Sustainable Living Unveiled: A Comprehensive Review of Key Studies on Zero Energy Homes

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Abstract

The journey to achieve Net Zero Energy in residential areas has progressed slowly. However, in recent times, the research behind accessing Net Zero has become more consistent. This paper discusses the steps to be taken in terms of technology, energy consumption, and energy efficiency to reach the goal of Net Zero. The timeline has been changed throughout discovering new and improved ways to complete the goal. Still, the main obstacle is in the form of timely accessibility and affordability to the average citizen. Contributions to Net Zero can only be attained through efforts from individuals, the industry, and lawmakers. As other countries have taken steps to reach their goals of Net Zero, the United States has been slow in processes. It has minimally implemented tax breaks in hopes of raising affordability. Still, the tax breaks need to be more significant to change each individual's life, therefore not motivating individuals to take on the personal responsibility of upgrading their homes. Unfortunately, this is insufficient, and policymakers and lawmakers must take more measures to invoke a paradigm shift in the country's housing sector. This paper collected 68 sources focusing on HVAC systems, cost ability, Photovoltaic systems, regional projects, etc. Through analysis of economic and functional use, this paper determined the steps needed to continue achieving Net Zero Energy homes.

Introduction

In the quest for sustainable and environmentally conscious living, Zero Energy Homes (ZEHs) stand at the forefront of innovative solutions to address the pressing challenges of energy consumption such as the use of photovoltaics (Shaw et al., 2019; O'Brien, Dioron, & Athienitis et. al., 2011) and climate change. This comprehensive review, titled "Sustainable Living Unveiled: A Comprehensive Review of Key Studies on Zero Energy Homes," embarks on a journey to unravel the intricacies surrounding ZEHs. As the demand for energy-efficient and eco-friendly housing solutions continues to rise, understanding the principles, challenges, and real-world applications of ZEHs becomes paramount (Mass.gov, n.d.). This review paper serves as a necessary foundation for the reader, establishing the context and importance of the topic before delving into detailed analysis and descriptions. Three pivotal questions guide this introduction: Why was this topic chosen? What is the overarching significance of this topic? And, what will the paper cover? The subsequent discussion presents a structured approach to addressing these questions.

Ideas explored in this context include our commitment to learning, the appeal of clean energy solutions, the novelty of zero-energy homes in scientific research, and the personal impact of transitioning to cleaner living spaces. We chose this topic because research into zero-energy homes allows us to gain a better understanding of how certain systems, within the world, can be optimized to reduce the carbon footprint. This would help reduce the impact of global warming, a change our generation aspires to witness. Clean energy is crucial for a better ecosystem, and we believe that educating others about this topic is essential for a sustainable future. We aim to captivate the reader's interest by presenting compelling reasons to care about zero-energy homes. Drawing from various sources, the group emphasizes the environmental benefits, cost-effectiveness, and the potential for widespread adoption (Liu et al., 2015).
Data suggests that modern homes fall short of sustainable living standards, necessitating a shift towards zero energy homes for reduced environmental impact (Gilbride & Dentz, 2016). With advancements in technology, these homes can realistically be implemented, offering not only ecological advantages but also more affordable living for participants (Thomas, 2013; Scott, 2013).

We outline the structure and content of the paper, providing an overview of the major discussion points. It mentions the use of established data, a historical overview, the inclusion of graphs and data tables, an examination of current drawbacks, and a comprehensive discussion on the importance and current state of zero-energy homes. This article synthesizes existing data to create a comprehensive and educational resource about zero-energy homes. It includes a historical overview, data-driven discussions, and a consideration of drawbacks. The paper aims to contribute to the understanding and promotion of sustainable living through zero-energy homes. We delve into the environmental and economic advantages of zero-energy homes, emphasizing the need for a shift toward sustainable living. Drawing from various sources, the discussion highlights cost-effectiveness, energy efficiency improvements, and proven benefits of elements like solar power in reducing maintenance costs (Dembo, et al., 2013) (Zeiler, Gvozdenović, de Bont, & Maassen, 2016), (Zanecki, 2013), (Wei, et al., 2021). The paragraph aims to build a compelling case for why zero-energy homes deserve attention and consideration (Hu & Qiu, 2019). In conclusion, the introduction sets the stage for an in-depth exploration of zero-energy homes, inviting the reader to join the journey toward sustainable living through comprehensive research and analysis.

Methods

In order to amass pertinent information for our review paper on Zero Net Energy Homes (Mass.gov, n.d.), a meticulous approach was adopted. We conducted an exhaustive search across diverse institution databases, including those affiliated with AIMS Community College, and consulted reputable sources available on Google Scholar. The selected sources were scrutinized for insights into the functionalities, systems, energy costs, and energy consumption patterns associated with Zero Net Energy Homes. A total of 68 sources were meticulously curated, with detailed records of titles, links, and succinct summaries for each source.
To streamline the subsequent writing process, these sources were systematically organized into distinct categories, encompassing HVAC Systems and Air Quality (Zeiler et al., 2016; Minea et al., 2017), Photovoltaic Systems (Stadle et al., 2011; Hoseinzadeh et al., 2019), (Liu et al., 2023), (Lu et al., 2019), (Radulovic et al., 2020). Modern Homes (Max et al., 2021; Farhar & Coburn, 2008), (Bucking et al., 2014). Zero Net Energy Homes (Liu et al., 2015; Heendeniya et al., 2020), Regional ZNEB projects (Olsthoorn et al., 2019), (Hu & Qiu, 2019), Policy (Lu et al., 2019; Arent et al., 2020), and Miscellaneous (Güğül & Bora, 2022); (Kaupa, 2022); (Zeiler et al., 2016); (Minea et al., 2017).

While considering additional categories such as Insulation, Soil Management, Water Management, and Waste Management, it was determined that no sources fitting these criteria were obtained. The resultant compilation of organized sources laid the groundwork for a structured and efficient review. Following the organization process, a thorough examination of each source ensued, with a focus on extracting the most pertinent figures. Typically, one or two key figures were identified for each source, and these figures were succinctly elucidated. Subsequently, a list of 10 particularly relevant studies was compiled, and from this selection, further refinement was conducted to isolate the studies deemed most crucial for inclusion in our paper. We compiled the 10 relevant studies and sorted them into categories in Table 1 in the discussion section of this paper. We also identified the most relevant figures in each of these 10 studies. This comprehensive methodological approach ensured that our review paper drew upon a robust foundation of diverse sources, offering a well-rounded exploration of Zero Net Energy Homes, substantiated by the most pertinent and impactful figures available in the literature.

Discussion

Sl No.	Title of paper	Category	Relevant figures	Citation	Relevant Citations
1	How NET ZERO Can Save New England Homeowners Thousands of Dollars	Regional ZNEB projects	Net Zero Home Energy Costs Comparison	(Thomas, 2013, 30-36)	(Zero Energy Project, 2019) (Not a direct citation but supports it)
2	Methodology for energy and economic modeling of net-zero energy communities	Regional ZNEB Projects	Cash Flow Analysis of Net Zero Energy Buildings	(Bucking & Cotton, 2015, 462-470)	(ASHRAE, 2010) (Directly cited in article)
3	Multi-Objective Optimal Design of a Near Net Zero Energy Solar House	Photovoltaic Systems	EcoTerra's Energy Consumption Comparison	(Bucking et al., 2014)	(Chen, 2009) (Directly cited in article)
4	A New Market Paradigm for Zero-Energy Homes: A Comparative Case Study	Regional ZNEB projects	Energy-Saving Impact on Types of Homes	(Farhar & Coburn, 2006)	(Singh, 2019) (Not a direct citation but supports it)
5	The future is a zero-carbon building sector: Perspectives from Durban, South Africa	Regional ZNEB projects	Evolution of Building Technologies and Emissions Impact	(Elias & Thambiran, 2022)	(South African Department of Environmental Affairs, 2014) (Directly cited in article)
6	Challenges to Statewide Net-Zero Energy Buildings: The Oregon Experience	Photovoltaic Systems	Code and Renewable Energy Impact on Net Zero Goals	(Heizer & Shelide, 2020)	(Heendeniya et al., 2020) (Supports need for renewable sources of energy)
7	Energy Performance, Comfort, and Lessons Learned from a Near Net Zero Energy Solar House	Regional ZNEB projects	Improved EcoTerra Home's Energy Consumption	(O'Brien et al., 2011)	(Ballarini et al., 20) (Supports need for transforming existing homes)

8	A comparison of building energy codes and policies in the USA, Germany, and China: progress toward the net-zero building goal in three countries	Regional ZNEB projects	Building Energy Consumption with Major Policy Changes	(Hu & Qiu, 2019)	(Arent et al., 2020) (Supports need for effective building codes)
9	Phase change material thermal energy storage systems for cooling applications in buildings: A review	HVAC Systems/ Air Quality	Future Areas of Study in Cooling and Heating Systems	(Castelain et al., 2019)	(Liu et al., 2020) (Related)
10	Occupants' acceptability of zero energy housing in Finland	Regional ZNEB projects	Awareness of Zero Energy House Concepts	(Paatero et al., 2019)	(O'Brien et al., 2011) (Not a direct citation but supports it)

Table 1: Table of relevant figures by categories

1. Net Zero Home Energy Costs Comparison

This study (Thomas, 2013, 30-36) presents a comparative analysis of Net Zero home energy costs against near-net zero homes, a control house, and the average cost in England. Remarkably, Net Zero home energy costs are only eight dollars per month, significantly more economical than other housing types. This finding underscores the cost-effectiveness of Net Zero homes in comparison to traditional counterparts. The low Net Zero home energy costs, as portrayed in this study, underscore the economic viability of transitioning to zero-energy homes. The considerable cost savings indicate a positive trajectory. Moving forward, there should be a concerted effort to disseminate information about these economic benefits to encourage wider adoption and dispel any misconceptions about the affordability of Net Zero homes.

2. Cash Flow Analysis of Net Zero Energy Buildings

This study (Bucking & Cotton, 2015, 462-470) delves into the cash flow dynamics of various Net Zero Energy buildings over time. The profitability over the long run is evident, particularly for townhouses and commercial buildings. This information emphasizes the economic viability of different types of Net Zero Energy buildings, showcasing their financial sustainability. This study's insightful cash flow analysis demonstrates the long-term profitability of various Net Zero Energy buildings. To expedite the shift toward sustainable construction, policymakers and developers should consider incentivizing and promoting the construction of townhouses and commercial buildings, which exhibit notable financial sustainability.

3. EcoTerra's Energy Consumption Comparison

This study (Bucking et al., 2014) illustrates EcoTerra's energy consumption in comparison to the national average and R-2000 homes. EcoTerra homes exhibit significantly lower energy density, shedding light on areas of energy efficiency. The study also pinpoints specific aspects

where EcoTerra homes outperform the national average and R-2000 homes. The comparison of EcoTerra's energy consumption to national averages reveals an encouraging trend towards energy efficiency. To propel this further, industry stakeholders should prioritize investments in technologies and practices that contribute to lower energy density in residential structures, fostering a broader culture of sustainability in home design and construction.

4. Energy-Saving Impact on Types of Homes

This study (Farhar & Coburn, 2006) provides a visual representation of the various types of homes that could be built based on the amount of energy saved and supplied by the home. This study underscores the flexibility and adaptability of home construction based on energy considerations, promoting a more sustainable housing landscape. This study's depiction of the energy-saving impact on various types of homes highlights the adaptability of construction practices. Future initiatives should emphasize the importance of energy-efficient design in construction regulations and codes, encouraging a diverse range of homes that contribute to reduced overall energy consumption.

5. Evolution of Building Technologies and Emissions Impact

This study (Elias & Thambiran, 2023) collectively depicts the evolution of building technologies over decades, correlating their effects on cost and emissions savings within the building sector. These graphs illuminate the advancements in technologies and the potential positive environmental impacts, offering a comprehensive view of the trajectory of building practices. This study collectively presents the evolving landscape of building technologies and their impact on emissions (Taherahmadi et al., 2023). Future research and development should focus on advancing technologies that minimize environmental footprints, with an emphasis on sustainable and cost-effective solutions (Liu et al., 2015). Collaboration between academia, industry, and policymakers is crucial to implementing these advancements (Heizer & Shelide, 2020).

6. Code and Renewable Energy Impact on Net Zero Goals

This study (Heizer & Shelide, 2020) highlights that adhering solely to codes is insufficient to reach Net Zero goals. It emphasizes the imperative of integrating renewable energy sources alongside regulatory codes to achieve Net Zero Energy standards. This insight underscores the multifaceted approach needed for sustainable housing solutions. It underscores the necessity of combining regulatory codes with renewable energy integration to achieve Net Zero goals. Future efforts should concentrate on refining building codes to incorporate stricter energy efficiency standards while promoting and incentivizing the adoption of renewable energy sources.

7. Improved EcoTerra Home's Energy Consumption

This study (O'Brien et al., 2011) envisions the potential energy consumption of an improved EcoTerra home. The implementation of improvements significantly lowers energy consumption, offering a tangible demonstration of the positive impact of enhancements in sustainable building practices. This study provides a glimpse into the potential impact of improvements on EcoTerra homes. This highlights the importance of ongoing research and development to identify and implement effective enhancements in building practices. Stakeholders should actively invest in

technologies and methodologies that can be universally applied to improve the energy performance of existing homes.

8. Building Energy Consumption with Major Policy Changes

This study (Hu & Qiu, 2019) illustrates the total building energy consumption with major policy changes. The substantial decrease in energy consumption highlights the potential positive outcomes of strategic policy interventions in fostering energy-efficient building practices. It showcases the substantial decrease in building energy consumption with major policy changes. Policymakers must take heed of such findings and consider implementing comprehensive policies that drive sustainable construction practices. Incentives, regulations, and awareness campaigns should be devised to promote energy-efficient building strategies.

9. Future Areas of Study in Cooling and Heating Systems

This study (Castelain et al., 2019) provides insights into possible future areas of study concerning passive and active systems related to cooling and heating in buildings. This study prompts discussions on the evolving landscape of HVAC systems and their potential impact on enhancing energy efficiency and indoor air quality. It raises important considerations about future areas of study in cooling and heating systems. As technology advances, researchers and industry professionals should prioritize the development and adoption of passive and active systems that enhance energy efficiency in HVAC systems, contributing to overall sustainability.

10. Awareness of Zero Energy House Concepts (Paatero et al., 2019).

This study (Paatero et al., 2019) gauges the awareness of polled individuals regarding the concept of a Zero Energy House. The data reveals a limited understanding among participants, indicating the need for broader educational efforts to disseminate knowledge about Net Zero buildings and related concepts. It indicates a lack of awareness among participants regarding Zero Energy House concepts. Initiatives should be undertaken to bridge this knowledge gap through educational programs, outreach campaigns, and community engagement. Creating awareness is fundamental to fostering public support for sustainable housing practices.

In synthesizing these results, the multifaceted nature of sustainable building practices becomes apparent. The studies collectively contribute to a nuanced understanding of the economic, environmental, and technological aspects that shape the landscape of Zero Net Energy Homes and sustainable construction practices. In conclusion, the landscape of Zero Energy Homes is promising but requires a concerted effort from various stakeholders to reach its full potential. Continued research, collaboration, and the integration of sustainable practices into policies and construction standards will play a pivotal role in advancing the adoption of Zero Energy Homes and ensuring a more sustainable future for the housing sector.

Conclusion

Paving the Way for a Sustainable Future in Housing

In the pursuit of comprehending the current landscape and envisioning the future trajectory of Zero Energy Homes, this review paper has delved into a diverse array of studies and findings from various sources. The synthesis of these insights offers a nuanced understanding of the advancements, challenges, and potential pathways that lie ahead in the realm of sustainable housing practices.

The studies presented from Regional ZNEB Projects, Photovoltaic Systems, Zero Net Energy Homes, and HVAC Systems/Air Quality collectively highlight the progress made and the areas that necessitate focused attention as we navigate the complex landscape of Zero Energy Homes.

Current Achievements and Insights:

1. Economic Viability: The evidence of low Net Zero home energy costs (Thomas, 2013, 30-36) underscores the economic viability of embracing sustainable housing. This economic advantage should be communicated widely to dispel misconceptions about affordability.

2. Financial Sustainability: The cash flow analysis of various Net Zero Energy buildings (Bucking & Cotton, 2015, 462-470) reveals promising long-term profitability, especially for townhouses and commercial buildings. This insight should guide policymakers and developers towards sustainable construction practices.

3. Energy Efficiency Advances: EcoTerra's energy consumption comparison (Photovoltaic Systems Source 8 Figure 2) demonstrates encouraging progress in energy efficiency. Investments in technologies that contribute to lower energy density should be prioritized for broader adoption(Bucking et al., 2014; Liu et al., 2023; O'Brien et al., 2011; Shaw et al., 2019; Stadler et al., 2023).

4. Adaptability in Construction: The depiction of the energy-saving impact on different types of homes (Regional ZNEB Projects Source 15 Figure 4) (Farhar & Coburn, 2006) emphasizes the adaptability of construction practices based on energy considerations. This encourages a diversified approach to sustainable home construction (Ma et al., 2019).

5. Evolution of Building Technologies: The figures (1-4) from Figures 1-4 (Regional ZNEB Source 7) (Elias & Thambiran, 2023) showcase the evolution of building technologies and their impact on emissions. This historical overview provides crucial insights for future research and development in advancing sustainable building practices.

Future Directions and Recommendations:

1. Holistic Approach to Codes and Renewable Energy: Figure 2 (Zero Net Energy Homes Source 6 Figure 2) (Lausselet et al., 2023) emphasizes the necessity of combining regulatory codes with renewable energy integration. Future efforts should focus on refining building codes and incentivizing the adoption of renewable energy sources for a holistic approach.

2. Continued Research and Development: Figures 10 and 5 (Regional ZNEB Projects Source 17 Figure 10) (O'Brien et al., 2011), (Hu & Qiu, 2019) underscore the importance of ongoing research and development. Identifying and implementing effective enhancements in building practices is crucial for improving the energy performance of existing and future homes.

3. Policy Changes for Energy Efficiency: Figure 5 (Hu & Qiu, 2019) demonstrates the substantial decrease in building energy consumption with major policy changes. Policymakers should consider implementing comprehensive policies that drive sustainable construction practices, coupled with incentives and awareness campaigns.

4. Advancements in HVAC Systems: Figure 13 (Castelain et al., 2019) prompts discussions on future areas of study in cooling and heating systems. Advancements in passive and active systems should be prioritized to enhance energy efficiency in HVAC systems.

5. Educational Initiatives: Figure 3 (Paatero et al., 2019) reveals a lack of awareness regarding Zero Energy House concepts. Initiatives should be launched to bridge this knowledge gap through educational programs, outreach campaigns, and community engagement.

Shaping a Future of Sustainable Living:

The journey toward achieving the ambitious goal of zero-net-energy homes necessitates a paradigm shift in our approach to energy consumption and housing. Despite the urgency of the environmental crisis, substantial changes have yet to be implemented, leaving many households reliant on conventional energy sources contributing to environmental degradation (Reichelstein, 2013). To usher in a sustainable future for generations to come, a transformative improvement in how we consume energy within our homes is imperative.

However, the challenge lies in the face of an ever-growing demand for electricity in the United States (EIA Staff, 2023). Affordability and accessibility remain significant barriers, with the average citizen unable to embrace eco-friendly solutions like solar panels (Reichelstein, 2013). Innovative strategies are essential to surmount these obstacles. One effective avenue is the introduction of tax breaks for individuals adopting environmentally friendly energy methods, fostering more widespread adoption of sustainable practices (Schlegelmilch & Joas, 2015).

Some regions have already taken commendable steps by offering tax credits for Zero Energy Ready Homes (Section 45L Tax Credits for Zero Energy Ready Homes, n.d.). Meanwhile, other nations, such as China and Saudi Arabia, have successfully implemented Zero Net Energy Homes for the general public (Liu, Z. et al, 2019). The question arises: Why has the United States not embraced similar changes? The answer lies in the perceived inconvenience and misconception that green energy solutions are prohibitively expensive and complicated for the average homeowner.

To bridge this gap and propel the nation toward sustainable living, several key initiatives can be explored. Mandating the integration of solar panels in all homes, coupled with the aforementioned tax breaks (Schlegelmilch & Joas, 2015), represents a tangible step forward. As these homes enter the manufacturing pipeline, it is crucial to emphasize their long-term affordability (Gilbride, Theresa L et al. 2016). Beyond initial costs, the benefits of reduced energy bills and a diminished environmental footprint make these eco-friendly homes a sound investment for both individuals and the broader community.
In conclusion, the journey toward achieving widespread adoption of Zero Energy Homes requires a collective and multifaceted effort. As we celebrate the achievements and insights

gained thus far, it is imperative to chart a course for the future that includes policy changes, continued research, technological innovations, and robust educational initiatives. By integrating these elements, we can pave the way for a sustainable and resilient future in housing, where Zero Energy Homes become the norm rather than the exception.

The transformation to zero-net-energy homes demands a concerted effort from individuals, policymakers, and the industry. By addressing economic barriers, dispelling misconceptions, and incentivizing green practices, the United States can pave the way for a future where sustainable living is not only accessible but also advantageous for all. This journey toward eco-friendly homes is not just an environmental imperative; it is a commitment to a more resilient, cost-effective, and harmonious way of life for present and future generations.

References

Abdou, N., Mghouchi, M., Hamdaoui, S., Asri, N., & Mouqallid, M. (2021, October 15). Multi-objective optimization of passive energy efficiency measures for net-zero energy building in Morocco. *Building and Environment*, *204*. https://www.sciencedirect.com/science/article/abs/pii/S0360132321005424?via%3Dihub

Arent, J., Athalye, R., & Taylor, S. (2020). Clearing the Path to ZNE with Energy Codes. *ASHRAE Transactions*, *126*. https://www.proquest.com/openview/5bb93c53c498afd6b5d373f119e54905/1?pq-origsite=gscholar&cbl=34619

ASHRAE. (2010). Standard 90.1. *ASHRAE*. http://www.ashrae.org/standards-research--technology/ standards--guidelines

Aytac, S., & Tran, C. (2022, August 16). *Towards Net Zero Energy Library Buildings | Issues in Science and Technology Librarianship*. Issues in Science and Technology Librarianship. Retrieved December 15, 2023, from https://journals.library.ualberta.ca/istl/index.php/istl/article/view/2701

Ballarini, I., Luca, G. D., Paragamyan, A., Pellegrino, A., & Corrado, V. (2019). Transformation of an Office Building into a Nearly Zero Energy Building (nZEB): Implications for Thermal and Visual Comfort and Energy Performance †. *Energies*, *12*(5). https://www.mdpi.com/1996-1073/12/5/895

Banfill, P. F. G., & Peacock, A. D. (2007). Energy-efficient new housing – the UK reaches for sustainability. *Building Research and Information*, *35*(4). https://www.tandfonline.com/doi/abs/10.1080/09613210701339454

Barthelmes, V., Becchio, C., & Corgnati, S. (2016). Occupant behavior lifestyles in a residential nearly zero energy building: Effect on energy use and thermal comfort. *Science and Technology for the Built Environment*, *22*(7). https://www.tandfonline.com/doi/full/10.1080/23744731.2016.1197758

Bucking, S. (2016). Optimization under economic uncertainty using a net zero energy commercial office case study. *ASHRAE Transactions*, *122*(1). https://link.gale.com/apps/doc/A462045184/AONE?u=anon~d70c46e2&sid=googleScholar&xid=54e8ac9e

Bucking, S., Athienitis, A., & Zmeureanu, R. (2014). Multi-Objective Optimal Design of a Near Net Zero Energy Solar House. *ASHRAE Transactions*. https://login.proxy.marmot.org/login?auth=aims&url=https://search-ebscohost-com.proxy.marmot.org/login.aspx?direct=true&db=aph&AN=96045424&site=ehost-live

Bucking, S., & Cotton, J. S. (2015). Methodology for Energy and Economic Modeling of Net Zero Energy Communities. *ASHRAE Transactions*, *121*(1), 462-470. EBSCOhost. https://login.proxy.marmot.org/login?auth=aims&url=https://search-ebscohost-com.proxy.marmot.org/login.aspx?direct=true&db=aph&AN=108334588&site=ehost-live

Bucking, S., Zmeureanu, R., & Athienitis, A. (2014, January). Multi-objective optimal design of a near net zero energy solar house. *ASHRAE Transactions*.

https://www.researchgate.net/publication/285964004_Multi-objective_optimal_design_of_a_near_net_zero_energy_solar_house

Carpino, C., Loukou, E., Heiselberg, P., & Arcuri, N. (2020). Energy performance gap of a nearly Zero Energy Building (nZEB) in Denmark: the influence of occupancy modelling. *Building Research and Information*, *48*(8). https://www.tandfonline.com/doi/full/10.1080/09613218.2019.1707639

Chegari, B., Tabaa, M., Simeu, E., Moutaouakkil, F., & Medromi, H. (2021, May 15). Multi-objective optimization of building energy performance and indoor thermal comfort by combining artificial neural networks and metaheuristic algorithms. *Energy and Buildings*, *239*. https://www.sciencedirect.com/science/article/abs/pii/S037877882100123 7?via%3Dihub

Chen, Y. (2009). *Modeling and design of a solar house with focus on a ventilated concrete slab coupled with a building-integrated photovoltaic/thermal system by Yuxiang Chen · 635374806 · OA.mg*. OA.mg. Retrieved December 16, 2023, from https://oa.mg/work/635374806

Copeland, C., MacKerron, G., & Foxon, T. J. (2022). Regional energy futures as decision support in the transition to net zero emissions: North of Tyne case study. *The International Journal of Justice and Sustainability*, *27*(6). https://www.tandfonline.com/doi/full/10.1080/13549839.2022.2075841

Cui, S., Wang, Y.-W., Shi, Y., & Xiao, J.-W. (2020, September). A New and Fair Peer-to-Peer Energy Sharing Framework for Energy Buildings. *IEEE Transactions on Smart Grid*, *11*(5), 3817-3826. https://ieeexplore.ieee.org/abstract/document/9061057

Dembo, A., Khaddad, F., & Fung, A. S. (2013, January). Least-cost upgrade solutions to achieve improved energy efficiency standards for residential new housing in Canada. *American Society of Heating, Refrigerating, and Air-Conditioning Engineers*, *119*(1). https://go.gale.com/ps/i.do?id=GALE%7CA331928041&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=00012505&p=AONE&sw=w&userGroupName=txshrpub100416&aty=ip

Egnatosyan, S., Avetisyan, A., & Khachikyan, S. (2023). Zero net energy building design as the way to increase the energy security of Armenia. *Environmental Sciences*, *420*. https://eds-p-ebscohost-com.proxy.marmot.org/eds/detail/detail?vid=0&sid=263e4246-bcfa-4468-b410-c9930ad3f67c%40redis&bdata=JnNpdGU9ZWRzLWxpdmU%3d#AN=edsdoj.f4e5b6d0b2914e86b3161f969251fbb3&db=edsdoj

Elias, N., & Thambiran, T. (2022, September 29). The future is a zero-carbon building sector: Perspectives from Durban, South Africa. *S Afr J Sci*. Retrieved December 17, 2023, from https://www.scielo.org.za/pdf/sajs/v118n9-10/18.pdf

Evaluation of Model Results and Measured Performance of Net-Zero Energy Homes in Hawaii: Preprint. (2013, June 26). NREL. Retrieved December 17, 2023, from https://www.nrel.gov/docs/fy13osti/58000.pdf

Faraj, K., Khaled, M., Faraj, J., Hachem, F., & Castelain, C. (2020, March). *Phase change material thermal energy storage systems for cooling applications in buildings: A review*.

Science Direct. Retrieved December 16, 2023, from https://www.sciencedirect.com/science/article/abs/pii/S1364032119307877

Farhar, B., & Coburn, T. (2008). A New Market Paradigm for Zero-Energy Homes: A Comparative Case Study. *Environment: Science and Policy for Sustainable Development*, *50*(1). https://www.tandfonline.com/doi/abs/10.3200/ENVT.50.1.18-32

Gilbride, T. L., & Dentz, J. (2016, September 1). Net Zero Energy Manufactured Homes May Be on their Way. *Home Energy*, (Fall 2016), 4-9. https://www.osti.gov/biblio/1406810

Gugul, G. N., & Bora, B. N. (2022, September). A certification tool for on-grid net zero energy consumption buildings. *Environmental Progress & Sustainable Energy*, *41*(5). https://aiche.onlinelibrary.wiley.com/doi/abs/10.1002/ep.13854

Haddad, Y., Pagone, E., Parra, R. V., Pearson, N., & Salonitis, K. (2022, August 4). How do small changes enable the shift to net-zero? a techno-environmental-economic analysis. *The International Journal of Advanced Manufacturing Technology*, *122*, 4247-4257. https://link.springer.com/article/10.1007/s00170-022-09869-8

Heendeniya, C., Sumper, A., & Eicker, U. (2020, June 1). The multi-energy system co-planning of nearly zero-energy districts – Status-quo and future research potential. *Applied Energy*, *267*. https://www.sciencedirect.com/science/article/abs/pii/S0306261920304657?via%3Dihub

Heizer, M., & Shelide, B. (2020). Challenges to Statewide Net-Zero Energy Buildings: The Oregon Experience. *ASHRAE Transactions*, *126*, 29 - 36. https://www.proquest.com/openview/5bb93c53c498afd68a338502949371bd/1?pq-origsite=gscholar&cbl=34619

Hoseinzadeh, S., Zakeri, M. H., Shirkhani, A., & Chamkha, A. J. (2015, February 15). Analysis of energy consumption improvements of a zero-energy building in a humid mountainous area. *Journal of Renewable and Sustainable Energy*, *11*(1). https://pubs.aip.org/aip/jrse/article-abstract/11/1/015103/1018954/Analysis-of-energy-consumption-improvements-of-a?redirectedFrom=fulltext

Hu, M., & Qiu, Y. (2019). A comparison of building energy codes and policies in the USA, Germany, and China: progress toward the net-zero building goal in three countries. *Clean Technologies and Environmental Policy*. https://www.researchgate.net/publication/328701132_A_comparison_of_building_energy_codes_and_policies_in_the_USA_Germany_and_China_progress_toward_the_net-zero_building_goal_in_three_countries

Kalamees, T. (2015, January). *(PDF) Lessons learnt from the first public buildings in Estonia intended to be passive houses*. ResearchGate. Retrieved December 17, 2023, from https://www.researchgate.net/publication/277354592_Lessons_learnt_from_the_first_public_buildings_in_Estonia_intended_to_be_passive_houses

Kaupa, C. (2022, November). Scrutinizing net zero: The legal problems of counting greenhouse gas emissions, removals and offsets together. *Special Issue: Ocean, sustainable development and human rights*, *31*(3), 447-457. https://onlinelibrary.wiley.com/doi/full/10.1111/reel.12452

Lausselet, C., Ager-Wick Ellingson, L., Stromman, A. H., & Brattebo, H. (2023, November 5). *A life-cycle assessment model for zero emission neighborhoods*. Wiley Library. Retrieved December 11, 2023, from https://onlinelibrary.wiley.com/doi/abs/10.1111/jiec.12960

Li, Y., O'Neill, Z., Zhang, L., Chen, J., Im, P., & DeGraw, J. (2021, August). Grey-box modeling and application for building energy simulations - A critical review. *Renewable and Sustainable Energy Reviews*, *146*. Retrieved December 15, 2023, from https://doi.org/10.1016/j.rser.2021.111174

Liu, J., Chen, X., Yang, H., & Li, Y. (2020, January 1). Energy storage and management system design optimization for a photovoltaic integrated low-energy building. *Energy*, *190*. Retrieved December 15, 2023, from https://doi.org/10.1016/j.energy.2019.116424

Liu, Z., Zhang, L., Gong, G., Li, H., & Tang, G. (2015, September 1). Review of solar thermoelectric cooling technologies for use in zero energy buildings. *Energy and Buildings*, *102*, 207-216. https://www.sciencedirect.com/science/article/abs/pii/S037877881530025?via%3Dihub

Lu, Y., Khan, Z., Gunduz, H., Wang, W., Li, J., & Zhang, X.-P. (2019, December 12). Economic Performance of Net-Zero Energy Community under Reward-Penalty Mechanism Considering PV System Reliability. *Environmental and Climate Technologies*, *23*(3), 26-42. Retrieved December 15, 2023, from https://sciendo.com/es/article/10.2478/rtuect-2019-0077

Ma, Z., Ren, H., & Lin, W. (2019, December 10). A review of heating, ventilation and air conditioning technologies and innovations used in solar-powered net zero energy Solar Decathlon houses. *Journal of Cleaner Production*, *240*. https://doi.org/10.1016/j.jclepro.2019.118158

Mahdavi Adeli, M., Farahat, S., & Sarhaddi, F. (2019, December 17). Increasing thermal comfort of a net-zero energy building inhabitant by optimization of energy consumption. *International Journal of Environmental Science and Technology*, *17*(5), 2819-2834. https://doi.org/10.1007/s13762-019-02603-0

Mahdavi Adeli, M., Farahat, S., & Sarhaddi, F. (2020, June 16). Parametric analysis of a zero-energy building aiming for a reduction of CO2 emissions for warm climate. *Environmental Science and Pollution Research*, *27*(27), 34121-34134. https://doi.org/10.1007/s11356-020-09467-9

Mass.gov. (n.d.). *What is a Zero Net Energy Building?* Mass.gov. Retrieved December, 2023, from https://www.mass.gov/info-details/what-is-a-zero-net-energy-building

Minea, V., Chen, Y., & Athienitis, A. K. (2016, November 7). Canadian low-energy housing: National energy context, and a case study of a demonstration house with focus on its ground-source heat pump. *Taylor & Francis Online*, *23*(4), 651-668. https://doi.org/10.1080/23744731.2016.1239468

Ming, H., & Yueming, Q. (2019, March). *A comparison of building energy codes and policies in the USA, Germany, and China: progress toward the net-zero building goal in three countries.* EBSCO. Retrieved December 15, 2023, from

https://eds-s-ebscohost-com.proxy.marmot.org/eds/detail/detail?vid=0&sid=78729214-7142-4c5c-a0ee-37d3fb183b57%40redis&bdata=JnNpdGU9ZWRzLWxpdmU%3d#AN=134870994&db=eih

Naseema, E., & Tirusha, T. (2022). The future is a zero-carbon building sector: Perspectives from Durban, South Africa. *S Afr J Sci*. https://www.scielo.org.za/pdf/sajs/v118n9-10/18.pdf

Ng, L., Poppendieck, D., Dols, W., & Emmerich, S. (2019, May 9). *Evaluating IAQ and Energy Impacts of Ventilation in a Net-Zero Energy House Using a Coupled Model*. NCBI. Retrieved December 16, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6506835/

Norton, P., Kiatreungwattana, K., & Kelly, K. J. (2013). Evaluation of Model Results and Measured Performance of Net-Zero Energy Homes in Hawaii. https://www.nrel.gov/docs/fy13osti/58000.pdf

O'Brien, W. T., Dioron, M., & Athienitis, A. (2011). *Energy Performance, Comfort and Lessons Learned from a Near Net-Zero Energy Solar House*. ResearchGate. Retrieved December 11, 2023, from https://www.researchgate.net/publication/268095264_Energy_Performance_Comfort_and_Lessons_Learned_from_a_Near_Net-Zero_Energy_Solar_House_ML-11-010

Olsthoorn, M., Schleich, J., & Faure, C. (2019, June). Exploring the diffusion of low-energy houses: An empirical study in the European Union. *Energy Policy*, *129*, 1382-1393. https://www.sciencedirect.com/science/article/abs/pii/S0301421519302162

Oreskovic, L., Gupta, R., & Strong, D. (2021). In-use energy and carbon performance of a true zero carbon housing development in England. *Science and Technology for the Built Environment*, *27*, 1425-1439. https://www.tandfonline.com/doi/epdf/10.1080/23744731.2021.1949201?needAccess=true

Paatero, J. V., Moula, M. E., & Alanne, K. (2018, November 8). *Occupants' acceptability of zero energy housing in Finland*. tandfonline. Retrieved December 17, 2023, from https://www.tandfonline.com/doi/abs/10.1080/14786451.2018.1539396

Phillips, T.J., & Levin, H. (2015). Indoor environmental quality research needs for low-energy homes. *Science and Technology for the Built Environment*, *21*(1). https://www.tandfonline.com/doi/abs/10.1080/10789669.2014.975056

Radulovic, J., Bojic, M., Nikolic, D., Skerlic1, J., & Taranovic, D. (2020, December 25). *TOWARDS NET ZERO ENERGY BUILDINGS: POSSIBILITIES FOR PHOTOVOLTAIC USE*. Center for Quality, Faculty of Engineering, University of Kragujevac. Retrieved December 15, 2023, from https://www.cqm.rs/2013/cd/7iqc/pdf/45.pdf

Raide, I., Mauring, T., & Kalamees, T. (2015, January). Lessons learnt from the first public buildings in Estonia intended to be passive houses. *Proceedings of the Estonian Academy of Sciences*. https://www.researchgate.net/publication/277354592_Lessons_learnt_from_the_first_public_buildings_in_Estonia_intended_to_be_passive_houses

Scott, R. (2013, March 17). *Energy-Positive Homes in Devens, Mass*. American Solar Energy Society. Retrieved December 19, 2023, from https://ases.org/energy-positive-homes-in-devens-mass/

Shaw, D., Susilawati, C., Walker, G., & Varendorff, J. (2019, September 20). *Towards net-zero energy neighbourhoods utilising high rates of residential photovoltaics with battery storage: a techno-economic analysis*. ResearchGate. Retrieved December 12, 2023, from https://www.researchgate.net/publication/335957391_Towards_net-zero_energy_neighbourhoods_utilising_high_rates_of_residential_photovoltaics_with_battery_storage_a_techno-economic_analysis

Shell. (2020, April 16). *A net-zero emissions energy business*. Shell Global. Retrieved December 16, 2023, from https://www.shell.com/media/speeches-and-articles/2020/a-net-zero-emissions-energy-business.html

Singh, S. (2019, November). *Zero energy Buildings Market Size, Share, Growth | Report, 2032*. Market Research Future. Retrieved December 16, 2023, from https://www.marketresearchfuture.com/reports/zero-energy-buildings-market-5325

Siranush, E., Artur, A., & Sos, K. (2023). Zero net energy building design as the way to increase the energy security of Armenia. *LCC: Environmental Sciences*, *420*. https://eds-s-ebscohost-com.proxy.marmot.org/eds/detail/detail?vid=0&sid=b84ef65d-47fe-4d8c-8473-0285da85c1eb%40redis&bdata=JnNpdGU9ZWRzLWxpdmU%3d#AN=edsdoj.f4e5b6d0b2914e86b3161f969251fbb3&db=edsdoj

Soni, K. M., & Bhagat Singh, P. (2020, April). First onsite net zero energy green building of India. *International Journal of Environmental Science & Technology*, *17*(4), 2197-2204. https://eds-p-ebscohost-com.proxy.marmot.org/eds/detail/detail?vid=0&sid=41a6a85b-1bc8-49a4-ab6e-3e24ffdeeec1%40redis&bdata=JnNpdGU9ZWRzLWxpdmU%3d#AN=142383542&db=eih

South African Department of Environmental Affairs. (2014). *South Africa's Greenhouse Gas Mitigation Potential Analysis*. DFFE. Retrieved December 16, 2023, from https://www.dffe.gov.za/sites/default/files/docs/mitigationreport.pdf

Stadler, M., Siddiqui, A., Marney, C., Aki, H., & Lai, J. (2023, March 2). *Control of greenhouse gas emissions by optimal DER technology investment and energy management in zero-net-energy buildings*. European Transactions on Electrical Power. Retrieved December 15, 2023, from https://doi.org/10.1002/etep.418

Sudhakar, K., Winderl, M., & Priya, S. (2019, March). Net-zero building designs in hot and humid climates: A state-of-art. *Case Studies in Thermal Engineering*, *13*. https://www.sciencedirect.com/science/article/pii/S2214157X18304131?via%3Dihub

Taherahmadi, J., Noorollahi, Y., & Panahi, M. (2023, November 5). *Toward comprehensive zero energy building definitions: a literature review and recommendations*. Taylor and Francis Online. Retrieved December 15, 2023, from https://www.tandfonline.com/doi/abs/10.1080/14786451.2020.1796664

Thomas, W. D. (2013, September/October). How NET ZERO Can Save New England Homeowners THOUSANDS OF DOLLARS. *Home Energy*, *30*(5), 30-36. EBSCOhost. https://login.proxy.marmot.org/login?auth=aims&url=https://search-ebscohost-com.proxy.marmot.org/login.aspx?direct=true&db=eih&AN=89761548&site=ehost-live

Wei, M., Lee, S. H., Hong, T., Conlon, B., McKenzie, L., Hendron, B., & German, A. (2022, October 2). *Approaches to cost-effective near-net zero energy new homes with time-of-use value of energy and battery storage*. Advances in Applied Energy. Retrieved December 18, 2023, from https://www.sciencedirect.com/science/article/pii/S2666792421000111?via%3Dihub

Yip, A., & Richman, R. (2015, September 30). Reducing Ontario's new single-family residential heating energy consumption by 80% by 2035: economic analysis of a tiered framework of performance targets. *Canadian Journal of Civil Engineering*, *42*(12), 1135-1145. https://doi.org/10.1139/cjce-2015-0234

Zanecki, V. P. (2013, April 19). *Affordable Net-Zero-Energy in Outlying D.C.* American Solar Energy Society. Retrieved December 17, 2023, from https://ases.org/affordable-net-zero-energy-in-outlying-d-c/

Zeiler, W., Gvozdenovic, K., de Bont, K., & Massen, W. (2016, July 1). Toward cost-effective nearly zero energy buildings: The Dutch Situation. *Taylor & Francis Online*, *22*(7), 911-927. https://doi.org/10.1080/23744731.2016.1187552

Zero Energy Project. (2019, March 23). *Zero Energy Homes - A Financial Win for Homeowners*. Zero Energy Project. Retrieved December 16, 2023, from https://zeroenergyproject.com/2019/03/23/everybody-profits-with-zero-energy-homes/