Economics of Electricity Grids and Electric Vehicles

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	Scenario			
Item/Asset	BASE	RNEW	CAP	GEN
Year	2015	2014	2014	2015
Total cost ($2015 bil)	5.5	17,618.0	5.6	6.7
Emissions (Mt CO_2)	48.61	–	26.13	21.21
Battery size (MW)	–	10,918	549	350
Battery size (GWh)	–	10.92	0.55	0.35
# of wind turbines	413	14,888,315	1,470	2,700
# of solar panels	–	30,883,274	100,000	100,000
		Generating capacity (MW)		
coal	6,299	–	–	–
GT	916	–	3,450	4,878
CC	6,680	–	6,913	5,691
wind	1,446	52,109,103	5,145	9,450
solar	-	154,417	500	500
Total	15,341	52,263,520	16,009	20,520
		Generation (TWh)		
coal	38.3	–	–	–
GT	4.1	–	15.7	18.4
CC	33.2	–	47.1	30.2
wind	4.9	175,930.1	17.5	31.9
solar	-	229.5	0.7	0.7
Total	80.4	176,159.5	81.0	81.2

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Source: van Kooten, G.C., P. Withey and J. Duan, 2020. How big a Battery? *Renewable Energy* 146: 196-204.

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Hourly and Annual Estimated Increase in Energy from Electric Vehicles and Potential Increase in Generating Capacities Required, Selected Jurisdictions

Item	Canada	BC	Alberta	Ontario	Quebec
	Annual increase (GWh)				
Mean	88,787.7	12,543.2	10,245.4	33,558.0	19,071.9
Standard deviation	16,177.4	2,313.8	1,882.1	6,258.5	3,488.4
	Hourly increase (MW)				
Mean	10,135.6	1,431.9	1,169.6	3,830.8	2,177.2
Proportional increase	15.4%	15.8%	15.3%	24.8%	9.1%
	Potential hydro facilities needed				
Based on mean increase	17	3	2	7	4
95% guarantee	24	4	3	9	5
	Potential number of 750-MW capacity gas plants needed[3]				
Based on mean increase	15	3	2	6	4
95% guarantee	21	3	3	8	5
	Wind power capacity and required turbines (3.5 MW cap)				
Capacity (MW)	40,542	5,727	4,678	15,323	8,709
Number of turbines	11,584	1,636	1,337	4,378	2,488
95% guarantee	15,805	2,240	1,828	6,011	3,398

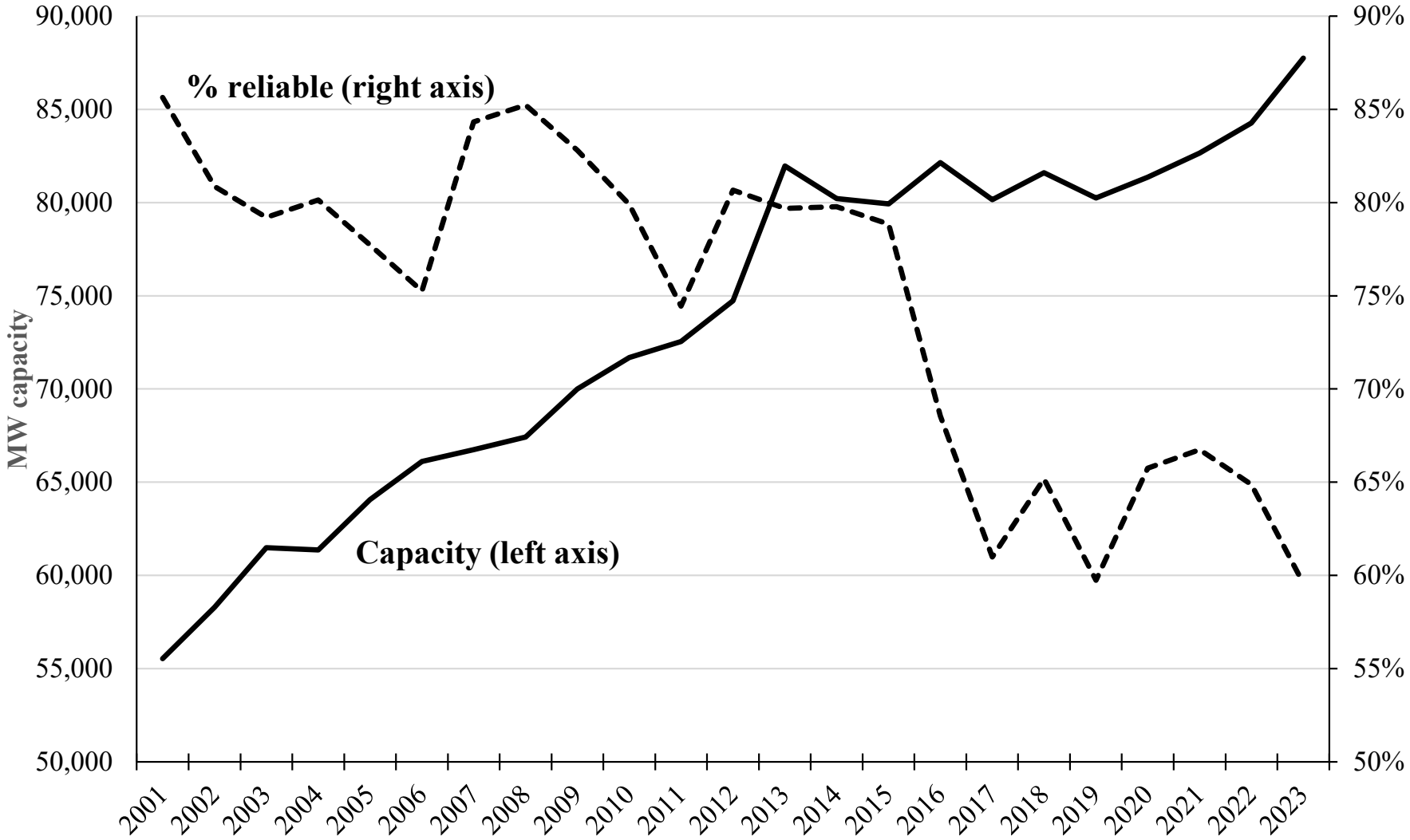
95% guarantee represents a worst-case scenario where actual requirements are 2 SD higher than the mean.

Source: van Kooten, G.C. and Tracy E. Stobbe, 2024. The Economics of Electric Vehicles with Application to Electricity Grids, *Energies* 17(16): 4109.

Projection of Load Increase due to Data Centers and Artificial Intelligence, California, Various Growth Scenarios 2030

		Projected Growth for 2030: Scenarios			
Item	Current 2023	Low (3.7%)	Moderate (5%)	High (10%)	Highest (15%)
Data & AI (MWh)	9,331,619	12,042,078	13,130,525	18,184,686	24,777,000
% Data & AI	3.70%	4.43%	4.81%	6.54%	8.70%
Increase (MWh)		2,710,459	3,798,906	8,853,067	15,445,381

Source: EPRI (2024, Table 2, p.13, Table A1, p.28)



Generating Capacity and Reliability Indicator, California Electricity Grid, 2001-2022

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Electricity generation under expected future load;[a] double in-state wind and solar capacity;[b] no in-state nuclear or fossil-fuel generation; including imports from Wyoming and Alberta, TWh (except CO_2)

Year	Load[c]	Solar	Wind	US imports	AB Imports	Curtail-ments	Mt CO_2
2018	198.67	27.78	33.09	74.33	115.27	5.3	9.46
2019	193.16	28.62	31.69	64.63	111.97	7.7	9.36
2020	208.83	29.94	32.26	69.53	123.49	6.8	8.21
2021	205.19	34.06	37.93	63.96	112.06	12.9	7.86
2022	213.57	37.08	36.94	57.01	118.15	15.7	7.80
2023	210.69	39.81	41.69	36.84	111.21	21.8	8.24

[a] Future load is 1.57 times current total California electricity demand.

[b] Installed wind and solar capacity is doubled, but wind and solar energy profiles remain unchanged except across years.

[c] Load refers to the load to be met after in-state solar and wind generation, along with imports, are subtracted from total load.