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Date:	09/13/2023
Instructor:	Professor Samuel Chukwuemeka
Project Name:	Residential Power Bill Rates
Company Used:	Virginia Electric and Power Company https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/virginia/residential-rates/schedule-1.pdf
Objectives:	A). I will arithmetically calculate the power bill for residents in Virginia, within each specified rate. B). I will write a piecewise function for the residential rates provided. C). I will recalculate the same power bill rates for residents in Virginia, using the piecewise function I have created.
Key Components:	A). Basic Customer Charge: Basic Customer Charge $6.58 per billing month. B). **Plus**, Distribution per kWh Charge (October - May): First 800 kWh @ 2.1086¢ per kWh Over 800 kWh @ 1.1943¢ per kWh C). **Plus**, Generation per kWh Charge (October - May): First 800 ES kWh @ 3.4933¢ per kWh Over 800 ES kWh @ 2.6942¢ per kWh D). **Plus**, Transmission kWh Charge (October - May): All kWh @ 0.970¢ per kWh

Usage by Month:

October	November	December
0 kWh	686 kWh	752 kWh
January	**February**	**March**
1,417 kWh	1,594 kWh	1,600 kWh

Project Information:

1) For the sake of this project, however, I will only be factoring in the *distribution rate* and the *basic customer charge*. I will *not* be using the *generation* and *transmission rates*.
2) For simplicity of the math, I will convert the cent amount into the amount shown as a dollar sign.
3) I will convert the value in cents to the value as a dollar, for distribution the rate, by multiplying it by $\frac{1}{100}$, in order to move the decimal over two places to the left.

Arithmetic Method:

I will take the usage amounts from the chart above and multiply them by their applicable rate categories. I will need to multiply the kWh (Kilowatts per hour) amount by the distribution rate. Then, adding that amount with the basic customer charge of $6.58, will tell me how much the power bill will be.

$2.1086 * \frac{1}{100} = 0.021086$ *or* $\$0.021086$ for kWh less than or equal to 800.

$1.1943 * \frac{1}{100} = 0.011943$ *or* $\$0.011943$ for kWh greater than 800, but less than or equal to 1,600.

October: 0 kWh

*Monthly Fee + Distribution Rate * kWh = Bill Amount*

$\$6.58 + \$0.021086 * (0) = \$6.58$

So, for the month of October, the total bill is $6.58.

November: 686 kWh

$\$6.58 + \$0.021086 * (686) = \$21.044996$

But that number is long, so let's round it to the nearest one-thousandth.

November Bill ≈ $21.05

December: 752 kWh

$\$6.58 + \$0.021086 * (752) = \$22.436672$

December Bill ≈ $22.44

January: 1,417 kWh

For this amount of kWh, we must use greater than 800 kWh portion of the residential rates. For this we start by calculating the amount of the first 800 kWh.

$\$0.021086 * 800\ kWh = \$16.8688$

So, 800 kWh @ $0.021086 per hour = $16.8688

So, we take the monthly flat fee plus the \$16.8688, and add that to the remaining hours over 800 kWh multiplied by the greater than 800 kWh rate.

800 kWh @ \$0.021086 per hour = \$16.8688

$\$6.58 + \$16.8688 + \$0.011943 * (1{,}417 - 800) = Cost$

$\$6.58 + \$16.8688 + \$7.368831 = \$30.817631$

January Bill ≈ \$30.82

February: 1,594 kWh

800 kWh @ \$0.021086 per hour = \$16.8688

$\$6.58 + \$16.8688 + \$0.011943 * \ (1{,}594 - 800)$

$\$6.58 + \$16.8688 + \$9.482742 = \$32.931542$

February Bill ≈ \$32.93

March: 1,600 kWh

800 kWh @ \$0.021086 per hour = \$16.8688

$\$6.58 + \$16.8688 + \$0.011943 * (1{,}600 - 800)$

$\$6.58 + \$16.8688 + \$0.011943 * (800)$

$\$6.58 + \$16.8688 + \$9.5544 = \$33.0032$

March Bill ≈ \$33.00 (This is roughly the *theoretical* maximum one could pay to use the full 1,600 kWh in this pricing schedule.)

Piecewise Function:

For the Piecewise function, let:

C = Monthly Cost or Bill; k = kWh Usage; Basic Customer Charge = \$6.58

First Piece:

$C(k) = \$0.021086(k) + \$6.58$

For kilowatt hour usage greater than or equal to zero, and less than or equal to 800.

Second Piece:

\$0.011943 per hour for kWh over 800.

\$16.8688 is the highest amount a resident can pay for 800 kWh.

$C(k) = \$6.58 + \$16.8688 + \$0.011943(k - 800)$

$C(k) = \$6.58 + \$16.8688 + \$0.011943k - 9.5544$

$C(k\ ) = \$0.011943(k) + \$13.8944$

For kilowatt hour usage greater than 800, but less than or equal to 1,600.

$$C(k) = \begin{cases} \$6.58; & k = 0 \\ \$0.021086(k) + \$6.58; & k \leq 800 \\ \$0.011943(k) + \$13.8944; & 800 < k \leq 1{,}600 \end{cases}$$

Piecewise Function Method:

Usage by Month to Test:

October	November	December
0 kWh	686 kWh	752 kWh
January	**February**	**March**
1,417 kWh	1,594 kWh	1,600 kWh

Using the Piecewise Function: To test the piecewise function, I will plug each month's kWh usage amount into the value of *k*. Then, I will solve the appropriate equation based on the piece that is fitting for the value of *k.* I will solve the equation without using rounded values, to be as accurate as possible. Each solution will be rounded to the nearest 1,000th decimal place after calculations.

October: 0 kWh

$C(k) = \$6.58$ when k=0.

$C(0) = \$6.58$ Thus, the cost is $6.58.

November: 686 kWh

$C(k) = \$0.021086(k) + \$6.58$

$C(686) = \$0.021086(686) + \$6.58$

$C(686) = \$14.464996 + \$6.58$

$C(686) = \$21.044996,$ Rounded, the cost is $21.05.

December: 752 kWh

$C(k) = \$0.021086(k) + \$6.58$

$C(752) = \$0.021086(752) + \$6.58$

$C(752) = \$15.856672 + \$6.58$

$C(752) = \$22.436672$ Rounded, the cost is \$22.44.

January: 1,147 kWh

$C(k) = \$0.011943(k) + \$13.8944$

$C(1{,}147) = \$0.011943(1{,}147) + \$13.8944$

$C(1{,}417) = \$16.923231 + \$13.8944$

$C(1{,}417) = \$30.817631$ Rounded, the cost is \$30.82.

February: 1,594 kWh

$C(k) = \$0.011943(k) + \$13.8944$

$C(1{,}594) = \$0.011943(1{,}594) + \$13.8944$

$C(1{,}594) = \$19.037142 + \$13.8944$

$C(1{,}594) = \$32.931542$ Rounded, the cost is \$32.93.

March: 1,600 kWh

$C(k) = \$0.011943(k) + \$13.8944$

$C(1{,}600) = \$0.011943(1{,}600) + \$13.8944$

$C(1{,}600) = \$19.1088 + \$13.8944$

$C(1{,}600) = \$33.0032$ Rounded, the cost is $33.00.

Citations (APA):

Chukwuemeka, S. (2018). *Piecewise Functions*. Piecewise functions. https://precalculus.appspot.com/PiecewiseFunctions/piecewise-functions.html#studentProjectPowerBill

Virginia Electric and Power Company Schedule 1 RESIDENTIAL SCHEDULE. Dominion Energy. (2021, December 9). https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/virginia/residential-rates/schedule-1.pdf?la=en&rev=77a761f57c8241038dfa13e990c3caf0&hash=BF54C2E8EC883D3A6C6323326A3E3F25