LOCATIONAL MARGINAL PRICING ASSIGNMENT USING AMES

BY

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Table of Contents

1.0 AMES

1.1 Task 1a.

Figure 1 shows the hourly values for the locational marginal price (LMP) benchmark of the 5 bus test case in the AMES software for 24 hours which will be the same each day, while figure 2 shows the hourly values of the LMP for the adaptive GenCo agents on the last day of the simulation (day 51). The two figures show wide spread values each hour with less variation in values until 16th hour where there is a significant change in value. In both cases (fig 1 and 2), Bus 1 show a drop at the 17th hour (peak demand hour see appendix 1) while bus 4 shows an insignificant change in values, bus 2,3 and 4 experienced a substantial spike at the in value at the 16th hour with all bus reaching its peak at the 17th hour followed by a gradual fall at the 18 hour.

The LMP for the last day experienced a more significant value compared to the first day due to the profit motives of each Gencos. Each GenCo agents are restricted from communicating with each other to avoid price fixing but still uses a statistical learning technique in determining a profitable supply price. They do this by using their daily net earnings from the previous day in deciding the next day supply offer. The accumulation of each day values over the 51 days will result in a larger peak in the 51st day as seen in figure 2. The learning enabled the Gencos to extract higher LMP from the LSE. **NB:** LMP(Benchmark) represent the LMPs without learning.

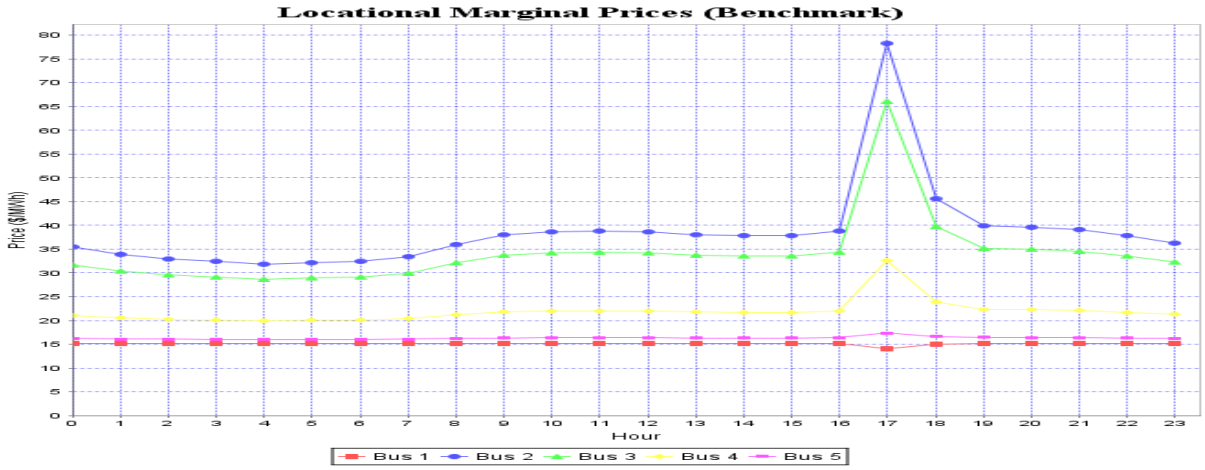


Figure 1.0: The Locational Marginal Prices (Benchmark)

Figure 2.0: The Locational Marginal Prices for the last day (24hours)

1.2 Task 1b.

Figure 3 shows the initial maximum capacity used for the simulation in task **1a**. These values were changed in the case > case parameter tab to 2000MWs as shown in figure 4. These parameters were changed to remove the constraint from all the branches. The Genco1-6 have a capacity ranging from 100-600MWs (figure 5) and branches capacity ranging from 150-400MWs figure 6, changing all branches maximum capacity to 2000MWs will allow any restricted GenCos to provide their maximum capacity whenever possible.

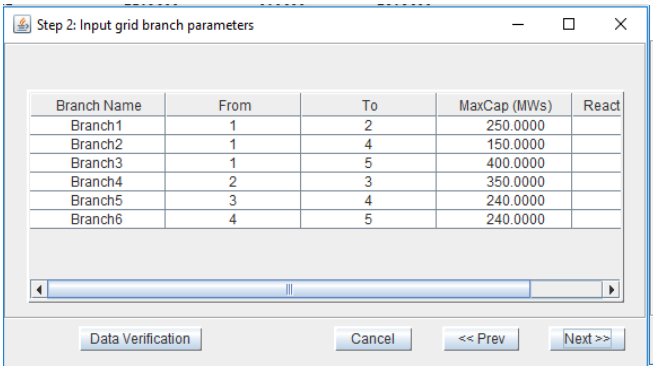


Figure 3.0: Initial Maximum Capacity

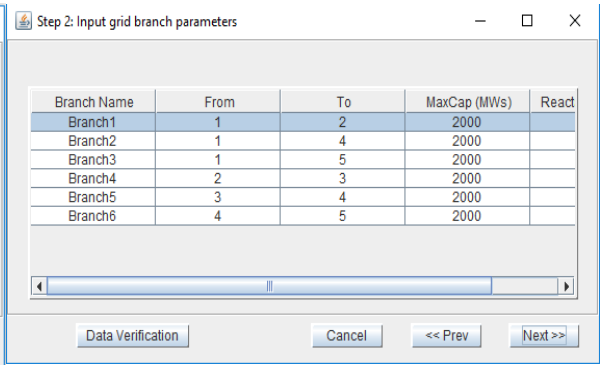


Figure 4.0: New Maximum Capacity

Number of GenCo Agents: 5
GenCo Data:

ID	atBus	FCost	a	b	capL	capU
1	1	0.0000	14.0000	0.0050	0.0000	110.0000
2	1	0.0000	15.0000	0.0060	0.0000	100.0000
3	3	0.0000	25.0000	0.0100	0.0000	520.0000
4	4	0.0000	30.0000	0.0120	0.0000	200.0000
5	5	0.0000	10.0000	0.0070	0.0000	600.0000

Figure 5.0: The GenCos Data

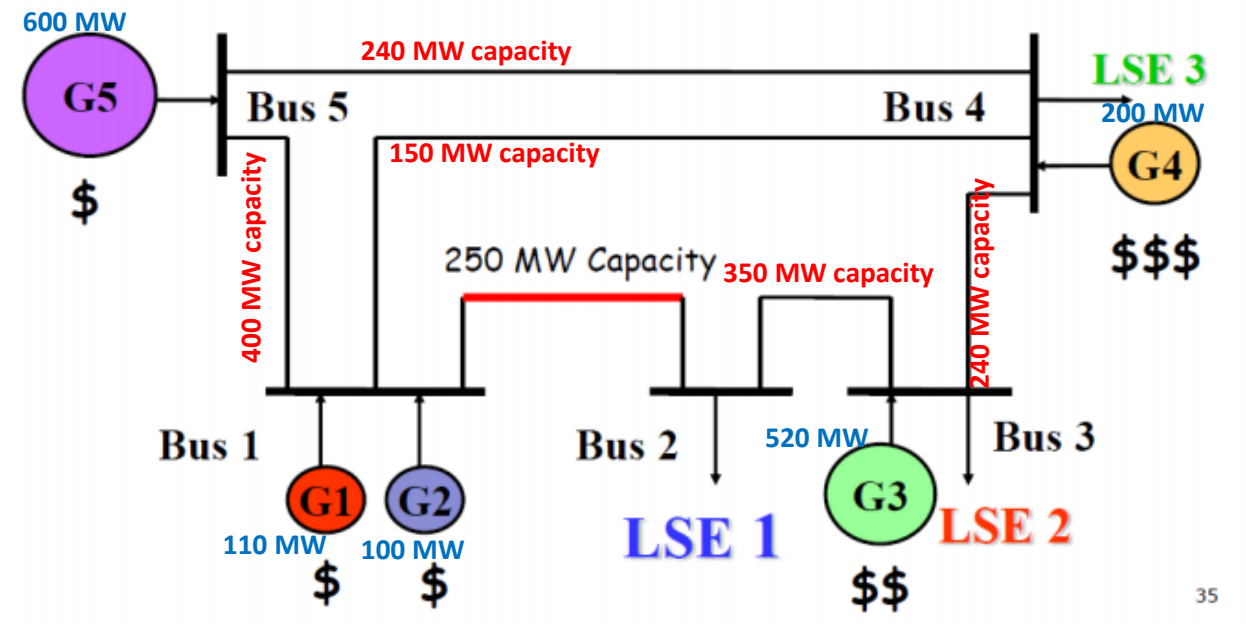


Figure 6.0: the schematics of the 5-bus test case (red – line capacity, blue – GenCos capacity)

Task 1b continues

Figure 7 shows the LMP benchmark unconstrained while figure 8 shows the LMP unconstrained on the 51st day. All LMPs were observed to overlap; this is as a result of removing the constraint from the branches allowing all GenCos to compete against each other in the same market without any advantage over each other.

The unconstrained LMP benchmark (figure 7) experienced its peak at 32$/MWh (17th hour) and lowest price at 18$/MWh (4th hour) which is considerably lower to the unconstrained LMP at the 51th day whose peak at 17th hour is 52$/MWh and its lowest price is 33$/MWh. This increment on the 51st day can be attributed to the profit-seeking behaviour of each GenCos. The GenCo use a learning method explained in **1a.** The benchmark represents the LMP prices without learning while the increment experienced on the LMP curve on the 51st day was a result of the learning performed by the GenCos allowing them to adjust their prices to a higher value.

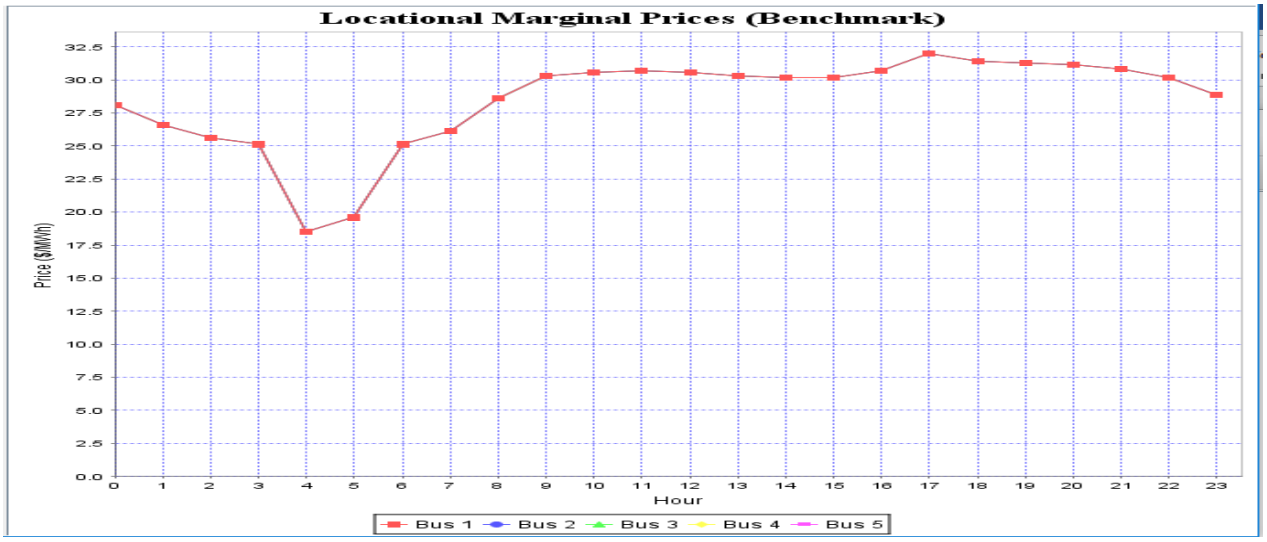


Figure 7.0: The new LMP benchmark after changing the Max. Capacity of all branches to 2000MWs (**NB:** Same for GenCos)

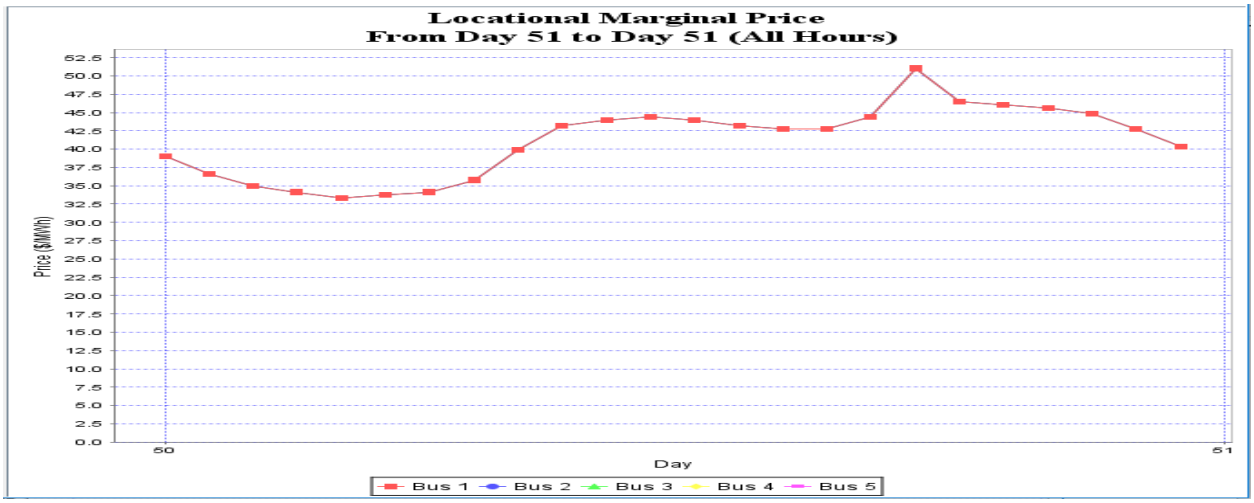


Figure 8.0: The new LMP benchmark on the last day after changing the Max. Capacity of all branches to 2000MWs. **NB:** Same for Gencos

1.3 Task 1c

Figure 9 shows the Genco commitments for the initial values, while figure 10 shows the Genco commitment benchmark for new maximum capacity. As seen in figure 10, increasing the maximum capacity of all branches lead to these new observations:

I. The Genco 1, 2 and 5 are now operating at the maximum capacity of 110,100 and 600MWs at every hour of the day without any variation at any time compared to the initial simulation, this is possible because these three GenCos are the cheapest (Appendix 1) therefore the loads will prefer purchasing from them at all time; therefore their commitment will be the maximum capacity they can offer.

II. Initially, Genco 4 never experienced significant commitment until 17 hours, but due to change in the maximum capacity, it experienced a rise in commitment in the 9th hours with gradual fall at the 12th hour. Also gradual increase again at the 15th hour reaching a peak at 17th hour followed by a gradual fall until the 23rd hour. Genco 4 is the most expensive supplier (appendix 1); therefore the LSEs are not willing to purchase resulting in lower commitment. GenCo is only used when GenCos 1, 2 and 5 are not sufficient, to ramp up the peak demand during the afternoon.

III. Genco 3, experienced a similar pattern of commitment compared to GenCo 4. It experienced an overall lower commitment compared to when the branches were constrained. In fig 9, it reaches a peak of 500MWs out of its maximum 520 MWs at the 17th hour while it's experienced its lowest commitment of 180MW at the 4th hour. However, lifting the constrained gave cheaper GenCos greater supply power, GenCo 3 experienced the least commitment of 0MWs at 4th hour and a peak of 350MWs at 17hour because LSEs will only use its services during peak demand to meet excess power requirements.

In Particular, The Genco5 is now producing at maximum capacity because it is the cheapest GenCo on the network. GenCo 5 has a capacity of 600MW while the branch 5-4 was initially constrained to 240MW, since that the constraint has been lifted, GenCo 5 five will be able to supply all its capacity if requested by LSE 3.

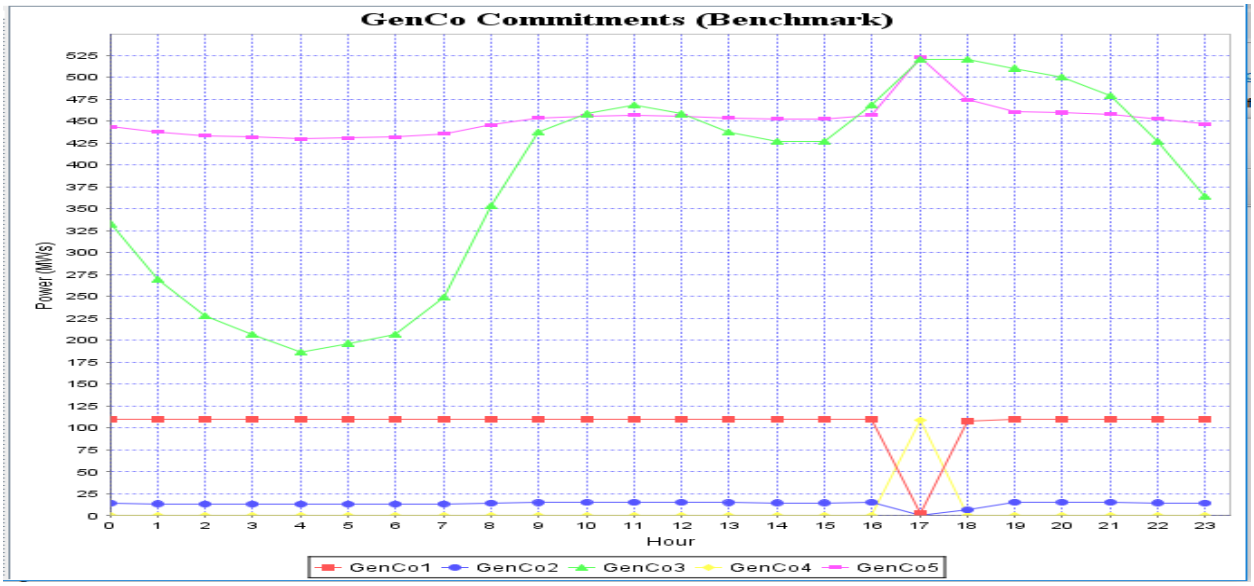


Figure 9.0: The old GenCo Commitments (Benchmark) before changing the maximum capacity

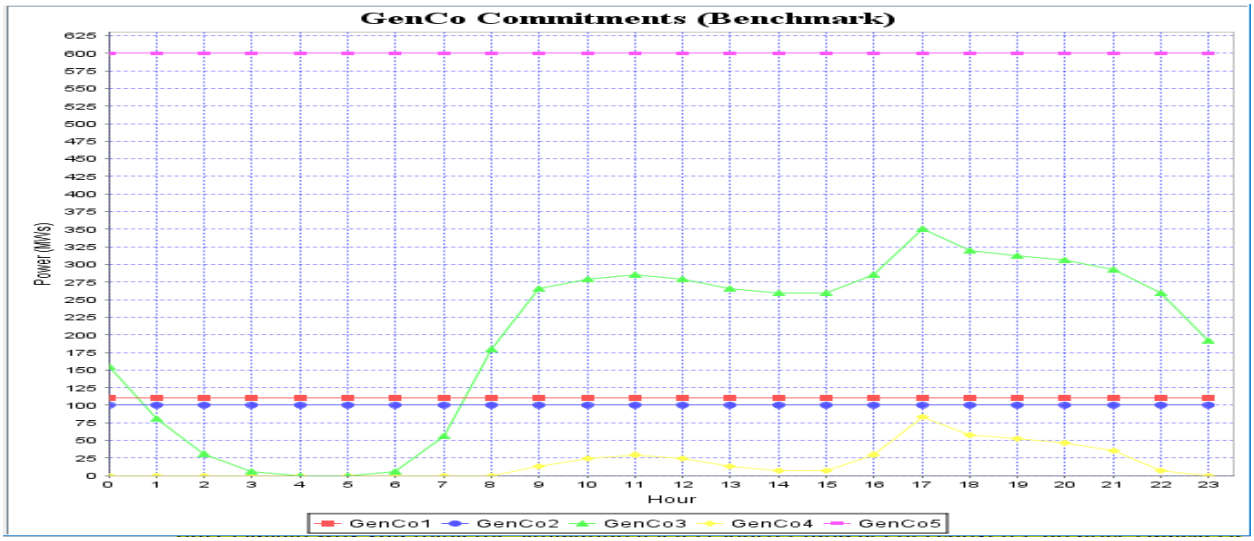


Figure 10: The new GenCo Commitments (Benchmark) after changing the maximum capacity

2.0 Physical Transmission Rights

2.1 Advantage of Physical Transmission Right

1. The utilisation of a congested path between two zones, say zone A and B would only be granted to the owner of a physical transmission right up to the level of capacity acquired by the owner. These owners can decide whatsoever they wish to do with the rights, they can choose to use it, sell it in the secondary market or transfer it to any other agent willing to hold it. The agents are profit-oriented and will be willing to generate at maximum capacity in a perfectly competitive market to obtain maximum profit at all time, therefore withholding this right in a given zone will increase the value of local generation resources [1].

Disadvantages of Physical Transmission Right

1. A 100% perfectly competitive market is usually difficult to attain; therefore a less perfectly competitive market will give a physical transmission right owner the abilities to exercise power in the market. Considering two Individuals (A & B) in a two-node market, If Individual A possess the physical transmission right up to a certain capacity and decides neither to use it nor sell it, it will decrease the amount of power that the individual can supply by Individual B. This reduction in transmission capacity enhances the market power that A exerts on B and allows it to increase the profit margin on its production. It also has an adverse effect on the economic efficiency of the market [2].
2. The second disadvantage bout the physical transmission right is the ability of the owner to remove that capacity from the marketplace. For a stringent physical right condition, the owner may decide to neither sell it nor use it which will reduce the capacity in the market [1].

2.3 Potential Solutions to the two disadvantages

1. The first potential solution to the disadvantages is to exert a policy called “use them or lose them”. For this policy, transmission capacity that a participant has reserved but does not use is released to others who wish to use it. Enforcing this condition is difficult because the unused transmission capacity may be released so late that other market participants are unable to readjust their trading positions [2].

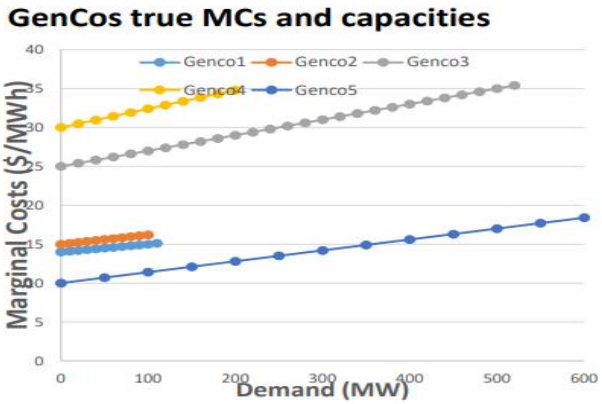
2. Modifications that require the “release” of spare capacity back into an open market could potentially reduce this problem, but there is concern that such releases would not occur far enough in advance to be of much use to schedulers. Similarly, the transmission capacity that is made available for use by non-rights holders can also be exploited by the owners of transmission rights [1].

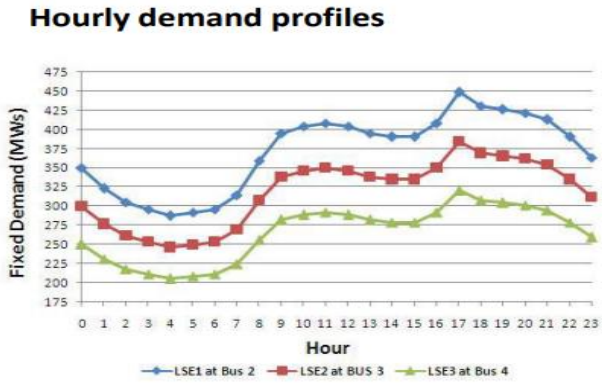
References

[1] M. Power and J. Bushnell, “Transmission Rights and Market Power,” vol. 6190, no. October, pp. 77–85, 1999.

[2] D. S. Kirschen and G. Strbac, “Fundamentals of Power System Economics.”

Appendix





Appendix 1: