

HIGG FEM 2025

# FEM 2025 Energy Source Changes

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A detailed summary of the changes in energy calculations,  
including emission factors, between FEM 2024 and FEM 2025.

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## Summary

A number of important changes were made to FEM 2025's energy and emissions calculations and constants some of which impact comparability between FEM 2024 and FEM 2025.

1. The annual update to country grid emission factors was performed to reflect the most recently licensed values from IEA. Grid factors are now based on either 2022 data or, where available from IEA, provisional 2023 data. *The update reflects the changing nature of national grids and does not impact comparability between FEM 2025 and earlier editions.* The specific values of the country grid emission values may not be shared due to IEA's licensing terms. However, we include a summary of the countries most impacted to allow data consumers to understand the potential impact of the update.
2. Many fuel and specific electricity energy sources have been updated to use better sources or more defensible models in cases with incomplete information. *These emission factor changes mean the emissions reported in FEM 2024 and FEM 2025 are not directly comparable without caveats and understanding why changes have occurred.*
3. The models for energy intensity of the district heating and chilled water energy sources have changed to better align with industry and global models. *These changes mean the energy usage and emissions reported in FEM 2024 and FEM 2025 are not directly comparable without caveats and understanding why changes have occurred.*
4. The specific emission factors used in FEM have been consistently formatted to reflect the understood number of significant figures available from the source for the emission factor. This means that the number used in FEM and reported in documentation may not appear exactly as it does in the source but it communicates the level of uncertainty inherent in the figures and is best practice in the domain. *No significant impact will be caused by this change.*
5. Where an FEM reports the mix of biomass fuel sources those figures are used to calculate the emission factor of biomass usage. *Although this will cause changes to emissions in most cases the change to the assumed emission factor of biomass will have a larger direct impact in comparability.*

## Impact

### Grid Emission Factors

Excluding a single outlying country which had a very large relative increase to a very low emission factor **the average change in grid emission factors between FEM24 and FEM25 is a decrease of 3%.** The change is much smaller across countries where FEMs are common. **The average change in emissions associated with grid electricity if the new grid factors are applied backward to FEM24 is less than one half of one percent.**

In some specific circumstances, such as comparing only grid emissions at facilities in a single country, users may experience significant changes attributable to grid emission factor changes. The Democratic Republic of the Congo, Costa Rica, and Uganda all have very large increases to their emission factors in FEM25. However, each country has an emission factor substantially below average so the impact on aggregate calculations is small. Djibouti, Ethiopia, and Swaziland all have very large decreases in their emission factors. However, each country already had an emission factor substantially below average so the impact on aggregate calculations is small.

### Fuel and Electricity Source Emission Factors

On average source emission factors increase by 4% in FEM25. The increase is largely driven by the change of the default model for steam and district heating to coal instead of fuel oil. The FEM 2025 calculation `ghg_emissions_increase_from_2024_model_percent` gives, for an individual FEM, the percentage change in `totalGHGEmissions` attributable to these model changes alone (excluding the grid factor update), so consumers can separate model effects from real changes in a facility's footprint. Facilities are allowed, and encouraged, to document and report the specific fuel sources used for the generation of these energy sources which overrides the default assumptions. The model was

changed to account for cases where the energy source was known to be coal but the specific energy source was not reported leading to lower than appropriate emissions being calculated by FEM.

**All emission factors are kg CO<sub>2</sub>e per MJ**

| Energy Source     | FEM 2024 Value | FEM 2025 Value | Justification for Change                                                                           |
|-------------------|----------------|----------------|----------------------------------------------------------------------------------------------------|
| biodiesel         | 0.0712         | 0.071          | Incorporating significant figures into model                                                       |
| biogas            | 0.055          | 0.0547         | Incorporating significant figures into model                                                       |
| biomasscert       | 0.11           | 0.1139         | Incorporating significant figures into model                                                       |
| biomassgen        | 0.11           | 0.1139         | Incorporating significant figures into model                                                       |
| chilledwater      | 0.0778         | None           | Chilled water is modeled using the country grid factor                                             |
| cng               | 0.0563         | 0.0562         | Incorporating significant figures into model                                                       |
| coal              | 0.095          | 0.0953         | Incorporating significant figures into model                                                       |
| coalwaterslurry   | 0.095          | 0.0953         | Incorporating significant figures into model                                                       |
| diesel            | 0.075          | 0.0744         | Incorporating significant figures into model                                                       |
| districtheating   | 0.0778         | 0.0953         | Default energy source changed from fuel oil to coal                                                |
| electricpurch     | None           | None           | See Grid Emission Factor Changes                                                                   |
| ethanol           | 0.0719         | 0.0722         | Incorporating significant figures into model                                                       |
| fabricwaste       | 0.11           | 0.1312         | Model adjusted from 100% biomass to account for industry split of biological and synthetic fabrics |
| fueloil           | 0.0778         | 0.0777         | Incorporating significant figures into model                                                       |
| geotherm          | 0              | 0              | No change                                                                                          |
| hydro             | 0              | 0              | No change                                                                                          |
| hydrogenr         | 0              | 0              | No change                                                                                          |
| hydrogenr         | 0              | 0              | No change                                                                                          |
| lng               | 0.0563         | 0.0562         | Incorporating significant figures into model                                                       |
| lpg               | 0.0582         | 0.0632         | Mapped to IPCC's "liquefied petroleum gases"                                                       |
| microhydro        | 0              | 0              | No change                                                                                          |
| muniwaste         | 0.1012         | 0.0978         | Mapped to IPCC's "municipal waste" emission factors. 50% biomass and 50% non-biomass               |
| naturalgas        | 0.0563         | 0.0562         | Incorporating significant figures into model                                                       |
| petrol            | 0.0729         | 0.0696         | Mapped to IPCC's "motor gasoline"                                                                  |
| propane           | 0.0582         | 0.0632         | Mapped to IPCC's "liquefied petroleum gases"                                                       |
| purchrenew        | 0              | 0              | No change                                                                                          |
| renewablepurch    | 0              | 0              | No change                                                                                          |
| renewother        | 0              | 0              | No change                                                                                          |
| renewunknown      | 0              | None           | Unknown source renewables are mapped to grid emission factor per reporting guidelines              |
| solarphoto        | 0              | 0              | No change                                                                                          |
| solarthermal      | 0              | 0              | No change                                                                                          |
| steampurch        | 0.0778         | 0.0953         | Default energy source changed from fuel oil to coal                                                |
| wind              | 0              | 0              | No change                                                                                          |
| solarphoto_onsite | 0              | 0              | No change                                                                                          |

## Energy Intensity Models

Chilled water and district heating have updated models for calculating the MJ or energy used to generate the energy source.

District heating now has an assumed fuel efficiency of 80% applied in calculation engine to account for thermal conversion and transportation losses. 1MJ of district heating consumed is converted to 1.25MJ of primary energy by the model. This is in line with the way the model currently treats steam and will be reflected in all calculations reporting energy usage attributable to district heating.

Chilled water is now modeled with an assumed COP of 3 to account for heat pump efficiency. 1MJ of chilled water consumed is converted to 1/3MJ of primary energy by the model. The dramatic reduction this will cause in energy attributable to chilled water will be somewhat offset by chilled water's emission factor changing from a model of fuel oil to using the country's grid emission factor.

## Consistent Use of Significant Digits

The specific emission factors used in FEM have been consistently formatted to reflect the understood number of significant figures available from the source for the emission factor. The values used in documentation are now the exact values used in the model specification that the Worldly Platform uses to calculate energy usage and emissions. However, the calculations are not performed using variable precision arithmetic so significant figures are not carried through to resulting values. The decision to present and use significant figures in this context is intended to communicate one source of uncertainty in the calculations and resulting data **not** to imply that significant figures are respected or used throughout the system.

## Biomass Fuel Source Breakout

Facilities have been able to report the source of biomass energy since FEM 2024. In FEM 2025 facilities that do so will have the emissions of their biomass attributed energy calculated based on that data.

The default emission factor for biomass is 0.1139 the sources and their emission factors follow:

### All emission factors are kg CO<sub>2</sub>e per MJ

| Source        | Description                            | Emission Factor |
|---------------|----------------------------------------|-----------------|
| agresidue     | Residues from agricultural processes   | 0.1019          |
| crops         | Dedicated crops                        | 0.1019          |
| forestresidue | Residues from forests                  | 0.1139          |
| mill          | Residues from sawmills and paper mills | 0.1139          |
| solidwood     | Solid wood                             | 0.1139          |

## Changes Released During the FEM 2025 Cycle

Three calculation fixes shipped in FEM 2025 patch releases after the cadence went live. Each changed reported values for the affected facilities without any change to the model described above.

| Release         | Fix                                                                                                                                                                                                                                                                                 |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| fem2025-v0.0.20 | The reported biomass source mix ( <code>ensourcebiomasscertmix</code> , <code>ensourcebiomassgenmix</code> ) was never applied to the biomass emission factor; the default 0.1139 was always used. Fixed so the mix is applied when the facility answers <code>yes</code> .         |
| fem2025-v0.0.27 | All energy from ethanol or petrol was dropped when a facility did not report the fuel as a blend ( <code>enethanolvehicle</code> OR <code>enpetrolvehicle</code> not <code>yes</code> ). Fixed; vehicle energy is a small share of any footprint, so the effect on totals is minor. |

| Release         | Fix                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| fem2025-v0.0.31 | The per-sub-process wastewater values <code>wwProcess[sub]CO2e</code> divided by <code>10^3</code> , which the expression parser evaluated as a bitwise operation ( <code>9</code> ) rather than <code>1000</code> , so <code>wwProcessCO2e</code> and <code>biogenicCO2e</code> were about 111 times too large for facilities reporting sub-process BOD5 data. Fixed. |

None of these fixes affects scores or completion.