"Life Cycle Assessment With Respect to CDM: A Case Study"

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ABSTRACT

This paper evaluates the critical ecological impacts of a residential banglow in India. The building has total built up area of 982sq.ft and projected help life of 50 years. In this examination, a far reaching life cycle ecological evaluation of the structure was directed to discover the energy utilization what's more, ozone harming substance (GHG) outflows by the structure. This investigation shows that RCC structure and steel in the structure are the most noteworthy donor in GHG discharges for total banglow. Moreover, of the absolute energy is burned-through just in the activity stage. In the majority of the structures, life cycle stages have huge effect in some class, in any case; just two life cycle stages viz. development and activity appear to be more critical in all effect classifications (energy and emanations).Some of the alternavites which can be applied are listed.

1. INTRODUCTION

As land area is expanding quickly, the requirement for quality inner climate and miniature environmental factors has gotten key issue for both, home purchasers and domain designers. Structures have huge consequences for climate from its development to destruction. From recent years, natural effects identified with structures for example an unnatural weather change, ozone layer consumption, nursery gas (GHG) discharges, squander collection, and so forth are quickly expanding. Exploration from the previous year shows that these progressions in worldwide environment are expanding quickly and will proceed with time. As the number of inhabitants on the planet is expanding quickly, development is occurring at huge rate all around the world to oblige world's moving populace towards metropolitan area. In building material creation represents as much as CO2 emanations. The development and building area have been discovered to be answerable for a huge piece of natural impacts on human exercises. Building utilizes energy for the duration of its life for example from support to grave. The structure area represents 40% of the essential energy consumption what's more, 36% of the energy identified with CO2 emanations in the industrialized nations (International Panel on Climate Change, 2011b). There is critical impact of building area over the complete regular asset utilization and on the outflows delivered, alongside their related ecological effects. In the event that we investigate on asset utilization during its development, then, at that point the structure devours 40% of the stone, sand and rock, 25% of wood, 40% of energy from petroleum derivatives; and 16% of water worldwide consistently in the world. The home grown energy utilization, in terms of per capita net utilization, expanded by which is a significant issue of concern.

During use (activity) period of the structure, a great deal of electrical energy is devoured by lighting and electrical apparatuses. More than 40% of the all out energy utilized in a structure is burned-through by warming, ventilation and cooling (HVAC) frameworks. The above information demonstrates that a lot of energy is devoured by structures for warming and cooling purposes. In this manner, there is an incredible need to limit the energy utilization by structures with the goal that the ecological effects can be decreased. In any case, previously going into the decrease of building energy utilization, the essential thing is to get the quantitative upsides of natural impacts related with as long as building can remember cycle for example GHG emanations, energy utilization, and so on In this investigation, life cycle evaluation (LCA) method is utilized to complete the ecological investigation of a building. LCA is one of the notable devices for investigating the ecological effects by an item through its whole life for example from acquisition of crude material to discarding it. LCA is pertinent for every one of the phases of building and discovering the significant adjustments to augment the presentation of building.

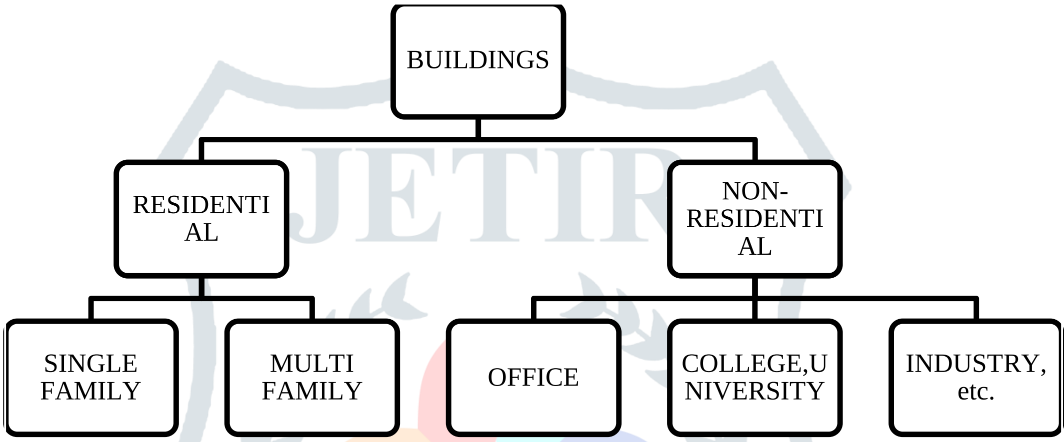

Fig.1 Classification of Buildings.

Structures can be sorted by their use for example private also, non-private structures. Private structures can further be partitioned into single-family house and multi-family house, what's more, non-private structures are those which are utilized for business purposes for example school, college,office, industry, and so on. The order of the structures is displayed in Fig. 1.

For the current investigation, residential banglow has been chosen to contemplate essential energy utilization and GHG emanations delivered by the structure. The structure has ground and first stories and the investigation of all the building has been done in one frame. After this, aftereffects of all stories have been analyzed. LCA strategy is utilized to examine the energy utilization and GHG discharges by the structure. The point of this work is to examine the energy uses and GHG emanations of a building working in of India.

2. LIFE CYCLE ASSESSMENT

The executives of ecological issues identified with the structures requires information and devices that empower the control of ecological viewpoints. LCA is one of the well realized instruments utilized for the quantitative appraisal of a material utilized, energy streams and natural effects of items. It follows a deliberate way to deal with evaluate the effect of every material, cycle and item. LCA is the most proper system for the recognizable proof, measurement, and assessment of the information sources, yields, furthermore, the possible ecological effects for the duration of its life cycle (support to grave). LCA methodological system includes of four phases, for example objective and degree definition; life cycle stock investigation; life cycle sway evaluation; and life cycle understanding. With the assistance of this device it is feasible to evaluate and look at the ecological effects of various structures.

Four phases of LCA methodological system remembered for this study are displayed in Fig. 2. The objective and degree definition is the one which builds up the utilitarian unit, framework limits, and quality standards for stock information. The existence cycle stock investigation (LCIA) manages the assortment and amalgamation of data on actual material and energy streams in different phases of the items life cycle.

In the existence cycle sway appraisal, these ecological effects of different progressions of material and energy are doled out to diverse natural effect classes. For this the portrayal factor is utilized to figure the commitment of each of the constituents for different natural pointers (for example GHG outflows, ozone layer consumption, and so on) At long last the existence cycle understanding manages the understanding of results from both the life cycle stock investigation and life cycle sway appraisal. It incorporates the recognizable proof of huge issues and the assessment of results.

Essentially there are three sorts of LCA techniques for example measure based LCA, input–yield LCA and mixture LCA (Bullard and Herendeen, 1975; Facanha and Horvath, 2006; Guinea, 2002; Heijungs and Suh, 2002; Kofoworola and Gheewala, 2008; Suh and Huppes, 2005). In this study measure based LCA has been completed. In a cycle based LCA, the client diagrams all cycles related with all life-cycle periods of an item, and partners sources of info and yields with each measure, by which absolute natural burden energy can be resolved.

2.1. Power situation of India

India is as of now the biggest power creating country furthermore, represents about 4% of the world's complete yearly power age. India is likewise presently positioned 6th in yearly power utilization, representing about 3.5% of the world's all out yearly power utilization. Generally, India's requirement for power is developing at a tremendous rate; yearly power age and utilization in India have expanded, and its extended pace of increment for power utilization is one of the most noteworthy on the planet. An outline of flow power age situation in India is displayed in Table 1.in the world. A summary of current electricity generation scenario in India is shown in Table 1 (Ministry of Power,2020).

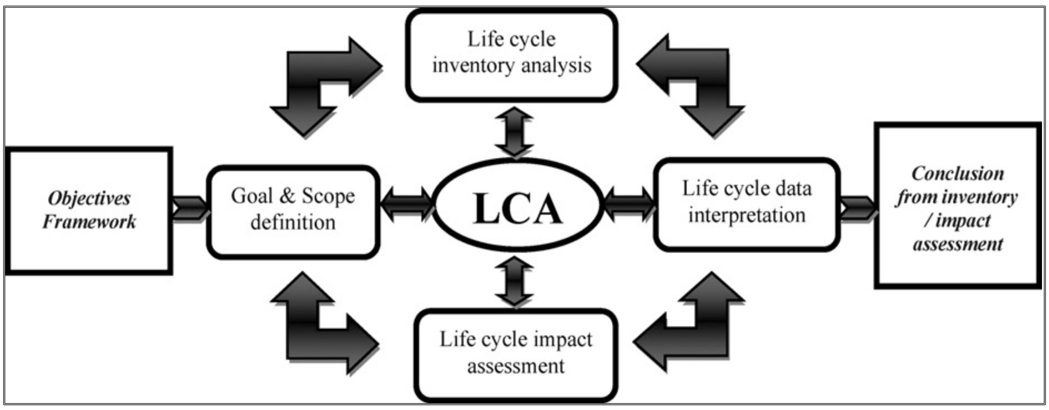

Fig.2 Structure of life cycle assessment.

Table 1

Current electricity generation scenario in India.

Sr. No	Source	Installed Capacity (MW)	Percentage (%)	Associated GHG emissions (g CO2eq/kWhe)
1.	Thermal	2,21,803	64	2126.94
1.a	Coal	1,96,097	56.9	2509.35
1.b	Gas	24,867	7.2	824.063
1.c	Oil	838	0.24	454.011
2.	Hydro	45,487	13	50.518
3.	Nuclear	6,780	2	41.14
4.	Renewable source	70,648	21	186.72
	Total	**3,44,718**	**100**	**1417.53**

3. METHODOLOGY

In this investigation, LCA is utilized to examine the energy utilization and GHG discharges of banglow working at loni arranged in condition of Maharashtra, India. The existence pattern of the structure is isolated into three fundamental stages: development, activity (use) and support. Yearly working energy of the structure is thought to be same for the duration of its life expectancy. Because of changes in environment conditions, working energy of the structure may change in future, however this isn't mulled over in the investigation. As the destruction requires less energy (1%) when contrasted with the existence cycle energy of the fabricating consequently it's anything but thought to be in the current examination. The activity period of the structure is thought to be 50 years. The assessed natural effect during this stage depends with the understanding that no expansions and re-development are made during the long term life cycle. The effect of this stage has been assessed through its energy use. The building materials fundamentally affect activity energy of the structure. Energy necessity for space warming, cooling, lighting, ventilation, PC work and for working substantial/little apparatus was determined. In upkeep stage, just consecutive upkeep, for example re-painting has been taken into account. Henceforth, 5% of complete energy use in development stage is considered according.

Fig. 3 shows procedure utilized in the current investigation. The first step of this examination was to figure the stock information of the material. The stock information of the structure was gathere d and determined to perform LCA. The detail of the development material utilized in the structure was gathered from the arrangement displayed in Fig. 4 and by visual review of the structure. Items which are significant supporter in the outflows from building were thought of. Then, at that point, their relating typified energies for every one of the section were determined autonomously. Typified energy is alluded to the energy devoured in extraction, assembling, get together and transportation of a specific item. The encapsulated energy coefficients of the structure materials are taken from the writing (Gumaste, 2006; Reddy, 2004; Reddy and Jagadish, 2003; Scheuer, Keoleian, and Reppe, 2003). The encapsulated energy coefficients of the structure materials are introduced in Table 2. The absolute epitomized energy of the structure is gotten by including the epitomized energy of the relative multitude of materials needed in development.

The related GHG emanations were assessed by utilizing the flow power situation of India. Likewise the energy utilized by the working for various stages was determined. The energy utilization because of lighting is kept consistent as indicated by a given timetable. Power from the public framework is being utilized for all activities of the structure like running climate control systems, hefty hardware and lighting. The change of essential energy (warm) into power is taken as 1 MJpri = 0.111 kWhe. The normal power change productivity from nuclear power has been taken as 0.40. The itemized assessment of energy necessity for development and activity periods of the structure from an essential energy point of view is being thought of. The energy utilized for the remodel of the structure is required to be little. The activity energy of the structure incorporates the energy for warming, cooling, lighting and the power utilized by machines like washing, etc. This energy has been assessed by gathering power bills for last 2–3 years. The absolute normal power utilization for a very long time is 1.74 GWhe. The related life cycle

GHG emanations can be assessed as:

Life cycle GHG emanations = Total life cycle energy (pri)

× Transformation factor for essential to electrical

× normal discharge coefficient

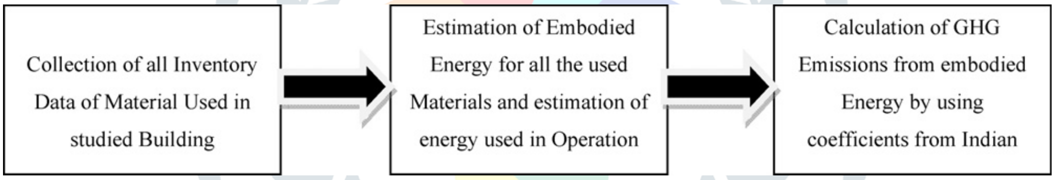

Fig 3. Methodology used For LCA of Building.

Table 2

Constructive material consider and their corresponding embodied energies.

Sr.No.	Material	Emboided Energy
1.	Cement mortar	1268MJ/m^3
2.	RCC framework	730 MJ/m3
3.	Brick Masonary	2141 MJ/m3
4.	Steel	42 MJ/kg
5.	Glass	25.8 MJ/kg
6.	Timber	10.8 MJ/kg
7.	Ceramic tiles	5.5 MJ/kg
8.	Kota stone	2560 MJ/m3
9.	Aluminium	207 MJ/kg
10.	Cast iron	32.8 MJ/kg

4. CASE STUDY

4.1 Description of Building

Fig. 5 shows the pictorial view of building at loni. The main construction components used in construction were consider. Components taken into consideration are ; Cement mortar, Reinforcement Cement Concrete (RCC) Framework. Brick masonary, Glass, Aluminium frame, Timber, Ceramic tiles, Steel, etc.

Table 3

Building Parameters	**Values**
Location	LONI, A. Nagar, Maharashtra.
Service Life time	50 years
Total B/UP area	982 SQ.FT
Structure	Ground parking and first floor, RCC framework, brick and aluminium frame.

4.2 Limitations

To estimate the environmental impact, certain simplifications have to be made. In cases where manufacturer's specific information was not available, typical generic data or data for equivalent products has been used. The environmental aspects included in the study account only for external effects. The effects on human like noise, odor and work environment have not been taken into account.

Table 4

Total energy for the selected building at construction phase.

Sr. No	Name of Item	Volume (m^3)	Density (kg/m^3)	Weight (kg)	Total embodied energy (MJ_{pri})
1.	Cement Mortar	67.4149	-	-	85,482.09
2.	R.C.C Work	134.53	-	-	99,547.538
3.	Brick Masonary	39.546	-	-	84,667.986
4.	Glass	0.3456	2500		23,182.848
5.	Timber	0.42	800	336	3,628.8
6.	Ceramic	0.046	2000	292	1,606
7.	Aluminium	-	-	88.64	18,389.88
8.	Steel	-	-	3829.89	160,855.38

5. Results and Discussions

An LCA has been carried out for the building at Loni. All the floors of building were assessed and their associated GHG emissions have been calculated. The system studied includes the entire life cycle of the building, including construction, use (operation) and maintenance phase. Most of the buildings life-cycle phases have significant impacts in some category, however; only two life-cycle phases, construction and operation seem to be more significant in all impact categories.

Table 5

Total life cycle energy usage for the selected building

Sr.No.	Energy use	MJ	Percentage
1.	Construction	475,754.522	16.79%
2.	Maintenance	23,787.73	0.85%
3.	Operation	2,332,800	82.36%
	Total	2,832,342.248	100

5.1 Energy Usage

The total energy usage for building in different phases i.e. construction, operation and maintenance is shown in Tables 4 and 5. The construction phase consumes about 475,754.522 MJ of primary energy which is around 17% of the total energy requirement. The energy usage for use (operation) phase was calculated to be maximum and it has been found out to be around 82% of total energy usage. Most of the use energy is required for heating/ cooling, computer usage in the building. Working hours are 24h per day as the light and fans are required in night also. During the operational phase almost all the life-cycle elements cause significant impacts. In maintenance phase the energy usage is around 23,787.7261MJ which is less than 1% of total energy usage.

5.2. GHG emissions

The GHG emissions from the building for its whole life cycle are shown in Table 6. The total life cycle GHG emissions contributed by the building are 524.298 ton CO2eq. The operation phase consume maximum about 82% of total life cycle GHG emissions. Table 6 point out that steel has the biggest share in the GHG emissions i.e. about 25% of total GHG emissions in construction phase. This is due to high large amount of steel used in the construction. During the construction phase, RCC framework and steel are the highest contributor of total GHG emissions for building.

Table 6

Total life cycle GHG emission for the selected building.

Sr.No.	Material	Life cycle GHG emissions(Mg-CO_{2eq})
1.	Cement Mortar	13.45
2.	R.C.C. Work	15.663
3.	Red Brick Masonary	13.332
4.	Glass	3.647
5.	Timber	0.57
6.	Ceramic	0.2526
7.	Aluminium	2.89
8.	Steel	25.31
	Total	**75.1146**
9.	Operation	445.65
10.	Maintenance	3.74
	Grand Total	**524.505**

5.2.1. Comparison and discussion

The comparison of GHG emissions of the present study with other case studies is done. They indicate that commercial buildings have more impact on environment as compared to the residential buildings. Also, the GHG emissions per unit area decrease with the increase in the floor area of the building. These high GHG emissions from commercial buildings have a (big amount of) significant contribution in Global Warming Potential. Consequently, there is a need to develop some new techniques by which GHG emissions from the buildings can be reduced and the problem of Global Warming can be reduced. The consumption of electricity varies as per the type of building. Normally commercial building consumes more amount of energy as compared with the residential buildings but some commercial buildings even consume less energy as compared with the residential buildings. Some commercial buildings operate 24 h in a day and some might be operate for around 8–10 h in a day which decreases their energy requirement even to around 50%, compared to the buildings which are operated for 24 h. As we see that life cycle GHG emissions about 50–80% are contributed by operation phase and this could vary because of climatic conditions, type of structure and availability of energy sources.

6.Conclusion

In this study all building is assessed and GHG emissions for construction phase has been calculated separately for each material. RCC framework and steel were found to be the highest contributor in the construction phase of life cycle GHG emissions. It was also seen that most of the energy (82%) was consumed during the use (operation) phase of the building due to electrical appliances viz. AC, heating devices,etc. Since the operation phase is very dominant and there is conformity between the energy use and the environmental impact during the life cycle, it is wise to include both: design of buildings that are energy-efficient during their occupation phase, and to produce energy (electricity) with low emissions. This study reveals that the architects and engineers must explore some other techniques and methods of building construction, operation and maintenance so that the problems of high energy consumption, GHG emissions can be reduced significantly. Also the study demands to open the doors of passive solar building design. Therefore, if some new techniques like Trombe wall or rat-trap bond are used then a lot of energy can be saved during use phase. This will lead to environmentally adapted building. Consequently, significant reductions in the environmental impacts of building can be achieved through the practice. Finally, it is observed that if the above considerations are taken while designing the building, large amount of emissions can be reduced. High performance envelopes and equipment, building commissioning and design with future renovations can ensure that the building will have an efficient operational life.

REFERENCE

1. "Scenario Analysis Of CO2 Emission Reduction Potential In Road Transport Sector" International Scientific Conference "Environmental and Climate Technologies", CONECT 2018
2. "Multiple Benefits Assessment Of The Clean Energy Development In Asian Cities" 4th International Conference on Energy and Environment Research, ICEER 2017, 17-20 July2017,
3. "Developing Sustainable Infrastructure for Small Hydro Power Plants through Clean Development Mechanisms in Colombia" International Conference on Sustainable Design, Engineering and Construction 2016
4. "Integrating Clean Development Mechanism In to The Development Approval Process Of Buildings: A Case Of Urban Housing In Uganda" Received in revised form 11 December 2015
5. "Can The Clean Development Mechanism (CDM) Deliver?"
6. "Toward An Effective Implementation Of Clean Development Mechanism Projects In China" 19 September 2005
7. "Potential of Kyoto Protocol Clean Development Mechanism in transfer of clean energy technologies to Small Island Developing States: case study of Cape Verde" *Research Group on Energy and Sustainable Development* Received 31 October 2002; accepted 5 November 2002
8. Research Group on Energy and Sustainable Development, Toward an effective implementation of clean development mechanism projects in China 19 September 2005
9. The Clean Development Mechanism in the Solid Waste Management Sector: Sustainable for Whom? 8 August 2012
10. Business responsibility regarding climate change in Latin America: An empirical analysis from Clean Development Mechanism (CDM) project developers a Institute of Energy and Environment 27 February 2018.
11. Co-benefits and additionality of the clean development mechanism: An empirical analysis 30 March 2011.
12. Bullard, C., & Herendeen, R. (1975). The energy cost of goods and services. Energy Policy, 3(4), 268–278.

13. Facanha, C., & Horvath, A. (2006). Environmental assessment of freight in the US. International Journal for Life Cycle Assessment, 11(4), 229–239.

14. Gumaste, K. S. (2006). Embodied energy computations in buildings. Advances in Building Research, 404–409.

15. Kofoworola, O. F., & Gheewala, S. H. (2008). Environmental life cycle assessment of a commercial office building in Thailand. International Journal of Life Cycle Assessment, 13, 498–511.

16. Suh, S., & Huppes, G. (2005). Methods for life cycle inventory of a product. Journal of Clean Production, 13, 687–697.

17. Varun, Bhat, I. K., & Prakash, R. (2009). LCA of renewable energy for electricity generation systems – A review. Renewable and Sustainable Energy Reviews, 13(5), 1067–1073.