Accepted Manuscript

Pathways to carbon neutral energy systems at the University of California, Davis

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PII: S0960-1481(18)30752-3

DOI: 10.1016/j.renene.2018.06.100

Reference: RENE 10256

To appear in: Renewable Energy

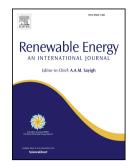
Received Date: 3 November 2017

Revised Date: 23 June 2018

Accepted Date: 25 June 2018

Please cite this article as: Wiryadinata S, Morejohn J, Kornbluth K, Pathways to carbon neutral energy systems at the University of California, Davis, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.06.100.

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ACCEPTED MANUSCRIPT

1	Pathways to Carbon Neutral Energy Systems at the University of California, Davis
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8	Abstract
9	To achieve carbon neutrality by 2025 the University of California, Davis (UCD) seeks to eliminate its dependence
10 11	on fossil energy sources. This study outlines a methodology to identify optimal equipment phase-in and capacities, and the major technical and economic drivers influencing the implementation of a carbon-neutral energy system.
12	The analysis, focused on UCD, considers solar photovoltaic and thermal, biomass combined heat and power,
13	biomass boiler, heat pump and electric boiler as replacement systems. Three cases besides the baseline are
14	presented: 1) biomass-based system, 2) combination of biomass and electrification, and 3) electrification. Analysis
15	period spans 2016-2035, with equipment phasing limited to the 2020-2025 period, and capacity limited to the peak
16	campus loads of 40 MW _e for electricity and 80 MW _t for thermal. Results indicate that balancing the supply-demand
17	mismatch is the greatest challenge for high renewable penetration at UCD, thus making thermal storage and
18	generation systems which can modulate with variable loads crucial. The cost of carbon credits offset has negligible influence in the results due to its low value in the present market. Relative to the baseline 20-yr present cost of
19 20	\$634M, the 3 alternate cases are projected to incur between \$629M (Case 1) and \$704M (Case 3).
21	Keywords: techno-economic analysis, renewable penetration, energy system, university low carbon transition,
21	system phasing
23	-Jarren Lemmañ
24	Nomenclature
25 26	Alt = alternate BM = biomass
20 27	BTE = biomass-to-energy
28	B/C = benefit/cost ratio
29 30	CHP = combined heat and power CNI = carbon neutrality initiative (UC system initiative)
30 31	COP = coefficient of performance
32	CF = capacity factor
33	CPI = consumer price index eBoiler = electric boiler
34 35	eBoller = electric boller eChiller = electric chiller
36	GHG = greenhouse gas
37	GT = gas turbine
38 39	HRSG = heat recovery steam generator HVAC = heating, ventilation and air conditioning
40	HW = hot water
41	IGCC = integrated gasification combined cycle
42 43	IRR = incremental rate of return LCOS = levelized cost of service
44	LHV = lower heating value, kJ/kg
45 46	NG = natural gas
46 47	NPC = net present cost, \$ NOCT = nominal operating cell temperature
48	O&M = operations and maintenance
49 50	PC = point of maximum curvature, related to demand duration curve
50 51	PPA = power purchase agreement PV = photovoltaic
52	SRCC = Solar Rating & Certification Corporation
53 54	ROR = rate of return
54 55	ST = solar thermal STM = steam turbine
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