Envisioning the Utopian City: A Futuristic Approach to Sustainable Urban Infrastructure

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RESEARCH QUESTION

Food production, transportation, energy, and architecture: How can these four areas of infrastructure drive sustainability in the cities of the future ?

INTRODUCTION

It is vital for the global community to develop practical and innovative approaches to sustainable urban infrastructure, ensuring a livable future for generations to come. **Transformative change is required in four key pillars of urban life: food production, transportation, energy, and architecture.** This research aims to advocate for these changes by investigating existing practices and scientific research. Additionally, it will present **"The Line City"** in Saudi Arabia as a futuristic smart city that exemplifies the required changes across these four pillars.

The Line City's futuristic building (Moss and Fog, 2024)

ANALYSIS OF 4 AREAS OF INFRASTRUCTURE

Food Production

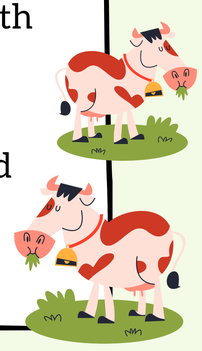
Burgers Without Animal-Based Ingredients

- Animal-based food accounts for 57% of global food production GHG emissions, with 87% of a burger's emissions coming from the patty.

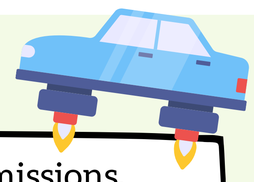
Solutions:

- **Plant-based meat:** Made from vegetables, grains, and legumes, plant-based meat offers healthier and more eco-friendly alternatives with significantly lower emissions, land use, and energy demands compared to animal meat.
- **Cultivated meat:** Grown from animal cells, cultivated meat can reduce the carbon footprint by up to 90% and requires far less land and water than traditional livestock farming.

Ex: Beyond Burger, Impossible Burger, and Mr. Charlie's demonstrate that plant-based alternatives can successfully meet market demands.



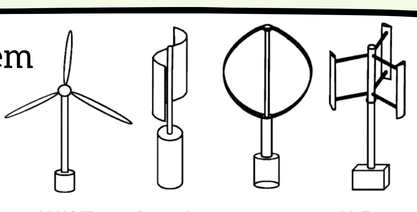
Transportation



- Transport accounts for about one-fifth of global CO2 emissions, with cars and planes as major contributors.
- Despite decarbonization efforts, challenges remain: **electric vehicle production can increase CO2 emissions if powered by fossil fuels, and cobalt used in batteries raises human rights concerns, including child labor in African mines.** Hydrogen vehicles are costly and emit harmful gases, and decarbonizing air travel remains technically difficult.
- **Rapid trains can replace domestic flights and car use, cutting emissions by up to 86%.** Promoting non-motorized transport through pedestrian-friendly designs, cycling lanes, and bike-sharing programs is also essential for sustainable urban mobility.

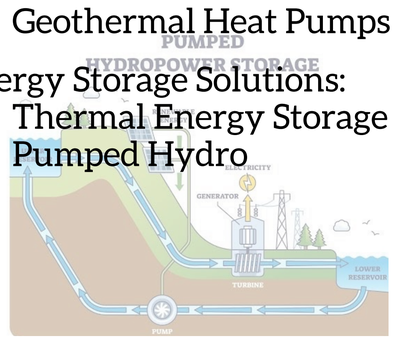
Energy

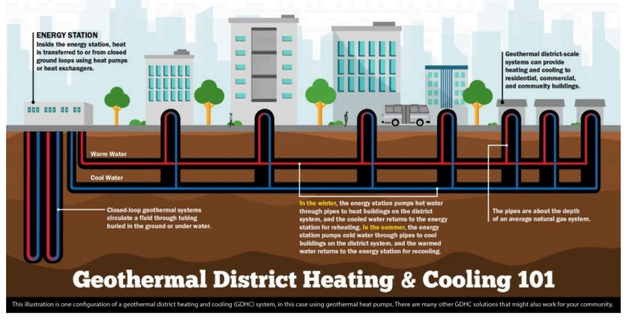
- Rooftop Solar Panels: using hybrid system
- Vertical Wind Turbines:
  - Darrieus Wind Turbines
  - Savonius Wind Turbines
- Geothermal Heat Pumps



Energy Storage Solutions:

- Thermal Energy Storage
- Pumped Hydro





Architecture

Sustainable Housing: Comfortable, Stylish, and Energy-Efficient

(Nasution & Syahreza, 2017)

10 Criteria for Sustainable Housing (Nainggolan, Dewi, & Panjaitan, 2020)

1. Building: Climate adaptation
2. Energy: Reduced consumption
3. Water & Waste: Reuse & management
4. Site: Land use & green space
5. Behavior: Environmental awareness
6. Housing Quality: Policy compliance
7. Culture & Values
8. Transport & Communication
9. Safety & Comfort
10. Affordability & Availability

Sustainable Design Elements

- **Wooden Materials**: Lower energy use than steel, absorbs CO2, and improves mental well-being . (Ojala et al., 2023)
- **Green Curtains**: Plants on balconies regulate humidity and temperature. Filtered wastewater sustains plants, with "flying gardeners" managing maintenance.
- **High-Performance Windows**: Advanced **glazing reduces heat loss, lowering energy use by up to 40%.** (Building Technologies Office, 2022)

Green and Adaptive Architecture

Eastgate Centre, Zimbabwe

- Inspired by termite mounds for passive cooling.
- It uses integrated fans to store heat during the day and release it at night, keeping temperatures stable year-round without air conditioning and reducing energy costs. (Jacquez, n.d.)

Adaptive Housing for Changing Populations

Urban melancholy—feelings of alienation in cities—particularly affects older adults, who spend 80% of their time at home with limited social interaction. (Shankari, 2024)

Matthias Hollwich's **"flex living"** features apartments with two entrances, two bedrooms, and flexible spaces. The award-winning **Older Women's Co-Housing** (OWCH) in London exemplifies this, **fostering collaboration, reducing isolation, and sharing care costs among women aged 50–87.** (Mairs, 2016; "Design for an ageing population," 2021).

CASE STUDY: The Line City in Saudi Arabia

City located in Neom. Preserves 100% natural life. Utilize AI.

Food Production: **Overpopulation poses challenges to food production.**

- Sustainable food systems integrated within urban spaces.

Transportation:

- **Car-free city designed for people, promoting walkability.**
- Ultra-high-speed transportation ensures transportation efficiency and accessibility.

Energy: Facilities powered entirely by renewable energy from wind and solar.

Architecture:

- Three land layers: open space, parks, gardens, and natural environments.
- Combines sustainable food production with a lifestyle in harmony with nature. (Al-sayed et.al., 2021)

CONCLUSION

There are various approaches to driving transformative changes toward a sustainable society. These approaches include actions that individuals can take. Reflecting on the case of The Line City, it is also essential for nations to actively pursue environmental protection and uphold human rights through these initiatives.

REFERENCES

1. Al-sayed, A., AL-shammari, F., Alshutayri, A., Aljojo, N., Aldhahri, E., & Abouola, O. (2022). The Smart City-Line in Saudi Arabia: Issue and Challenges. Postmodern Openings, 13(Sup1), 15-37. https://doi.org/10.18662/po/13.1Sup1/412
2. Ann O, Joel K, Jari V, Hanna M, Ida W, Linda V, Riina Muilu-Mäkelä. (2023).Psychological and physiological effects of a wooden office room on human well-being: Results from a randomized controlled trial,Journal of Environmental Psychology, 89,102059,ISSN 0272-4944, https://doi.org/10.1016/j.jenvp.2023.102059.
3. asknature. (n.d.). Passively cooled building inspired by termite mounds - innovation - asknature. AskNature Passively Cooled Building Inspired by Termite Mounds Comments. https://asknature.org/innovation/passively-cooled-building-inspired-by-termite-mounds/
4. Chint Global. (2023). Grid-Tied vs. Off-Grid Solar: Which is Right for You? Grid-Tied vs. Off-Grid Solar: Which Is Right for You? https://chintglobal.com/blog/grid-tied-solar-vs-off-grid-solar/
5. Crownhart, C. (2023). Here's what a lab-grown burger tastes like: Companies are engineering meat in the lab. Will anyone eat it? MIT Technology Review. https://www.technologyreview.com
6. Design for an ageing population. (2021). Architecture Today - The independent architecture magazine. https://architecturetoday.co.uk/design-for-an-ageing-population/
7. Food and Agriculture Organization of the United Nations. (2018). Sustainable food systems: Concept and framework. Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/server/api/core/bitstreams/b620989c-407b-4caf-a152-f790f55fec71/content
8. France Bans Short-haul Flights to Cut Carbon Emissions. (2023). BBC News. https://www.bbc.com/news/world-europe-65687665
9. Geothermal Technologies Office. (n.d.). Geothermal Heating & Cooling.Energy.gov. https://www.energy.gov/eere/geothermal/geothermal-heating-cooling
10. Glover, E. (2023). What Is A Hybrid Solar System, And Is It Worth It? Forbes Home. https://www.forbes.com/home-improvement/solar/what-is-a-hybrid-solar-system/
11. Green Life Zen. (2023). The Ultimate Guide To Vertical Axis Wind Turbines. Green Life Zen. https://greenlifezen.com/vertical-axis-wind-turbines/
12. hacheng1@gmail.com. (2023). Rooftop Solar Systems: The Basics, Benefits and Costs. Solarstarinfo.com. https://solarstarinfo.com/solar/rooftop-solar-systems/
13. Irma N. Nasution, Syahreza Alvan.(2017),Optimization of Sustainable House in Urban Area,Procedia Engineering,171, 250-257,ISSN 1877-7058, https://doi.org/10.1016/j.proeng.2017.01.332.
14. Jacquez, A. (n.d.). 15 best green building projects around the world. Novatr. https://www.novatr.com/blog/green-building-projects
15. Lindberg, L., Reid McCann, R., Smyth, B., Woodside, J. V., & Nugent, A. P. (2024). The environmental impact, ingredient composition, nutritional and health impact of meat alternatives: A systematic review. Trends in Food Science & Technology, 149, 1-15. https://doi.org/10.1016/j.tifs.2024.02.001
16. Mairs, J. (2022). Pollard Thomas Edwards completes UK's first over 50s co-housing scheme. Dezeen. https://www.dezeen.com/2016/12/09/pollard-thomas-edwards-architecture-first-older-co-housing-scheme-owch-uk/
17. AMasterson, V. (2021). These 4 energy storage technologies are key to climate efforts. World Economic Forum. https://www.weforum.org/agenda/2021/04/renewable-energy-storage-pumped-batteries-thermal-mechanical/
18. Mehrpooya, P. (2014). Figure 1.1. Schematic of Horizontal-Savonius drag-based, Darrieus... ResearchGate. https://www.researchgate.net/figure/Schematic-of-Horizontal-Axis-Savonius-drag-based-Darrieus-curved-blade-and-Giromill_fig1_265126459
19. Moss and Fog. (2024). Neom's the line megacity promises it's actually being built. Moss and Fog. https://mossandfog.com/neoms-the-line-megacity-promises-its-actually-being-built/
20. Mueller, M. (2017). *5 Things You Should Know about Geothermal Pumps*. Energy.gov. https://www.energy.gov/eere/articles/5-things-you-should-know-about- geothermal-heat-pumps
21. Rafal, K. (2020, June 10). *Reliable hybrid renewable microgrid and storage*. KEZO: Reliable Renewable Power with Hybrid Storage and DEIF Controllers; DEIF. https://www.deif.com/land-power/cases/reliable-hybrid-renewable-microgrid-and-storage
22. Ritchie, H. (2020). *Cars, planes, trains: Where do CO_2 emissions from transport come from?* Our World in Data. https://ourworldindata.org/co2-emissions-from-transport
23. Ritchie, H. (2023). *Which form of transport has the smallest carbon footprint?* Our World in Data. https://ourworldindata.org/travel-carbon-footprint
24. Sarma, J., Jain, S., Mukherjee, P., & Saha, U. K. (2021). Hybrid/Combined Darrieus–Savonius Wind Turbines: Erstwhile Development and Future Prognosis. *Journal of Solar Energy Engineering*, *143*(5). https://doi.org/10.1115/1.4050595
25. Shankari, K. (2024, March 14). *The impact of population growth on urban planning and design*. RTF | Rethinking The Future. https://www.re-thinkingthefuture.com/architectural-community/a12262-the-impact-of-population-growth-on-urban-planning-and-design/
26. SURGE accelerator. (2021, December 11). *8 Types Of Wind Turbines (Interesting Designs)*. Power Generation & Renewable Energy. https://surgeaccelerator.com/types-of-wind-turbines/#Vertical_Axis_Wind_Turbines_VAWT
27. STEFANO BOERI ARCHITETTI. https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/
28. Susanti Muvana Nainggolan, Ova Candra Dewi, Toga H Panjaitan(2020), 10 Criteria of Sustainable Housing: A Literature Review, Advances in Social Science, Education and Humanities Research, 475, 42-53, CC BY-NC 4.0, 10.2991/assehr.k.201009.005
29. TRIP.COM. (n.d.). *2024 Shanghai Maglev Train-The Fastest Train from PVG to downtown Shanghai Travel Notes and guides – trip.com travel guides*. https://www.trip.com/blog/all-you-need-to-know-about-shanghai-maglev/
30. Wadrop, K. (2023, December 12). The low-emission, environmentally friendly burger of the future. *Sustainable Future Journal*. Center for Process Innovation. https://www.uk-cpi.com/blog/the-low-emission-environmentally-friendly-burger-of-the-future
31. White, S. M. (2024, July 15). How is plant-based meat made? *Auguste Escoffier School of Culinary Arts*. https://www.escoffier.edu/blog/world-food-drink/how-is-plant-based-meat-made
32. YES ENERGY. (2024). *What Is Pumped Hydro Storage, and How Does It Work?*Blog.yesenergy.com.https://blog.yesenergy.com/yeblog/what-is-pumped-hydro-storage-and-how-does-it-work