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 route 66 (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. AGC was also tested with signals being sent every 25 seconds to multiple generators in each area. In cases with delay, Pref signals were delayed by 10 seconds.

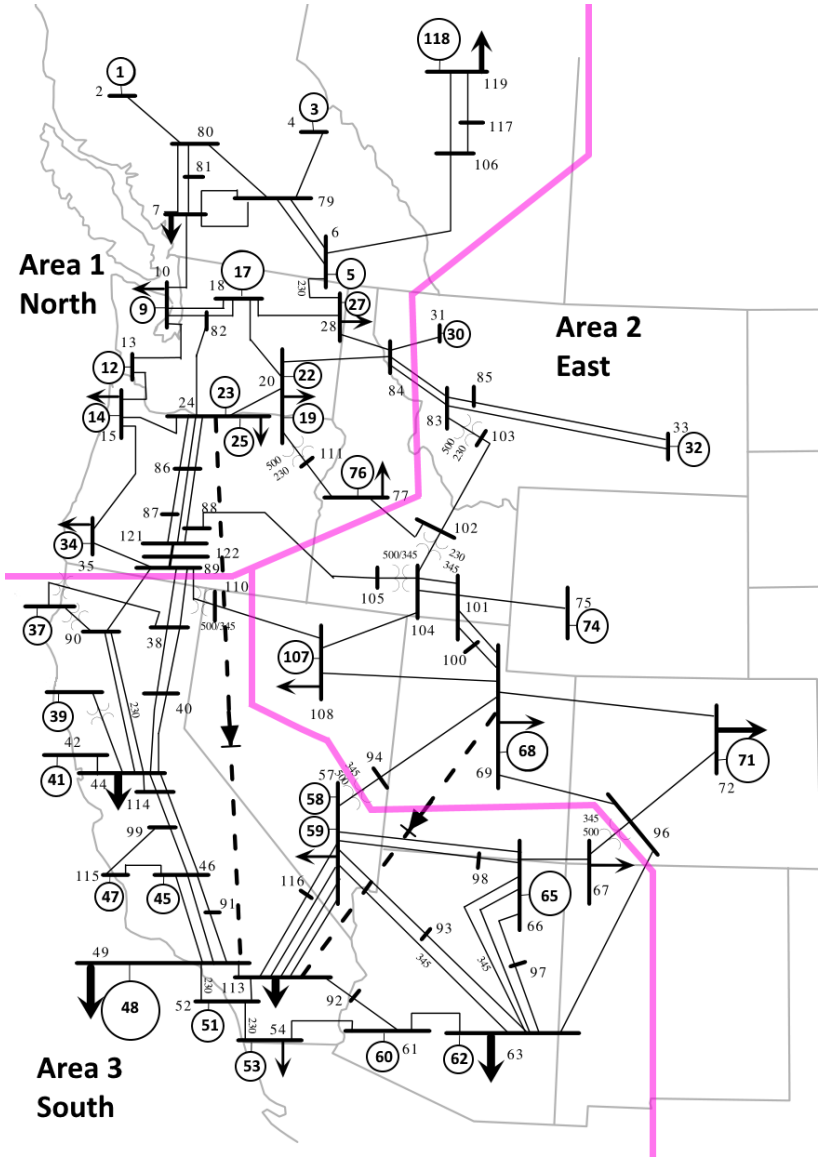
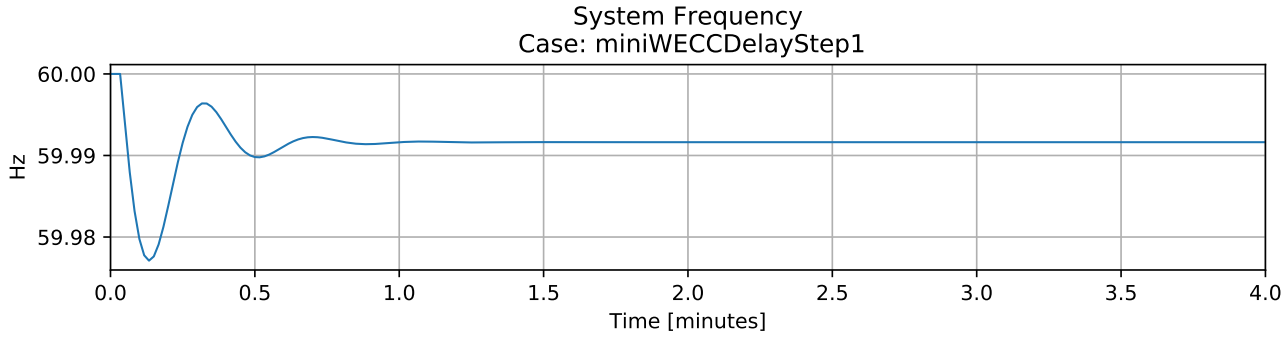
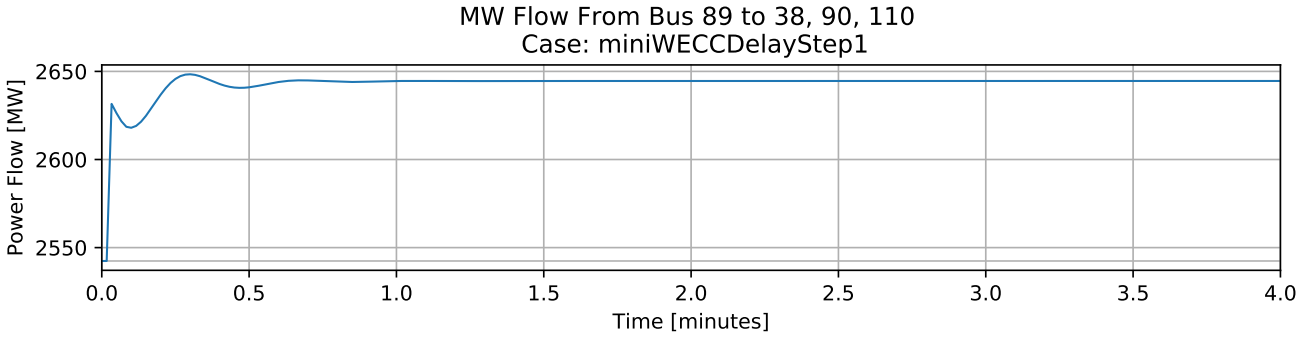


Figure 1: Three Area Mini WECC system.

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. This increase in line flow is more apparent in AGC cases where the line flow does not return to its original level.

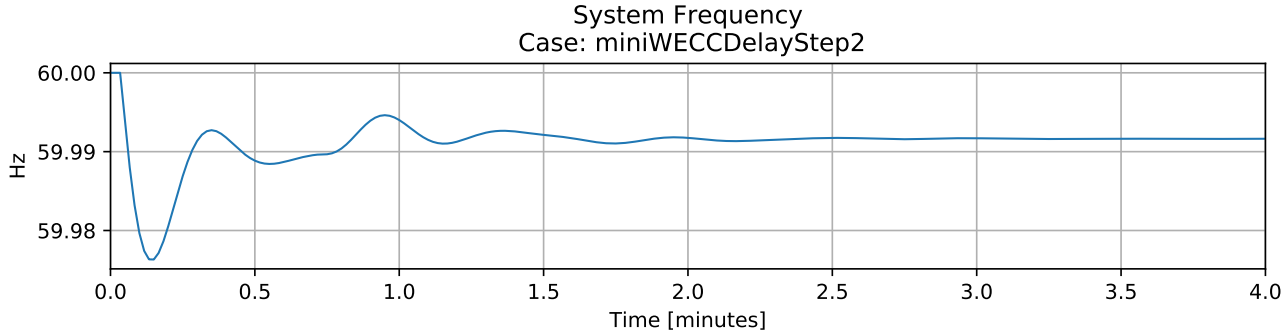
Base Case - Load Step +200 MW

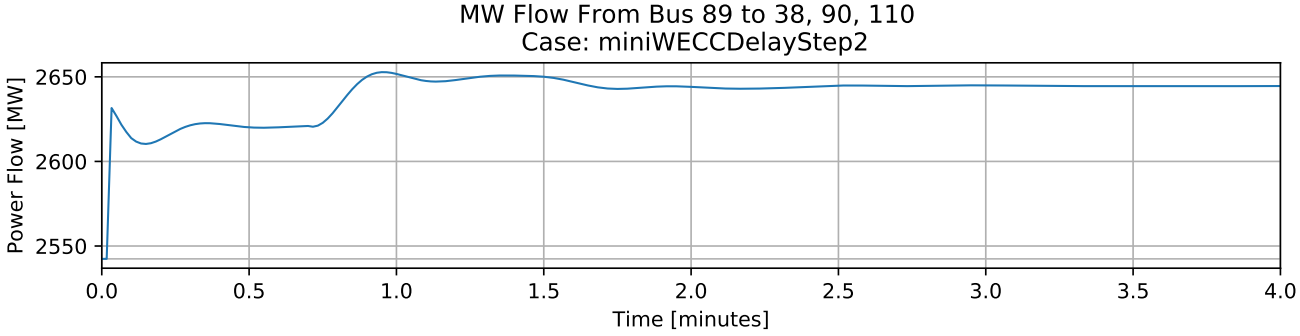




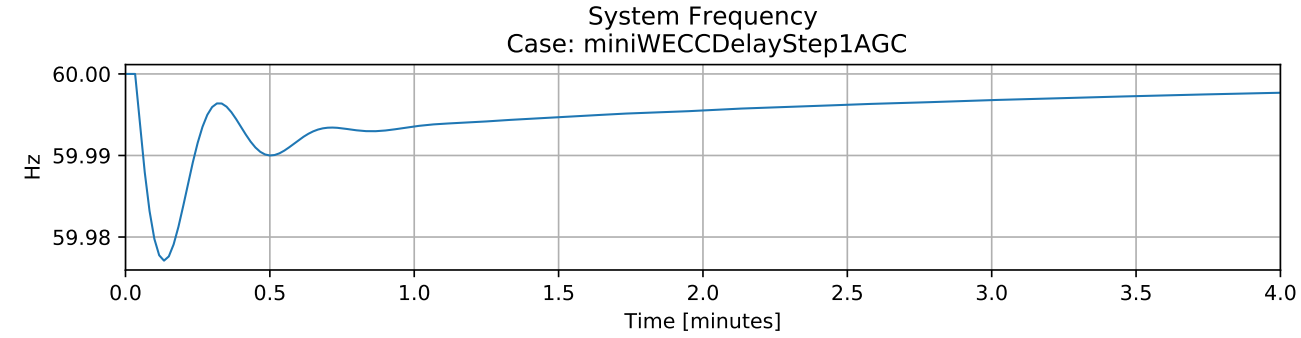
Delay Case - Load Step +200 MW

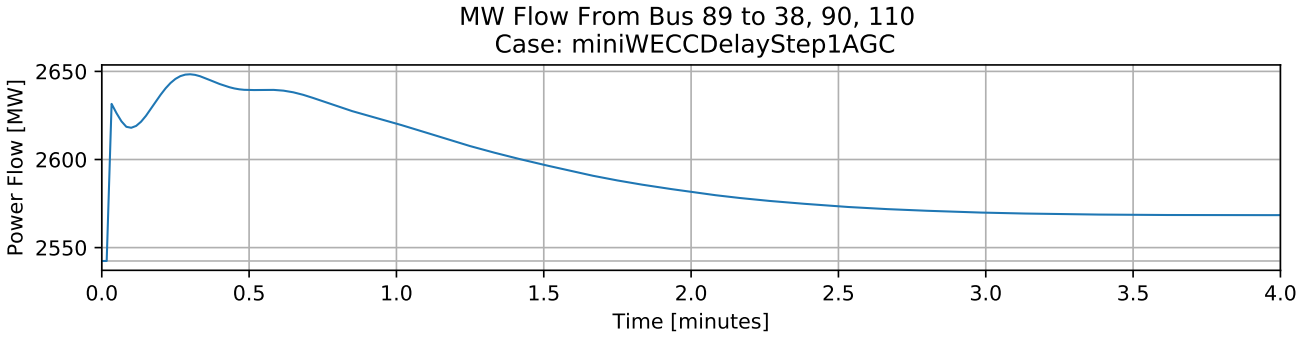
Input ω was delayed by 40 seconds.





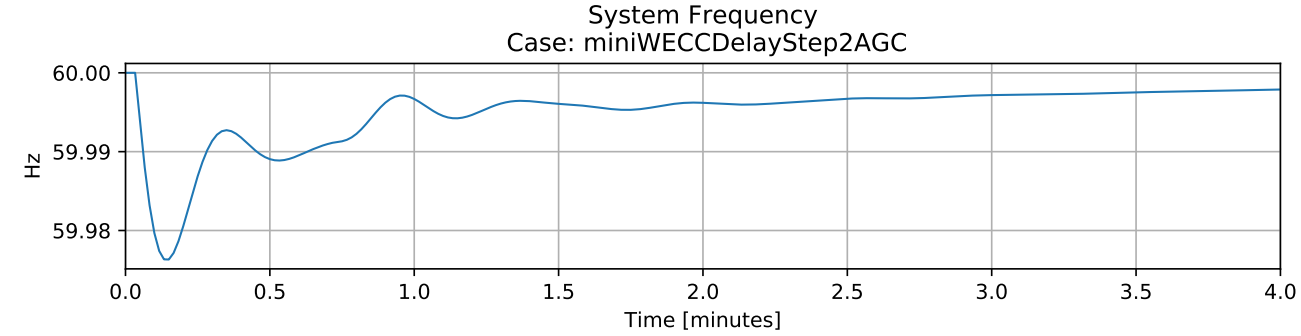
Base Case AGC - Load Step +200 MW

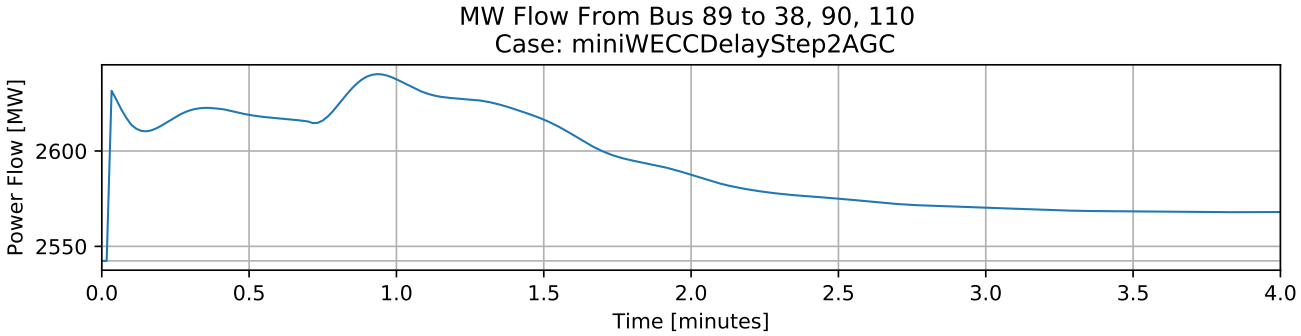




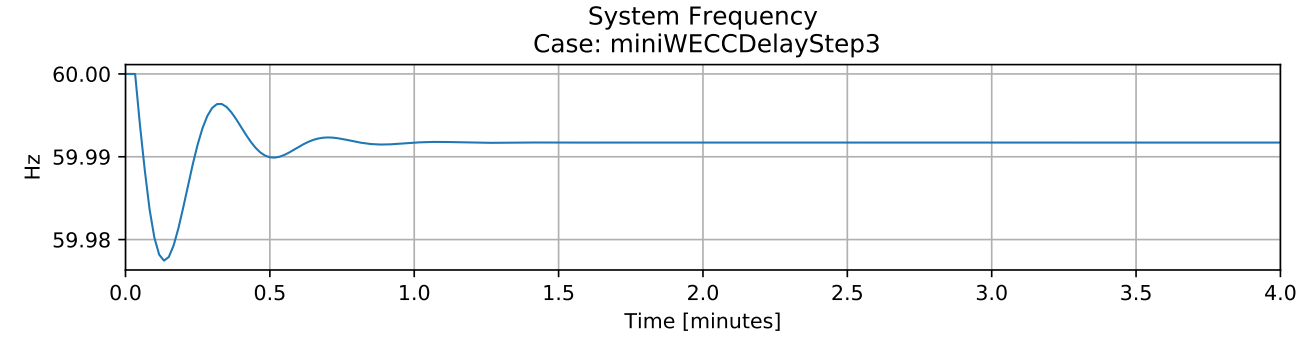
Delay Case AGC - Load Step +200 MW

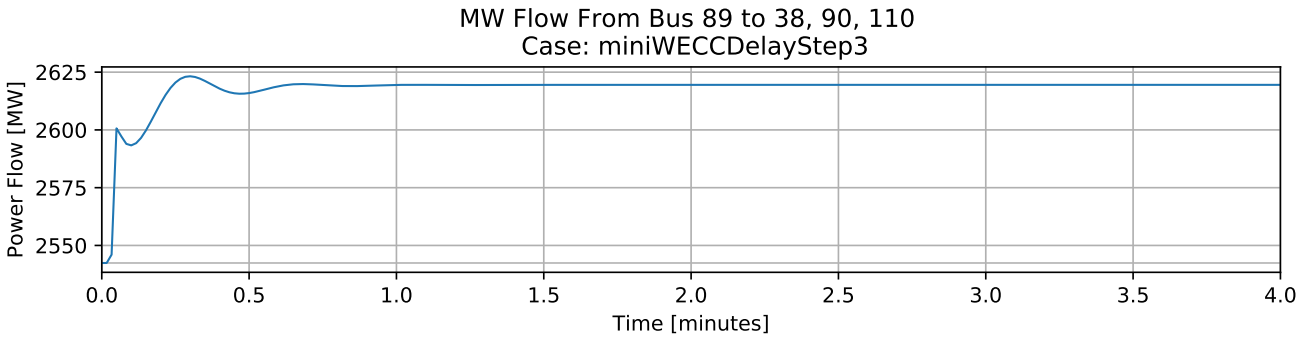
Input ω was delayed by 40 seconds, Pref delayed by 10 seconds.





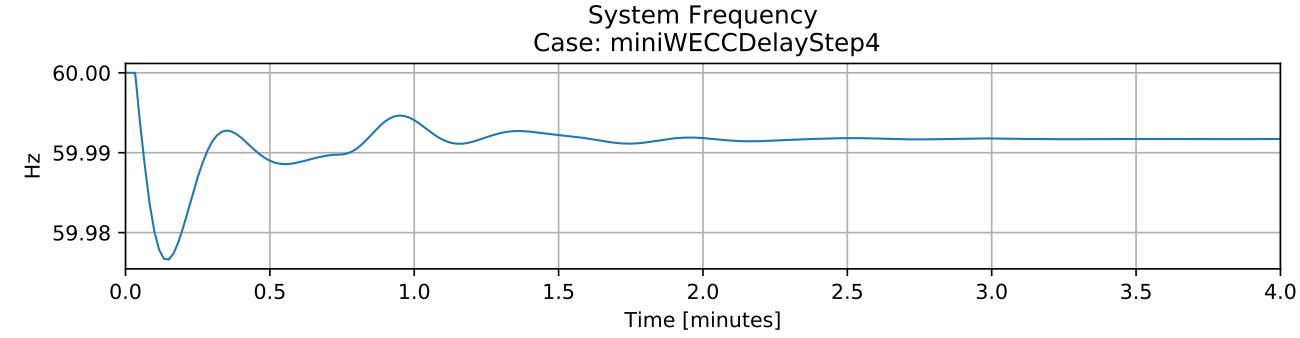
Base Case - Generation step -200 MW

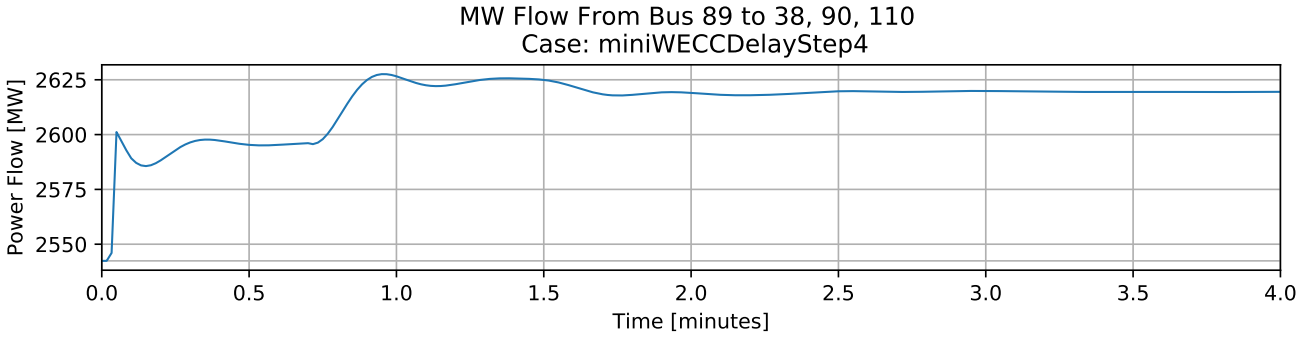




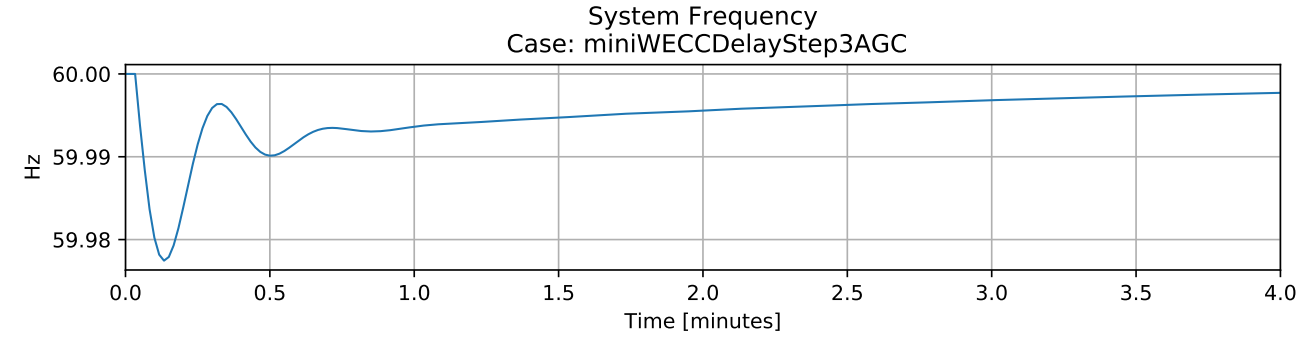
Delay Case - Generation step -200 MW

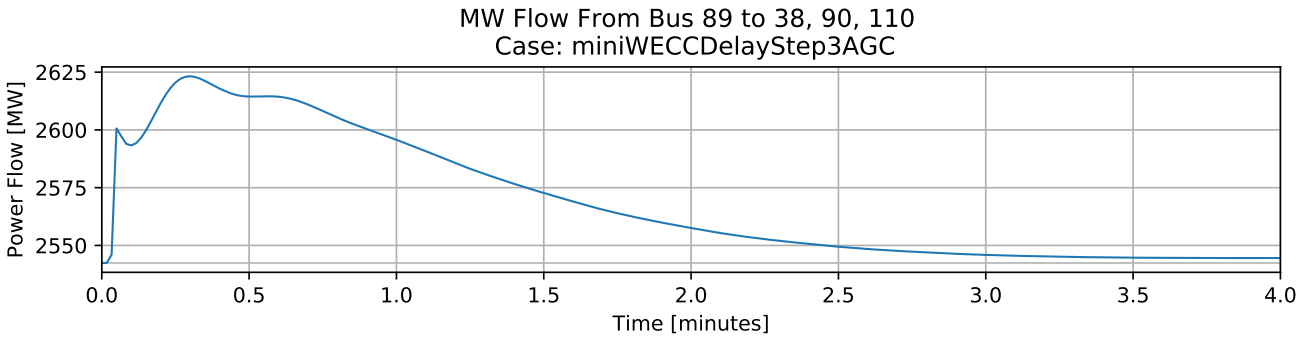
Input ω was delayed by 40 seconds.





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.