management

Solid waste is managed in a sustainable way in ZED projects. The residents association and the developer both have been engaged in this process.

Construction Waste Management: ZED projects have found innovative ways of re-using the waste generated during the construction stage.

Reuse of construction left overs into landscaping: The construction waste and left over blocks from construction are used for landscaping. The hollow blocks act as lining to the internal landscaping area and plants grown in them (see picture-3a). Similarly, the used paint buckets are used for potted plants (see picture-3b).

The left over wood waste from construction and furnishing of housing units are used as mail boxes (see picture-4a). The left over pipes have been used as planters (hanging from roof) and integrated into the landscape (see picture-4b). The remaining inert waste is sent to identified agencies to handle it scientifically.

Household waste: Residents association are actively engaged in monitoring waste management activities. The maintenance staff in ZED projects is trained in collection and management of household waste.

Picture 3: Reuse of construction left overs into landscaping *Source: NIUA*

Picture 4: Innovative use of left over wood and pipes *Source: NIUA*

Picture 5: Composting drum *Source: NIUA*

Picture 6: Organic waste collection and mulching *Source: NIUA*

Picture 7: Ventilation design in a villa *Source: NIUA*

Picture 8: Green sloping roofs in villas *Source: NIUA*

The household waste is segregated at source. Residents actively participate in this endeavour and segregate waste at home. Wet waste is composted and the manure is used for landscaping (see picture-5). A designated space is provided for a composting drum. The dry inert waste from households is sent to recyclers.

Leaves and other waste generated from plants and trees is collected in the tree guard (see picture-6) and it gets converted into humus instead of being burnt, which is a common practice in Indian cities. This practice helps in cutting GHG emissions and can be replicated in other housing developments and in the city of Bangalore.

Energy

Climate change will have serious impact on the energy sector. Electricity generation (hydro electricity) will be impacted due to reduced availability of water resources due to climate change. Simultaneously, the demand for electricity will rise due to heat and cold waves, and also due to increase in humidity levels.

ZED projects housing projects are designed in a way that reduces energy consumption and GHG emissions. ZED projects consume much less electricity from the grid than other similar developments. The energy efficiency features are:

a) **Design of housing units:** ZED homes are well ventilated and airy in design. Windows and ventilators let in natural light throughout the day, reducing demand for electricity during day time (see picture-7). Ventilators are provided at a good height for the exit of hot air, reducing/ eliminating the need for air-conditioning. The design includes cross-ventilation throughout the house.
b) **White reflective roofs/ green roofs:** ZED homes have reflective white roofs. There is provision for roof top garden in the villas. The sloping roof has grass planted on it (see picture-8). All these features ensure the roof does not absorb heat and transmit it into the house. This allows the indoor ambient temperature to remain comfortable during the day time and reduces the need for air-conditioning, thus saving electricity.
c) **Landscaping:** The ZED Earth villas use bio-walls as dividers between two villas and trees shade the side walls and facade (see picture-9). This aids cooling of villas and the surrounding area. A small water pool is integrated into the villa design which helps cool the air entering the villa (see picture-10).
d) **Energy efficient appliances and light fixtures:** CFLs

Picture 9: Green area and Bio Wall in between two villas at ZED Earth *Source: NIUA*

Picture 10: Pool integrated into the design to cool the interior *Source: NIUA*

Picture 11: Exhaust of earth cooling system *Source: NIUA*

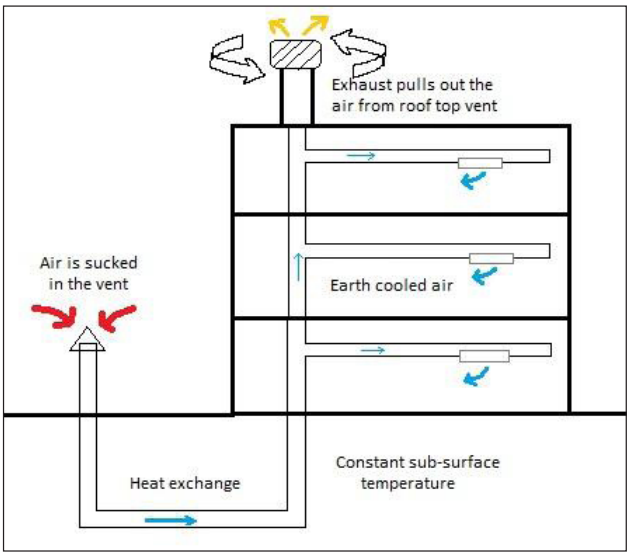


Figure 3: Illustration of earth cooling system at ZED Collective project *Source: NIUA*

and electronic tubelights are being used for internal lighting. These are energy efficient fixtures. CFLs consume only 20-30 per cent of electricity consumed by incandescent bulbs to produce same amount of light. Just 100 ZED homes save as much as 250,000KWh of electric units a year[3] ! ZED homes have fans that consume 50 watts against the regular 75 watts. Similarly, ZED ACs are energy efficient (efficiency ratio of 3.65) and work on 5 amp plug using a 2pin switch. conventional ACs need a 15-amp 3-phase 3-pin switch. These ACs consume 600 watts electricity as against conventional ACs' 1200 KWH.

e) **Geo-thermal Cooling**: ZED Collective uses geo-thermal cooling for its apartments to substitute for air conditioning. It is an initiative which takes advantage of the sub-surface temperature (which remains constant throughout the year irrespective of the temperature above ground) to adjust the indoor temperature. This system reduces the need for cooling or heating, thus reducing energy consumption (see picture-11 and figure-3).

f) **Solar energy**: ZED homes use solar energy to reduce dependence on external power grid. Roof top solar water heaters are provided in all projects and there is also provision for using roof top solar panels. The illustration (see figure-4) shows the energy efficient features of ZED projects.

Summary of Resilient features of ZED Housing Projects

Water and wastewater: The water and wastewater system in ZED projects are self contained; they are not connected to the city network systems. The ZED projects use only ground water. Aquifers are identified in each project area and one or two aquifers are used for water supply at any given point of time. The others remain as reserves. The aquifers are recharged and over time they will have sufficient water for use. This method of using aquifers and recharging them continuously becomes a sustainable process. Similarly re-use of treated wastewater for landscaping helps in recharging the aquifers. So the water cycle is a closed loop in ZED projects. These features make ZED housing developments resilient to climate change.

Rain Water Harvesting: All rainwater in ZED projects is captured in rainwater harvesting structures. The landscaping is done in such a way that all rainwater is captured and aquifers recharged with this water. This helps in solving

3 ZEDiquette, p. 19

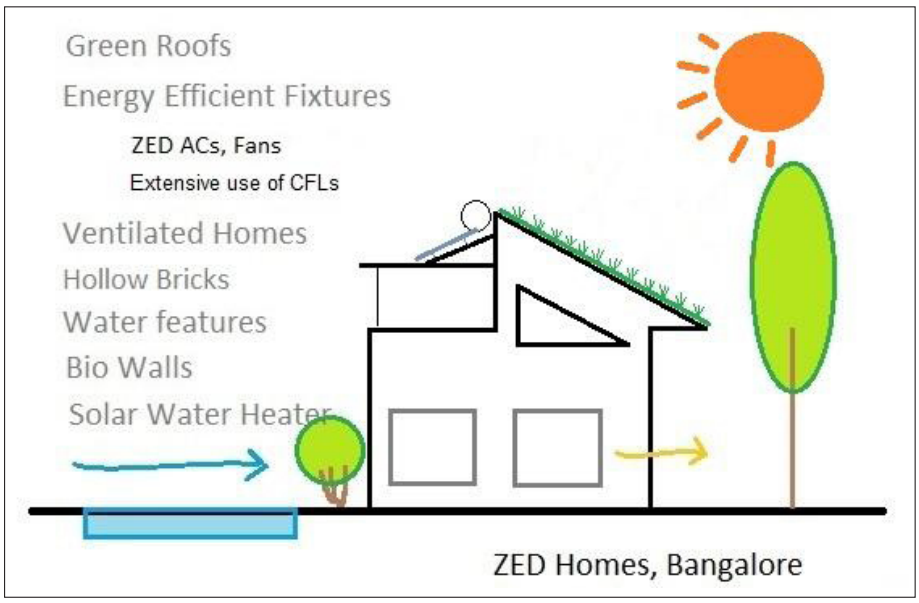


Figure 4: Illustration of Energy Demand Management at ZED Homes *Source: NIUA*

the twin problem of water shortage as well as excess runoff causing flooding, both of which are likely to get exacerbated by climate change.

Waste Management: ZED homes segregate dry and wet waste. The wet waste is composted and the compost used for gardens and greenery within the project area. The dry and inert waste is handed over to identified recyclers. This makes the waste management system in ZED developments sustainable.

Energy Management: Energy saved is energy produced. At ZED homes, effort is made to reduce the consumption of electricity in every possible way. These include energy efficient fixtures and appliances, street lights, passive cooling measures like ventilation, cool roofs, greenery and use of hollow bricks. All these elements help in reducing demand for electricity. Reduced energy consumption also results in reduced GHG emissions.

Conclusion

ZED homes is one example of sustainable urban development that is network free for water and wastewater. In a city that is able to supply water for a few hours and only on alternate days, the design features of ZED developments need to be emulated, at least in all new developments. Energy efficiency is another feature that can be emulated both is existing and new developments. Since Bangalore is urbanising rapidly (as are other major cities in India), it is necessary for new housing developments to be less of a burden on the existing city networks and at the same time be climate resilient.