Project Market Analysis of Compact HCPV units

Objective

To evaluate the application of HCPVs as indoor residential alternative power supply units.

Plan of Action

1. Design a 2-axis tracking HCPV unit to generate electricity for application in residential high-rises in densely populated cities.
2. Literature review to analyze various HCPV technology, minimal energy consuming 2-axis tracking and controls, and photodiode-based controllers for solar tracking during cloudy days.
3. Simulation to study feasibility of system considering other design parameters (such as shading, inverter selection, losses) and cost and CO_2 savings.
4. Understand CPV's potential market value, Simple Payback.

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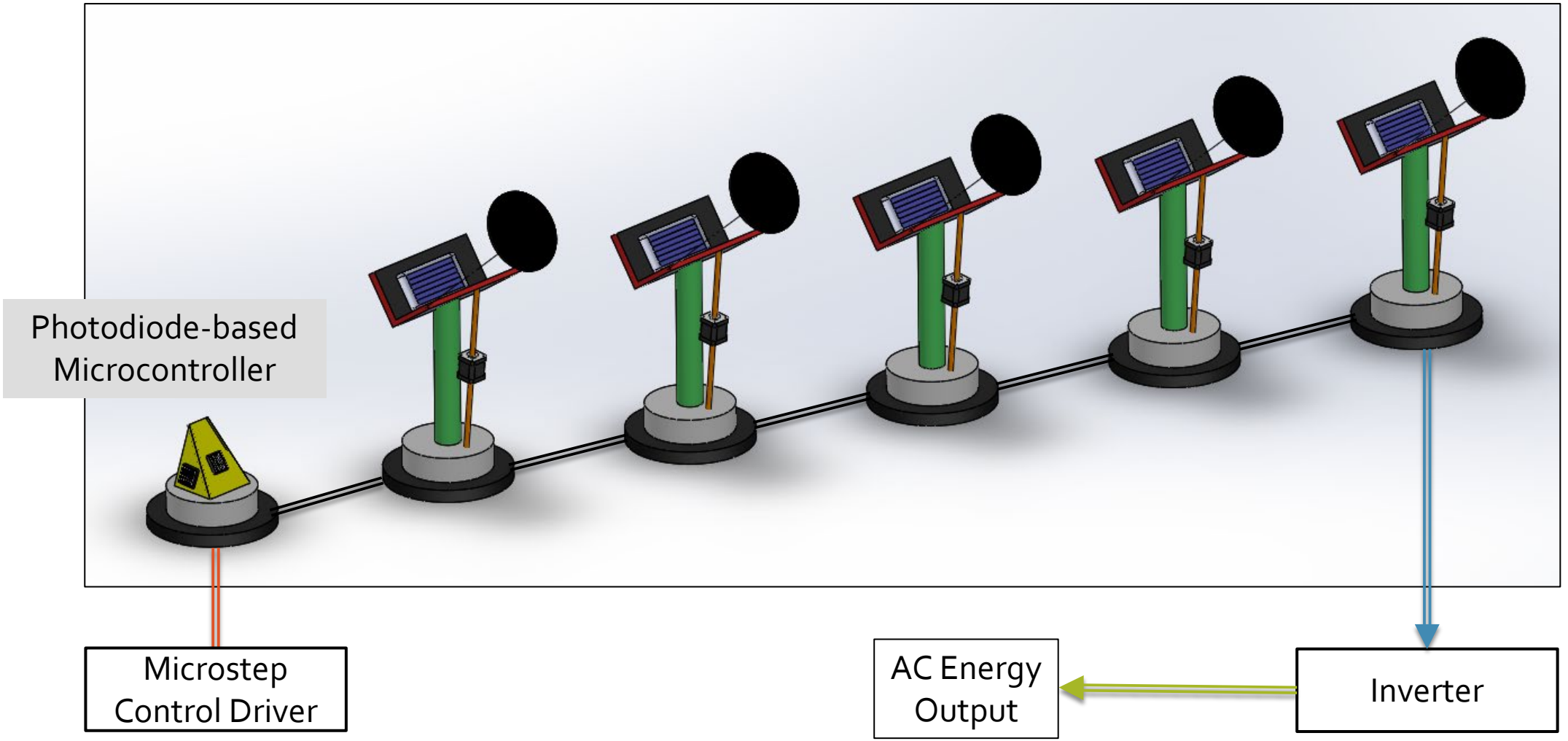
System Model



Simple Payback

SPP gives the time taken for recouping initial investment.

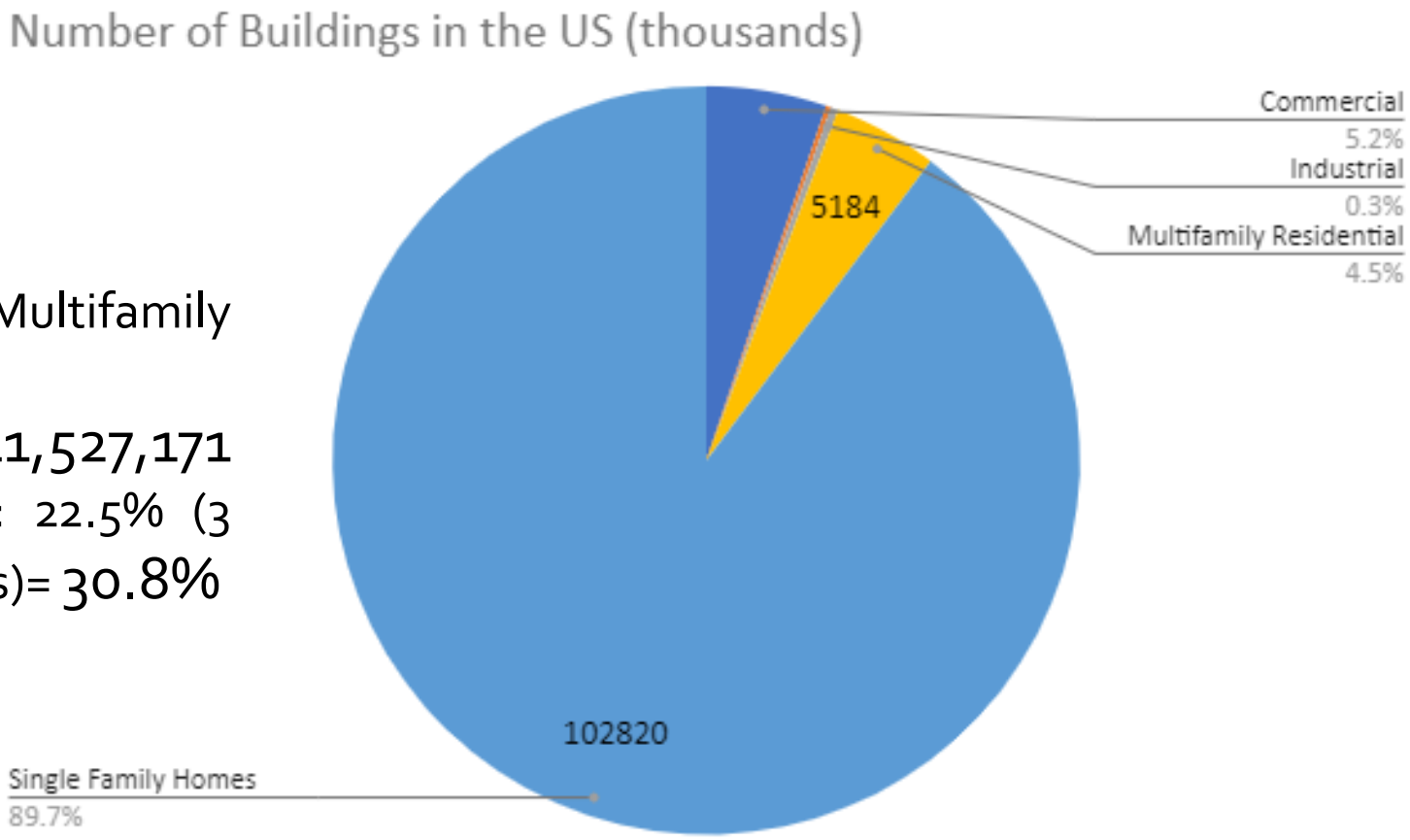
Simple Payback for 1 device	
Expenditure	**Cost**
Device sum of component costs (includes Fresnel lens, HCPV cell, inverter, 3D-printed support structure, robotic arms, controls)	$ 205
Mounts, assembly and wiring (assuming approx. 50 feet of total wiring)	$ 20
Labor cost (approx. 1 hour)	$ 14
Total Capital Cost for 1 device	**$ 239**
Total Energy Generated (in kWh)	117
APS fixed rate plan for >1000 kWhr	$ 0.13478
Monthly Energy Savings ($/yr)	**$ 7**
Simple Payback (in years)	**15.16**

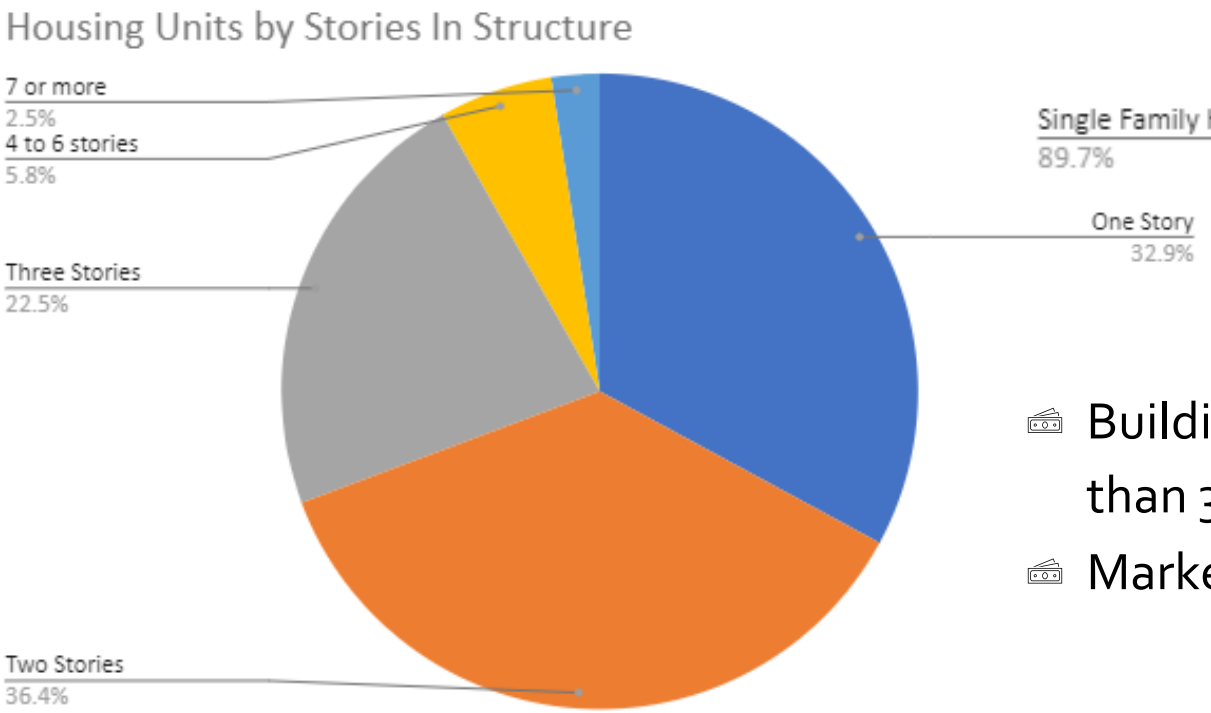
Simple Payback for 1 system	
Expenditure	**Cost**
Device sum of component costs (includes Fresnel lens, HCPV cell, inverter, 3D-printed support structure, robotic arms, controls)	$ 840
Mounts, assembly and wiring (assuming approx. 50 feet of total wiring)	$ 22
Labor cost (approx. 1 hour)	$ 14
Total Capital Cost for 1 device	**$ 876**
Total Energy Generated (in kWh)	585
APS fixed rate plan for >1000 kWhr	$ 0.13478
Monthly Energy Savings ($/yr)	**$ 78.85**
Simple Payback (in years)	**11.12**

Simple Payback for 1 system (Made in China)	
Expenditure	**Cost**
Device sum of component costs (includes Fresnel lens, HCPV cell, inverter, 3D-printed support structure, robotic arms, controls)	$ 420
Mounts, assembly and wiring (assuming approx. 50 feet of total wiring)	$ 22
Labor cost (approx. 1 hour)	$ 14
Total Capital Cost for 1 device	**$ 456**
Total Energy Generated (in kWh)	585
APS fixed rate plan for >1000 kWhr	$ 0.13478
Monthly Energy Savings ($/yr)	**$ 78.85**
Simple Payback (in years)	**5.79**

Market Size

- Total Buildings in the USA- 108,004,000 (89.7% Single Family Homes + 4.5% Multifamily Homes)
- Total High Density housing units: 11,527,171 Buildings with 3 or more than 3 stories: 22.5% (3 Stories)+ 5.8% (4-6 Stories)+ 2.5% (7+Stories)= 30.8%





- Buildings in High Density areas with 3 or more than 3 stories: 3,550,369
- Market Size at $205/pc would be $727,193,345!!

References

1. Gagnon, P., Margolis, R., Melius, J., Phillips, C., and Elmore, R. (2016) Rooftop Solar Photovoltaic Technical Potential in the United States. A Detailed Assessment. United States
2. Jones, J. (2022). U.S. Cities With the Most High-Density Housing, Construction Coverage - https://constructioncoverage.com/research/cities-with-the-most-high-density-housing-2022
3. Chakraborty, A., Knaap, G.-J., Nguyen, D., & Jung Ho Shin. (2010). The Effects of High-density Zoning on Multifamily Housing Construction in the Suburbs of Six US Metropolitan Areas. Urban Studies, 47(2), 437-451. https://doi.org/10.1177/0042098009348325

Appendix 1 - LCOE

Levelized Cost of Interest is the payback in terms of $/kWhr for a set analysis period.

Capital and Operating Costs

System capacity	0.322 kW	
	(●) Enter costs in $	( ) Enter costs in $/kW
Capital cost	205.00	140.00
Fixed operating cost (annual)	5.00	15.00
Variable operating cost	0.0110 $/kWh	

Reference Values

Capital recovery factor (CRF)	0.125
Project financing factor (PFF)	1.065
Construction financing factor (CFF)	1.012

LCOE = (FCR · CC + FOC) / Annual Energy + VOC

Financial Assumptions

( ) Enter fixed charge rate — (●) Calculate fixed charge rate

Fixed charge rate (real)	0.098
Analysis period	10 years
Inflation rate	2.5 %/year
Internal rate of return (nominal)	13 %/year
Project term debt	60 % of capital cost
Nominal debt interest rate	4 %/year
Effective tax rate	28 %/year
Depreciation schedule (Value / Sched)	Edit... % of capital cost
Annual cost during construction (Value / Sched)	100 % of capital cost
Nominal construction interest rate	3.5 %/year

Fixed charge rate (FCR) 0.13506247131

FCR = CRF · PFF · CFF (see below)

Capital cost (CC)	205.00	$
Fixed operating cost (FOC)	5.00	$
Variable operating cost (VOC)	0.01	$/kWh
WACC (for reference only)	0.043	

Metric	Value
Annual AC energy (year 1)	-117 kWh
DC capacity factor (year 1)	-4.1%
LCOE Levelized cost of energy	-26.90 ¢/kWh