MIDDLE EAST TECHNICAL UNIVERSITY

ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT

EE 300 Summer Practice Report

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SP Company: Trakya Electricity Distribution Inc.(TREDAŞ)

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1) COMPANY NAME: TRAKYA ELEKTRİK DAĞITIM A.Ş. (TREDAŞ)

2) COMPANY LOCATION:

100. Yıl Mah. Barboros Cd. No24/1(A Blok) Süleymanpaşa/ TEKİRDAĞ

3) ABOUT THE COMPANY:

TREDAŞ is the company in charge of electric power distribution in Trakya area – cities Tekirdağ, Edirne and Kırklareli- which occupies an area of 19.125 km^2. This service area of the company can be observed from the Figure 1.

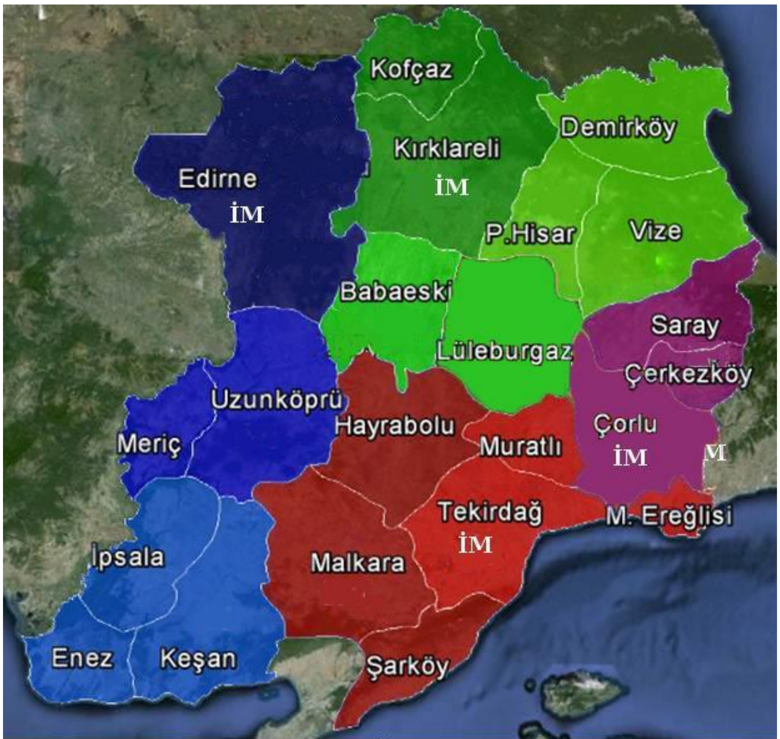


Figure 1. Distribution of Electric Power Operations Management Among the Trakya Area

The company has 22 service points and these points provide an energy distribution service amounting 5,994 GWh. More details can be found from Table 1.

Service Area	19.125 km^2
City	3
District	28
Town	21
Village	431
Population	1,6 million
Total Customer	968 thousand
Service Point	22
Distributed Energy	5.994 GWh

Table 1. Details About the Service Area of TREDAŞ

4) HISTORY OF THE COMPANY:

Date	Event
1995	TREDAŞ, which provides electrical distribution service in Trakya region, was established in 1995.
2006	Taking over agreements of operating rights was signed with Turkish Electrical Distribution Corporation to involve in privatization process with other electrical distribution companies.
30.12.2011	TREDAŞ was taken of by IC İçtaş Energy for $575 million.
01.01.2013	Distribution and retailing activities execute by separated legal entities with respect to obligations.
2035	TREDAŞ has electricity distribution license in Trakya region till 2035.

Table 2. Historical Process of TREDAŞ

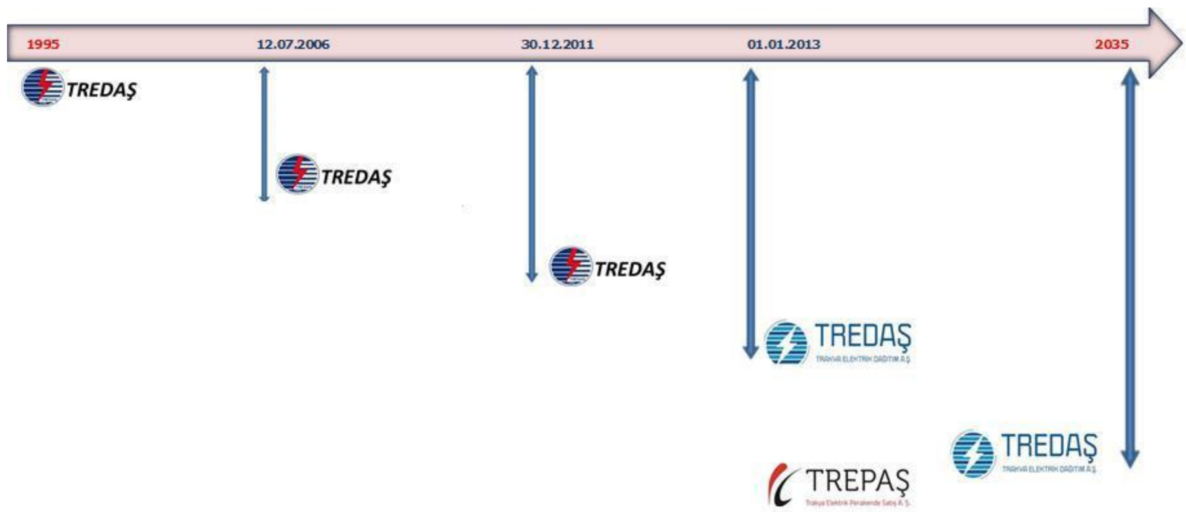


Figure 2. Schematic Representation of Historical Process of TREDAŞ

5) ORGANIZATIONAL STRUCTURE OF THE COMPANY

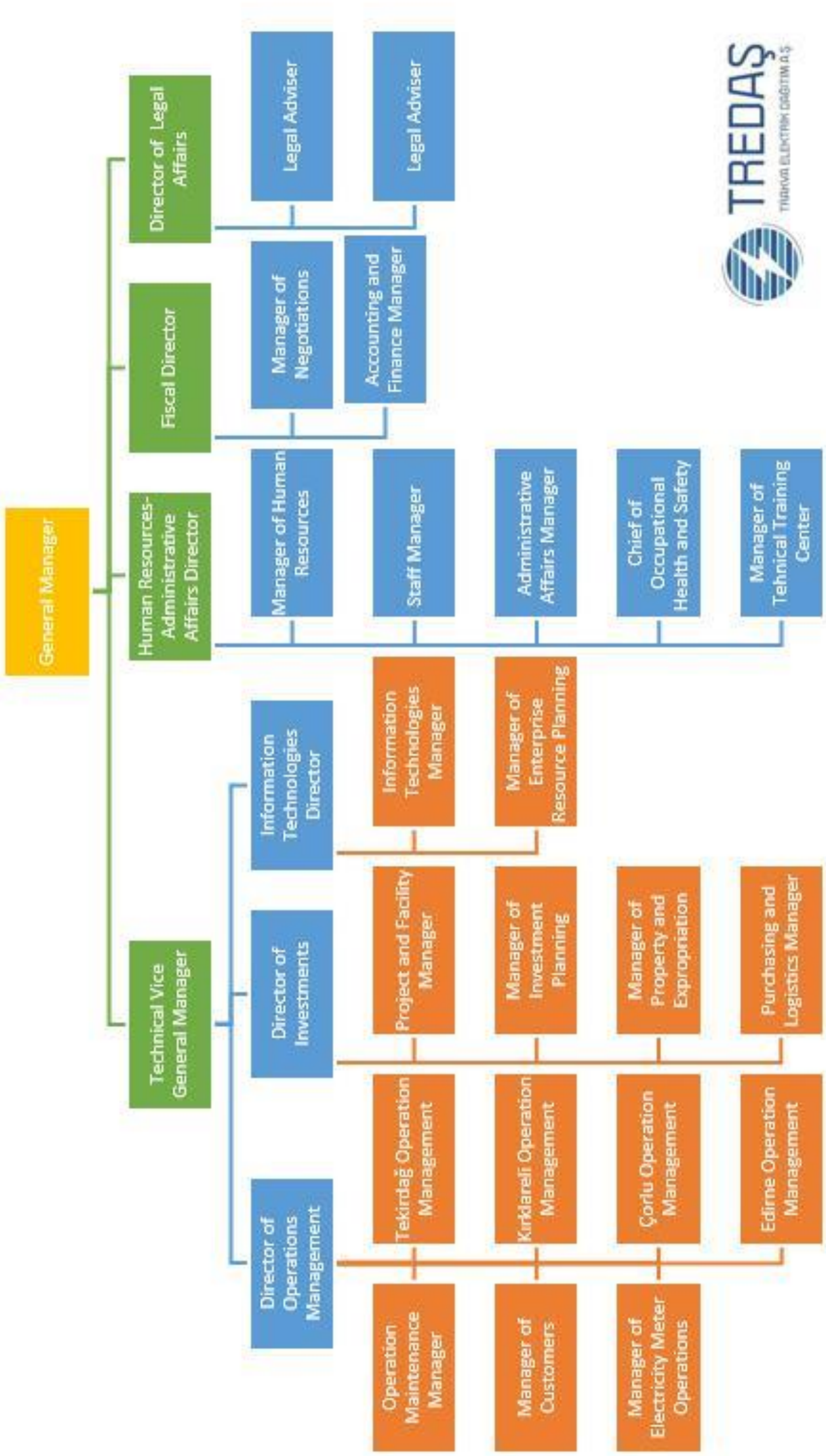


Figure 3. Organizational Structure of TREDAŞ

6) EMPLOYEES OF THE COMPANY:

TREDAŞ has 389 employees totally, where 64 of them are engineers. Ratio of electrical & electronics engineers in the company can be observed from the pie chart in Figure 4.

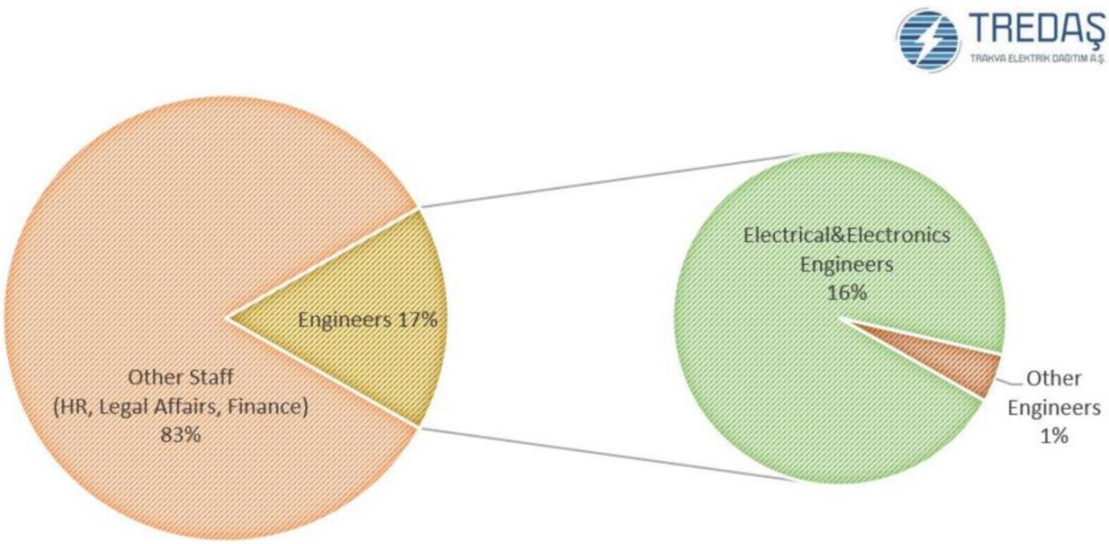


Figure 4. Employees of TREDAŞ on a Pie Chart

7) INTRODUCTION:

I have performed my summer practice in TREDAŞ (Trakya Electricity Distribution Inc.). During this summer practice, I studied some basic concepts of electrical & power engineering. First, I studied basic concepts of AC Power and Power flow. Some of the engineers working in the company were graduated from METU EE Department and they suggested me to study from the "AC Power" lecture notes of Professor Doctor Osman Sevaioğlu who is a lecturer in our department. I reviewed the concepts of active and reactive powers with which I was familiar from EE202 Circuit Theory 2 course.

Then, I studied in simulations of electricity power grids in interconnected systems of cities in Trakya area and focused on KET (Küçük Elektrik Tesisi) Projects (Small Investments) and reviewed these projects' reconnaissance documents. In the last week of my practice, I joined the field visits of these KET Projects and visited the SCADA (Supervisory Control and Data Acquisition) Department of the company.

8) GETTING INTO ENERGY SECTOR

First, I will make an abstract about the electricity power and its grid system.

Electricity passes through 3 steps until it arrives us:

1) Generation
2) Transmission
3) Distribution

The electricity is generated in several ways (thermoelectric, hydroelectric etc.). After it is generated, It is transmitted to electrical substations. The interconnected line system from the generator to these substations forms the transmission network. These substations turn the high voltage (more than 35 kV) into medium voltage levels ranging from 2 kV to 35 kV to be delivered to customers by transformers. The system from substations to customers forms the electric power distribution system.

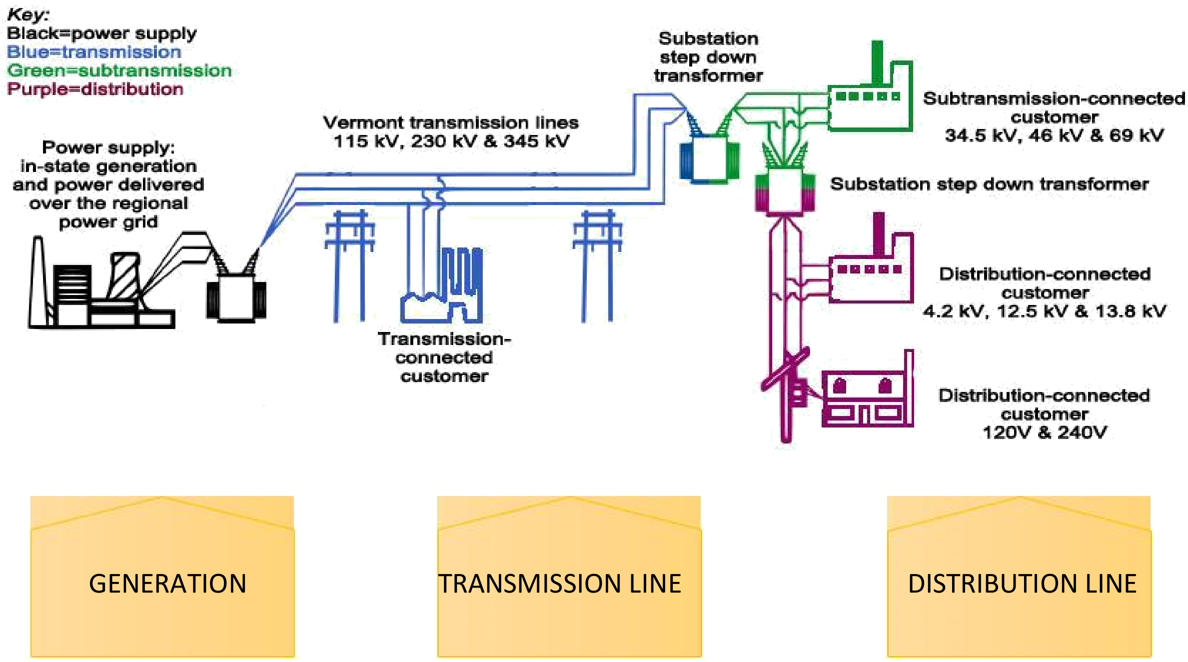


Figure 5. All stages of electric power from generation to customers

Generation and transmission lines of Turkey are shown on a map called 'Interconnected System' published by TEİAŞ (Turkish Electricity Transmission Company) every year.

Figure 6. Interconnected System Map of Turkey (Generation & Transmission System)

Now, I will give some brief information of power systems and analysis of these systems.

Power-flow study (load-flow study) is a numerical analysis of electric power systems. These analyses show the expansion characteristic of power systems. The power-flow study is interested in several concepts of AC power such as voltage, phase angle, reactive and real power parameters.

A load flow is especially important for systems with multiple load centers. By multiple loads, I mean the whole electricity grid line of 3 cities of Trakya area. Working with the load flow system allows us to obtain maximum power efficiency and minimize the operating costs while setting up the electricity grid line.

To analyze power grids in electrical engineering, we use a non-linear model in simulation of power distribution. The reason why we choose a nonlinear model is that power flow of any load is a function of the square of its voltage.

Making the analysis of a three-phase system might be too confusing so we reduce the three-phase system to a one-line diagram by assuming that the system is balanced. I was familiar with this transition from EE 202 course so I easily understood the concept of passing to one-line diagram. As it can be seen from Figure 7, we can show the grid with single line (one phase) instead of showing 3 separate phases.

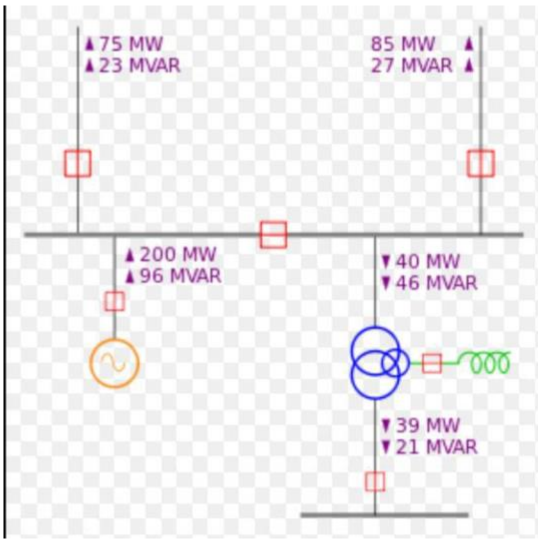


Figure 7. One-line diagram Representation of a Electrical Power Grid System

I worked on updating the static electricity line network with NEPLAN which is a system analysis software used in power, water and gas grid of interconnected systems. This software helps us analyze all generation, transmission and distribution steps of electricity power. I generally worked on reviewing and updating the existing distribution system of Trakya area that can be observed from Figure 8.

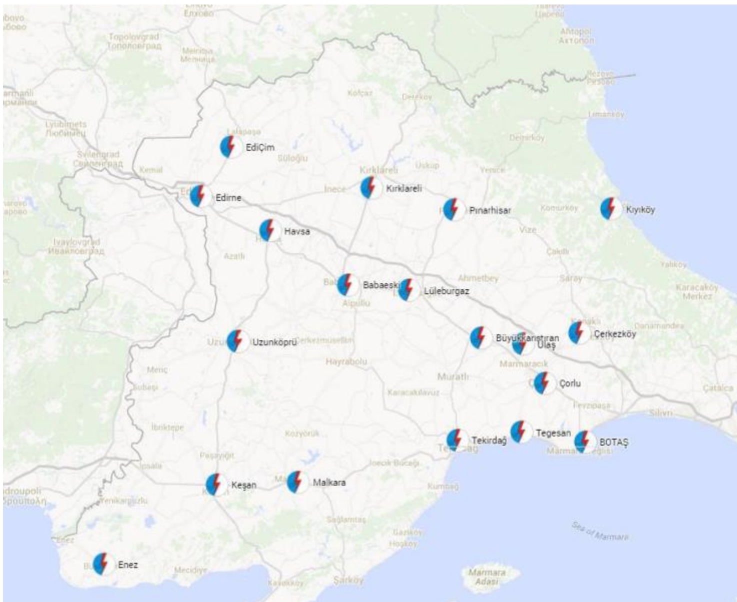


Figure 8. Electricity Distribution Grid of Trakya Area

a) Getting Started with NEPLAN:

Before using Neplan, I had some tutorials about it. I learned how to use some fundamental concepts of the software. To model a electricity grid network, we will need some circuit components like *Network Feeder, Node, Switch, Transformer.*

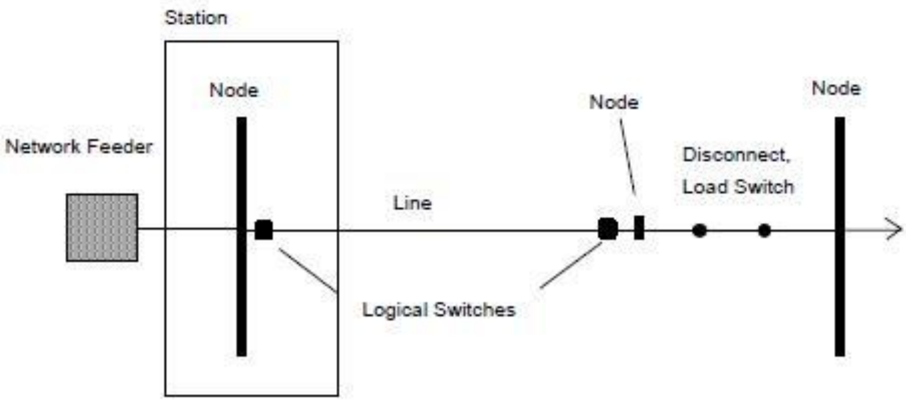


Figure 9. One Line Diagram with Network Components

Network Feeder: It is an active element. A network feeder can represent the output of a neighboring network. The important thing is that it provides energy/voltage to the system. In our grid network, TEİAŞ Transformer Stations are the network feeders.

In NEPLAN, this element behaves like a black box giving energy to the system we only need its active & reactive power (P-Q values) or magnitude & phase angle values to model it in NEPLAN. The model representation of network feeder can be seen from Figure 9.

Node: A node is the intersection point of two elements/lines. It has several parameters as it can be seen in Figure 10.

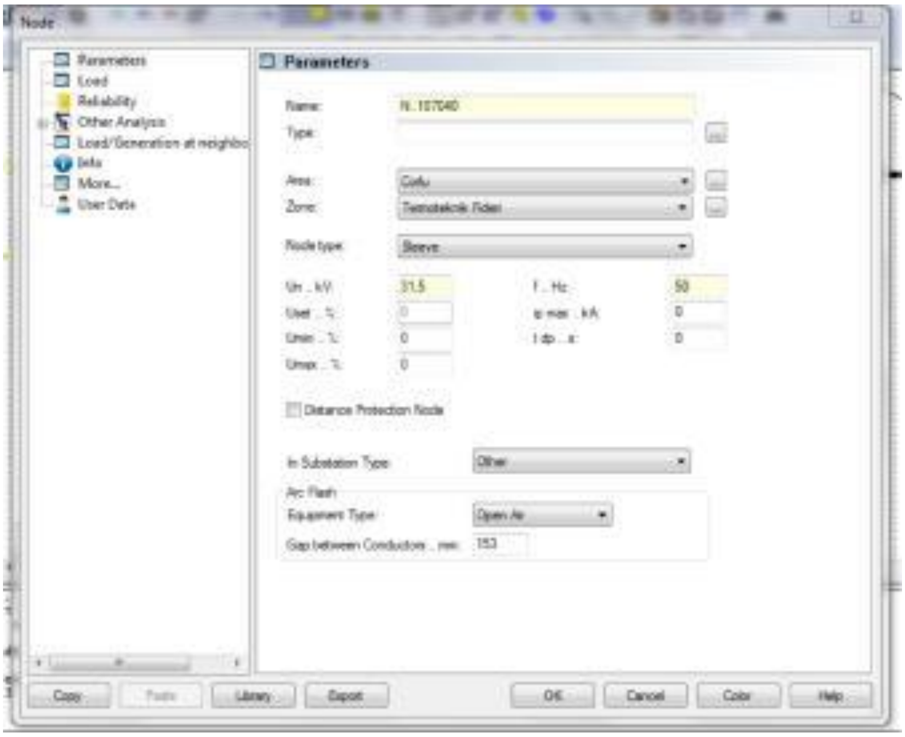


Figure 10. Parameters of a Node in NEPLAN

Switch: In NEPLAN, the switches change the access of network (on/off). There are 2 types of switches used in NEPLAN:

- physical switch
- logical switch.

Symbols of two switches in NEPLAN can be observed from Figure 9.

Transformer: Transformer is the electrical device to transfer electrical energy between 2 or more circuits by electromagnetic induction.

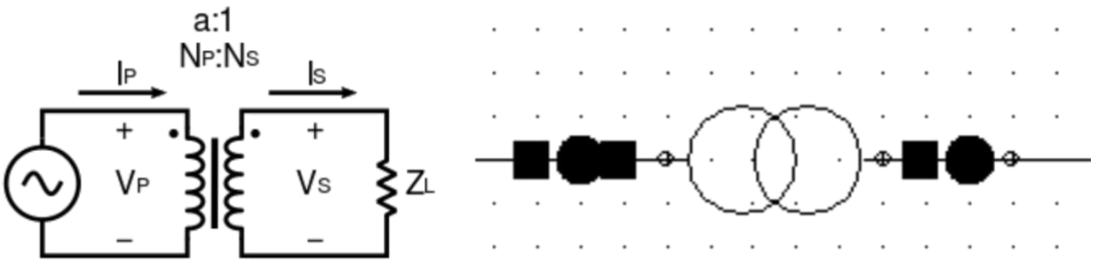


Figure 11. Schematic and NEPLAN Representation of Transformer

Parameters of a transformer in NEPLAN can be observed from Figure 12.

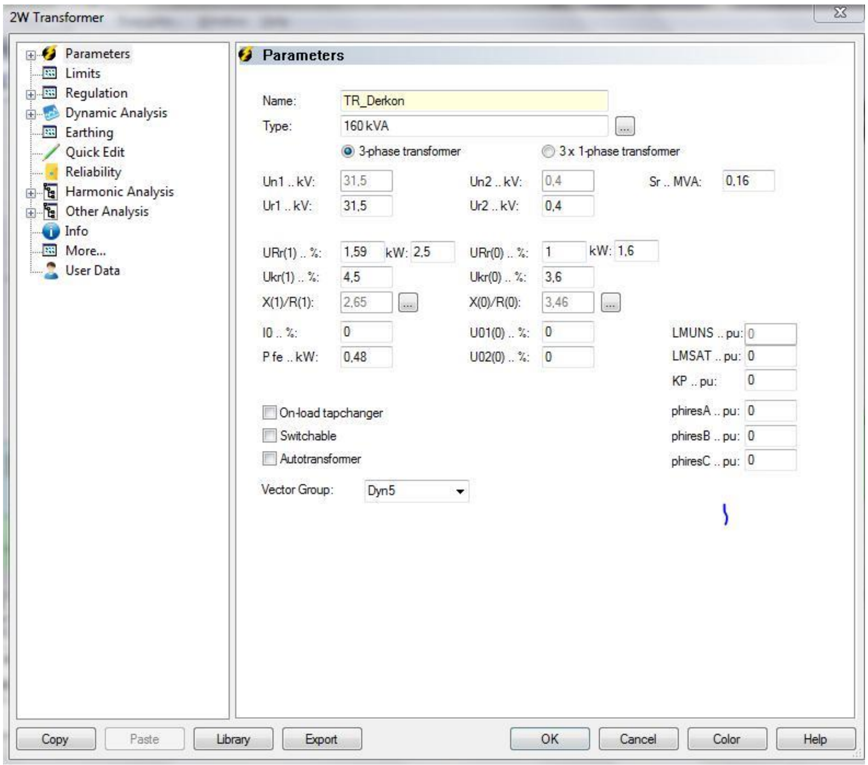


Figure 12. Parameter window of transformer element

Transformers are classified by the amount of desired complex power. These complex power values of transformers are determined by Renard numbers which was established by Charles Renard, a French army engineer, in 1870. These classified transformers can be seen from Figure 3.

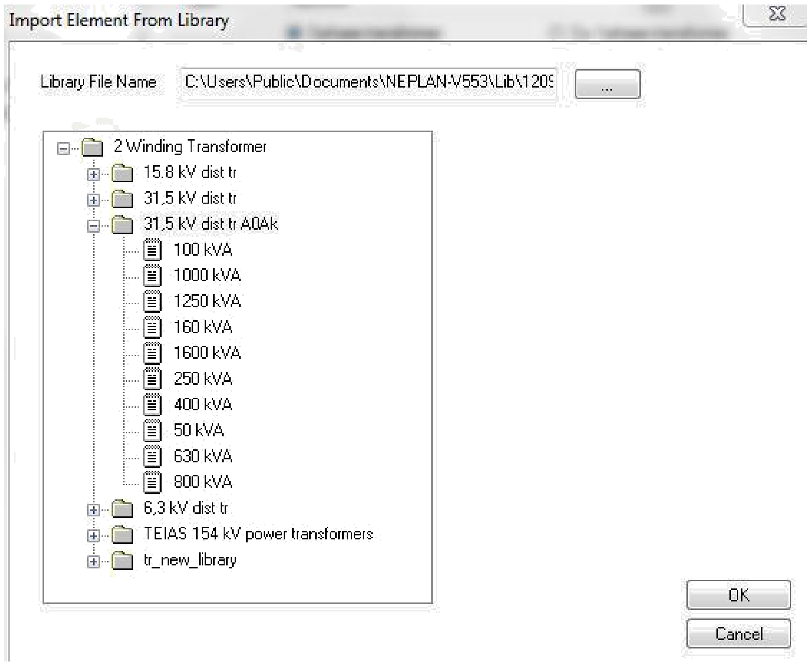


Figure 13. List of transformers classified with respect to their complex power values

While reviewing and updating the NEPLAN models of Trakya Region, I needed a list of active, reactive and complex power values of each transformer, so I prepared a table for power values of transformers-Table 3.

While preparing this table, I paid attention to have applied 2 assumptions:

1) $|P\_out| = |S\_in| * 0.4$

Although output active power of a transformer can be equal or even more than the magnitude of input complex power, we prefer a 40% ratio. Because, the transformer may be damaged if it is exposed to have high output power values. So transformers are set such that 40% of input power is transformed in real life.

2) $\text{Cos}(\Phi)=0,98$

The complex power of output is assumed to have the power ratio of (0.98) .

Cos(Φ)=0,98 İÇİN HAZIRLANMIŞ TRAFO P,Q,S DEĞERLERİ				
TRAFO GELEN GÜÇ	**P (KW)**	**P (MW)**	**Q (MVAR)**	**S (MVA)**
50 KVA	20	0,02	0,004061173	0,020408163
100 KVA	40	0,04	0,008122346	0,040816327
1000 KVA	400	0,4	0,081223464	0,408163265
1250 KVA	500	0,5	0,10152933	0,510204082
160 KVA	64	0,064	0,012995754	0,065306122
1600 KVA	640	0,64	0,129957543	0,653061224
250 KVA	100	0,1	0,020305866	0,102040816
400 KVA	160	0,16	0,032489386	0,163265306
630 KVA	252	0,252	0,051170782	0,257142857
800 KVA	320	0,32	0,064978771	0,326530612

Table 3. Table of Real, Reactive and Complex Power Values of Transformers

P and Q values in 3rd and 4th column are values going to the loads which can be factories, villages or even landed property. These values are found with information that power factor value is 0.98.

Line: Line component is used to connect nodes and other network components. Main parameters of line are length and type. In parallel with these variables, resistance and capacitance values belonging to line can change.

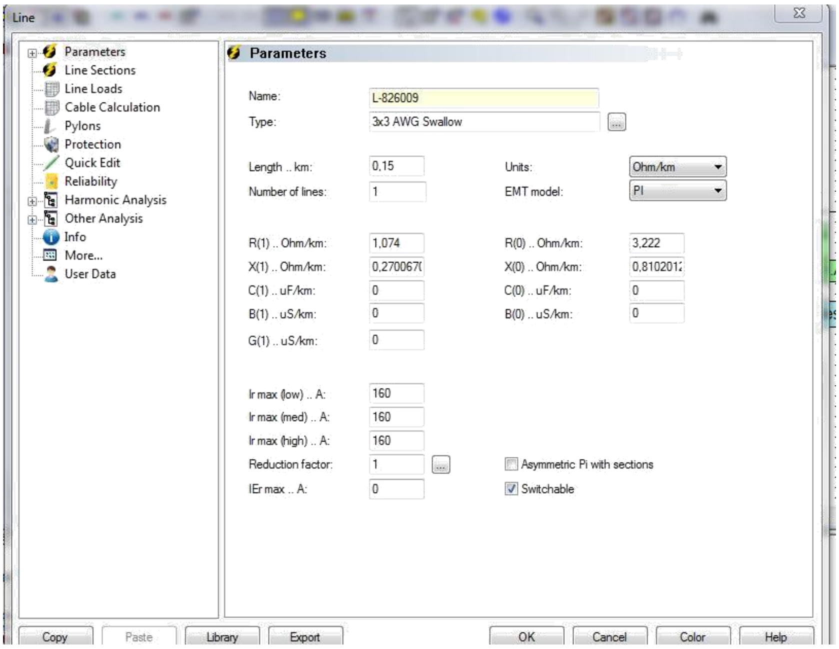


Figure 14. Parameters of Line Component

There are several types of cables used in Turkey but we can separate them into two groups as;

1)Overhead Transmission Line:

This type of line is used in transmission and distribution along large distances. It is chosen more than underground transmission as it has a lower cost. This transmission is generally done by transmission towers.

A single-circuit line | A double-circuit line | Parallel single-circuit lines | Four circuits on one tower line

Figure 15. Different Types of Overhead Transmission Towers

We can also categorize overhead lines with respect to their cross-section areas.

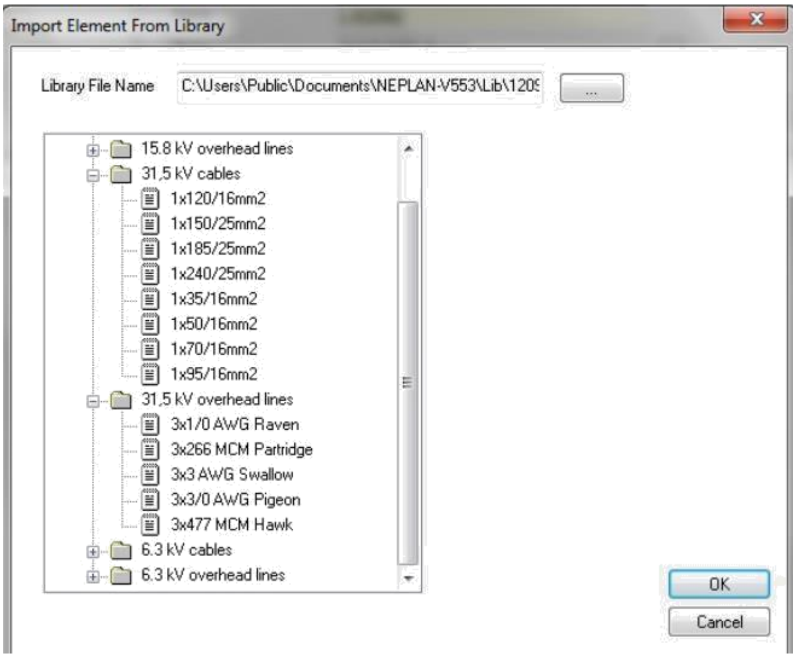


Figure 16. Classification of Lines With Respect to Their Cross Section Areas

Different types of lines refer to different carrying capacity and different cross section areas. With changing request and need, the most suitable line type is chosen.

2)Underground Transmission Line:

When It is hard to build a tower in an area, the transmission can be done under the ground as well. But by comparison with overhead, this method is much more expensive.

Just like the overhead lines, there are different types of underground lines with respect to characteristics.

b) About Geographic Information System and Smallworld Electric Office:

Geographic Information System (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. These systems are often used to model road networks and public utility networks, such as electric, gas, and water networks. In TREDAŞ, there is a department called GIS making field researches and transferring data to the electronic environment via AutoCad and Smallworld Electric Office, electric distribution GIS software provided by GE Electric.

After the necessary data is provided to Smallworld Software by GIS Department of TREDAŞ, my department takes this data from Smallworld and transfer it into NEPLAN.

A simple Smallworld and AutoCad window can be observed from Figure 17 and Figure 18.

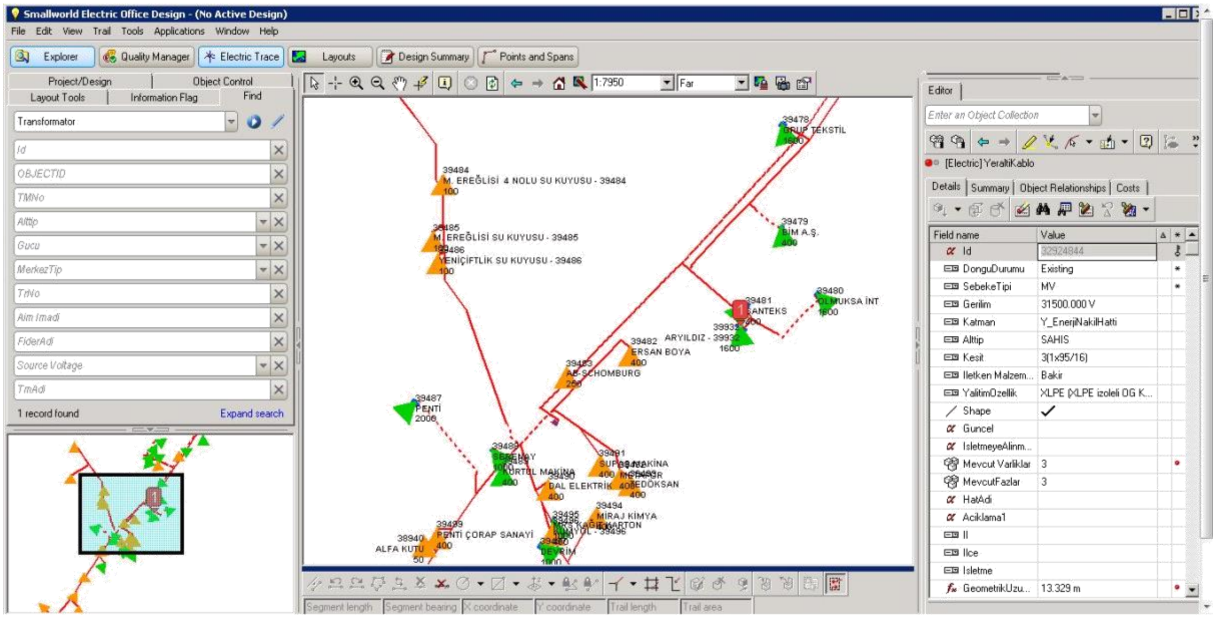


Figure 17. An example window from Smallworld Electric Office

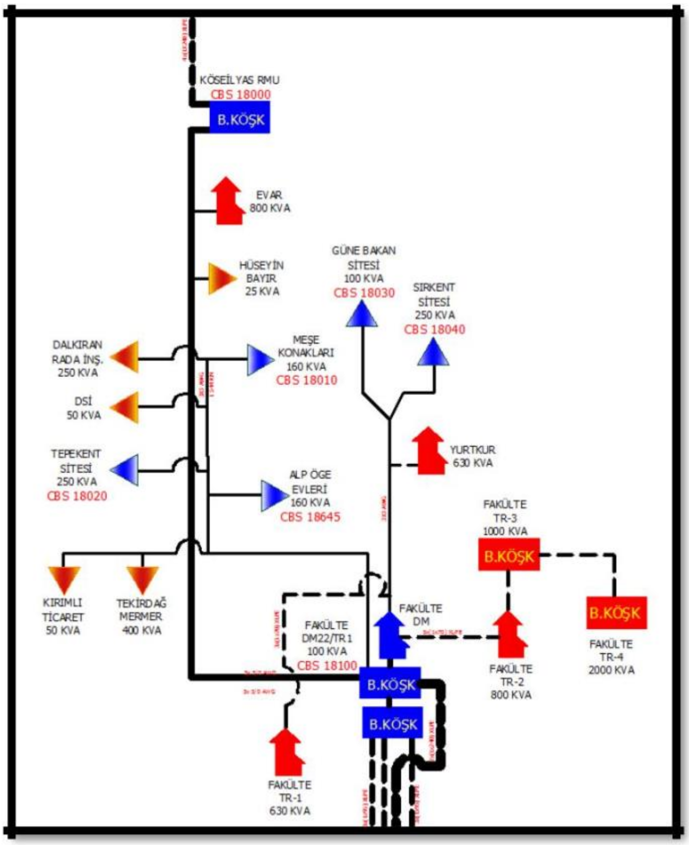
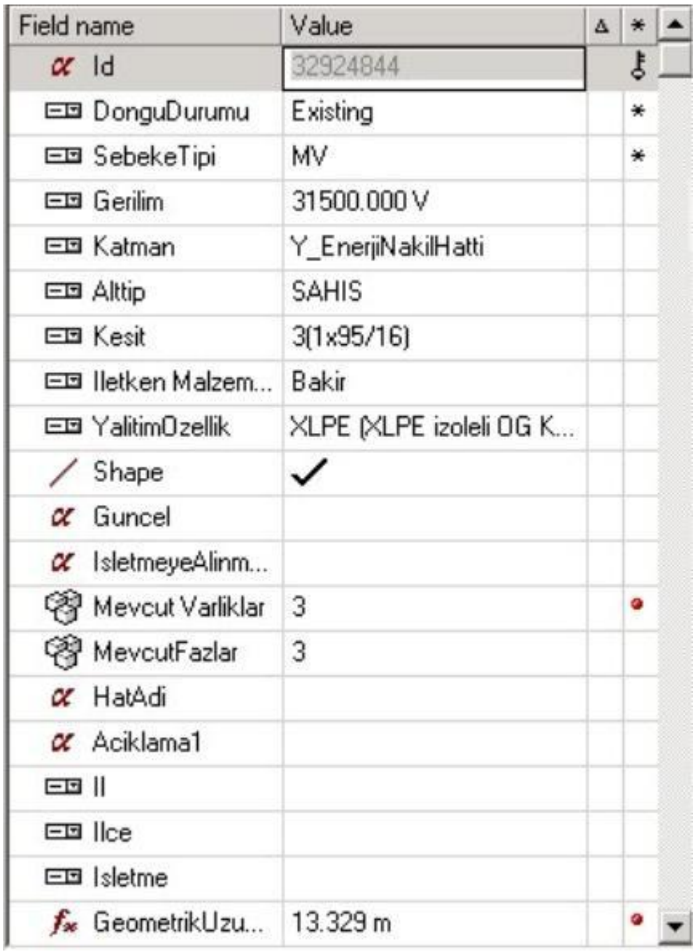


Figure 18. An AutoCad Drawing Example of the Power Grid

In the middle, there is a map representing the electricity distribution grid created by GIS Department of TREDAŞ. When you click onto a grid line, an information windows appears on the right side of the screen. Characteristics of the wire/facility can be observed from this menu shown in Figure 19.



Field name	Value	Δ	*
Id	32924844		
DonguDurumu	Existing		*
SebekeTipi	MV		*
Gerilim	31500.000 V		
Katman	Y_EnerjiNakilHatti		
Alttip	SAHIS		
Kesit	3(1x95/16)		
Iletken Malzem...	Bakir		
YalitimOzellik	XLPE (XLPE izoleli OG K...		
Shape	✓		
Guncel			
IsletmeyeAlinm...			
Mevcut Varliklar	3		
MevcutFazlar	3		
HatAdi			
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Il			
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GeometrikUzu...	13.329 m		

Figure 19. Characteristics of a Line in Smallworld Electric Office

c) Updating Distribution Grids:

As TREDAŞ is responsible from power distribution of Trakya Region, I was given to work on updating power grid of Çorlu Region. Updating power grid on NEPLAN is important because it can easily be observed how much power is consumed for any workplace/factory. There is a electric power consumption about 25 MW in Çorlu. But when I started updating, the observed consumption on NEPLAN was about 11 MW. I usually labored to increase this number during my internship and could make it 18.7MW as it can be seen from Figure 20.

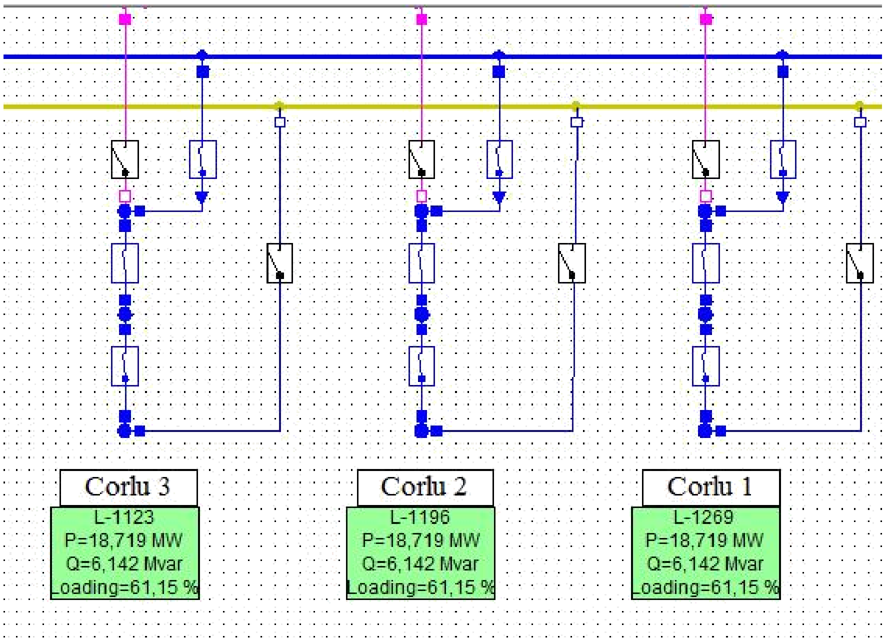

Figure 20. NEPLAN Representation of Root Electricity Transformers of Çorlu

d) A Simple Example of Grid Updating on NEPLAN

During my internship, I completed many loads' (any place consuming electricity) and lines' analysis. In this part, I will briefly explain how to do this operation with a simple example.

I decided a starting point for each street and I tried to complete the whole line grid of all streets. During this process, I paid attention to whether the following information is true and corrected if they are wrong:

-Name of the facility

-Type of each facility's transformers

-Alias Number of each facility

(like a characteristic number created by TREDAŞ, each facility has its own alias number)

-Length of each line

-P, Q and Φ(fi) values of each transformers

This data is corrected with the menus shown in Figure 22.

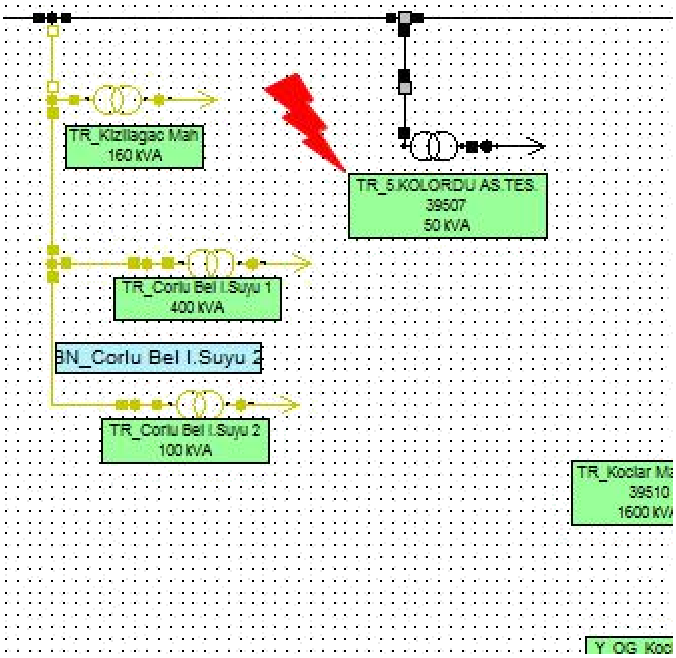

Figure 21. Load Representation of a Facility

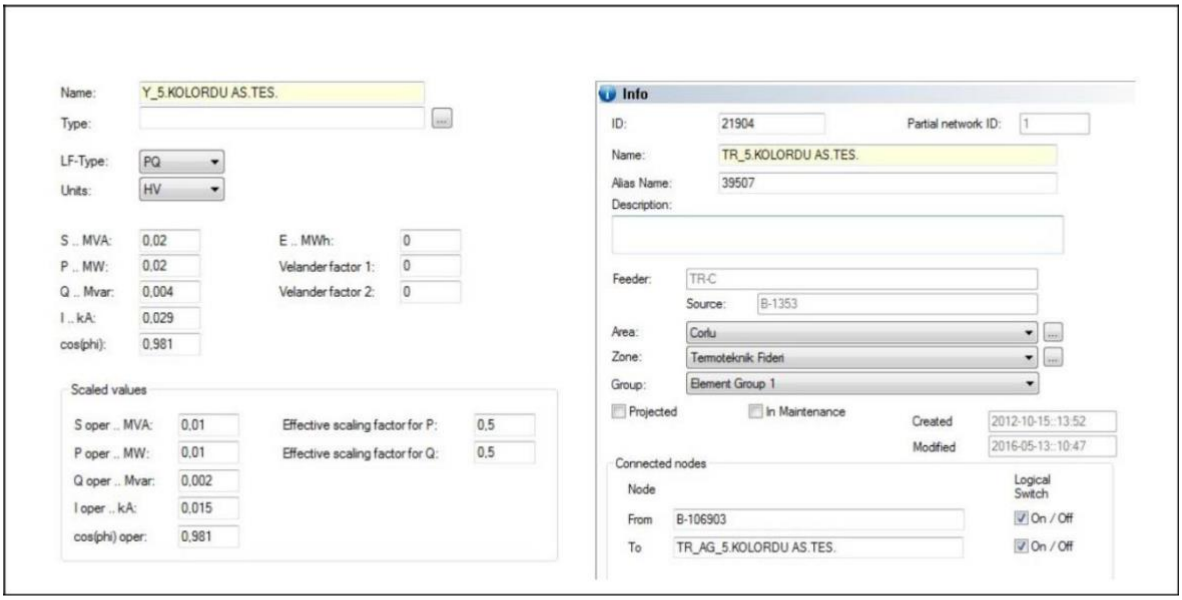

Figure 22. Characteristics of a Facility Load in NEPLAN

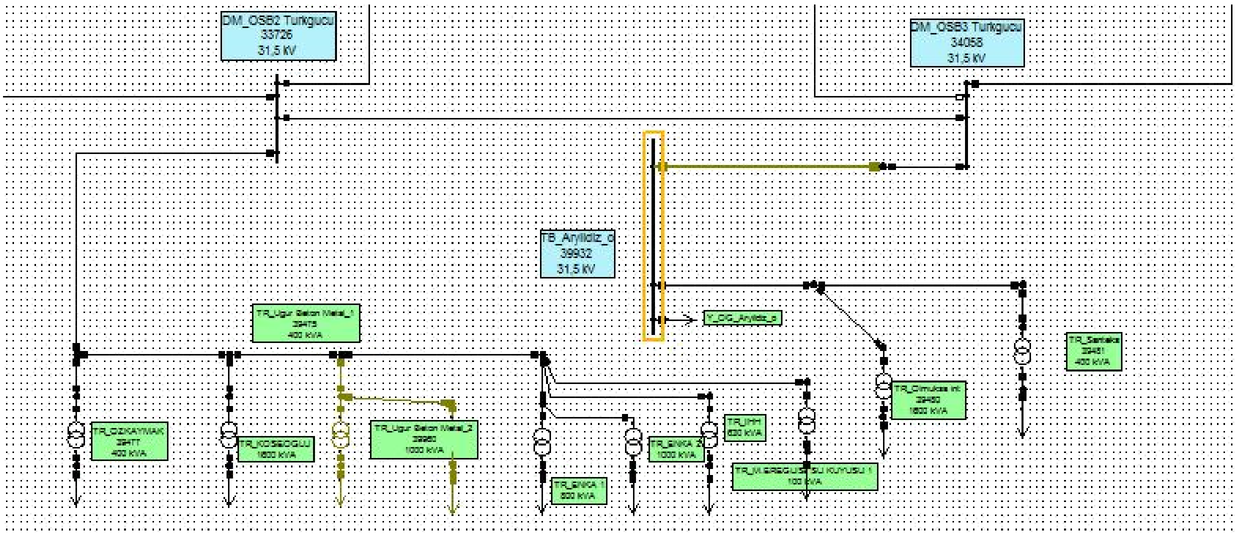

Figure 23. One of the streets in Çorlu area that I worked on with NEPLAN

e) Working on KET(Small Investments) Projects

KET(Küçük Ek Tesis) projects are small investments to install new power lines or fix the broken lines. Their budgets are usually less than main investments. These investments are made from among requests by consumers. After the request of any consumer is made from the website of TREDAŞ, electrical engineers analyze each investment request whether they are necessary or not. If they are found necessary, then a project is created with a budget determined with respect to the possible spending.

I worked on analyzing some KET Projects and recorded important data of each one to an excel sheet. This sheet was useful to put KET projects into order with respect to their priority. Then, to decide whether they are necessary or not, I joined some field visits.

Figure 24. A photo of KET Project from the field visit

As is seen from the Figure 25, The electricity tower is unsafely close to the building. The owner of construction requested it to be removed and set a new one. Engineers did the necessary field research near this tower to decide about this project.

After the field visit, I also visited TEİAŞ' (Turkish Electricity Transmission Company) Çorlu Transformer Station and saw these huge transformers that can be seen in Figure 25 and 26.

Figure 25. TEİAŞ Çorlu Transformer Station

Figure 26. TEİAŞ Çorlu Transformer Station

f) About the SCADA

In the last week of my summer practice, I was in SCADA (Supervisory Control and Data Acquisition). I observed what SCADA does and learned basic concepts of it.

SCADA is a software system to monitor and control the whole electric power grid system remotely. By this method, a possible problem on the grid can easily be learned and solved before it causes a damage.

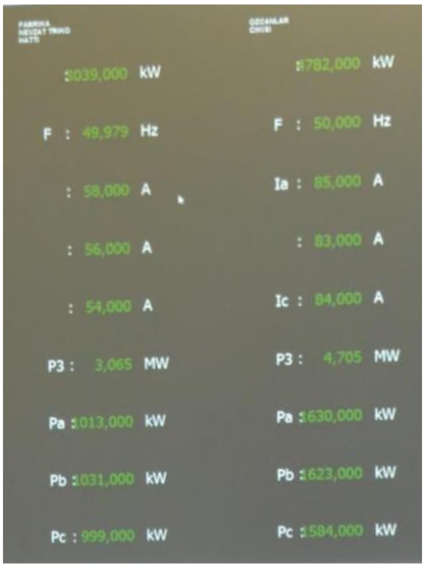

Figure 27. Observed Power Data of Loads on SCADA Software

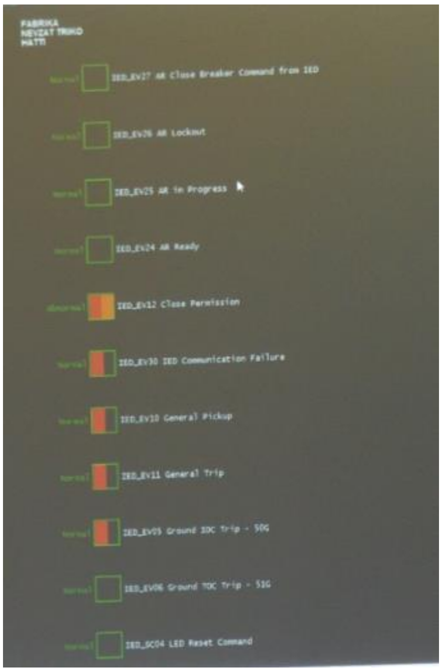

Figure 28. Status Screen of Loads on SCADA

These boxes in Figure 28 show the status of each transformer, load etc. If a problem occurs in the grid, it can immediately be solved automatically by computer or manually.

g) About the R&D Projects

During my summer practice, I also studied on two R&D projects of TREDAŞ.

One of them was about the birds damaging the electric wires. TREDAŞ does many field visits and researches to reduce birds' deaths and wires' getting damaged.

Second project was about the arc flash explosions. Arc flash is an electrical explosion that happens with a sudden discharging and may be too fatal. There are also some researches and solution offers made by TREDAŞ to people/companies having arc flash problems.

I studied deeper on these subjects. But due to the privacy policy of TREDAŞ, I cannot explain more about R&D Projects.

9) CONCLUSION

It was a great experience for me to perform my first summer practice at TREDAŞ. Until my internship, I did not have a very positive attitude towards energy & power sector. At this point, this internship has completely changed my mind about power area. I learned how to use necessary software, joint important meetings and had a chance to see almost all departments in company. Engineers in my department was very nice to me. They replied every question I asked. Especially, supervisor engineer of me, Recep Çildarul always tried to help me in every respect. There was a sincere environment in the department.

During the internship, I gained a wide knowledge of power systems from generation to distribution. But I mainly focused on distribution systems. I learned to use power system analysis software NEPLAN that is one of the most popular software among power engineers. I also worked on KET Projects to learn the process of energy projects, SCADA and R&D projects.

I don’t know in which sector I will build my career but I can easily say that this internship has completely broken taboos on energy power sector for me. Now, I am much more interested in this area than I used to be. So in whichever area I work in the future, this internship created a good aspect on me about being an engineer.

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