Solutions

1a) 63 €/MWh

1b) Buy back hour 19 if you’re at the beginning of the season and potentially have many other hours where you can sell again above 65 €/MWh. By buying back, you lock-in 14 €/MWh. If we are at the end of the season, most possibly hours above 65 €/MWh are rare and buying back at 65 is too expensive.

1c) Income without ancillary services: 200 x (69 + 71 + 66 + 63 + 79 + 75) = 84'600 €
Income with ancillary services: 50 x 24 x 59 = 70'800 €
Lost income: 13’800 €
Sold regulation band: 30 MW
Minimum bid for ancillary services: 13’800 / 30 = 460 €/MW/d

1d) You start using more water than in normal operation per day. To calculate the opportunity costs you need to know the value of the water that you ‘consume from the future’.

1e) 64 €/MWh; the hours with 100 MW production is not stored water but driven by inflows. As we cannot manage the balancing basin, whenever we turbine we also turbine on the lower level and thus, the 15h of operation due to inflows are complemented by 3h with 200 MW through the cascade.

1f) I expect to sell above 64€/MWh in the coming winter, otherwise I should save the water rather for the coming winter season. If I turbine above 64 €/MWh, I should have roughly 1000h of operation in the season October to March.

1g) There are several possible reasons:
   - Extraordinary maintenance in early spring such that only 1000h are available
   - 2000h means rather 59 €/MWh than 64 €/MWh; for e.g. reasons of security of supply we plan to have a lake level of 90% by October and thus plan to both fill the lake and to cash in good hours.

1h) The price for turbining stored water in June is not related to the winter season. We need to turbine in order to prevent spilling of the reservoir.

2a) Q4: 61'205'760 € (44 €/MWh x 630 MW x (744h + 720h + 744h))
   Q1: 72'532'800 € for Q1 (46 €/MWh x 730 MW x (744h + 672h + 744h))
   Total income from selling up-front (going short): 133'738'560 €.

2b) Some of the water is moved to Q1 as the prices in Q1 are better now than in Q4. December has already some 10 days with low consumption; the increased availability thanks to the nuclear power plants has obviously no impact on the average production in December.

2c) My hedge in Q4 made money, I sold a short position of 630 MW that I now could buy back 1 €/MWh cheaper, thus for each MW we earn 1 € m2m:
   1 €/MWh x 630 MW x (744h + 720h + 744h) = 1’391’040 €.
   But our hedge is not corresponding to our long position anymore. The new long position is now 610 MW instead of 630 in Q4 and 750 MW instead of 730 MW in Q1. We have to re-adjust the hedge by buying back 20 MW in Q4 and by selling 20MW in Q1.

2d) Buying back 20 MW of our short position costs 20 MW x (744h + 720h + 744h) x 43 €/MWh = 1’898’880 €. Thus, re-adjusting the position at first hand looks more expensive than what we earned with the hedge position so far. On the other hand, we need to sell another 20 MW in Q1 as the larger long position would cost too much risk capital. So we go short another 20 MW in Q1, earning 20 MW x (744h + 672h + 744h) = 1’987’200 €.
   After all, readjusting the hedge has three effects:
   - Our position in Q4 has made money of 1’391’040 €
   - Buying back 20 MW of the short position in Q4 costs -1’898’880 €
   - Increasing our short position in Q1 results in an income of 1’987’200 €
   Total balance, after adjusting the hedge 1’479’360 €

Thanks to the flexibility of our assets we were able to move water from Q4 into the higher value Q1, by doing so locking in the delta of the two positions.