Mainstreaming of Energy-Efficient Technologies and Construction Practices in the Residential Sector in India

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ABSTRACT

'*Mainstreaming of energy-efficient technologies and construction practices*' stands for the acceptance and adoption, of these technologies and practices by the mainstream building industry.

Housing construction in urban India consists of multi-storied, high density housing complexes. Demand for basic infrastructure services like water supply, sewage treatment, electricity has not kept pace with the growth in urban population and the housing boom. An ongoing program has been designed to provide indications about the key factors influencing energy-efficient and environment-friendly housing (Eco-Housing). This program is being implemented in the western Indian city of Pune.

This program in partnership with the urban local body makes an innovative attempt to accelerate adoption of energy efficient technologies and practices in the residential sector using a multi-pronged approach targeted at developers, architects, financial institutions, policy makers, technology and service providers, and end-users The program is characterized by specific interventions, including the *development of Eco-Housing performance assessment tool*, integration of *Eco-Housing policy and fiscal incentives*, a *demonstration project*, *capacity building* and the development of a *sustainable institutional mechanism* to mainstream energy-efficient housing practices.

Program interventions designed to scale up the adoption of energy efficient technologies by the developer community help create a market for eco-friendly products and services. In turn, economics of scale is expected to ensure rapid transferability and higher benchmarking levels.

Background

It is estimated that nearly 36% of India's population is likely to be urbanized by 2025 (MOUEPA 2005, 3). Housing markets in urban India are experiencing a boom and the magnitude of housing requirements is set to grow. While construction companies are tapping this opportunity, resource use in housing has become unsustainable. High-density housing development directly impacts infrastructure services like water supply, sewage treatment, solid waste management and electricity supply. For instance in the western Indian city of Pune, the demand for energy in the residential sector has seen a steady increase from 435 Million Units (MUs) in 1996-97 to 797 MU in 2001-02 (IIEC 2005). With the population in Pune expected to cross the 5 million mark by 2025, the municipal council has plans to increase the existing water capacity of 797 Million Liters per Day (MLD) to 1506 MLD by 2025 in a phased manner (PMC 2004). Urban local bodies responsible for providing the basic infrastructure services are finding it increasingly difficult to meet the demand-supply gap. While there is a need to bridge the gap for housing, it is important that there is a shift to resource efficient and sustainable construction

practices through a widespread use of efficient technologies. The Eco-housing initiative addresses this challenge of containing the ever-increasing demand of resources through interventions spanning policy and market development aspects.

Evolution of the Partnership

Eco-housing was not scaling up on its own without any interventions in India. Although there is a sizeable community of architects aware of ecological design, application of ideas is limited. Most green building and energy efficiency programs initiated in the country have focused on demonstration projects or proof of concept, precluding mainstream market participation. Moreover the lack of institutional setup to support the Eco-housing movement at a regional, state and national level limited the reach of the concept. Despite a proven track record of performance internationally, sustainable design is seen as a niche market and has not been embraced by the mainstream building industry. The green building movement in India started with the initiation of the LEED® platinum rated, CII-Sohrabji Godrej Green Building Center in March 2000. Today there are three completed and seven upcoming LEED® rated commercial projects in the country (CIIGBC 2006). Though green design efforts directed towards commercial projects have gained market acceptance through the LEED® standard, there has been a complete lack of a similar movement in the residential sector. The intent of this program was to develop a rating system for housing taking into account local environmental and climatic conditions.

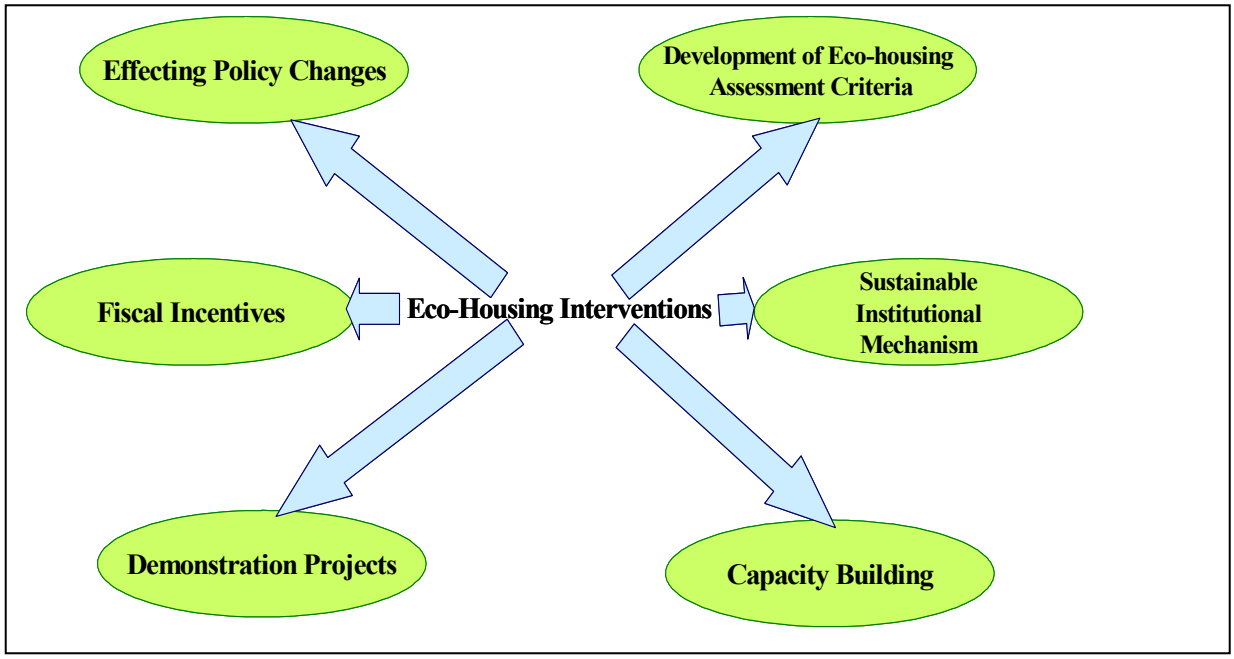
In order to scale-up the demand for energy efficient and sustainable housing, this program initiated under a grant from United States Agency for International Development (USAID) and implemented by the International Institute for Energy Conservation in partnership with one urban local body, association of architects, builders, housing finance institutions and educational institutions aims to scale-up the movement towards resource efficient residential buildings. Understanding key factors influencing the successful application of energy efficient technologies and construction practices through the interventions in this initiative has resulted in aligning further efforts leading to a large-scale program in India. Pune was chosen as the champion city to launch the program as it represents one of the most rapidly expanding cities in western India. Market acceptance to the program would help influence scale-up in other cities. Program implementation has been in partnership with stakeholders including the municipal council; Pune Municipal Corporation (PMC), leading developers, architects, housing finance institutions and technology providers. This Eco-housing model is unique as it has been designed to include the involvement of all stakeholders groups that will influence the scale-up of energy-efficient technologies in the residential sector through a market development process.

The implementation approach included creating an enabling environment for Eco-housing through strategic stakeholder participation on the supply and demand side of the housing and finance market. This meant demonstrating the sustainability and green credential of housing to the planning authority (PMC), developers, housing finance institutions as well as consumers. To ensure scale up of Eco-housing it was important to establish the benefits that green design and adoption of energy efficient technologies would hold for each stakeholder group. In order to reduce the negative environmental impact of construction, the interventions as seen in Figure 1 included effecting policy changes, fiscal incentives, development of the Eco-housing assessment criteria, capacity building, establishing a sustainable institutional mechanism and a demonstration project to showcase and help quantify the benefits of Eco-housing. The

development of the Eco-housing assessment criteria is the single most important aspect of the program, which forms the basis of the voluntary Eco-housing certification for developers. The interventions are directed towards scale-up of Eco-housing and expanding the market for efficient technologies.

Program interventions designed to push the housing sector in India towards resource conservation and energy efficiency at every stage in the construction process from design to operation and maintenance are discussed in the following sections.

Figure 1. Eco-Housing Interventions



IIEC 2005

Program Interventions and Outcome

The program interventions have been designed to look at all aspects that influence the scale up of Eco-housing practices. The focus is to initiate and accelerate the shift towards green building design in the residential sector and develop a market for sustainable and energy efficient technologies and products. The work carried out under each intervention and the outcome is discussed below.

Creating Enabling Environment through Policy-Intervention

The success or failure of any major social or environmental policy change efforts has depended upon the ability of the state or local government to advocate the agenda and effect policy changes. An important part of the program was to evaluate the housing policy environment and identify opportunities for policy interventions by PMC to foster Eco-housing in the city. Housing policy and building construction bylaws as outlined in the city development control (DC) rules, that are planned and implemented by the municipal corporation were studied and changes in building bylaws to promote Eco-housing were identified. Based on the recommendations certain minimum criteria required for certification of a building as

environment friendly have been made mandatory in the building bylaws (IIEC, 2005). The process of approval by the city council required to make the new bylaws a part of the development control rules of the city is underway. The modified building bylaws will address environmental concerns like site planning, environment design, energy efficiency and conservation, green building materials and water and solid waste management.

Eco-Housing Assessment Criteria – A Prescriptive Tool to Drive Innovative Designs

Performance rating is a good method of moving the performance benchmarks in the market place towards a higher level. A jump in performance levels will depend on change in market demand, and such change cannot occur until investors can identify buildings that perform to a higher standard. Thus as a part of the program, a set of Eco-Housing assessment criteria were developed for including a project in its fold. The criteria are based on local environmental issues and include a checklist of measures aimed at architects, builders, financial institutions, and homeowners. Designed to serve as a performance assessment tool, the criteria helps quantify the environmental achievement of the building and provides a meaningful differentiation of buildings in the marketplace. The assessment criteria encourage the adoption of several efficient and eco-friendly measures to ensure resource conservation during the life cycle of the project. For example, measures like rainwater harvesting, water recycle, reduces the water demand in each household of a building and also reduces the amount of water that the municipality otherwise would have to supply to that building.

Table 1. Intent of Assessment Criteria

Category	Intent of measures in the category	Technology interventions
Site Planning	Bio-diversity conservation, use of renewable energy for on-site lighting, preservation of top soil, mitigate heat island effect, storm water drainage	Landscaping and taking advantage of natural contouring for water management; use of PV in site lighting
Environment Architecture	Prevent excessive heat gain into building, enable solar access, adequate day lighting, maximum ventilation	Changing design practices
Energy Efficient Lighting	Reduce lighting load	Pre-wired CFLs, low loss ballast, appropriate lighting power density
Solar Water Heaters	Reduce water heating load	Use of solar-water heaters and plumbing technologies
Efficient Building Materials	Minimize use of unsustainable, energy intensive building material.	Use recycled, rapidly renewable products with low embodied energy
Water Conservation	Minimize fresh water consumption	Use of rainwater harvesting, treatment of grey water by using non-energy intensive technologies, water reuse and recycle technologies of water for landscaping purposes, use of low-flow bathroom fittings, dual flush tanks
Solid Waste Management	Reduce per-capita solid-waste burden on municipal services	Segregation of waste and resource recovery
Other Innovative Technologies	Safety during construction, handicap access, control level of SPM	

IIEC 2006

The Eco-Housing assessment criteria have been developed into a voluntary rating system to help developers and architects design and evaluate the green quotient of new residential projects. To determine the environmental performance of a building the Eco-Housing assessment criteria is divided into eight broad categories: site planning, environment architecture, energy efficient lighting, solar water heaters, efficient building materials, water conservation, solid waste management and other innovative technologies. As appliances are purchased by the individual home owner, the criteria does not include measures related to the use of energy efficient household appliances like refrigerators, televisions, AC, washing machines etc. The intent of Eco-housing measures as seen in Table 1 is to ensure that at every stage of the project life cycle, focus remains on sustainability and scale up of efficiency practices.

Each individual category describes a set of measures that need to be fulfilled. Every measure has been assigned points depending on its impact on environment, and its relevance to local conditions. The objective (intent), submittal requirement, financial implications and the impact of each measure across the value chain, wherever possible, has been summarized. For instance the use of pre cast components for columns, beams, and slabs will reduce costs by over 30% while the use of blended Portland cement or direct addition of fly ash (30%) to cement will bring down costs by 13% (STP 2005). The criteria have also been developed into a web based assessment tool. The tool gives the user the flexibility to assess the expected eco- performance of a project and gauge the rating a project might achieve based on the combination of measures being attempted. All the above technology interventions lead to increased market potential for providers of innovative technologies. With the above interventions, in Pune city alone, energy savings of close to 3 MUs and water savings of up to 15 MLD are expected in the first 10 years of program implementation. Learning from this experience and with the program expansion plans, a much larger savings potential exists in the cities in the Western Region in India.

Creating competitive eco-housing market. The Eco-Housing assessment criteria developed for the city of Pune is spread over eight focus areas. Made up of 88 measures it includes both voluntary and mandatory criteria.

Table 2. Eco-Housing Point Allocation

Category	No. of Measures	Total Points	Mandatory		Voluntary	
			Measures	Points	Measures	Points
Site Planning	24	260	7	70	17	190
Environment Architecture	5	80	1	25	4	55
Energy Efficient Lighting	4	50	1	5	3	45
Solar Water Heaters	3	50	--	--	3	50
Efficient Building Materials	21	200	6	25	15	175
Water Conservation	18	200	7	75	11	125
Solid Waste Management	5	80	2	50	3	30
Other Innovative Technologies	8	80	3	30	5	50
Total	**88**	**1000**	**27**	**280**	**61**	**720**

IIEC 2006

Table 2 gives the total number of measures under each category and the breakup of voluntary and mandatory measures. Each measure has been assigned points depending on the environmental impact. Points can be earned by meeting the performance intent of the criteria. The maximum achievable points are 1000 and the project has to get a minimum of 500 points to qualify for Eco-Housing rating.

Each measure has a submittal requirement and the necessary documentation should be enclosed with the Eco-Housing proposal to show compliance with the measures being attempted. The Eco-Housing rating system is based on the number of points earned. As seen in Table 3, the greater the number of measures attempted, the higher the Eco-Housing rating. The assessment criteria allow the practitioners to create a balance between innovation and increased first-costs. During the first year of the inception, developers enjoying the top 20% share have been able to meet the stringency of the technical interventions. On an average, most of the initial plans assessed meet the 600 to 700 points range. In the years to come, this market development effort will result in shifting the baseline upwards.

Table 3. Eco-Housing Rating System

Focus Area	Points
500	★
501 – 600	★ ★
601 – 700	★★★
701 – 800	★★★★
>800	★★★★★

IIEC 2006

Incentivizing Developers and Consumers

The initial costs of implementing Eco-housing measures are higher than that of conventional buildings. A typical Eco-housing project includes the integration of several efficiency related technologies (solar PV, SWH, eco-friendly materials, technologies for wastewater treatment and solid waste management) that push up project costs. This can act as a deterrent to the adoption and popularity of such programs. It was felt that providing financial benefits through low interest loans, tax breaks or other financial incentives would help push the acceptance of energy efficient products and technologies. In addition financial inducement was likely to be effective in an environment where financial return is often the deciding factor. One of the largest implications of providing financial grants or incentives is that it offsets the extra cost or at least the perception of extra cost attached with the designing energy efficient buildings. Thus fiscal incentives by both housing finance institutions and urban local bodies were identified as a critical component to help mainstream Eco-housing. The proposed incentive structure attempts to balance the 15% increase in construction cost, envisaged for Eco-housing projects.

Incentives by housing finance institutions. Presently most finance schemes for energy efficiency are targeted at industries and commercial establishments. Housing finance institutions are in the process of developing specific environment and energy efficiency related product-financing lines for the domestic sector. When such funding is made available, developers approaching housing finance institutions for project financing would also be able to avail product specific finance. Housing finance institutions can play a vital role in influencing the conservative

construction industry and supporting the market for environmentally sound and energy efficient technologies in the residential sector by launching specific products for developers as well as end users. A reduction in interest rate on housing loans for Eco-housing projects would be an attractive option for investors and help create a market for green sustainable housing. At the same time component finance options for specific Eco-housing technologies like solar water heaters, sewage treatment plants working on the ecological engineering principles, solar photo-voltaic, rainwater harvesting units, mobile brick making machines will benefit developers and help address the initial price barrier.

Both these finance options have been proposed and are being discussed with leading public and private housing finance institutions in India. Due to the highly competitive housing finance market, banks are cautious about reducing the interest rate as it directly impacts their profits. Public and private institutions in fact are interacting with government and multilateral financing institutions for interest rate buy-downs and refinancing options. However they have been more receptive to launching component finance products directed at the project developers and technology suppliers In the case of component finance for Eco-housing technologies, an interest rate of 7-10 % per annum calculated on a reducing balance has been proposed. A maximum loan term of 5 years for products costing less than INR[1] 50,000 ($1100) and 8 years for product cost greater than INR 50,000 but less than INR 500,000 ($11000) is being considered.

Incentives by municipal council. Tax rebates by the urban local body will also play an important role in the scale-up of Eco-housing. The tax incentives proposed by Pune Municipal Corporation for both end users as well as developers were determined based on a consultative process between the corporation and other stakeholders and will be reviewed periodically. Rebates have been proposed for certain classes of taxes which will reduce burden on municipal facilities. A 50 % reduction in tax for water charges, solid waste management, sewage treatment, and road tax as seen in Table 4 is an attractive incentive for consumers and will tilt the balance in favor of Eco-housing projects.

Table 4. PMC Tax Structure

Tax	Current	Proposed
Water charges (fixed per year)	INR 1500	INR 750
Solid waste management	15%	7.5%
Water supply charges	4%	2%
Sewage treatment charges	5%	2.5%
Road tax	10%	5%
Solid waste management	10%	5%

PMC 2006

On an average, the annual tax for a typical apartment unit within the PMC jurisdiction comes to around INR 16 per sq. ft. For an apartment of 1000 sq. ft., the annual tax works out to INR 16,000 ($355) which is quite steep. Based on the reduced tax rates as proposed in Table 4, the rebate is as seen in Table 5.

[1] Conversion rate US$:Indian Rupees (INR) : 1:45

Table 5. Rebate in Tax Structure

Tax	Amount
Annual tax	INR 16,000 ($355)
Proposed tax as per Table 4	INR 8540 ($189)
Rebate offered (50%)	INR 4270 ($94)

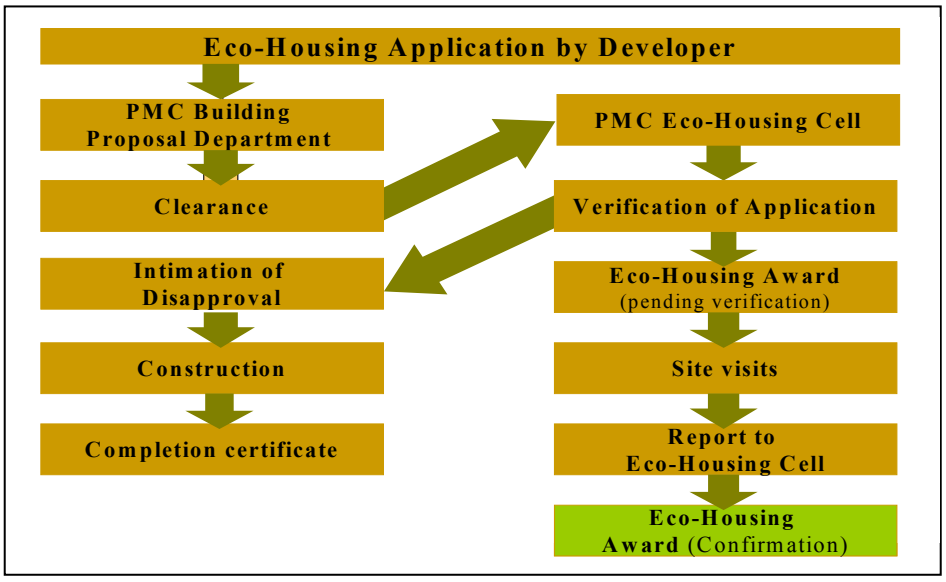
Incentives offered would be linked to building performance, which will be evaluated during the review of Eco-housing certification. This will guarantee that systems installed in Eco-housing projects are maintained.

For developers, PMC has proposed a 50% rebate in the land development and development charges, which stand at INR 30/sq.mt and INR 60/sq.mt respectively. This is a substantial reduction and is very attractive for developers. In case of a homeowner having an apartment of 1000 sq.ft., a combined effect of the rebate in tax structure would mean a reduction of 10% in the annual taxes paid. To this extent, the repayment capacity for loan-servicing also goes up.

Merits of a Sustainable Institutional Mechanism

The efficacy of the program largely depends on the structure and nature of the agency implementing the program. Developing a lasting institutional mechanism to evaluate, verify, rate Eco-housing projects and through which program directives get implemented assumes great significance.

Figure 2. Eco-Housing Certification Process



IIEC 2005

The Pune Municipal Corporation (PMC) will serve as the apex body for certification of Eco-housing projects and they have set up an Eco-housing cell with dedicated staff to manage the program. Projects applying for certification will be evaluated based on the assessment criteria. As seen in Figure 2 to certify a project the developer submits his proposal to PMC's

Building Proposal Department. Here building plans are scrutinized to see if it meets the existing PMC norms. On clearance the proposal is sent to the PMC's Eco-housing Cell. The Eco-housing Cell forwards the proposal to an independent third party[2] registered with the Pune Municipal Corporation which carries out monitoring and verification of all such projects. Independent consultants depending on their area of expertise are empanelled to assist in the verification process. A temporary Eco-housing certification is awarded to projects that pass the initial checks enabling the builder to brand his project as Eco-housing for all promotional and marketing activities. Verification of all other measures adopted takes place during site visits in the construction phase. After verification a complete report is submitted to the Eco-housing Cell based on which PMC gives the final certification.

A regional and national institutional set-up will be established as the program expands to different regions of the country and is adopted by other urban local bodies. This will ensure that the uniformity of program directives and the Eco-housing brand is maintained across regions.

The success of the program in Pune has fueled the interest of municipal corporations in Maharashtra and other parts of the country. The project implementation team will be extending technical support to three interested municipal corporations including the Pimpri Chinchwad Municipal Corporation (PCMC), Thane Municipal Corporation (TMC) and Municipal Corporation of Greater Mumbai (MCGM). Here the Eco- housing assessment criteria will be adapted to suit regional needs. This geographic expansion will include a business model for institutionalizing Eco-housing concepts at a national level.

Having established market acceptance of the technical Eco-housing assessment criteria and the regulatory pressure to construct energy efficient buildings, it is now critical to ensure that the demand for Eco-housing can be adequately met to ensure the scale-up of Eco-housing activities in Pune and other cities. For such replication, setting up a Sustainable Building Technology Center (SBTC) is proposed. Through a self sustainable business model consisting of building technology demonstration, training programs, and certification processes, the SBTC will provide a long term institutional home to the efforts that have already attracted substantial participation and commitment from the government and the private sector in India. The geographic scale-up will be supported by sensitization and capacity building of stakeholders along the Eco-housing supply chain – which will be one of the core functions of the SBTC.

Eco-Housing Demonstration Project

Demonstrations become important for creating market acceptance for the idea. Showing people the benefits of adoption of such a program will enable the public to accept the directives of building green. Several such demonstrations will help evaluate and establish building performance, increase visibility of the benefits of Eco-housing, and contribute positively to the market acceptance of green design. Taking the lead, PMC has initiated a demonstration Eco-housing project for its employees. Land provided is at a prime central location ensuring good visibility for the completed project. Preparation of the tender document incorporating the Eco-housing assessment criteria is complete; the notice inviting tender has been issued and will be finalized shortly after technical and financial scrutiny. The response of the developer community to Eco-housing has been encouraging. A growing community of developers are convinced that Eco-housing would help differentiate projects in the market and in the initial years can be used an effective marketing tool. A number of leading builders have come forward to construct their

[2] Science and Technology Park, University of Pune

upcoming projects based on Eco-housing principles, which is an indication of growing awareness and receptiveness of the private sector (developers and consumers).

Training and Capacity Building

The increase in trained professionals and service providers will give a boost to the Eco-housing movement by providing a capable workforce for project implementation, verification and monitoring. This is essential to be able to generate enough technical resource and know-how to assist the public community to design and construct sustainable housing infrastructure. A series of capacity building workshops were conducted for architects, developers, and service providers to familiarize them with different technical aspects of Eco-housing.

Conclusions

The Eco-housing program has been successful in understanding the factors influencing the scale up of sustainable housing development. The Eco-housing Partnership has in the first phase effectively created a significant momentum in the regional market for Eco–housing practices. The project has seen the development of the technical Eco-housing assessment criteria, a web based application tool, institution of Eco-housing policy and fiscal incentives by city government and financial institutions, and the establishment of an institutional mechanism to mainstream sustainable construction practices through a market development approach. This novel partnership has been successful in developing a strong technical base to promote the implementation and scale-up of clean technologies in the urban housing sector. Adoption of the Eco-Housing assessment criteria supports the efforts in creating a market pull for new Eco-Housing development. Benefits of interventions such as efficient water treatment and pumping, sewage treatment and recycle, use of renewable energy technologies in water heating and area lighting is influencing the adoption of these green technologies. While reducing the impact of urban sprawl, these interventions have a discernible impact in the reduction of demand on resources and service that otherwise have to be provided by the local urban body. Policy support received at the local and State level has been encouraging. Tax breaks by the urban local body and specific housing mortgage products will play a decisive role in pushing the agenda of sustainable construction.

Interventions under this program support a combination of policy driven and market based mechanism that is required to build a consensus among the demand and supply networks. Effective and strong policy support at the state and national level has helped in expansion of the program and accelerate the scale up process. Moreover the adoption of efficient technology in the construction sector is an indication of market acceptance. Further, scale up of efforts by establishing the Sustainable Building Technology Center (SBTC) will provide a platform to build on the efforts of the program and ensure the sensitization and initiation of a larger audience to Eco-housing practices.

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