# Updating Transmission and Distribution Losses in the GREET<sup>®</sup> Model

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#### ACRONYMS

- eGRID Emissions & Generation Resource Integrated Database
- EIA Energy Information Agency
- EPA Environmental Protection Agency
- ERCOT Electric Reliability Council of Texas
- T&D transmission and distribution

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### Updating Transmission and Distribution Losses in the GREET<sup>®</sup> Model

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This memo documents an update of the transmission and distribution loss factor for electricity in the GREET<sup>®</sup> model. Based on recent data, a new transmission and distribution loss factor will be incorporated into GREET 2018 for the United States. The updated data builds upon methods used by Cai et al. (2012), the Energy Information Administration (EIA) (2018) and the Environmental Protection Agency (EPA) (2018). Details regarding data, methods, and technical considerations are provided.

#### 1. Introduction

The electrical grid consists of generation, transmission, and distribution. Electricity generation via thermal cycles account for 83% of the U.S. electricity generation and energy is lost as a consequence of energy conversion inefficiencies from that generation (EIA 2018). During transmission and distribution (T&D) energy is lost in the form of heat as electricity flows through transformers and power lines. EIA tracks information on the total disposition of electricity within the United States along with estimated electricity losses, and the electricity that is directly used from generating facilities (thus, not subject to these T&D losses). In 2012 the T&D loss factor in GREET was updated using EIA information (Cai et al. 2012). In that report, Cai et al. collects the loss, disposition and direct use information for each state from EIA and then calculates the associated grid gross loss (GGL) factor for each state, and then uses an electricity weighted approach to calculate the GGL factors that seem unreasonable and they opted to omit those values and not use them in calculating the national average T&D loss factor. They calculated a national average T&D loss factor of 6.5%.

#### 2. Methodology and Data

While the EIA does not report T&D losses directly, they provide the necessary data (EIA 2018), along with a formulation for GGL losses estimation (EIA 2018). The GGL equation is the same for the EIA and the EPA (2018), and is the same as was used in Cai et al. (2012). It is presented in Equation 1,

which states that GGL (T&D) is equal to the estimated electricity losses divided by the result of total disposed electricity less any directly used electricity.

$$GGL = \frac{EstimatedLosses}{TotalDisposedElectricity - DirectlyUsedElectricity}$$

EIA provides this information on a state-by-state basis and at a national level. The EPA utilizes the EIA's information for its Emissions & Generation Resource Integrated Database (eGRID) database, and reports T&D losses at the total US level, the interconnection level (East, West, and Electric Reliability Council of Texas [ERCOT]), and for the non-contiguous states of Hawaii and Alaska (EPA 2018).

Despite this common formulation there are differences between the EIA and eGRID results for the national level T&D losses. Figure 1 presents a time series of T&D losses as reported or calculated from EIA, EPA, and Cai (EIA 2018; EPA 2018; Cai et al. 2012). We notice a difference between the EIA and eGRID GGL factors for 2016. The author contacted EPA regarding this issue, and EPA subsequently contacted EIA to understand the difference. From those discussions, it is clear that EPA has used a different method than EIA in aggregating estimated losses, total disposition, and direct use from state level data to the national aggregate. This issue remains unresolved at present, however, it should be noted that one potentially valuable resource associated with eGRID's reporting is that it reports not only the US average T&D loss factor, but also factors for each of the three US electrical grid interconnects. This added layer of spatial resolution may be valuable for future GREET updates.



Figure 1. Time series representation of transmission and distribution loss as reported or calculated.

From Figure 1, we also see that the EIA and Cai et al. have differences in their time series. Since EIA retains their old data files, which contain temporal information but provide new files annually with updated data, we determined that EIA updated some of the state file data for prior years. In Cai et al.'s report, several states had unrealistic GGL factors, and were thus omitted in their determination of the U.S.

GGL. Since EIA has since updated their own data files, it is reasonable to believe that the updates were intended to correct prior errors in data reporting.

Since there is a discrepancy between the EIA and eGRID GGL results, and because there is an outstanding issue regarding that discrepancy, we choose to use the calculated GGL value based on EIA data, while allowing that in the future there may be significant value to using eGRID's more regional scoping so long as we have confidence that the data are aggregated consistently with EIA. This update to GREET uses EIA data along with Equation 1 to determine a T&D loss factor for the United States. Those data are presented in Table 1 and reveal a national T&D loss factor of 4.9% for 2016.

## Table 1. Reproduction of EIA electrical grid data and calculation of transmission and distribution loss factors for 2016 at the U.S. level.

Geographic	Data	Estimated losses	Total disposition	Direct use	T&D Loss
Boundary	year	(MWh)	(MWh)	(MWh)	(GGL) Factor
U.S.	2016	196,366,940	4,146,436,002	141,167,519	4.90%

#### 3. Implementation

The T&D loss factor described above is implemented in the GREET 2018 release as the loss factor for the entire United States. The T&D loss factor is equal to the US average as calculated from US EIA data (4.9%).

#### References

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