BOXABL "CASITA" Modular Building Life Cycle Assessment Report

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Executive Summary

Boxabl Inc. engaged Humann Building Solutions, LLC to perform a comprehensive lifecycle assessment (LCA) to compare their "Casita" with typically constructed single family home configurations with the same size and functional attributes as their Casita. The Boxabl Casita is a 400 square foot modular building incorporating efficiency and sustainability measures constructed at the Boxabl Factory which utilizes advanced modular building manufacturing techniques to create their unique highly effective building unit. The goal of the LCA study would be the understanding of not only the global warming potential (GWP) of the Boxabl Casita yet, as well where it would compare to conventional construction over the complete Cradle to Grave lifecycle of each building. The table in Image 8, output from the Athena Impact Estimator for Buildings version 5.4 utilized for this LCA analysis provides "Cradle to Grave" reporting for LEED and other Green Building Rating systems compliance. The Baseline Building is a conventionally constructed Single Family Home, with the Proposed Building the Boxabl Casita. Rating Systems typically recognize improvement of 5% in three categories, then 10% in three categories with no negatives followed by a typical maximum of 10% in three categories with the others having a 5% or greater differential. The results indicated here indicate an Innovation in Design and Exemplary Performance when aligned with the LEED building rating systems.

Image 1: Athena LEED Report - Whole-Building LCA Results

Whole-building LCA Results

Results System Boundary: Cradle to Grave (A to D)

Life Cycle Assessment Impact Measures	Baseline Building	Proposed Building	Units	Percent Difference (%)
Global warming potential	300,945.17	207,746.58	kg CO_2 eq	-30.97%
Stratospheric ozone depletion	0.03	0.02	kg CFC-11 eq	-33.33%
Acidification of land and water	1,052.07	632.58	kg SO_2 eq	-39.87%
Eutrophication	297.53	190.49	kg N eq	-35.98%
Tropospheric ozone formation	10,291.54	5,649.64	kg O_3 eq	-45.10%
Depletion of non-renewable energy resources	5,332,068.41	3,428,566.97	MJ	-35.70%
Number of measures with at least 10% reduction *(a reduction corresponds to a negative value percent difference)*				6

The resultant outcomes of this Whole Building LCA investigation serve to quantify multiple factors of environmental impacts from the production of a building (Single Family Residence) over its lifetime from 'Cradle to Grave'. The investigation therefore followed ISO 14040 protocols in recognizing the LCA Product Life Cycle Stages and quantifying the inputs of energy and resources needed within each particular stage illustrated within Image 2.

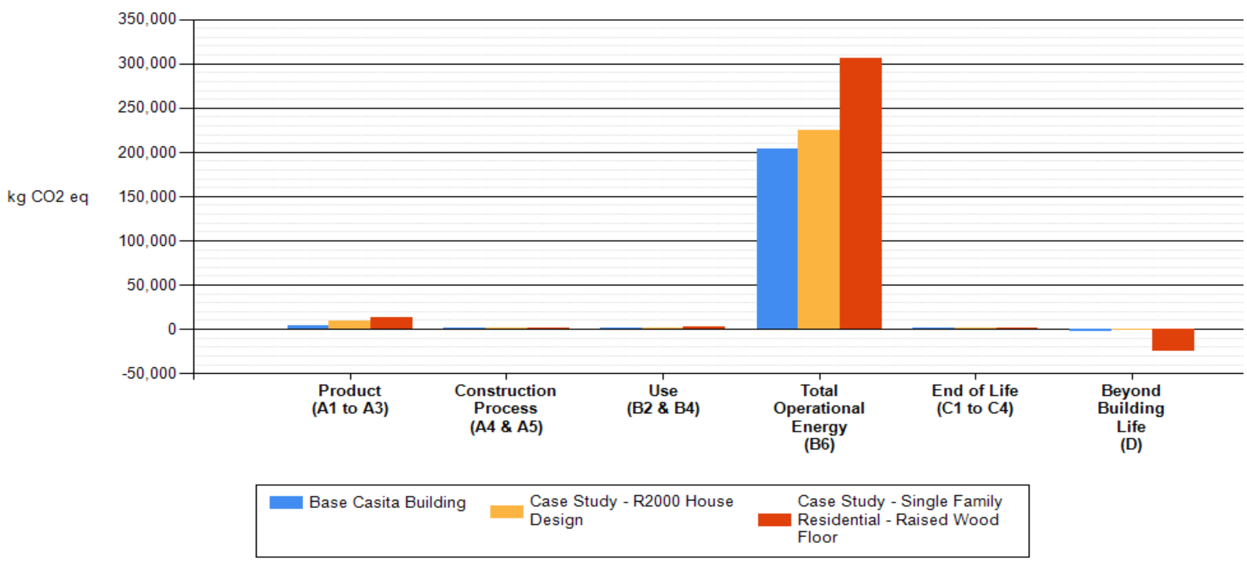
Image 2: LCA Product Life Cycle Stages -ISO 14040 aligned

Product Life Cycle Stages																	
Production			Construction Process		Use							End of Life				Recovery
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw Materials (extraction and Supply)	Transport	Manufacturing	Transport	Construction - Installation Processes	Use	Maintenance	Repair	Peplacement	Refurbishment	Operational Energy	Operational Water	Deconstruction / Demolition	Transport	Waste Processing	Disposal	Reuse - Recovery - Recycling Potential

This LCA investigation established a baseline for typically constructed buildings, providing a comparison analysis utilizing known best of currently adopted techniques the R2000 buildings that are very energy efficient, as well as the current Boxabl Casita utilizing factory modular construction. The iterations as well looked to future improvements with the Boxabl Casita Max which exceeds US Department of Energy Zero Energy Ready Home alignment adding options for Net Positive Energy and Well Health Safety Rating incorporated into the facility.

When the LCA analysis are run for the typologies and then compared the following Image 3 - Comparisons of Global Warming Potential By Life Cycle Stage is generated. As we would

Image 3: Comparisons of Global Warming Potential By Life Cycle Stage.



As we would expect the Single-Family typical building construction methodology is the most intensive in its Global Warming Potential. The Boxabl Casita LCA demonstrates improvements that its construction methodology has where reductions due to the factory process are indicated in the Construction Process, it uses less energy for its raw materials as a factor of reduced waste as well as the accuracy and repeatability of the factory construction. The table presented within Image 3-tbl presents data generated by the Athena LCA Software for the documentation of GWP

Image 3-tbl: Comparisons of Global Warming Potential By Life Cycle Stage.

Project Name	Unit	Product (A1 to A3)	Construction Process (A4 & A5)	Use (B2 & B4)	Total Operational Energy (B6)	End of Life (C1 to C4)	Beyond Building Life (D)	Total
Base Casita Building	kg CO2 eq	3.88E+03	4.65E+02	1.43E+03	2.04E+05	1.77E+02	-2.47E+03	**2.08E+05**
Case Study - R2000 House Design	kg CO2 eq	9.48E+03	1.47E+03	1.55E+03	2.25E+05	5.84E+02	-1.87E+03	**2.36E+05**
Case Study - Single Family Residential - Raised Wood Floor	kg CO2 eq	1.31E+04	1.41E+03	3.13E+03	3.06E+05	1.30E+03	-2.44E+04	**3.01E+05**
Total	**kg CO2 eq**	**2.65E+04**	**3.34E+03**	**6.11E+03**	**7.35E+05**	**2.06E+03**	**-2.88E+04**	**7.45E+05**

The Total Operational Energy sees an approximately one-third reduction for the Boxabl Casita in comparison to the Single-Family home which is significant since the plug loads compromising almost 50% of the long-term energy usage would be the same. Therefore, the energy use savings built into the Casita provide a measurable differentiation. The Athena Software also provides detailed LCA Measures including Global Warming Potential, Acidification Potential, HH Particulate (in PM2.5 equivalent), Eutrophication Potential, Ozone Depletion Potential, Smog Potential, Total Primary Energy, Non-Renewable Energy, Fossil Fuel Consumption as is seen in summary in Image 8 Whole Building LCA Results as well as in Image 4 Detailed LCA Measure Table by Life Cycle Stages.

Image 4: Detailed LCA Measure Table by Life Cycle Stages

Detailed LCA Measure Table By Life Cycle Stages

Project: Base Casita Building

		PRODUCT (A1 to A3)			CONSTRUCTION PROCESS (A4 & A5)			USE (B2, B4 & B6)				END OF LIFE (C1 to C4)			BEYOND BUILDING LIFE (D)			TOTAL EFFECTS	
LCA Measures	Unit	Manufacturing	Transport	Total	Construction-Installation Process	Transport	Total	Replacement Manufacturing	Replacement Transport	Operational Energy Use Total	Total	De-construction, Demolition, Disposal & Waste Processing	Transport	Total	BBL Material	BBL Transport	Total	A to C	A to D
Global Warming Potential	kg CO2 eq	3.22E+03	1.25E+02	**3.34E+03**	2.92E+02	2.38E+02	**5.29E+02**	1.66E+03	1.74E+02	2.04E+05	**2.06E+05**	1.15E+02	7.52E+01	**1.90E+02**	-2.50E+03	0.00E+00	**-2.50E+03**	**2.10E+05**	**2.08E+05**
Acidification Potential	kg SO2 eq	1.74E+01	1.32E+00	**1.87E+01**	2.17E+00	2.45E+00	**4.61E+00**	1.14E+01	1.84E+00	5.93E+02	**6.06E+02**	1.60E+00	7.24E-01	**2.33E+00**	-2.20E+00	0.00E+00	**-2.20E+00**	**6.32E+02**	**6.30E+02**
HH Particulate	kg PM2.5 eq	1.09E+01	6.50E-02	**1.10E+01**	6.41E-01	1.30E-01	**7.71E-01**	1.52E+01	9.51E-02	6.26E+02	**6.41E+02**	6.82E-02	4.01E-02	**1.08E-01**	-9.64E-01	0.00E+00	**-9.64E-01**	**6.53E+02**	**6.52E+02**
Eutrophication Potential	kg N eq	2.23E+00	8.16E-02	**2.31E+00**	2.02E-01	1.52E-01	**3.54E-01**	5.22E-01	1.14E-01	1.87E+02	**1.88E+02**	1.00E-01	4.50E-02	**1.45E-01**	-1.13E-01	0.00E+00	**-1.13E-01**	**1.90E+02**	**1.90E+02**
Ozone Depletion Potential	kg CFC-11 eq	3.99E-05	4.48E-09	**3.99E-05**	3.23E-06	8.83E-09	**3.23E-06**	1.26E-05	6.55E-09	1.68E-02	**1.68E-02**	5.03E-09	2.63E-09	**7.65E-09**	0.00E+00	0.00E+00	**0.00E+00**	**1.68E-02**	**1.68E-02**
Smog Potential	kg O3 eq	2.61E+02	4.19E+01	**3.03E+02**	5.27E+01	7.76E+01	**1.30E+02**	1.47E+02	5.84E+01	4.95E+03	**5.16E+03**	5.32E+01	2.28E+01	**7.60E+01**	-2.22E+01	0.00E+00	**-2.22E+01**	**5.67E+03**	**5.65E+03**
Total Primary Energy	MJ	5.35E+04	1.80E+03	**5.53E+04**	4.42E+03	3.46E+03	**7.88E+03**	4.65E+04	2.52E+03	3.51E+06	**3.56E+06**	1.71E+03	1.10E+03	**2.81E+03**	-4.40E+03	0.00E+00	**-4.40E+03**	**3.63E+06**	**3.62E+06**
Non-Renewable Energy	MJ	4.54E+04	1.80E+03	**4.72E+04**	3.98E+03	3.45E+03	**7.43E+03**	4.43E+04	2.52E+03	3.32E+06	**3.37E+06**	1.71E+03	1.10E+03	**2.81E+03**	-4.40E+03	0.00E+00	**-4.40E+03**	**3.43E+06**	**3.42E+06**
Fossil Fuel Consumption	MJ	4.30E+04	1.80E+03	**4.48E+04**	3.85E+03	3.45E+03	**7.30E+03**	4.20E+04	2.52E+03	2.42E+06	**2.47E+06**	1.71E+03	1.10E+03	**2.81E+03**	-8.83E+03	0.00E+00	**-8.83E+03**	**2.52E+06**	**2.51E+06**

One of the initial uses of the results of this LCA will inform governmental, energy efficiency, regulatory agency, potential customers and investors of the inherent benefits of the Boxabl patented Modular Constructed Buildings.

The current development of the Boxabl Max as well as the continual production and operational improvements at Boxabl will see ongoing improvement of environmental outcomes as well as improved building energy performance from GWP reducing strategies incorporation. The GWP reductions related to Transportation, efficient Construction Process, Operational Energy Use reduction and beneficial End of Life are key differentiators found from this LCA study.

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Abbreviations and Acronym Identification

AAP	Aquatic Acidification Potential
AP	Acidification Potential
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BEES®	Building for Environmental and Economic Sustainability
BREEAM	Building Research Establishment Environmental Assessment Method
CMU	Concrete Masonry Unit
DPWS	Department of Public Works and Services
EIO-LCA	Economic Input Output – Life Cycle Assessment
EP	Eutrophication Potential
EPA	Environmental Protection Agency
EPD	Environmental Product Declarations
GBI	Green Building Initiative
GG	Green Globes (Building Certification Standard)
GWP	Global Warming Potential
IGCC	International Green Construction Code
ILFI	International Living Future Institute
ISO	International Organization for Standardization
LBC	Living Building Challenge
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCEA	Life Cycle Energy Analysis
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LCM	Life Cycle Management
LEED	Leadership in Energy and Environmental Design (Building Certification Standard)
NREL	National Renewable Energy Laboratories
OD	Ozone Depletion
POCP	Photochemical Smog Potential
SETAC	Society of Environmental Toxicology and Chemistry
TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
UNEP	United Nations Environment Programme
USGBC	United States Green Building Council

Introduction

Boxabl Inc. engaged Humann Building Solutions, LLC to perform a comprehensive lifecycle assessment (LCA) on several typical configurations of single-family residential buildings with the same size and functional attributes as their "Casita". The Boxabl Casita is a 400 square foot modular building incorporating efficiency and sustainability measures which as well utilizes state of the art innovations in building manufacturing techniques and functional attributes to create a highly effective building unit. Boxabl knew that their Casita Design, their innovations in the manufacturing and construction techniques utilized as well as the enhanced efficiency of their factory Modular Building processes provided significant positive impacts for the final product. Therefore, a primary goal of the LCA study would be the understanding of not only the global warming potential (GWP) per square foot of each configuration from the Typical Construction of a 400 square foot single-family dwelling through conventional best of current breed as well as the Boxabl Casita. The LCA documents 3 (+1) differing typologies and that comparison is included within this report as well as the future of Boxabl with the delineation of the long-term improvements provided with the Casita Max (which is the +1).

Boxabl has successfully developed their innovative, factory constructed modular buildings (single-family homes for many) as very energy efficient buildings relying on their patented standardized folding modular building systems. The Engineering Marvel is in the drastic paradigm shift on how to construct a building for a multitude of configurations which is rapidly deployable, easy to final assemble due to its expanding folding nature, more efficient and more affordable than competitors' conventional construction.

Image 5: Boxabl Wall (left) vs. Traditional Wall (right)

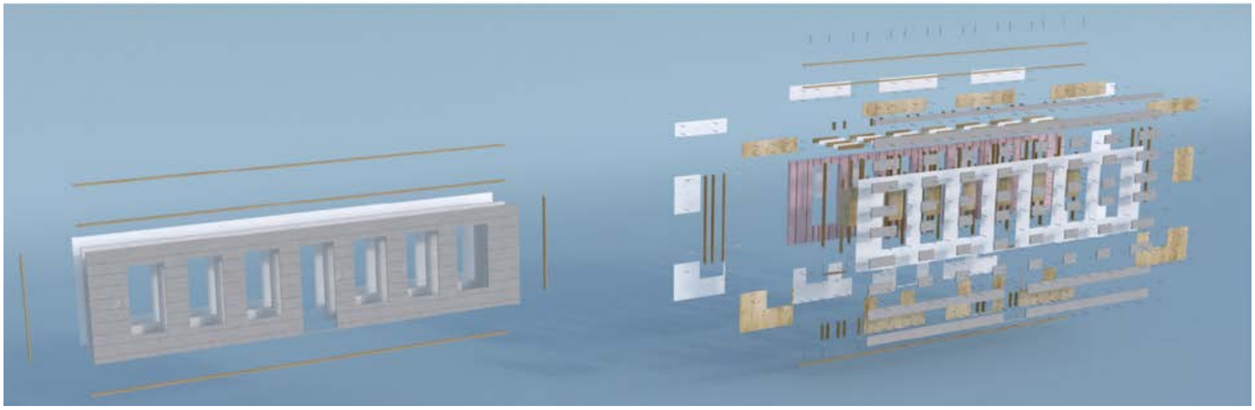


Image 5, above, illustrates just one of the unique and patented features of the Boxabl Construction System. Conventional "stick-framing" is illustrated on the right and became more adopted nearly one hundred years ago when "balloon-framing" became a more expensive and difficult means of construction. Stick-framing or platform-framing depends on dimensional lumber and ushered in the 8-foot wall height. We notice the stark contrast in the Boxabl Structurally Insulated Panel (SIP) wall, where the stick-framed limitations go away, so does the lack of 3-dimensional rigidity and sturdiness. The Boxabl Structurally Insulated Panel wall has excellent rigidity, dimensional accuracy, repeatability and as well is much more first resource efficient. The Boxabl SIP utilizes a Magnesium Oxide exterior and interior panels for its envelope’s resilient enclosure. Due to the planned locations of electrical, plumbing heating and cooling elements the interior of the wall contains all of the necessary utility routing within the wall with electrical outlets and switches placed within the assembled wall according to code. The Factory assembly and advanced construction techniques see materials cut within the factory to precise lengths for virtually no waste. In dramatic contrast to conventional construction the Boxabl exterior wall, floor and roof construction exhibit virtually zero thermal bridging.

When we can calculate the Boxabl Casita’s insulating R-Values utilizing REM/Rate Energy Analysis (or similar) software, which was professionally performed in February of 2022 providing predictable good results. In April 2022 Boxabl had their walls evaluated by Quast Consulting and Testing, Inc. a third-party testing laboratory certified to perform ASTM C1363-19 Thermal Performance Testing of walls. Quast during testing at their laboratory measured R-23.5 wall insulation values for the conventional Boxabl Wall. The February 2022 software calculated the floor and roof at R-36 minimum insulation values. These are the base values of the current EPS based Structurally Insulated Panel (SIP) walls utilizing subcontractor supplied EPS panels. In the same series of April 2022 Quast laboratory wall testing a Boxabl future graphite-EPS SIP wall was measured to have R-34.26 values approximately 50% increased insulation effectiveness beyond the Boxabl base wall.
Additionally, this is significantly beyond the May 2022 Federal Register Proposed Energy Conservation Standards for Manufactured Housing which established wall insulation R-21 compliance requirements equal to that of full Residential Construction IECC 2021 requirements. Boxabl energy efficient construction has already seen reducing energy use per square foot by over 50% or more compared to traditional homes, in an evaluation performed by Home Energy Connection, LLC. in February of 2022. That International Energy Code Compliance evaluation (for Modular Buildings) REM/Rate Energy Analysis software output provided that the annual utility costs for heating and cooling only totaled $103 per year for 361 net square feet of interior space.

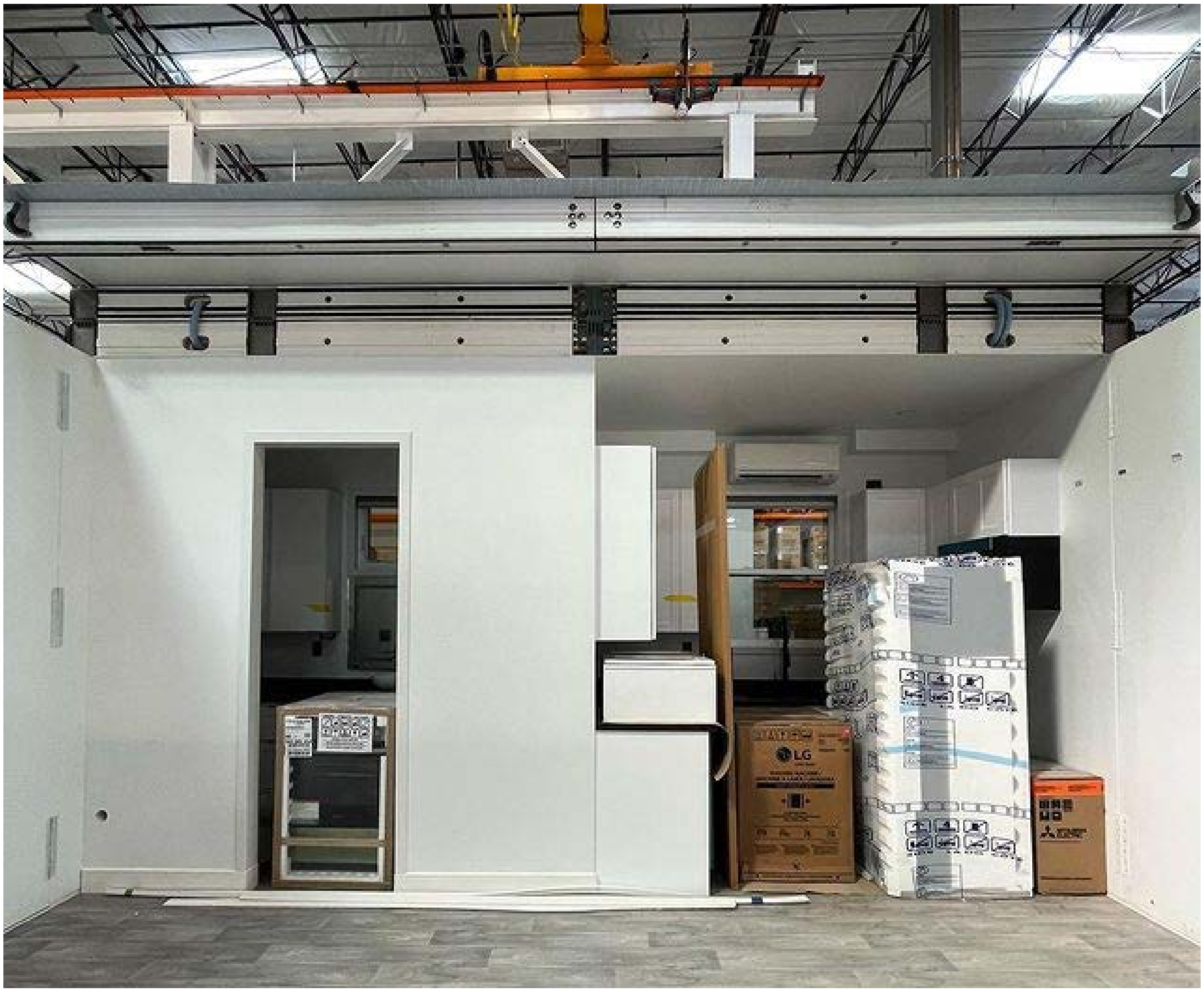
Boxabl had their initial Electrical Service needs and appliances evaluated for alignment with NEC 2020 by Saracen Energy Solution who provided an analysis and reporting February 17, 2022, which indicates that appliance and plug loads electrical energy demands will far exceed the heating and cooling loads for the Boxabl Casita. This confirms the analysis done by Home Energy Connection, LLC. in February of 2022.

Boxabl's factory-built module/modular design basis when executed enables the delivery of higher quality commercial or residential buildings which can be constructed more rapidly, at higher levels of consistency and quality while being more resource efficient than any existing building system in the world; all these attributes at lower delivered costs according to Boxabl. Within this modular factory setting, Boxabl utilizes automation for most advantage within as much of the construction process as possible. The predictability of Boxabl's construction methodology allows their engineering team to continue process improvement which concurrently sees focus on maximizing the delivered emissions reductions and energy efficiency of the finished product.

The founders of Boxabl purposely looked to modernize and make more effective the building process using engineering and manufacturing knowledge with their power of invention applied. Boxabl has leveraged engineering to streamline manufacturing, maximize accuracy and tolerancing yielding consistent replicability. Boxabl modules are therefore built differently than traditional homes; they have been engineered with mass production in mind. Their SIP component panels are designed to implement increased three-dimensional strength and rigidity for use as floors and roof structural components as well as for walls while also providing a significant reduction in the quantity of individual components involved in the manufacturing process. Imagine being able to calculate the minimal length of electrical cable (or other utility conduit) needed within a wall. Then install those elements consistently within an optimized structure with no potential negative outcomes because of the engineered construction management process utilizing assembly line operations and manufacturing techniques to exceed conventional stick construction in a multitude of beneficial ways.
The resultant Boxabl laminated panel technology includes steel and EPS foam bonded to an interior and exterior structural mineral-based concrete-like-panel which is extremely resilient, stronger, fire and impact resistant, more durable, higher quality, more energy efficient, and boasts many superior features over a traditional wall. These patented and innovative manufacturing techniques have been developed to allow Boxabl to scale production as quickly and efficiently as possible to meet the needs of the domestic and global housing market in a very environmentally and resource efficient way.
The Boxabl engineered SIP walls provide another substantial benefit as well, the incorporation of their high-quality structural pivot mechanisms into the modular design is the source of the Boxabl Paradigm Shift in Delivery. The Casita the ability to compress the factory-built buildings

to gain maximum maneuverability while at the same time a much higher level of protection in the structurally optimized unit for delivery. Image 6 provides a very good illustration of a Casita

Image 6: Boxabl Casita being prepared for shipment



finished unit in preparation for shipping. The centralization of mass and structurally solid connection points allow the packaged Casita to be easily picked up via a crane and hoisted onto a transportation trailer to be very quickly and efficiently installed at the final site location. This innovative process description is only part of Boxabl's patented shipping technology which again provides optimization of energy and resources required for transportation over very large geographic areas from the current Las Vegas Valley based factory, resulting in substantially lower transportation and shipping costs versus competitors' outdated deployment methods.

Via this LCA we learn how much Boxabl can help reduce the residential sector's environmental and climate footprint, using non-traditional resilient materials, factory-based construction techniques, and transportation-delivery methods that provides very effective efficiency.

Life Cycle Assessment Purpose

Whole Building Life Cycle Assessment (LCA) is similar to yet varies from an individual product LCA, in that a complete whole building LCA includes all materials in the building yet due to common conditions some elements are assessed as assemblies. The resultant outcomes of the Whole Building LCA are to quantify multiple factors of environmental impacts from the production of a building over its lifetime from 'Cradle to Grave'. Given this perspective, the functional limits of the whole building LCA are limited to only the materials and assemblies found in the largest quantities or with the most impact. In this instance the respective buildings assessed within this LCA for comparative purposes include the same 400-square-feet of functional space with respective service life for "the entire building from design to demolition being established at a 60-year service life,".

LCA aims to quantify the environmental impacts that arise from material inputs and outputs, such as energy use or air emissions, over a product's entire life cycle to assist end users in making informed decisions that will benefit the environment in addition to their economic and operational goals. LCA is typically a "cradle-to-grave" approach, which begins with the gathering of raw materials from the earth to create the product and ends at the point when all materials are returned to the earth, these stages are illustrated in Image 2 redisplayed below.

Image 2: LCA Product Life Cycle Stages -ISO 14040 aligned

Product Life Cycle Stages															
Production			Construction Process		Use							End of Life			Recovery
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw Materials (extraction and supply)	Transport	Manufacturing	Transport	Construction - Installation Processes	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy	Operational Water	Deconstruction / Demolition	Transport	Waste Processing	Disposal	Reuse - Recovery - Recycling Potential

Whole building LCA principles can also be used for a variety of purposes, such as:

- Quantify or otherwise characterize all the inputs and outputs over a product's life cycle
- Specify the potential environmental impacts of these material flows
- To provide insights into building materials choices (including new products) and design options.
- To show benefits of refurbishment vs. demolition + reconstruction

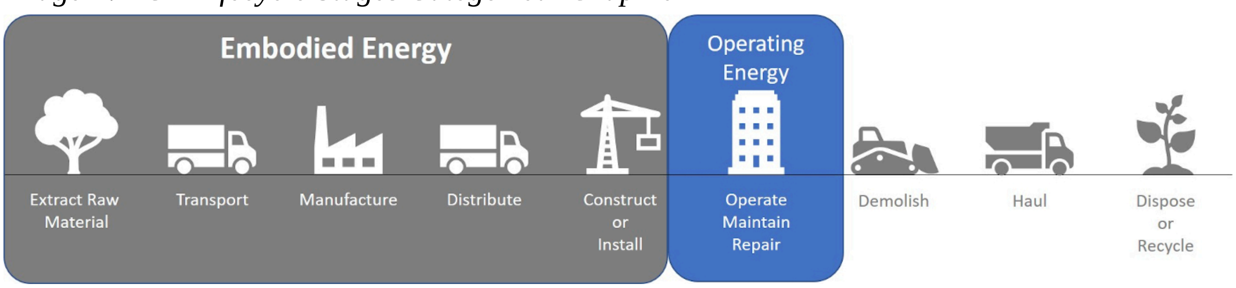
- To compare structural systems and finish choices for reduced environmental impact
- To achieve an LCA-based certification, or to make environmental claims about buildings
- To provide decision support for policy design, including the introduction of new building technologies
- To provide guidance on product and process development, marketing, and selection of suppliers or subcontractors

The whole building LCA process is informed by ISO 14040, which sets standard references and modeling assumptions. The reporting is utilized to objectively compare whole buildings LCAs in codes, standards, and rating systems.

Scope and Methodology

To understand the impacts of different building typologies and how the Boxabl Casita compares to other common and best of building assembly/construction typologies, four separate LCA studies were conducted using the Athena Impact Estimator for Buildings version 5.4 the software recognized by the US General Services Administration, US Green Building Council, Green Building Initiative, International Living Future Institute and other key developers of the ISO 14040 protocols for Life Cycle Assessment.

Image 7: LCA Lifecycle Stages Categorical Graphic



When we consider the major impacts that we can have with any product's production and that product's lifecycle the related energy, benefit, discharge and end of life concerns are the key attributes of a successful LCA. The environmental impact measures that Athena Impact Estimator for Buildings version 5.4 calculates are global warming potential, Acidification potential, HH particulate, eutrophication potential, Ozone depletion potential, smog potential, total primary energy, non-renewable energy and fossil fuel consumption. These are the WBLCA metrics used in nationally recognized high-performance green building codes, standards and rating systems (e.g. International Green Construction Code, ASHRAE 189.1 and in LEED v4/4.1). The primary impact considered within most LCAs including this study is Global Warming Potential (GWP). Image 7: LCA Lifecycle Stages Categorical Graphic provides a very good parallel to the evaluation Life Cycle Stages within and reported from our

Athena LCA Software and those categorical align with the ISO 14040 Life Cycle Stages, the software outputs will include:
Product Impacts A1-A3 *Raw Materials Extraction, Related Transport and Manufacturing*
Construction Process A4-A5 *Related Distribution Transport, On-site Construction (energy use+)*
Lifespan Intended Use B2, B4, B6 *Replacement Manufacturing, Replacement Transport, Operational Energy Use (total related emissions)*
End of Life C1 to C4 *De-construction, Demolition, Disposal & Waste Processing, EOL Transport to Landfill (repurpose considered within D)*
Beyond Building Life D *Beyond…are there potential beneficial uses?*

Our Athena Software output reporting will include the following Impact Categories previously noted herein including:
Global Warming Potential, Acidification Potential, HH Particulate (in PM2.5 equivalent), Eutrophication Potential, Ozone Depletion Potential, Smog Potential, Total Primary Energy, Non-Renewable Energy, Fossil Fuel Consumption

The benefits of the Athena Software include the ability to do comparisons of the individual LCA analysis evaluations for several LCA models. This comparison provides great value in the thorough review of impacts and implications. The iteration of runs and audit of materials within BEES is an integral part of the overall analysis and therefore considerations regarding exemplary performance and additional human benefits will be provided as well such that this information may be used as a reference for ESG reporting.

Steps of this LCA Process

In alignment with the ISO 14040 protocols for Life Cycle Assessment this evaluation and analysis does contain the four necessary components stages: (1) Goal, Scope and Boundary Definition, (2) Inventory Analysis, (3) Impact Assessment, and (4) Interpretation.

1. Goal, Scope, and Boundary Definition

The initial Goal of this study involves establishing the baseline for typically constructed buildings, providing a comparison analysis utilizing known best of currently adopted techniques and buildings that are very energy efficient, providing a comparison analysis of the current Boxabl Casita the Modular Innovative Building/Dwelling, providing a comparison analysis of the future Boxabl Casita Max a further evolution to the Modular Innovative Building/Dwelling which will incorporate additional features to have it become a fully compliant Zero Energy Ready Home with as well added options for Net Positive Energy and Well Health Safety Rating incorporated into the facility. The intended use of the results of this LCA will inform governmental, energy efficiency, regulatory agency, potential customers and investors of the inherent benefits of the Boxabl patented Modular Constructed buildings. The environmental goals established are to provide proof that optimal credit can be obtained within Green Building Rating Systems for LCA that indicates a significant level of environmental stewardship and improvement over a minimum of 3 of the LCA Primary Measures.

Impact Categories: Our LCA reporting will include outputs and comparisons of the specific environmental impacts to be considered following these established Impact Categories include:
Global Warming Potential, Acidification Potential, HH Particulate (in PM2.5 equivalent),
Eutrophication Potential, Ozone Depletion Potential, Smog Potential,
Total Primary Energy, Non-Renewable Energy, Fossil Fuel Consumption

Note: The glossary expands upon the definitions of these Impact Categories with thorough descriptions

Functional Unit: Within this LCA the functional unit is a 400 gross square foot independently standing dwelling unit containing all appurtenant features for full functional usage.

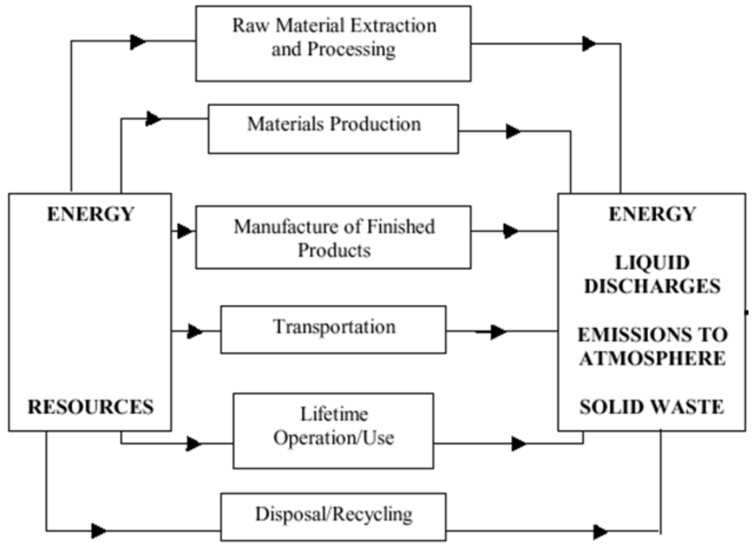
System Boundary: Within this LCA the system boundary shall set the life cycle analysis at 60 years term of study. The databases utilized will be of domestic origin and include the life cycle impact catalog of information at NREL (National Renewable Energy Laboratories) the breadth and depth of the proposed LCA will utilize the maximal capabilities of the Athena Impact Estimator for Buildings version 5.4 software for LCA of Buildings. For this analysis ancillary appliances beyond those for Heating and cooling are generalized within the software on a per unit minimum utilizing square footage as the denominator. Sub-assembly items not included in a detailed Bill of Materials will include items like clips, brackets, fasteners, and sealant. The major categories that have 'drop-down' menus for delineated specification within the software include Foundations, Beams and Lintels, Walls, Roofs, and Extra Items for example Walls or Roofs include delineation items for insulation type and thickness, interior and exterior finishes and fenestration. Using these parametric determinations provides a very accurate comparative LCA.

2. Inventory Analysis

Within this LCA Process and our evaluation of the energy, raw materials and other resources used and or consumed provide resultant output products as well as emissions to atmosphere, water, and soil; these uses, and impacts are quantified for each process then combined in the process flow analysis and related to the functional basis for each typology being evaluated for eventual comparative analysis. Again, the Functional Basis for this LCA is a 400 gross square foot independently standing dwelling unit.

3. Impact Assessment

Image 8: Impact Assessment Iterative Flow Diagram *Source: British Royal Chemistry Society*



This graphical representation of the Inventory Analysis which within this LCA will be performed by the Athena software and then comparative analysis to check componentry within the BEES database then utilizing a spreadsheet analysis of the resultant output data as well for iteration and 360 check to ensure accuracy as well as to optimize the level of analysis beyond large component elements. The process illustrated within Image 4 was directly can be applied to each of the successive phases of the analysis to provide iterative evaluation of the overall functional units which were analyzed. This figurative building block was applied to each discreet sub-product and process within an overall LCA.

Beyond a basic spreadsheet comparison this LCA's impact assessment utilizing the Athena software for optimal inclusion and calculation accuracy translated the emissions from a various given products and/or processes into impacts on various human and terrestrial eco-systems identified for comparison utilizing the Primary LCA Measures in correlation with the identified Impact Categories. The initial goals for this study in regard to emissions outputs were to define the comparative Global Warming Potential of the various analyzed subject buildings. Thus the data from the Inventory Analysis was attributed to an appropriate Impact Category defined in '1. Goal, Scope, and Boundary Definition'. The iteration of the Impact Assessment specific stages and their 360 reviews provides the feedback for the final analysis of the Boxabl Casita comparative differentiation due to its numerous innovative processes, materials and transportation ultimate impacts.

4. Interpretation

This Boxabl LCA results have been reported in the most informative way possible and the need and opportunities to reduce the impact of the product(s) or service(s) on the environment are systematically evaluated. In this step, the results are often presented in the form of tables or graphs, which is especially helpful when comparing two competing design options or products.

The outcome of this step is directly useful in making environmentally friendly decisions. Like any other design feedback tool, LCA can be an iterative process; the interpretation of the LCA can lead to changes in the proposed design, which then leads back to Step 2 in the process.

Within the Athena Impact Estimator LCA software tool; the system boundaries and assumptions for calculation are already embedded within the tool, therefore we performed the additional levels of iterative analysis, product verifications within the BEES database and tertiary calculations to arrive at our final summaries.

Where the very strong elements of differentiation of Boxabl Techniques and Technology apply the calculations always trend at the very conservative. We know that the long term incrementally positive effects of building within factories, producing specific machines for automation, building delivery transportation systems, or other activities related to basic systems are not included in the software calculations which were major considerations within these iterations, analyses and calculations on the ultimate benefits of Boxable related to reducing Green House Gas Emissions. As such in the interpretation phases of this LCA additional considerations for energy use associated with processing, transporting, delivering fuel and energy were further validated and again conservatively accounted for. Importantly, impacts from site selection and site preparation is not accounted for with all 4 evaluations.

All building components and assemblies that are recycled or reused at present are assumed to get recycled or reused after the end of product's life, as no reliable data are available for these practices 40-60 years from now.

Image 9: BEES (Building for Environmental and Economic Sustainability) impact categories and weighting

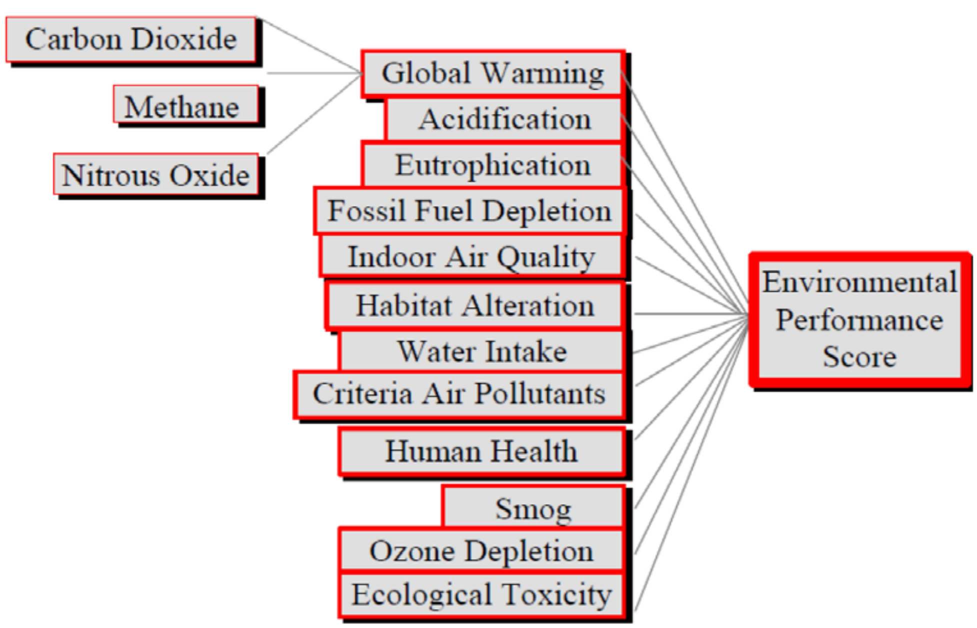


Image 9: *(on previous page)* 'BEES (Building for Environmental and Economic Sustainability) impact categories and weighting' illustrates the somewhat differing weighting strategies may be selected in order to establish the environmental performance score which is done within the BEES Software. Since the LCA Process looks specifically at the Building as a whole in this analysis the BEES methodology and database information was used for comparative and verification purposes; not specifically to get into minutia of individual building elements in a cumbersome way in alignment with the goals of this LCA analysis.

Study 1: The 'Baseline' Option

Case Study - Single Family Residential - Raised Wood Floor is the internal descriptor within the Athena Impact Estimator LCA. This descriptor is the current code compliant level typical wood framed construction. The construction is very much common practice over the several decades with small incremental improvements included to align with International Energy Conservation Code (IECC) for Residential Construction. This provides a very good point of 'Baseline' reference with what is typically delivered today.

Study 2: The previous Best Of

Case Study - R2000 House Design was a program initiated in Canada to develop very energy efficient residential building envelopes to provide energy efficiency and comfort for the more energy intensive primarily heating locations in Canada. The imitation of energy recovery ventilation for residential construction coincided with this construction technology in addition to the implementation of condensing furnaces. The wall construction is a minimum 2" x 6" wall with R-21 insulation. Fenestration also is higher in efficiency. Interesting coincidence this week the Federal Register published standards for Modular Homes which would require a minimum wall insulation level of typically R-21. This construction is very much commonly marketed as upgraded improved energy efficiency and is as well having features included adopted within the IECC version 2021 which will be ushered into practice more so commonly in the next Building Code cycle.

Study 3: General Designed Casita

The Boxabl Casita is a factory constructed patented Structurally Insulated Panel based nearly 400 gross square foot Modular Building. The Boxabl Structurally Insulated Panel wall has excellent rigidity, dimensional accuracy, repeatability and as well is much more first resource efficient. The Boxabl SIP utilizes a magnesium oxide exterior and interior panel and via its factory construction all of the necessary utility routing for the walls with electrical outlets and switches are complete, placed within the assembled wall according to code. Material efficiency is optimized via precision of components cut within the factory for virtually no waste. The walls have lab verified R-23.5 insulation value, with the roof at R-36 minimum insulation values to currently be the only Modular Home Manufacture that exceeds the Federal May 2022 Proposed Energy Conservation Standards for Manufactured Housing established wall insulation R-21 compliance requirements equal to that of Residential Construction IECC 2021 requirements. This Boxabl exceptionally efficient construction has already seen reducing energy use per square foot by over 50% or more for heating and cooling compared to traditional homes. A February 2022 HERS evaluation performed in North Las Vegas resulted in annual utility costs for heating and cooling which total $107 per year for 361 net square feet of interior space! All this for a very reasonable cost of $49,950.

Study 4: Casita via Bill of Materials Approach

The Boxabl Casita Max intends to provide a premium offering that starts with the construction technology and methodology of the Casita and looks to optimize every category it can. This version will have walls with advanced EPS foam based sips that have R-34.26 values approximately 50% increased insulation effectiveness beyond the Federal May 2022 Proposed Energy Conservation Standards for Manufactured Housing's R-21. Similarly roof and floor insulation levels will as well increase to insulation levels approaching R-50. Other features will include for example windows and doors utilizing advanced glazing capable of reaching R-16 insulation levels bringing added levels of comfort with added positive energy responsibility over four times that of conventional windows and doors. The comfort and air quality features will include constant energy recovery ventilation and filtration to bring very high air quality levels to the Casita Max. Water efficiency as well will see the incorporation of premium EPA WaterSense fixtures to be conserving there as well. Lastly on the interior appliances are being selected to all be Energy Star compliant. These features will have the Boxabl Max become the first mass produced ZERH (Zero Energy Ready Home) in the world. Exterior options to take the Casita Max to Net Positive Energy are being finalized as well. The Casita Max will incorporate all of the features, resource conservation and energy efficiency elements to be able to attain very high levels of Certification in all major global Green Building Rating Systems. Since many options for the Casita Max are in process this portion of the evaluation is not included in the Executive Summary since it could be considered theoretical yet are the observations are included within the body of this report to indicate paths for further improvements that are being planned by Boxabl.

Material Assumptions -

Concrete

Within the LCA software there are several strengths of concrete able to be utilized in the projects analysis. Concrete is one of the materials with a greater contribution to environmental impact due to the large energy expenditure needed to manufacture Portland Cement. Using concrete wisely is a combination of good structural engineering principles and being considerate of the impacts. Concrete is highly durable, so its long lifespan is a consolation. For our analyzed individual subject evaluations we utilized concrete foundation systems virtually identical. The conventional construction utilized an insulated 2-foot-tall knee wall to provide insulation and thermal break to ensure their floors would have ample code compliant levels of insulation at times not typically considered. The Boxabl Casita is founded on a foundation or other support and for these evaluations it used the same area and mass of concrete as the other typologies.

Steel

Like concrete, Steel is also an intensive energy building product. For our analysis we utilized structural elements that did not rely on steel for their primary structural systems. This choice provided the conventional construction with an opportunity to optimize the benefit of word when used in trusses and other effective choices. The Boxabl Casita has its integral patented structural system that is primarily EPS foam, magnesium oxide board panels, wood and steel. This innovative SIP construction far exceeds conventional and inferior SIP systems which do not provision for utility pathways within, have reduced rigidity, are susceptible to water infiltration damage, vermin affected and finally fail the resilience test in their inability to be impact resistant.

Glazing, Insulation, and Finishes

Within the LCA software there is ample opportunity to select glazing, insulation and finishes for the building being analyzed. As a matter of consistency interior finishes were selected as identical to dismiss any variation outside the building construction typology. Again, the individual buildings were modelled and analyzed within Athena Impact Estimator for Buildings version 5.4 with specific construction typologies specified to align with their typical inclusions and construction methods. Insulation within the conventional construction was batt type within framed walls and roof areas. Insulation for the Boxabl Casita is EPS foam via the SIP panels, it was very beneficial to be able to accurately specify the insulation thickness or depth within the software for analysis. For fenestration choices the available options ranged from insulated glass windows to Low-E with Argon gas fill and a variety of frame construction types; for doors we utilized a default steel insulated door which contrasts to the fiberglass insulated doors within the Boxabl Casita being built currently.

For the Casita Max we have a new Graphite EPS insulation option, the April 2022 laboratory tested SIP walls was measured to have R-34.26 values approximately 50% increased insulation effectiveness beyond the May 2022 Proposed Energy Conservation Standards for Manufactured Housing established wall insulation R-21 compliance requirements equal to that of Residential Construction IECC 2021 requirements. This option is evaluated within this report for the Casita Max as well.

Transportation Assumptions

Transportation settings within the LCA software has its basis established in alignment with the materials databases. We do provide within this analysis the consideration of the substantially improved Transportation Impacts that occur within Stage - Construction Process (A4 & A5) and additionally within Stage - Use (B2 & B4) resulting from the innovative Boxabl Factory Manufacturing Processes. Analysis and the 360 review of database inputs with BEES database information provide no significant differentiation of results. When we look to the Casita Max there are theoretical additional impacts to be gained during the initial building product manufacturing, yet those factors were not elaborated upon within this LCA analysis due to lack of scientific testing information that establishes those differentials.

Lifespan Assumptions

For the purposes of these studies, the lifespan of all materials is set within the software defaults whereas that building default setting is set at 60 years. The significance of these settings would favor materials with service lives of 30 years or more therefore, being replaced only once during a building’s lifespan. The implications for the Boxabl Casita and the Boxabl Casita Max is that they have three dimensionally structural roofs, floors and walls that are highly resilient as well which certainly would outlive the Baseline Buildings. This consideration and its relevance do impact the use phase of the analysis and would indicate a greater differential for the Casita(s) for this emissions stage B2&B4.

Results

The below Image 10 Initial LCA analysis Reporting 05-12-2022 provides the LCA Summary of the analysis utilizing the Athena Impact Estimator for Buildings version 5.4 software prior to comprehensive 360 review audits of materials in the respective buildings.

Image 10: Initial LCA analysis Reporting 05-12-2022

Detailed LCA Measure Table By Life Cycle Stages

Project: Case Study - Single Family Residential - Raised Wood Floor

		PRODUCT (A1 to A3)			CONSTRUCTION PROCESS (A4 & A5)			USE (B2, B4 & B6)	
LCA Measures	Unit	Manufacturing	Transport	Total	Construction-Installation Process	Transport	Total	Replacement Manufacturing	Replacement Transport
Global Warming Potential	kg CO2 eq	1.17E+04	1.32E+03	1.30E+04	8.79E+02	5.32E+02	1.41E+03	2.70E+03	1.48E+02
Acidification Potential	kg SO2 eq	9.24E+01	1.29E+01	1.05E+02	8.12E+00	5.32E+00	1.34E+01	1.89E+01	1.56E+00
HH Particulate	kg PM2.5 eq	2.71E+01	7.04E-01	2.78E+01	1.67E+00	2.87E-01	1.96E+00	1.04E+01	8.05E-02
Eutrophication Potential	kg N eq	1.29E+01	8.03E-01	1.37E+01	9.23E-01	3.30E-01	1.25E+00	5.06E-01	9.65E-02
Ozone Depletion Potential	kg CFC-11 eq	1.00E-04	4.65E-08	1.00E-04	1.06E-05	1.92E-08	1.06E-05	3.03E-05	5.54E-09
Smog Potential	kg O3 eq	1.28E+03	4.09E+02	1.69E+03	1.72E+02	1.68E+02	3.40E+02	1.61E+02	4.94E+01
Total Primary Energy	MJ	3.21E+05	1.93E+04	3.40E+05	1.88E+04	7.75E+03	2.66E+04	1.16E+05	2.15E+03
Non-Renewable Energy	MJ	1.70E+05	1.93E+04	1.90E+05	1.11E+04	7.74E+03	1.88E+04	1.15E+05	2.14E+03
Fossil Fuel Consumption	MJ	1.65E+05	1.92E+04	1.84E+05	1.07E+04	7.73E+03	1.84E+04	1.13E+05	2.14E+03

	USE (B2, B4 & B6)		END OF LIFE (C1 to C4)			BEYOND BUILDING LIFE (D)			TOTAL EFFECTS	
LCA Measures	Operational Energy Use Total	Total	De-construction, Demolition, Disposal & Waste Processing	Transport	Total	BBL Material	BBL Transport	Total	A to C	A to D
Global Warming Potential	0.00E+00	2.85E+03	1.03E+03	2.76E+02	1.31E+03	-2.43E+04	0.00E+00	-2.43E+04	1.86E+04	-5.69E+03
Acidification Potential	0.00E+00	2.05E+01	1.47E+01	2.65E+00	1.73E+01	-1.84E+00	0.00E+00	-1.84E+00	1.57E+02	1.55E+02
HH Particulate	0.00E+00	1.05E+01	4.16E-01	1.47E-01	5.63E-01	-8.09E-01	0.00E+00	-8.09E-01	4.09E+01	4.01E+01
Eutrophication Potential	0.00E+00	6.02E-01	9.15E-01	1.65E-01	1.08E+00	-9.48E-02	0.00E+00	-9.48E-02	1.66E+01	1.65E+01
Ozone Depletion Potential	0.00E+00	3.03E-05	4.50E-08	9.62E-09	5.46E-08	0.00E+00	0.00E+00	0.00E+00	1.41E-04	1.41E-04
Smog Potential	0.00E+00	2.11E+02	4.87E+02	8.36E+01	5.71E+02	-1.87E+01	0.00E+00	-1.87E+01	2.81E+03	2.79E+03
Total Primary Energy	0.00E+00	1.18E+05	1.53E+04	4.02E+03	1.94E+04	-3.69E+03	0.00E+00	-3.69E+03	5.04E+05	5.00E+05
Non-Renewable Energy	0.00E+00	1.18E+05	1.53E+04	4.02E+03	1.94E+04	-3.69E+03	0.00E+00	-3.69E+03	3.46E+05	3.42E+05
Fossil Fuel Consumption	0.00E+00	1.15E+05	1.53E+04	4.01E+03	1.93E+04	-7.41E+03	0.00E+00	-7.41E+03	3.37E+05	3.29E+05

Detailed LCA Measure Table By Life Cycle Stages

Project: Base Casita Building

		PRODUCT (A1 to A3)			CONSTRUCTION PROCESS (A4 & A5)			USE (B2, B4 & B6)	
LCA Measures	Unit	Manufacturing	Transport	Total	Construction-Installation Process	Transport	Total	Replacement Manufacturing	Replacement Transport
Global Warming Potential	kg CO2 eq	3.22E+03	1.25E+02	3.34E+03	2.92E+02	2.38E+02	5.29E+02	1.66E+03	1.74E+02
Acidification Potential	kg SO2 eq	1.74E+01	1.32E+00	1.87E+01	2.17E+00	2.45E+00	4.61E+00	1.14E+01	1.84E+00
HH Particulate	kg PM2.5 eq	1.09E+01	6.50E-02	1.10E+01	6.41E-01	1.30E-01	7.71E-01	1.52E+01	9.51E-02
Eutrophication Potential	kg N eq	2.23E+00	8.16E-02	2.31E+00	2.02E-01	1.52E-01	3.54E-01	5.22E-01	1.14E-01
Ozone Depletion Potential	kg CFC-11 eq	3.99E-05	4.48E-09	3.99E-05	3.23E-06	8.83E-09	3.23E-06	1.26E-05	6.55E-09
Smog Potential	kg O3 eq	2.61E+02	4.19E+01	3.03E+02	5.27E+01	7.76E+01	1.30E+02	1.47E+02	5.84E+01
Total Primary Energy	MJ	5.35E+04	1.80E+03	5.53E+04	4.42E+03	3.46E+03	7.88E+03	4.65E+04	2.52E+03
Non-Renewable Energy	MJ	4.54E+04	1.80E+03	4.72E+04	3.98E+03	3.45E+03	7.43E+03	4.43E+04	2.52E+03
Fossil Fuel Consumption	MJ	4.30E+04	1.80E+03	4.48E+04	3.85E+03	3.45E+03	7.30E+03	4.20E+04	2.52E+03

	USE (B2, B4 & B6)		END OF LIFE (C1 to C4)			BEYOND BUILDING LIFE (D)			TOTAL EFFECTS	
LCA Measures	Operational Energy Use Total	Total	De-construction, Demolition, Disposal & Waste Processing	Transport	Total	BBL Material	BBL Transport	Total	A to C	A to D
Global Warming Potential	2.04E+05	2.06E+05	1.15E+02	7.52E+01	1.90E+02	-2.50E+03	0.00E+00	-2.50E+03	2.10E+05	2.08E+05
Acidification Potential	5.93E+02	6.06E+02	1.60E+00	7.24E-01	2.33E+00	-2.20E+00	0.00E+00	-2.20E+00	6.32E+02	6.30E+02
HH Particulate	6.26E+02	6.41E+02	6.82E-02	4.01E-02	1.08E-01	-9.64E-01	0.00E+00	-9.64E-01	6.53E+02	6.52E+02
Eutrophication Potential	1.87E+02	1.88E+02	1.00E-01	4.50E-02	1.45E-01	-1.13E-01	0.00E+00	-1.13E-01	1.90E+02	1.90E+02
Ozone Depletion Potential	1.68E-02	1.68E-02	5.03E-09	2.63E-09	7.65E-09	0.00E+00	0.00E+00	0.00E+00	1.68E-02	1.68E-02
Smog Potential	4.95E+03	5.16E+03	5.32E+01	2.28E+01	7.60E+01	-2.22E+01	0.00E+00	-2.22E+01	5.67E+03	5.65E+03
Total Primary Energy	3.51E+06	3.56E+06	1.71E+03	1.10E+03	2.81E+03	-4.40E+03	0.00E+00	-4.40E+03	3.63E+06	3.62E+06
Non-Renewable Energy	3.32E+06	3.37E+06	1.71E+03	1.10E+03	2.81E+03	-4.40E+03	0.00E+00	-4.40E+03	3.43E+06	3.42E+06
Fossil Fuel Consumption	2.42E+06	2.47E+06	1.71E+03	1.10E+03	2.81E+03	-8.83E+03	0.00E+00	-8.83E+03	2.52E+06	2.51E+06

Detailed LCA Measure Table By Life Cycle Stages

Project: Casita Max BOM Method

		PRODUCT (A1 to A3)			CONSTRUCTION PROCESS (A4 & A5)			USE (B2, B4 & B6)	
LCA Measures	Unit	Manufacturing	Transport	Total	Construction-Installation Process	Transport	Total	Replacement Manufacturing	Replacement Transport
Global Warming Potential	kg CO2 eq	1.09E+04	1.18E+02	1.10E+04	4.48E+02	3.48E+02	7.96E+02	1.56E+03	1.60E+02
Acidification Potential	kg SO2 eq	5.28E+01	1.18E+00	5.40E+01	4.03E+00	3.55E+00	7.58E+00	1.09E+01	1.70E+00
HH Particulate	kg PM2.5 eq	1.57E+01	6.20E-02	1.57E+01	6.85E-01	1.90E-01	8.75E-01	1.41E+01	8.75E-02
Eutrophication Potential	kg N eq	1.07E+01	7.35E-02	1.08E+01	3.38E-01	2.20E-01	5.58E-01	9.91E+00	1.05E-01
Ozone Depletion Potential	kg CFC-11 eq	1.81E-04	4.16E-09	1.81E-04	6.46E-06	1.28E-08	6.47E-06	5.40E-05	6.05E-09
Smog Potential	kg O3 eq	7.90E+02	3.75E+01	8.28E+02	1.01E+02	1.12E+02	2.14E+02	1.55E+02	5.40E+01
Total Primary Energy	MJ	1.55E+05	1.71E+03	1.56E+05	7.84E+03	5.06E+03	1.29E+04	2.76E+04	2.32E+03
Non-Renewable Energy	MJ	1.41E+05	1.71E+03	1.43E+05	7.14E+03	5.06E+03	1.22E+04	2.65E+04	2.32E+03
Fossil Fuel Consumption	MJ	1.35E+05	1.70E+03	1.37E+05	6.99E+03	5.05E+03	1.20E+04	2.42E+04	2.32E+03

	USE (B2, B4 & B6)		END OF LIFE (C1 to C4)			BEYOND BUILDING LIFE (D)			TOTAL EFFECTS	
LCA Measures	Operational Energy Use Total	Total	De-construction, Demolition, Disposal & Waste Processing	Transport	Total	BBL Material	BBL Transport	Total	A to C	A to D
Global Warming Potential	1.58E+05	1.60E+05	2.84E+02	1.27E+02	4.11E+02	-2.82E+03	0.00E+00	-2.82E+03	1.72E+05	1.69E+05
Acidification Potential	4.59E+02	4.71E+02	4.01E+00	1.22E+00	5.23E+00	-1.92E+00	0.00E+00	-1.92E+00	5.38E+02	5.36E+02
HH Particulate	4.84E+02	4.98E+02	1.34E-01	6.77E-02	2.02E-01	-8.42E-01	0.00E+00	-8.42E-01	5.15E+02	5.14E+02
Eutrophication Potential	1.45E+02	1.55E+02	2.50E-01	7.59E-02	3.26E-01	-9.86E-02	0.00E+00	-9.86E-02	1.66E+02	1.66E+02
Ozone Depletion Potential	1.30E-02	1.30E-02	1.24E-08	4.43E-09	1.68E-08	0.00E+00	0.00E+00	0.00E+00	1.32E-02	1.32E-02
Smog Potential	3.83E+03	4.04E+03	1.33E+02	3.85E+01	1.72E+02	-1.94E+01	0.00E+00	-1.94E+01	5.25E+03	5.23E+03
Total Primary Energy	2.72E+06	2.75E+06	4.22E+03	1.85E+03	6.08E+03	-3.84E+03	0.00E+00	-3.84E+03	2.92E+06	2.92E+06
Non-Renewable Energy	2.57E+06	2.60E+06	4.22E+03	1.85E+03	6.07E+03	-3.84E+03	0.00E+00	-3.84E+03	2.76E+06	2.76E+06
Fossil Fuel Consumption	1.87E+06	1.90E+06	4.22E+03	1.85E+03	6.06E+03	-7.71E+03	0.00E+00	-7.71E+03	2.05E+06	2.05E+06

Detailed LCA Measure Table By Life Cycle Stages

Project: Case Study - R2000 House Design

		PRODUCT (A1 to A3)			CONSTRUCTION PROCESS (A4 & A5)			USE (B2, B4 & B6)	
LCA Measures	Unit	Manufacturing	Transport	Total	Construction-Installation Process	Transport	Total	Replacement Manufacturing	Replacement Transport
Global Warming Potential	kg CO2 eq	9.25E+03	2.29E+02	9.48E+03	5.77E+02	6.09E+02	1.19E+03	1.37E+03	8.38E+01
Acidification Potential	kg SO2 eq	5.38E+01	2.24E+00	5.60E+01	4.47E+00	6.98E+00	1.15E+01	1.15E+01	8.93E-01
HH Particulate	kg PM2.5 eq	1.80E+01	1.22E-01	1.82E+01	5.51E-01	3.10E-01	8.61E-01	2.62E+00	4.51E-02
Eutrophication Potential	kg N eq	3.14E+00	1.39E-01	3.28E+00	3.08E-01	4.32E-01	7.40E-01	2.31E-01	5.54E-02
Ozone Depletion Potential	kg CFC-11 eq	8.84E-05	8.07E-09	8.84E-05	6.47E-06	2.23E-08	6.49E-06	3.17E-05	3.13E-09
Smog Potential	kg O3 eq	5.94E+02	7.07E+01	6.65E+02	8.91E+01	2.24E+02	3.13E+02	8.02E+01	2.84E+01
Total Primary Energy	MJ	1.36E+05	3.34E+03	1.39E+05	9.52E+03	8.66E+03	1.82E+04	3.49E+04	1.22E+03
Non-Renewable Energy	MJ	1.27E+05	3.34E+03	1.30E+05	8.69E+03	8.66E+03	1.73E+04	3.47E+04	1.22E+03
Fossil Fuel Consumption	MJ	1.04E+05	3.33E+03	1.07E+05	6.62E+03	8.65E+03	1.53E+04	3.34E+04	1.21E+03

	USE (B2, B4 & B6)		END OF LIFE (C1 to C4)			BEYOND BUILDING LIFE (D)			TOTAL EFFECTS	
LCA Measures	Operational Energy Use Total	Total	De-construction, Demolition, Disposal & Waste Processing	Transport	Total	BBL Material	BBL Transport	Total	A to C	A to D
Global Warming Potential	3.46E+05	3.47E+05	3.93E+02	1.93E+02	5.86E+02	-1.86E+03	0.00E+00	-1.86E+03	3.59E+05	3.57E+05
Acidification Potential	2.97E+03	2.98E+03	5.21E+00	1.86E+00	7.07E+00	8.50E-01	0.00E+00	8.50E-01	3.05E+03	3.06E+03
HH Particulate	1.77E+02	1.80E+02	3.92E-01	1.03E-01	4.96E-01	3.73E-01	0.00E+00	3.73E-01	1.99E+02	2.00E+02
Eutrophication Potential	2.92E+01	2.94E+01	3.24E-01	1.16E-01	4.40E-01	4.37E-02	0.00E+00	4.37E-02	3.39E+01	3.39E+01
Ozone Depletion Potential	1.39E-07	3.18E-05	1.71E-08	6.75E-09	2.39E-08	0.00E+00	0.00E+00	0.00E+00	1.27E-04	1.27E-04
Smog Potential	7.45E+03	7.56E+03	1.72E+02	5.87E+01	2.30E+02	8.60E+00	0.00E+00	8.60E+00	8.77E+03	8.78E+03
Total Primary Energy	6.04E+06	6.07E+06	5.82E+03	2.82E+03	8.64E+03	1.70E+03	0.00E+00	1.70E+03	6.24E+06	6.24E+06
Non-Renewable Energy	6.03E+06	6.07E+06	5.82E+03	2.82E+03	8.64E+03	1.70E+03	0.00E+00	1.70E+03	6.23E+06	6.23E+06
Fossil Fuel Consumption	6.03E+06	6.07E+06	5.81E+03	2.82E+03	8.63E+03	3.42E+03	0.00E+00	3.42E+03	6.20E+06	6.20E+06

As additional information was realized and resolved during the reviews and iteration this additional information has been added to the contributing source data for deeper analysis within the return iteration of 05-31-2022 and finally the last iteration of information on 06-02-2022 which incorporates the most robust levels of analysis leading to greater LCA output accuracy.

The Athena Impact Estimator for Buildings version 5.4 software provides the ability to evaluate two different buildings for their ability to comply with LEED and Green Globes Certification Ratings Systems for LCA analysis of impacts. The summary for LEED Compliance was run using the Baseline Single Family 400 square foot residence and the Boxabl Casita as the Proposed. Extracts from this analysis is presented herein within Image 11 and following Image 12.

Image 11: LEED Whole-Building LCA Credit Submittal partial.

LCA Software Summary

General Information

Report template generated by	Athena Impact Estimator for Buildings
Software version	5.4.0103
Date this report was created	02 June 2022

The Athena Sustainable Materials Institute certifies that the *Impact Estimator for Buildings* LCA software tool is fully compliant with the requirements of the LEED v4 whole-building life cycle assessment credit.

Software Data Sources

Life Cycle Scenarios	Scenarios used in this assessment come from databases maintained by the Athena Sustainable Materials Institute.
Life Cycle Inventory (LCI)	LCI data used in this assessment is from the Athena LCI database and is compliant with ISO 14040 and ISO 14044.
Life Cycle Impact Assessment (LCIA) method	TRACI v2.1

See the software's *User Manual and Transparency Document* for further information on data sources.

The above Image 11 provides the summary of the report generation parameters output by the Athena Impact Estimator for Buildings when the specific report Green Building Certification Compliance report is generation is enabled. This Athena Sustainable Materials Institute compliant documentation which includes the software version, date and data sources is utilized to generate the whole report to gain the respective LEED v4 whole-building life cycle assessment credit for New Construction projects. For brevity we include this required cover page and the following Image 12 which is the Whole-Building LCA Results table that documents the System Boundary as complete Cradle to Grave (A to D) emission stage time intervals.

Image 12: Athena LEED Report - Whole-Building LCA Results

Whole-building LCA Results

Results System Boundary: Cradle to Grave (A to D)

Life Cycle Assessment Impact Measures	Baseline Building	Proposed Building	Units	Percent Difference (%)
Global warming potential	300,945.17	207,746.58	kg CO2 eq	-30.97%
Stratospheric ozone depletion	0.03	0.02	kg CFC-11 eq	-33.33%
Acidification of land and water	1,052.07	632.58	kg SO2 eq	-39.87%
Eutrophication	297.53	190.49	kg N eq	-35.98%
Tropospheric ozone formation	10,291.54	5,649.64	kg O3 eq	-45.10%
Depletion of non-renewable energy resources	5,332,068.41	3,428,566.97	MJ	-35.70%
Number of measures with at least 10% reduction *(a reduction corresponds to a negative value percent difference)*				6

The above Image 12 Whole-Building LCA Results have the priorities presented, utilized to document the quantity of points potentially earned from LCA analysis. Of primary overall impact importance, the Global Warming Potential reduction for an individual Boxabl Casita provides a reduction of over 30% as compared to the typical code compliant single-family home using conventional construction technology and practices.

If seeking LEED Certification this example provides 6 measures of Life Cycle Assessment Impact Measures that all exceed 30% reductions. For certification only 3 measures need to reach a 10% reduction. This example would additionally qualify for an Innovation in Design Credit for Exemplary Performance since the maximum threshold for this credit is a 20% reduction over the minimum for 3 measures with no other measure being less than a 5% reduction.

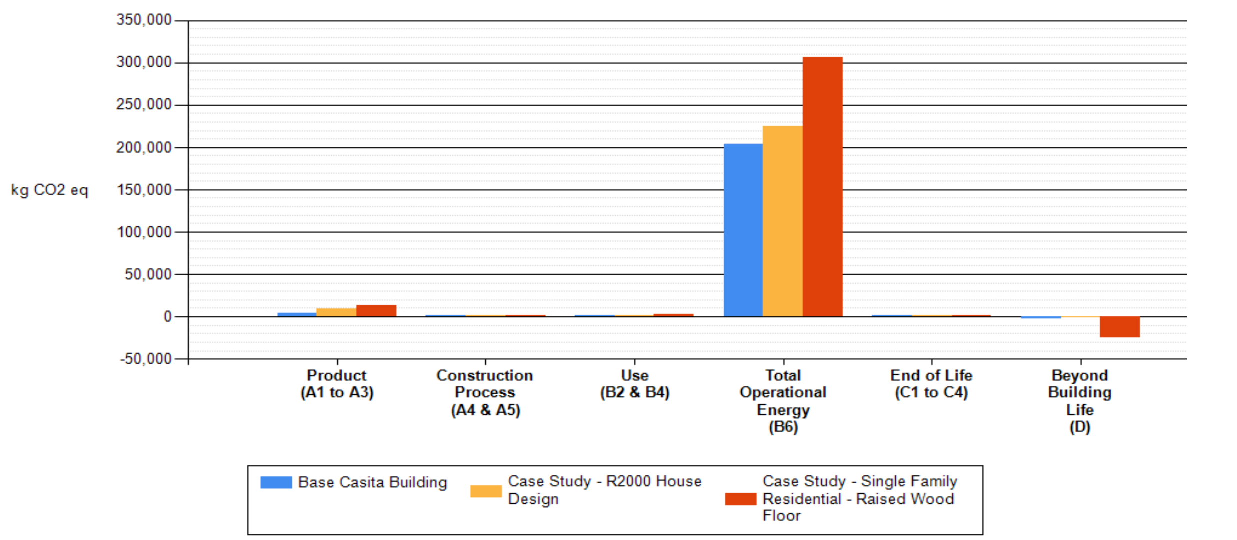
Since the Casita Max is in development the analysis was completed utilizing its higher performing and emissions reducing performance components within the above six Life Cycle Assessment Impact Measures. The Casita Max exceeds the emissions of the Boxabl Casita in the initial "Product Stage A1 to A3" due to the increased quantities of components used in its components manufacturing. There is active and ongoing work from Boxabl engineering team in collaboration with the provider of the graphite foam for example to find expanding/blowing agents for that graphite EPS which deliver optimal performance while concurrently reducing

Global Warming Potential. While the Casita Max has greater impact in that first Product Stage all of the following Stages have beneficial reductions from its advanced energy saving qualities. When the renewable energy is applied the Total Operational Energy reduces to negative since the Boxabl can accommodate 5kW of energy production in the form of a resilient solar PV and solar thermal system integrated into the roofing system.

Observations:

In the first analysis the Boxabl Casita performed significantly better in all categories versus Study 1 Single Family Residential The ‘Baseline’ Option, and Study 2 The previous Best Of R2000 House Design. Importantly in the initial analysis the Boxabl Casita which was constructed to the late 2021 standards and was evaluated for its REM/Rate Energy Analysis energy efficiency in February 2022 performed measurably better than the other two in all Comparisons of Global Warming Potential By Life Cycle Stage as is displayed within Image 13.

Image 13: Comparisons of Global Warming Potential By Life Cycle Stage.



Project Name	Unit	Product (A1 to A3)	Construction Process (A4 & A5)	Use (B2 & B4)	Total Operational Energy (B6)	End of Life (C1 to C4)	Beyond Building Life (D)	Total
Base Casita Building	kg CO2 eq	3.88E+03	4.65E+02	1.43E+03	2.04E+05	1.77E+02	-2.47E+03	**2.08E+05**
Case Study - R2000 House Design	kg CO2 eq	9.48E+03	1.47E+03	1.55E+03	2.25E+05	5.84E+02	-1.87E+03	**2.36E+05**
Case Study - Single Family Residential - Raised Wood Floor	kg CO2 eq	1.31E+04	1.41E+03	3.13E+03	3.06E+05	1.30E+03	-2.44E+04	**3.01E+05**
Total	**kg CO2 eq**	**2.65E+04**	**3.34E+03**	**6.11E+03**	**7.35E+05**	**2.06E+03**	**-2.88E+04**	**7.45E+05**

The Total Operational Energy sees an approximately one-third reduction for the Boxabl Casita in comparison to the Single-Family home which is significant since the plug loads compromising almost 50% of the long-term energy usage would be the same. Therefore, the energy use savings built into the Casita provide a measurable differentiation.

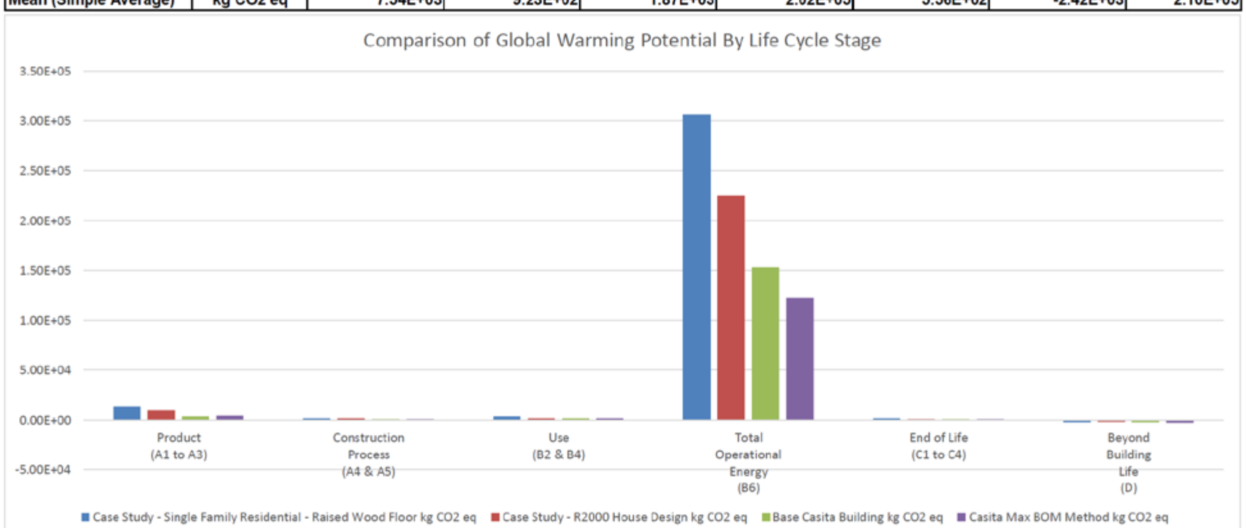
It is very important to note that the further analyzed attributes related to the factory manufacturing benefits, the transportation benefits and the End-of-Life positive use of the Boxabl Casita were not fully resolved within the Image 13 indicated LCA Evaluations and the data shared within its table.

When the transportation impact reductions due to factory construction are conservatively considered, the transportation impact reductions in the construction process are considered and the considerations of the substantial reductions of energy usage documented within the REM/Rate Energy Analysis reporting of the Boxabl Casita in February of 2022 are applied conservatively another set of performance criteria appear. The REM/Rate Energy Analysis assessment score of 79 (21% better than code) provided that the Boxabl at the time had fenestration which was only code compliant which has been improved in the most recent approximately 250 Casitas to a more energy efficient choice. The score also indicates that at the time of analysis the Boxabl Casita exceeds energy efficiency of the Modular Home standards of that time by over 50%. The Boxabl Casita in that REM/Rate Energy Analysis had a demonstrated evaluation providing energy costs for Heating and Cooling of only $107 per year.

Image 14: Comparisons of Global Warming Potential By Life Cycle Stage.

Comparison of Global Warming Potential By Life Cycle Stage

Project Name	Unit	Product (A1 to A3)	Construction Process (A4 & A5)	Use (B2 & B4)	Total Operational Energy (B6)	End of Life (C1 to C4)	Beyond Building Life (D)	Total
Case Study - Single Family Residential - Raised Wood Floor	kg CO2 eq	1.31E+04	1.41E+03	3.13E+03	3.06E+05	1.30E+03	-2.44E+03	**3.23E+05**
Case Study - R2000 House Design	kg CO2 eq	9.48E+03	1.47E+03	1.55E+03	2.25E+05	5.84E+02	-1.87E+03	**2.36E+05**
Base Casita Building	kg CO2 eq	3.36E+03	4.17E+02	1.43E+03	1.53E+05	1.74E+02	-2.64E+03	**1.56E+05**
Casita Max BOM Method	kg CO2 eq	4.19E+03	3.96E+02	1.35E+03	1.23E+05	1.62E+02	-2.72E+03	**1.26E+05**
Mean (Simple Average)	**kg CO2 eq**	**7.54E+03**	**9.23E+02**	**1.87E+03**	**2.02E+05**	**5.56E+02**	**-2.42E+03**	**2.10E+05**



In Image 14 (previous page) we see that the noted additional considerations have been included within an algorithm that provides a very representative analysis of the Global Warming Potential of both the April 2022 Boxabl Casita and the Boxabl Max prior to including renewable energy production for both exemplars. The data presented within the table in Image 14 corresponds to the additional research and analysis provided and these iteration values input into the analysis algorithms. The Total Global Warming Potential “Cradle to Grave” of the Boxabl Casita ends up at nearly half of that of a conventional equal square footage typically constructed Single Family Home for a 60-year lifespan. The Casita Max with its extra embedded energy efficiencies provides further reductions. The operational energy portion of the graph is really impactful where the plug loads in the Boxabl Product provide the majority of the Total Operational Energy Global Warming Potential over the 60-year study period. When we see the application of Renewable Energy applied to the Boxable Zero Energy Ready Home the outcome delivers a building that can realistically be Net Zero even when considering the environmental impact of the creation and transportation of the Solar Energy System.

Conclusions

We purposely performed this LCA analysis and study with several comparisons such that the net effective impacts of the Boxabl Casita could be explored with direct comparisons to conventional delivery modeled most consistently using the GSA, GBI, LEED, Living Future and IWBI platforms and the compliance reporting that those Green Building Rating Systems mandated.

The study and exploration provided a perspective on some limitations. It is the opinion of this author that Boxabl has optimized the insulation efficiency and rating to wall thickness ratio for their Graphite EPS SIP Wall and Roof panels. The current attainments exceed current code and to be implemented code mandates by enough margin that their efficiency advantage will not be an easy reach for competitors.

Glass is also a significant contributor to Global Warming Potential in both its manufacture and within the performance of the Fenestration Systems. The currently being explored Vacuum Insulated Glazing would bring at least three significant betterments to the Boxabl Casita Max. First - Substantially better R-15+ ratings for the glazing approximately four times the current expectations. Secondly - The tempered glass construction would further complement the resilience in the construction. Third - The vacuum insulation is not affected by elevation change which makes shipping and transport concerns much less relevant.

The steel structural members make up significant portions of the global warming potential in buildings therefore the importance of incorporating recycled steel is highly impactful in reducing another GWP and embodied Carbon. The Boxabl designs optimize the benefits of the steel structural members within their advanced SIP floor, wall and roof panels.

As mentioned within this reporting to really reduce Global Warming Potential incorporation of an aligned comprehensive solar energy roof system will accomplish several initiatives. The largest portion of GWP impact is in operational energy use and when that can be renewably sourced then the reduction of impacts can be very substantial. The observations are that this comprehensive roofing system should be resilient, impact resistant, fire resistant and hurricane proof rated to optimally align with the Casita and Boxabl's modular construction typology.

The directions that the Casita has initiated, and the Casita Max are setting are impressive as is the initiative to become the first large scale Zero Energy Ready Home manufacturer another approaching first for Boxabl. The Wellness attributes are beginning to be considered within Boxabl as well which will hit another priority for society.

The following observational conclusions have been drawn from this study:
Climate Change is one of the most urgent problems which should be addressed with particular attention. Boxabl with this study and their innovative technologies presents the construction sector a narrative to the large potential for significantly reducing GHG emissions and Global Warming Potential to mitigate the impact of climate change.

Sustainability in construction has major opportunity for inclusion by looking to more innovative ways as evidenced by Boxabl.

Green building certification needs to include LCA when pursuing LEED certification, to actively address how the negative impacts from the building construction can be reduced.

Selected Bibliography & Web-links

EPA LCA Research http://www.epa.gov/nrmrl/lcaccess/index.html
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BEES Tool http://www.bfrl.nist.gov/oae/software/bees/
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REM/Rate - Residential Energy Analysis and Rating 28 February 2022

Glossary, Tertiary Comments and Considerations

Impact Categories

The impact categories of LCA methodologies vary from system to system. Environmental Impact Categories are mappings from quantities of emissions to the environmental impacts that these emissions cause. They can be thought of as a class of environmental issues of concern to which Life Cycle Inventory (LCI) results may be assigned. The impact categories have been established from nationally recognized standards established by agencies such as the Environmental Protection Agency, Occupational Safety and Health Administration, and National Institutes of Health. The impact is usually given as a ratio of the quantity of the impact per functional unit of product produced. Each category is an indicator of the contribution of a product to a specific environmental problem. These categories are defined by the Life Cycle Impact Assessment (LCIA) methods.

Global Warming Potential (GWP)

Global Warming Potential, or GWP, has been developed to characterize the change in the greenhouse effect due to emissions and absorptions attributable to humans. The unit for measurement is grams equivalent of CO2 per functional unit of product (note that other greenhouse gases, such as methane, are included in this category, thus the term "CO2 equivalent" is an impact and not an emission).

Acidification Potential (AP)

Acidifying compounds emitted in a gaseous state either dissolve in atmospheric water or fixed on solid particles. They reach ecosystems through dissolution in rain. The two compounds principally involved in acidification are sulfur and nitrogen compounds. The unit of measurement is grams of hydrogen ions per functional unit of product.

Smog Formation Potential

Under certain climatic conditions, air emissions from industry and fossil-fueled transportation can be trapped at ground level, where they react with sunlight to produce photochemical smog. The contribution of a product or system to smog formation is quantified by this category. The unit of measurement is grams of nitrogen oxide per functional unit of product. This highlights an area where a regional approach to LCA may be appropriate, as certain regions of the world are climatically more susceptible to smog.

Ozone Depletion Potential

Emissions from some processes may result in the thinning of the ozone layer, which protects the earth from certain parts of the solar radiation spectrum. Ozone depletion potential measures the extent of this impact for a product or system. The unit of measurement is CFC-11 per functional unit of the product.

Ecological Toxicity

The ecological toxicity impact measures the potential of a chemical released into the environment to harm terrestrial and aquatic ecosystems. The unit of measurement is grams of 2, 4-dichlorophenoxy-acetic acid per functional unit of product.

Water Use

Water resource depletion has not been routinely assessed in LCAs to date, but researchers are beginning to address this issue to account for areas where water is scarce, such as the western United States. The unit of measurement is liters per functional unit.

It should be noted that the impact categories listed above is in accordance with TRACI LCIA method used in the Building for Environmental and Economic Stability (BEES®) tool [15]. Other impact categories included in BEES but not described here are Habitat Alteration, Criteria Air Pollutants and Human Health. These definitions and units may differ depending on the LCIA method used (see below).

Eutrophication Potential (EP)

Eutrophication is the addition of mineral nutrients to the soil or water. In both media, the addition of large quantities of mineral nutrients such as nitrogen and phosphorous results in generally undesirable shifts in the number of species in ecosystems and a reduction in ecological diversity. In waterways, excess nutrient leads to increased biological oxygen demand (BOD) from the dramatic increase in flora that feed on these nutrients, a subsequent reduction in dissolved oxygen levels, and the collapse of fish and other aquatic species. The unit of measurement is grams of nitrogen per functional unit of product.

Fossil Fuel Depletion

This impact addresses only the depletion aspect of fossil fuel extraction, not the fact that the extraction itself may generate impacts. The unit for measurement is mega joules (MJ) of fossil-based energy per functional unit of the product. This category helps demonstrate positive environmental goals, such as reducing the energy needed to produce a product, or such as producing a product with renewable, non-fossil-based energy.

Incentives for conducting LCA – Building Standards and Rating Systems

Performing a LCA analysis dependent on the levels of engagement is a time and resource intensive process. Evidence is substantial to verify LCA process integrated into building construction as well as many industrial manufacturing systems because of benefits available to the manufacturer and the consumer. Specifically, within building industries these potential incentive benefits include:

Indirect monetary incentives

With respect to Boxabl's manufacturing processes optimizing via repetitive nature of production the construction of modular buildings the impacts can be more specifically characterized. An improvement in one process stage affects all subsequent units of production. Thus time and other resources are optimized, will lead to monetary savings and increased budgeting predictability for the manufacturer, which have an impact on delivering the most effective economical market pricing to benefit the consumers. LCA implementation can benefit buildings if construction variance and operation become more standardized. The use of LCA with its present capabilities and limitations tends to consume more time and resources than it saves for individual building projects. In preparation for emissions regulations Boxabl is looking to set the example widely adopted thresholds prior to emissions limitations being implemented. In many locations around the planet there is a change evolving at times referred to as cap and trade, where indirect economic payback for reduction of emissions beyond the threshold levels set by environmental regulators will result in cities like New York City and Los Angles as two examples where required energy efficiency improvements completion to time limits correlate with the assessed levels of energy/environment burden surcharges being implemented.

Direct monetary incentives

Direct monetary incentives can be defined in terms of tax credits or benefits which are available to the manufacturer for using LCA or complying with programs that have LCA embedded in it. Consumers also receive monetary incentives if LCA-compliant (validated green) products or technologies are available at subsidized rates.

Carbon Cap-and-Trade Bill(s)

The carbon cap-and-trade bill passed by the US House of Representatives in June 2009 contains a number of provisions that would, indirectly, encourage the use of LCA, as LCA is the primary methodology for calculating the carbon footprint of a building. "The bill sets a cap on emissions of greenhouse gases. By 2020, emissions must be reduced 17 percent over 2005 levels. By 2050, emissions must be reduced 80 percent or more. Staying under these caps is done with a system of permits or allowances. Companies must have an allowance for every ton of greenhouse gas they emit. They are allowed to buy and sell those allowances, but gradually the total number of allowances will be reduced, thus reducing overall emissions." This suggests that companies are looking for opportunities to offset their greenhouse gases emissions. As mentioned in Chapter 1, buildings account for 38 percent of the total carbon emissions. Thus, large amount of emission reduction can be achieved by making buildings greener. This will encourage building owners and developers to conduct abbreviated LCA to account for the total emissions due to construction and use of facilities.