

**DRAFT -- Switching from Old APS Fossil & Nuclear-Centric Sourcing to New Community Choice Energy (CCE) Renewables-Oriented Electrical Mix, Savings in Bills, Carbon Emissions, and Water**

By Russell Lowes, 6/4/2022

For a Typical Household Running 750 Kilowatt-Hours of Electricity (kWh) Per Month in Arizona, after about Five Years of Starting a CCE

**Current APS Household vs. Community Choice Energy (CCE) Household, With Two Different Scenarios of Energy Mix Including Primarily Gas, Nuclear and Coal for the Utility, and Primarily Solar and Wind with Storage for the CCE**

**Table 1: APS Generating+Non-Generating Costs:**

Electricity Source/ Efficiency or Storage Option:	APS Electri- city Mix (a)(b)	APS House- hold kWh/ Month	APS Cost for Typical House- hold	APS CO2 Grams/ Energy Option	APS CO2 Lbs/ Energy Option	APS Gal- lons/ Energy Option	APS Genera- tion Cost
Coal <sup>(l)</sup>	20.0%	150	\$ 21.60	150,000	331	84	\$ 12.60
Gas <sup>(c)(L)</sup>	36.3%	272	\$ 39.15	203,906	450	58	\$ 22.84
Utility Renewable Energy (RE) <sup>(d)(o)(i)</sup>	8.8%	66	\$ 6.56	1,313	2.9	1	\$ 2.63
RE Purchased <sup>(p)</sup>	3.8%	28	\$ 2.81	563	1.2	1	\$ 1.13
Wind, On-Shore <sup>(m)</sup>	0.0%	0	\$ -	0	0.0	0	\$ -
Nuclear <sup>(e)(k)(q)</sup>	31.3%	234	\$ 59.77	15,234	33.6	195	\$ 45.70
Energy Efficiency	0.0%	0	\$ -	0	0.0	0	\$ -
Hydroelectric	0.0%	0	\$ -	0	0.0	0	\$ -
Battery/Storage	0.0%	0	\$ -	0	0.0	0	\$ -
Firming/Backup Energy <sup>(f)</sup>	0.0%	0	\$ -	0	0.0	0	\$ -
<b>Totals/Month</b>	<b>100.0%</b>	<b>750</b>	<b>\$ 129.89</b>	<b>371,016</b>	<b>817.9</b>	<b>338</b>	<b>\$ 84.89</b>
Total Cost,CO2,Gals./kWh:			\$0.173	494.7	1.1	0.45	\$0.113
APS Non-Gen./Delivery Cost:			\$0.060				

**Table 2:**

New Deliv- ered Cost/ kWh	CO2 grams/ kWh	Lbs CO2/ kWh	Water Use: Gal- lons/ kWh
0.144	1000	2.205	0.56
0.144	750	1.653	0.22
0.10	20	0.044	0.02
0.10	20	0.044	0.02
0.10	10	0.022	0.00
0.255	65	0.143	0.83
0.045	5	0.011	0.00
0.105			
0.106	831	1.831	0.45
<b>\$0.106</b>	<b>100% of above<sup>(n)</sup></b>		

**Table 3: CCE Generating Costs:**

CCE Genera- tion Cost	CCE Prefer- ed e-Mix % <sup>(s)</sup>	CCE House- hold kWh/ Month	CCE New Cost for Typical House- hold	CCE CO2 Grams/ Energy Option	CCE CO2 Lbs/ Energy Option	CCE Gal- lons/ Energy Option
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ 21.60	72.0%	540	\$ 54.00	10,800	23.8	10.8
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ 2.40	8.0%	60	\$ 6.00	600	1.3	-
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ -	0.0%	0	\$ -	0	0.0	0.0
\$ 15.96	20.0%	150	\$ 15.96	124,595	274.7	67.5
\$ 39.96	100.0%	750	\$ 75.96	135,995	299.8	78.3
\$0.0533		\$0.101		181	0.40	0.10
↓↓ See below for Non-Gen. Cost						
		\$0.04		\$30.00		
		Monthly CCE Fee < Utility ("MCE" APS rate plan):		\$22.33	Total CCE+Grid: \$ 92.29 . . . i.e. CCE Gen.+Non-Gen.	
		APS Delivery Costs/kWh & \$/Mo:		\$52.33	Delivered \$/kWh: \$0.123	

or this many pounds produced/month:

Summary: Monthly savings in cost, CO2 emissions in pounds of CO2, and gallons of water usage, for CCE +/():	Bill Savings/Mo	CO2 Svgs Pounds /Mo	Water Savings, Gal/Mo	CCE RE kWh/Mo & Multiple of APS RE
\$ 37.60	518	260	608	
Savings as a percentage for CCE +/():	28.9%	63.3%	76.9%	6.5

APS water use is much higher than the CCE alternative, due to cooling at its nuclear and fossil fuel plants.

By contrast, solar uses a small amount, 0.02 gal/kWh for cleaning of the panels. Wind has negligible water usage.<sup>(m)</sup>

**TABLE 4: ---APS Electricity Import Recalculation---**<sup>(a)(b)</sup>

Electricity Option	Current % of APS Electricity Self- Generated*	To Convert Prior Col. To 100%	To Back Out Demand Side Mgmt to Just Yield Production Blend	Adding 5% Imported, Spread Evenly	Est'd. APS Mix Generated + Imported
Nuclear	25.0%	26.3%	29.7%	1.6%	31.3%
Coal	16.0%	16.8%	19.0%	1.0%	20.0%
Gas	29.0%	30.5%	34.4%	1.8%	36.3%
CCS Coal	0.0%	0.0%	0.0%	0.0%	0.0%
Utility Renewables including PV <sup>(r)</sup>	7.0%	7.4%	8.3%	0.4%	8.8%
Rooftop PV	3.0%	3.2%	3.6%	0.2%	3.8%
Wind	0.0%	0.0%	0.0%	0.0%	0.0%
Energy Efficiency	0.0%	0.0%	0.0%	0.0%	0.0%

Battery	0.0%	0.0%	0.0%	0.0%	0.0%	*Self generated includes rooftop and other distributed-generation solar, because the utility takes credit for it as a Renewable Energy Credit.
Demand Side Mgmt	15.0%	15.8%				
	95.0%	100.0%	95.0%	5.0%	100.0%	

NOTES

- a> See APS Annual Report 2021: <https://sec.report/Document/0000764622-22-000014/> Go to "Energy Sources and Resource Planning" pie chart.  
This has been adjusted in the table above, increasing the % for electricity (aka e), by assuming the same mix of purchased e as APS-generated e.  
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- b> Ibid., the solar figures for APS are not broken down in the annual report for centralized versus rooftop/distributed generation, they are only broken down into utility-owned versus purchased renewables -- this could include merchant renewable purchases, power purchase agreements and rooftop solar.
- c> The CO2 from gas is roughly estimated, to include the industry-reported on-site CO2 emission plus the future emissions all along the line from well field to the power plant.  
The standard 450 grams per kWh often cited by government and company officials has not been updated in many years, all while we know that fracking extractions and well fields have higher emissions.
- d> The CO2 emissions from the lifecycle of solar (from manufacturing, recycling, etc.) are given much higher estimates by older studies and lower by newer ones. The estimate based on a trend of lowered embedded energy in the lifecycle analyses.
- e> The two meta-studies done on the CO2 emissions from nuclear energy both estimate about 65 grams of CO2 per kilowatt-hour from nuclear energy as the average of the studies that passed their screens for transparency, etc. However, these studies do not count the true CO2 production from three areas that are more difficult to quantify. The highest of the three unquantified CO2 emissions source is from long term nuclear waste management from nine different waste steps.  
See: [http://www.nirs.org/climate/background/sovacoool\\_nuclear\\_ghg.pdf](http://www.nirs.org/climate/background/sovacoool_nuclear_ghg.pdf) AND [http://www.energiastostenible.org/mmf/ile/GCT2008%20Doc\\_ML-LCE%26Emissions.pdf](http://www.energiastostenible.org/mmf/ile/GCT2008%20Doc_ML-LCE%26Emissions.pdf)
- f> Utility coverage of gaps in renewable energy is priced at 95% the average retail rate.
- g>
- h> A typical franchise fee (aka exit fee) that the CCE has to pay the utility might run about 3-4¢/kWh.  
↳ <https://www.seia.org/initiatives/water-use-management>
- j> Water use for coal is at: U.S. Department of Interior, Bureau of Reclamation, "Proposed Modifications to the Four Corners Powerplant and Navajo Mine, Final Environmental Impact Statement," vol. 1, 1976, p. I.19; and Federal Power Commission, "Steam-Electric Plant Construction Cost and Annual Production Expenses," 1972-74.
- k> Water use and production at PVNGS is at: <https://www.neimagazine.com/features/featurean-oasis-filled-with-grey-water/> and <https://www.eia.gov/nuclear/state/archive/2010/>
- L> Average water usage for gas (although highly variable) is at: <https://www.ucsus.org/resources/water-natural-gas>
- m> Wind turbine water usage is virtually zero: <https://www.energy.gov/sites/prod/files/2015/01/f19/WINDExchange-Wind-Energy-Fact-Sheet.pdf>
- n> This is a difficult number to predict, under development, but a typical average sourcing cost for firming might be expressed as a % of the average retail price of electricity.  
This percentage accounts for much of the sourced energy being bought at typical wholesale rates of about 3¢/kWh, plus spot and short-term peak purchases at a much higher price.
- o> Examples of solar cost/kWh being approximately 4¢, and lower are at 2017 source at <https://www.utilitydive.com/news/updated-tucson-electric-signs-solar-storage-ppa-for-less-than-45kwh/443293/>  
2019 source at <https://www.greentechmedia.com/articles/read/arizona-water-provider-approves-lower-cost-solar-ppa-to-replace-coal#gs.yYOuz6w>
- p> Solar prices have fallen below 4¢/kWh for PPAs: Lawrence Berkeley National Lab [https://emp.lbl.gov/sites/default/files/utility\\_scale\\_solar\\_2021\\_edition\\_slides.pdf](https://emp.lbl.gov/sites/default/files/utility_scale_solar_2021_edition_slides.pdf) AND the parent site at <https://emp.lbl.gov/utility-scale-solar/>  
Further information at this LBL site, spreadsheet (18 MB Excel): [https://emp.lbl.gov/sites/default/files/2021\\_utility-scale\\_solar\\_data\\_update\\_0.xlsx](https://emp.lbl.gov/sites/default/files/2021_utility-scale_solar_data_update_0.xlsx)  
Solar prices have fallen below 2¢/kWh in some cases: <https://solarbuildermag.com/policy/ieefa-record-low-solar-ppas-are-another-nail-in-carbon-captures-coffin/>  
Solar prices for PPAs by region are at: [https://www.renewableenergyworld.com/solar/amazons-massive-renewable-energy-portfolio-just-got-a-lot-bigger/?utm\\_source=rew\\_weekly\\_newsletter&utm\\_medium=email&utm\\_campaign=2021-12-08](https://www.renewableenergyworld.com/solar/amazons-massive-renewable-energy-portfolio-just-got-a-lot-bigger/?utm_source=rew_weekly_newsletter&utm_medium=email&utm_campaign=2021-12-08)
- q> Nuclear generation costs have been estimated to run about 15¢/kWh in World Nuclear Industry Status Report, 2020 at [https://www.worldnuclearreport.org/IMG/pdf/wnisr2020-v2\\_lr.pdf](https://www.worldnuclearreport.org/IMG/pdf/wnisr2020-v2_lr.pdf) page 269.  
In the most recent annual report by Lazard, this company projects a cost of 13.1-20.4¢/kWh for generation cost. Adding 7¢ for delivery cost, 1¢ more than the average to account for new and upgraded transmission capacity needed, this cost range delivered would be 20.1 to 27.4¢ per kWh. Here I project 25¢/kWh, which is probably on the low side, considering the recent overruns at the only nuclear plant under construction in the U.S., 2 reactors at the Vogtle plant in Georgia. See: <https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen/>  
In my projections for nuclear energy costs, I find 28.5¢ to be the most likely cost for this plant, when completed, in probably about 2023. Here I give a more conservative estimate of 25¢/kWh delivered.
- r> Self generated includes rooftop and other distributed-generation solar, because the utility takes credit for it as a Renewable Energy Credit.
- s> 90% solar X (1 minus fraction of firming factor); and 10% wind X (1 minus fraction of firming factor)