

Scalable Multi-Period Optimal Power Flow for Active Power Distribution Systems

or simply, Scalable MP-OPF in ADS

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Terminal SOC Constraint Relaxed

DDP

```
*****
\nablaL {B j^t} for [61, 1]: 0 0649
VL {B j^t} for [61, 2]: 0 0695
\nabla L \{B_j^t\}  for [61, 3]: 0_0257
\nabla L \{B \ j^t\} \ for [61, 4]: -0 01
\nabla L_{B_j^t}  for [61, 5]: -258_3461
VL {B j^t} for [61, 6]: 255 2
VL {B j^t} for [61, 7]: 0 7125
\nabla L_{B_j^*t} for [61, 8]: 0_3203
\nablaL {B j^t} for [61, 9]: -0 6333
VL {B j^t} for [61, 10]: 0 003
\nabla L \{B j^t\}  for [61, 11]: -0 1014
VL_{B_j^t} for [61, 12]: 1_774
\nabla L_{B_j^t} for [61, 13]: 0_3056
\nabla L \{B j^t\}  for [61, 14]: -2 1936
VL {B j^t} for [61, 15]: -0 1915
VL_{B_j^t} for [61, 16]: 1_479
VL {B j^t} for [61, 17]: 1 605
\nabla L_{B_j^t} for [61, 18]: 1_241
\nabla L \{B_j^t\}  for [61, 19]: 1 549
\nabla L_{B_j^t} for [61, 20]: 0_2987
\nabla L_{B_j^t} for [61, 21]: -1_1867
\nabla L \{B j^t\}  for [61, 22]: -0 2987
VL_{B_j^t} for [61, 23]: 2_219
\nabla L \{B_j^t\}  for [61, 24]: 0_0
*****
Total KKT balance for B_61: 22_08
*****
```

All-Time Substation Power Cost $(P_{SubsCost}^{allT})$ across Forward Passes using Temporally Decomposed via DDP, Spatially Centralized OPF with 40% PVs and 51% Batteries optimizing for Cost of Substation Power with model BranchFlowModel 1ph S $\cos t$ O DDP Temporally Brute-Forced 2400 Power 2300 Substation 2200 2100 All-Time 11 Forward Pass [k]

```
i^t} for [61, 1]: 0 0
          for [61, 2]: 0 0
          for [61, 3]: 0 0
          for [61. 4]: -0 0
          for [61, 5]: 0 0
          for [61, 6]: 0 0
       ^t} for [61, 7]: 0 0
          for [61. 8]: 0 0
          for [61. 9]: 0 0
          for [61. 10]: 0 0
       ^t} for [61. 11]: -0 0
          for [61, 12]: 0 0
          for [61, 13]: 0 0
          for [61, 14]: 0 0
       `t} for [61. 15]: -0 0
       `t} for [61. 16]: 0 0
       `t} for [61. 17]: 0 0
       ^t} for [61. 18]: 0 0
       `t} for [61. 19]: 0 0
          for [61. 20]: 0 0
          for [61, 21]: -0_0
   {B j^t} for [61, 22]: 0 0
   {B_j^t} for [61, 23]: 0_0
\nabla L \{B_j^t\}  for [61, 24]: -0.0
Total KKT balance for B 61: 0 0
*****
```

Terminal SOC Constraint Relaxed

DDP

```
*****
\nabla L \{B j^t\}  for [61, 1]: 0 0649
VL_{B_j^t} for [61, 2]: 0 0695
\nabla L \{B_j^t\}  for [61, 3]: 0_0257
\nabla L \{B \ j^t\} \ for [61, 4]: -0 01
VL_{B_j^t} for [61, 5]: -258_3461
\nabla L \{B_j^t\}  for [61, 6]: 255_2
VL {B j^t} for [61, 7]: 0 7125
\nabla L_{B_j^t} for [61, 8]: 0_3203
\nabla L \{B j^t\}  for [61, 9]: -0.6333
VL {B j^t} for [61, 10]: 0 003
\nabla L_{B_j^t} for [61, 11]: -0_1014
\nabla L \{B j^t\}  for [61, 12]: 1 774
VL {B j^t} for [61, 13]: 0 3056
\nabla L_{B_j^t} for [61, 14]: -2_1936
\nabla L \{B \ j^t\}  for [61, 15]: -0 1915
\nabla L_{B_j^*t} for [61, 16]: 1_479
\nabla L \{B_j^t\}  for [61, 17]: 1 605
\nabla L \{B j^t\}  for [61, 18]: 1 241
\nabla L_{B_j^*t} for [61, 19]: 1_549
\nabla L \{B_j^t\}  for [61, 20]: 0_2987
VL {B j^t} for [61, 21]: -1 1867
VL_{B_j^t} for [61, 22]: -0_2987
\nabla L \{B j^t\}  for [61, 23]: 2 219
\nabla L \{B \ j^t\} \ for [61, 24]: 0 0
*****
Total KKT balance for B_61: 22_08
*****
```

```
|λ_lb[61, 1] = 0_0 | λ_ub[61, 1] = 0_0
\lambda = 10[61, 2] = 0.0 \mid \lambda = 10[61, 2] = 0.0
\lambda \, lb[61, 3] = 0 \, 0 \, | \, \lambda \, ub[61, 3] = 0 \, 0
\lambda_{b}[61, 4] = 0_0 \mid \lambda_{b}[61, 4] = 0_0
λ lb[61, 5] = 0 0 | λ ub[61, 5] = 0 0
\lambda_{b}[61, 6] = 0_0 \mid \lambda_{ub}[61, 6] = 0_{0001}
\lambda_lb[61, 7] = 0_0 | \lambda_ub[61, 7] = 0_0
\lambda_{b}[61, 8] = 0_{0} \mid \lambda_{ub}[61, 8] = 0_{0}
\lambda \, lb[61, 9] = 00 | \lambda \, ub[61, 9] = 00
\lambda \ lb[61, 10] = 0 0 | \lambda \ ub[61, 10] = 0 0
\lambda lb[61, 11] = 0 0 | \lambda ub[61, 11] = 0 0
λ lb[61, 12] = 0 0 | λ ub[61, 12] = 0 0
\lambda \ lb[61, 13] = 0 \ 0 \ | \ \lambda \ ub[61, 13] = 0 \ 0
\lambda_{b}[61, 14] = 0_0 \mid \lambda_{ub}[61, 14] = 0_0001
\lambda \ lb[61, 15] = 0 0 | \lambda \ ub[61, 15] = 242 6
\lambda_lb[61, 16] = 0_0 | \lambda_ub[61, 16] = 3_98
\lambda lb[61, 17] = 0 0 | \lambda ub[61, 17] = 0 9011
\lambda lb[61, 18] = 0 0 | \lambda ub[61, 18] = 0 5681
\lambda lb[61, 19] = 0 0 | \lambda ub[61, 19] = 0 0649
\lambda \ lb[61, 20] = 0 \ 0 \ | \ \lambda \ ub[61, 20] = 0 \ 0
\lambda_{b}[61, 21] = 0_0 \mid \lambda_{b}[61, 21] = 0_0
\lambda_{b}[61, 22] = 244_{1} | \lambda_{ub}[61, 22] = 0_{0}
λ_lb[61, 23] = 1_809 | λ_ub[61, 23] = 0_0
\lambda lb[61, 24] = 47 34 | \lambda ub[61, 24] = 0 0
```

```
\mu[61, 1, 11] = 49_05
\mu[61, 2, 11] = 48 99
\mu[61, 3, 11] = 48_92
μ[61. 4. 11] = 48 89
\mu[61, 5, 11] = 48_9
\mu[61, 6, 11] = 307_2
\mu[61, 7, 11] = 52_03
\mu[61, 8, 11] = 51 32
\mu[61, 9, 11] = 51_0
\mu[61. 10. 11] = 51 63
\mu[61, 11, 11] = 51_63
\mu[61, 12, 11] = 51 73
\mu[61, 13, 11] = 49 95
\mu[61, 14, 11] = 49_65
\mu[61, 15, 11] = 51_84
\mu[61, 16, 11] = 294_6
\mu[61, 17, 11] = 297 1
\mu[61, 18, 11] = 296_4
\mu[61. 19. 11] = 295 7
\mu[61, 20, 11] = 294_2
\mu[61, 21, 11] = 294 0
\mu[61, 22, 11] = 295_1
\mu[61, 23, 11] = 51 37
\mu[61, 24, 11] = 47_34
```

Terminal SOC Constraint Relaxed

```
\nabla L_{B_j^t}  for [61, 1]: 0_0
VL {B j^t} for [61, 2]: 0 0
\nabla L_{B_j^t}  for [61, 3]: 0_0
\nabla L \{B j^t\}  for [61, 4]: -0 0
\nabla L_{B_j^t}  for [61, 5]: 0_0
\nabla L \{B j^t\}  for [61, 6]: 0 0
\nabla L_{B_j^t}  for [61, 7]: 0_0
\nabla L_{B_j^t}  for [61, 8]: 0_0
\nabla L_{B_j^t}  for [61, 9]: 0_0
\nabla L_{B_j^t}  for [61, 10]: 0_0
\nabla L_{B_j^t}  for [61, 11]: -0_0
\nabla L \{B j^t\}  for [61, 12]: 0 0
\nabla L_{B_j^t}  for [61, 13]: 0 0
\nabla L_{B_j^*t} for [61, 14]: 0_0
\nabla L \{B_j^t\}  for [61, 15]: -0.0
\nabla L_{B_j^t}  for [61, 16]: 0_0
\nabla L \{B_j^t\}  for [61, 17]: 0_0
\nabla L \{B j^t\}  for [61, 18]: 0 0
\nablaL {B j^t} for [61, 19]: 0 0
\nabla L \{B_j^t\}  for [61, 20]: 0_0
\nabla L \{B j^t\}  for [61, 21]: -0 0
\nabla L_{B_j^t}  for [61, 22]: 0_0
\nabla L_{B_j^t}  for [61, 23]: 0_0
\nabla L \{B j^t\}  for [61, 24]: -0 0
Total KKT balance for B 61: 0 0
*****
```

```
λ_lb[61, 1] = 0_0 | λ_ub[61, 1] = 0_0
\lambda_{b}[61, 2] = 0_0 \mid \lambda_{b}[61, 2] = 0_0
\lambda = 10[61, 3] = 0.0 \mid \lambda = 0[61, 3] = 0.0
\lambda \ lb[61, 4] = 0 0 | \lambda \ ub[61, 4] = 0 0
\lambda_{b}[61, 5] = 0_0 \mid \lambda_{b}[61, 5] = 0_0
\lambda \ lb[61, 6] = 0 \ 0 \ | \ \lambda \ ub[61, 6] = 0 \ 0
λ lb[61. 7] = 0 0 | λ ub[61. 7] = 0 0
\lambda_{b}[61, 8] = 0.0 \mid \lambda_{ub}[61, 8] = 0.0
\lambda \ lb[61, 9] = 0 0 | \lambda \ ub[61, 9] = 0 0
\lambda lb[61, 10] = 0 0 | \lambda ub[61, 10] = 0 0
\lambda lb[61, 11] = 0 0 | \lambda ub[61, 11] = 0 0
\lambda lb[61, 12] = 0 0 | \lambda ub[61, 12] = 0 0
\lambda lb[61, 13] = 0 0 | \lambda ub[61, 13] = 0 0
λ_lb[61, 14] = 0_0 | λ_ub[61, 14] = 0_0001
\lambda lb[61, 15] = 0 0 | \lambda ub[61, 15] = 240 6
\lambda lb[61, 16] = 0 0 | \lambda ub[61, 16] = 1 425
λ lb[61, 17] = 0 0 | λ ub[61, 17] = 0 7012
\lambda lb[61, 18] = 0 0 | \lambda ub[61, 18] = 0 3623
\lambda_{b}[61, 19] = 0_0 \mid \lambda_{ub}[61, 19] = 0_0001
\lambda_{b}[61, 20] = 0.0 \mid \lambda_{b}[61, 20] = 0.0
\lambda lb[61, 21] = 0 0001 | \lambda ub[61, 21] = 0 0
\lambda lb[61, 22] = 243 9 | \lambda ub[61, 22] = 0 0
\lambda_{b}[61, 23] = 2_{515} | \lambda_{ub}[61, 23] = 0_{0}
\lambda lb[61, 24] = 48 58 | \lambda ub[61, 24] = 0 0
```

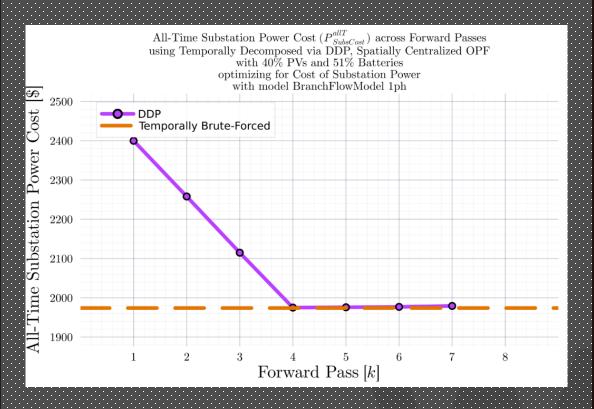
```
\mu[61. 1] = 51.84
\mu[61, 2] = 51_84
\mu[61, 3] = 51.84
\mu[61, 4] = 51 84
\mu[61. 5] = 51.84
\mu[61, 6] = 51_84
\mu[61, 7] = 51_84
\mu[61, 8] = 51.84
\mu[61, 9] = 51 84
\mu[61. 10] = 51.84
\mu[61, 11] = 51_84
u[61. 12] = 51 84
\mu[61, 13] = 51.84
\mu[61. 14] = 51.84
\mu[61, 15] = 51_84
\mu[61. 16] = 292 5
\mu[61, 17] = 293_9
u[61, 18] = 294 6
u[61. 19] = 295_0
\mu[61. 20] = 295 0
\mu[61, 21] = 295_0
\mu[61, 22] = 295_0
\mu[61, 23] = 51 09
\mu[61. 24] = 48 58
```



Terminal SOC Constraint Relaxed

DDP

```
\nablaL {B j^t} for [61, 1]: -0 058
VL {B j^t} for [61, 2]: 0 2752
\nabla L \{B \ j^t\} \ for [61, 3]: -0 0761
\nabla L_{B_j^t} for [61, 4]: 0_2075
VL {B j^t} for [61, 5]: 0 0649
\nabla L \{B_j^t\}  for [61, 6]: 0_0695
VL {B j^t} for [61, 7]: 0 0257
\nabla L \{B j^t\}  for [61, 8]: -0 01
\nabla L \{B \ j^t\} \ for [61, 9]: -258 \ 3464
VL {B j^t} for [61, 10]: 255 2
\nabla L_{B_j^t} for [61, 11]: 0_7125
VL {B j^t} for [61, 12]: 0 3203
\nabla L \{B j^t\}  for [61, 13]: -0 6333
VL_{B_j^t} for [61, 14]: 0_0029
VL {B j^t} for [61, 15]: 0_1537
VL_{B_j^t} for [61, 16]: 250_4
\nabla L \{B j^t\}  for [61, 17]: 0 3057
\nabla L \{B \ j^t\} \ for [61, 18]: -244 \ 7698
\nabla L \{B \ j^t\} \ for [61, 19]: -4 1714
\nabla L_{B_j^t} for [61, 20]: 0_5775
VL {B j^t} for [61, 21]: 1 291
\nabla L_{B_j^t} for [61, 22]: -0_0283
VL {B j^t} for [61, 23]: 0 0327
\nabla L \{B j^t\}  for [61, 24]: -0_0
*****
Total KKT balance for B 61: 42 41
*****
```



```
{B j^t} for [61, 1]: 0 0
       `t} for [61, 2]: 0 0
      j^t} for [61, 3]: 0 0
       `t} for [61, 4]: -0 0
       `t} for [61. 5]: 0 0
   {B_j^t} for [61, 6]: 0 0
     j^t} for [61, 7]: 0 0
       ^t} for [61. 8]: 0 0
       `t} for [61. 9]: 0 0
       ^t} for [61. 10]: 0 0
     i^t} for [61. 11]: -0 0
       `t} for [61. 12]: 0 0
          for [61, 13]: 0 0
   {B j^t} for [61, 14]: 0 0
     j^t} for [61, 15]: -0 0
       ^t} for [61, 16]: 0 0
  {B i^t} for [61. 17]: 0 0
   {B i^t} for [61. 18]: 0 0
      i^t} for [61. 19]: 0 0
          for [61. 20]: 0 0
          for [61, 21]: -0 0
   {B j^t} for [61, 22]: 0 0
  _{B_j^t} for [61, 23]: 0_0
\nabla L \{B j^t\}  for [61, 24]: -0 0
*****
Total KKT balance for B 61: 0 0
******
```

Terminal SOC Constraint Relaxed

DDP

```
\nabla L \{B j^t\}  for [61, 1]: -0 058
\nabla L_{B_j^t}  for [61, 2]: 0_2752
VL {B j^t} for [61, 3]: -0 0761
VL {B j^t} for [61. 4]: 0 2075
\nablaL {B j^t} for [61, 5]: 0 0649
\nabla L \{B_j^t\}  for [61, 6]: 0_0695
VL {B j^t} for [61, 7]: 0 0257
\nabla L_{B_j^t}  for [61, 8]: -0 01
\nabla L \{B j^t\}  for [61, 9]: -258 3464
VL {B j^t} for [61, 10]: 255 2
\nabla L_{B_j^t}  for [61, 11]: 0_7125
\nabla L \{B j^t\}  for [61, 12]: 0 3203
\nabla L_{B_j^t}  for [61, 13]: -0_6333
VL {B j^t} for [61, 14]: 0 0029
\nabla L_{B_j^t}  for [61, 15]: 0_1537
\nabla L_{B_j^*t} for [61, 16]: 250_4
\nabla L \{B_j^t\}  for [61, 17]: 0_3057
\nabla L_{B_j^t}  for [61, 18]: -244_7698
\nabla L \{B_j^t\}  for [61, 19]: -4_1714
VL_{B_j^t} for [61, 20]: 0_5775
VL {B j^t} for [61, 21]: 1 291
\nabla L_{B_j^t} for [61, 22]: -0_0283
VL {B j^t} for [61, 23]: 0 0327
\nabla L_{B_j^t}  for [61, 24]: -0_0
*****
Total KKT balance for B_61: 42_41
*****
```

```
λ lb[61, 1] = 0 0 | λ ub[61, 1] = 0 0
\lambda_{b}[61, 2] = 0_0 \mid \lambda_{b}[61, 2] = 0_0
\lambda_{b}[61, 3] = 0_0 \mid \lambda_{b}[61, 3] = 0_0
\lambda_{b}[61, 4] = 0_0 \mid \lambda_{b}[61, 4] = 0_0
\lambda_lb[61, 5] = 0_0 | \lambda_ub[61, 5] = 0_0
\lambda = 0 = 0 = 0
\lambda \, lb[61, 7] = 0.0 \mid \lambda \, ub[61, 7] = 0.0
\lambda_{b}[61, 8] = 0_{0} \mid \lambda_{ub}[61, 8] = 0_{0}
\lambda \ lb[61, 9] = 0 0 | \lambda \ ub[61, 9] = 0 0
\lambda_{b}[61, 10] = 0_0 \mid \lambda_{ub}[61, 10] = 0_0001
\lambda lb[61, 11] = 0 0 | \lambda ub[61, 11] = 0 0
\lambda_{b}[61, 12] = 0_0 \mid \lambda_{b}[61, 12] = 0_0
\lambda lb[61, 13] = 0_0 | \lambda ub[61, 13] = 0_0
\lambda lb[61, 14] = 0 0 | \lambda ub[61, 14] = 0 0
\lambda lb[61, 15] = 0 0 | \lambda ub[61, 15] = 243 9
\lambda lb[61, 16] = 0 0 | \lambda ub[61, 16] = 4 984
\lambda lb[61, 17] = 0 0 | \lambda ub[61, 17] = 0 0
\lambda \ lb[61, 18] = 0 \ 0 \ | \ \lambda \ ub[61, 18] = 0 \ 0
\lambda_{b}[61, 19] = 0_0 \mid \lambda_{ub}[61, 19] = 0_0
\lambda_lb[61, 20] = 0_0 | \lambda_ub[61, 20] = 0_0
\lambda lb[61, 21] = 0 0001 | \lambda ub[61, 21] = 0 0
\lambda lb[61, 22] = 245 7 | \lambda ub[61, 22] = 0 0
\lambda lb[61, 23] = 2 532 | \lambda ub[61, 23] = 0 0
\lambda lb[61, 24] = 48 49 | \lambda ub[61, 24] = 0 0
```

```
\mu[61, 1, 7] = 49_4
\mu[61, 2, 7] = 49_46
\mu[61, 3, 7] = 49_18
\mu[61, 4, 7] = 49_26
\mu[61, 5, 7] = 49_05
\mu[61, 6, 7] = 48_99
\mu[61, 7, 7] = 48 92
\mu[61, 8, 7] = 48_89
\mu[61, 9, 7] = 48_9
\mu[61, 10, 7] = 307_2
\mu[61, 11, 7] = 52_03
\mu[61, 12, 7] = 51 32
\mu[61, 13, 7] = 51 0
\mu[61, 14, 7] = 51 63
\mu[61, 15, 7] = 51_63
\mu[61, 16, 7] = 295_3
\mu[61, 17, 7] = 49_95
\mu[61, 18, 7] = 49_65
\mu[61, 19, 7] = 294 4
\mu[61, 20, 7] = 298_6
\mu[61, 21, 7] = 298_0
\mu[61, 22, 7] = 296_7
\mu[61, 23, 7] = 51_05
\mu[61, 24, 7] = 48_49
```



Terminal SOC Constraint Relaxed

DDP

```
\nabla L \{B j^t\}  for [61, 1]: 0 2341
VL {B j^t} for [61, 2]: 0 0087
\nabla L_{B_j^*t} for [61, 3]: 0 0049
VL {B j^t} for [61, 4]: -0 1182
\nabla L_{B_j^t} for [61, 5]: 0_0026
VL {B j^t} for [61, 6]: -239 3876
VL_{B_j^t} for [61, 7]: 239_1
\nabla L \{B j^t\}  for [61, 8]: 0 2523
\nabla L_{B_j^t} for [61, 9]: 0_1387
\nabla L_{B_j^t}  for [61, 10]: -0_0274
\nabla L_{B_j^t} for [61, 11]: -0_0082
\nabla L \{B j^t\}  for [61, 12]: -0_0664
\nabla L_{B_j^t} for [61, 13]: -0_0043
\nabla L \{B_j^t\}  for [61, 14]: 0 1052
VL {B j^t} for [61, 15]: -0 7692
VL_{B_j^t} for [61, 16]: 0_103
VL {B j^t} for [61, 17]: -0 3328
\nabla L_{B_j^t} for [61, 18]: -0_0635
\nabla L_{B_j^t} for [61, 19]: 0_4364
\nabla L_{B_j^t}  for [61, 20]: 0_01
\nabla L \{B j^t\}  for [61, 21]: 0 0276
\nabla L_{B_j^t} for [61, 22]: 0_0446
VL_{B_j^t} for [61, 23]: 0 0227
\nabla L_{B_j^t} for [61, 24]: 0_0
*****
Total KKT balance for B 61: 20 05
*****
```

```
All-Time Substation Power Cost (P_{SubsCost}^{allT}) across Forward Passes
                       using Temporally Decomposed via DDP, Spatially Centralized OPF
                                         with 40% PVs and 51% Batteries
                                     optimizing for Cost of Substation Power
                                        with model BranchFlowModel 1ph
\odot
\cos t
              O DDP
               Temporally Brute-Forced
    2400
Power
    2300
Substation
    2200
    2100
All-Time
    2000
    1900
                                             Forward Pass [k]
```

```
{B i^t} for [61, 1]: 0 0
          for [61, 2]: 0 0
       `t} for [61. 3]: 0 0
        `t} for [61. 4]: -0 0
          for [61, 5]: 0 0
   {B_j^t} for [61, 6]: 0 0
       ^t} for [61, 7]: 0 0
       `t} for [61. 8]: 0 0
        `t} for [61. 9]: 0 0
       `t} for [61. 10]: 0 0
      i^t} for [61. 11]: -0 0
       `t} for [61. 12]: 0 0
          for [61, 13]: 0 0
       ^t} for [61, 14]: 0 0
       `t} for [61, 15]: -0 0
       ^t} for [61, 16]: 0 0
       ^t} for [61. 17]: 0 0
   {B i^t} for [61. 18]: 0 0
      i^t} for [61. 19]: 0 0
          for [61. 20]: 0 0
          for [61, 21]: -0_0
   {B j^t} for [61, 22]: 0 0
  _{B_j^t} for [61, 23]: 0_0
\nabla L \{B j^t\}  for [61, 24]: -0.0
Total KKT balance for B 61: 0 0
*****
```

Terminal SOC Constraint Relaxed

DDP

```
VL \{B j^t\}  for [61, 1]: 0_2341
VL {B j^t} for [61, 2]: 0 0087
\nabla L \{B_j^t\}  for [61, 3]: 0_0049
VL {B j^t} for [61, 4]: -0 1182
\nabla L_{B_j^t} for [61, 5]: 0_0026
VL {B j^t} for [61, 6]: -239 3876
VL_{B_j^t} for [61, 7]: 239_1
VL {B j^t} for [61, 8]: 0 2523
\nabla L_{B_j^t}  for [61, 9]: 0_1387
\nabla L \{B_j^t\}  for [61, 10]: -0_0274
\nabla L_{B_j^t} for [61, 11]: -0_0082
\nabla L_{B_j^*t} for [61, 12]: -0_0664
\nabla L \{B j^t\}  for [61, 13]: -0 0043
\nabla L_{B_j^t} for [61, 14]: 0_1052
\nabla L \{B j^t\}  for [61, 15]: -0 7692
\nabla L_{B_j^t} for [61, 16]: 0_103
\nabla L \{B_j^t\}  for [61, 17]: -0_3328
VL {B j^t} for [61, 18]: -0 0635
\nabla L_{B_j^*t} for [61, 19]: 0_4364
\nabla L \{B j^t\}  for [61, 20]: 0 01
\nabla L_{B_j^t} for [61, 21]: 0_0276
\nabla L \{B j^t\}  for [61, 22]: 0 0446
VL_{B_j^t} for [61, 23]: 0_0227
\nabla L \{B_j^t\}  for [61, 24]: 0_0
*****
Total KKT balance for B_61: 20_05
*****
```

```
|λ_lb[61, 1] = 0_0 | λ_ub[61, 1] = 0_0
λ_lb[61, 2] = 0_0 | λ_ub[61, 2] = 0_0
\lambda = 0  | \lambda = 0 | \lambda = 0 | \lambda = 0
\lambda = 0  | \lambda = 0 | \lambda = 0 | \lambda = 0
\lambda \ lb[61, 5] = 0 \ 0 \ | \ \lambda \ ub[61, 5] = 0 \ 0
\lambda_{b}[61, 6] = 0_0 \mid \lambda_{ub}[61, 6] = 0_0
\lambda lb[61, 7] = 0 0 | \lambda ub[61, 7] = 0 0001
\lambda lb[61, 8] = 0 0 | \lambda ub[61, 8] = 0 0001
\lambda \ lb[61, 9] = 0 \ 0 \ | \ \lambda \ ub[61, 9] = 0 \ 0
\lambda \ lb[61, 10] = 0 \ 0 \ | \ \lambda \ ub[61, 10] = 0 \ 0
λ_lb[61, 11] = 0_0 | λ_ub[61, 11] = 0_0
\lambda lb[61, 12] = 0 0 | \lambda ub[61, 12] = 0 0
\lambda lb[61, 13] = 0_0 | \lambda ub[61, 13] = 0_0
\lambda = 10[61, 14] = 0_0 \mid \lambda = 10[61, 14] = 0_0
\lambda \ lb[61, 15] = 0 \ 0 \ | \ \lambda \ ub[61, 15] = 239 \ 9
\lambda \ lb[61, 16] = 0 \ 0 \ | \ \lambda \ ub[61, 16] = 1 \ 511
\lambda lb[61, 17] = 0 0 | \lambda ub[61, 17] = 1 149
\lambda lb[61, 18] = 0 0 | \lambda ub[61, 18] = 0 2085
\lambda \ lb[61, 19] = 0 \ 0 \ | \ \lambda \ ub[61, 19] = 0 \ 0001
\lambda \ lb[61, 20] = 0 \ 0 \ | \ \lambda \ ub[61, 20] = 0 \ 0
\lambda lb[61, 21] = 0_0001 | \lambda ub[61, 21] = 0 0
\lambda \ lb[61, 22] = 244_0 \mid \lambda_ub[61, 22] = 0_0
λ lb[61, 23] = 2 555 | λ ub[61, 23] = 0 0
λ lb[61, 24] = 48 45 | λ ub[61, 24] = 0 0
```

```
\mu[61, 1, 25] = 51_84
\mu[61, 2, 25] = 51_6
\mu[61, 3, 25] = 51_6
\mu[61, 4, 25] = 51_{59}
\mu[61, 5, 25] = 51 71
\mu[61, 6, 25] = 51_{71}
\mu[61, 7, 25] = 291 1
\mu[61, 8, 25] = 52 02
\mu[61, 9, 25] = 51_76
\mu[61, 10, 25] = 51 62
\mu[61, 11, 25] = 51.65
\mu[61, 12, 25] = 51 66
\mu[61, 13, 25] = 51_{73}
\mu[61, 14, 25] = 51_{73}
\mu[61, 15, 25] = 51_63
\mu[61, 16, 25] = 292 3
\mu[61, 17, 25] = 293_7
\mu[61, 18, 25] = 295_2
\mu[61, 19, 25] = 295_5
\mu[61, 20, 25] = 295_1
\mu[61, 21, 25] = 295 1
\mu[61, 22, 25] = 295_0
\mu[61, 23, 25] = 51_03
\mu[61, 24, 25] = 48 45
```

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