

CHAPTER 5

Result Analysis and Discussion

5.1 Data of Analysis

This research proposes the Lambda iteration method to find the optimal dispatching of hydro power generations in the central-1 network of Laos, which consists of the 5 hydropower plants for finding the optimum cost.

EDL has power purchase agreement with each hydropower plant which is supplied to the EDL's grid. The tariffs are different values as follows in the table 5.1.

Table 5.1 The tariff of 5 hydro power plants in 2014

No.	Generations	Tariff (\$/kWh)	Owner
1	Nam Ngum 1	0.05330	EDL-Gen
2	Nam Luek	0.05330	EDL-Gen
3	Nam Mang 3	0.05330	EDL-Gen
4	Nam Lik 1/2	0.04822	IPP _d
5	Nam Ngum 5	0.04729	IPP _d

From the step of analysis coefficients of the quadratic generation cost function. A procedure of simulating coefficient of each power generation is considered by using PowerWorld simulation program and Excel function. The First, the existing power transmission system in central-1 network of the EDL is modelled in the Power World simulation program. Then, each generator is modelled. After that, power flow and power losses of power system when connected generators are calculated. Finally, the cost function of each generator (α_i , β_i and γ_i) is analyzed by using Excel function. The result of coefficient for power generation cost as shown in table 5.2.

Table 5.2 Coefficient of power generation cost

HydroPower Plant	Coefficient of power generation cost			Limit of generation	
	α (\$/h)	B (\$/MWh)	γ (\$/MW2h)	Min (MW)	Max (MW)
NNG 1	442.39	54.109	0.0087	15	160
NL	642.57	54.381	0.0200	20	60
NM 3	775.62	52.609	0.0198	10	40
NL 1/2	329.37	48.996	0.0154	20	100
NNG 5	348.51	47.635	0.0204	20	120

5.2 The Result of the Optimal Dispatch by Using Lambda Iteration Method

The simulation result of an optimal load dispatch of hydropower plants in the central-1 network which are consist of 5 hydropower plants namely NNG 1, NL, NM 3, NL 1/2 and NNG 5. The optimal system is analyzed which are based on the actual generation in year 2014. The testing result of Lambda iteration method is compare with the actual generation.

The system is analyzed which based on load demand. The simulated result of optimal dispatch is the NNG 5 and NL 1/2 hydropower plant are generators selected first, when the load demand is low. Because the generation costs of both units are the lowest. When the load demand increases, due to the limitation of each generator, the higher cost of the generator such as NM 3 and NN 1 hydropower plant in respectively are selected according to load demand and the cost of the generator. NL is scheduled for the last, because this is the most expensive of all the generators.

The optimal dispatch in this research there are two study cases as following:

Case 1: Optimal load dispatch by using Lambda iteration method neglecting generator limits.

Case 2: Optimal load dispatch by using Lambda iteration method including minimum generator limits.

5.3 Optimal Load Dispatch Neglecting Generator Limits (Case 1)

According to the simulation results of the optimal power output. EDL should schedule the power generation of each hydropower plant based on actual generation statistic to get the effective result of power generation within a minimum generative cost.

5.3.1 Optimal load dispatch in January 2014

Table 5.3 Power output of scheduling 5 HPP in January 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL1/2	NNG5	NNG1	NL	NM3	NL1/2	NNG5
1	6,520.3	3,612.0	252.0	340.0	960.0	1,356.3	344.6	63.4	832.3	2,400.0	2,880.0
2	6,854.3	3,900.0	252.0	340.0	960.0	1,402.3	526.6	121.4	926.3	2,400.0	2,880.0
3	5,480.2	2,540.0	252.0	340.0	960.0	1,388.2	140.0	22.1	454.0	2,243.6	2,620.5
4	5,594.4	2,638.5	252.0	320.0	960.0	1,423.9	138.8	4.6	518.6	2,267.9	2,664.5
5	5,460.0	2,757.0	-	320.0	960.0	1,423.0	84.1	5.5	444.1	2,271.7	2,654.6
6	5,335.6	2,637.0	-	340.0	960.0	1,398.6	55.9	5.6	381.8	2,259.7	2,632.6
7	5,547.7	2,636.0	252.0	340.0	960.0	1,359.7	188.1	27.5	463.4	2,246.2	2,622.4
8	6,134.9	2,901.0	252.0	340.0	1,202.8	1,439.1	255.5	48.8	589.4	2,399.3	2,841.9
9	6,008.8	2,821.0	252.0	300.0	1,200.6	1,435.2	233.7	45.3	515.0	2,398.9	2,815.9
10	6,226.3	2,854.0	252.0	480.0	1,200.0	1,440.3	239.6	47.9	658.8	2,400.0	2,880.0
11	6,081.5	2,849.5	252.0	340.0	1,200.0	1,440.0	243.1	49.4	558.0	2,400.0	2,831.0
12	6,081.5	2,849.5	252.0	340.0	1,200.0	1,440.0	243.1	49.4	558.0	2,400.0	2,831.0
13	5,814.7	2,852.0	-	320.0	1,200.0	1,442.7	53.7	-	536.9	2,400.0	2,824.1
14	4,255.0	2,463.0	252.0	340.0	1,200.0	-	-	-	95.0	1,866.9	2,293.1
15	5,257.2	2,802.0	252.0	340.0	1,200.0	663.2	185.4	24.6	430.2	2,117.7	2,499.3
16	6,547.9	2,794.5	308.0	340.0	1,200.0	1,905.4	545.1	148.6	621.6	2,400.0	2,832.6
17	6,008.5	2,995.8	224.0	340.0	1,200.0	1,248.7	146.3	13.9	568.3	2,400.0	2,880.0
18	6,746.8	2,913.0	252.0	320.0	1,200.0	2,061.8	631.6	173.1	716.0	2,376.6	2,849.5
19	6,038.8	2,873.0	-	300.0	1,200.0	1,665.8	60.8	1.5	696.5	2,400.0	2,880.0
20	5,860.5	2,909.7	-	300.0	1,200.0	1,450.8	68.4	-	573.0	2,400.0	2,819.1
21	6,182.0	2,980.0	252.0	340.0	1,200.0	1,410.0	198.5	36.3	688.3	2,395.3	2,863.6
22	6,077.2	2,882.0	224.0	320.0	1,200.0	1,451.2	223.8	42.8	594.7	2,400.0	2,815.9
23	6,108.2	2,907.0	224.0	340.0	1,200.0	1,437.2	230.9	46.5	602.7	2,400.0	2,828.1
24	6,052.1	2,873.0	252.0	320.0	1,200.0	1,407.1	216.2	37.8	592.1	2,400.0	2,806.0
25	6,075.6	2,872.0	252.0	320.0	1,200.0	1,431.6	235.8	43.2	594.2	2,400.0	2,802.4
26	5,692.0	2,923.5	-	300.0	1,200.0	1,268.5	50.1	-	485.4	2,380.8	2,775.8
27	5,726.3	2,950.0	-	300.0	1,200.0	1,276.3	82.7	4.4	460.1	2,398.3	2,780.8
28	5,921.1	2,785.0	280.0	340.0	1,200.0	1,316.1	200.9	33.2	540.0	2,375.4	2,771.6
29	5,898.6	2,807.5	252.0	340.0	1,200.0	1,299.1	166.3	22.2	531.4	2,388.8	2,789.9
30	5,896.2	2,758.5	254.2	340.0	1,200.0	1,343.5	194.5	34.7	526.4	2,371.7	2,768.9
31	5,876.2	2,821.0	252.0	320.0	1,200.0	1,283.2	198.3	26.8	563.9	2,348.6	2,738.6

The table 5.3 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st January 2014. The optimal power schedule was

selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. In the table observed the actual power in some day unnecessary to operate which is NNG 5 off on 14th and 15th and NL off in the weekend.

Figure 5.1 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st January 2014 by using the Lambda iteration method.

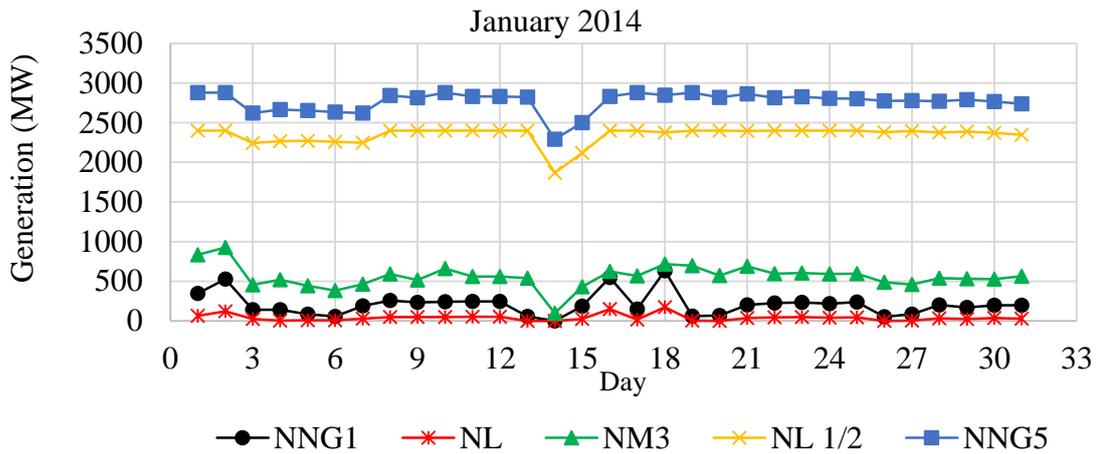


Figure 5.1 The result of optimal dispatch by using Lambda iteration method

Figure 5.2 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The both of values are different. The optimal cost is lower than actual cost. The cost saving of January is \$ 450,422.78, which is equivalent to 4.82 %. In the figure we observed the cost of date 14th and 15th is too low, because NNG 5 had some maintenance. During this period the generator is stopped running.

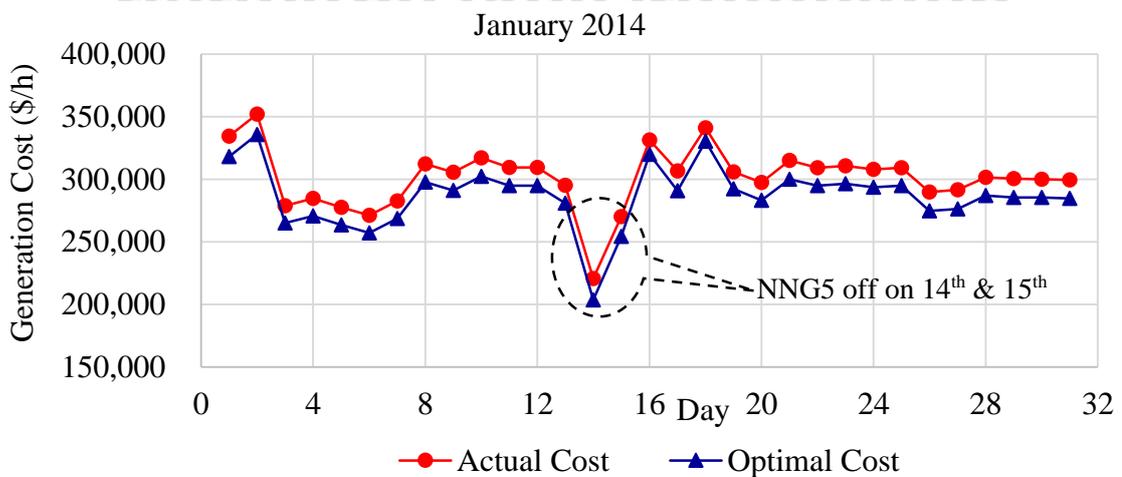


Figure 5.2 Comparison actual cost and optimal cost in January 2014

5.3.2 Optimal load dispatch in February 2014

The table 5.4 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 28th February 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The NL is unnecessary to operate on 13th to 28th while low load. The actual power in some day doesn't operate which is NL off in the weekend.

Table 5.4 Power output of scheduling 5 HPP in February 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,989.60	3,729.0	280.9	320.0	1,200.0	1,459.7	607.8	141.8	960.0	2,400.0	2,880.0
2	6,672.40	3,720.0	-	320.0	1,200.0	1,432.4	385.1	47.3	960.0	2,400.0	2,880.0
3	6,658.80	3,699.0	-	320.0	1,200.0	1,439.8	372.0	46.8	960.0	2,400.0	2,880.0
4	6,953.50	3,684.0	280.7	340.0	1,200.0	1,448.8	578.8	135.8	958.9	2,400.0	2,880.0
5	6,929.93	3,684.0	282.0	320.0	1,200.0	1,443.9	559.0	132.8	958.1	2,400.0	2,880.0
6	6,943.31	3,664.0	281.1	340.0	1,200.0	1,458.2	571.6	132.8	958.9	2,400.0	2,880.0
7	6,939.87	3,660.0	281.9	340.0	1,200.0	1,458.0	569.5	130.4	960.0	2,400.0	2,880.0
8	6,914.89	3,649.6	282.2	346.1	1,200.0	1,437.0	552.1	122.8	960.0	2,400.0	2,880.0
9	6,571.50	3,635.6	-	320.0	1,200.0	1,415.9	319.2	38.4	933.9	2,400.0	2,880.0
10	6,590.82	3,631.7	-	323.5	1,200.0	1,435.6	321.9	34.0	954.9	2,400.0	2,880.0
11	6,926.57	3,612.0	280.7	402.3	1,200.0	1,431.6	560.0	133.8	952.8	2,400.0	2,880.0
12	6,360.80	2,990.7	362.6	380.0	1,200.0	1,427.5	188.0	18.3	874.6	2,400.0	2,880.0
13	5,952.10	2,744.4	223.1	344.6	1,200.0	1,440.0	100.1	-	572.0	2,400.0	2,880.0
14	5,926.32	2,736.0	222.0	340.0	1,200.0	1,428.3	89.4	-	556.9	2,400.0	2,880.0
15	5,907.53	2,721.6	225.9	320.0	1,200.0	1,440.0	93.1	-	534.4	2,400.0	2,880.0
16	5,697.00	2,723.5	-	340.0	1,200.0	1,433.5	-	-	417.0	2,400.0	2,880.0
17	5,678.69	2,717.3	-	325.1	1,200.0	1,436.3	-	-	398.7	2,400.0	2,880.0
18	5,964.24	2,712.0	282.6	320.0	1,200.0	1,449.6	116.6	-	567.6	2,400.0	2,880.0
19	5,920.00	2,700.0	282.4	300.0	1,200.0	1,437.6	108.2	-	531.8	2,400.0	2,880.0
20	5,930.71	2,700.0	281.6	320.0	1,200.0	1,429.1	100.4	-	550.3	2,400.0	2,880.0
21	5,742.52	2,700.9	283.3	141.2	1,200.0	1,417.1	66.0	-	399.2	2,400.0	2,877.3
22	6,141.47	2,700.0	311.9	480.0	1,200.0	1,449.6	123.8	-	737.7	2,400.0	2,880.0
23	5,639.40	2,700.4	-	312.0	1,200.0	1,427.0	-	-	359.4	2,400.0	2,880.0
24	5,624.12	2,681.8	-	322.7	1,200.0	1,419.6	-	-	344.1	2,400.0	2,880.0
25	5,874.07	2,677.7	249.1	323.5	1,200.0	1,423.8	79.4	-	514.6	2,400.0	2,880.0
26	5,914.52	2,677.3	280.3	322.5	1,200.0	1,434.4	92.2	-	542.4	2,400.0	2,880.0
27	5,890.57	2,674.5	279.7	321.4	1,200.0	1,414.9	84.0	-	526.5	2,400.0	2,880.0
28	5,913.63	2,673.4	280.0	322.6	1,200.0	1,437.6	98.2	-	535.4	2,400.0	2,880.0

Figure 5.3 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 28th February 2014 by using the Lambda iteration method.

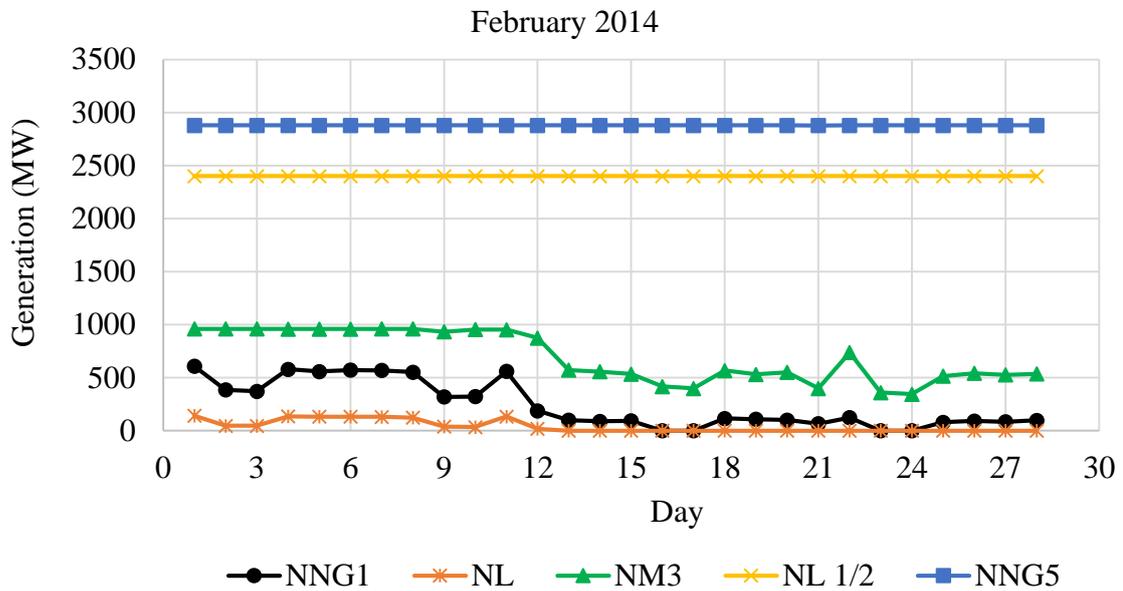


Figure 5.3 The result of optimal dispatch by using Lambda iteration method

Figure 5.4 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of February is \$ 413,953.50, which is equivalent to 4.64 %.

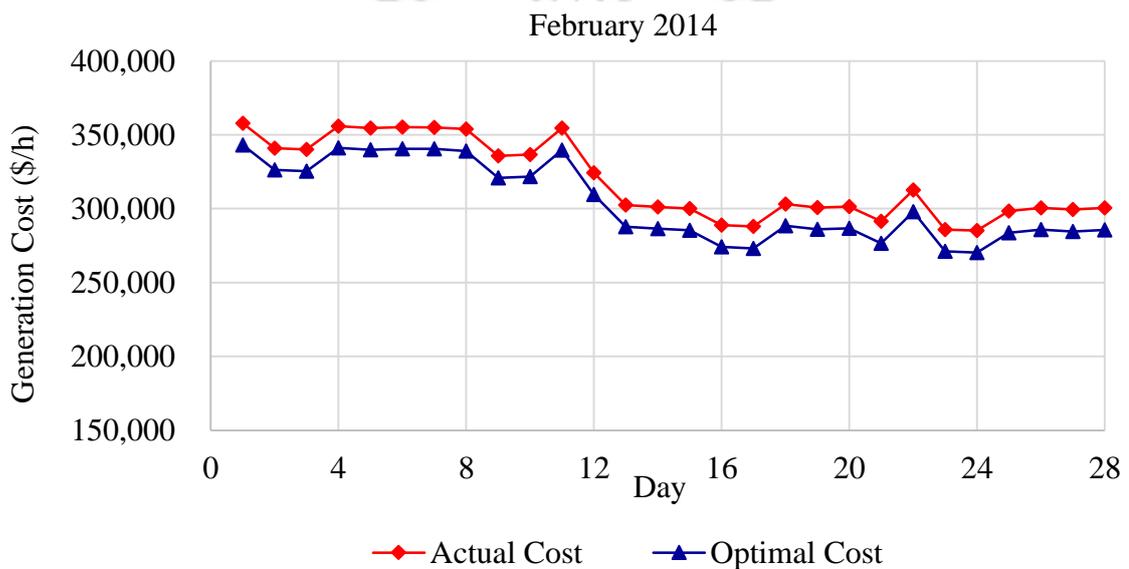


Figure 5.4 Comparison actual cost and optimal cost in February 2014

5.3.3 Optimal load dispatch in March 2014

The table 5.5 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st March 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The NNG 1 and NL are unnecessary to operate while low load.

Table 5.5 Power output of scheduling 5 HPP in March 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	5,960.0	2,670.8	365.8	304.1	1,200.0	1,419.4	110.5	-	569.6	2,400.0	2,880.0
2	5,550.5	2,669.2	-	261.7	1,200.0	1,419.6	-	-	281.7	2,400.0	2,868.8
3	5,562.7	2,668.8	-	265.9	1,200.0	1,428.0	-	-	282.7	2,400.0	2,880.0
4	5,960.8	2,668.8	365.3	305.4	1,200.0	1,421.3	115.0	-	565.8	2,400.0	2,880.0
5	5,941.0	2,657.0	335.9	302.6	1,200.0	1,445.6	106.3	-	554.7	2,400.0	2,880.0
6	5,933.9	2,654.4	335.4	304.1	1,200.0	1,440.0	105.9	-	548.0	2,400.0	2,880.0
7	5,912.7	2,647.2	335.4	304.1	1,200.0	1,426.1	90.7	-	543.0	2,400.0	2,879.0
8	6,493.9	3,213.6	336.9	303.4	1,200.0	1,440.1	458.8	108.6	646.4	2,400.0	2,880.0
9	6,577.1	3,492.2	139.9	302.6	1,200.0	1,442.4	327.6	49.0	920.5	2,400.0	2,880.0
10	6,527.8	3,484.4	141.3	263.6	1,200.0	1,438.6	294.5	47.0	906.3	2,400.0	2,880.0
11	6,764.8	3,468.0	336.8	320.0	1,200.0	1,440.0	466.3	102.5	916.0	2,400.0	2,880.0
12	7,211.1	3,468.0	478.9	640.0	1,200.0	1,424.2	781.7	232.0	917.5	2,400.0	2,880.0
13	7,156.7	3,440.2	476.4	600.0	1,200.0	1,440.0	744.8	216.2	915.7	2,400.0	2,880.0
14	6,588.6	3,446.2	224.9	303.3	1,200.0	1,414.3	342.2	60.5	905.9	2,400.0	2,880.0
15	6,117.3	2,927.9	254.2	301.8	1,200.0	1,433.4	67.1	-	775.0	2,400.0	2,875.2
16	4,681.6	2,580.3	-	304.1	1,200.0	597.3	-	-	-	2,233.7	2,447.9
17	5,507.5	2,583.3	-	304.8	1,200.0	1,419.4	-	-	249.1	2,400.0	2,858.4
18	5,865.6	2,592.0	334.4	304.1	1,200.0	1,435.2	71.2	-	534.2	2,400.0	2,860.2
19	5,842.4	2,565.4	335.3	304.3	1,200.0	1,437.4	56.8	-	532.2	2,400.0	2,853.4
20	5,798.8	2,497.2	337.5	340.9	1,200.0	1,423.3	55.7	-	501.1	2,400.0	2,841.5
21	5,889.6	2,604.0	336.8	304.0	1,200.0	1,444.8	84.4	-	536.9	2,400.0	2,868.3
22	5,884.0	2,604.0	336.7	303.3	1,200.0	1,440.0	81.4	-	536.2	2,400.0	2,866.5
23	5,645.6	2,580.0	139.9	303.7	1,200.0	1,422.1	23.5	-	371.6	2,400.0	2,850.5
24	5,652.9	2,580.0	139.6	302.9	1,200.0	1,430.4	26.5	-	372.5	2,400.0	2,853.9
25	5,865.1	2,574.5	332.1	322.7	1,200.0	1,435.8	58.7	-	549.0	2,400.0	2,857.2
26	5,917.8	2,584.8	333.7	361.3	1,200.0	1,438.1	66.0	-	587.0	2,400.0	2,864.8
27	5,902.1	2,562.2	336.0	366.5	1,200.0	1,437.4	59.6	-	584.8	2,400.0	2,857.7
28	5,888.1	2,556.0	328.5	364.9	1,200.0	1,438.8	49.1	-	581.3	2,400.0	2,857.8
29	6,111.9	2,804.2	323.3	364.8	1,200.0	1,419.6	220.5	41.0	602.4	2,400.0	2,848.0
30	6,494.4	3,334.4	166.1	364.1	1,200.0	1,429.8	279.7	38.9	895.8	2,400.0	2,880.0
31	6,483.6	3,325.3	165.8	362.2	1,200.0	1,430.4	276.4	39.1	888.0	2,400.0	2,880.0

Figure 5.5 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st March 2014 by using the Lambda iteration method.

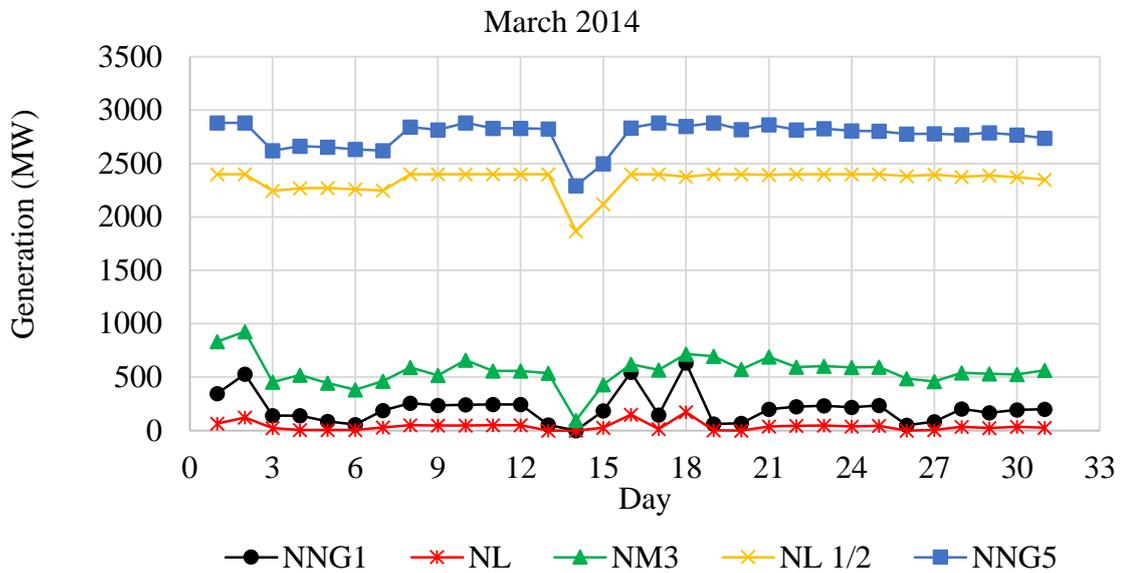


Figure 5.5 The result of optimal dispatch by using Lambda iteration method

Figure 5.6 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving in February 2014 is \$ 458,755.36, which is equivalent to 4.80 %.

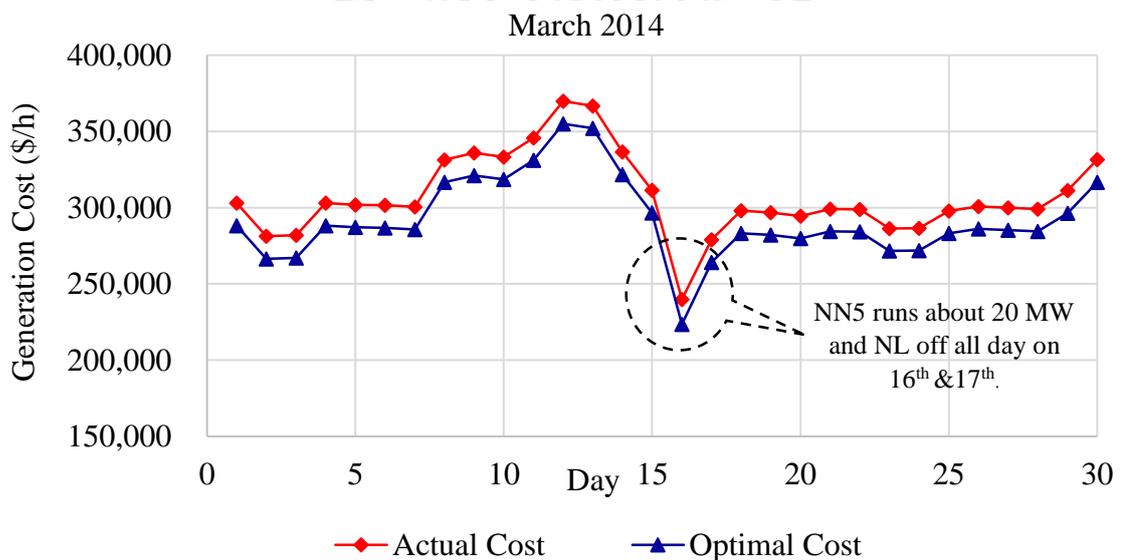


Figure 5.6 Comparison actual cost and optimal cost in March 2014

5.3.4 Optimal load dispatch in April 2014

The table 5.6 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th April 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The NNG 1 and NL are unnecessary to operate while low load. The actual power of NNG 5 does not operate on 23rd to 30th.

Table 5.6 Power output of scheduling 5 HPP in April 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,559.7	3,320.2	502.8	325.9	1,200.0	1,210.8	368.8	71.3	839.6	2,400.0	2,880.0
2	6,455.4	3,287.6	500.3	324.4	1,200.0	1,143.2	367.9	78.6	728.9	2,400.0	2,880.0
3	6,378.5	3,150.3	503.9	364.9	1,200.0	1,159.5	380.2	83.9	634.4	2,400.0	2,880.0
4	6,440.1	3,101.7	501.9	480.0	1,200.0	1,156.6	342.1	67.5	750.5	2,400.0	2,880.0
5	6,476.7	3,138.0	501.3	486.5	1,200.0	1,150.9	366.2	77.9	752.6	2,400.0	2,880.0
6	6,005.1	3,134.5	138.9	303.8	1,200.0	1,227.9	134.4	25.7	565.0	2,400.0	2,880.0
7	5,947.3	3,123.6	166.0	305.8	1,200.0	1,151.9	104.0	10.7	553.9	2,400.0	2,878.7
8	6,333.4	3,128.9	498.1	345.4	1,200.0	1,161.0	365.8	77.7	609.9	2,400.0	2,880.0
9	6,342.3	3,139.3	489.9	343.7	1,200.0	1,169.4	367.6	78.4	618.0	2,400.0	2,878.3
10	6,476.1	3,125.8	495.7	485.1	1,200.0	1,169.4	369.2	79.1	747.8	2,400.0	2,880.0
11	6,476.0	3,135.4	497.4	485.2	1,200.0	1,158.0	362.7	76.3	757.0	2,400.0	2,880.0
12	6,245.7	3,135.0	498.8	262.3	1,200.0	1,149.6	219.9	54.5	691.9	2,400.0	2,879.5
13	6,116.6	3,108.8	165.1	482.8	1,200.0	1,159.9	107.2	12.0	717.4	2,400.0	2,880.0
14	6,208.8	3,205.2	165.5	482.9	1,200.0	1,155.2	173.4	40.5	715.0	2,400.0	2,880.0
15	6,435.3	3,098.7	497.4	482.9	1,200.0	1,156.3	347.7	69.9	737.7	2,400.0	2,880.0
16	6,403.5	3,074.1	499.9	482.9	1,200.0	1,146.6	334.5	64.2	724.8	2,400.0	2,880.0
17	6,232.6	3,054.9	338.3	482.9	1,200.0	1,156.5	218.3	53.4	681.0	2,400.0	2,880.0
18	6,395.6	3,058.8	497.1	482.9	1,200.0	1,156.8	332.5	63.3	719.7	2,400.0	2,880.0
19	6,990.1	2,871.8	500.3	482.9	1,968.0	1,167.1	612.3	137.7	960.0	2,400.0	2,880.0
20	6,453.9	2,860.3	137.0	480.0	1,968.0	1,008.5	281.4	26.6	869.6	2,400.0	2,876.3
21	6,601.9	2,858.7	136.7	481.7	1,968.0	1,156.8	327.4	34.5	960.0	2,400.0	2,880.0
22	6,953.0	2,858.1	498.6	481.7	1,968.0	1,146.6	585.1	127.9	960.0	2,400.0	2,880.0
23	5,736.5	2,732.1	555.9	480.5	1,968.0	-	17.4	1.4	437.8	2,400.0	2,880.0
24	5,792.5	2,846.7	497.3	480.5	1,968.0	-	78.7	3.2	430.6	2,400.0	2,880.0
25	5,781.9	2,836.1	497.3	480.5	1,968.0	-	78.0	2.9	424.7	2,400.0	2,876.3
26	5,784.4	2,871.8	464.1	480.5	1,968.0	-	16.0	0.7	487.7	2,400.0	2,880.0
27	5,644.1	2,832.0	464.1	380.0	1,968.0	-	14.8	0.2	449.1	2,379.6	2,800.5
28	5,415.5	2,832.0	135.5	480.0	1,968.0	-	-	-	135.5	2,400.0	2,880.0
29	5,436.2	2,826.0	162.2	480.0	1,968.0	-	-	-	159.2	2,400.0	2,877.0
30	5,463.8	2,846.2	162.1	487.5	1,968.0	-	-	-	183.8	2,400.0	2,880.0

Figure 5.7 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th April 2014 by using the Lambda iteration method.

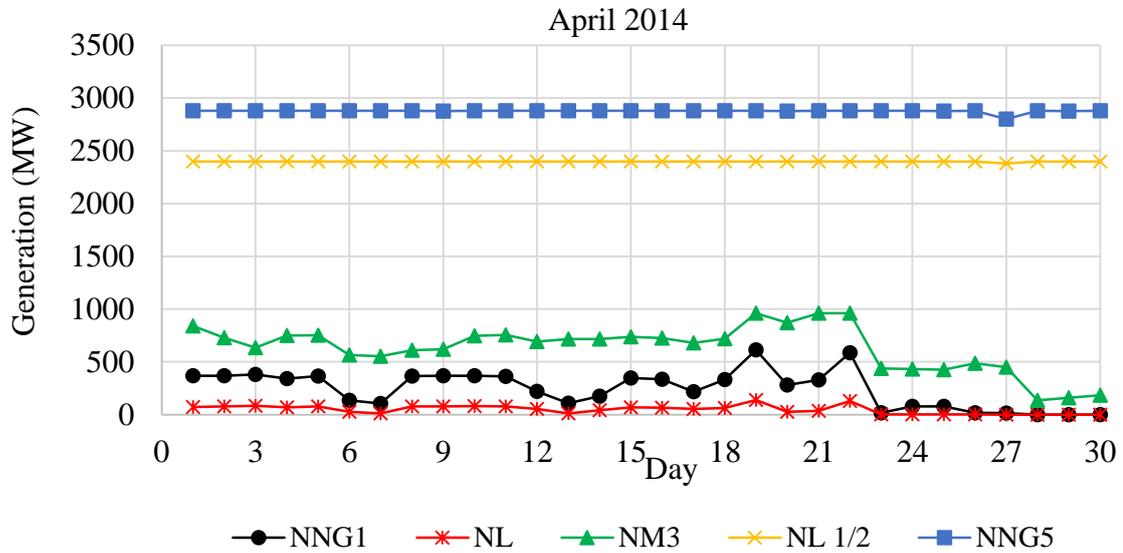


Figure 5.7 The result of optimal dispatch by using Lambda iteration method

Figure 5.8 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of April 2014 is \$ 502,224.22, which is equivalent to 5.27 %.

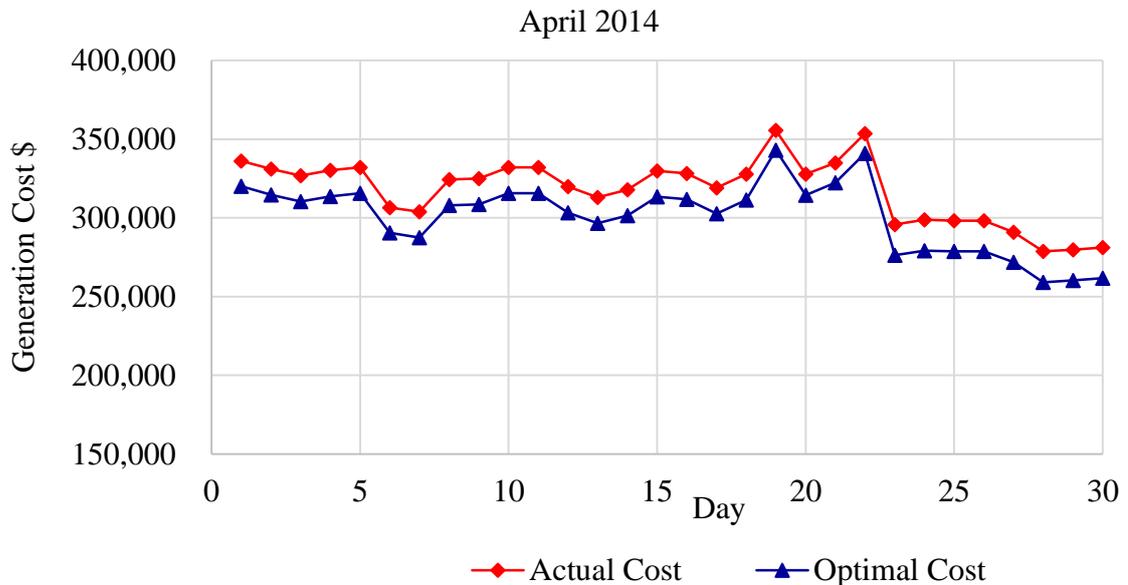


Figure 5.8 Comparison actual cost and optimal cost April 2014

5.3.5 Optimal load dispatch in May 2014

The table 5.7 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st May 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The NNG 1 and NL are unnecessary to operate while low load. The actual power of NNG 5 does not operate on 01st to 21st.

Table 5.7 Power output of scheduling 5 HPP in May 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	5,346.74	2,871.75	162.40	344.59	1,968.00	-	-	-	190.40	2,378.35	2,777.98
2	5,347.37	2,890.32	162.49	326.56	1,968.00	-	9.58	-	220.22	2,366.60	2,750.97
3	5,353.42	2,824.17	216.66	344.59	1,968.00	-	5.86	-	260.89	2,353.71	2,732.96
4	5,251.25	2,740.99	216.66	325.60	1,968.00	-	12.24	-	248.07	2,303.29	2,687.64
5	5,175.2	2,668.0	216.5	322.7	1,968.0	-	10.5	-	274.0	2,252.3	2,638.5
6	5,262.5	2,755.0	216.8	322.7	1,968.0	-	5.5	-	278.7	2,303.5	2,674.8
7	5,321.0	2,647.8	379.4	325.8	1,968.0	-	5.3	-	423.3	2,252.5	2,640.0
8	5,295.3	2,622.9	380.2	324.1	1,968.0	-	7.9	-	391.8	2,261.5	2,634.1
9	5,435.1	2,767.5	377.6	322.1	1,968.0	-	9.2	-	435.0	2,301.3	2,689.6
10	5,585.7	2,916.0	376.4	325.3	1,968.0	-	12.9	-	444.8	2,371.8	2,756.2
11	5,385.0	2,869.0	188.0	360.0	1,968.0	-	6.5	-	234.6	2,372.1	2,772.0
12	5,324.8	2,866.5	188.0	302.3	1,968.0	-	7.3	-	184.7	2,369.4	2,763.5
13	5,662.6	2,956.5	378.1	360.0	1,968.0	-	19.4	-	531.2	2,362.7	2,749.3
14	5,855.5	3,154.5	373.0	360.0	1,968.0	-	38.7	1.9	582.8	2,400.0	2,832.0
15	5,976.4	3,151.8	376.2	480.5	1,968.0	-	19.7	-	677.7	2,400.0	2,879.0
16	5,970.8	3,143.8	376.9	482.2	1,968.0	-	18.8	-	672.1	2,400.0	2,880.0
17	5,766.1	3,156.0	162.1	480.0	1,968.0	-	8.2	-	477.9	2,400.0	2,880.0
18	5,507.3	3,161.0	135.0	243.3	1,968.0	-	8.8	-	295.1	2,400.0	2,803.5
19	5,498.8	3,154.3	135.2	241.2	1,968.0	-	6.2	-	289.9	2,400.0	2,802.7
20	4,213.8	3,146.1	107.7	-	960.0	-	-	-	-	1,968.5	2,245.3
21	4,497.6	3,146.0	107.4	284.2	960.0	-	-	-	-	2,104.5	2,393.0
22	5,469.3	3,120.0	108.3	380.0	984.0	877.0	-	-	238.3	2,400.0	2,831.0
23	5,172.2	3,120.0	108.2	-	984.0	960.0	-	-	72.2	2,400.0	2,700.0
24	5,535.1	3,132.0	107.7	360.0	960.0	975.4	-	-	307.9	2,400.0	2,827.2
25	5,188.8	3,120.0	106.7	40.0	960.0	962.1	-	-	85.7	2,400.0	2,703.1
26	5,633.1	3,130.9	107.6	480.0	960.0	954.6	-	-	353.1	2,400.0	2,880.0
27	5,622.4	3,099.6	107.9	482.8	960.0	972.0	-	-	342.6	2,400.0	2,879.8
28	5,435.9	3,119.7	241.1	160.9	960.0	954.2	-	-	224.0	2,400.0	2,811.9
29	5,148.2	3,120.0	108.2	-	960.0	960.0	-	-	68.2	2,400.0	2,680.0
30	5,229.3	3,120.0	108.3	140.0	984.0	877.0	-	-	107.5	2,400.0	2,721.8
31	5,427.5	3,119.7	213.7	180.0	960.0	954.2	-	-	290.5	2,400.0	2,737.0

Figure 5.9 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st May 2014 by using the Lambda iteration method.

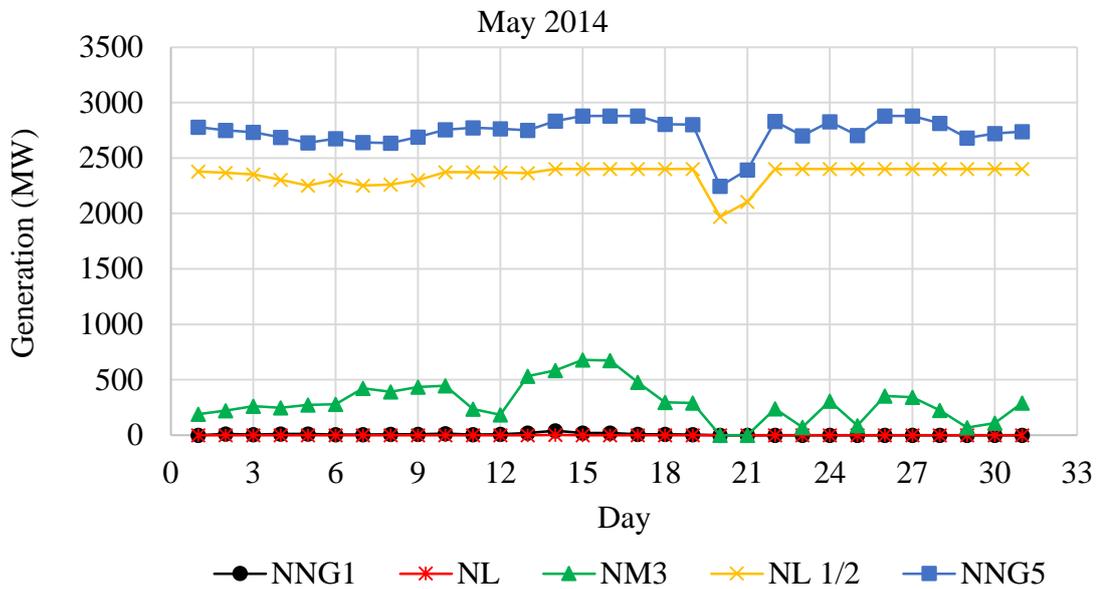


Figure 5.9 The result of optimal dispatch by using Lambda iteration method

Figure 5.10 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of May 2014 is \$ 573,563.49, which is equivalent to 6.68 %.

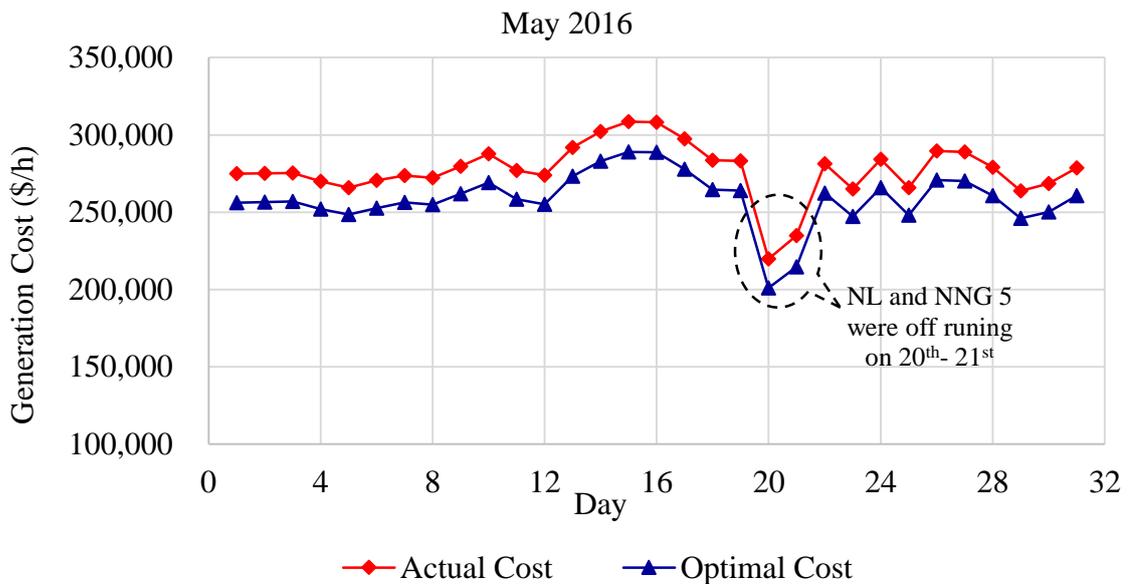


Figure 5.10 Comparison actual cost and optimal cost in May 2014

5.3.6 Optimal load dispatch in June 2014

The table 5.8 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th June 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The NNG 1 and NL are unnecessary to operate while low load on 1st to 4th and 15th to 20th. The actual power of NNG 5 does not operate on 8th to 15st.

Table 5.8 Power output of scheduling 5 HPP in June 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	5,153.0	3,116.9	107.8	-	960.0	968.2	-	-	70.2	2,396.3	2,686.5
2	5,151.2	3,115.6	108.3	-	960.0	967.2	-	-	67.8	2,399.4	2,684.0
3	5,573.5	3,114.0	189.2	343.1	960.0	967.2	-	-	362.0	2,400.0	2,811.4
4	5,722.5	3,113.7	189.8	487.1	960.0	971.9	-	-	442.5	2,400.0	2,880.0
5	6,267.6	3,130.5	432.0	785.9	960.0	959.3	252.9	16.9	717.8	2,400.0	2,880.0
6	6,953.4	3,147.8	919.4	972.2	960.0	954.1	601.7	111.7	960.0	2,400.0	2,880.0
7	6,641.4	3,136.5	920.9	972.5	972.0	639.6	363.5	38.0	960.0	2,400.0	2,880.0
8	6,652.4	3,132.2	1,027.5	972.7	1,520.0	-	459.6	104.8	808.0	2,400.0	2,880.0
9	6,991.7	3,167.9	932.0	971.8	1,920.0	-	628.5	123.2	960.0	2,400.0	2,880.0
10	6,659.4	3,118.0	650.5	970.9	1,920.0	-	396.1	23.3	960.0	2,400.0	2,880.0
11	6,918.2	3,088.0	1,058.3	885.5	1,886.4	-	589.3	121.9	927.0	2,400.0	2,880.0
12	7,055.7	3,152.5	1,053.3	963.5	1,886.4	-	673.2	142.5	960.0	2,400.0	2,880.0
13	6,944.8	3,143.9	962.7	963.2	1,875.0	-	595.7	109.1	960.0	2,400.0	2,880.0
14	5,714.0	3,128.8	325.2	740.0	1,520.0	-	16.6	1.0	510.4	2,400.0	2,786.0
15	5,251.2	3,108.4	726.2	480.5	936.0	-	-	-	62.8	2,400.0	2,788.4
16	5,637.3	3,074.0	648.0	480.7	936.0	498.5	4.8	-	425.9	2,400.0	2,806.6
17	5,989.3	3,029.8	459.5	480.0	936.0	1,084.0	0.2	-	709.1	2,400.0	2,880.0
18	5,878.7	3,054.4	404.7	480.9	864.0	1,074.7	-	-	598.7	2,400.0	2,880.0
19	5,614.9	2,965.7	296.8	480.6	840.0	1,031.7	-	-	378.1	2,400.0	2,836.7
20	5,801.3	3,075.5	270.0	481.5	840.0	1,134.3	5.2	-	516.1	2,400.0	2,880.0
21	6,607.2	3,036.9	837.0	820.0	840.0	1,073.3	516.3	118.2	710.9	2,400.0	2,861.8
22	7,180.9	2,877.8	1,311.7	968.2	936.0	1,087.1	760.2	180.6	960.0	2,400.0	2,880.0
23	7,191.2	2,914.0	1,328.9	968.5	905.8	1,074.0	767.6	183.6	960.0	2,400.0	2,880.0
24	7,465.1	3,127.8	1,346.0	960.0	936.0	1,095.3	959.5	265.6	960.0	2,400.0	2,880.0
25	8,360.0	2,976.5	1,355.7	961.1	1,856.6	1,210.1	1,602.0	548.0	930.1	2,400.0	2,880.0
26	7,982.9	3,218.2	655.3	963.1	1,848.0	1,298.3	1,321.6	421.3	960.0	2,400.0	2,880.0
27	8,384.1	3,237.2	1,002.5	964.7	1,867.6	1,312.1	1,602.2	541.9	960.0	2,400.0	2,880.0
28	8,691.1	3,241.0	1,352.8	964.7	1,848.0	1,284.7	1,816.9	634.3	960.0	2,400.0	2,880.0
29	8,576.7	3,276.0	1,351.1	965.5	1,848.0	1,136.1	1,736.9	599.9	960.0	2,400.0	2,880.0
30	8,757.7	3,298.9	1,314.4	967.3	1,864.8	1,312.4	1,863.5	654.3	960.0	2,400.0	2,880.0

Figure 5.11 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th June 2014 by using the Lambda iteration method.

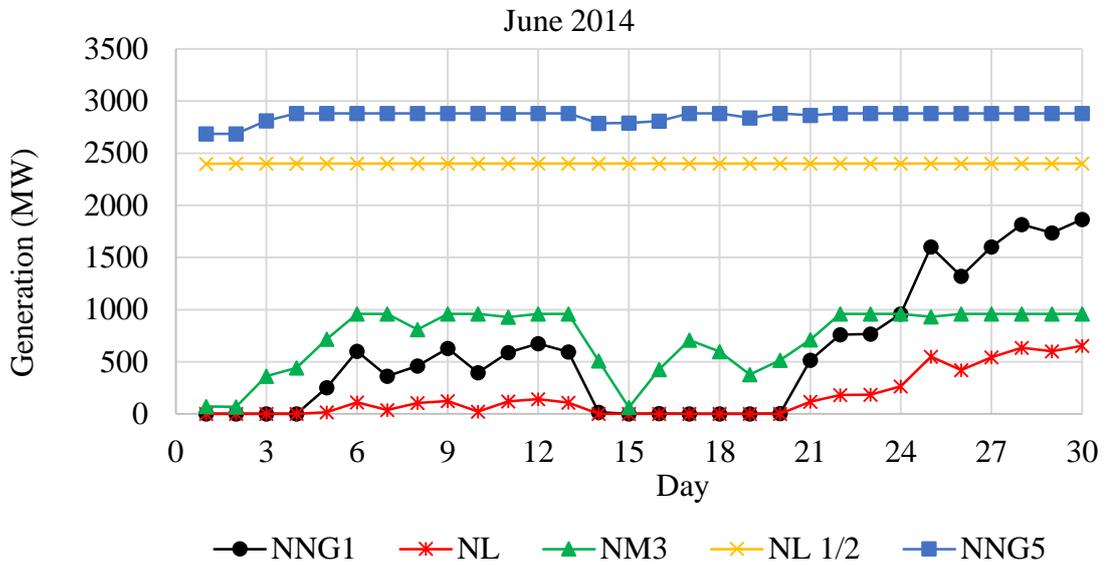


Figure 5.11 The result of optimal dispatch by using Lambda iteration method

Figure 5.12 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of June 2014 is \$ 548,813.74, which is equivalent to 5.27 %.

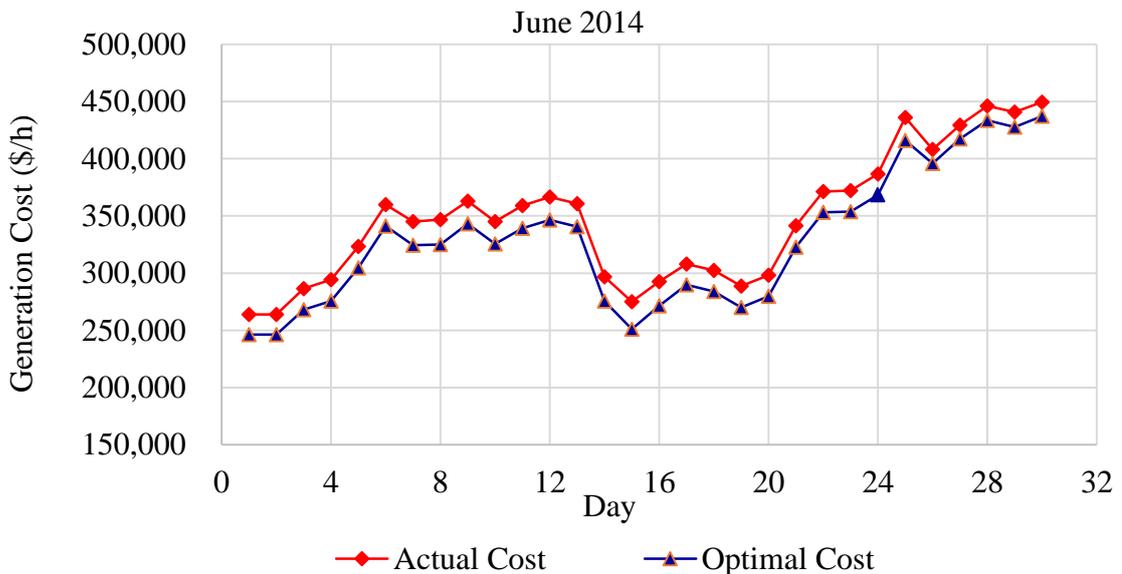


Figure 5.12 Comparison actual cost and optimal cost in June 2014

5.3.7 Optimal load dispatch in July 2014

The table 5.9 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st July 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power is not much difference.

Table 5.9 Power output of scheduling 5 HPP in July 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	8,501.7	3,062.4	1,315.5	967.3	1,848.0	1,308.5	1,684.4	577.3	960.0	2,400.0	2,880.0
2	8,704.7	3,234.6	1,325.5	967.3	1,848.0	1,329.3	1,826.3	638.3	960.0	2,400.0	2,880.0
3	8,506.6	3,009.5	1,326.5	966.8	1,848.0	1,355.9	1,687.8	578.8	960.0	2,400.0	2,880.0
4	8,865.8	3,297.7	1,327.2	966.3	1,655.6	1,619.0	1,939.0	686.8	960.0	2,400.0	2,880.0
5	8,049.1	3,328.6	1,332.0	964.6	1,287.0	1,136.9	1,367.9	441.2	960.0	2,400.0	2,880.0
6	7,002.8	3,302.2	651.4	965.9	952.1	1,131.2	636.2	126.6	960.0	2,400.0	2,880.0
7	7,173.4	3,305.7	647.6	965.8	1,403.0	851.3	782.0	213.8	897.6	2,400.0	2,880.0
8	7,886.0	3,098.1	648.2	960.0	1,850.1	1,329.6	1,253.8	392.2	960.0	2,400.0	2,880.0
9	7,748.5	2,912.9	910.5	967.2	1,848.0	1,109.9	1,157.7	350.8	960.0	2,400.0	2,880.0
10	9,174.0	2,651.3	1,344.0	967.9	1,848.0	2,362.9	2,154.6	779.5	960.0	2,400.0	2,880.0
11	7,986.7	2,723.3	1,272.5	960.0	1,850.0	1,180.9	1,324.3	422.4	960.0	2,400.0	2,880.0
12	8,202.7	2,843.6	1,361.1	960.0	1,883.0	1,155.0	1,475.3	487.4	960.0	2,400.0	2,880.0
13	7,670.1	2,991.0	679.6	966.5	1,896.0	1,137.1	1,102.9	327.2	960.0	2,400.0	2,880.0
14	8,420.9	3,086.5	1,362.0	968.1	1,896.0	1,108.3	1,627.9	553.0	960.0	2,400.0	2,880.0
15	8,528.2	3,089.7	1,360.1	969.2	1,941.0	1,168.2	1,702.9	585.3	960.0	2,400.0	2,880.0
16	9,421.8	3,026.6	1,398.3	926.8	1,896.0	2,174.1	2,327.8	854.0	960.0	2,400.0	2,880.0
17	8,679.8	3,271.6	1,396.8	967.0	1,941.0	1,103.5	1,809.0	630.8	960.0	2,400.0	2,880.0
18	9,983.4	3,246.2	1,392.0	966.7	1,896.0	2,482.5	2,720.5	1,022.8	960.0	2,400.0	2,880.0
19	10,594.8	3,506.2	1,393.6	967.0	1,958.4	2,769.6	3,148.1	1,206.7	960.0	2,400.0	2,880.0
20	10,594.8	3,506.2	1,393.6	967.0	1,958.4	2,769.6	3,148.1	1,206.7	960.0	2,400.0	2,880.0
21	8,689.3	3,516.7	1,397.2	960.0	1,981.0	834.4	1,815.6	633.7	960.0	2,400.0	2,880.0
22	10,496.5	3,499.5	1,404.0	921.5	1,992.0	2,679.5	3,079.5	1,177.1	960.0	2,400.0	2,880.0
23	10,118.1	2,973.4	1,428.0	964.0	2,040.0	2,712.8	2,814.8	1,063.4	960.0	2,400.0	2,880.0
24	10,671.9	3,520.6	1,428.0	967.4	2,040.0	2,715.9	3,202.0	1,229.9	960.0	2,400.0	2,880.0
25	10,345.6	3,529.5	1,428.0	969.2	2,040.0	2,378.9	2,973.8	1,131.7	960.0	2,400.0	2,880.0
26	10,695.7	3,533.3	1,428.0	969.4	2,040.0	2,725.0	3,218.6	1,237.0	960.0	2,400.0	2,880.0
27	10,726.0	3,539.3	1,438.6	969.5	2,040.0	2,738.7	3,239.9	1,246.2	960.0	2,400.0	2,880.0
28	10,723.2	3,558.1	1,425.4	970.5	2,040.0	2,729.2	3,237.9	1,245.3	960.0	2,400.0	2,880.0
29	9,399.3	3,593.3	1,428.0	972.1	1,998.4	1,407.4	2,312.1	847.2	960.0	2,400.0	2,880.0
30	10,286.5	3,591.8	1,428.0	971.1	1,430.3	2,865.3	2,932.5	1,114.0	960.0	2,400.0	2,880.0
31	11,064.9	3,621.7	1,428.0	946.0	2,175.9	2,893.4	3,476.9	1,348.1	960.0	2,400.0	2,880.0

Figure 5.13 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st July 2014 by using the Lambda iteration method.

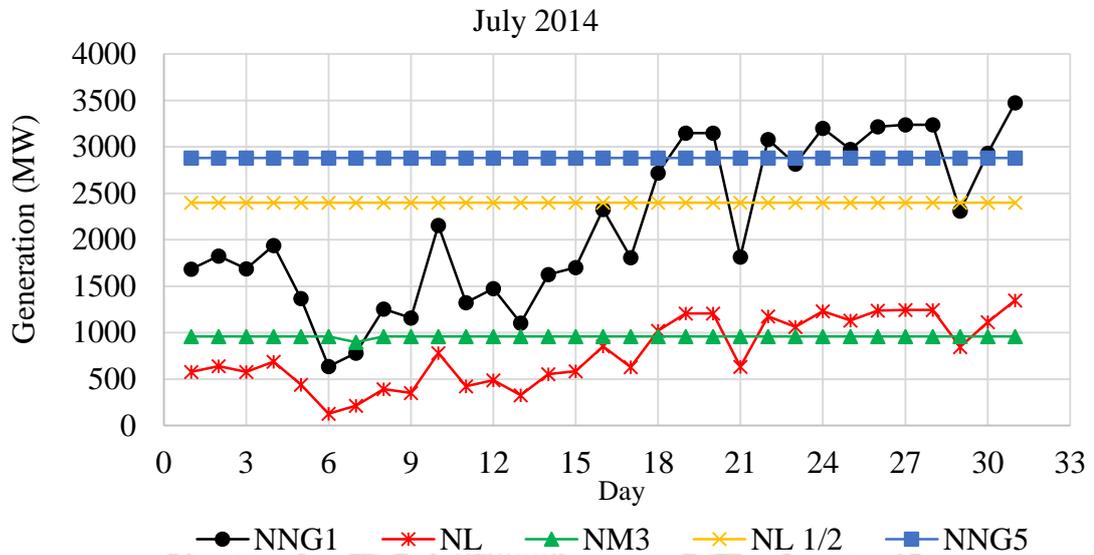


Figure 5.13 The result of optimal dispatch by using Lambda iteration method

Figure 5.14 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of July 2014 is \$ 279,365.83, which is equivalent to 1.92 %.

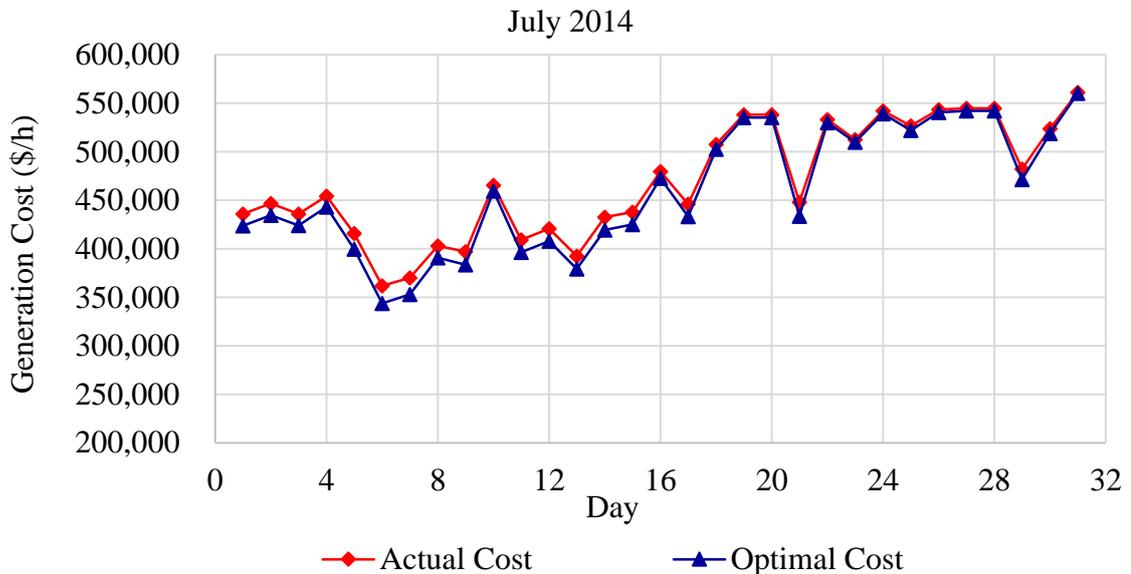


Figure 5.14 Comparison actual cost and optimal cost in July 2014

5.3.8 Optimal load dispatch in August 2014

The table 5.10 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st August 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power of actual and optimal are similar.

Table 5.10 Power output of scheduling 5 HPP in August 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	11,146.6	3,690.0	1,425.6	960.0	2,191.0	2,880.0	3,534.0	1,372.6	960.0	2,400.0	2,880.0
2	11,223.1	3,738.2	1,437.9	964.7	2,222.0	2,860.2	3,588.2	1,394.8	960.0	2,400.0	2,880.0
3	11,192.7	3,656.7	1,440.0	960.0	2,256.0	2,880.0	3,566.2	1,386.5	960.0	2,400.0	2,880.0
4	11,301.2	3,705.2	1,440.0	960.0	2,316.0	2,880.0	3,642.1	1,419.1	960.0	2,400.0	2,880.0
5	11,233.7	3,675.5	1,440.0	960.0	2,379.2	2,779.0	3,596.1	1,397.6	960.0	2,400.0	2,880.0
6	11,008.2	3,762.8	1,440.0	960.0	2,379.2	2,466.2	3,450.3	1,317.9	960.0	2,400.0	2,880.0
7	11,387.5	3,794.7	1,464.0	967.9	2,379.2	2,781.7	3,727.0	1,420.5	960.0	2,400.0	2,880.0
8	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
9	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
10	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
11	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
12	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
13	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
14	11,514.9	3,840.0	1,440.0	960.0	2,400.0	2,874.9	3,834.9	1,440.0	960.0	2,400.0	2,880.0
15	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
16	10,095.9	3,840.0	1,440.0	960.0	2,400.0	1,455.9	2,799.2	1,056.7	960.0	2,400.0	2,880.0
17	10,096.9	3,840.0	1,440.0	960.0	2,400.0	1,456.9	2,799.9	1,057.0	960.0	2,400.0	2,880.0
18	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
19	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
20	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
21	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
22	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
23	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
24	10,933.0	3,840.0	853.0	960.0	2,400.0	2,880.0	3,392.1	1,300.9	960.0	2,400.0	2,880.0
25	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
26	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
27	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
28	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
29	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
30	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
31	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0

Figure 5.15 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st August 2014 by using the Lambda iteration method.

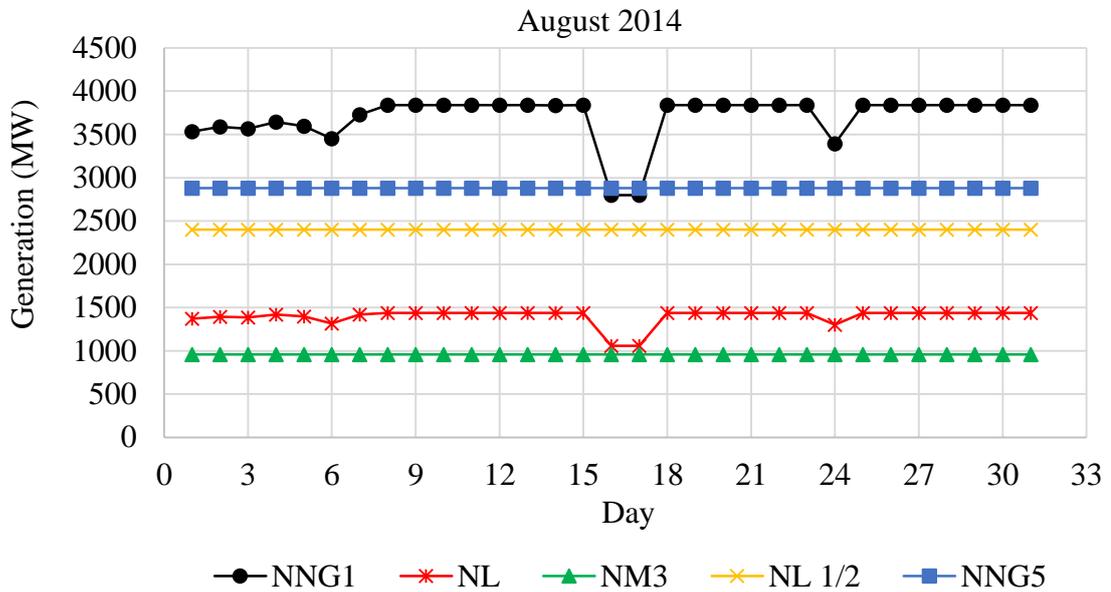


Figure 5.15 The result of optimal dispatch by using Lambda iteration method

Figure 5.16 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of August 2014 is \$ 24,405.84, which is equivalent to 0.14 %.

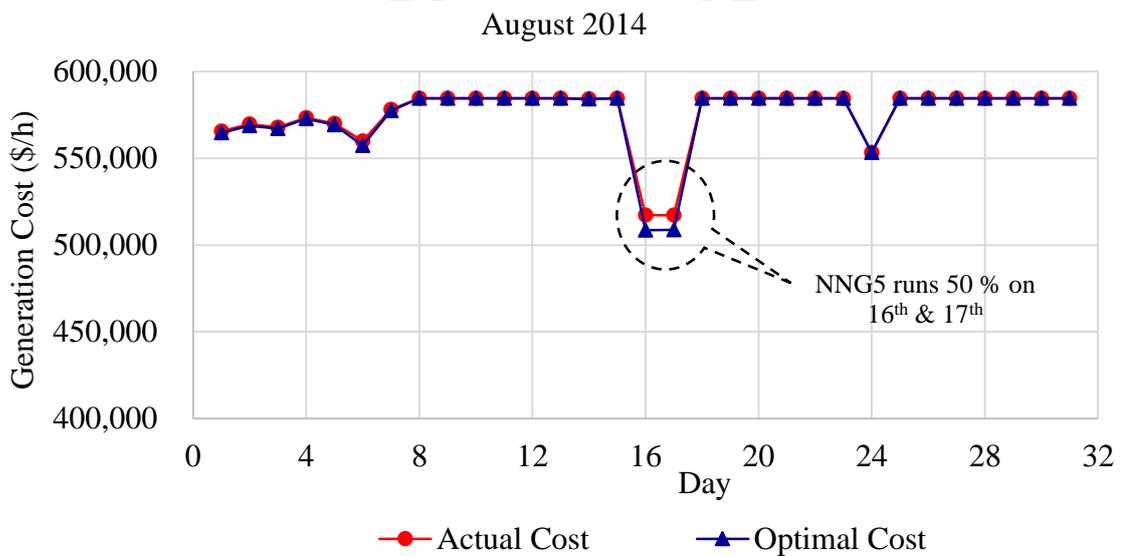


Figure 5.16 Comparison actual cost and optimal cost in August 2014

5.3.9 Optimal load dispatch in September 2014

The table 5.11 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th September 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power of actual and optimal are not much difference.

Table 5.11 Power output of scheduling 5 HPP in September 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	11,494.2	3,840.0	1,440.0	960.0	2,400.0	2,854.2	3,814.2	1,440.0	960.0	2,400.0	2,880.0
2	11,480.3	3,840.0	1,440.0	960.0	2,400.0	2,840.3	3,800.3	1,440.0	960.0	2,400.0	2,880.0
3	11,483.8	3,840.0	1,440.0	960.0	2,400.0	2,843.8	3,803.8	1,440.0	960.0	2,400.0	2,880.0
4	11,482.6	3,840.0	1,440.0	960.0	2,400.0	2,842.6	3,802.6	1,440.0	960.0	2,400.0	2,880.0
5	11,483.8	3,840.0	1,440.0	960.0	2,400.0	2,843.8	3,803.8	1,440.0	960.0	2,400.0	2,880.0
6	11,483.8	3,840.0	1,440.0	960.0	2,400.0	2,843.8	3,803.8	1,440.0	960.0	2,400.0	2,880.0
7	11,488.6	3,840.0	1,440.0	960.0	2,400.0	2,848.6	3,808.6	1,440.0	960.0	2,400.0	2,880.0
8	11,477.5	3,840.0	1,440.0	960.0	2,400.0	2,837.5	3,799.3	1,438.2	960.0	2,400.0	2,880.0
9	11,493.5	3,840.0	1,440.0	960.0	2,400.0	2,853.5	3,813.5	1,440.0	960.0	2,400.0	2,880.0
10	11,493.6	3,840.0	1,440.0	960.0	2,400.0	2,853.6	3,813.6	1,440.0	960.0	2,400.0	2,880.0
11	11,490.9	3,840.0	1,440.0	960.0	2,400.0	2,850.9	3,810.9	1,440.0	960.0	2,400.0	2,880.0
12	10,547.4	3,840.0	1,440.0	960.0	2,400.0	1,907.4	3,127.4	1,180.0	960.0	2,400.0	2,880.0
13	10,569.6	3,840.0	1,440.0	960.0	2,400.0	1,929.6	3,144.5	1,185.1	960.0	2,400.0	2,880.0
14	11,516.8	3,840.0	1,440.0	960.0	2,400.0	2,876.8	3,836.8	1,440.0	960.0	2,400.0	2,880.0
15	11,487.6	3,840.0	1,440.0	960.0	2,400.0	2,847.6	3,807.6	1,440.0	960.0	2,400.0	2,880.0
16	11,489.0	3,840.0	1,440.0	960.0	2,400.0	2,849.0	3,809.0	1,440.0	960.0	2,400.0	2,880.0
17	11,491.0	3,840.0	1,440.0	960.0	2,400.0	2,851.0	3,811.0	1,440.0	960.0	2,400.0	2,880.0
18	11,489.2	3,840.0	1,440.0	960.0	2,400.0	2,849.2	3,809.2	1,440.0	960.0	2,400.0	2,880.0
19	11,488.5	3,840.0	1,440.0	960.0	2,400.0	2,848.5	3,808.5	1,440.0	960.0	2,400.0	2,880.0
20	11,491.4	3,840.0	1,440.0	960.0	2,400.0	2,851.4	3,811.4	1,440.0	960.0	2,400.0	2,880.0
21	11,386.5	3,840.0	1,440.0	960.0	2,400.0	2,746.5	3,735.1	1,411.4	960.0	2,400.0	2,880.0
22	11,483.7	3,840.0	1,440.0	960.0	2,400.0	2,843.7	3,803.7	1,440.0	960.0	2,400.0	2,880.0
23	11,492.0	3,840.0	1,440.0	960.0	2,400.0	2,852.0	3,812.0	1,440.0	960.0	2,400.0	2,880.0
24	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
25	11,054.4	3,840.0	1,440.0	960.0	2,400.0	2,414.4	3,490.4	1,324.0	960.0	2,400.0	2,880.0
26	10,062.9	3,840.0	1,440.0	960.0	2,400.0	1,422.9	2,776.1	1,046.7	960.0	2,400.0	2,880.0
27	10,071.6	3,840.0	1,440.0	960.0	2,400.0	1,431.6	2,782.2	1,049.4	960.0	2,400.0	2,880.0
28	10,074.4	3,840.0	1,440.0	960.0	2,400.0	1,434.4	2,784.2	1,050.2	960.0	2,400.0	2,880.0
29	10,061.6	3,840.0	1,440.0	960.0	2,400.0	1,421.6	2,775.2	1,046.4	960.0	2,400.0	2,880.0
30	9,607.2	3,840.0	1,440.0	488.9	2,400.0	1,438.3	2,457.5	909.7	960.0	2,400.0	2,880.0

Figure 5.17 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th September 2014 by using the Lambda iteration method.

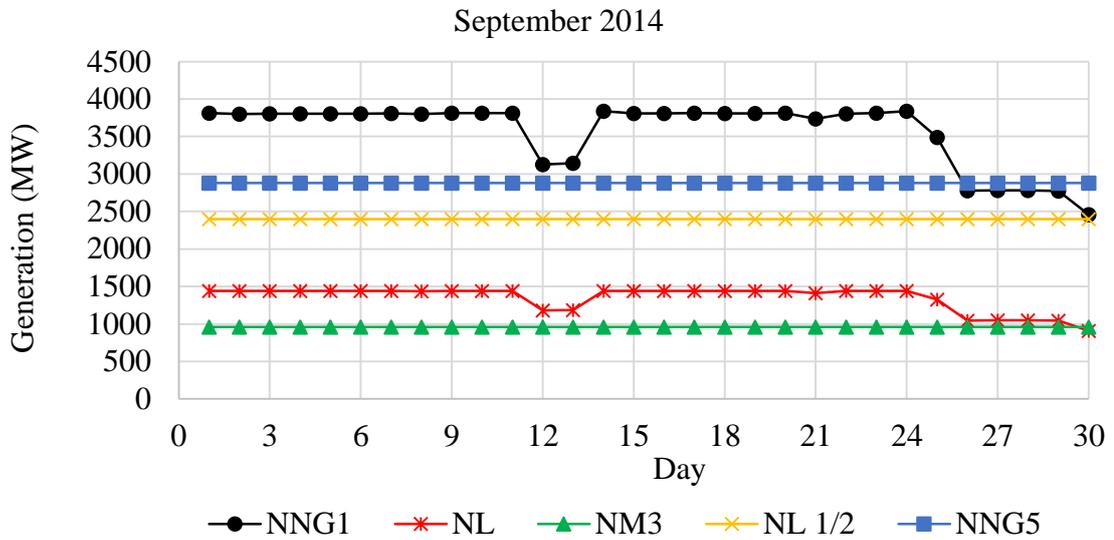


Figure 5.17 The result of optimal dispatch by using Lambda iteration method

Figure 5.18 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of September 2014 is \$ 62,497.85, which is equivalent to 0.37 %.

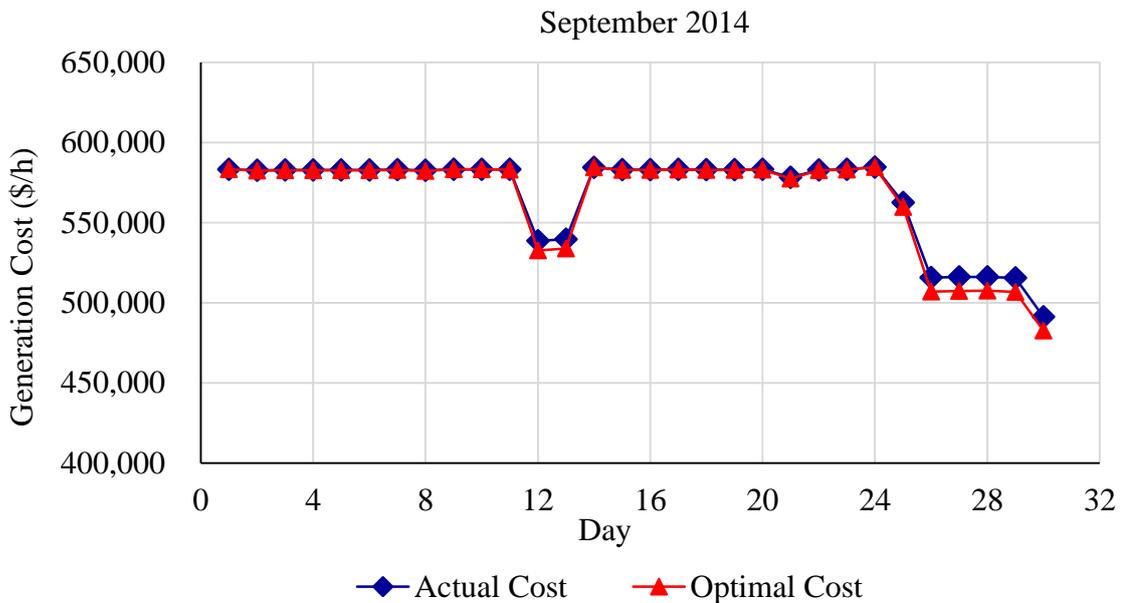


Figure 5.18 Comparison actual cost and optimal cost in September 2014

5.3.10 Optimal load dispatch in October 2014

The table 5.12 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st October 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power of actual and optimal are similar.

Table 5.12 Power output of scheduling 5 HPP in October 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	9,894.4	4,317.4	1,452.7	489.0	2,526.3	1,108.9	2,658.3	996.1	960.0	2,400.0	2,880.0
2	8,991.0	4,330.5	727.4	320.3	2,531.0	1,081.8	2,026.6	724.4	960.0	2,400.0	2,880.0
3	9,008.0	4,324.1	729.4	305.3	2,532.5	1,116.7	2,038.5	729.5	960.0	2,400.0	2,880.0
4	8,959.6	4,308.8	723.0	304.1	2,527.6	1,096.1	2,004.6	715.0	960.0	2,400.0	2,880.0
5	8,933.8	4,304.1	722.4	301.8	2,523.7	1,081.8	1,986.5	707.2	960.0	2,400.0	2,880.0
6	8,967.8	4,299.1	722.2	306.1	2,523.7	1,116.7	2,010.3	717.4	960.0	2,400.0	2,880.0
7	8,849.6	4,284.0	731.2	303.3	2,442.7	1,088.4	1,927.7	681.9	960.0	2,400.0	2,880.0
8	8,795.7	4,284.0	720.0	303.3	2,400.0	1,088.4	1,890.0	665.7	960.0	2,400.0	2,880.0
9	8,858.0	4,276.7	720.0	304.6	2,402.7	1,154.1	1,933.6	684.4	960.0	2,400.0	2,880.0
10	8,977.9	4,292.7	720.0	304.2	2,354.5	1,306.6	2,017.4	720.5	960.0	2,400.0	2,880.0
11	8,812.6	4,289.7	303.7	720.0	2,410.6	1,088.6	1,901.8	670.8	960.0	2,400.0	2,880.0
12	7,141.7	3,212.8	120.2	304.1	2,418.7	1,085.8	733.3	168.3	960.0	2,400.0	2,880.0
13	7,182.2	3,218.4	149.6	304.9	2,415.9	1,093.4	761.6	180.5	960.0	2,400.0	2,880.0
14	8,148.8	3,925.1	455.3	284.8	2,413.2	1,070.5	1,437.6	471.2	960.0	2,400.0	2,880.0
15	7,519.0	3,387.0	452.7	304.5	2,417.5	957.3	1,046.2	356.9	835.8	2,400.0	2,880.0
16	6,853.4	3,415.2	332.4	304.7	1,716.6	1,084.5	536.0	133.2	915.5	2,400.0	2,868.7
17	5,848.7	3,380.9	452.6	304.7	607.4	1,103.1	273.1	31.7	577.7	2,287.1	2,679.1
18	6,457.2	3,410.3	448.9	304.0	1,209.2	1,084.7	520.7	132.0	600.0	2,400.0	2,804.4
19	6,149.1	3,386.3	149.5	323.1	1,210.4	1,079.8	315.7	50.0	585.8	2,400.0	2,797.7
20	5,528.4	2,768.8	150.9	304.2	1,211.7	1,092.8	9.5	-	315.0	2,400.0	2,803.8
21	5,831.6	2,835.4	420.0	263.1	1,211.9	1,101.2	243.5	24.5	559.2	2,316.1	2,688.3
22	5,728.5	2,845.1	330.0	264.1	1,212.2	1,077.1	201.9	19.5	507.0	2,313.7	2,686.4
23	5,853.5	2,828.4	420.0	300.0	1,211.7	1,093.4	256.3	24.5	560.0	2,318.4	2,694.3
24	6,226.8	2,838.1	422.4	262.3	1,611.2	1,092.9	453.3	109.2	604.0	2,333.4	2,727.0
25	7,007.0	2,826.8	421.2	261.6	2,403.5	1,093.9	729.8	228.0	769.2	2,400.0	2,880.0
26	6,803.6	2,834.7	210.3	241.6	2,412.3	1,104.6	581.7	164.4	777.5	2,400.0	2,880.0
27	6,769.4	2,830.0	150.0	282.2	2,415.5	1,091.7	557.8	154.1	777.4	2,400.0	2,880.0
28	7,023.5	2,830.7	451.1	242.2	2,411.1	1,088.4	728.7	223.0	791.8	2,400.0	2,880.0
29	6,963.2	2,832.7	482.1	242.1	2,315.8	1,090.5	721.1	224.3	737.8	2,400.0	2,880.0
30	5,878.0	2,856.0	481.5	244.4	1,205.7	1,090.5	238.0	27.4	563.0	2,327.3	2,722.4
31	5,878.2	2,856.0	481.7	244.4	1,205.7	1,090.5	238.1	27.4	563.1	2,327.3	2,722.4

Figure 5.19 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st October 2014 by using the Lambda iteration method.

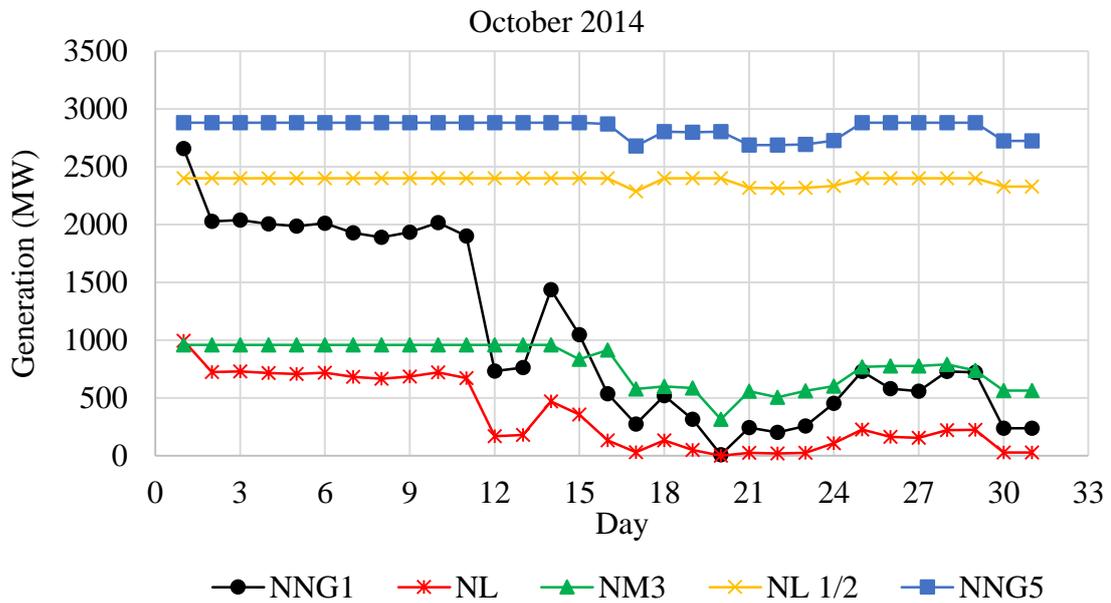


Figure 5.19 The result of optimal dispatch by using Lambda iteration method

Figure 5.20 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of October 2014 is \$ 381,550.99, which is equivalent to 3.25 %.

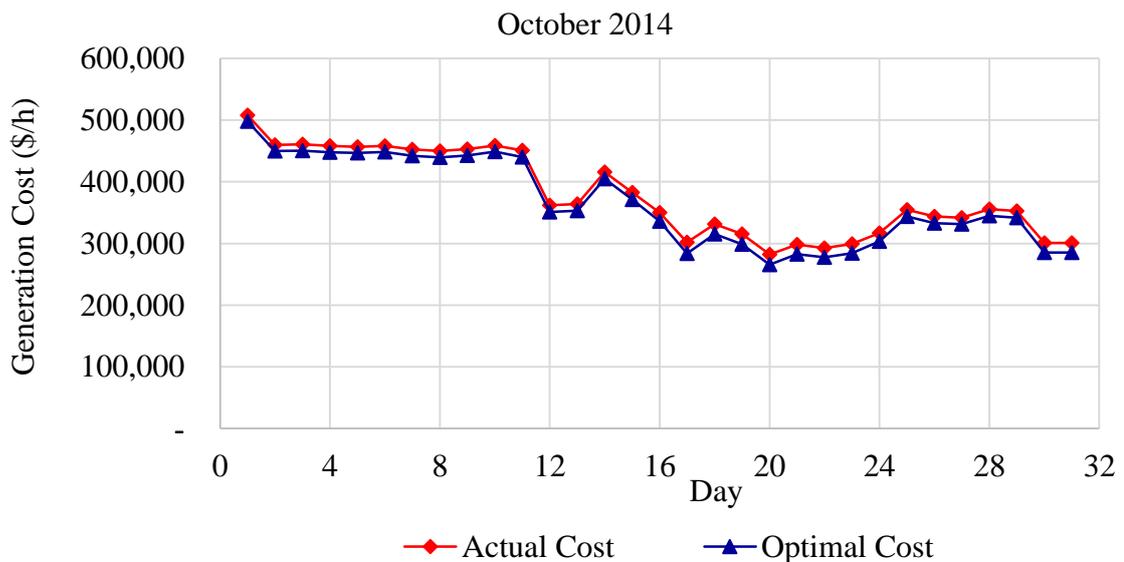


Figure 5.20 Comparison actual cost and optimal cost in October 2014

5.3.11 Optimal load dispatch in November 2014

The table 5.13 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th November 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power of NNG 5 does not operate on 9th to 13th.

Table 5.13 Power output of scheduling 5 HPP in November 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,097.4	3,075.9	420.0	305.0	1,205.3	1,091.2	265.1	28.2	599.5	2,400.0	2,804.5
2	5,851.7	3,078.1	180.0	305.3	1,204.1	1,084.1	112.5	11.6	521.1	2,400.0	2,806.4
3	5,864.2	3,083.2	180.0	305.3	1,204.1	1,091.6	115.0	12.7	524.6	2,400.0	2,811.9
4	6,411.7	3,297.4	390.0	304.8	1,204.2	1,215.4	474.4	123.4	610.3	2,400.0	2,803.6
5	6,180.3	3,251.0	390.6	304.0	1,158.5	1,076.1	345.7	75.1	560.3	2,400.0	2,799.2
6	6,212.5	3,217.2	391.3	305.8	1,213.4	1,084.8	359.0	74.7	573.9	2,400.0	2,804.9
7	6,192.0	3,251.0	390.6	304.0	1,158.5	1,087.8	347.4	75.9	560.7	2,400.0	2,808.0
8	6,244.0	3,242.5	391.6	305.4	1,215.1	1,089.4	367.4	78.4	593.6	2,400.0	2,804.6
9	4,950.4	3,250.6	179.6	305.5	1,214.7	-	71.4	6.2	192.5	2,190.1	2,490.2
10	4,991.8	3,236.3	237.3	302.8	1,215.3	-	69.8	5.5	217.7	2,186.0	2,512.7
11	5,158.1	3,253.8	390.0	304.4	1,209.9	-	68.2	4.8	298.1	2,199.8	2,587.2
12	5,557.3	3,231.8	390.0	325.6	1,207.6	402.3	247.7	63.6	426.4	2,203.7	2,615.8
13	5,158.1	3,253.8	390.0	304.4	1,209.9	-	68.2	4.8	298.1	2,199.8	2,587.2
14	6,221.0	3,231.6	390.0	303.1	1,208.3	1,088.0	356.0	73.5	592.6	2,400.0	2,799.0
15	6,237.5	3,248.3	390.0	304.8	1,209.3	1,085.1	361.7	75.9	589.3	2,400.0	2,810.5
16	5,996.2	3,217.8	179.7	305.2	1,208.7	1,084.7	226.2	60.5	510.1	2,400.0	2,799.3
17	6,028.6	3,240.9	180.0	305.6	1,215.8	1,086.3	234.4	64.0	526.0	2,400.0	2,804.1
18	6,206.4	3,217.8	390.0	305.2	1,208.7	1,084.7	349.6	70.7	586.7	2,400.0	2,799.3
19	6,179.1	3,171.5	390.0	305.6	1,222.7	1,089.3	355.1	89.0	538.8	2,400.0	2,796.2
20	6,134.9	3,132.6	390.0	304.7	1,223.6	1,084.0	327.9	81.8	539.3	2,400.0	2,785.9
21	6,134.9	3,132.6	390.0	304.7	1,223.6	1,084.0	327.9	81.8	539.3	2,400.0	2,785.9
22	5,895.5	3,111.3	392.6	303.1	1,006.0	1,082.5	255.7	54.8	483.5	2,364.0	2,737.4
23	4,749.1	2,202.3	150.0	304.3	1,005.6	1,086.9	-	-	53.2	2,206.2	2,489.6
24	4,787.2	2,213.3	181.7	303.3	1,004.7	1,084.2	-	-	69.4	2,211.4	2,506.4
25	5,888.6	3,069.9	450.0	283.3	1,003.2	1,082.2	361.5	75.8	533.8	2,264.3	2,653.1
26	5,844.6	3,081.9	390.0	284.2	1,002.2	1,086.3	367.1	78.2	520.0	2,252.3	2,627.0
27	5,836.4	3,066.9	390.0	283.6	1,008.0	1,087.9	366.2	77.8	520.0	2,248.3	2,624.1
28	5,855.8	3,074.2	393.9	302.4	1,002.8	1,082.5	375.7	81.9	520.0	2,251.6	2,626.6
29	5,791.0	3,061.7	330.5	283.9	1,029.7	1,085.1	299.1	61.4	536.6	2,253.3	2,640.6
30	4,810.8	2,192.7	242.1	282.3	1,028.0	1,065.7	-	-	88.0	2,199.7	2,523.1

Figure 5.21 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th November 2014 by using the Lambda iteration method.

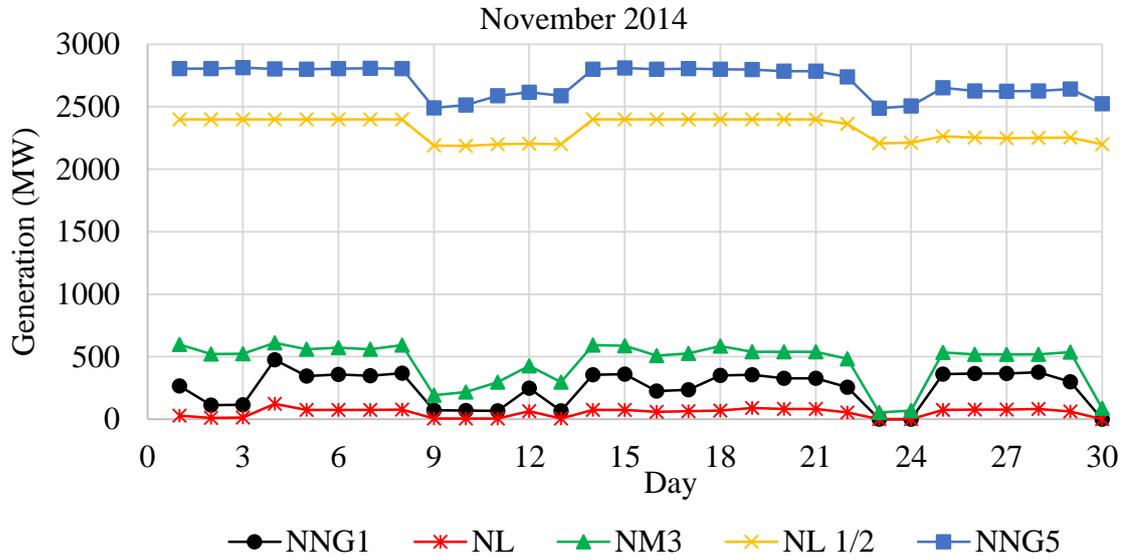


Figure 5.21 The result of optimal dispatch by using Lambda iteration method

Figure 5.22 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of November 2014 is \$ 500,031.27, which is equivalent to 5.62 %.

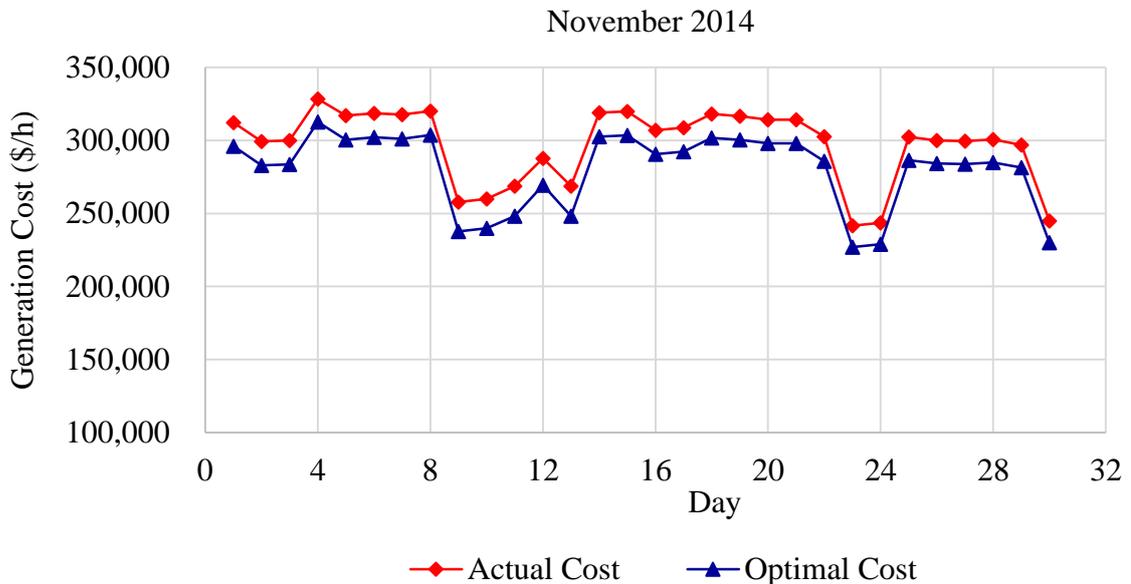


Figure 5.22 Comparison actual cost and optimal cost in November 2014

5.3.12 Optimal load dispatch in December 2014

The table 5.14 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st December 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power of NNG 5 does not operate on 9th to 15th.

Table 5.14 Power output of scheduling 5 HPP in December 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	4,959.2	2,193.2	151.0	151.1	1,375.3	1,088.6	106.3	15.1	212.5	2,144.3	2,481.1
2	6,488.0	2,808.0	392.9	221.3	2,052.6	1,013.2	479.1	126.3	602.7	2,400.0	2,880.0
3	6,057.2	2,818.8	390.9	241.9	2,060.0	545.6	316.1	58.9	561.4	2,375.1	2,745.8
4	5,405.2	2,798.8	392.6	244.1	882.0	1,087.6	59.5	2.9	482.9	2,235.0	2,624.9
5	4,983.5	2,798.8	-	222.1	869.9	1,092.7	-	-	142.9	2,234.4	2,606.4
6	5,593.6	2,865.9	420.3	224.2	1,766.8	316.4	207.0	21.2	528.8	2,215.9	2,620.7
7	5,457.1	2,874.6	149.5	241.9	1,074.5	1,116.7	29.5	2.8	407.1	2,306.0	2,711.8
8	6,891.1	2,866.7	120.9	243.0	849.3	2,811.2	602.9	155.1	853.1	2,400.0	2,880.0
9	6,565.4	4,150.5	425.5	223.4	1,766.0	-	618.5	180.8	585.1	2,395.8	2,785.2
10	5,756.2	3,384.1	392.7	224.5	1,754.9	-	192.0	15.1	525.5	2,318.4	2,705.2
11	5,897.9	3,490.3	423.4	223.8	1,760.4	-	426.8	110.5	557.3	2,200.5	2,602.8
12	6,562.4	4,142.8	420.0	221.2	1,778.4	-	609.8	177.2	592.6	2,400.0	2,782.8
13	6,613.2	4,126.5	420.0	223.8	1,842.9	-	642.1	185.3	608.4	2,395.4	2,782.1
14	4,826.5	3,613.2	119.8	242.4	851.1	-	-	-	201.0	2,121.7	2,503.9
15	4,901.6	3,685.7	120.8	244.8	850.3	-	-	-	205.2	2,155.1	2,541.3
16	6,321.1	3,744.8	420.0	222.9	849.0	1,084.4	431.0	99.6	592.8	2,400.0	2,797.7
17	6,321.7	3,744.8	420.7	222.9	848.9	1,084.4	431.5	99.8	592.8	2,400.0	2,797.7
18	5,354.9	2,764.0	423.3	224.5	851.4	1,091.8	20.7	-	497.1	2,220.1	2,617.1
19	5,331.0	2,744.0	420.0	222.3	852.8	1,091.8	17.6	-	485.5	2,215.3	2,612.6
20	5,565.2	2,756.9	420.0	223.5	844.2	1,320.5	104.3	-	528.0	2,268.6	2,664.3
21	4,966.9	2,165.4	388.2	260.0	850.9	1,302.4	-	-	111.8	2,250.5	2,604.5
22	6,242.0	2,165.4	120.0	183.0	854.6	2,919.0	148.9	21.5	791.5	2,400.0	2,880.0
23	5,555.0	2,736.5	420.6	222.3	858.3	1,317.3	102.2	-	523.6	2,267.6	2,661.6
24	5,487.3	2,672.1	419.0	221.3	858.1	1,316.8	80.7	-	469.1	2,271.9	2,665.6
25	5,564.7	2,728.2	420.0	223.5	851.8	1,341.3	108.5	-	525.3	2,269.1	2,661.8
26	5,473.5	2,669.6	420.0	221.9	852.0	1,310.0	83.9	-	523.8	2,230.8	2,635.0
27	5,548.3	2,712.6	409.6	220.8	890.7	1,314.6	103.8	8.5	521.7	2,258.7	2,655.7
28	4,663.7	2,069.6	360.0	241.9	867.8	1,124.4	-	-	1.1	2,150.8	2,512.0
29	4,954.3	2,045.6	423.6	231.8	914.7	1,338.6	7.2	-	133.4	2,224.2	2,589.7
30	4,850.9	2,045.6	360.0	240.0	890.7	1,314.6	3.9	-	109.0	2,179.2	2,558.8
31	4,807.7	2,098.4	388.8	270.7	896.6	1,153.2	-	-	47.8	2,191.7	2,568.2

Figure 5.23 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st December 2014 by using the Lambda iteration method.

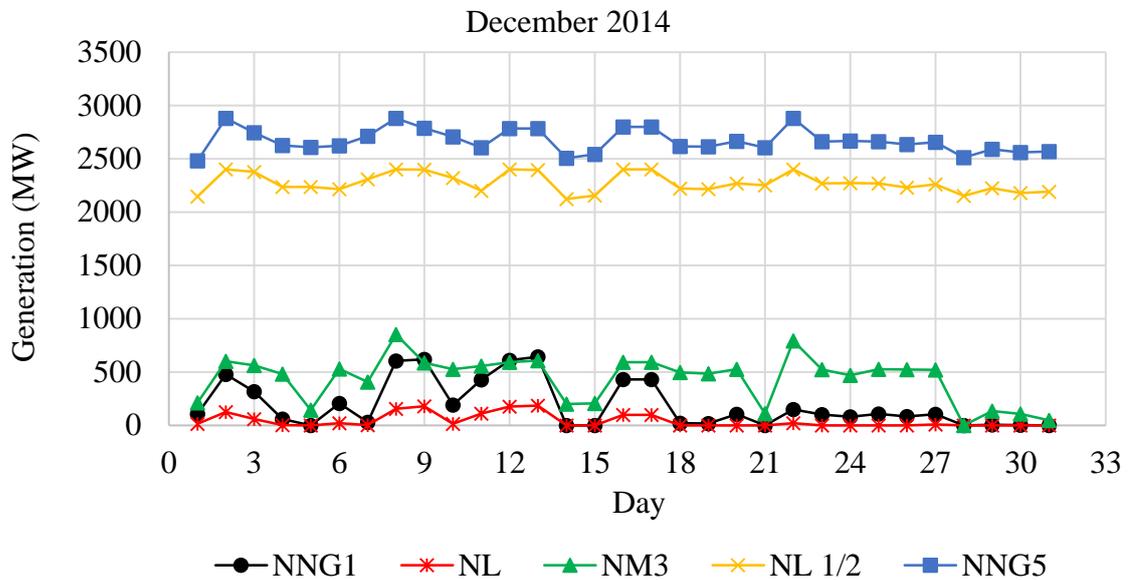


Figure 5.23 The result of optimal dispatch by using Lambda iteration method

Figure 5.20 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of December 2014 is \$ 492,692.62, which is equivalent to 5.53 %.

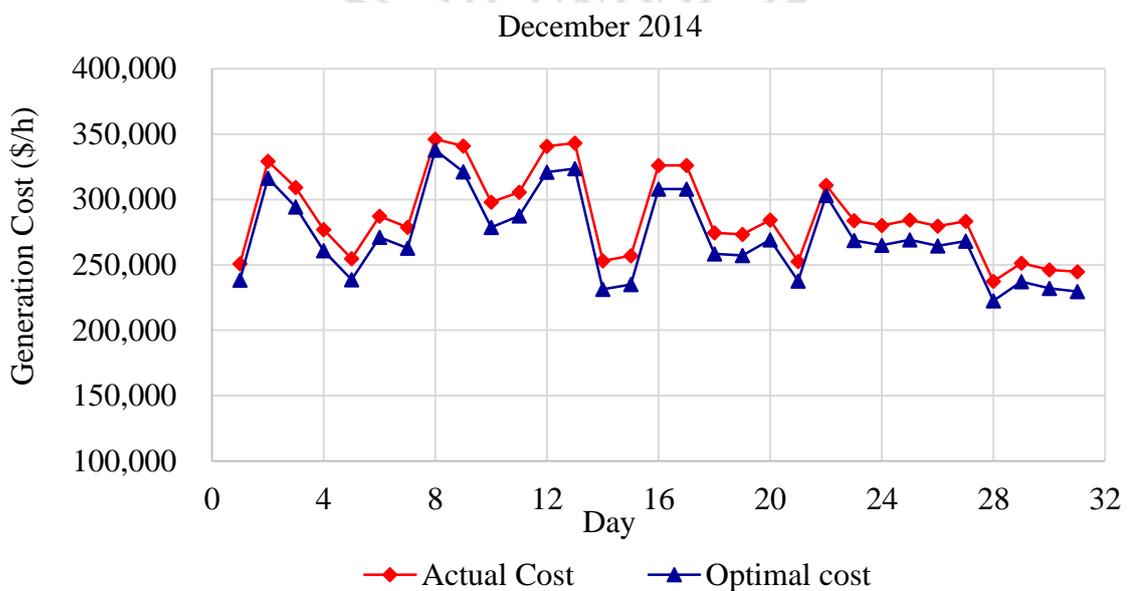


Figure 5.24 Comparison actual cost and optimal cost in December 2014

5.4 The Result of the Optimal Dispatch Neglecting Generator Limits (Case 1)

Figure 5.25 shows the optimal cost of 5 hydropower plants in central-1 network of EDL in whole year 2014. The detail of the power output and cost generation by using Lambda iteration method of each month in 2014 as shown in appendix A.

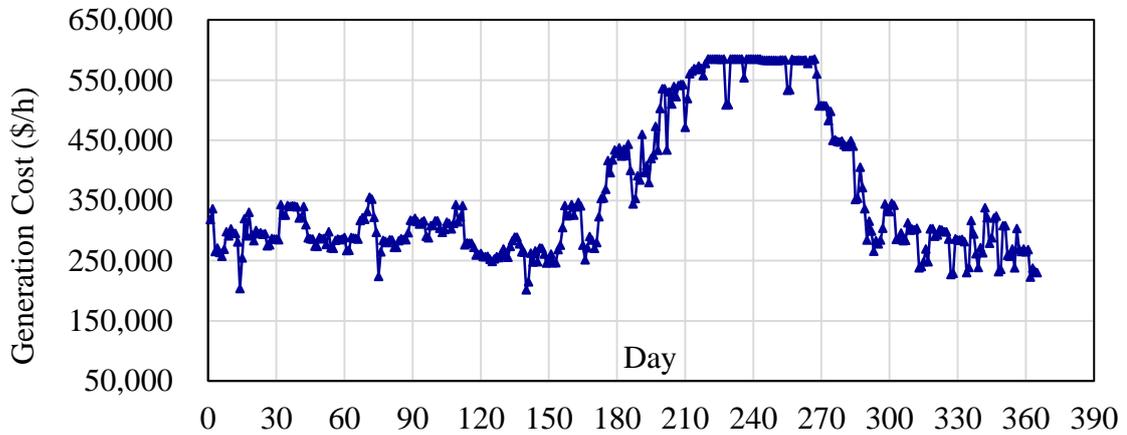


Figure 5.25 Optimal cost in 2014

The comparison between the actual cost and optimal cost in the whole year 2014, the values are different. The optimal cost is lower than actual cost as shown in figure 5.26.

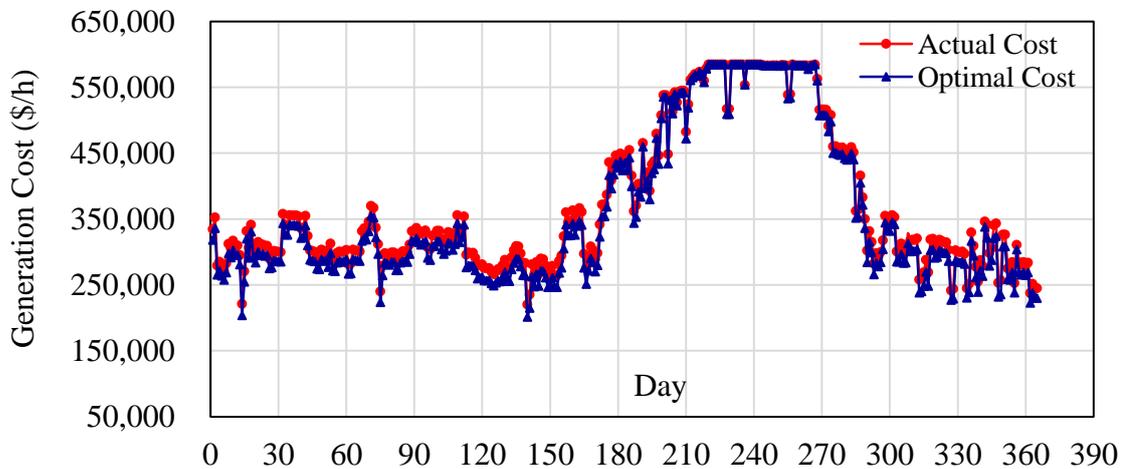


Figure 5.26 Comparison actual and optimal cost on daily 2014

The different cost value of daily in year 2014 between actual cost and optimal cost. When the generator running with low load the different cost is high such as January to June and September to December, because in this period there can choose generator

which is minimized of generation cost. If each unit of the generators are operated full load such as July to August, the generations cost are not much different as shown in figure 5.28.

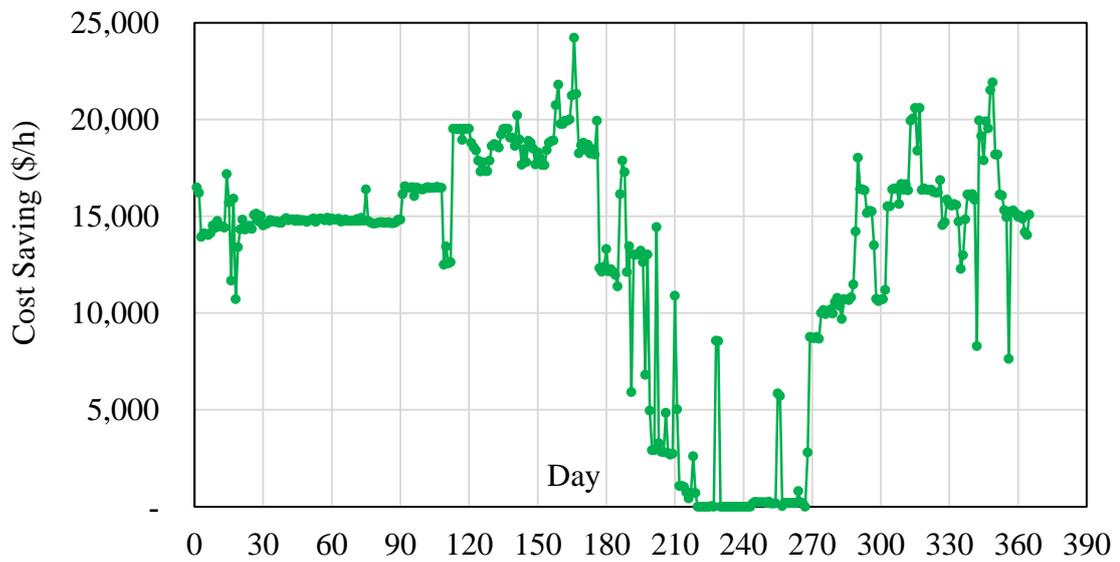


Figure 5.27 Different cost between actual and optimal value in 2014

The comparison low and high load between the actual cost and optimal cost, the values are different. The optimal cost is lower than actual cost. When the generator running with low load the different cost is high, because in this period there can choose generator which is minimized of generation cost. If each unit of the generators are operated full load, the generations cost are not much different as shown in figure 5.27.

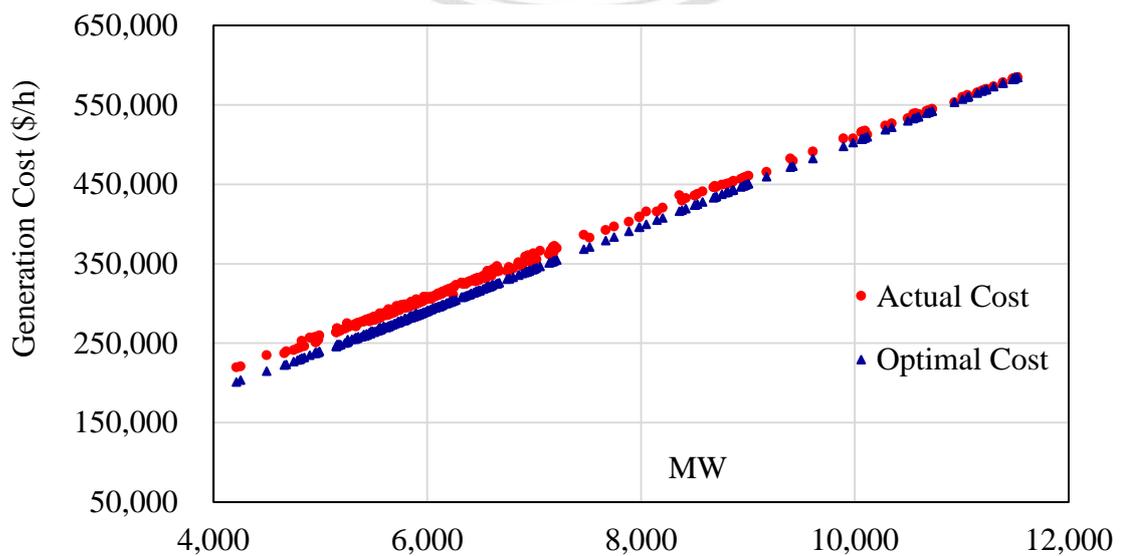


Figure 5.28 Comparison actual and optimal cost with low to high load in 2014

Table 5.15 shows the result of power load demand, actual cost, optimal cost and cost saving of scheduling of 5 hydropower plants in central-1 network of EDL. The study can observe that the optimized operation cost is lower than actual operation cost. The cost saving in every month is different. Some months the different cost is high such as May. The cost saving is \$ 573,563, which is equivalent to 6.68 %, because in this period there can choose generator which is minimized of generation cost. The different cost is too low in August. The cost saving is \$ 24,406, which is equivalent to 0.14 %, this period the generators are operated full load, the generation cost is not much different. The amount of cost saving for the case 1 in whole year 2014 is \$ 4,688,278, which is equivalent to 3.46 %.

Table 5.15 Result of power and cost output of scheduling 5 HPP in 2014

Month	P-Load (MW)	Actual Cost (\$/h)	Optimal Cost (\$/h)	Cost Saving (\$)	Percentage (%)
Jan	183,360.41	9,338,771	8,888,348	450,423	4.82
Feb	175,168.89	8,924,551	8,510,598	413,953	4.64
Mar	187,689.80	9,553,539	9,094,784	458,755	4.80
Apr	185,982.23	9,530,823	9,028,599	502,224	5.27
May	166,894.23	8,590,257	8,016,694	573,563	6.68
Jun	201,768.04	10,422,893	9,874,079	548,814	5.27
Jul	284,912.47	14,551,126	14,271,760	279,366	1.92
Aug	351,533.64	17,847,326	17,822,920	24,406	0.14
Sep	334,737.39	17,019,632	16,957,134	62,498	0.37
Oct	229,839.88	11,729,602	11,348,051	381,551	3.25
Nov	173,466.70	8,905,092	8,405,060	500,031	5.62
Dec	173,966.19	8,909,852	8,417,160	492,693	5.53
Total	2,649,319.86	135,323,464	130,635,187	4,688,278	3.46

5.5 Optimal Load Dispatch Including Minimum Generator limits (Case 2)

Optimal dispatch by using Lambda iteration method including minimum generator limits. The generation limit of each unit has minimum and maximum as below:

$$15 \leq \text{NNG } 1 \leq 160$$

$$20 \leq \text{NL} \leq 60$$

$$10 \leq \text{NM } 3 \leq 40$$

$$20 \leq \text{NL}1/2 \leq 100$$

$$20 \leq \text{NNG } 5 \leq 120$$

According to the simulation results of the optimal power output. EDL should schedule the power generation of each hydropower plant based on actual generation statistic to get the effective result of power generation within a minimum generative cost. The results of the optimal compared with actual cost.

5.5.1 Optimal load dispatch in January 2014

The table 5.16 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants including generator limits on 1st to 31st January 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power in some day do not operate which is NNG 5 off on 14th and 15th and NL off in the weekend.

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Table 5.16 Power output of scheduling 5 HPP in January 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,520.3	3,612.0	252.0	340.0	960.0	1,356.3	384.2	480.0	538.8	2,358.5	2,758.8
2	6,854.3	3,900.0	252.0	340.0	960.0	1,402.3	510.2	480.0	650.8	2,395.1	2,818.2
3	5,480.2	2,540.0	252.0	340.0	960.0	1,388.2	392.0	480.0	325.1	1,941.6	2,341.5
4	5,594.4	2,638.5	252.0	320.0	960.0	1,423.9	360.0	480.0	338.4	2,018.0	2,398.1
5	5,460.0	2,757.0	-	320.0	960.0	1,423.0	360.0	480.0	304.6	1,989.9	2,325.5
6	5,335.6	2,637.0	-	340.0	960.0	1,398.6	360.0	480.0	286.5	1,944.0	2,265.1
7	5,547.7	2,636.0	252.0	340.0	960.0	1,359.7	376.5	480.0	394.1	1,950.3	2,346.7
8	6,134.9	2,901.0	252.0	340.0	1,202.8	1,439.1	388.8	480.0	465.5	2,219.7	2,580.9
9	6,008.8	2,821.0	252.0	300.0	1,200.6	1,435.2	387.9	480.0	446.1	2,176.5	2,518.3
10	6,226.3	2,854.0	252.0	480.0	1,200.0	1,440.3	387.0	480.0	455.5	2,286.5	2,617.3
11	6,081.5	2,849.5	252.0	340.0	1,200.0	1,440.0	390.0	480.0	457.5	2,200.3	2,553.7
12	6,081.5	2,849.5	252.0	340.0	1,200.0	1,440.0	390.0	480.0	457.5	2,200.3	2,553.7
13	5,814.7	2,852.0	-	320.0	1,200.0	1,442.7	360.0	480.0	273.7	2,199.9	2,501.1
14	4,255.0	2,463.0	252.0	340.0	1,200.0	-	360.0	480.0	240.0	1,463.4	1,711.6
15	5,257.2	2,802.0	252.0	340.0	1,200.0	663.2	360.0	480.0	405.0	1,785.0	2,227.2
16	6,547.9	2,794.5	308.0	340.0	1,200.0	1,905.4	600.7	480.0	623.0	2,223.5	2,620.7
17	6,008.5	2,995.8	224.0	340.0	1,200.0	1,248.7	360.0	480.0	360.2	2,248.3	2,560.0
18	6,746.8	2,913.0	252.0	320.0	1,200.0	2,061.8	610.9	480.0	712.8	2,262.3	2,680.8
19	6,038.8	2,873.0	-	300.0	1,200.0	1,665.8	360.0	480.0	282.0	2,307.5	2,609.3
20	5,860.5	2,909.7	-	300.0	1,200.0	1,450.8	360.0	480.0	278.4	2,215.7	2,526.4
21	6,182.0	2,980.0	252.0	340.0	1,200.0	1,410.0	374.5	480.0	420.3	2,295.2	2,612.0
22	6,077.2	2,882.0	224.0	320.0	1,200.0	1,451.2	377.0	480.0	444.6	2,217.1	2,558.5
23	6,108.2	2,907.0	224.0	340.0	1,200.0	1,437.2	376.7	480.0	455.7	2,231.2	2,564.6
24	6,052.1	2,873.0	252.0	320.0	1,200.0	1,407.1	370.2	480.0	438.8	2,211.5	2,551.6
25	6,075.6	2,872.0	252.0	320.0	1,200.0	1,431.6	375.3	480.0	453.7	2,209.4	2,557.2
26	5,692.0	2,923.5	-	300.0	1,200.0	1,268.5	360.0	480.0	256.9	2,135.4	2,459.7
27	5,726.3	2,950.0	-	300.0	1,200.0	1,276.3	360.0	480.0	300.9	2,138.8	2,446.6
28	5,921.1	2,785.0	280.0	340.0	1,200.0	1,316.1	361.9	480.0	427.2	2,149.4	2,502.6
29	5,898.6	2,807.5	252.0	340.0	1,200.0	1,299.1	360.0	480.0	383.5	2,165.3	2,509.8
30	5,896.2	2,758.5	254.2	340.0	1,200.0	1,343.5	363.4	480.0	425.8	2,142.5	2,484.5
31	5,876.2	2,821.0	252.0	320.0	1,200.0	1,283.2	360.0	480.0	415.1	2,127.3	2,493.8

Figure 5.29ot shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st January 2014 by using the Lambda iteration method.

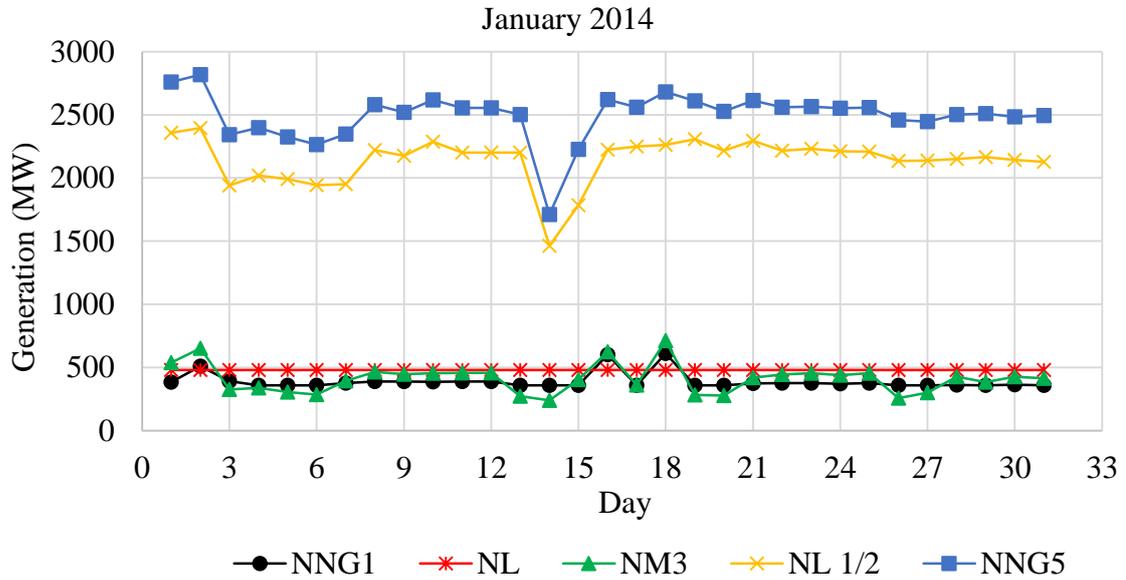


Figure 5.29 The result of optimal dispatch by using Lambda iteration method

Figure 5.30 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of January is \$ 367,177.36, which is equivalent to 3.93 %.

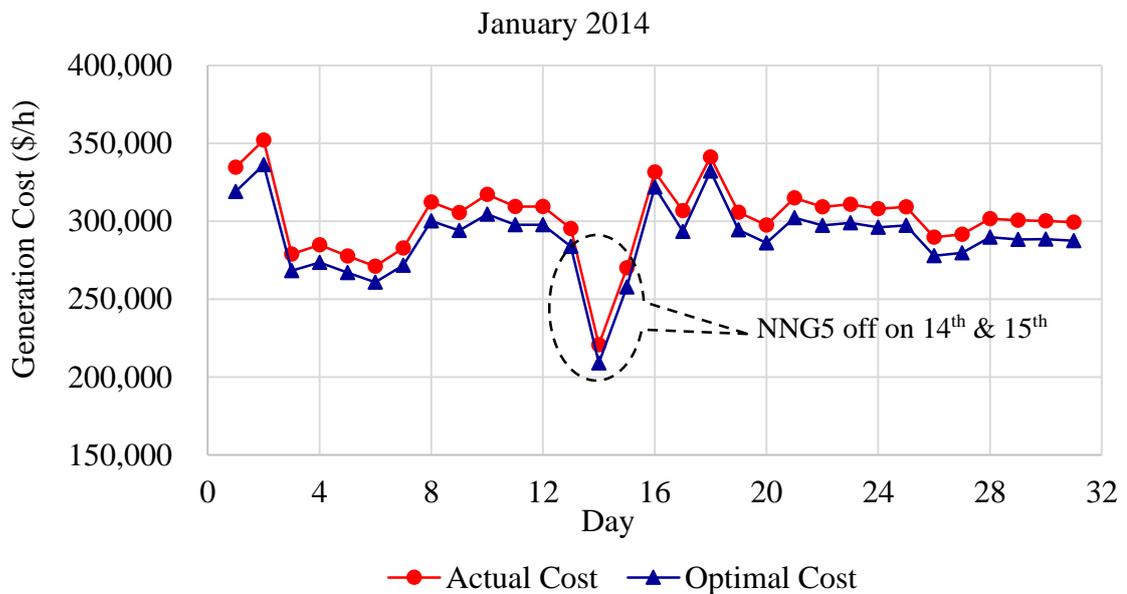


Figure 5.30 Comparison actual cost and optimal cost in January 2014

5.5.2 Optimal load dispatch in February 2014

The table 5.17 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on on 1st to 28th February 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power of NL does not operate in the weekend.

Table 5.17 Power output of scheduling 5 HPP in February 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,989.60	3,729.0	280.9	320.0	1,200.0	1,459.7	551.3	480.0	679.6	2,400.0	2,878.7
2	6,672.40	3,720.0	-	320.0	1,200.0	1,432.4	360.0	480.0	552.4	2,400.0	2,880.0
3	6,658.80	3,699.0	-	320.0	1,200.0	1,439.8	360.0	480.0	543.4	2,400.0	2,875.4
4	6,953.50	3,684.0	280.7	340.0	1,200.0	1,448.8	536.3	480.0	672.6	2,400.0	2,864.6
5	6,929.93	3,684.0	282.0	320.0	1,200.0	1,443.9	534.6	480.0	655.0	2,400.0	2,860.3
6	6,943.31	3,664.0	281.1	340.0	1,200.0	1,458.2	528.5	480.0	670.2	2,400.0	2,864.6
7	6,939.87	3,660.0	281.9	340.0	1,200.0	1,458.0	523.5	480.0	667.3	2,400.0	2,869.1
8	6,914.89	3,649.6	282.2	346.1	1,200.0	1,437.0	503.7	480.0	661.7	2,400.0	2,869.5
9	6,571.50	3,635.6	-	320.0	1,200.0	1,415.9	360.0	480.0	515.6	2,400.0	2,815.9
10	6,590.82	3,631.7	-	323.5	1,200.0	1,435.6	360.0	480.0	501.0	2,400.0	2,849.8
11	6,926.57	3,612.0	280.7	402.3	1,200.0	1,431.6	538.3	480.0	663.8	2,400.0	2,844.5
12	6,360.80	2,990.7	362.6	380.0	1,200.0	1,427.5	366.1	480.0	380.0	2,379.6	2,755.0
13	5,952.10	2,744.4	223.1	344.6	1,200.0	1,440.0	360.0	480.0	300.1	2,250.4	2,561.6
14	5,926.32	2,736.0	222.0	340.0	1,200.0	1,428.3	360.0	480.0	289.4	2,241.8	2,555.1
15	5,907.53	2,721.6	225.9	320.0	1,200.0	1,440.0	360.0	480.0	293.1	2,229.0	2,545.4
16	5,697.00	2,723.5	-	340.0	1,200.0	1,433.5	360.0	480.0	240.0	2,197.8	2,419.2
17	5,678.69	2,717.3	-	325.1	1,200.0	1,436.3	360.0	480.0	240.0	2,187.4	2,411.3
18	5,964.24	2,712.0	282.6	320.0	1,200.0	1,449.6	360.0	480.0	306.6	2,239.0	2,578.6
19	5,920.00	2,700.0	282.4	300.0	1,200.0	1,437.6	360.0	480.0	298.2	2,218.7	2,563.1
20	5,930.71	2,700.0	281.6	320.0	1,200.0	1,429.1	360.0	480.0	290.4	2,229.2	2,571.1
21	5,742.52	2,700.9	283.3	141.2	1,200.0	1,417.1	360.0	480.0	276.0	2,159.5	2,467.0
22	6,141.47	2,700.0	311.9	480.0	1,200.0	1,449.6	360.0	480.0	308.8	2,331.3	2,661.3
23	5,639.40	2,700.4	-	312.0	1,200.0	1,427.0	360.0	480.0	240.0	2,165.0	2,394.4
24	5,624.12	2,681.8	-	322.7	1,200.0	1,419.6	360.0	480.0	240.0	2,156.3	2,387.8
25	5,874.07	2,677.7	249.1	323.5	1,200.0	1,423.8	360.0	480.0	275.3	2,213.3	2,545.4
26	5,914.52	2,677.3	280.3	322.5	1,200.0	1,434.4	360.0	480.0	283.0	2,224.7	2,566.9
27	5,890.57	2,674.5	279.7	321.4	1,200.0	1,414.9	360.0	480.0	277.9	2,216.2	2,556.5
28	5,913.63	2,673.4	280.0	322.6	1,200.0	1,437.6	360.0	480.0	288.2	2,220.7	2,564.7

Figure 5.31 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 28th February 2014 by using the Lambda iteration method.

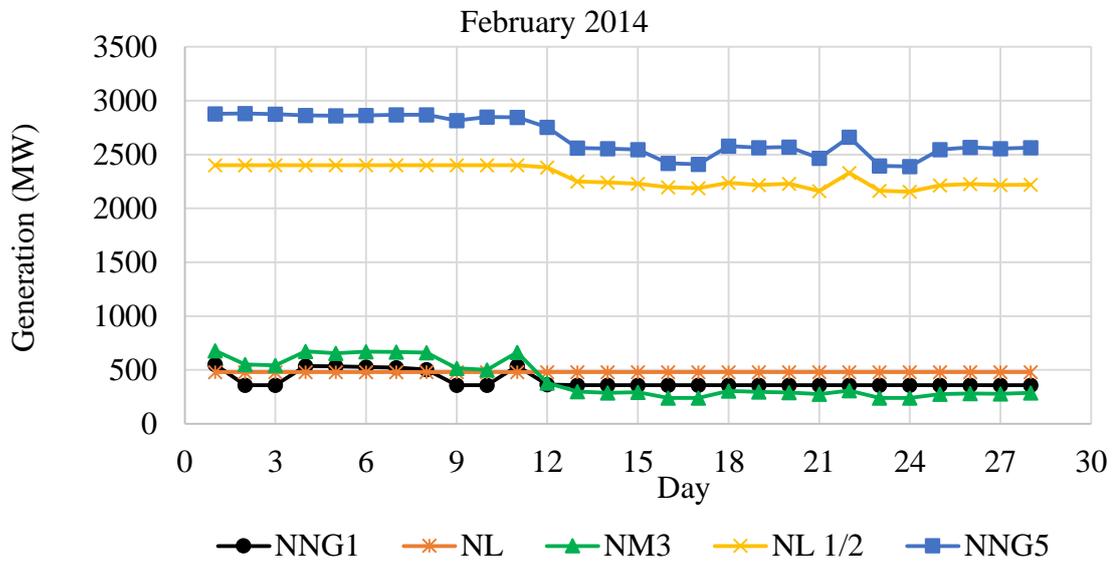


Figure 5.31 The result of optimal dispatch by using Lambda iteration method

Figure 5.32 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of February is \$ 362,562.45, which is equivalent to 4.06 %.

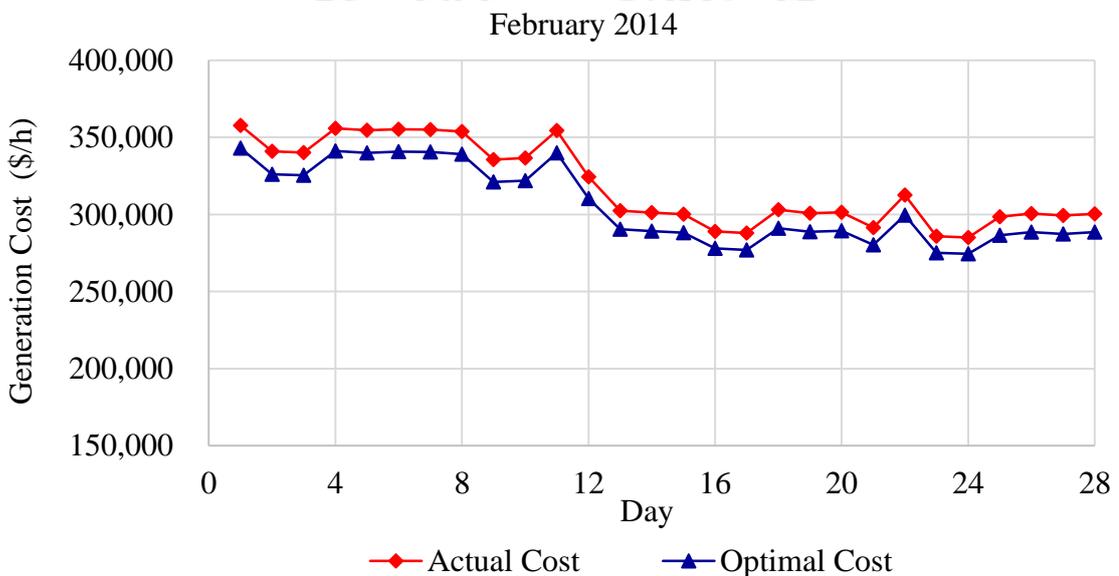


Figure 5.32 Comparison actual cost and optimal cost in February 2014

5.5.3 Optimal load dispatch in March 2014

The table 5.18 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on on 1st to 31st March 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power of NL does not operate on 2nd to 3rd and 16th to 17th, and NGG 5 operate at minimum at 20 MW on 16th and 17th.

Table 5.18 Power output of scheduling 5 HPP in March 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	5,960.0	2,670.8	365.8	304.1	1,200.0	1,419.4	360.0	480.0	287.0	2,226.8	2,606.2
2	5,550.5	2,669.2	-	261.7	1,200.0	1,419.6	360.0	480.0	240.0	2,114.5	2,356.0
3	5,562.7	2,668.8	-	265.9	1,200.0	1,428.0	360.0	480.0	240.0	2,121.4	2,361.2
4	5,960.8	2,668.8	365.3	305.4	1,200.0	1,421.3	360.0	480.0	290.0	2,224.7	2,606.1
5	5,941.0	2,657.0	335.9	302.6	1,200.0	1,445.6	360.0	480.0	286.3	2,222.8	2,591.9
6	5,933.9	2,654.4	335.4	304.1	1,200.0	1,440.0	360.0	480.0	285.9	2,219.0	2,589.0
7	5,912.7	2,647.2	335.4	304.1	1,200.0	1,426.1	360.0	480.0	272.3	2,215.6	2,584.9
8	6,493.9	3,213.6	336.9	303.4	1,200.0	1,440.1	467.9	480.0	624.5	2,259.7	2,661.7
9	6,577.1	3,492.2	139.9	302.6	1,200.0	1,442.4	403.8	480.0	497.8	2,400.0	2,795.5
10	6,527.8	3,484.4	141.3	263.6	1,200.0	1,438.6	402.8	480.0	473.7	2,400.0	2,771.3
11	6,764.8	3,468.0	336.8	320.0	1,200.0	1,440.0	450.8	480.0	638.0	2,400.0	2,796.0
12	7,211.1	3,468.0	478.9	640.0	1,200.0	1,424.2	789.4	480.0	739.3	2,398.1	2,804.4
13	7,156.7	3,440.2	476.4	600.0	1,200.0	1,440.0	753.6	480.0	722.4	2,400.0	2,800.7
14	6,588.6	3,446.2	224.9	303.3	1,200.0	1,414.3	394.7	480.0	533.0	2,400.0	2,780.9
15	6,117.3	2,927.9	254.2	301.8	1,200.0	1,433.4	360.0	480.0	253.5	2,344.8	2,679.0
16	4,681.6	2,580.3	-	304.1	1,200.0	597.3	360.0	480.0	240.0	1,620.4	1,981.2
17	5,507.5	2,583.3	-	304.8	1,200.0	1,419.4	360.0	480.0	240.0	2,090.0	2,337.4
18	5,865.6	2,592.0	334.4	304.1	1,200.0	1,435.2	360.0	480.0	251.2	2,199.9	2,574.5
19	5,842.4	2,565.4	335.3	304.3	1,200.0	1,437.4	360.0	480.0	241.4	2,194.9	2,566.1
20	5,798.8	2,497.2	337.5	340.9	1,200.0	1,423.3	360.0	480.0	253.1	2,179.3	2,526.4
21	5,889.6	2,604.0	336.8	304.0	1,200.0	1,444.8	360.0	480.0	264.4	2,206.0	2,579.2
22	5,884.0	2,604.0	336.7	303.3	1,200.0	1,440.0	360.0	480.0	261.4	2,204.6	2,578.1
23	5,645.6	2,580.0	139.9	303.7	1,200.0	1,422.1	360.0	480.0	240.1	2,133.0	2,432.6
24	5,652.9	2,580.0	139.6	302.9	1,200.0	1,430.4	360.0	480.0	241.5	2,135.4	2,435.9
25	5,865.1	2,574.5	332.1	322.7	1,200.0	1,435.8	360.0	480.0	240.8	2,206.7	2,577.6
26	5,917.8	2,584.8	333.7	361.3	1,200.0	1,438.1	360.0	480.0	246.1	2,232.5	2,599.2
27	5,902.1	2,562.2	336.0	366.5	1,200.0	1,437.4	360.0	480.0	240.1	2,227.2	2,594.7
28	5,888.1	2,556.0	328.5	364.9	1,200.0	1,438.8	360.0	480.0	240.3	2,226.1	2,581.8
29	6,111.9	2,804.2	323.3	364.8	1,200.0	1,419.6	362.5	480.0	440.6	2,227.3	2,601.5
30	6,494.4	3,334.4	166.1	364.1	1,200.0	1,429.8	364.9	480.0	463.8	2,390.1	2,795.7
31	6,483.6	3,325.3	165.8	362.2	1,200.0	1,430.4	365.6	480.0	460.0	2,385.7	2,792.3

Figure 5.33 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st March 2014 by using the Lambda iteration method.

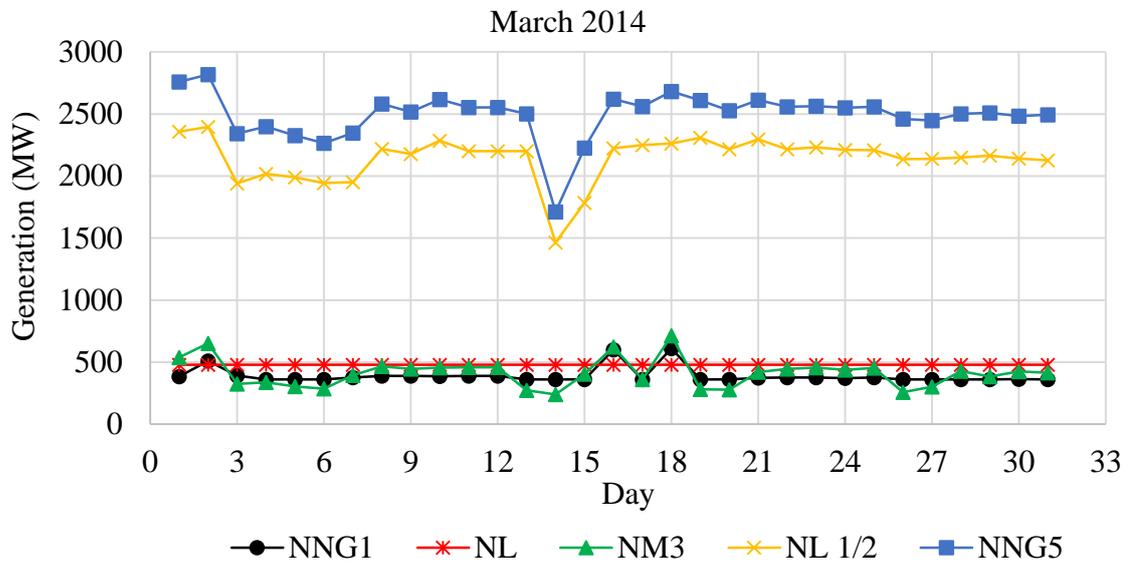


Figure 5.33 The result of optimal dispatch by using Lambda iteration method

Figure 5.34 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving in February 2014 is \$ 383,940.80, which is equivalent to 4.02 %.

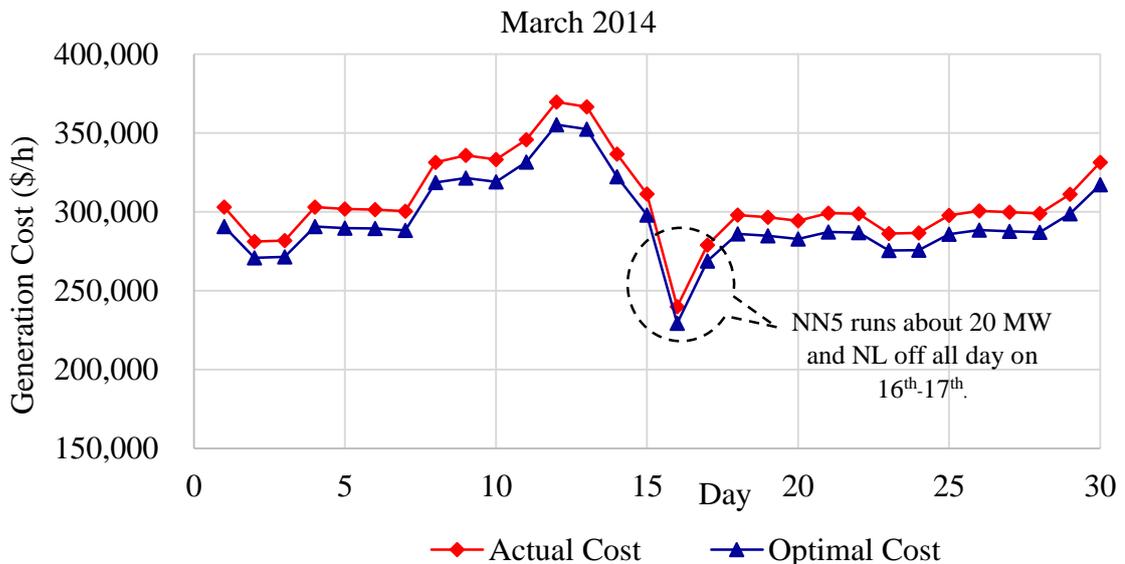


Figure 5.34 Comparison actual cost and optimal cost in March 2014

5.5.4 Optimal load dispatch in April 2014

The table 5.19 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on on 1st to 30th April 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power NNG 5 does not operate on 23rd to 30th.

Table 5.19 Power output of scheduling 5 HPP in April 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,559.7	3,320.2	502.8	325.9	1,200.0	1,210.8	422.1	480.0	538.0	2,367.0	2,752.5
2	6,455.4	3,287.6	500.3	324.4	1,200.0	1,143.2	440.9	480.0	540.7	2,311.6	2,682.3
3	6,378.5	3,150.3	503.9	364.9	1,200.0	1,159.5	449.3	480.0	549.8	2,263.7	2,635.7
4	6,440.1	3,101.7	501.9	480.0	1,200.0	1,156.6	412.1	480.0	532.5	2,329.7	2,685.8
5	6,476.7	3,138.0	501.3	486.5	1,200.0	1,150.9	440.9	480.0	538.2	2,330.9	2,686.7
6	6,005.1	3,134.5	138.9	303.8	1,200.0	1,227.9	360.0	480.0	371.6	2,240.0	2,553.5
7	5,947.3	3,123.6	166.0	305.8	1,200.0	1,151.9	360.0	480.0	324.6	2,234.4	2,548.2
8	6,333.4	3,128.9	498.1	345.4	1,200.0	1,161.0	442.3	480.0	536.2	2,249.7	2,625.1
9	6,342.3	3,139.3	489.9	343.7	1,200.0	1,169.4	434.1	480.0	546.9	2,253.4	2,627.9
10	6,476.1	3,125.8	495.7	485.1	1,200.0	1,169.4	442.1	480.0	541.2	2,328.2	2,684.6
11	6,476.0	3,135.4	497.4	485.2	1,200.0	1,158.0	439.3	480.0	534.7	2,333.4	2,688.6
12	6,245.7	3,135.0	498.8	262.3	1,200.0	1,149.6	437.6	480.0	390.0	2,297.2	2,640.9
13	6,116.6	3,108.8	165.1	482.8	1,200.0	1,159.9	360.0	480.0	329.3	2,330.3	2,617.1
14	6,208.8	3,205.2	165.5	482.9	1,200.0	1,155.2	434.2	492.2	337.4	2,332.0	2,612.9
15	6,435.3	3,098.7	497.4	482.9	1,200.0	1,156.3	428.7	480.0	523.8	2,322.5	2,680.3
16	6,403.5	3,074.1	499.9	482.9	1,200.0	1,146.6	426.1	480.0	507.6	2,315.1	2,674.7
17	6,232.6	3,054.9	338.3	482.9	1,200.0	1,156.5	428.4	480.0	408.2	2,312.5	2,603.4
18	6,395.6	3,058.8	497.1	482.9	1,200.0	1,156.8	423.2	480.0	507.6	2,312.2	2,672.5
19	6,990.1	2,871.8	500.3	482.9	1,968.0	1,167.1	548.2	480.0	681.9	2,400.0	2,880.0
20	6,453.9	2,860.3	137.0	480.0	1,968.0	1,008.5	366.0	480.0	437.0	2,359.8	2,811.1
21	6,601.9	2,858.7	136.7	481.7	1,968.0	1,156.8	370.8	480.0	471.1	2,400.0	2,880.0
22	6,953.0	2,858.1	498.6	481.7	1,968.0	1,146.6	515.6	480.0	677.4	2,400.0	2,880.0
23	5,736.5	2,732.1	555.9	480.5	1,968.0	-	360.0	480.0	253.8	2,203.2	2,439.6
24	5,792.5	2,846.7	497.3	480.5	1,968.0	-	360.0	480.0	296.9	2,183.3	2,472.3
25	5,781.9	2,836.1	497.3	480.5	1,968.0	-	360.0	480.0	296.0	2,177.8	2,468.1
26	5,784.4	2,871.8	464.1	480.5	1,968.0	-	360.0	480.0	251.7	2,232.1	2,460.5
27	5,644.1	2,832.0	464.1	380.0	1,968.0	-	360.0	480.0	250.1	2,154.7	2,399.4
28	5,415.5	2,832.0	135.5	480.0	1,968.0	-	360.0	480.0	240.0	2,037.7	2,297.8
29	5,436.2	2,826.0	162.2	480.0	1,968.0	-	360.0	480.0	240.0	2,049.5	2,306.7
30	5,463.8	2,846.2	162.1	487.5	1,968.0	-	360.0	480.0	240.0	2,065.2	2,318.6

Figure 5.35 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th April 2014 by using the Lambda iteration method.

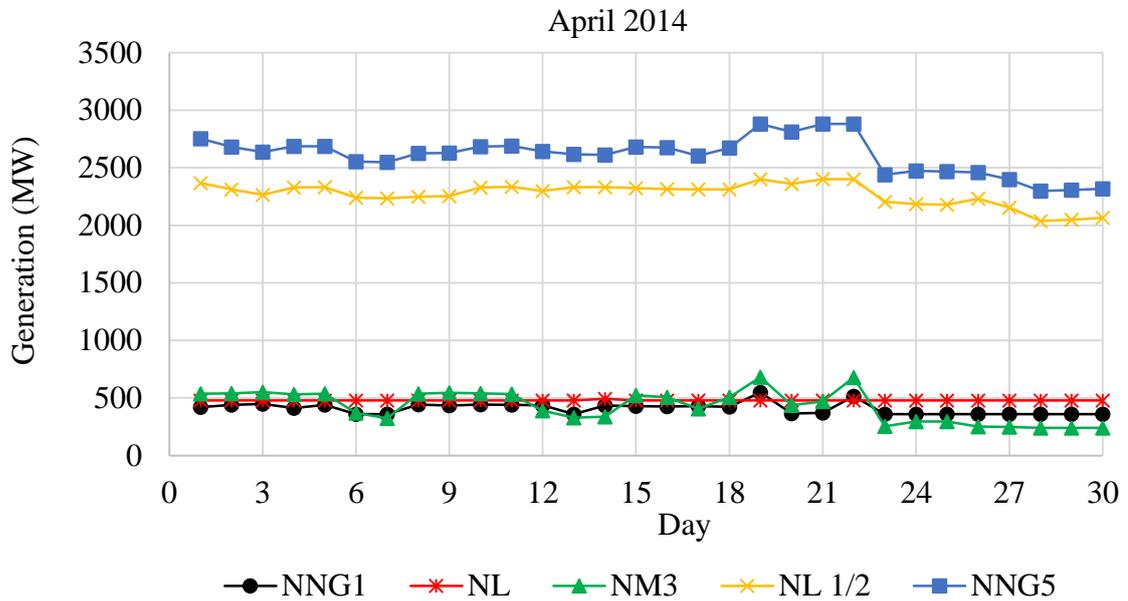


Figure 5.35 The result of optimal dispatch by using Lambda iteration method

Figure 5.36 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of April 2014 is \$ 434,410.65, which is equivalent to 4.56 %.

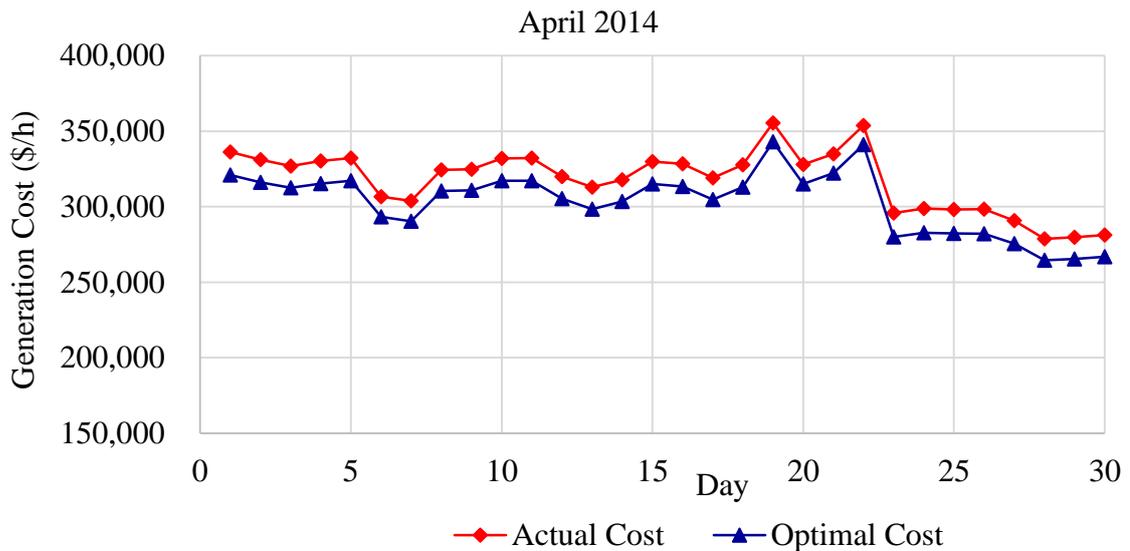


Figure 5.36 Comparison actual cost and optimal cost April 2014

5.5.5 Optimal load dispatch in May 2014

The table 5.20 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on on 1st to 30th May 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power NNG 5 does not operate on 1st to 21st. It is during maintenance.

Table 5.20 Power output of scheduling 5 HPP in May 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	5,346.74	2,871.75	162.40	344.59	1,968.00	-	360.00	480.00	240.00	1,998.62	2,268.12
2	5,347.37	2,890.32	162.49	326.56	1,968.00	-	360.00	480.00	240.00	1,976.68	2,290.69
3	5,353.42	2,824.17	216.66	344.59	1,968.00	-	360.00	480.00	240.00	1,983.16	2,290.26
4	5,251.25	2,740.99	216.66	325.60	1,968.00	-	360.00	480.00	240.00	1,920.26	2,250.99
5	5,175.2	2,668.0	216.5	322.7	1,968.0	-	360.0	480.0	240.0	1,874.4	2,220.8
6	5,262.5	2,755.0	216.8	322.7	1,968.0	-	360.0	480.0	240.0	1,931.8	2,250.7
7	5,321.0	2,647.8	379.4	325.8	1,968.0	-	360.0	480.0	240.0	1,975.8	2,265.2
8	5,295.3	2,622.9	380.2	324.1	1,968.0	-	360.0	480.0	240.0	1,948.6	2,266.7
9	5,435.1	2,767.5	377.6	322.1	1,968.0	-	360.0	480.0	240.0	2,023.2	2,331.9
10	5,585.7	2,916.0	376.4	325.3	1,968.0	-	360.0	480.0	240.0	2,109.5	2,396.2
11	5,385.0	2,869.0	188.0	360.0	1,968.0	-	360.0	480.0	240.0	2,000.6	2,304.4
12	5,324.8	2,866.5	188.0	302.3	1,968.0	-	360.0	480.0	240.0	1,969.4	2,275.5
13	5,662.6	2,956.5	378.1	360.0	1,968.0	-	360.0	480.0	241.5	2,127.0	2,454.2
14	5,855.5	3,154.5	373.0	360.0	1,968.0	-	360.0	480.0	255.7	2,209.3	2,550.5
15	5,976.4	3,151.8	376.2	480.5	1,968.0	-	360.0	480.0	240.0	2,289.9	2,606.6
16	5,970.8	3,143.8	376.9	482.2	1,968.0	-	360.0	480.0	240.0	2,293.1	2,597.8
17	5,766.1	3,156.0	162.1	480.0	1,968.0	-	360.0	480.0	240.0	2,208.7	2,477.5
18	5,507.3	3,161.0	135.0	243.3	1,968.0	-	360.0	480.0	240.0	2,064.7	2,362.7
19	5,498.8	3,154.3	135.2	241.2	1,968.0	-	360.0	480.0	240.0	2,061.9	2,356.9
20	4,213.8	3,146.1	107.7	-	960.0	-	360.0	480.0	240.0	1,354.4	1,779.4
21	4,497.6	3,146.0	107.4	284.2	960.0	-	360.0	480.0	240.0	1,515.8	1,901.8
22	5,469.3	3,120.0	108.3	380.0	984.0	877.0	360.0	480.0	240.0	2,061.6	2,327.7
23	5,172.2	3,120.0	108.2	-	984.0	960.0	360.0	480.0	240.0	1,899.4	2,192.8
24	5,535.1	3,132.0	107.7	360.0	960.0	975.4	360.0	480.0	240.0	2,092.5	2,362.7
25	5,188.8	3,120.0	106.7	40.0	960.0	962.1	360.0	480.0	240.0	1,908.8	2,200.0
26	5,633.1	3,130.9	107.6	480.0	960.0	954.6	360.0	480.0	240.0	2,151.2	2,401.9
27	5,622.4	3,099.6	107.9	482.8	960.0	972.0	360.0	480.0	240.0	2,143.2	2,399.1
28	5,435.9	3,119.7	241.1	160.9	960.0	954.2	360.0	480.0	240.0	2,049.3	2,306.6
29	5,148.2	3,120.0	108.2	-	960.0	960.0	360.0	480.0	240.0	1,885.7	2,182.5
30	5,229.3	3,120.0	108.3	140.0	984.0	877.0	360.0	480.0	240.0	1,925.1	2,224.2
31	5,427.5	3,119.7	213.7	180.0	960.0	954.2	360.0	480.0	240.0	2,030.3	2,317.2

Figure 5.37 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st May 2014 by using the Lambda iteration method.

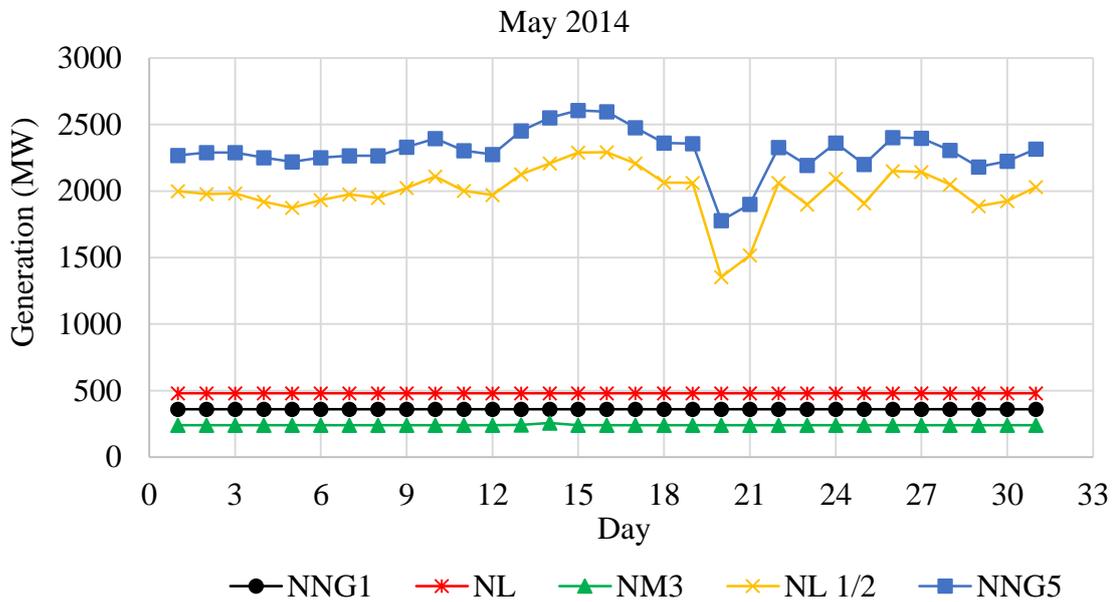


Figure 5.37 The result of optimal dispatch by using Lambda iteration method

Figure 5.38 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of May 2014 is \$ 438,741.32, which is equivalent to 5.11%.

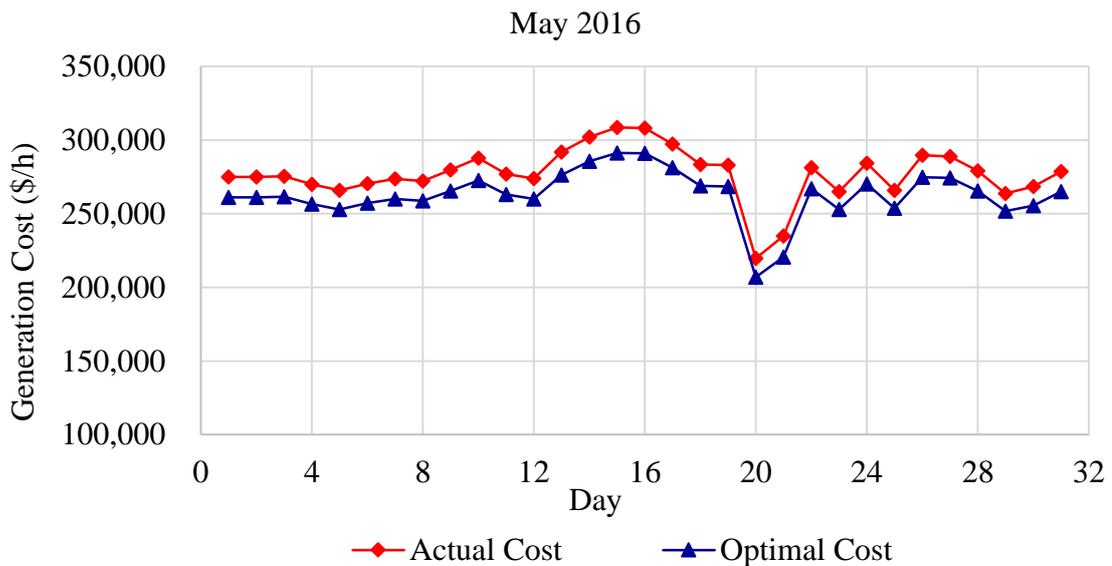


Figure 5.38 Comparison actual cost and optimal cost in May 2014

5.5.6 Optimal load dispatch in June 2014

The table 5.21 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on on 1st to 30th June 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power NNG 5 does not operate on 8th to 15th. It is during maintenance.

Table 5.21 Power output of scheduling 5 HPP in June 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	5,153.0	3,116.9	107.8	-	960.0	968.2	360.0	480.0	240.0	1,888.4	2,184.5
2	5,151.2	3,115.6	108.3	-	960.0	967.2	360.0	480.0	240.0	1,887.4	2,183.7
3	5,573.5	3,114.0	189.2	343.1	960.0	967.2	360.0	480.0	240.0	2,108.9	2,384.6
4	5,722.5	3,113.7	189.8	487.1	960.0	971.9	360.0	480.0	240.0	2,190.3	2,452.2
5	6,267.6	3,130.5	432.0	785.9	960.0	959.3	360.0	480.0	434.8	2,299.7	2,693.1
6	6,953.4	3,147.8	919.4	972.2	960.0	954.1	475.0	480.0	718.4	2,400.0	2,880.0
7	6,641.4	3,136.5	920.9	972.5	972.0	639.6	381.4	480.0	500.1	2,400.0	2,880.0
8	6,652.4	3,132.2	1,027.5	972.7	1,520.0	-	467.0	480.0	612.5	2,344.6	2,748.3
9	6,991.7	3,167.9	932.0	971.8	1,920.0	-	501.7	480.0	730.0	2,400.0	2,880.0
10	6,659.4	3,118.0	650.5	970.9	1,920.0	-	360.0	480.0	539.4	2,400.0	2,880.0
11	6,918.2	3,088.0	1,058.3	885.5	1,886.4	-	464.0	480.0	737.2	2,390.1	2,846.9
12	7,055.7	3,152.5	1,053.3	963.5	1,886.4	-	495.5	480.0	800.1	2,400.0	2,880.0
13	6,944.8	3,143.9	962.7	963.2	1,875.0	-	360.0	480.0	824.8	2,400.0	2,880.0
14	5,714.0	3,128.8	325.2	740.0	1,520.0	-	360.0	480.0	252.6	2,161.3	2,460.1
15	5,251.2	3,108.4	726.2	480.5	936.0	-	360.0	480.0	240.0	1,944.3	2,226.9
16	5,637.3	3,074.0	648.0	480.7	936.0	498.5	360.0	480.0	240.0	2,120.3	2,436.9
17	5,989.3	3,029.8	459.5	480.0	936.0	1,084.0	360.0	480.0	240.0	2,315.5	2,593.8
18	5,878.7	3,054.4	404.7	480.9	864.0	1,074.7	360.0	480.0	240.0	2,274.7	2,523.9
19	5,614.9	2,965.7	296.8	480.6	840.0	1,031.7	360.0	480.0	240.0	2,143.8	2,391.0
20	5,801.3	3,075.5	270.0	481.5	840.0	1,134.3	360.0	480.0	240.0	2,225.3	2,496.0
21	6,607.2	3,036.9	837.0	820.0	840.0	1,073.3	461.6	480.0	687.9	2,279.1	2,698.6
22	7,180.9	2,877.8	1,311.7	968.2	936.0	1,087.1	592.5	480.0	828.4	2,400.0	2,880.0
23	7,191.2	2,914.0	1,328.9	968.5	905.8	1,074.0	595.3	480.0	835.9	2,400.0	2,880.0
24	7,465.1	3,127.8	1,346.0	960.0	936.0	1,095.3	745.1	480.0	960.0	2,400.0	2,880.0
25	8,360.0	2,976.5	1,355.7	961.1	1,856.6	1,210.1	1,588.7	596.2	930.0	2,387.4	2,857.6
26	7,982.9	3,218.2	655.3	963.1	1,848.0	1,298.3	1,262.9	480.0	960.0	2,400.0	2,880.0
27	8,384.1	3,237.2	1,002.5	964.7	1,867.6	1,312.1	1,582.9	561.2	960.0	2,400.0	2,880.0
28	8,691.1	3,241.0	1,352.8	964.7	1,848.0	1,284.7	1,816.9	634.3	960.0	2,400.0	2,880.0
29	8,576.7	3,276.0	1,351.1	965.5	1,848.0	1,136.1	1,733.4	618.0	945.3	2,400.0	2,880.0
30	8,757.7	3,298.9	1,314.4	967.3	1,864.8	1,312.4	1,863.5	654.3	960.0	2,400.0	2,880.0

Figure 5.39 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th June 2014 by using the Lambda iteration method.

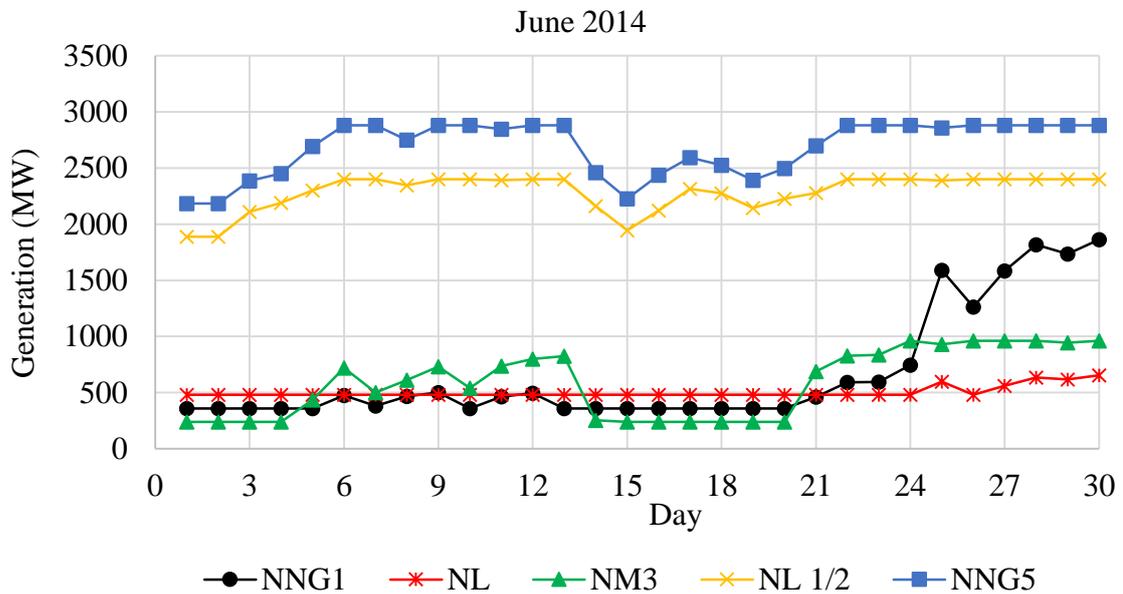


Figure 5.39 The result of optimal dispatch by using Lambda iteration method

Figure 5.40 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of June 2014 is \$ 500,544.61, which is equivalent to 4.80 %.

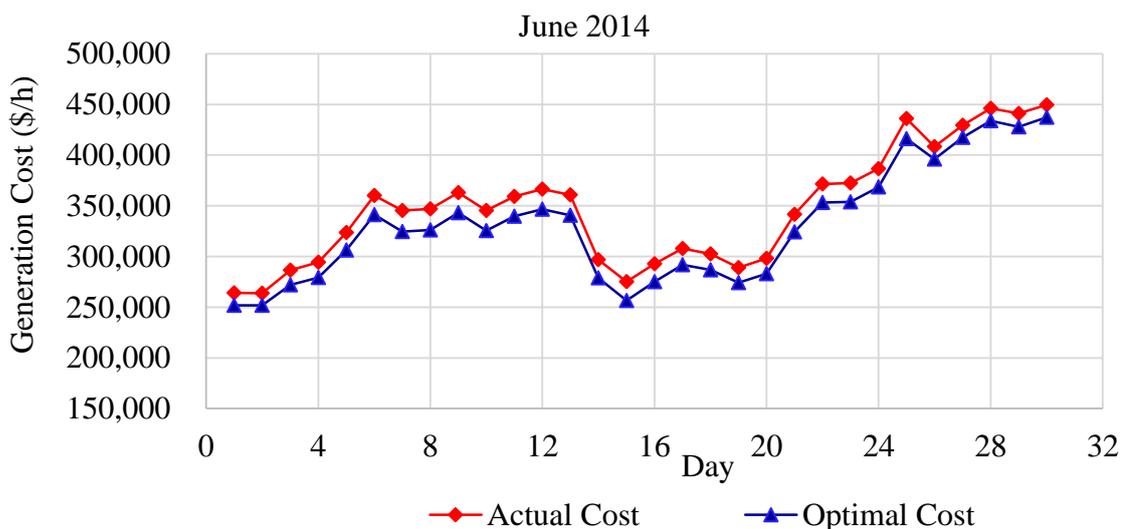


Figure 5.40 Comparison actual cost and optimal cost in June 2014

5.5.7 Optimal load dispatch in July 2014

The table 5.22 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st July 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power is not much difference.

Table 5.22 Power output of scheduling 5 HPP in July 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	8,501.7	3,062.4	1,315.5	967.3	1,848.0	1,308.5	1,674.2	587.5	960.0	2,400.0	2,880.0
2	8,704.7	3,234.6	1,325.5	967.3	1,848.0	1,329.3	1,826.3	638.3	960.0	2,400.0	2,880.0
3	8,506.6	3,009.5	1,326.5	966.8	1,848.0	1,355.9	1,674.9	591.7	960.0	2,400.0	2,880.0
4	8,865.8	3,297.7	1,327.2	966.3	1,655.6	1,619.0	1,915.8	721.3	948.7	2,400.0	2,880.0
5	8,049.1	3,328.6	1,332.0	964.6	1,287.0	1,136.9	1,285.2	523.9	960.0	2,400.0	2,880.0
6	7,002.8	3,302.2	651.4	965.9	952.1	1,131.2	360.0	480.0	882.8	2,400.0	2,880.0
7	7,173.4	3,305.7	647.6	965.8	1,403.0	851.3	740.5	480.0	755.3	2,382.3	2,815.3
8	7,886.0	3,098.1	648.2	960.0	1,850.1	1,329.6	1,166.0	480.0	960.0	2,400.0	2,880.0
9	7,748.5	2,912.9	910.5	967.2	1,848.0	1,109.9	1,030.8	485.4	952.3	2,400.0	2,880.0
10	9,174.0	2,651.3	1,344.0	967.9	1,848.0	2,362.9	2,154.6	779.5	960.0	2,400.0	2,880.0
11	7,986.7	2,723.3	1,272.5	960.0	1,850.0	1,180.9	1,264.2	482.5	960.0	2,400.0	2,880.0
12	8,202.7	2,843.6	1,361.1	960.0	1,883.0	1,155.0	1,432.9	529.8	960.0	2,400.0	2,880.0
13	7,670.1	2,991.0	679.6	966.5	1,896.0	1,137.1	953.7	480.0	956.4	2,400.0	2,880.0
14	8,420.9	3,086.5	1,362.0	968.1	1,896.0	1,108.3	1,601.9	578.9	960.0	2,400.0	2,880.0
15	8,528.2	3,089.7	1,360.1	969.2	1,941.0	1,168.2	1,676.1	612.1	960.0	2,400.0	2,880.0
16	9,421.8	3,026.6	1,398.3	926.8	1,896.0	2,174.1	2,316.5	865.2	960.0	2,400.0	2,880.0
17	8,679.8	3,271.6	1,396.8	967.0	1,941.0	1,103.5	1,798.8	641.0	960.0	2,400.0	2,880.0
18	9,983.4	3,246.2	1,392.0	966.7	1,896.0	2,482.5	2,720.5	1,022.8	960.0	2,400.0	2,880.0
19	10,594.8	3,506.2	1,393.6	967.0	1,958.4	2,769.6	3,148.1	1,206.7	960.0	2,400.0	2,880.0
20	10,594.8	3,506.2	1,393.6	967.0	1,958.4	2,769.6	3,148.1	1,206.7	960.0	2,400.0	2,880.0
21	8,689.3	3,516.7	1,397.2	960.0	1,981.0	834.4	1,780.2	669.1	960.0	2,400.0	2,880.0
22	10,496.5	3,499.5	1,404.0	921.5	1,992.0	2,679.5	3,079.5	1,177.1	960.0	2,400.0	2,880.0
23	10,118.1	2,973.4	1,428.0	964.0	2,040.0	2,712.8	2,776.7	1,101.4	960.0	2,400.0	2,880.0
24	10,671.9	3,520.6	1,428.0	967.4	2,040.0	2,715.9	3,202.0	1,229.9	960.0	2,400.0	2,880.0
25	10,345.6	3,529.5	1,428.0	969.2	2,040.0	2,378.9	2,968.5	1,137.1	960.0	2,400.0	2,880.0
26	10,695.7	3,533.3	1,428.0	969.4	2,040.0	2,725.0	3,218.6	1,237.0	960.0	2,400.0	2,880.0
27	10,726.0	3,539.3	1,438.6	969.5	2,040.0	2,738.7	3,239.9	1,246.2	960.0	2,400.0	2,880.0
28	10,723.2	3,558.1	1,425.4	970.5	2,040.0	2,729.2	3,237.9	1,245.3	960.0	2,400.0	2,880.0
29	9,399.3	3,593.3	1,428.0	972.1	1,998.4	1,407.4	2,302.0	857.2	960.0	2,400.0	2,880.0
30	10,286.5	3,591.8	1,428.0	971.1	1,430.3	2,865.3	2,932.5	1,114.0	960.0	2,400.0	2,880.0
31	11,064.9	3,621.7	1,428.0	946.0	2,175.9	2,893.4	3,476.9	1,348.1	960.0	2,400.0	2,880.0

Figure 5.41 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st July 2014 by using the Lambda iteration method.

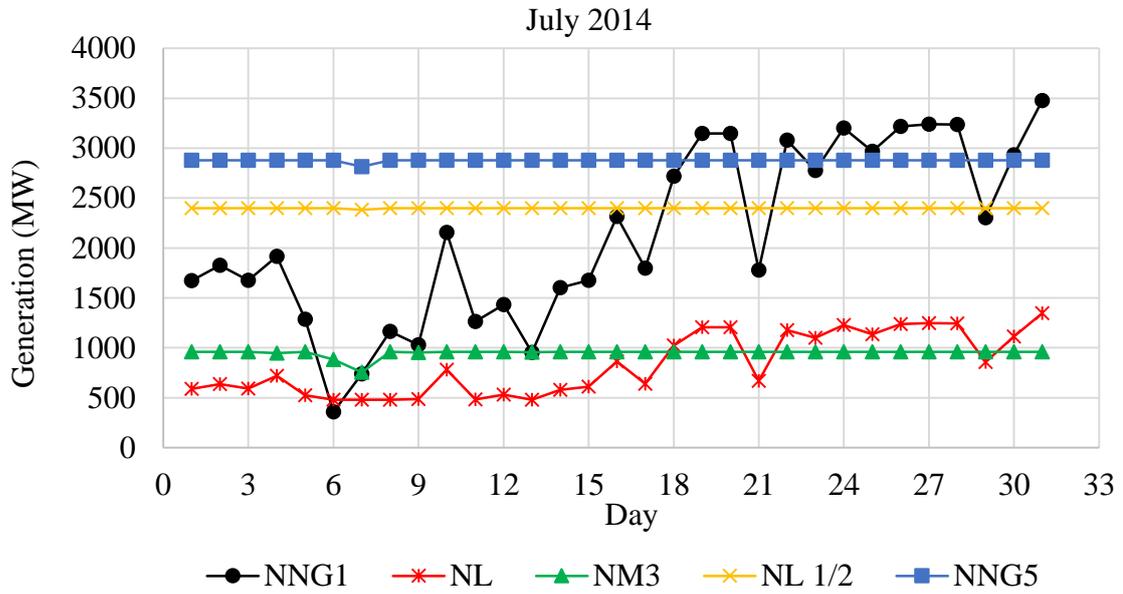


Figure 5.41 The result of optimal dispatch by using Lambda iteration method

Figure 5.42 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of July 2014 is \$ 278,886.82, which is equivalent to 1.92 %.

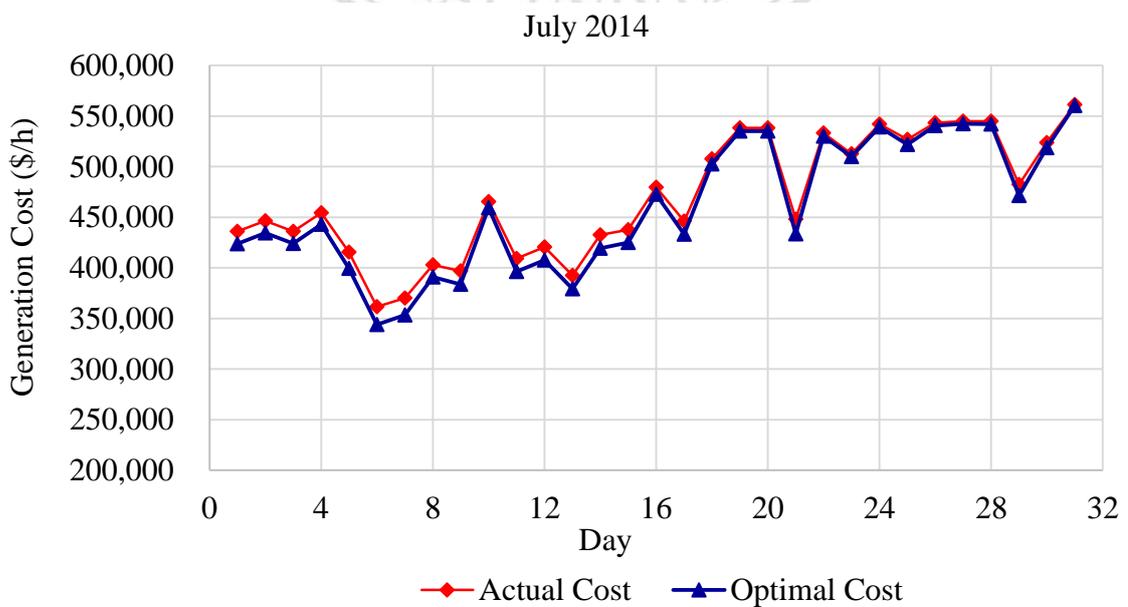


Figure 5.42 Comparison actual cost and optimal cost in July 2014

5.5.8 Optimal load dispatch in August 2014

The table 5.23 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st August 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power of actual and optimal are similar. This month no need to optimization.

Table 5.23 Power output of scheduling 5 HPP in August 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	11,146.6	3,690.0	1,425.6	960.0	2,191.0	2,880.0	3,534.0	1,372.6	960.0	2,400.0	2,880.0
2	11,223.1	3,738.2	1,437.9	964.7	2,222.0	2,860.2	3,588.2	1,394.8	960.0	2,400.0	2,880.0
3	11,192.7	3,656.7	1,440.0	960.0	2,256.0	2,880.0	3,566.2	1,386.5	960.0	2,400.0	2,880.0
4	11,301.2	3,705.2	1,440.0	960.0	2,316.0	2,880.0	3,642.1	1,419.1	960.0	2,400.0	2,880.0
5	11,233.7	3,675.5	1,440.0	960.0	2,379.2	2,779.0	3,596.1	1,397.6	960.0	2,400.0	2,880.0
6	11,008.2	3,762.8	1,440.0	960.0	2,379.2	2,466.2	3,450.3	1,317.9	960.0	2,400.0	2,880.0
7	11,387.5	3,794.7	1,464.0	967.9	2,379.2	2,781.7	3,727.0	1,420.5	960.0	2,400.0	2,880.0
8	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
9	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
10	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
11	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
12	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
13	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
14	11,514.9	3,840.0	1,440.0	960.0	2,400.0	2,874.9	3,834.9	1,440.0	960.0	2,400.0	2,880.0
15	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
16	10,095.9	3,840.0	1,440.0	960.0	2,400.0	1,455.9	2,799.2	1,056.7	960.0	2,400.0	2,880.0
17	10,096.9	3,840.0	1,440.0	960.0	2,400.0	1,456.9	2,799.9	1,057.0	960.0	2,400.0	2,880.0
18	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
19	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
20	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
21	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
22	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
23	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
24	10,933.0	3,840.0	853.0	960.0	2,400.0	2,880.0	3,392.1	1,300.9	960.0	2,400.0	2,880.0
25	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
26	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
27	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
28	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
29	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
30	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
31	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0

Figure 5.43 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st August 2014 by using the Lambda iteration method.

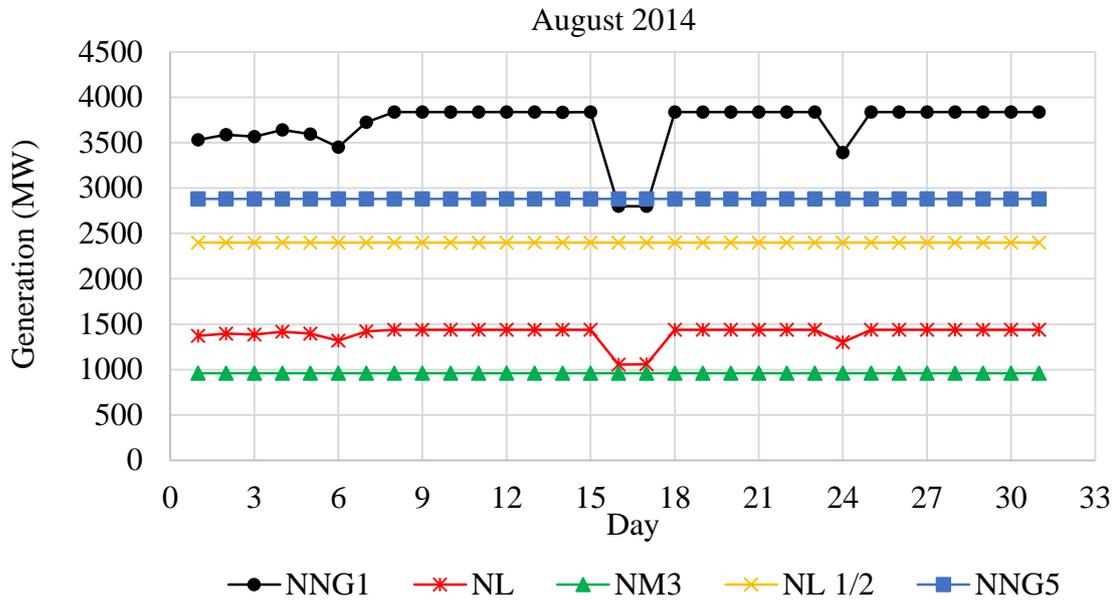


Figure 5.43 The result of optimal dispatch by using Lambda iteration method

Figure 5.44 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of August 2014 is \$ 24,405.84, which is equivalent to 0.14 %.

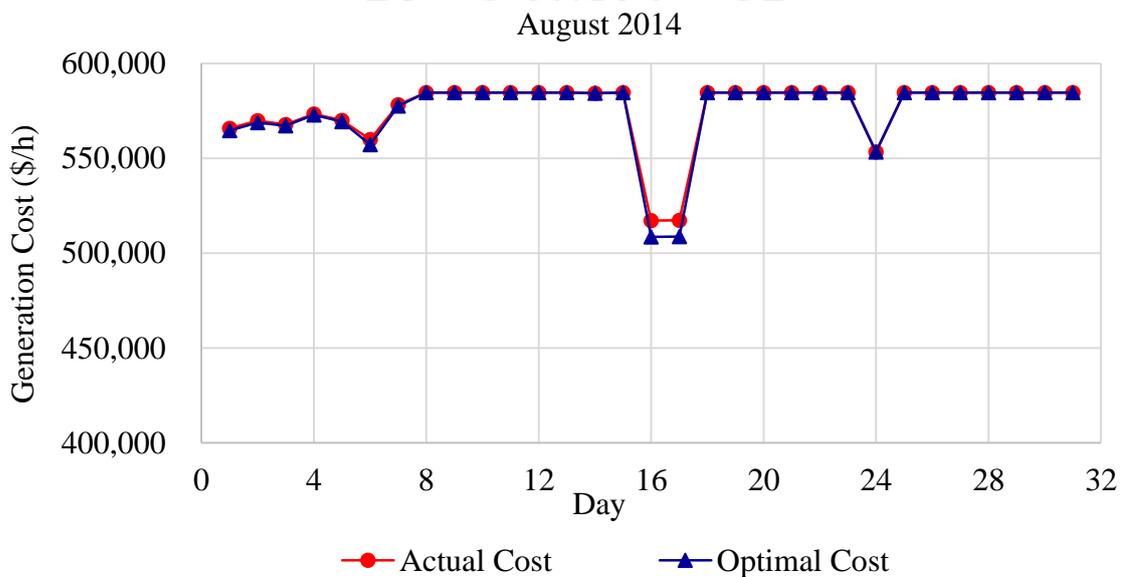


Figure 5.44 Comparison actual cost and optimal cost in August 2014

5.5.9 Optimal load dispatch in September 2014

The table 5.24 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th September 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power of actual and optimal are not much difference. This month is inessential optimization.

Table 5.24 Power output of scheduling 5 HPP in September 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	11,494.2	3,840.0	1,440.0	960.0	2,400.0	2,854.2	3,814.2	1,440.0	960.0	2,400.0	2,880.0
2	11,480.3	3,840.0	1,440.0	960.0	2,400.0	2,840.3	3,800.3	1,440.0	960.0	2,400.0	2,880.0
3	11,483.8	3,840.0	1,440.0	960.0	2,400.0	2,843.8	3,803.8	1,440.0	960.0	2,400.0	2,880.0
4	11,482.6	3,840.0	1,440.0	960.0	2,400.0	2,842.6	3,802.6	1,440.0	960.0	2,400.0	2,880.0
5	11,483.8	3,840.0	1,440.0	960.0	2,400.0	2,843.8	3,803.8	1,440.0	960.0	2,400.0	2,880.0
6	11,483.8	3,840.0	1,440.0	960.0	2,400.0	2,843.8	3,803.8	1,440.0	960.0	2,400.0	2,880.0
7	11,488.6	3,840.0	1,440.0	960.0	2,400.0	2,848.6	3,808.6	1,440.0	960.0	2,400.0	2,880.0
8	11,477.5	3,840.0	1,440.0	960.0	2,400.0	2,837.5	3,799.3	1,438.2	960.0	2,400.0	2,880.0
9	11,493.5	3,840.0	1,440.0	960.0	2,400.0	2,853.5	3,813.5	1,440.0	960.0	2,400.0	2,880.0
10	11,493.6	3,840.0	1,440.0	960.0	2,400.0	2,853.6	3,813.6	1,440.0	960.0	2,400.0	2,880.0
11	11,490.9	3,840.0	1,440.0	960.0	2,400.0	2,850.9	3,810.9	1,440.0	960.0	2,400.0	2,880.0
12	10,547.4	3,840.0	1,440.0	960.0	2,400.0	1,907.4	3,127.4	1,180.0	960.0	2,400.0	2,880.0
13	10,569.6	3,840.0	1,440.0	960.0	2,400.0	1,929.6	3,144.5	1,185.1	960.0	2,400.0	2,880.0
14	11,516.8	3,840.0	1,440.0	960.0	2,400.0	2,876.8	3,836.8	1,440.0	960.0	2,400.0	2,880.0
15	11,487.6	3,840.0	1,440.0	960.0	2,400.0	2,847.6	3,807.6	1,440.0	960.0	2,400.0	2,880.0
16	11,489.0	3,840.0	1,440.0	960.0	2,400.0	2,849.0	3,809.0	1,440.0	960.0	2,400.0	2,880.0
17	11,491.0	3,840.0	1,440.0	960.0	2,400.0	2,851.0	3,811.0	1,440.0	960.0	2,400.0	2,880.0
18	11,489.2	3,840.0	1,440.0	960.0	2,400.0	2,849.2	3,809.2	1,440.0	960.0	2,400.0	2,880.0
19	11,488.5	3,840.0	1,440.0	960.0	2,400.0	2,848.5	3,808.5	1,440.0	960.0	2,400.0	2,880.0
20	11,491.4	3,840.0	1,440.0	960.0	2,400.0	2,851.4	3,811.4	1,440.0	960.0	2,400.0	2,880.0
21	11,386.5	3,840.0	1,440.0	960.0	2,400.0	2,746.5	3,735.1	1,411.4	960.0	2,400.0	2,880.0
22	11,483.7	3,840.0	1,440.0	960.0	2,400.0	2,843.7	3,803.7	1,440.0	960.0	2,400.0	2,880.0
23	11,492.0	3,840.0	1,440.0	960.0	2,400.0	2,852.0	3,812.0	1,440.0	960.0	2,400.0	2,880.0
24	11,520.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0	3,840.0	1,440.0	960.0	2,400.0	2,880.0
25	11,054.4	3,840.0	1,440.0	960.0	2,400.0	2,414.4	3,490.4	1,324.0	960.0	2,400.0	2,880.0
26	10,062.9	3,840.0	1,440.0	960.0	2,400.0	1,422.9	2,776.1	1,046.7	960.0	2,400.0	2,880.0
27	10,071.6	3,840.0	1,440.0	960.0	2,400.0	1,431.6	2,782.2	1,049.4	960.0	2,400.0	2,880.0
28	10,074.4	3,840.0	1,440.0	960.0	2,400.0	1,434.4	2,784.2	1,050.2	960.0	2,400.0	2,880.0
29	10,061.6	3,840.0	1,440.0	960.0	2,400.0	1,421.6	2,775.2	1,046.4	960.0	2,400.0	2,880.0
30	9,607.2	3,840.0	1,440.0	488.9	2,400.0	1,438.3	2,457.5	909.7	960.0	2,400.0	2,880.0

Figure 5.45 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th September 2014 by using the Lambda iteration method.

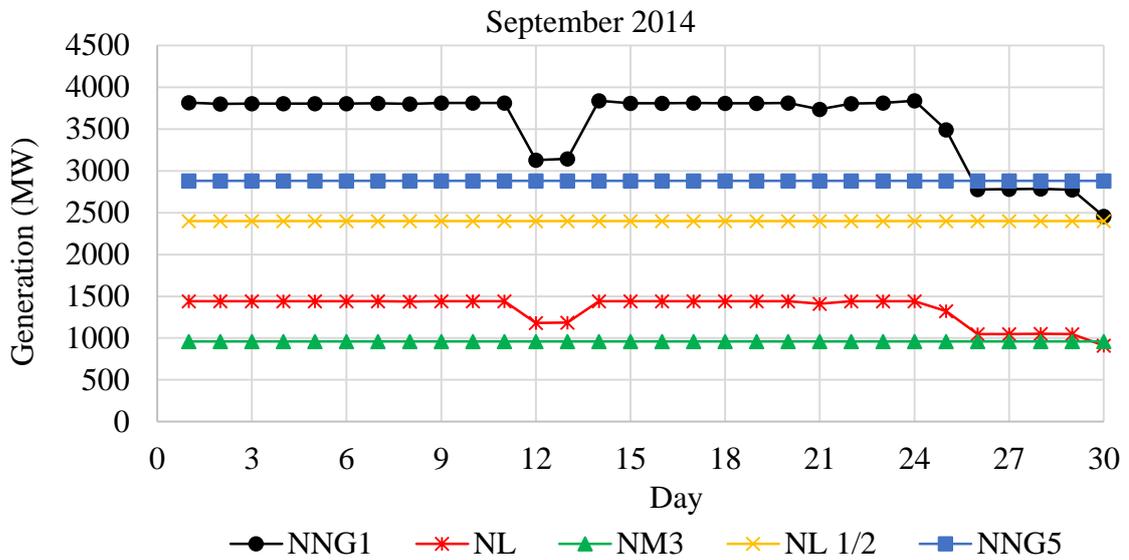


Figure 5.45 The result of optimal dispatch by using Lambda iteration method

Figure 5.46 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of September 2014 is \$ 62,497.85, which is equivalent to 0.37 %.

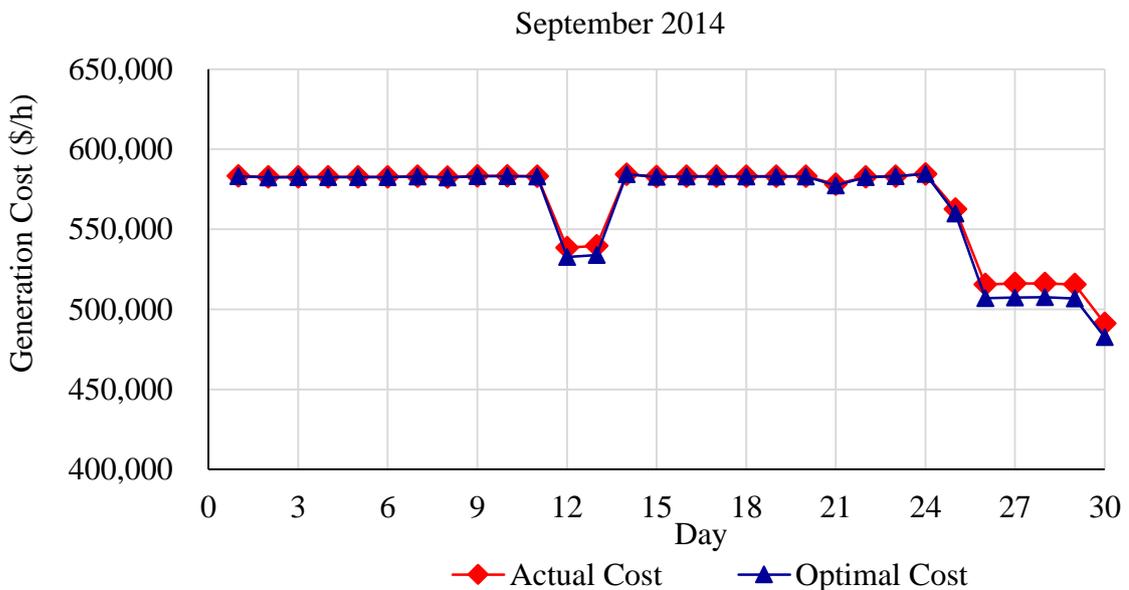


Figure 5.46 Comparison actual cost and optimal cost in September 2014

5.5.10 Optimal load dispatch in October 2014

The table 5.25 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 31st October 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. When operating at full load, the power of actual and optimal are similar.

Table 5.25 Power output of scheduling 5 HPP in October 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	9,894.4	4,317.4	1,452.7	489.0	2,526.3	1,108.9	2,658.3	996.1	960.0	2,400.0	2,880.0
2	8,991.0	4,330.5	727.4	320.3	2,531.0	1,081.8	2,026.6	724.4	960.0	2,400.0	2,880.0
3	9,008.0	4,324.1	729.4	305.3	2,532.5	1,116.7	2,038.5	729.5	960.0	2,400.0	2,880.0
4	8,959.6	4,308.8	723.0	304.1	2,527.6	1,096.1	2,004.6	715.0	960.0	2,400.0	2,880.0
5	8,933.8	4,304.1	722.4	301.8	2,523.7	1,081.8	1,986.5	707.2	960.0	2,400.0	2,880.0
6	8,967.8	4,299.1	722.2	306.1	2,523.7	1,116.7	2,010.3	717.4	960.0	2,400.0	2,880.0
7	8,849.6	4,284.0	731.2	303.3	2,442.7	1,088.4	1,927.7	681.9	960.0	2,400.0	2,880.0
8	8,795.7	4,284.0	720.0	303.3	2,400.0	1,088.4	1,890.0	665.7	960.0	2,400.0	2,880.0
9	8,858.0	4,276.7	720.0	304.6	2,402.7	1,154.1	1,933.6	684.4	960.0	2,400.0	2,880.0
10	8,977.9	4,292.7	720.0	304.2	2,354.5	1,306.6	2,017.4	720.5	960.0	2,400.0	2,880.0
11	8,812.6	4,289.7	303.7	720.0	2,410.6	1,088.6	1,901.8	670.8	960.0	2,400.0	2,880.0
12	7,141.7	3,212.8	120.2	304.1	2,418.7	1,085.8	561.1	480.0	820.6	2,400.0	2,880.0
13	7,182.2	3,218.4	149.6	304.9	2,415.9	1,093.4	590.9	480.0	831.2	2,400.0	2,880.0
14	8,148.8	3,925.1	455.3	284.8	2,413.2	1,070.5	1,399.7	626.2	842.9	2,400.0	2,880.0
15	7,519.0	3,387.0	452.7	304.5	2,417.5	957.3	1,170.9	544.8	690.0	2,365.1	2,748.2
16	6,853.4	3,415.2	332.4	304.7	1,716.6	1,084.5	550.5	480.0	627.5	2,375.3	2,820.2
17	5,848.7	3,380.9	452.6	304.7	607.4	1,103.1	360.0	480.0	474.8	2,048.6	2,485.3
18	6,457.2	3,410.3	448.9	304.0	1,209.2	1,084.7	491.8	480.0	685.9	2,192.3	2,607.1
19	6,149.1	3,386.3	149.5	323.1	1,210.4	1,079.8	412.8	480.0	482.9	2,184.8	2,588.7
20	5,528.4	2,768.8	150.9	304.2	1,211.7	1,092.8	360.0	480.0	240.0	2,076.1	2,372.3
21	5,831.6	2,835.4	420.0	263.1	1,211.9	1,101.2	360.0	480.0	441.5	2,060.3	2,489.8
22	5,728.5	2,845.1	330.0	264.1	1,212.2	1,077.1	360.0	480.0	406.4	2,041.0	2,441.1
23	5,853.5	2,828.4	420.0	300.0	1,211.7	1,093.4	360.0	480.0	450.8	2,065.0	2,497.7
24	6,226.8	2,838.1	422.4	262.3	1,611.2	1,092.9	549.2	480.0	543.3	2,117.1	2,537.3
25	7,007.0	2,826.8	421.2	261.6	2,403.5	1,093.9	827.8	480.0	660.0	2,335.9	2,703.3
26	6,803.6	2,834.7	210.3	241.6	2,412.3	1,104.6	630.0	480.0	646.1	2,340.6	2,706.9
27	6,769.4	2,830.0	150.0	282.2	2,415.5	1,091.7	582.0	480.0	660.0	2,340.6	2,706.9
28	7,023.5	2,830.7	451.1	242.2	2,411.1	1,088.4	810.9	480.0	665.8	2,344.3	2,722.5
29	6,963.2	2,832.7	482.1	242.1	2,315.8	1,090.5	815.4	480.0	660.0	2,318.0	2,689.8
30	5,878.0	2,856.0	481.5	244.4	1,205.7	1,090.5	360.0	480.0	442.1	2,088.5	2,507.5
31	5,878.2	2,856.0	481.7	244.4	1,205.7	1,090.5	360.0	480.0	442.2	2,088.5	2,507.6

Figure 5.47 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st October 2014 by using the Lambda iteration method.

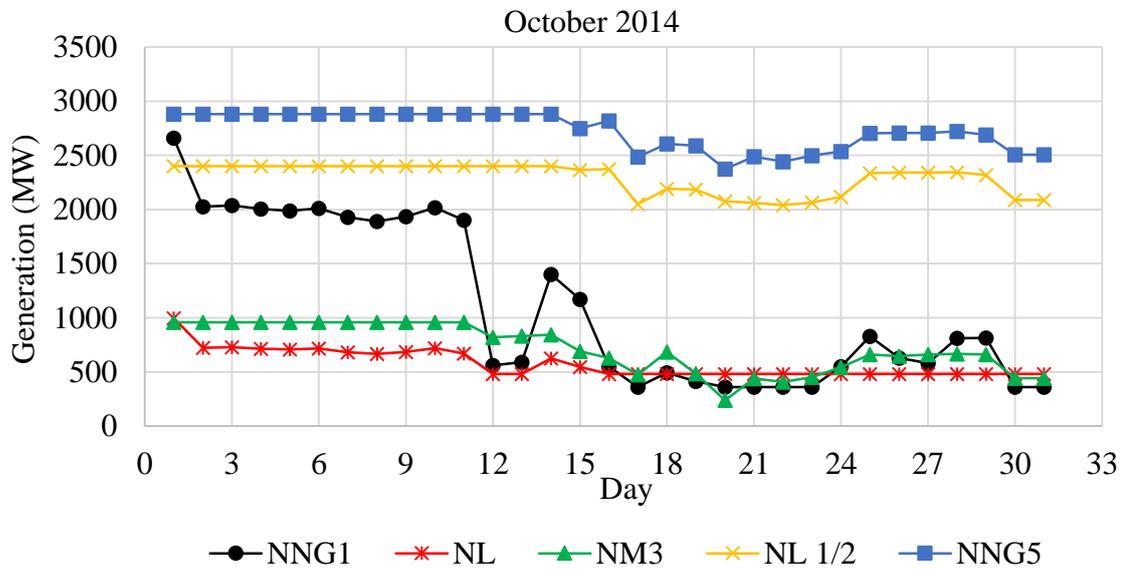


Figure 5.47 The result of optimal dispatch by using Lambda iteration method

Figure 5.48 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of October 2014 is \$ 347,003.00, which is equivalent to 2.96 %.

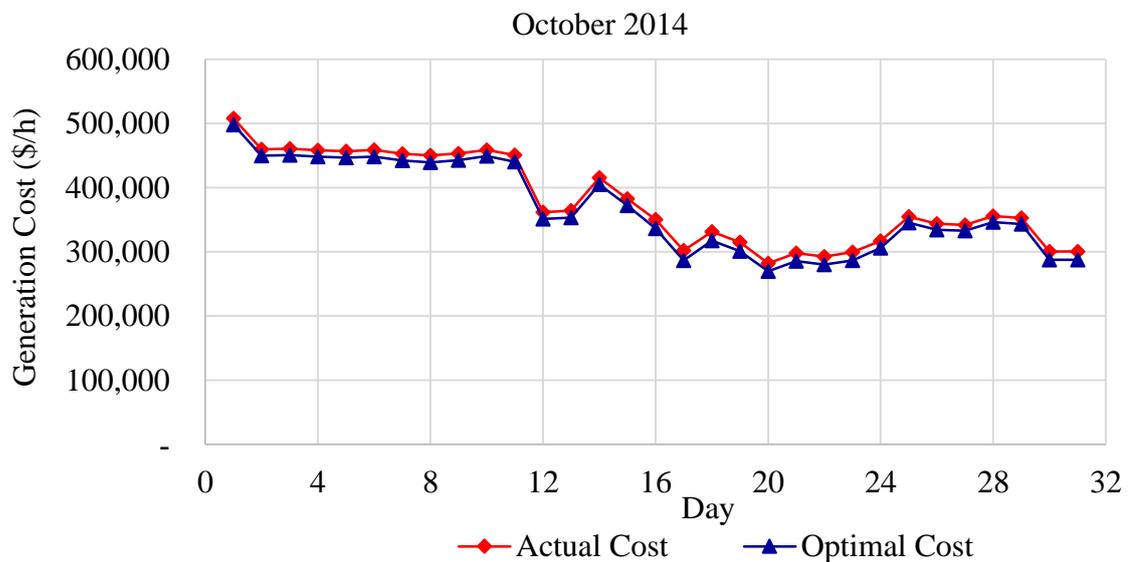


Figure 5.48 Comparison actual cost and optimal cost in October 2014

5.5.11 Optimal load dispatch in November 2014

The table 5.26 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th November 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power of NNG 5 does not operate on 9th to 13th.

Table 5.26 Power output of scheduling 5 HPP in November 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	6,097.4	3,075.9	420.0	305.0	1,205.3	1,091.2	360.0	480.0	463.3	2,196.5	2,597.5
2	5,851.7	3,078.1	180.0	305.3	1,204.1	1,084.1	360.0	480.0	334.2	2,188.5	2,489.0
3	5,864.2	3,083.2	180.0	305.3	1,204.1	1,091.6	360.0	480.0	337.7	2,193.6	2,492.9
4	6,411.7	3,297.4	390.0	304.8	1,204.2	1,215.4	557.5	480.0	573.1	2,202.4	2,598.7
5	6,180.3	3,251.0	390.6	304.0	1,158.5	1,076.1	481.6	480.0	479.2	2,180.0	2,559.4
6	6,212.5	3,217.2	391.3	305.8	1,213.4	1,084.8	472.1	480.0	496.5	2,186.5	2,577.3
7	6,192.0	3,251.0	390.6	304.0	1,158.5	1,087.8	480.5	480.0	482.8	2,185.2	2,563.4
8	6,244.0	3,242.5	391.6	305.4	1,215.1	1,089.4	482.7	480.0	498.1	2,197.4	2,585.8
9	4,950.4	3,250.6	179.6	305.5	1,214.7	-	360.0	480.0	297.6	1,711.4	2,101.4
10	4,991.8	3,236.3	237.3	302.8	1,215.3	-	360.0	480.0	295.4	1,736.2	2,120.2
11	5,158.1	3,253.8	390.0	304.4	1,209.9	-	360.0	480.0	293.0	1,832.1	2,193.0
12	5,557.3	3,231.8	390.0	325.6	1,207.6	402.3	473.6	480.0	402.8	1,910.2	2,290.7
13	5,158.1	3,253.8	390.0	304.4	1,209.9	-	360.0	480.0	293.0	1,832.1	2,193.0
14	6,221.0	3,231.6	390.0	303.1	1,208.3	1,088.0	475.9	480.0	488.5	2,193.5	2,583.0
15	6,237.5	3,248.3	390.0	304.8	1,209.3	1,085.1	474.4	480.0	498.3	2,198.5	2,586.3
16	5,996.2	3,217.8	179.7	305.2	1,208.7	1,084.7	468.7	480.0	388.0	2,178.2	2,481.2
17	6,028.6	3,240.9	180.0	305.6	1,215.8	1,086.3	477.4	480.0	391.0	2,189.8	2,490.4
18	6,206.4	3,217.8	390.0	305.2	1,208.7	1,084.7	468.7	480.0	486.7	2,190.7	2,580.3
19	6,179.1	3,171.5	390.0	305.6	1,222.7	1,089.3	448.6	480.0	540.0	2,162.7	2,547.8
20	6,134.9	3,132.6	390.0	304.7	1,223.6	1,084.0	445.3	480.0	511.8	2,157.9	2,539.9
21	6,134.9	3,132.6	390.0	304.7	1,223.6	1,084.0	445.3	480.0	511.8	2,157.9	2,539.9
22	5,895.5	3,111.3	392.6	303.1	1,006.0	1,082.5	360.0	480.0	505.5	2,094.1	2,455.8
23	4,749.1	2,202.3	150.0	304.3	1,005.6	1,086.9	360.0	480.0	240.0	1,658.8	2,010.3
24	4,787.2	2,213.3	181.7	303.3	1,004.7	1,084.2	360.0	480.0	240.0	1,680.4	2,026.7
25	5,888.6	3,069.9	450.0	283.3	1,003.2	1,082.2	360.1	480.0	612.3	2,000.3	2,435.9
26	5,844.6	3,081.9	390.0	284.2	1,002.2	1,086.3	360.0	480.0	620.3	1,970.8	2,413.5
27	5,836.4	3,066.9	390.0	283.6	1,008.0	1,087.9	360.4	480.0	618.6	1,966.9	2,410.5
28	5,855.8	3,074.2	393.9	302.4	1,002.8	1,082.5	375.6	480.0	617.0	1,970.2	2,413.0
29	5,791.0	3,061.7	330.5	283.9	1,029.7	1,085.1	360.3	480.0	536.6	1,988.5	2,425.5
30	4,810.8	2,192.7	242.1	282.3	1,028.0	1,065.7	360.0	480.0	240.0	1,693.9	2,036.9

Figure 5.49 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 30th November 2014 by using the Lambda iteration method.

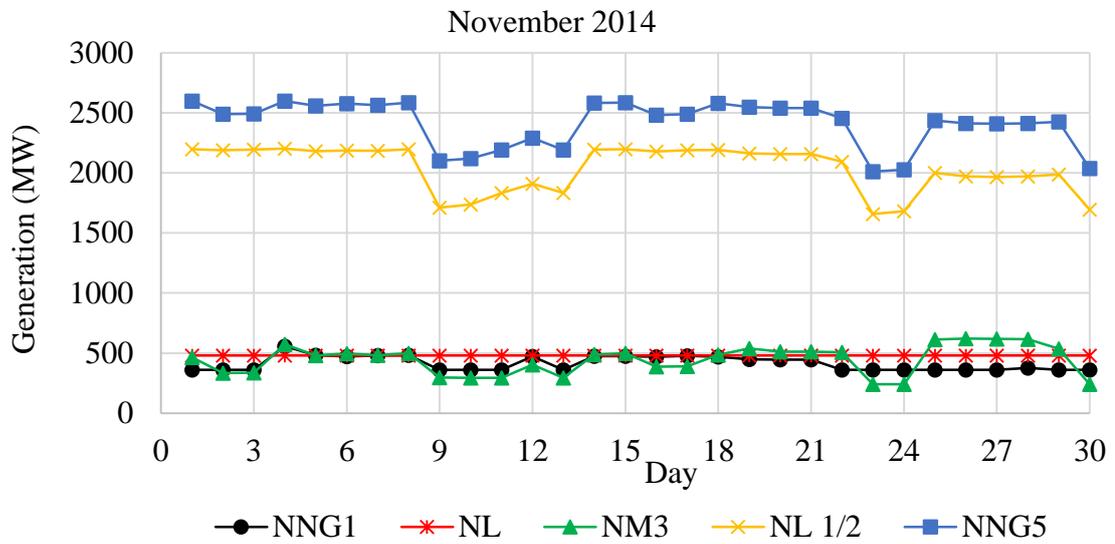


Figure 5.49 The result of optimal dispatch by using Lambda iteration method

Figure 5.50 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of November 2014 is \$ 403,837.69, which is equivalent to 4.53 %.

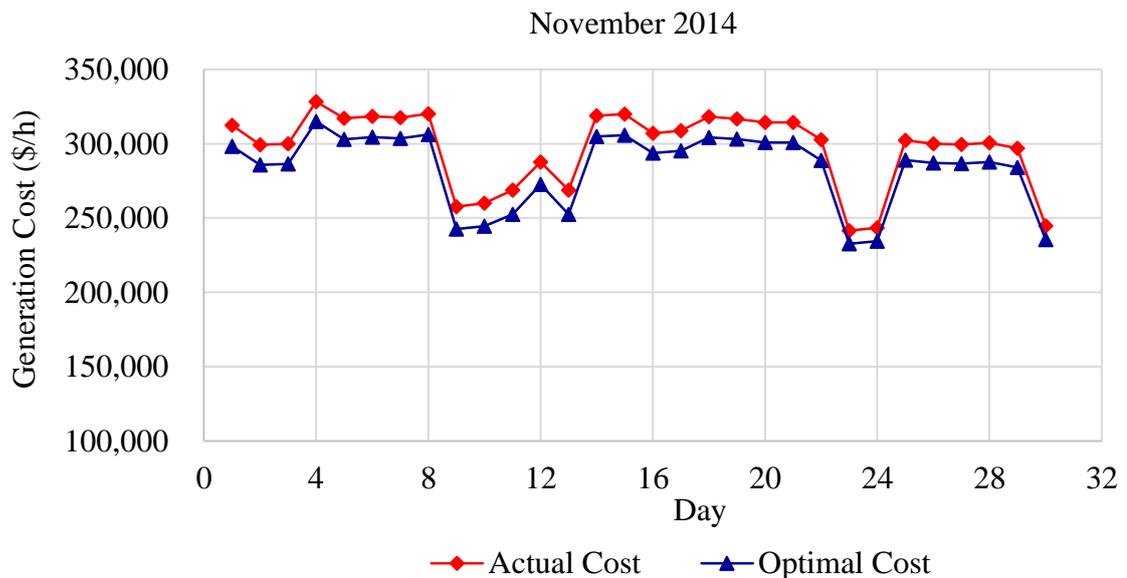


Figure 5.50 Comparison actual cost and optimal cost in November 2014

5.5.12 Optimal load dispatch in December 2014

The table 5.27 shows the generation schedule for optimal power based on load demand gives us the guideline to run and generate power of 5 hydropower plants neglecting generator limits on 1st to 30th November 2014. The optimal power schedule was selected the hydropower plant which has the lowest to the highest cost, such as NNG 5, NL 1/2 are firstly selected. Then NM 3, NNG 1 and NL are selected respectively. The actual power of NNG 5 does not operate on 9th to 15th.

Table 5.27 Power output of scheduling 5 HPP in December 2014

Date	P-Load	Actual Generation (MW)					Lambda iteration method (MW)				
		NNG1	NL	NM3	NL 1/2	NNG5	NNG1	NL	NM3	NL 1/2	NNG5
1	4,959.2	2,193.2	151.0	151.1	1,375.3	1,088.6	360.0	480.0	336.3	1,687.1	2,095.8
2	6,488.0	2,808.0	392.9	221.3	2,052.6	1,013.2	523.5	480.0	616.6	2,239.4	2,628.4
3	6,057.2	2,818.8	390.9	241.9	2,060.0	545.6	375.2	480.0	534.8	2,131.7	2,535.6
4	5,405.2	2,798.8	392.6	244.1	882.0	1,087.6	360.0	480.0	258.9	1,947.7	2,358.6
5	4,983.5	2,798.8	-	222.1	869.9	1,092.7	360.0	480.0	240.0	1,792.1	2,111.4
6	5,593.6	2,865.9	420.3	224.2	1,766.8	316.4	360.0	480.0	412.1	1,952.9	2,388.6
7	5,457.1	2,874.6	149.5	241.9	1,074.5	1,116.7	360.0	480.0	258.4	2,020.1	2,338.5
8	6,891.1	2,866.7	120.9	243.0	849.3	2,811.2	583.7	480.0	689.3	2,370.3	2,767.8
9	6,565.4	4,150.5	425.5	223.4	1,766.0	-	691.3	480.0	637.9	2,175.0	2,581.2
10	5,756.2	3,384.1	392.7	224.5	1,754.9	-	360.0	480.0	392.0	2,057.6	2,466.5
11	5,897.9	3,490.3	423.4	223.8	1,760.4	-	557.3	480.0	519.7	1,945.9	2,395.0
12	6,562.4	4,142.8	420.0	221.2	1,778.4	-	679.4	480.0	637.6	2,180.0	2,585.4
13	6,613.2	4,126.5	420.0	223.8	1,842.9	-	685.6	480.0	666.7	2,181.7	2,599.1
14	4,826.5	3,613.2	119.8	242.4	851.1	-	360.0	480.0	240.0	1,692.1	2,054.4
15	4,901.6	3,685.7	120.8	244.8	850.3	-	360.0	480.0	240.0	1,733.4	2,088.2
16	6,321.1	3,744.8	420.0	222.9	849.0	1,084.4	439.4	480.0	621.2	2,188.4	2,592.1
17	6,321.7	3,744.8	420.7	222.9	848.9	1,084.4	441.3	480.0	619.9	2,188.4	2,592.1
18	5,354.9	2,764.0	423.3	224.5	851.4	1,091.8	360.0	480.0	240.0	1,946.6	2,328.3
19	5,331.0	2,744.0	420.0	222.3	852.8	1,091.8	360.0	480.0	240.0	1,936.4	2,314.5
20	5,565.2	2,756.9	420.0	223.5	844.2	1,320.5	360.0	480.0	289.3	2,014.7	2,421.2
21	4,966.9	2,165.4	388.2	260.0	850.9	1,302.4	360.0	480.0	240.0	1,782.6	2,104.2
22	6,242.0	2,165.4	120.0	183.0	854.6	2,919.0	365.0	480.0	355.4	2,366.4	2,675.2
23	5,555.0	2,736.5	420.6	222.3	858.3	1,317.3	360.0	480.0	287.2	2,010.1	2,417.7
24	5,487.3	2,672.1	419.0	221.3	858.1	1,316.8	360.0	480.0	275.7	1,992.7	2,378.9
25	5,564.7	2,728.2	420.0	223.5	851.8	1,341.3	360.0	480.0	293.5	2,012.0	2,419.2
26	5,473.5	2,669.6	420.0	221.9	852.0	1,310.0	360.0	480.0	268.9	1,974.1	2,390.4
27	5,548.3	2,712.6	409.6	220.8	890.7	1,314.6	367.5	480.0	289.8	2,000.6	2,410.5
28	4,663.7	2,069.6	360.0	241.9	867.8	1,124.4	360.0	480.0	240.0	1,610.2	1,973.5
29	4,954.3	2,045.6	423.6	231.8	914.7	1,338.6	360.0	480.0	242.2	1,767.0	2,105.2
30	4,850.9	2,045.6	360.0	240.0	890.7	1,314.6	360.0	480.0	240.0	1,710.0	2,060.9
31	4,807.7	2,098.4	388.8	270.7	896.6	1,153.2	360.0	480.0	240.0	1,692.1	2,035.6

Figure 5.51 shows the optimal power output of generation scheduling of 5 HPP simulation on 1st to 31st December 2014 by using the Lambda iteration method.

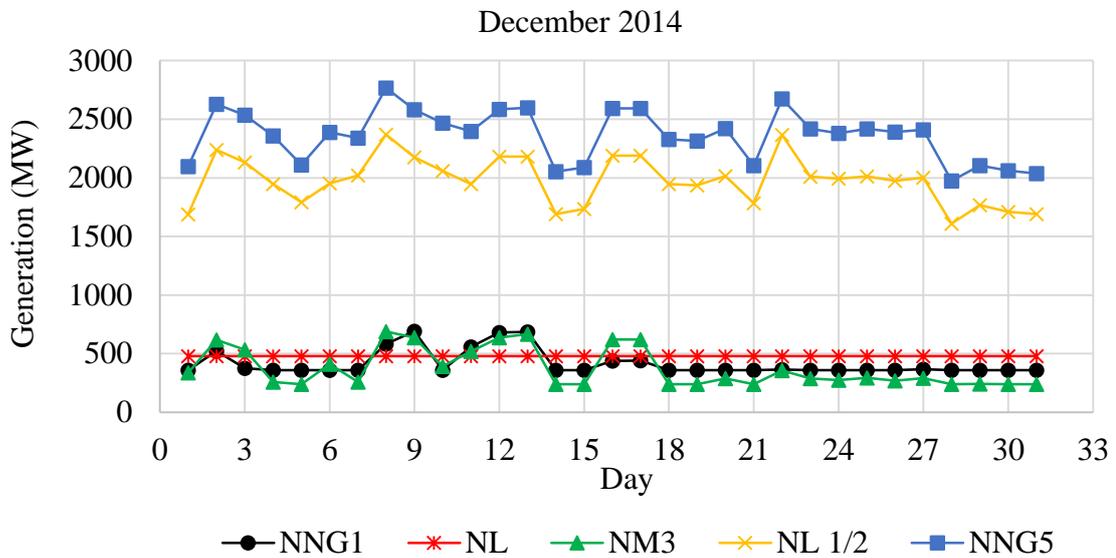


Figure 5.51 The result of optimal dispatch by using Lambda iteration method

Figure 5.52 shows the result of the comparison between actual cost and optimal cost by using the Lambda iteration method. The values of both are different. The optimal cost is lower than actual cost. The cost saving of December 2014 is \$ 388,724.45, which is equivalent to 4.36 %.

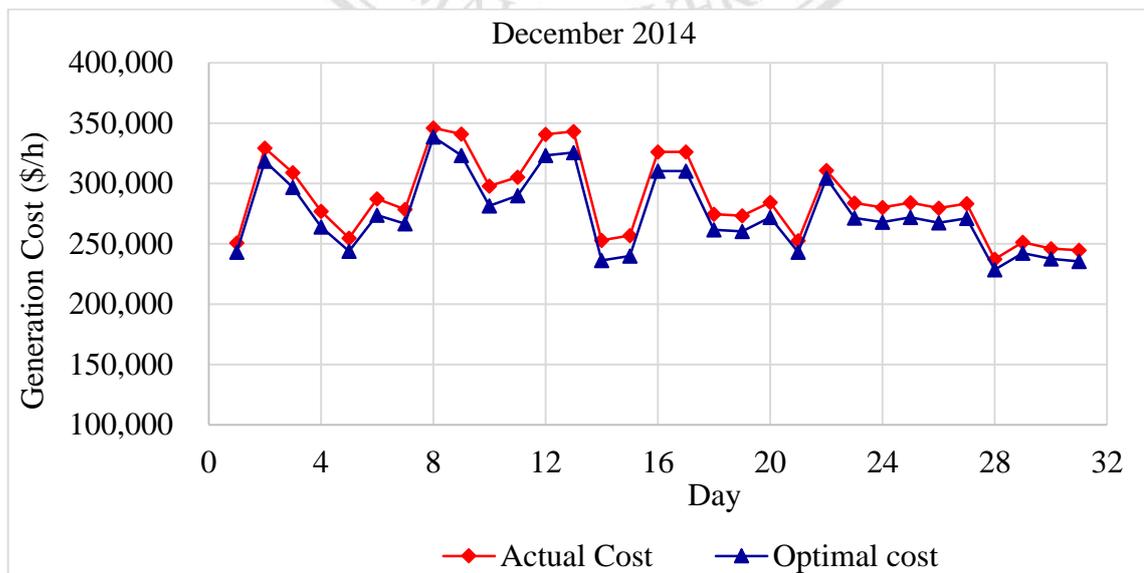


Figure 5.52 Comparison actual cost and optimal cost in December 2014

5.6 The Result of the Optimal Dispatch Including Minimum Generator Limits (Case 2)

Figure 5.53 shows the optimal cost of 5 hydropower plants in central-1 network of EDL in whole year 2014. The detail of the power output and cost generation by using Lambda iteration method of each month in 2014 as shown in appendix B.

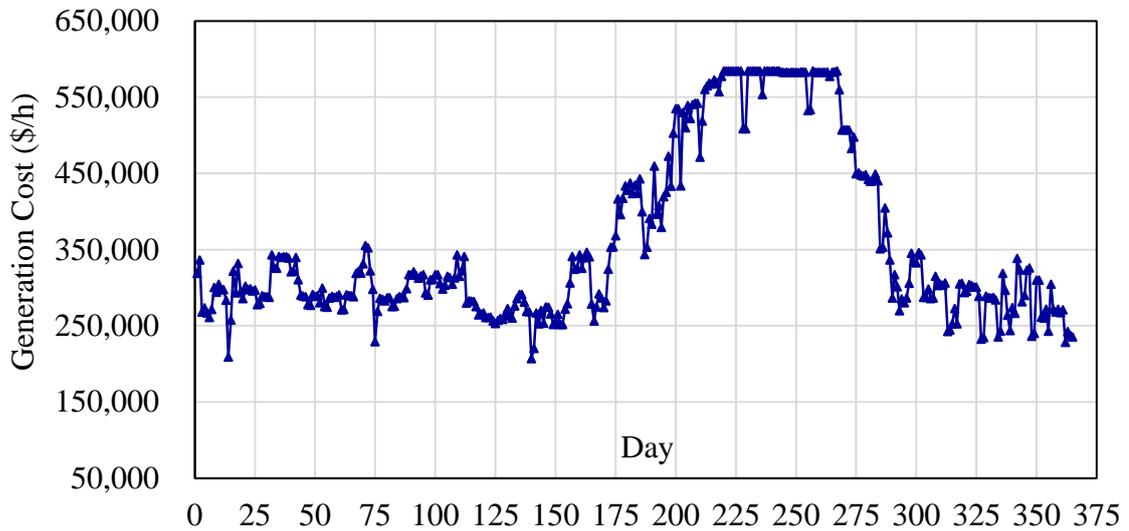


Figure 5.53 Optimal cost in year 2014 (Case 2)

The comparison between the actual cost and optimal cost in the whole year 2014, the values are different. The optimal cost is lower than actual cost as shown in figure 5.54.

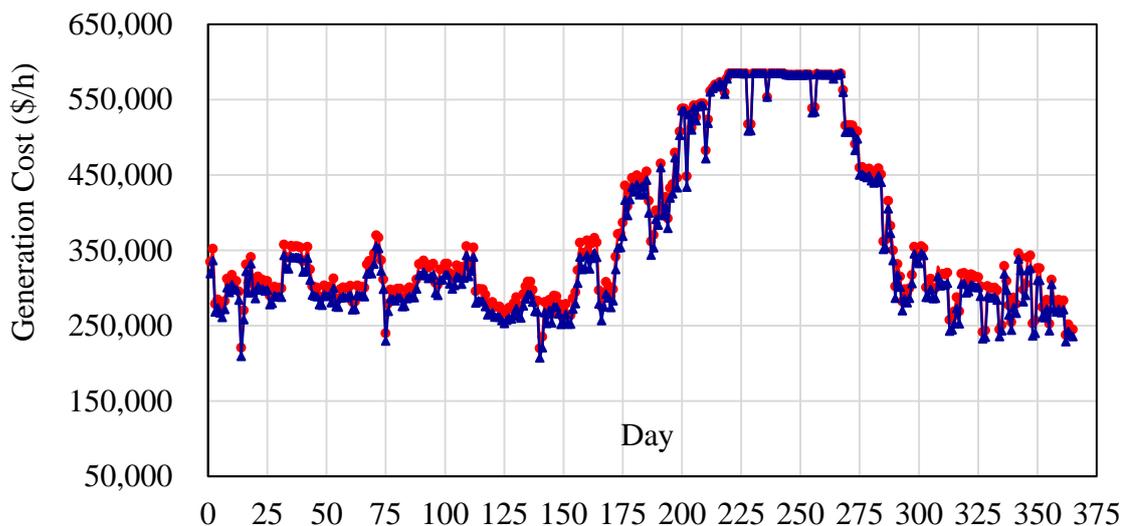


Figure 5.54 Comparison actual cost and optimal cost in year 2014 (Case 2)

The different cost value of daily in year 2014 between actual cost and optimal cost. When the generator running with low load the different cost is high such as January to June and September to December, because in this period there can choose generator which is minimized of generation cost. If each unit of the generators are operated full load such as July to August, the generations cost are not much different as shown in figure 5.55.

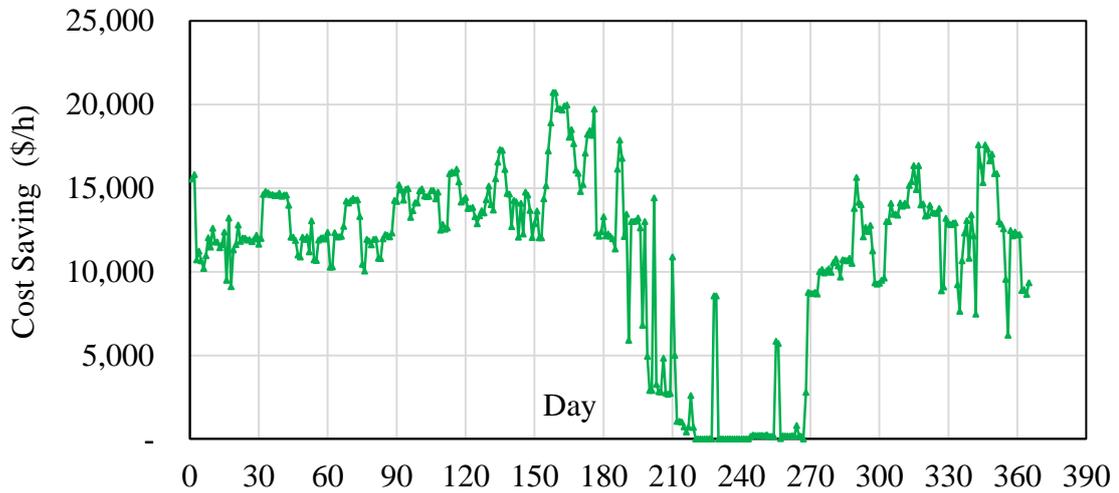


Figure 5.55 Different cost between actual and optimal value in 2014

The comparison low and high load between the actual cost and optimal cost, the values are different. The optimal cost is lower than actual cost. When the generator running with low load the different cost is high, because in this period there can choose generator which is minimized of generation cost. If each unit of the generators are operated full load, the generations cost are not much different as shown in figure 5.56.

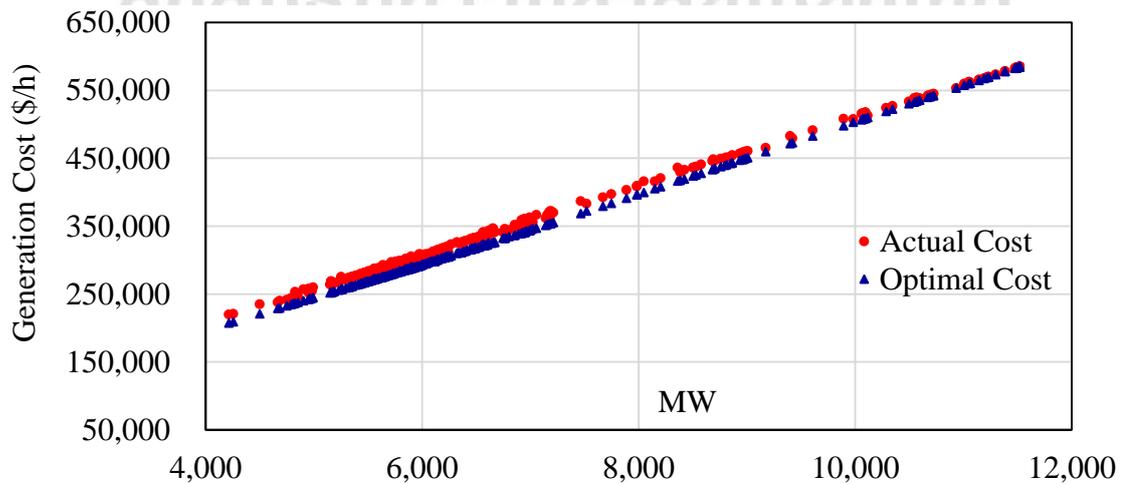


Figure 5.56 Comparison actual and optimal cost with low to high load in 2014

Table 5.28 shows the result of power load demand, actual cost, optimal cost and cost saving of scheduling of 5 hydropower plants in central-1 network of EDL. The study can observe that the optimized operation cost is lower than actual operation cost. The cost saving in every month is different. Some months the different cost is high such as May. The cost saving is \$ 500,545, which is equivalent to 4.80 %, because in this period there can choose generator which is minimized of generation cost. The different cost is too low in August. The cost saving is \$ 24,406, which is equivalent to 0.14 %, this period the generators are operated full load, the generation costs are not much different. The total of cost saving for the case 1 in whole year 2014 is \$ 399,2733, which is equivalent to 2.95 %.

Table 5.28 Result of power and cost output of scheduling 5 HPP in 2014

Month	P-Load (MW)	Actual Cost (\$/h)	Optimal Cost (\$/h)	Cost Saving (\$)	Percentage (%)
Jan	183,360.41	9,338,771	8,971,593	367,177	3.93
Feb	175,168.89	8,924,551	8,561,989	362,562	4.06
Mar	187,689.80	9,553,539	9,169,598	383,941	4.02
Apr	185,982.23	9,530,823	9,096,412	434,411	4.56
May	166,894.23	8,590,257	8,151,516	438,741	5.11
Jun	201,768.04	10,422,893	9,922,348	500,545	4.80
Jul	284,912.47	14,551,126	14,272,239	278,887	1.92
Aug	351,533.64	17,847,326	17,822,920	24,406	0.14
Sep	334,737.39	17,019,632	16,957,134	62,498	0.37
Oct	229,839.88	11,729,602	11,382,599	347,003	2.96
Nov	173,466.70	8,905,092	8,501,254	403,838	4.53
Dec	173,966.19	8,909,852	8,521,128	388,724	4.36
Total	2,649,319.86	135,323,464	131,330,731	3,992,733	2.95

❖ Discussion

Figure 5.57 shows a comparison of costs between actual cost and optimal cost (case 1), actual cost and optimal cost (case 2). The differential cost of comparison between actual cost and optimal cost (case 1) is \$ 4,688,278 or 3.46%. The differential cost of comparison between actual cost and optimal cost (case 2) is \$ 3,992,733 or 2.9%. The optimal cost of case 1 is lower than case 2 and the different cost is \$ 695,545 or 0.51%.

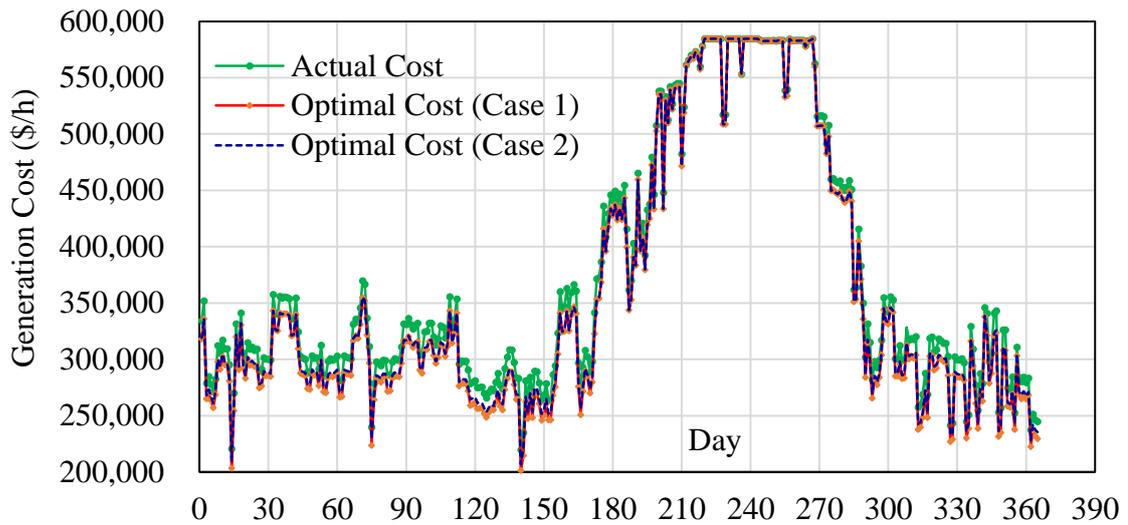


Figure 5.57 Cost compare between actual costs, optimal cost (Case 1) and (case 2)

The different cost between actual cost, optimal cost case 1 and optimal cost case 2 in 2014 as shown in figure 5.58. The optimal cost of case 1 is lower than case 2. When the generator supplies low load, because the different cost is high in January to June and October to December. The reason for this case is the minimized generation cost is chosen and the case 2 has the constraint for minimum generation limited. If generators operated within full load such as in July to September, the different from generation cost is very small.

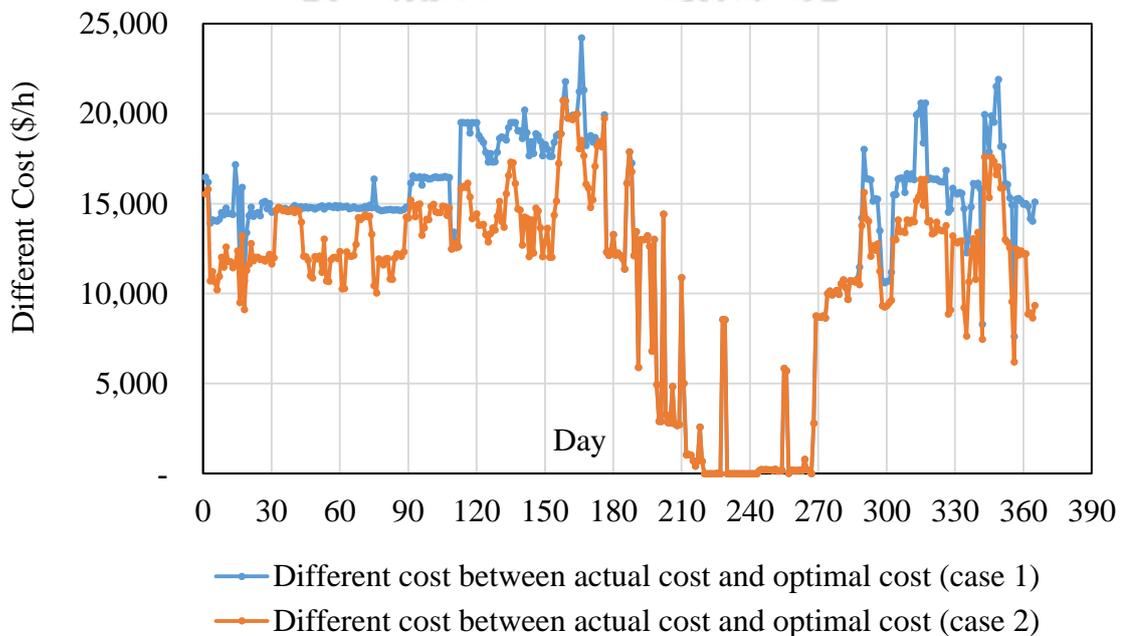


Figure 5.58 Different cost between actual and optimal cost in 2014