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Global emission assessment of local manufactured solar technologies

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Global energy consumption for our modern economy has an adverse impact on the environment, particularly when it relies mostly on fossil fuel (Owusu and Asumadu-Sarkodie 2016). Rapid climate change in the past few decades has provided the impetus for strategic implementation of solar collectors around the world (Owusu and Asumadu-Sarkodie 2016). To achieve the Paris Agreement goal of 2 ℃ global climate temperature reduction, the total global greenhouse gas emission must be decreased by about 1% each year (from 48 billion tonnes of CO_{2e} in 2010 to 41 Bt CO_{2e} by 2025 and 37 Bt CO_{2e} by 2030) (Meinshausen et al. 2015). Although solar technologies produce clean energy during their usage phase, they still have embodied emissions during their manufacturing phase. Thus, solar technologies must be evaluated for their life cycle impacts (embodied emissions), and more studies are needed to compare these technologies from this perspective.

In this study, we investigate the CO_{2e} emissions mitigation potential of implementing solar collectors in the industrial sector—a sector which consumes about 32 % of the total final energy consumption (Philibert 2017). Industrial applications can be divided into low, medium, and high temperature applications; however, this study considers medium temperature application due to its huge untapped potential (Bany Mousa, Taylor, and Shirazi 2019). Assuming a particular industry wants to install a solar system on their roof, they then face the choice of which type of collector, photovoltaic or thermal, to use. An approach developed by (Bany Mousa, Kara, and Taylor 2019) has been followed in this study to find the global embodied emissions of locally manufactured solar PV and linear Fresnel ST collectors in any location worldwide. Solar photovoltaic and linear Fresnel thermal collectors are used in this comparison because they can be easily installed over factories rooftops and produce high quality medium temperature heat either directly (using the Fresnel thermal collectors) or indirectly using the (PV panels coupled with heat pumps).

Globally, the results revealed that solar PV embodied emissions vary between 318–952 kg CO_{2e}/m^2_{ap}. Linear Fresnel ST collectors embodied emission vary between 169 – 1437 kg CO_{2e}/m^2_{ap}. These results were further analyzed to assess solar technologies embodied emissions and emission saving impacts on global emission scenarios, and thus the 1.75–2 ℃ median warming scenario was selected.

Medium temperature process heat –solar technologies– have negligible extra impacts on the global GHG_e (see Fig 1). Although solar technologies in the medium temperature process heat applications have negligible impacts compared to the total global GHG emissions, they save millions of tonnes of CO_{2e}. Solar technologies will add a small CO_2 to the environment due to their embodied emissions till 2030, and then they will retrieve some of their embodied emissions annually toward the end of their lifetime (i.e., technologies that was produced ion 2010 will end in 2040). Due to the large increase in solar technologies production between 2023 – 2050 (expected to double), solar technologies will still add up slight GHGe on the total global GHGe. However, their embodied emissions are expected to pay back and contribute to the global GHGe reduction before 2080.

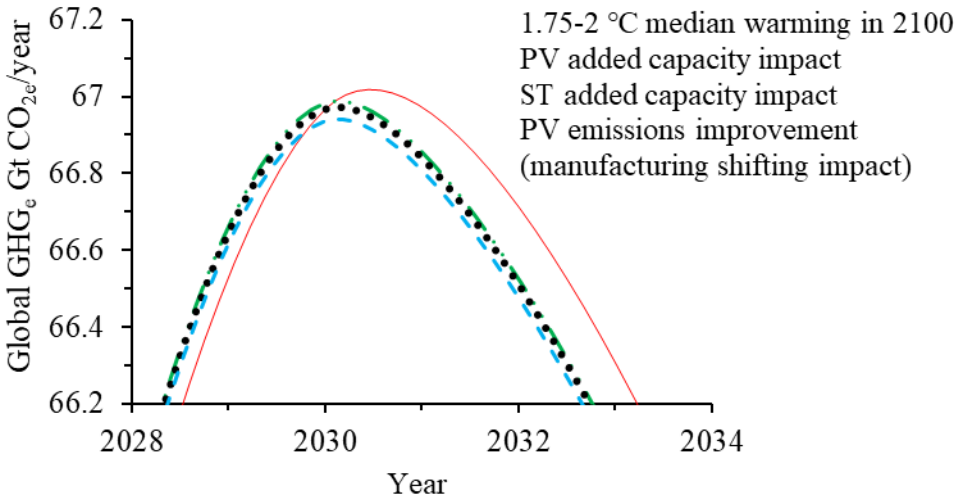

Fig 1 Medium temperature heating solar technologies impact on the 1.75–2 ℃ median warming scenario

Fig 1 shows that the difference between solar PV and solar ST scenarios is not significant compared to the total global GHG_e scenario (up to 22 Mt CO_{2e} difference). PV Manufacturers transition from China and the best practice country (or if China meets the best practice country emission) can reduce the PV GHG_e (for medium temperature process heat applications) by up to 45 Mt CO_{2e}. This study is significant as it contributes to the global emission mitigation scenarios by resources management.

References

Bany Mousa, Osama, Sami Kara, and Robert A. Taylor. 2019. 'Comparative energy and greenhouse gas assessment of industrial rooftop-integrated PV and solar thermal collectors', *Applied Energy*, 241: 113-23.

Bany Mousa, Osama, Robert A. Taylor, and Ali Shirazi. 2019. 'Multi-objective optimization of solar photovoltaic and solar thermal collectors for industrial rooftop applications', *Energy Conversion and Management*, 195: 392-408.

Meinshausen, Malte, Louise Jeffery, Johannes Guetschow, Yann Robiou du Pont, Joeri Rogelj, Michiel Schaeffer, Niklas Höhne, Michel den Elzen, Sebastian Oberthür, and Nicolai Meinshausen. 2015. 'National post-2020 greenhouse gas targets and diversity-aware leadership', *Nature Climate Change*, 5: 1098.

Owusu, Phebe Asantewaa, and Samuel Asumadu-Sarkodie. 2016. 'A review of renewable energy sources, sustainability issues and climate change mitigation', *Cogent Engineering*, 3: 1167990.

Philibert, Cédric. 2017. 'Renewable Energy for Industry', *Paris: International Energy Agency*.