# ECEN 615 FALL 2025 DESIGN PROJECT: New West Texas Electric Load

## Introduction

The goal of this design project is for you to gain experience in planning new transmission. The project requires 1) each student to turn in the final deliverables as noted below by the end of the day on the last day of TAMU classes, i.e., December 8, 2025. The design project itself is motivated by what is happening in the real world, with the Public Utility Commission of Texas (PUCT) in late 2023 directing ERCOT to develop a reliability plan for the Permian Basin in which the anticipated future load is substantially higher than today. ERCOT completed that report in July 2024, with a copy of the report included in the ECEN 615 design project material. In completing this report, they noted in their cover letter to the PUCT that, "ERCOT's preparation of the Permian Basin Reliability Plan represents the culmination of a significant engineering effort undertaken by ERCOT System Planning Staff with the cooperation and assistance of the affected Transmission and Distribution Service Providers (TDSPs) in the ERCOT Region." What you'll be doing for this design project is somewhat similar, but much simpler, tailored for a graduate design project. Also, since detailed transmission information about the actual grid is considered Critical Energy/Electricity Infrastructure Information (CEII), you will be working with a modified version of the 2000 bus Texas Synthetic Grid.

## Electric Grid and Scenarios

The project utilizes an approximately 2000 bus synthetic grid with a 500/230/161/115 kV transmission grid. The goal is to optimally supply electricity to five new 1000 MW loads at buses 1100, 1101, 1102, 3200, and 3201, with the definition of "optimally" given below. Your design is based on how well it performs under four scenarios, with the scenarios provided in the associated PowerWorld *.pwb files. For each of these new loads, the starting point is a substation with a single 230 kV bus, with the requirement being that the load must be supplied at 230 kV. The geographic locations of these new loads are given in the below table.

| Sub Number | Sub Name | Bus Number | Bus Name | Latitude | Longitude |
|---|---|---|---|---|---|
| 2000 | Sub1100 | 1100 | NewLoad1100 | 30.870 | -101.559 |
| 2001 | Sub1101 | 1101 | NewLoad1101 | 31.400 | -102.600 |
| 2002 | Sub1102 | 1102 | NewLoad1102 | 30.700 | -104.200 |
| 2003 | Sub3200 | 3200 | NewLoad3200 | 30.316 | -100.044 |
| 2004 | Sub3201 | 3201 | NewLoad3201 | 29.787 | -100.808 |

## Design Procedure

The design procedure consists of modifying the transmission grid, with the same modifications applying to each scenario, and then solving each scenario using the dc optimal power flow (DCOPF). The costs for the transmission grid modifications are given below. The objective is to minimize the total yearly production cost plus 0.129 times the

new transmission costs. The total yearly production cost is calculated assuming the grid operates in each of the four scenarios for 25% of the time over a year (i.e., 2190 hours each). So, to get the total yearly production cost sum  the Total Final Cost Values for each of the four scenarios (given by the DCOPF) and multiply that sum by 2190.  The 0.129 (12.9%) new transmission scalar is based on the value ERCOT uses in their production cost savings test associated with the first-year annual revenue requirement.

## Simplifying Assumptions

To simplify the analysis, several assumptions are made:

1. All analysis is done using the DC OPF. Hence, reactive power issues and device resistances are ignored.
2. While the Simulator requires that three limits be specified for each new device, only the first (A) limit is used here.
3. No contingencies are considered except for single device contingencies associated with the new lines/transformers that you add. Hence, each of the new loads needs to be supplied by at least two transmission lines or transformers. This means that you need to demonstrate that with one of your new devices out of service, there is still at least 1000 MW of transfer capacity to each of the loads.
4. The new loads need to be supplied at 230 kV, and their substations with this voltage level bus work already exist.
5. All generation is assumed to be available, though the maximum MW values for the wind and solar generation are modified in some scenarios based on assumed weather conditions.
6. There are no restrictions on where new transmission lines can be constructed, and all new transmission of a particular voltage level is assumed to cost the same dollars per mile.
7. Assume that the new transmission line right-of-way (ROW) lengths are 120% of the geographic distance between the substations.
8. All substations can be modified to accommodate new 500 kV and/or 230 kV transmission lines and transformers.
9. All new devices of a particular type have a fixed rating and costs, with the details given in the Assumed Costs section.

## Assumed Transmission Line and Transformer Parameters

Since this project only involves DC power flow analysis, only the per-unit reactance values are needed, with all values given using a 100 MVA base. For 500 kV transmission lines assume $X = 0.0002$ per unit per mile with a rating of 1600 MVA and a maximum ROW length of 200 miles. For 230 kV transmission, assume $X = 0.0012$ per unit per mile with a rating of 400 MVA and a maximum ROW length of 115 miles. For 500/230 kV transformers, assume an X of 0.015 per unit and a rating of 1100 MVA. For 230/115 kV transformers, assume an X of 0.05 and a rating of 200 MVA.

## Assumed Costs

You may add new substations anywhere. You should only add new 500 kV or 230 kV transmission lines, or 500/230 or 230/115 kV transformers. New transmission lines include a fixed cost and a variable cost. The fixed cost is for the design work, the purchase/installation of the three-phase circuit breakers, associated relays, and changes to the substation bus structure.  The fixed costs are $15,000,000 for a 500 kV line, and $8,000,000 for a 230 kV line. The variable costs are $3,000,000 per mile for 500 kV lines and $1,300,000 per mile for 230 kV lines.  Cost for a new 500/230 kV, 1100 MVA transformer (including associated circuit breakers, relaying and installation) is $12,000,000.  Cost for a 230/115 kV, 200 MVA transformer (also with associated circuit breakers, relaying and installation) is $1,800,000.

Upgrading an existing 230 kV substation to include 500 kV costs $8,000,000. Building a new 500 kV substation costs $11,000,000 with an extra $3,000,000 to also include 230 kV. Building a new 230 kV substation costs $7,000,000. Upgrading an existing 115 kV substation to include 230 kV costs $4,000,000, with another $8,000,000 to add 500 kV. For all substation upgrades the cost of any associated transformers is extra with the costs given in the previous paragraph. While the grid does include 161 kV and 115 kV lines, no new lines at these voltage levels should be added.

## Final Deliverables (I.E., Required Material to Turn In)

By the last day of TAMU Fall Semester classes, i.e., December 8 ,2025 at 9:30 am, each student needs to turn in 1) a report describing your new design that clearly indicates all associated cost values and your final cost function and 2) four *.pwb files, one for each of the four scenarios showing your new design.