

**UNDERTAKING J15.6**

**Undertaking**

To provide a response to Mr. Rubin's 30-day scenario regarding the impact of Sir Adam Beck Pump Generating Station operation on the "hourly volume" or monthly average hourly net energy production for the regulated hydroelectric facilities.

**Response**

OPG has addressed Mr. Rubin's 30-day scenario by considering the following:

1. a) What is the change in the "hourly volume" or the actual average hourly net energy production over the month when the Sir Adam Beck Pump Generating Station ("PGS") pumps full-out during the last day of the month?  
b) What is the impact on OPG's revenue?
2. Same as for 1, except pump full-out for the last two days of the month.
3. What is the change in the "hourly volume" or the actual average hourly net energy production over the month when the PGS pumps full-out every day of the month?

**Assumptions:**

The responses below assume that the regulated hydroelectric production averages 1,900 MW per hour.

The table below presents the hourly production loss at the Sir Adam Beck complex associated with pumping / generating 1 unit at the PGS. Note that hour 1 is a "pumping" hour, and hour 2 is a "generating" hour. They are labeled hours 1 and 2 for notational convenience; the numbers do not imply that these hours are necessarily the first and second hour of the day. For illustrative purposes, the off-peak spot price is assumed to be  $S_1 = \$32 / \text{MWh}$  and the on-peak spot price is assumed to be  $S_2 = \$50 / \text{MWh}$ , for a daily average of  $\$44 / \text{MWh}$ .

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Hour	Source	Production	Spot Price	Comment	
1 (Pumping)	PGS	-30 MW	$S_1 = \$32/\text{MWh}$	Energy consumption and pumping losses during pump operations in moving the water into storage Reduced production from the downstream plants when water is pumped	
	Downstream	-80 MW	$S_1 = \$32/\text{MWh}$		
	Total		-110 MW		
2 (Generating)	PGS	+30 x 0.5MW	$S_2 = \$50/\text{MWh}$	Energy production, with 50% efficiency losses at PGS when the pumped water is generated using PGS units Energy production at an assumed 90% efficiency from the downstream plants	
	Downstream	+80 x 0.9MW	$S_2 = \$50/\text{MWh}$		
	Total		+87 MW		
	Total Net Generation		-23 MW		

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**Results:**

The results below demonstrate that there could theoretically be a very small marginal increase in revenues associated with a maximum pumping scenario and a resulting reduction in the average hourly net energy production over the month. However, even these small marginal impacts require assumptions that are unsupported, as discussed below:

- The Beck complex cannot physically accommodate the amount of pumping assumed in these examples. In addition to economic signals, the amount of pumping is dependant on unit reliability, elevation of the pump storage facility, AGC requirements and hydrologic conditions.
- Due to daily fluctuations in the above factors, the PGS could not consistently pump the same daily amount for 28 to 30 days of the month.
- The spread between on-peak and off-peak market prices is uncertain, unknowable in advance and may be insufficient to recover pump losses and non-energy charges. This could result in lost revenue for OPG.
- Mr. Rubin's scenario (using a flat profile for the majority of the month) could result in losses compared to the optimal use of the incentive mechanism over the entire month. The flat profile of 1900 MWh per hour for the first 28 or 29 days of the month would reduce incentive revenues to OPG as compared to efficient operation of the PGS.

**Specific Results:**

1. a) Assume that the regulated hydroelectric production averages 1,900 MW per hour for the first 29 days of the month. Pumping at maximum efficiency on the last day of the month results in a loss of 23 MW for every pumping hour for each unit, as per Table 1.

1 The maximum pumping capability for one day is assumed by running 6 units during 6 of  
2 the 8 off-peak hours.<sup>1</sup> This amount of pumping reduces the energy production volume for  
3 that day by 6 units x 6 hours x 23 MW = 828 MWh. In this example, the new monthly  
4 average hourly net energy production becomes:  
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$$\frac{1900 \times 24 \times 29 + 1900 \times 24 - 828}{24 \times 30} = 1898.85 \text{ MW}$$

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8 This represents a reduction of 1.15 MW in the hourly volume which is equivalent to a  
9 reduction, in relative terms, of 0.06%.

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12 b) In order to examine the revenue impact that results from pumping only during the last  
13 day of the month, for illustrative purposes, assume a daily HOEP profile with off-peak  
14 prices of \$32 / MWh, on-peak prices of \$50 / MWh, and an average price of \$44 / MWh,  
15 consistent with the numbers that were used in Ex. I1-T1-S1. The payment amount is  
16 \$37.90/MWh, consistent with OPG'S application.

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18 Assuming a constant production of 1,900 MW, for every hour, for 30 days, the revenues,  
19 as per the equation in section 5.2 of Ex. I1-T1-S1, are given by:  
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$$30 \times 24 \times 1900 \times \$37.90 = \$51,847,200.$$

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23 Now consider the situation under a), where OPG pumps to the maximum capacity of the  
24 PGS units on the last day of the month. The hourly volume goes down from 1,900 MW to  
25 1,898.85 MW. The revenues associated with this scenario, as per the equation in section  
26 5.2 of Ex. I1-T1-S1, for the first 29 days are:  
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$$29 \times 24 \times (1898.85 \times \$37.90 + (1900 - 1898.85) \times \$44.00) = \$50,123,842.$$

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30 On the last day there are six off-peak hours with a volume of  $1900 - 6 \times 110 = 1240$  MW,  
31 two off-peak hours with a volume of 1900 MW, six on-peak hours with a volume of  
32  $1900 + 6 \times 87 = 2422$  MW, and ten on-peak hours with a volume of 1900 MW. The  
33 revenues for that last day are:  
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$$\begin{aligned} &6 \times (1898.85 \times \$37.90 + (1240 - 1898.85) \times \$32.00) + \\ &2 \times (1898.85 \times \$37.90 + (1900 - 1898.85) \times \$32.00) + \\ &6 \times (1898.85 \times \$37.90 + (2422 - 1898.85) \times \$50.00) + \\ &10 \times (1898.85 \times \$37.90 + (1900 - 1898.85) \times \$50.00) = \$1,758,288 \end{aligned}$$

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<sup>1</sup> Note that it is rarely possible to pump 6 PGS units at maximum efficiency for 6 hours due to unit reliability issues, elevation of the pump storage facility, AGC requirements and hydrologic conditions.

- 1 The total revenues for the month are \$51,882,130. The incremental revenues are  
2 \$34,930. However, OPG incurs additional non-energy market charges for pumping.  
3 These are approximately \$15 per MWh pumped, and therefore amount to 6 units x 6  
4 hours x 30 MW per hour x \$15/MWh = \$16,200. This yields total incremental revenue of  
5 \$18,730, equivalent to an increase of 0.036%.  
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- 7 2. If OPG pumps to the maximum capacity of the PGS units on the last two days of the  
8 month, the impact on the hourly volume is twice that of scenario 1a): 2 days x 1.15 MW =  
9 2.3 MW reduction in the hourly volume or a reduction in relative terms, of 0.12%.
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11 The impact on revenue is twice the incremental value from 1b): 2 days x \$18,730 =  
12 \$37,460.  
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- 14 3. For every day that all six PGS units pump full-out during each of the eight off-peak hours,  
15 the hourly volume drops by 1.15 MW. Hypothetically (as, again, it is physically impossible  
16 to pump this amount of water), the absolute maximum reduction in the hourly volume is  
17 1.15 MW x 30 days = 34.5 MW.