Undergraduate Thesis Prospectus

Optimizing Solar Energy: Integrating Panels for the YMCA

(technical research project in Systems Engineering)

Promoting Affordable Solar Power in the United States

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General research problem

How can local community centers such as the YMCA effectively transition to and promote the use of renewable energy sources for a sustainable future?

Community centers, like the YMCA, are integral to local communities, offering various services from fitness facilities to educational programs. Transitioning them to renewable energy sources like solar or wind power can significantly reduce their carbon footprint, contribute to local sustainability goals, and set a precedent for other local institutions. Moreover, by adopting renewable energy, these centers can alleviate operational energy costs, redirecting funds towards enhancing community services.

The broader implications of this transition are manifold. Technically, integrating renewable energy systems in community centers poses challenges due to diverse energy needs, limited spaces, and often aged infrastructures. Socially, acceptance and advocacy for renewable energy within local communities are vital for such transitions to succeed. Economically, the upfront costs can be significant; hence understanding the long-term economic benefits and available funding mechanisms is essential.

This problem encapsulates a blend of technical, economic, and social challenges, demanding a multidisciplinary approach. Addressing this issue can not only propel community centers towards a sustainable operational model but also contribute to broader local, regional, and even national goals of reducing greenhouse gas emissions and promoting sustainability in the face of climate change. Through careful investigation and strategic implementation, the transition to renewable energy could serve as a blueprint for similar transitions in other local institutions, significantly contributing towards a sustainable future.

Optimizing Solar Energy: Integrating Panels for the YMCA

How can we determine the optimal configuration and placement of solar panels for the YMCA in Charlottesville, VA, to ensure maximum energy capture and conversion?

This project falls under the purview of the Systems Engineering department, guided by Dr. Reid Bailey. It is a collaborative effort as a Capstone Project, involving a team of two other Systems Engineering students and three Civil Engineering students. The collaborative nature of this project enhances the multidisciplinary approach required to tackle the technical, economic, and societal aspects entailed in integrating solar energy systems within community-centric establishments like the YMCA.

The aspiration of the Brooks Family YMCA to morph into a hallmark of community-led sustainability steers this project. Preliminary analysis divulges the potential of a rooftop solar system in offsetting approximately 22% of the YMCA's annual electricity draw. This venture not only portends significant reduction in electric utility expenses but also epitomizes a robust step towards economic and environmental sustainability, enriching the community's sustainability education and aligning with the YMCA's core objectives.

The cardinal goals of this project encapsulate the determination of optimal solar panel configurations and placements, technical and economic feasibility assessment, structural and electrical integrations requisite for solar energy adoption, estimation of potential energy offset alongside cost savings, and an examination of the wider community and educational ramifications emanating from the solar panel installation.

Certain constraints could potentially temper the project's ambitions. These include the structural integrity and warranty of the existing roof, the financial exigencies demanded for solar

panel integration, and the requisite operational considerations for maintenance post-installation. The contemporary tableau of solar technology unveils a variety of configurations like fixed solar panels, solar tracking systems, bifacial solar panels, and Building-Integrated Photovoltaics (BIPVs). However, their application in community centers like the YMCA is relatively unchartered, primarily owing to financial and technical hurdles.

The methodology delineated for this project comprises engagements with architectural and solar energy experts for structural feasibility assessment and optimal solar panel configuration design. Utilization of simulation software for energy yield and economic returns evaluation, examination of existing electrical infrastructure for devising solar energy integration plans, benchmarking against other similar institutions, consultations with solar companies for practical insights, and community engagement for assessing and augmenting the educational and societal value of the solar panel project form the crux of the technical approach.

At the culmination of this project, provided success is attained, a comprehensive recommendation on solar panel integration for the Brooks Family YMCA will be elucidated. This recommendation will harbor a technically viable, economically sustainable, and community-enriching blueprint for solar energy adoption. The consequential ripple effects could significantly bolster the YMCA's mission towards community development, healthy living, and environmental stewardship, while also serving as a precursor for similar sustainable endeavors in community centers across the region.

Promoting Affordable Solar Power in the United States

In the US, how have proponents of affordable solar panels promoted public policies to subsidize and accelerate their adoption?

The transition to renewable energy is not only a technical endeavor but a sociopolitical challenge, intertwining environmental, economic, social, and political dimensions. The push for renewable energy adoption, particularly solar power, stems from the urgency to address climate change impacts, balanced against local concerns and environmental regulations. The focal point of this research unfolds around the advocacy for affordable solar panels and the policy measures propelling their adoption in the United States.

A considerable force in shaping climate legislation is lobbying, where, between 2000 to 2016, over $2 billion was expended primarily by fossil fuel and related sectors. However, proponents of affordable solar panels, including solar industry advocates, environmental advocacies, government agencies, legislators, and local utilities like Dominion Energy, have been endeavoring to shift the narrative and policy framework towards favoring solar energy adoption (Brulle, 2018; Main, 2022). This advocacy is often staged on multiple fronts, encompassing regulatory support, sustainability and climate goals alignment, renewable energy targets, energy security, economic growth, and constituent demands.

The impartial stance of this research aspires to diagnose the strategies, narratives, and policy measures propelled by various stakeholders in promoting affordable solar power. By elucidating the dynamics and strategies employed in advocacy for affordable solar panels, this

research aims to foster a deeper understanding of the sociotechnical nexus surrounding solar energy adoption in the United States.

The affordable solar advocacy in the United States embodies a complex socio-political endeavor, where different stakeholders push for policy measures to accelerate solar panel adoption. Scholars like Brulle (2018) have highlighted the lobbying dynamics in climate change legislation, revealing how substantial forces shape climate policies. However, while the magnitude of lobbying is acknowledged, less is explored about how solar advocacy maneuvers against such forces, especially at a local community level like that of the YMCA in Charlottesville, VA.

Furthermore, the increasing home solar panel adoption trend identified by Leppert (2022) provides a window into the growing public interest in solar technology. Yet, the nuanced implications of this trend on community centers, like the YMCA, remain largely unexamined. The project seeks to delve into how community centers can navigate the technical, economic, and policy landscapes to transition towards renewable energy. The work of Main (2022), illustrating the shift of Dominion Energy towards selling residential solar, shows a change in utility providers' stance towards solar energy. However, it leaves the discussion open on how such transitions by utility providers impact or facilitate the solar adoption endeavors of community establishments.

Moreover, the broader implications of renewable energy adoption on community engagement and education, as highlighted in the project description, represent a fertile ground for exploration. The existing literature, like that of Wiseman (2020), discusses the balance between renewable energy goals and community interests but stops short of addressing the potential educational and community leadership aspects that the YMCA project aims to explore.

The proposed research, therefore, not only contributes to the understanding of technical and economic feasibility of solar energy adoption by community centers but also delves into the socio-political dynamics and community engagement aspects, filling the gaps left by the current literature. Through a meticulous examination of the YMCA case, the project intends to offer a nuanced understanding of how local community centers can effectively transition to and promote renewable energy sources amidst the existing socio-political and technical landscapes.

The transition to solar energy at the Brooks Family YMCA intertwines the objectives of several key participants, each harboring distinct agendas and perspectives. The Brooks Family YMCA stands at the forefront, aligning its initiative with its broader mission of fostering community engagement, reducing operational costs, and promoting sustainability (Brooks Family YMCA, 2022). Similarly, Dominion Energy, the current electricity provider, is gradually shifting its stance towards renewable energy solutions while maintaining a reliable energy supply, a change highlighted in a 2022 article by Ivy Main in the Virginia Mercury.

The local government of Charlottesville underpins its agenda on encouraging renewable energy initiatives, reducing carbon emissions, and nurturing community-led sustainable projects as part of a broader initiative to promote solar deployment (Energy.gov, 2022). Parallelly, the Virginia Renewable Energy Alliance (VA-REA) champions the growth of renewable energy in Virginia, bridging policy, and community-driven renewable energy projects like the one at the YMCA.

Community members and patrons of the YMCA form a vital participant group, driven by the desire for enhanced community services, educational opportunities on solar energy, and support for local sustainability initiatives. Their engagement is crucial for the success and acceptance of the solar project within the local community.

Solar installation companies and environmental advocacies emerge as significant players. While solar companies aim to expand the solar installation market and foster collaborations with local entities like the YMCA, environmental advocacies advocate for a transition to clean energy, support community-led renewable energy projects, and aim to reduce the carbon footprint of local establishments.

The combination of these participants and their respective agendas forms a multifaceted perspective towards the solar energy adoption initiative at the Brooks Family YMCA, encompassing a blend of economic, technical, and societal objectives.

References

Brulle, R.J. (2018). The climate lobby: A sectoral analysis of lobbying spending on climate change in the USA, 2000 to 2016. Climatic Change, 149(3), 289–303. https://doi.org/10.1007/s10584-018-2241-z

Leppert, R. (2022, October 14). Home solar panel adoption continues to rise in the U.S. Pew Research Center. https://www.pewresearch.org/short-reads/2022/10/14/home-solar-panel-adoption-continues-to-rise-in-the-u-s/

"Local Government Guide for Solar Deployment." Energy.gov. https://www.energy.gov/eere/solar/local-government-guide-solar-deployment.

Main, I. (2022, June 17). Dominion Energy Begins Selling Residential Solar. Virginia Mercury. https://www.virginiamercury.com/2022/06/17/if-you-cant-beat-em-join-em-dominion-energy-begins-selling-residential-solar/

Solar resilience: Keeping communities connected. Energy.gov. (n.d.). https://www.energy.gov/eere/solar/articles/solar-resilience-keeping-communities-connected

Wiseman, H. (2020, November 30). Balancing renewable energy goals with community interests. Kleinman Center for Energy Policy. https://kleinmanenergy.upenn.edu/research/publications/balancing-renewable-energy-goals-with-community-interests/

VA- REA About Us. Virginia Renewable Energy Alliance - What is VA-REA? (n.d.). https://www.va-rea.org/page-18163