

General Terms of Reference

Project:

Project no.: 14.2298.9-004.00

Tender: Preparation of database and adaptive model for thermal comfort of occupants in residential buildings of India, IGEN-EERB

Contract No. XXXXX

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## List of abbreviations

BAI	Building Association of India
BEE	Bureau of Energy Efficiency
CREDAI	Confederation of Real Estate Developers' Associations of India
DISCOMs	Distribution companies
ECBC	Energy Conservation Building Code
ECBC-R	Energy Conservation Building Code- Residential Building
EC Act	Energy Conservation Act
EE	Energy Efficiency
EEB	Energy Efficiency in Building
ESCOs	Energy Services Companies
FSI	Financial Services industry
GHG	Green House Gas
GRIHA	Green Rating for Integrated Habitat Assessment
IGEN	Indo German Energy Program
LCC	Life Cycle Cost
LEED	Leadership in Energy and Environmental Design
MEPS	Minimum Energy Performance Standards
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
MoUD	Ministry of Urban Development
M&V	Measurement and Verification
NAPCC	National Action Plan for Climate Change
NMEEE	National Mission on Enhanced Energy Efficiency
NDC	Nationally Determined Contributions
NREDCO	National Real Estate Development Council
NZEB	Net Zero Energy Building
PWD	Public Works Department
ULBs	Urban Local Bodies
TCs	Technical Co-operation
ToR	Terms of Reference

## 1 Project description

### 1.1 Brief description of the project

In 2012, residential buildings accounted for 20.4% of India's total electricity consumption and the electricity consumption in residential buildings is about 2.3 times more than that of commercial buildings. Projections shows that electricity consumption in residential buildings is expected to increase 7-fold during the period 2012-2032. The residential sector will become the largest consumer of electricity in the country with 36.5% share of the total electricity consumed in 2032.

The Ministry of Power and Bureau of Energy Efficiency (BEE) are entrusted with the task of implementation for the National Mission on Enhanced Energy Efficiency (NMEEE) under National Action Plan on Climate Change (NAPCC). This mission has a component which deals with the Commercial and Residential Building Energy

The Energy Conservation (EC) Act of 2001 provides the framework for energy efficiency imperatives in India followed by the National Mission for Enhanced Energy Efficiency (NMEEE) in 2008. India's Nationally Determined Contributions (NDC) aim to reduce the emissions intensity of our GDP by 33–35 per cent by 2030 from the 2005 level; mandates promotion of energy efficiency in the economy, notably in industry, transportation, buildings and appliances; as well as development of climate-resilient infrastructure. Over the past few years, BEE has introduced initiatives to promote design of energy-efficient commercial buildings based on ECBC so far related to commercial buildings; energy conservation in buildings and municipalities through performance contracting by ESCOs; adoption of energy-efficient consumer appliances through energy labeling; market transformation towards energy-efficient appliances through demand side management programs; energy efficient motors; and enhanced focus on energy-efficiency investments in industry due to energy data reporting and benchmarking practices. The project is aligned with the commitments made by the Indian Government to meet its objectives submitted under NDCs.

GIZ is an international cooperation enterprise for sustainable development which operates worldwide, on a public benefit basis. GIZ is fully owned by the German Federal Government, GIZ implement development programs in partner country on behalf of the German Government in achieving its development policy objectives.

The Federal Republic of Germany and the Government of the Republic of India have, under the Indo-German Technical Cooperation, agreed to jointly promote the "Indo-German Energy Programme" (IGEN) with the aim to promote energy efficiency/conservation in energy consumption so to use energy more efficiently and in turn improve the environment/climate protection.

Under IGEN-EE, considerable amount of work has been done in different programs such as Standard and Labeling, Energy Manager Training and Examination, Energy efficiency in Industries under PAT Program. BEE and GIZ mutually agreed that there is a need for development of Energy Efficiency Building program in India through the International experience gained by GIZ.

BEE has been working actively on development of policy instruments for energy efficiency in residential buildings. During the development and various technical meetings, it has been observed that India still does not have a defined thermal comfort study for the residential buildings and the policy instruments, without integration of these studies, may not be entirely correct.

As per classical definition of thermal comfort, it is that “condition of mind which expresses satisfaction with the thermal environment”. An alternative to conventional comfort theory (heat balance approach) termed as ‘adaptive theory’ of comfort embraces the idea that occupant acts as an active agent interacting with the person-environment system approach via multiple feedback loops. Occupants play an important role as an active agent in creating their thermal environment. Nicol and Humphreys [9] defined adaptive comfort approach; “if a self-regulating control system is working to secure thermal comfort, then the whole system, in any case, tends towards its optimum”. This area has recently regained momentum due to increasing concerns over the human impact on energy and the environment. The principle for adaptive thermal comfort states that ‘if a change occurs such as to produce discomfort, people react in ways that tend to restore their comfort’. It implies that human beings have shown an amazing tendency to adopt the variable climatic conditions for making themselves thermally comfortable. The generic term “adaptation” might broadly be interpreted as the gradual diminution of the organism’s response to repeated environmental stimulation. The adaptive thermal comfort approach has been classified into three principal components such as psychological adaptation, physiological adaptation and behavioral adaptation. Currently, the adaptive model is widely accepted as an efficient tool for enhancing human comfort in conditioned buildings and to enhance energy saving. In unconditioned buildings, it is useful to realistically evaluate extent to which buildings are able to provide comfort conditions to its occupants. Common adaptive actions include use of fan for air circulation, opening and closing of windows, change of clothing, change of work and body posture and similar actions including change of thermostat setting in conditioned buildings.

GIZ seeks to contract a consultant that will support in Preparation of database and adaptive model for thermal comfort of occupants in residential buildings of India. BEE is working extensively in developing new policies for energy efficiency in residential buildings so it is imperative to have a all supporting study specific to Indian conditions so that the outcomes of these studies can further strengthen the research and policy work.

## **1.2 Description of the measure of Technical Cooperation (TC)**

### **1.2.1 Objectives**

The objective of the proposed assignment is to select an agency that will support in Developing a database and carrying out analysis related to adaptive thermal comfort of occupants’ residential buildings.

### **1.2.2 Target group and other stakeholders**

The target group of the consulting work consists of the residences of various types located in different climatic zones of the country, spread over major economic and social categories covering major typologies.

### **1.2.3 Lead executing agency and implementing organization**

Lead executing agency and implementation organization will be BEE on behalf of the Ministry of Power, Government of India. The Government of India set up Bureau of Energy Efficiency (BEE) on 1st March 2002 under the provisions of the Energy Conservation Act, 2001. The mission of the Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy. This will be achieved with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all sectors.

## 2 Terms of Reference

### 2.1 Contractor's profile

The agency shall be consisting of team of experts in the field of thermal comfort, data collection, field survey and statistical analysis.

### 2.2 General Terms of Reference for the Contractor

The Terms of Reference (ToR) covers the scope and deliverables by the Contractor to include the creation of database for thermal comfort in residential buildings in India. The Contractor will be required to carry out conducting occupant surveys, monitoring thermal comfort parameters on site, as well as analysis of collected data for development of adaptive thermal comfort model for indian residential buildings.

The main activities outlined in this tender document provide a guideline for the activities envisaged by the Contractor is expected to adjust flexibly to changing demands for support. This tender solicits to develop the list following the strict timelines; the mobilization of activities will be based on demand and needs of the project tasks, and coordinated by the GIZ project coordinator in India in close coordination with the Indian partners and experts of the contractors.

#### 2.2.1. Profile of Bidder/Consultant/Consulting Firm

##### *Eligibility Criteria for Bidder/ Consultant/ Consulting Firm*

- Average annual turnover for the last three financial years (last- but- four financial can be included in case of invitation to tender held within six months of end of last financial year): At least 200000 Euro (Copy of related document must be submitted)
- Number of employees as at 31.12 of the previous year: Minimum 20 employees (Copy of related document)
- The technical assessment is only based on reference projects with a minimum commission value of 40000 Euro (Copy of related document)
- Experience of executing at least 5 Reference projects in monitoring of thermal comfort system and post occupancy evaluation through occupant feedback
- Experience of executing at least 3 Reference projects in India for thermal comfort assessment.in the last three years

#### 2.2.2. Requirement in Technical Proposal

**The bidder needs to follow the below heading only. Any other topic as found suitable by the bidder needs to added after section 12**

1. Executive summary
2. Scope of work, Objective and overview
3. Company profile
4. Understanding of the ToR (Graphical and tabular form preferred) (1.1)
5. Execution Methodology and strategy plan (Graphical and tabular form preferred) (1.1.2)

6. Relevant past experience (Graphical and tabular form) (1.1.2)
7. Cooperation (1.2)
  - Strategy for establishing cooperating with the relevant members. (1.2.1)
8. Proposed Governance Model (1.3)
  - Roles and responsibilities (tabular form preferred) (1.3.1)
9. Project tracking and communication – weekly and monthly reporting (1.3.2)
10. The timelines should include the review process from GIZ and BEE (1.4.1)
11. Detail list of tasks and subtasks along with the required number of days and proposed Timelines (Graphical and tabular form preferred) (1.4.2)
12. Learning and Innovation (1.5)
  - Knowledge management at partner and at GIZ (1.5.1)
  - Ideas and presentation of scaling up effects (1.5.2)
13. Team composition along with relevant details like experience (1.6.2)
14. Deliverables tracking and quality control plan. (1.6.2)
15. Backstopping strategy along with detailed profile (1.6.3).

## **2.3 Short description of the work packages**

The scope of work for agency includes following tasks

- Carrying out occupant survey and measurement of thermal comfort parameters including major adaptive actions.
- Curation and analysis of collected data for development of adaptive model
- Draw conclusions about occupant behavior in residential buildings, especially w.r.t. AC operation, fan operation, natural ventilation and clothing.

The entire activity is divided into following work packages:

- a. WP1: Develop comprehensive plan for carrying out thermal comfort survey and monitoring
- b. WP2: Carry out field surveys and monitoring as per developed plan spread over one complete year.
- c. WP3: Develop methodology to curate the collected data and carry out analysis of the same
- d. WP4: Apply the methodology on the collected data and analyze thermal adaptation in residential buildings to propose adaptive comfort model
- e. WP5: Organise awareness workshop/event for the launch of data set, findings and report

Agency should note that numerous studies have been conducted by various agencies/institutes/researchers in this field. Their work should be incremental and advancing the knowledge rather than being repetitive.

## 2.4 Detailed Specifications (Work Packages)

The Consultant will be responsible for successfully executing the following activities and tasks as part of the study. Execution of all activities and tasks must be conducted in close consultation with GIZ.

### 2.4.1 WP1: Develop comprehensive plan for carrying out thermal comfort survey and monitoring

The agency will be responsible for developing a comprehensive plan for year-long thermal comfort survey and monitoring, adequately covering major economic, social sectors in statistically relevant manner separately for each climatic zone.

- In composite climatic zone and warm & humid zone, due to large variation of climatic conditions within same zone, surveys and monitoring is to be carried out in two cities, Delhi and Hyderabad.
- Similarly, in warm & humid zone, Mumbai, Chennai and Kolkata are to be covered through nearly equal samples.
- For hot & dry, Ahmedabad, and for moderate zone, Bangalore is chosen.
- For Cold climatic zone, appropriate city may be chosen.
- In case, any city mentioned above is to be changed/substituted by other, prior approval for the same from GIZ upon submission of due justification for the same is required.

#### **Deliverables:**

1. Report on literature review, covering studies conducted worldwide, and especially in India; with conclusions drawn and gap analysis.
2. Report on method of occupant survey, monitoring plan with details of instruments, survey form, identification of typologies and socio-economic segments to be covered, number of samples targeted, manpower plan. Survey should not have bias towards age, social segment, income group and such demographic variations.
3. To ensure the same, methodology for sample selection is to be mentioned at early stage itself.

### 2.4.2 WP2: Carry out field surveys and monitoring as per developed plan spread over one complete year

The agency shall carry out occupant surveys and monitoring of thermal comfort parameters, as per the plan developed and approved under WP1, covering one complete year having:

- At least one set of measurements and surveys in each residence each month
- Method of measurement will be as per ASHRAE Class-II protocol
- Instruments to be used need to comply with latest version of ISHRAE IEQ Standard
- Minimum number of samples for each location is to be determined following sampling principles with 95% confidence level and 5% margin of error.
- Minimum measurements to be taken at any location should include Dry Bulb Temperature, Relative Humidity /Wet Bulb Temperature, Mean Radiant Temperature

and Air Velocity. Information about state of AC, Fan, Window, exhaust is also to be captured. Corresponding ambient temperature and humidity conditions at the time of survey, are also to be recorded by the team.

***Deliverables:***

1. Raw dataset having all information collected as per the plan outlined in WP1.

**2.4.3 WP3: Develop methodology to curate the collected data and carry out analysis of the same**

1. The agency shall develop method to curate the raw dataset and for carrying out analysis related to adaptive thermal comfort covering major adaptive actions taken by occupants.

***Deliverables:***

1. Report on methodology of processing raw data for identifying outliers, normalisation, or any other pre-processing as required.
2. Curated data set in open format so that it can be used by others for multiple purposes as deemed appropriate by GIZ.
3. Report on method to be adopted for analyzing the data.

**2.4.4 WP4: Apply the methodology on the collected data and analyse thermal adaptation in residential buildings to propose adaptive comfort model**

The agency shall apply the methodology detailed out under WP3 on the collected data and draw conclusions related to thermal adaptation in Indian residential buildings. Findings are expected to be different for each climatic zone.

***Deliverables:***

1. Report on analysis of thermal adaptation in Indian residential buildings.
2. Model for adaptive thermal comfort in residential buildings
3. Report on occupant behavior in residential buildings as evident from analysis of the data collected. Questionnaire/survey form should capture information required for this deliverable.

**2.4.5 WP5: Organize awareness workshop/event for the launch of data set, findings and report**

The agency shall organize workshops and committee meetings to get the plan approved.

***Deliverable:***

1. Organise at least four stakeholder workshops / committee meetings for sharing the findings of the project. Organize event for the launch of reports developed under the assignment

2. At least three research papers shall be developed and published (or accepted for publication) in a journal of good repute.

## 2.5 Specification of Inputs

### 2.5.1 Assignment of personnel

In total, the contract is projected to have a volume of up to 1100 man-days; however, bidders are expected to draw a detail expert-days distribution as per the table of Expert-day schedule & activities, to optimize the project timeline with a streamlined and efficient approach. Out of 1500 man-days at least 150 days have to be from senior consultant level.

S.no.	Expert Category	Tentative man-days
1	Team Lead	50 days
2	Pool of Experts (senior level)	150 days
3	Pool of Experts	900 days

### 2.5.2 Brief Profile of Experts

#### Team Lead (2.1)

- The team lead should be a person preferably from academia having at least 15 years of experience (2.1.1)
- Minimum 15 years of experience (2.1.2)
- S/he should also have experience of working in the field of thermal comfort, demonstrated through publications of research papers/reports. (2.1.3)

#### Expert 1 - Statistical Analysis (2.2)

- Bachelor's degree in Architecture/Engineering only from a recognized University or Institute (2.2.1)
- Master's degree (Preferable) in any other related field. (2.2.1)
- Minimum work experience of at least 10 years in related field. (2.2.3)
- Experience in usage of Data analytical tools which include project related data collection and analysis. (2.2.4)

#### Expert 2 - Adaptive Thermal comfort (2.3)

- Bachelor's degree in Architecture/Engineering only from a recognized University or Institute and master's degree in Architecture/Energy Engineering or any other related field. (2.3.1)
- Minimum work experience of at least 10 years in related field. (2.3.2)
- Experience in the fields of thermal/adaptive thermal comfort in Indian context. (2.3.3)

#### Expert 3 - Field surveys and monitoring (2.4)

- Bachelor's degree in Architecture/Engineering only from a recognized University or Institute and master's degree in Architecture/Energy Engineering or any other related field. (2.4.1)
- Minimum work experience of at least 10 years in related field. (2.4.2)
- Experience in energy monitoring in the field of building energy efficiency including field surveys with occupants and monitoring of thermal comfort parameters. (2.4.3)

**Pool of Experts on Statistical Analysis:** The contractor should propose a pool of experts in the area of data collection and analysis. At least 50 man-days should be proposed in the category of senior consultant in this pool. (2.6)

**Pool of Experts on adaptive thermal comfort:** The contractor should propose a pool of experts in the area of adaptive thermal comfort. At least 50 man-days should be proposed in the category of senior consultant in this pool. (2.7)

**Pool of Experts on Field surveys and monitoring:** The contractor should propose a pool of experts in the area of conducting field surveys with occupants and monitoring of thermal comfort parameters. At least 50 man-days should be proposed in the category of senior consultant in this pool. (2.7)

**Definition of senior consultant level:**

- the professional is supposed to cover in the project context and should be an Engineering graduate or Architect. (2.2 to 2.4)
- At least 10 years of experience in the area of expertise (2.2 to 2.4)

**Definition of consultant level:**

- The professional is supposed to cover in the project context and should be an Engineering graduate or Architect. (2.6&2.7)
- At least 5 years of experience in the area of expertise (2.6&2.7)

All the Senior Consultants / Consultants should have good command over English language (reading, writing and speaking)

The contractor has to assign no. of personnel, national and International Experts of different level for different activities during the course of project completion. It is expected from contractor to provide the list of assigned personnel for the activities along with expected man days as per format provided. In the case of a tender being submitted by a consortium or joint venture, for each of the consortium/joint venture partner a separate listing shall be provided.

Expert-day schedule & activities						
Sr. No.	Expert Category	Expert International /National	Activities Involved	Job Description	Tentative experts-days	Brief Profile Attached (Yes/No)
1	Team Lead					
2	Expert 1					
3	Expert 2...					
4	Expert ....					
5	etc.....					

**2.5.3 Timeframe of the contract**

Timeframe: The duration of contract shall be for 13 months.

## **2.5.4 Workshops, Meetings and Launch event**

Cost of venue, food etc. for organizing round-tables, workshops shall be borne by GIZ separately. All travel, instruments, accommodation, food etc. for the staff of the Contractor has to be borne by them and have to be budgeted in their proposal. Expenses incurred can only be reimbursed after cost proposals have been submitted to and approved by GIZ prior to the acceptance and if sufficient bills / proofs are submitted to GIZ as desired. All costs related to participants shall be borne either by the participants themselves or by GIZ separately.

## **2.6 Further Requirements**

- a) Data logging and field survey cost shall be included in the financial proposal submitted by the bidder. GIZ will not procuring any hardware under this project.
- b) The entire proposal including approach and methodology, including tool and software's proposed, CVs etc., needs to be in English. The CVs need to be in uniform format with a maximum of three pages.
- c) All activities including travels, meetings and tasks in different focus areas need to be aligned with the GIZ project co-ordinator (to be nominated by GIZ in the beginning of this assignment)
- d) In case the bidder is a consortium or joint venture, the lead bidder should as well take up tasks in the assignment and shall be involved as the responsible coordinator among the group. The share of tasks shall be evaluated on the basis of the proposal submitted as above. The Team Lead shall be from the Lead Bidder.
- e) All communication with media (TV, radio, print and other media) related to the assignment has to be approved by the responsible person of BEE/GIZ.
- f) All reports, slides, presentations and other media and information material need to be submitted to GIZ in English language in soft copy and in hard copy (at least 3 copies) as required.
- g) The Contractor should at all times of the assignment possess the copyrights (licenses in the case of software packages) of the documents, pictures, technical papers, standards used in the study.
- h) Any data to be purchased from external sources if necessary, for the purpose of execution of the contract shall be purchased by the Contractor on its own expense.
- i) Cost of venue, food etc. for organizing round-tables, workshops shall be borne by GIZ separately. All travel, accommodation, food etc. for the staff of the Contractor has to be borne by them and have to be budgeted in their proposal. Expenses incurred can only be reimbursed after cost proposals have been submitted to and approved by GIZ prior to the acceptance and if sufficient bills / proofs are submitted

to GIZ as desired. All costs related to participants shall be borne either by the participants themselves or by GIZ separately.

- j) The bidder should consider all the relevant and related activities, including but not limited to the activities proposed above in the work packages, to ensure the successful completion of all Work Packages.
- k) All deliverables under Work Packages shall be considered final after incorporating all the comments and Feedbacks from the stakeholders and final approval from GIZ.
- l) Tendering shall be executed in two stages, where the agencies have to be assessed through the Assessment grid for eligibility for qualification in next stage for opening of Technical bid. The technical assessment of the proposals will be undertaken for the bidders, who qualify in eligibility.

### 2.6.1 Timelines for deliverable and activities

S.no	Deliverables/Activities	Reporting	Milestone
0.1	Project kick-off meeting to discuss approach for the study and expected outcomes.	Within 10 days from award	
0.2	Inception Report: The consultant shall provide an overview for all sub activities mentioned under each Task.	Within 15 days from award	
0.3	Monthly Progress Reports: summary of progress on activities and tasks	monthly until project completion	
<b>WP1</b>	<b>Develop comprehensive plan for carrying out thermal comfort survey and monitoring</b>		
1.1	Develop comprehensive plan for carrying out thermal comfort survey and monitoring	Month 1	
1.2	Report on method of occupant survey, monitoring plan with details of instruments, survey form, identification of typologies and socio-economic segments to be covered, number of samples targeted, manpower plan	Month 2	<b>1</b>
<b>WP2</b>	<b>Carry out field surveys and monitoring as per developed plan spread over one year</b>		
2.1	Carry out field surveys and monitoring as per developed plan spread over one complete year	Monthly progress report	
2.2	Raw dataset having all information collected as per the plan outlined in WP1	Monthly progress report	<b>2</b>
<b>WP3</b>	<b>Develop methodology to curate the collected data and carry out analysis</b>		
3.1	Develop methodology to curate the collected data and carry out analysis of the same	Month 3	
3.2	Report on methodology of processing raw data for identifying outliers, normalisation, or any other pre-processing as required.	Month 4	
3.3	Report on method to be adopted for analyzing the data	Month 4	<b>3</b>
<b>WP4</b>	<b>Apply the methodology on the collected data and analyse thermal adaptation in residential buildings to propose adaptive comfort model</b>		
4.1	Apply the methodology on the collected data and analyze thermal adaptation in residential buildings to propose adaptive comfort model	Month 12	
4.2	Report on analysis of thermal adaptation in Indian residential buildings	Month 12	<b>4</b>
<b>WP5</b>	<b>Organise awareness workshop/event for the launch of data set, findings and report</b>		

5.1	Organise at least four stakeholder workshops / committee meetings for sharing the findings of the project. Organize event for the launch of reports developed under the assignment	Month 13	5
5.2	At least three research papers shall be developed and published (or accepted for publication) in a journal of good repute.	Month 13	6

## **Annexure A: Sample Template for Progress Report**

Activity	Responsible Consultant	Timeline as per work plan	Actual % Work Progress	Status	Remarks
WP 1					
Sub task 1.1					
...					
...					
WP 2					
...					
Brief summary in bullets to justify the status					
	Completed (100%)				
	in progress (26%-99%)				
	Progress less than 25%				