I think that you have misunderstood the meaning of $N_e^{euv}$ and $N_e^e$ in Zhang et al. (2010). These are quantities computed based solely on $P_{euv}$ and $P_e$, respectively. If you read the lines immediately following Zhang et al. eq. (5), you will see that the purpose of eq. (5) is to show how to combine electron densities from two different models, one providing $N_e^{euv}$ and the other providing $N_e^e$. (Actually, they provide NmE, but it is the same principle.) You write "$XY^{+euv}$ reacts not only with $e^{-euv}$ but also $e^{-e}$", but this is incorrect given the context, since Zhang et al. eq. (3) is for a physical setting in which ionization only results from solar EUV, and Zhang et al. eq. (4) is for a physical setting in which ionization only results from electron precipitation.