The Solar Frontier:

Methodologies of Clean Energy Finance in Marginalized Communities

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Introduction

In an ever changing world plagued by pollution, environmental degradation, and biodiversity loss, it is imperative for energy professionals and academics alike to investigate solutions that address such disparities. In particular, the core of America's energy needs are produced and carried out by fossil fuel infrastructures- specifically coal fired power plants, compressor stations, natural gas drilling, and pipelines. These developments pose significant risks to the environment and to public health respectively concerning heightened emission levels of CO2 and other greenhouse gases such methane, ozone, nitrous oxide.

Increased emissions deriving from anthropogenic activities-burning fossil fuels for energy purposes and land use- contribute to the phenomena widely known as global warming. Furthermore, the public health concerns are monumental and negatively impact communities by subjecting low-income communities of color to heightened levels of respiratory disorders, cancer, stroke, and birth defects in the population.

Motivation

Low income communities of color, largely composed of Black, Hispanic, and Indigenous individuals, are particularly vulnerable and disproportionately impacted by these ramifications of the fossil fuel industry. Social determinants of energy use- systemic racism, historical discrimination, and socioeconomic statis- and its unfavorable contributions to such impacted populations must be mitigated. As such, a global energy transition must take place- one that emphasizes equitable and accessible clean energy technologies- in order to foster a future rooted in sustainability and environmental justice.

Moreover, funding solar energy pilot projects are a way of combating such disparities while offering a meaningful solution- specifically the development of Charles City County High, a public high school with a total minority enrollment of 71%, with 57% of students being economically disadvantaged. 61% of students are Black, 5% Indigenous, 1% Hispanic, 1% Hawaiian, and 3% two or more races***(1)***. Charles City County High is the only high school in the Charles City County Public Schools.

Initial Barriers

* Low income individuals and businesses have a difficult time accessing financing options which are needed to secure long term contracts solar PV panels.
* Possible physical barriers for solar installations. To combat this, vegetation and other obstructions need to be cleared.
* Lack of education surrounding solar energy initiatives in low income and minority communities.
* Efficiency blockers present due to solar infrastructure being weather and environment dependent- cloud coverage, shading, pollution, etc.
* Solar system requires maintenance from solar professionals.

Objective

What theoretical financial expenditure components are necessary for solar PV infrastructures to cover the electricity renewable energy needs of Charles City County High?

Why Solar Infrastructure?

The commercial use of solar PV energy is an attainable energy production solution that will benefit marginalized, low-income American communities. In communal gathering points of localities, solar systems are a means to lower energy bills, increase energy efficiency processes, and promote equitable economic and environmental infrastructure development. While this research solely covers the cost analysis and theoretical policy mandates of financing a public high school, the methodologies behind Charles City County High can be used for other commercial buildings that benefit the public sector, such as community centers, food banks and religious institutions.

In shifting away from fossil fuel use and having the financial backing of the local, state and federal government to carry out solar pilot programs, present and future sustainability initiatives will be emphasized and public health will improve as a result of less pollutant emissions from fossil fuel developments. Government subsidies and financial contributions in commercial applications(primarily to address equitable access to renewable energy developments) of solar PV system infrastructure construction and monthly utility costs is a solution to renewable energy disparities.

Theoretical Policy Mandate and Financing Process

Collaboration between federal, state, and local government to produce a solar PV financing mandate for certain marginalized populations.

- Provides accessible financing options for governmental, commercial, and NPO entities with lower cost energy to meet the demand of energy needs through renewable technologies. Additionally, mandate should include funding for green workforce development programs based in the community.

Permit solar PV pilot programs through a solar installation contractor

- Government funding covers material, labor and construction costs for solar PV system installation.

Realized Economics incentives

- Connecting to the electrical grid and using net meter solar incentive technologies can offset fluctuations of energy production throughout the year.
- Conversely, additional electricity produced by solar system that is transferred in the electrical grid can be credited and offered as a rebate to fund green workforce development programs and future solar expansion initiatves.

Calculating Solar PV System Variables

$$E_{(W)} \times T_{(hrs)} \times P_{(\%)} \times X_{(\#)} = D_{(Wh)}$$

$$(D_{(Wh)} / 1000) = M_{(kWh)}$$

D = Daily watt-hours for total PV solar system
E = Solar panel watts ***(2)***
L = Total coverage of Charles City County High daily energy consumption needs
M = Daily kilowatt-hours for total PV solar system
T = Average hours of sunlight in region(solar irradiance in kWh/m^2/Day)***(4)***
P = Estimated solar panel efficiency(DC Power Data Efficiency) ***(3)***
X=Number of solar panel units
J = Number of solar power units needed to cover the full amount of Charles City County High daily energy consumption.
Z = Amount of Charles City County High daily electricity energy consumption

370 * 4.375 * .227 * 950= **~349,083 Wh**
(367.46/1000)=**~ 349.08 kWh**

To calculate daily percentage coverage of total electricity energy consumption, use the following equation;

$$M_{(kWh)} Z_{(kWh)} \times 100 = L_{(\%)}$$

348.65 kWh/1,141.8 kWh *100= **~30.54%**

To calculate the estimated full coverage of electricity energy needs, divide 100% by the total coverage of Charles City County High daily energy consumption needs(L) and then multiply the result with X, the number of solar panel units. The resulting integer will provide the number of 370W solar panel units that will need to be installed in order to cover the full amount of Charles City County High daily energy consumption.

$$(100_{(\%)} / L_{(\%)}) \times X_{(\#)} = J_{(\#)}$$

(~3.27) * 950= **~3,107**

Cost Analysis for Fossil Fuel Based Energy Sources

Using national averages of school electricity spending and facility size***(5),*** Charles City High School, a public school student body representing 305 students, spends **~$2,842 on monthly energy supply needs**

FSPS-facility size per student(ft2/student) * SB(student body) * .67($/ft2)/12= cost of monthly electricity energy supply

~167 ft^2 * ~305 * (~.67/12)=
~50,935 ft^2 * (~.0558)= ~$2,842 per month

According to the annual kWh parameters***(6),*** Charles City High School uses **~42,444 kWh of electricity per month**, ~1,141.8 kWh of electricity daily

TFS-total facility size(ft^2) * (~10kWh/12):

~50,935 ft^2 * (~.8333kWh)= 42,444 kWh per month for entire high school facility

To calculate the commercial cost of 1kWh, divide the cost of the monthly electricity energy supply by monthly kWh consumption;
~$.067 for 1 kWh

Conclusions and Limitations

Renewable energy developments, specifically solar PV infrastructure, are an attainable form of energy for Charles City County. The cost difference between monthly solar infrastructure payments and the former electricity bill derived from fossil fuel sources can be allocated for sustainable development use, specifically involving further solar development initiatives and other clean energy sources.

Due to not having access to the monthly electricity and energy use bill of Charles City County High, the calculated monthly electricity expenditure and energy use is calculated using national averages of sq. footage per student. The student body is not an exact reflection of Charles City County High, but an approximation from information gathered via demographic data that is publicly available. Additionally, the calculated space required for the solar system does not take into account space between rows of ballasted panels. Another limitation is that there is not any publicly available information on the prices of Sunpower's solar panels, specifically the 370W SunPower-X22-370-D-AC, so for future research, I will estimate the average solar PV market price per watt to calculate the total cost of the theoretical solar PV system for Charles City County High. Regarding the "Calculating Solar PV System Output and Variables" section, solar PV system solely refers to the estimated solar panels in the system, not accounting for other equipment, installation, tax, permits, inspections, and other costs associated with a full system.

References

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