Flare energy conversion from direct electric fields due to the sheared magnetic reconnection

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We propose a new mechanism of the main energy conversion of the solar flare. Because the rising velocity of a flare inducing prominence, or a magnetic flux tube at an early phase of CME is $\leq$ 300km s^{-1}, a continued plasma ejection with Alfvén velocities of 3000km s^{-1} below it may be hindered (obstacle), but perhaps with V$_z$ $\approx$ 100km s^{-1}. This requires discarding the slow shock mechanism.

Adopting reconnection morphology, we assume a magnetic component parallel to the photospheric neutral line, i.e. sheared fields B_y besides vertical antiparallel B_z components. Then Gauss law leads to non-zero electric charges σ: $4\pi\sigma$ = **div**$\boldsymbol{E}_{total}$ $\equiv$ **div**($\boldsymbol{E}_{\|}$+$\boldsymbol{E}_{\perp}$) = $-$**div**($\boldsymbol{V}$$\times$$\boldsymbol{B}$)/c $\approx$ $B_y \partial V_z / c \partial x$ ($B_y \approx B_z = 40$G and $\delta x \approx 10^3$km, and **div**$\boldsymbol{E}_{\|}$ = 0 is ascertained by numerical integration). Field-aligned electric fields $\boldsymbol{E}_{\|}$ far excess of the Dreicer field are expected from Coulomb law with σ, and accelerate electrons and protons. Due to large electric fields, the horizontal Poynting energy flux in area S_x is immediately converted to a kinetic energy of e.g. electron beams along the magnetic field in S_z; $V_x B^2 S_x / 4\pi = (1/2) m_e n_{beam} V_{beam}^3 S_z$ and e.g. $S_x/S_z \approx 3$. The total flare energy can be supplied by 10keV electrons of $(1/2) m_e V_{beam}^2$ and $n_{beam} = 2 \times 10^7$cm^{-3} for $V_x = 40$km s^{-1}, ensuring the flare short duration. There will be no charge accumulation, nor extra electric currents due to back-streaming majority electrons ($\approx 10^3$km s^{-1}) which are co-spatial with electron beams($\approx 10^5$km s^{-1}) because of 4π**div**$\boldsymbol{j}$/c = **div**(**rot**$\boldsymbol{B}$) = 0.