Corrigendum to "Integrated Life-cycle Assessment of Electricity Sources", UNECE

https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

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Summary

The report "Integrated Life-cycle Assessment of Electricity Sources" (UNECE 2021, hereafter "UNECE report") provides an overview of life cycle environmental impacts of electricity-generating technologies. For each technology, these impacts have been summarized as indicators, such as "climate change" (in kg CO_2 equivalents), "freshwater eutrophication" (in kg P eq.), or "water resource depletion" (in m^3). These and all indicators listed in Table 3 have been checked and no specific error or deviation from existing literature was found as far as the authors know. In addition, other indicators have been supplied, such as land use (in m^2-annum) or damage to human health (in DALY) and ecosystems (in species-year); these indicators have not undergone the same degree of quality check.

In June 2022, a reader found that the land use value (in m^2a) for some technologies suspiciously high and informed the authors. A few days later a modelling error was found regarding the inclusion of biomass in background electricity mixes, which artificially increased land use for energy-intensive processes. This happens to be relatively important for silicon photovoltaics, and this effect was exacerbated in regions with comparatively low solar irradiance, such as Japan. The error was corrected (see details in the next section) and the following land use figure created. Figure 1 replaces Figure 57 (page 78) in the UNECE report.

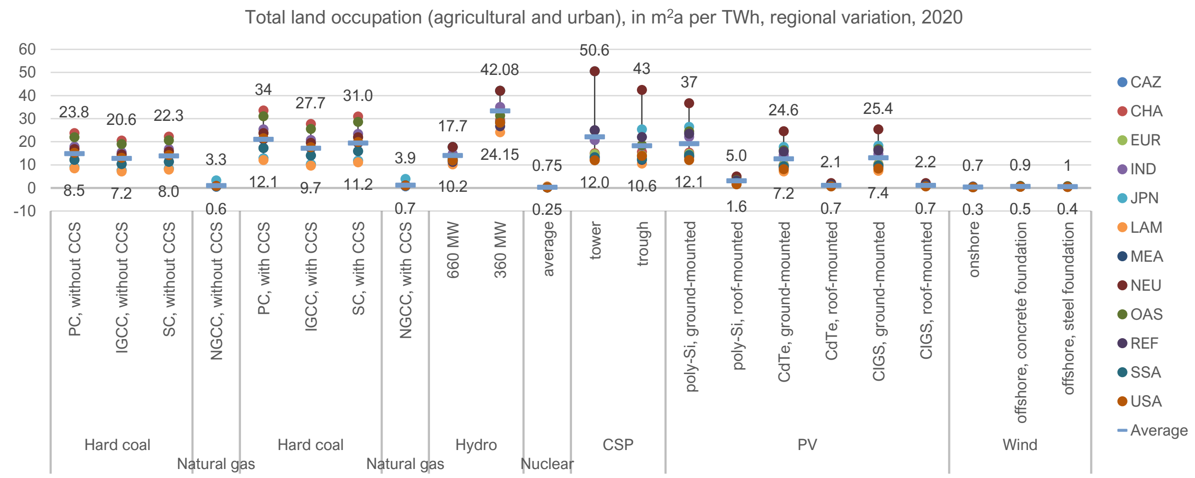

Figure 1. Lifecycle land use regional variations for year 2020. Variability is explained by several factors: electricity mix (all regions), origin of supply (fossil fuels), load factors (renewables). Nuclear power is modelled as a global average and therefore does not see any variation.

Technical information on the origin of the error

The background life cycle assessment data used in the report is a modified version of the ecoinvent database, adapted with results from the integrated assessment model (IAM) REMIND, which provides data such as electricity mixes and industrial efficiency values in various world regions. Specifically, the REMIND scenario used aligns with the SSP2[1] ("middle of the road") family of scenarios used in IPCC modelling efforts. The software *premise* [1] was used to integrate IAM outputs with the LCA data.

[1] SSP = Shared Socio-economic Pathway

In 2020, some regions use non-negligible shares of biopower, which was approximated with electricity from a typical BIGCC[2] power plant. The technological description for this technology was extracted from Volkart et al. (2013) [2], as available in a very early version of *premise*. Using this inventory led to very high agricultural land use, as illustrated in Figure 2. This was corrected in the latest version of *premise*, where this dataset was replaced, adapting the data from Briones-Hidrovo et al. (2021) instead [3]. This update corrected the land use value.

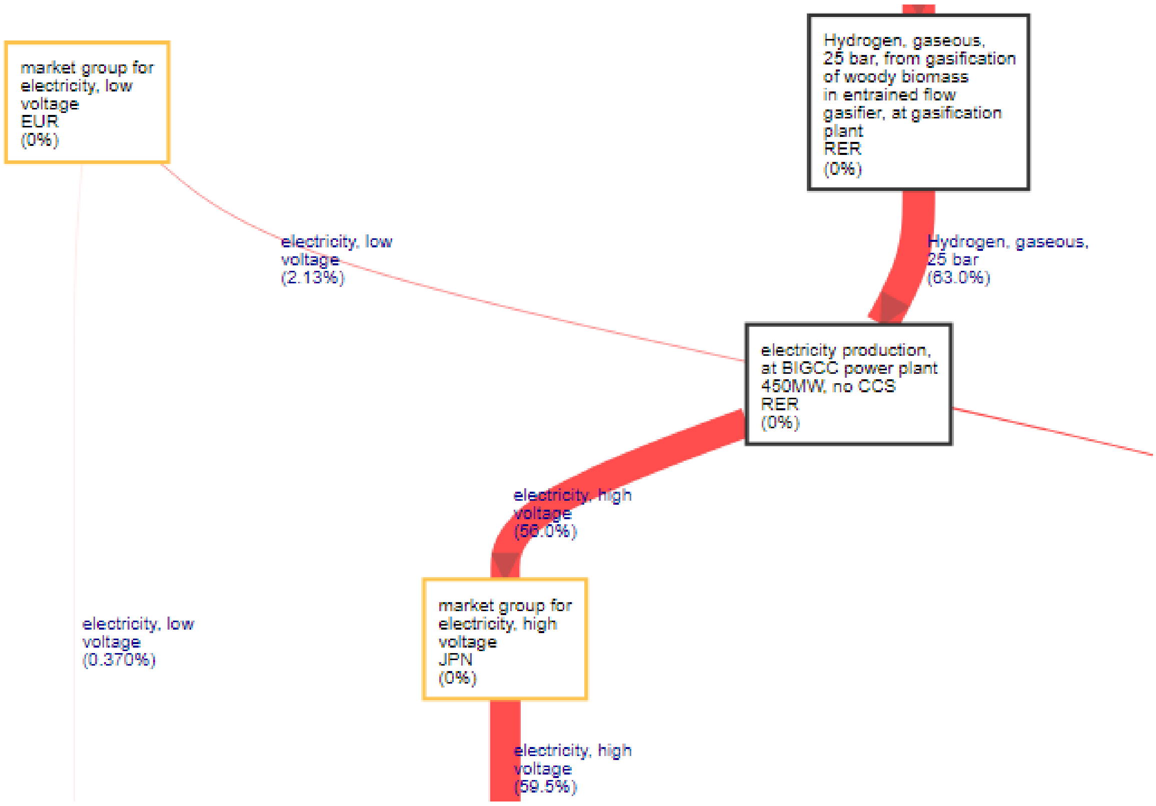

Figure 2. Flow of "agricultural land use" in the roof-mounted polycrystalline silicon PV model for the Japan region, 60% was originating from the use of biomass in the background electricity mix (for a share in the mix of <5%).

References

[1] Sacchi, R., Terlouw, T., Siala, K., Dirnaichner, A., Bauer, C., Cox, B., ... & Luderer, G. (2022). PRospective EnvironMental Impact asSEment (premise): A streamlined approach to producing databases for prospective life cycle assessment using integrated assessment models. *Renewable and Sustainable Energy Reviews*, *160*, 112311. https://doi.org/10.1016/j.rser.2022.112311

[2] Volkart, K., Bauer, C., & Boulet, C. (2013). Life cycle assessment of carbon capture and storage in power generation and industry in Europe. *International Journal of Greenhouse Gas Control*, *16*, 91-106. https://doi.org/10.1016/j.ijggc.2013.03.003

[3] Briones-Hidrovo, A., Copa, J., Tarelho, L. A., Gonçalves, C., da Costa, T. P., & Dias, A. C. (2021). Environmental and energy performance of residual forest biomass for electricity generation: Gasification vs. combustion. *Journal of Cleaner Production*, *289*, 125680. https://doi.org/10.1016/j.jclepro.2020.125680

[2] Biomass integrated gasification combined cycle