Scenario: Using the three area mini WECC system, Figure 1, a 200 MW step event was simulated in the South (Area 3) at $t = 2$. Initially, ≈2545 MW are being sent South over the COI. MW flows from Bus 89 to Area 3 are compared for both a 200 MW load step and a -200 MW generation step. Additionally, ω input to three generators in the North (Area 1) were delayed by 40 seconds. The combined MW capacity of the generators with delay is 16,900 MW, which is ≈40% of the area governed capacity or ≈13.8% of the total system governed capacity.

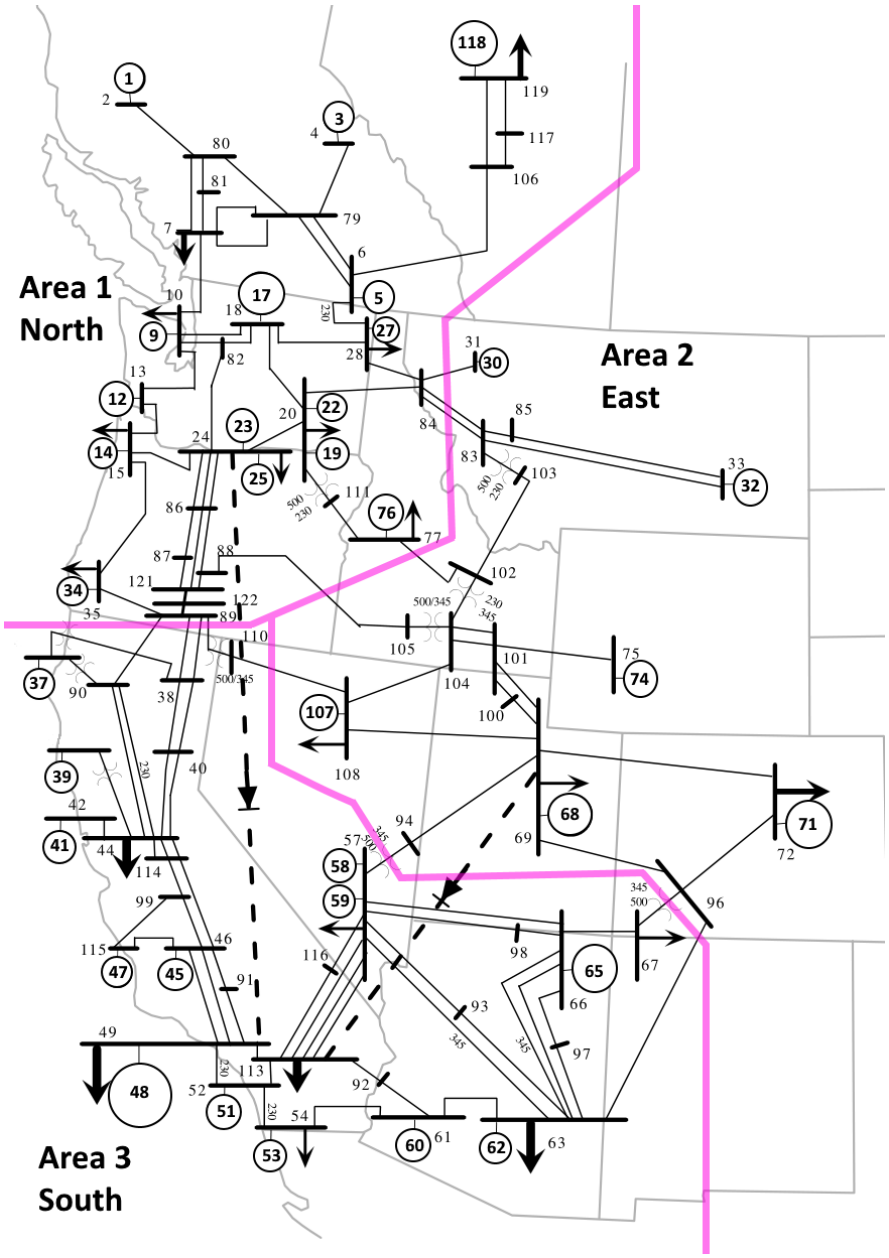
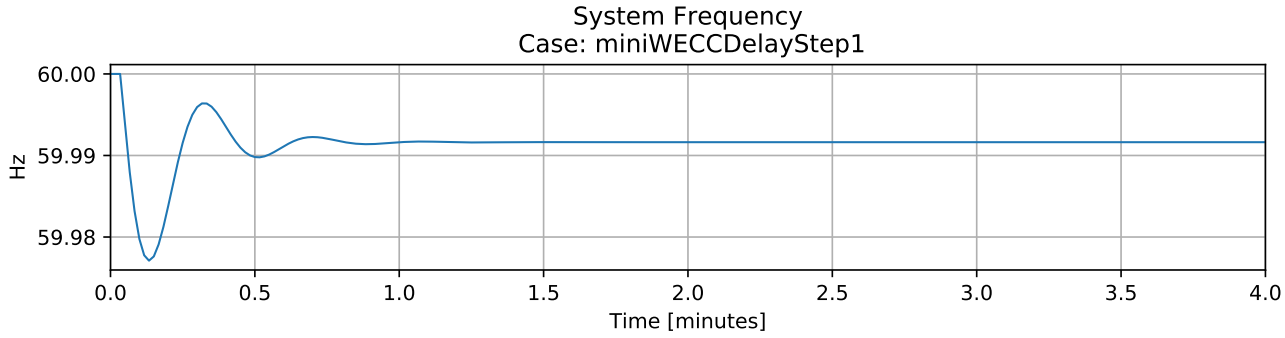
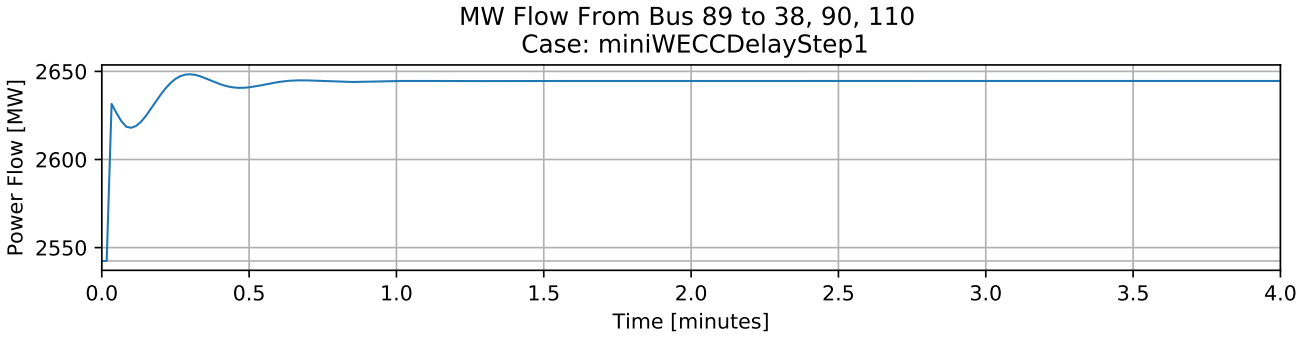


Figure 1: Three Area Mini WECC system.

Results: In a system of this size, delaying governor response has negligible effect on frequency nadir, however, the delay introduces a second frequency perturbance roughly 40 seconds after the first frequency event that leads to a slight MW flow over response from $t = 1$ to $t = 1.5$ minutes. Additionally, while the frequency response appears essentially the same between load step and generation step cases, MW flow is approximately 25 MW larger during a load step.

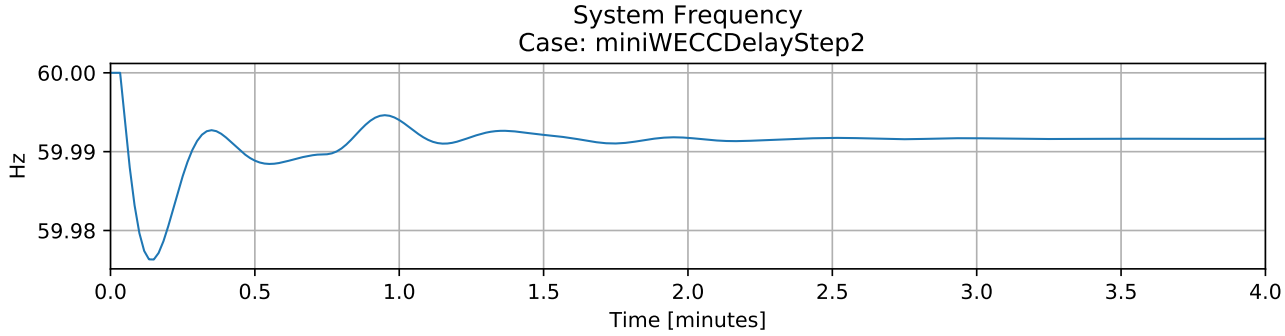
Base Case - Load Step +200 MW

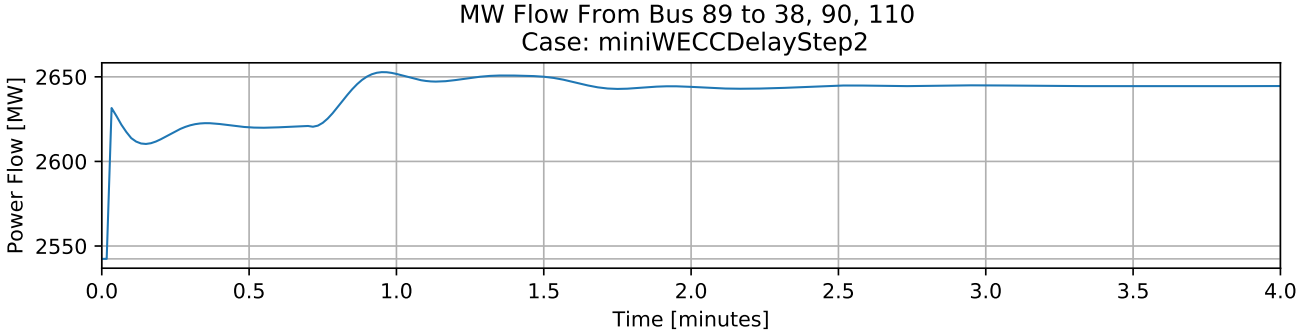




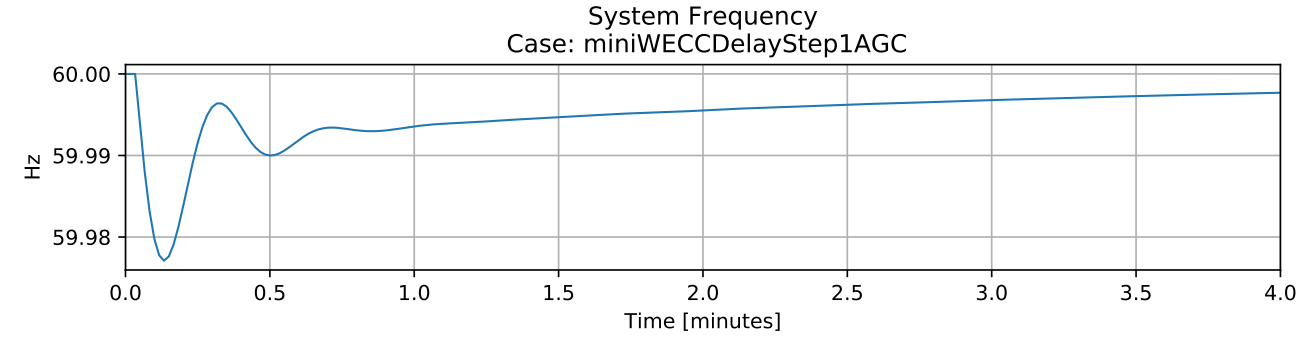
Delay Case - Load Step +200 MW

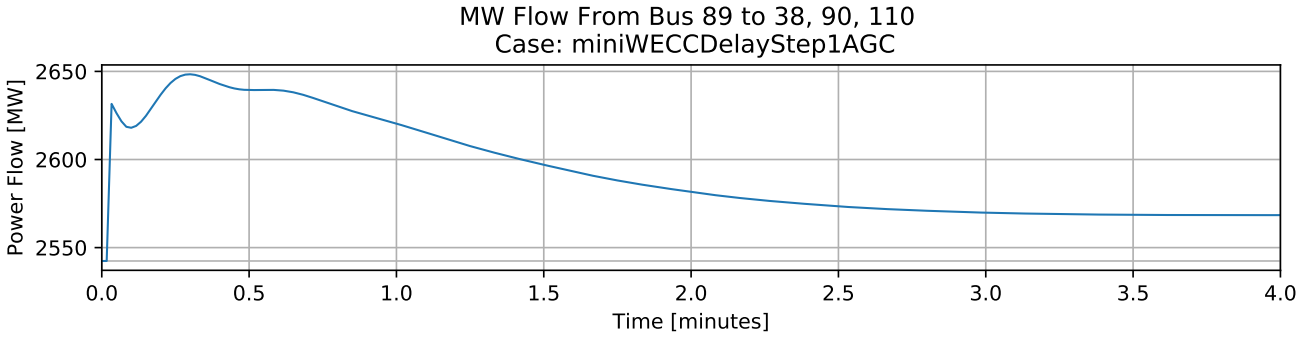
Input ω was delayed by 40 seconds.





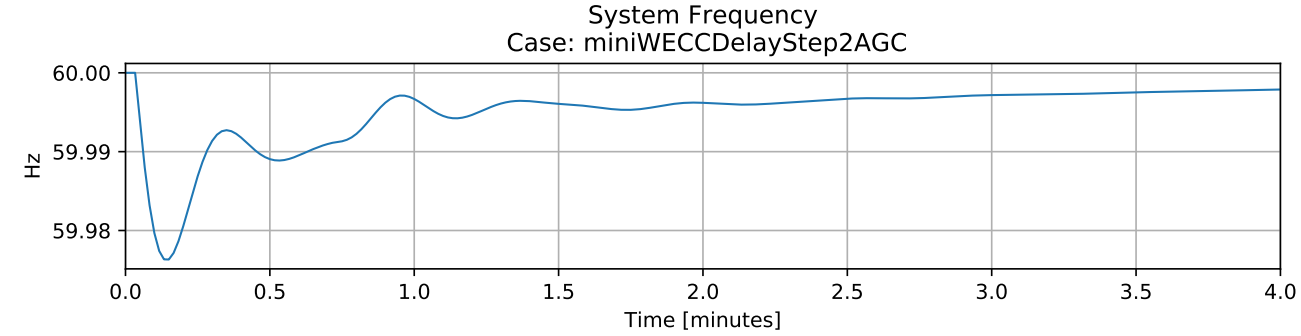
Base Case AGC - Load Step +200 MW

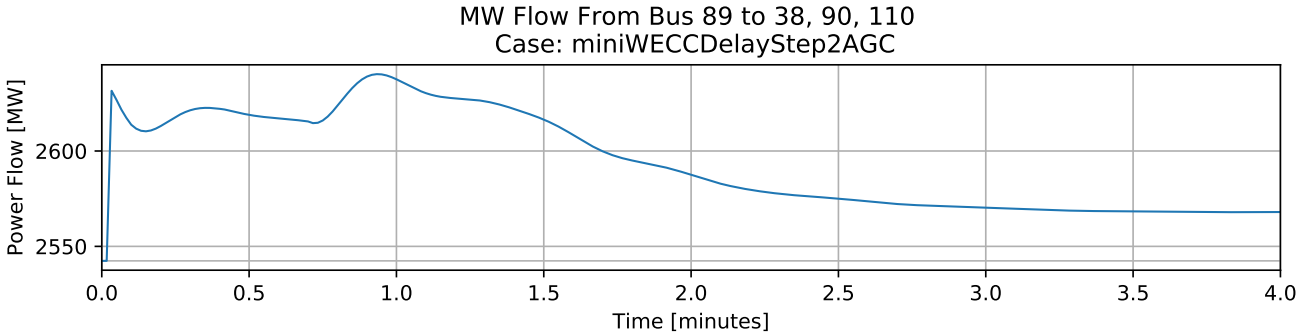




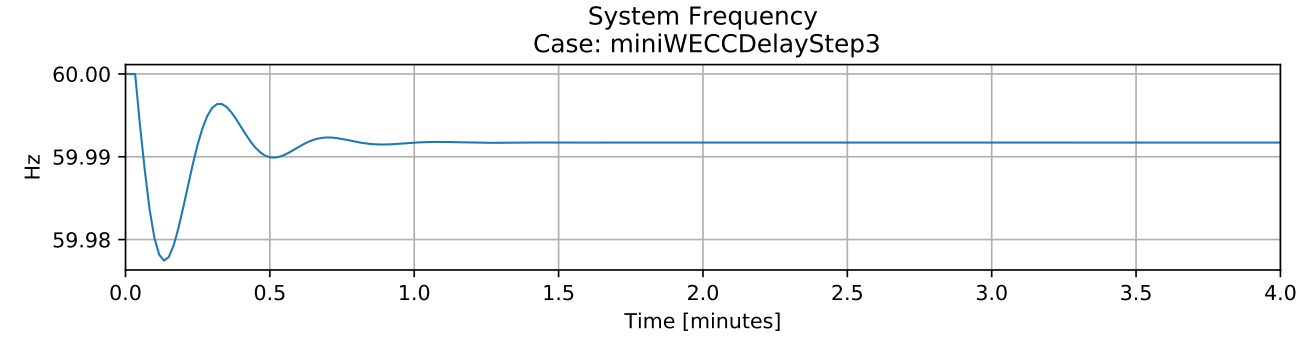
Delay Case AGC - Load Step +200 MW

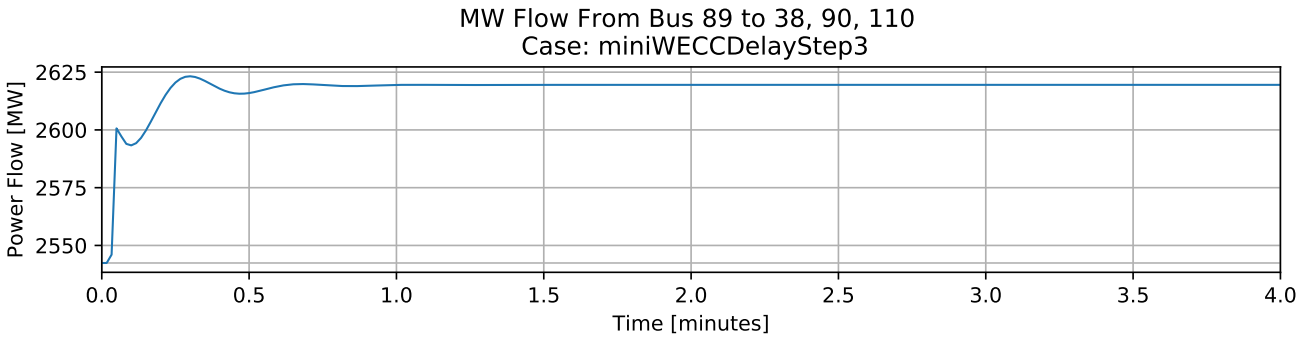
Input ω was delayed by 40 seconds, Pref delayed by 10 seconds.





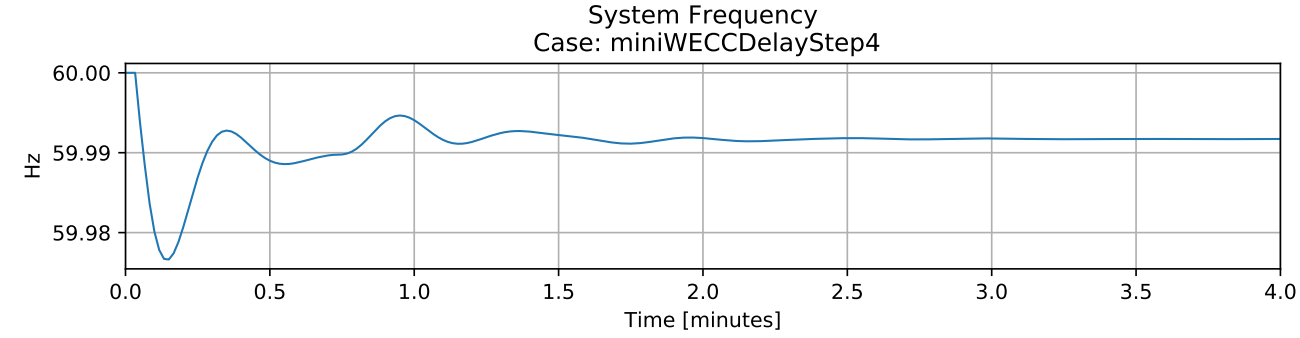
Base Case - Generation step -200 MW

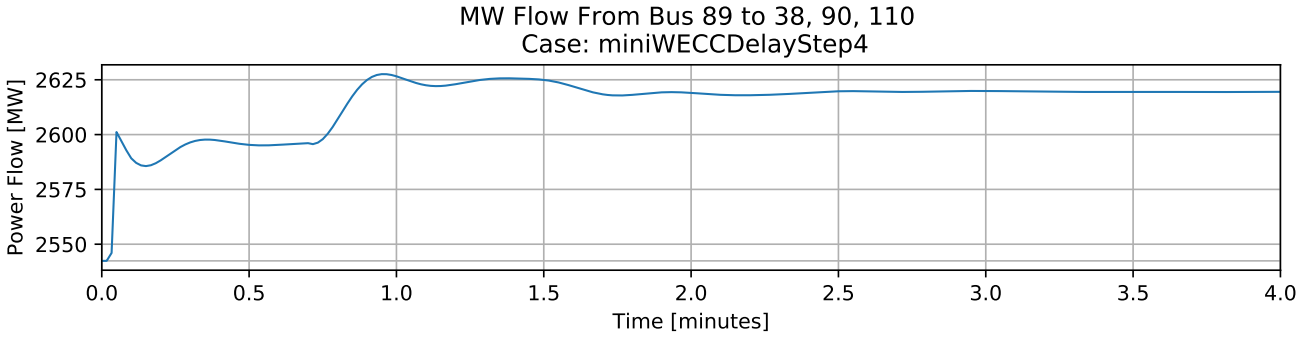




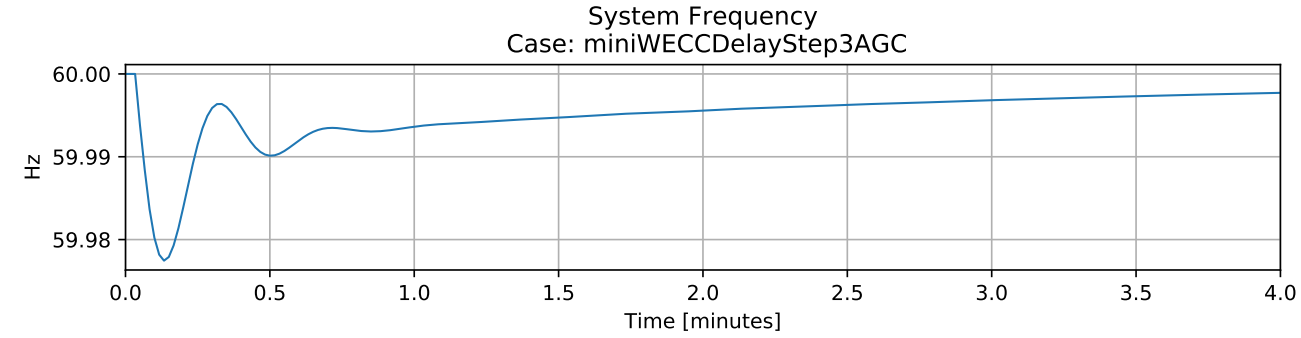
Delay Case - Generation step -200 MW

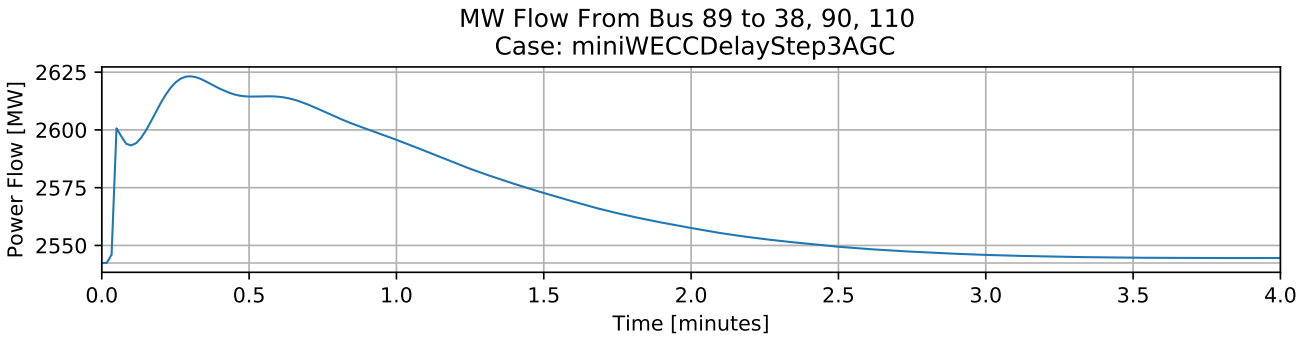
Input ω was delayed by 40 seconds.





Base Case AGC - Generation step -200 MW





Delay Case AGC - Generation step -200 MW

Input ω was delayed by 40 seconds, Pref delayed by 10 seconds.