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NICHE MARKETS FOR GRID-CONNECTED PHOTOVOLTAICS

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ABSTRACT

This paper identifies target market niches for Customer-Sited Photovoltaics (CSPV) in the United States.[1] The intent is to demonstrate markets that are cost-effective *today* and identify those showing the most near-term promise. Exploitation of niche markets is one strategy that could help speed the commercialization of grid-connected photovoltaics.

BACKGROUND

The niche market strategy directly engages utility customers, the end-user, to take advantage of incentives and attributes that are unique to CSPV systems, including:

- compensation for power at retail electric rates
- tax credits
- financing, leasing, and depreciation options
- net metering options and/or rate-based incentives
- building credits for architectural applications
- willingness to pay for clean power and innovation

Other important attributes include:

- quality of solar resource and customer load match
- progressive state government, regulatory, and utility support

The locations that have the best combinations of these incentives and attributes will be the best niche market candidates.

APPROACH

A two-step Geographic Information Systems (GIS) type of approach is used to identify target CSPV markets in the United States. The first step is to identify attributes such as PV electricity production, utility electric rates, solar tax incentives, and PV electricity production on a state-by-state basis. See Table 1 [1-6].

[1] CSPV is broadly defined to include all grid-connected PV applications that reside on residential and commercial customer sites. Sample applications include architectural PV as a dual-use building material, building rooftop additions, and parking lot structures.

The second step is to conduct financial cash-flow analyses for each state based on the data in Table 1 for a base case CSPV application. The cash-flow analysis determines the break-even PV system price, the price at which the net present value goes to zero [7].

To illustrate the approach, the base case is defined as a new residential development that incorporates 1-kW rooftop PV systems. The cost of the PV system is included in the homeowner's mortgage -- a 30-year 90%-debt loan with a fixed interest rate of 8%. The homeowner's federal tax bracket is 36% and general and electric rate inflation are both 3.5%/year.

RESULTS

Figs. 1 and 2 present the results. The states are ranked by break-even PV system price. Three market tiers are identified, with the best markets in the southwest and northeast. The top 5 CSPV niche markets are Hawaii, California, Arizona, New York, and Massachusetts with break-even PV prices between $4.30/W and $7.50/W. A 4% low interest loan would boost this range by 40% to $6.20/W-$10.30/W. In either case, *PV is cost-effective at today's prices* of about $6/W-7/W.

Utility rates and PV capacity factor are a good first-order screen for targeting markets. An added incentive, such as a tax credit, can catapult a market contender. Compare for example North and South Carolina. Each state has almost identical utility rates and PV capacity factor, but North Carolina's solar tax credit moves its market ranking to 6 while South Carolina ranks 26, in the middle of the pack.

HAWAII: THE LEADING CONTENDER

Fig. 3 presents the cashflow for a homeowner who finances a $7.50/W PV system on the big island of Hawaii, where residential rates are about 17¢/kWh. The year-by-year positive and negative cash flows are shown, together with the net cumulative cash flow. The net cash flow is immediately positive, so the customer has no out of pocket costs from the very first year forward. This presents a compelling case for marketing PV systems in Hawaii. Table 2 presents other electricity rates and break-even PV prices for selected islands. Particularly impressive are Kauai results.

Table 1. State-by-State Attributes and Incentives for Grid-Connected Photovoltaics [1-6]

	Market Ranking	Res. Rate (H/M/L)	Capacity Factor (H/M/L)	Res. Tax Incentive	Com. Tax Incentive	Net Metering	Res. Rate (¢/kWh)	Com. Rate (¢/kWh)	Capacity Factor (%)	Com. ELCC (%)
Alabama	31	M	M				8.2	6.9	18.1	61
Alaska	45	H	L				10.1	8.5	11.4	n/a
Arizona	3	M	H	1			9.6	8.6	22.8	65
Arkansas	13	H	M				11.0	7.1	18.1	76
California	2	H	H				13.1	10.3	20.9	64
Colorado	22	L	H				7.6	5.8	21.9	51
Connecticut	7	H	M				12.5	9.9	17.1	46
Delaware	20	H	M				10.1	7.0	17.1	57
Florida	28	M	M				8.5	6.6	18.1	48
Georgia	35	L	M				7.9	7.5	17.8	68
Hawaii	1	H	H	2a	2b	Pending	15.2	12.0	22.5	50
Idaho	37	L	H	3			5.3	4.3	20.0	32
Illinois	17	H	M				10.3	8.1	17.5	68
Indiana	36	M	L				8.5	6.0	16.2	57
Iowa	42	L	M				6.9	6.4	17.6	69
Kansas	21	M	H				8.5	6.7	20.0	78
Kentucky	49	L	L				6.1	5.3	16.2	41
Louisiana	38	L	M				7.2	7.2	18.5	71
Maine	16	H	L				12.2	9.3	15.2	24
Maryland	23	M	M				9.6	7.1	17.1	54
Mass	5	H	M	4a	4b		12.6	9.3	17.3	49
Michigan	41	M	L				8.5	8.3	14.7	67
Minnesota	44	L	L				7.4	6.1	16.2	56
Mississippi	25	M	M				9.0	7.3	18.2	50
Missouri	30	M	M				8.4	6.4	18.1	71
Montana	46	L	M				6.3	5.2	18.1	54
Nebraska	40	L	M				6.8	5.6	19.0	77
Nevada	19	M	H				8.0	6.3	22.3	71
New Hampshire	10	H	L				13.6	10.4	15.2	30
New Jersey	9	H	M				12.2	9.3	17.1	75
New Mexico	8	M	H				9.2	8.3	23.0	45
New York	4	H	M			Pending	14.5	11.2	17.1	60
North Carolina	6	M	M	5a	5b		8.6	6.6	17.6	52
North Dakota	32	L	M	6a	6b		7.5	6.5	17.6	49
Ohio	33	M	L				9.8	7.6	14.7	53
Oklahoma	12	L	H	7a	7b		7.8	6.1	20.0	74
Oregon	34	L	M	8a	8b		5.5	4.9	17.1	16
Pennsylvania	18	H	L				12.0	8.5	15.0	44
Rhode Island	11	H	M				12.0	10.1	17.1	59
South Carolina	26	M	M				8.8	6.2	17.8	43
South Dakota	29	M	M				8.5	6.8	18.1	43
Tennessee	48	L	M				6.1	6.5	17.1	30
Texas	14	M	H		9		9.1	6.7	20.9	68
Utah	27	L	H				7.0	6.0	22.3	27
Vermont	15	H	L				12.5	9.2	15.0	32
Virginia	24	M	M				9.6	6.2	17.1	47
Washington	50	L	L				5.5	4.3	14.3	8
West Virginia	39	M	L				8.1	5.6	16.2	45
Wisconsin	47	L	L				7.5	5.9	15.2	59
Wyoming	43	L	H				6.0	5.2	20.0	22

Market Ranking by break-even PV price; Res Rate High (>10¢/kWh), Medium (8-10¢/kWh), or Low (<8¢/kWh); Capacity Factor High (>20%), Medium (17%-20%), or Low (<17%). State Tax Incentives as Follows:: **(1)** 25% TC, $1,000 Max **(2a)** 35% TC, $1,750 Max **(2b)** 35% TC, no Max **(3)** 100% TD over 4 yrs, $5,000/yr Max [40% yr 1, 20% yrs 2, 3, & 4] **(4a)** 15% TC, $1,000 Max **(4b)** 100% TD, no Max **(5a)** 40% TC, $1,500 Max, can carry over 5 yrs **(5b)** 35% TC, $25,000 Max, can carry over 5 yrs **(6a & b)** 5% TC per yr for 3 yrs **(7a)** 30% TC, $25,000 Max, can carry over 5 yrs, expired '95 - extension pending for 7a&b **(7b)** 20% TC, $150,000 Max, can carry over 5 yrs **(8a)** 1996 and 1997: 48¢/kWh TC, $1,200 Max; 1998-2001: 40¢/kWh, $1,000 Max **(8b)** 35% TC over 5 yrs (10% yrs 1 & 2, 5% yrs 3, 4, & 5) **(9)** 100% TD on "taxable capital" or 10% TD from "taxable earned surplus". TC=Tax Credit; TD=Tax Deduction; Max=Maximum tax incentive allowed.

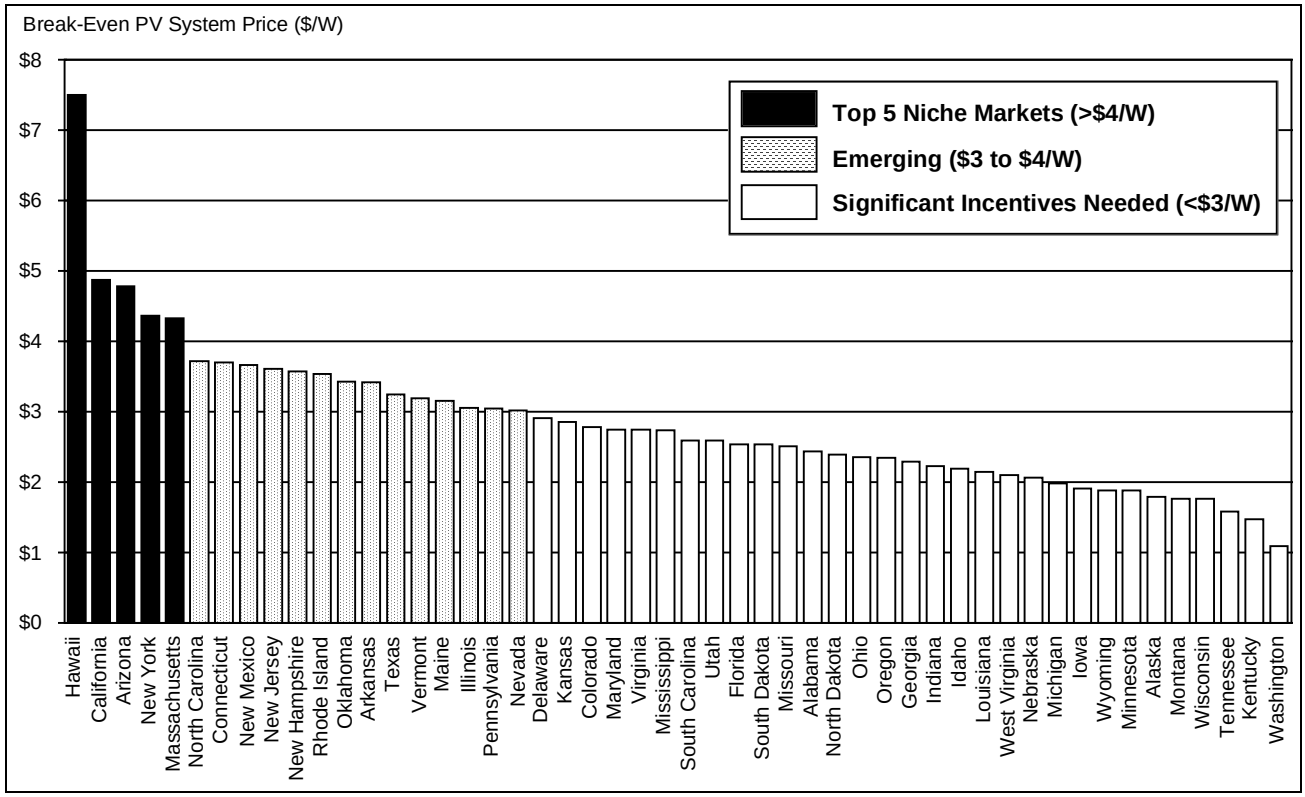

Fig. 1. States ranked by break-even PV system price.

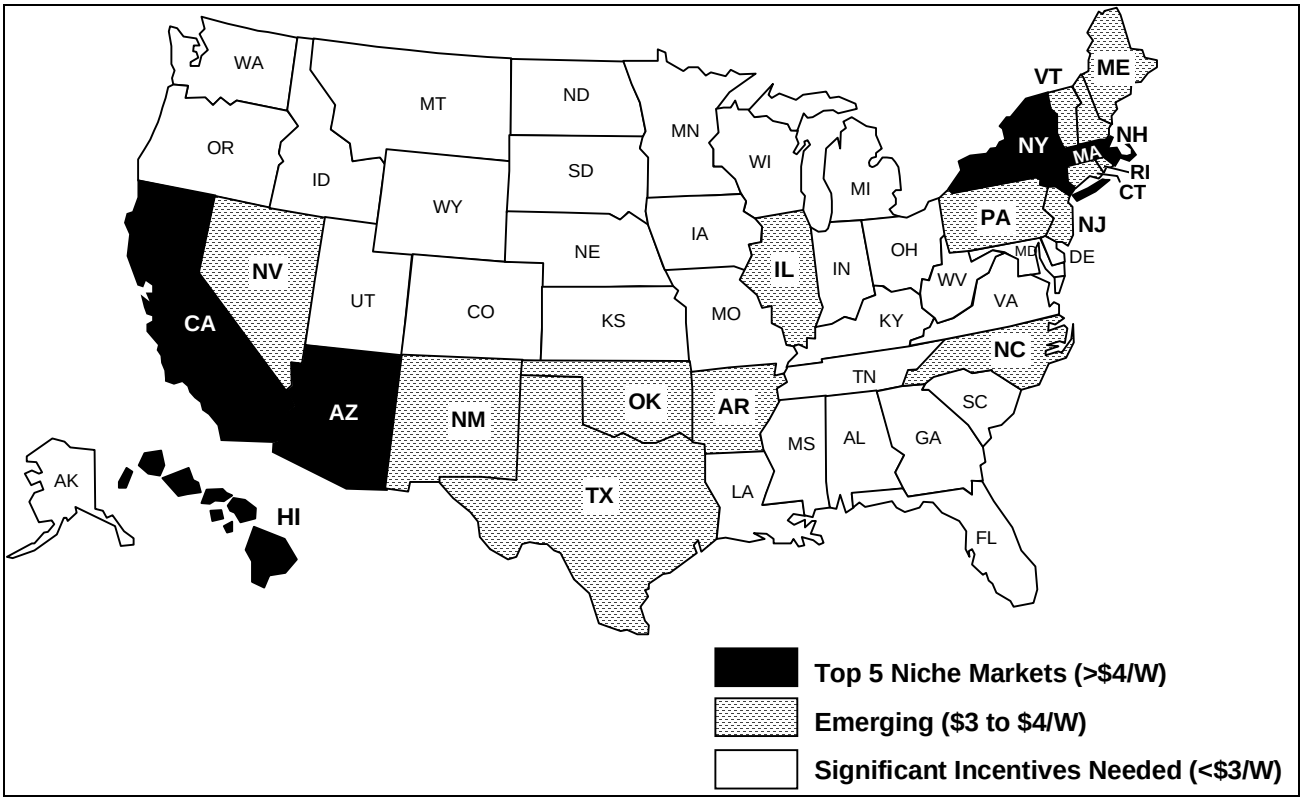

Fig. 2. Three market tiers identified: The best markets are in the southwest and northeast.

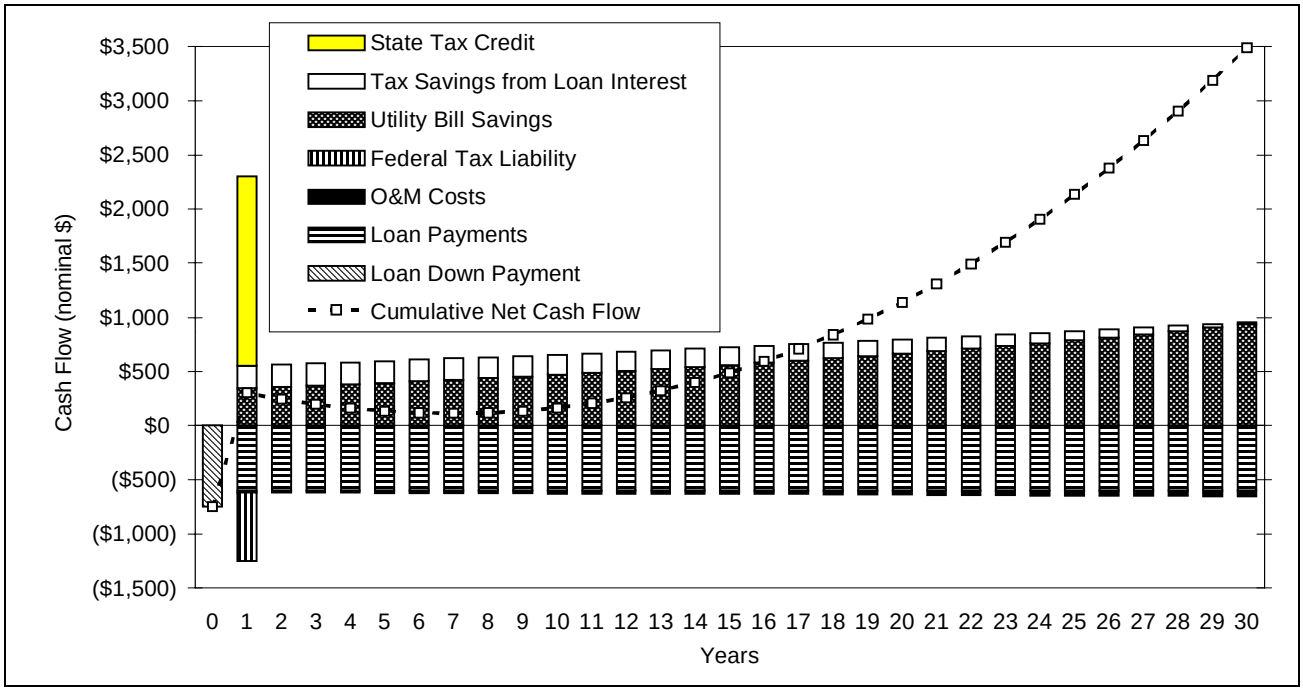

Fig. 3. 30-year cash flow for $7.50/W residential PV system in Hawaii: Cost-effective & cash flow always positive.

Table 2. PV Economics for Residents in Hawaii

Island	Electricity Rate (¢/kWh)	Break-Even PV Price ($/W)
Kauai	20.0	$9.70
Hawaii - Big Island	17.0	$8.40
Maui	13.8	$7.00
Oahu	12.3	$6.40

CONCLUSIONS

- A Geographic Information Systems (GIS) approach is useful for finding grid-connected PV markets.
- There are cost-effective grid-connected PV applications *today*, notably in Hawaii.
- Policy instruments, such as buy-downs of loan interest and capital cost (e.g., U.S. DOE-funded TEAM-UP program) are effective mechanisms for reaching cost-effectiveness in the top U.S. markets.
- The results presented in this paper are good approximations for commercial customers. The added commercial benefits of a 10% federal tax credit and depreciation are somewhat offset by typically shorter loan terms that are less leveraged by debt and more stringent rate of return and payback requirements. Electric rates and Effective Load Carrying Capability (ELCC) for commercial customers are provided in Table 1 for reference [6].

FUTURE WORK

Higher resolution analysis of the top niche markets is recommended for a number of applications. This will better define CPSV economics and the viability of the niche market commercialization approach. Also recommended are sensitivity analyses of the impacts of loan interest rate, buy-down, and other policy actions.

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