In this work, we investigated the Electroweak Phase Transition (EWPT) strength and Dark Matter (DM) nature and possible signature, in a neutrino mass motivated economical standard model extension, with two charged singlet scalars and three right handed (RH) neutrinos all at the electroweak scale. Here, the neutrino masses are generated at three loops, which provide an explanation for their smallness, and the lightest RH neutrino, $N_1$, is a DM candidate. We show that the model can be consistent with the neutrino oscillation data, lepton flavor violating processes, $N_1$ can have a relic density in agreement with the recent Planck data, and the EWPT can be strongly first order. We also show that the charged scalars may enhance the branching ratio $h \rightarrow \gamma \gamma$, where as $h \rightarrow \gamma Z$ get can get few percent suppression. We also discuss the phenomenological implications of the RH neutrinos at the collider.