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2-103

Icing Forecasting on Overhead Lines and Development of Early Warning System, a Real Case Study in Turkey

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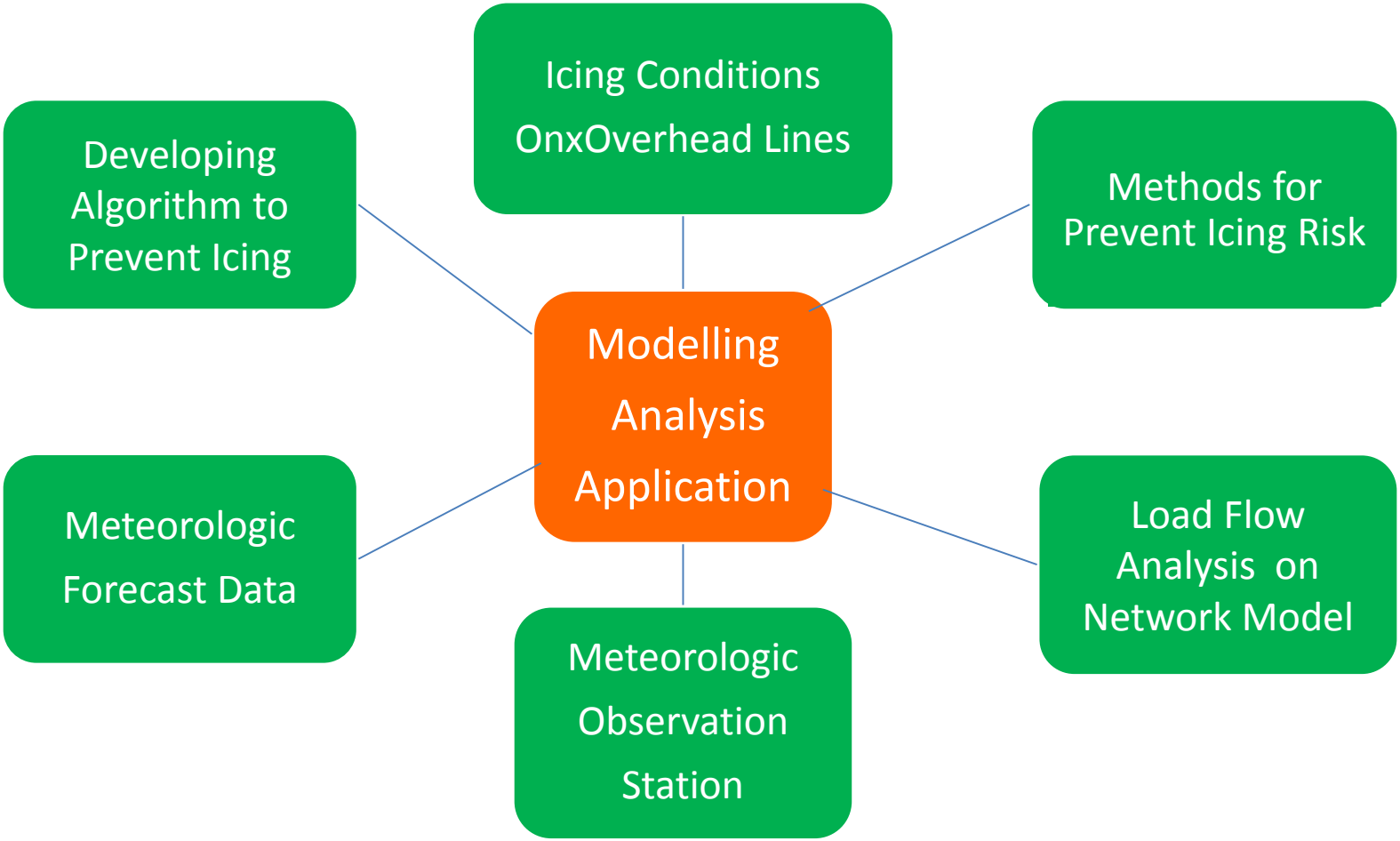
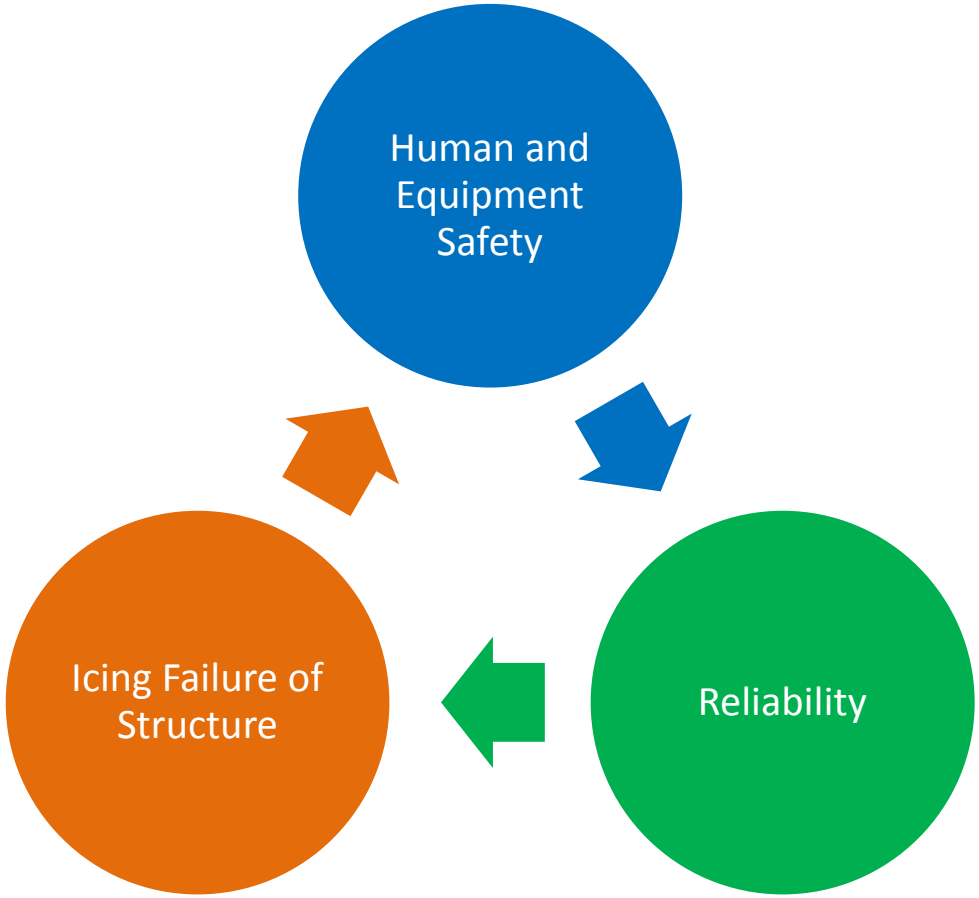
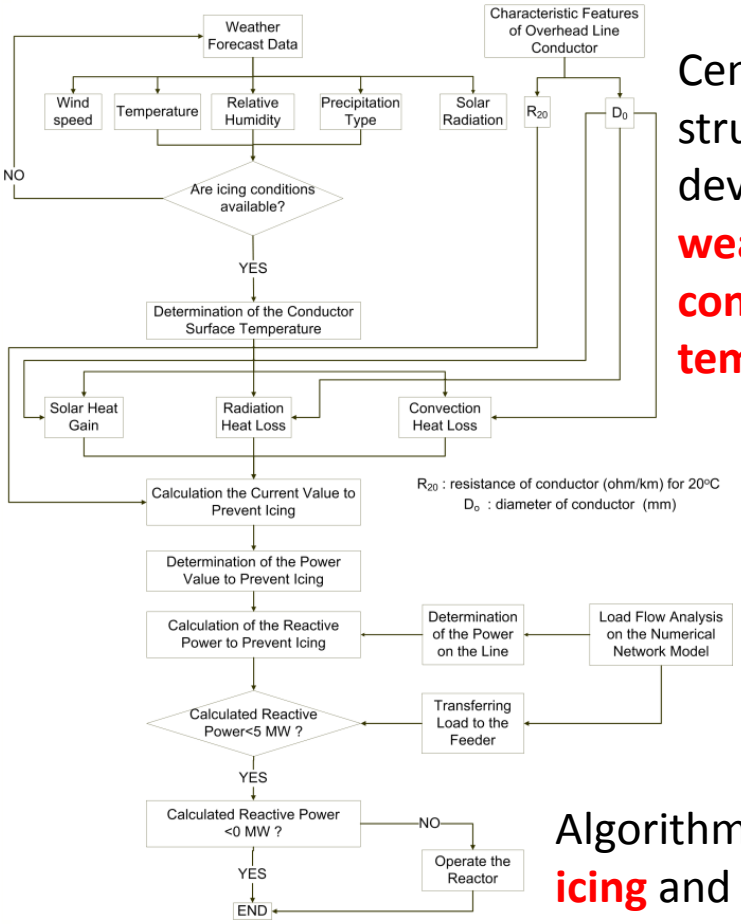
Overview


Icing Conditions OnxOverhead Lines
Developing Algorithm to Prevent Icing
Methods for Prevent Icing Risk
Modelling Analysis Application
Meteorologic Forecast Data
Load Flow Analysis on Network Model
Meteorologic Observation Station

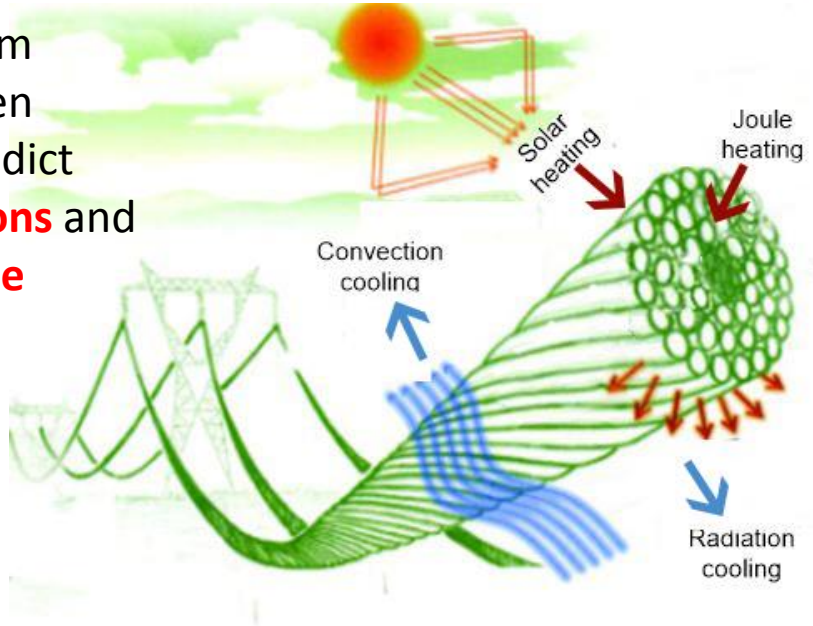
Problem Definition



Originality



Centralized system structure has been developed to predict **weather conditions** and **conductor surface temperature**.



Algorithms and software has developed to monitor **the risk of icing** and **warn the operator** when icing arised

Icing Conditions on Overhead Lines

Various factors that occur icing on the overhead lines are as follows:

Temperature: Icing events occur most between + 2°C and -8°C. However, if it is too cold (below -8°C), icing won't occur.

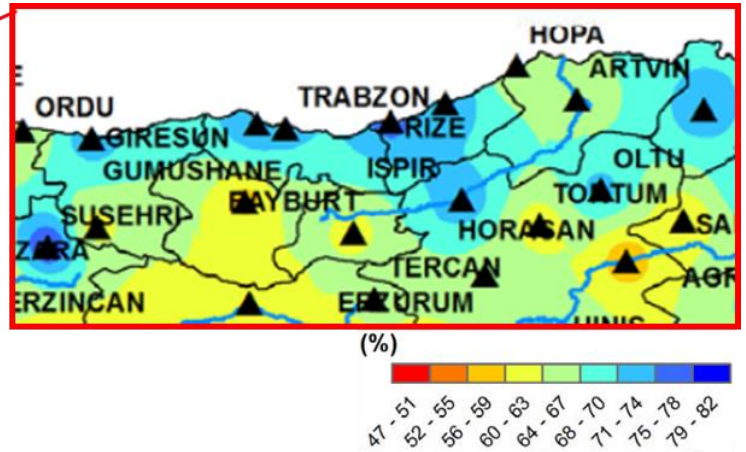
In addition, the amount and types of the precipitation affect the formation of ice.

City	Min. Temperature of Months(°C)					
	November	December	January	February	March	April
Trabzon	-1.6	-3.1	-7	-6.1	-5	-2
Rize	-4.8	-4	-6.5	-6.6	-7	-2.8
Giresun	-4.7	-2.4	-6.2	-9.8	-4	1.4
Artvin	-8.2	-10.8	-16.1	-11.9	-9.8	-7.1
Gümüşhane	-15	-21	-23.6	-25.7	-22.6	-11

Icing Conditions on Overhead Lines

Humidity: The relative humidity should be over 90% for the occurrence of icing.

Humidity rate decreases with the temperature drop. In this case, both the icing occurs and thickness of sheet increases over time.



Icing Conditions on Overhead Lines

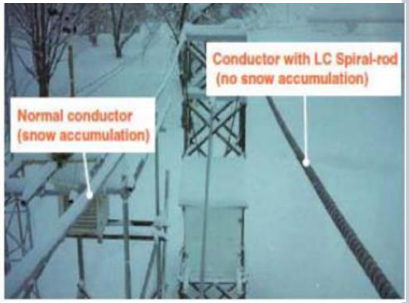
Wind: The wind causes water vapor and fog particle accumulates on conductor surface. It's important the speed of the wind with its direction for icing.

Topography conditions: The topography and the elevation from sea level affect the icing. The most crucial thing to pay attention is that lines should pass through the land where the slow wind blows

Solar radiation: It affects the heating of the conductor depending on the angle of the sun's rays.

Methods to Prevent Icing Risk

- Methods to Prevent Icing Risk
  - Passive Methods
    - Adding Counterweights
    - Alternative Phasing Configuration
  - Active Coatings and Devices Methods
    - Dielectric and ferromagnetic coating
  - Mechanical Methods
    - Scraping Devices
    - Shock wave methods
  - Thermal Methods
    - Reduced voltage short-circuit methods
    - Load shifting Methods



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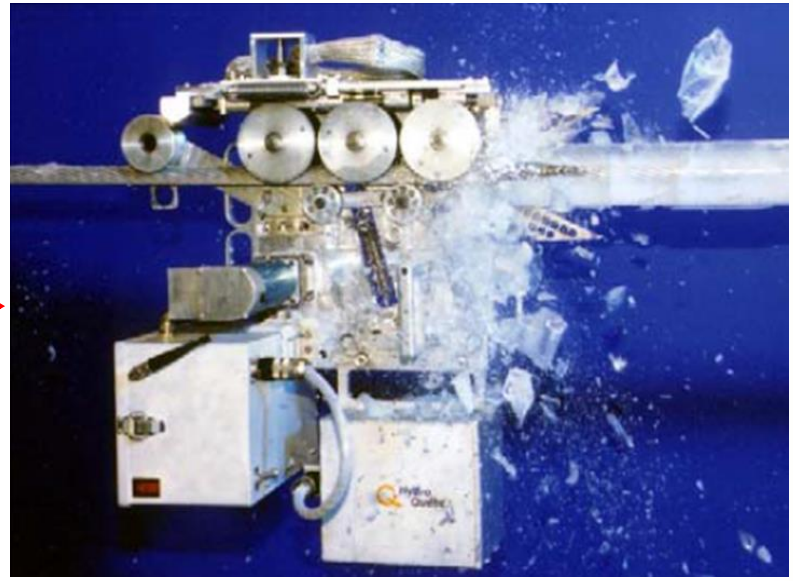
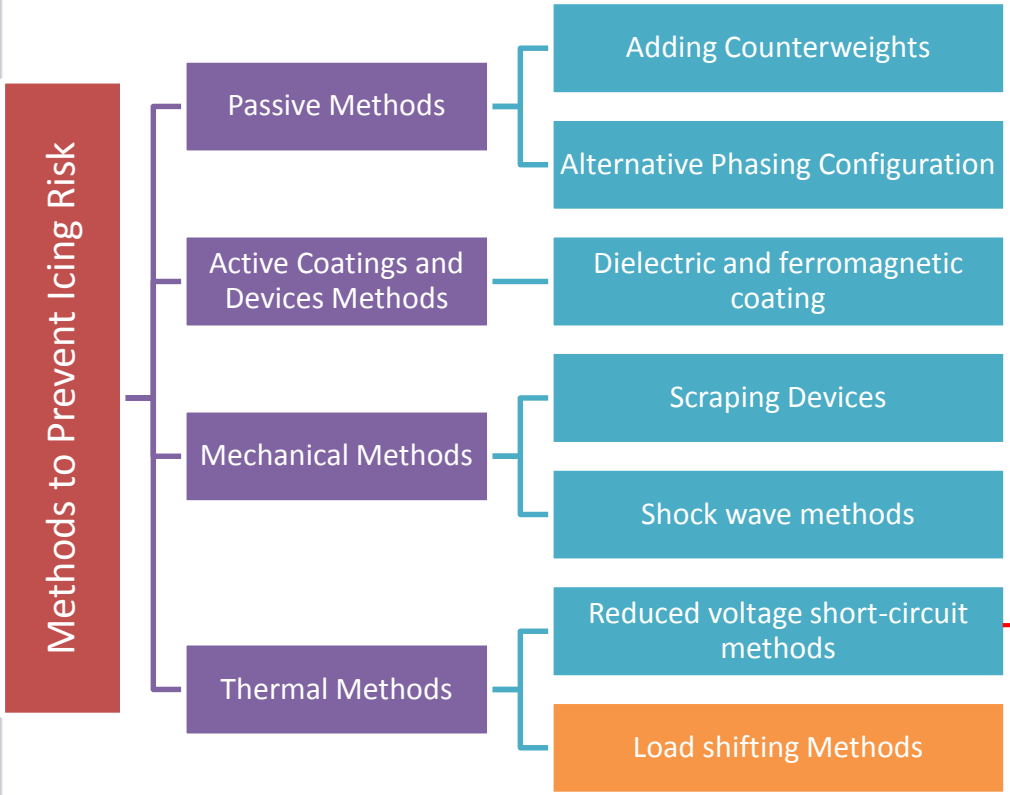
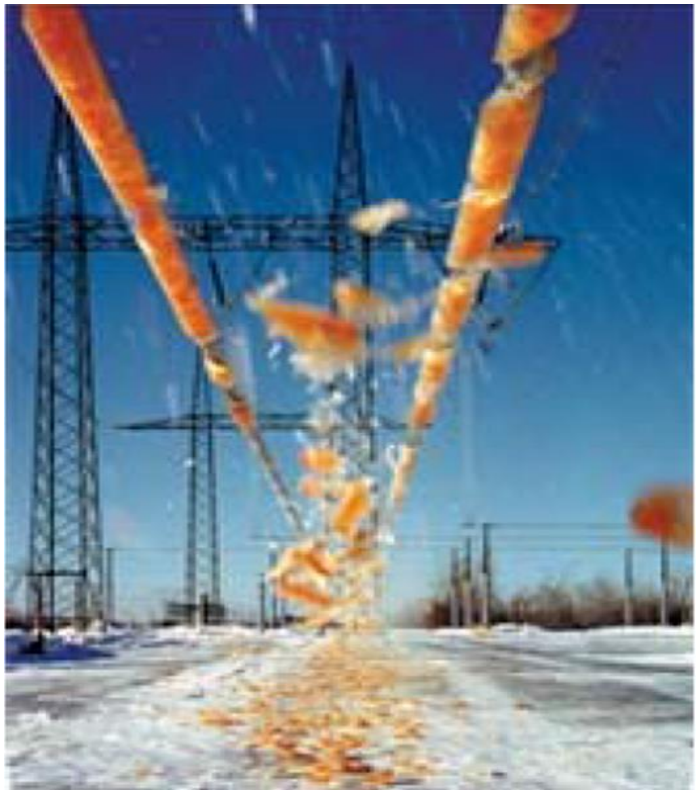


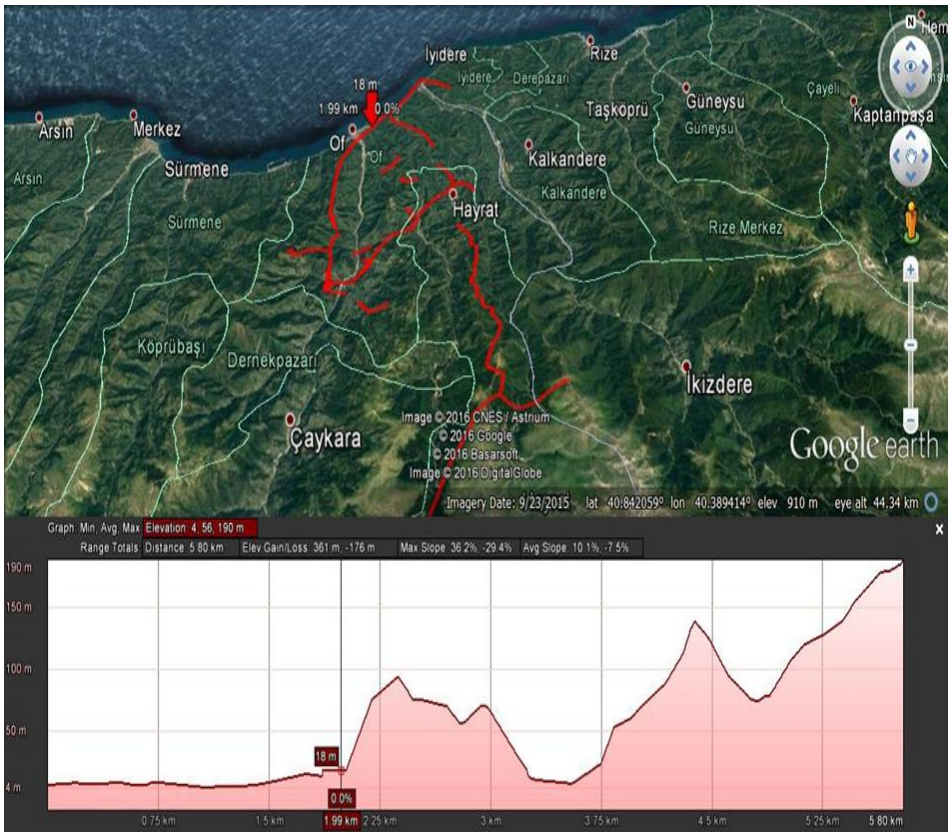
Methods to Prevent Icing Risk



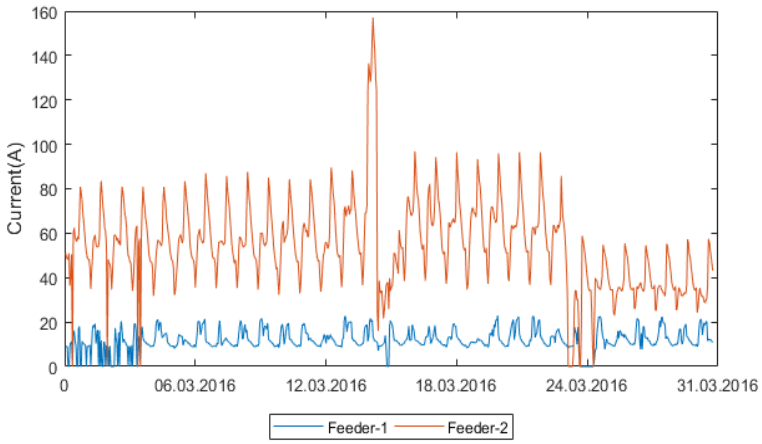


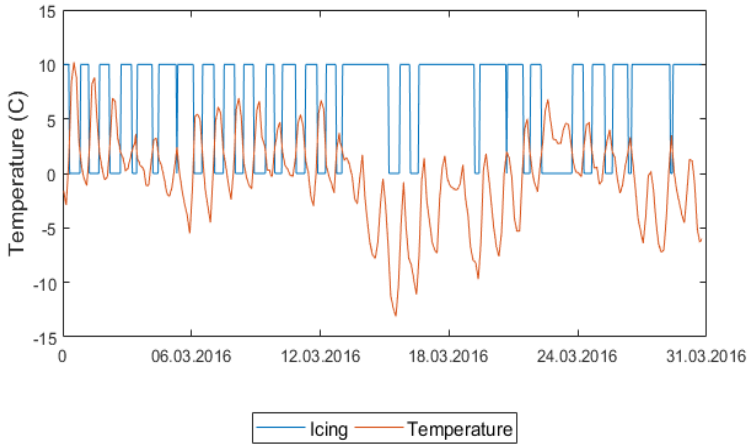
Network Analysis

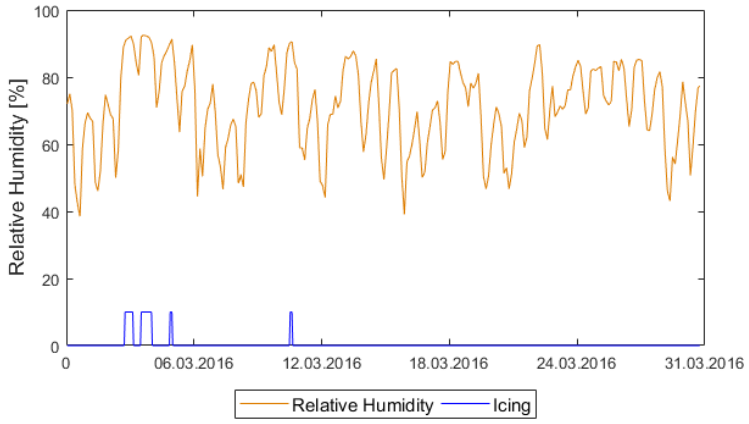
Feeder-1 Feeder-2

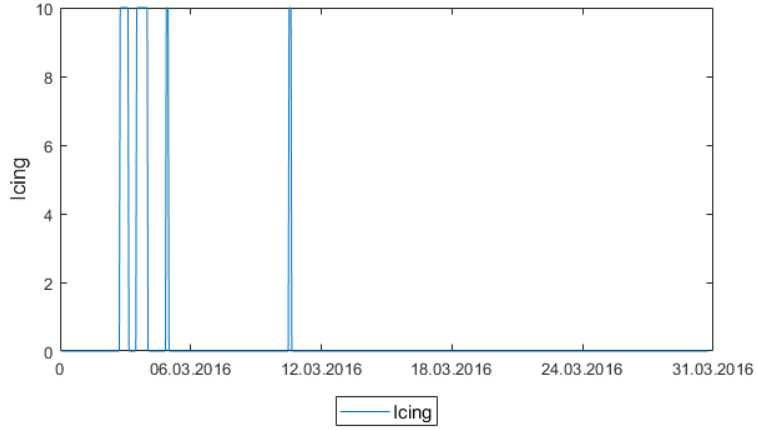


Network Analysis

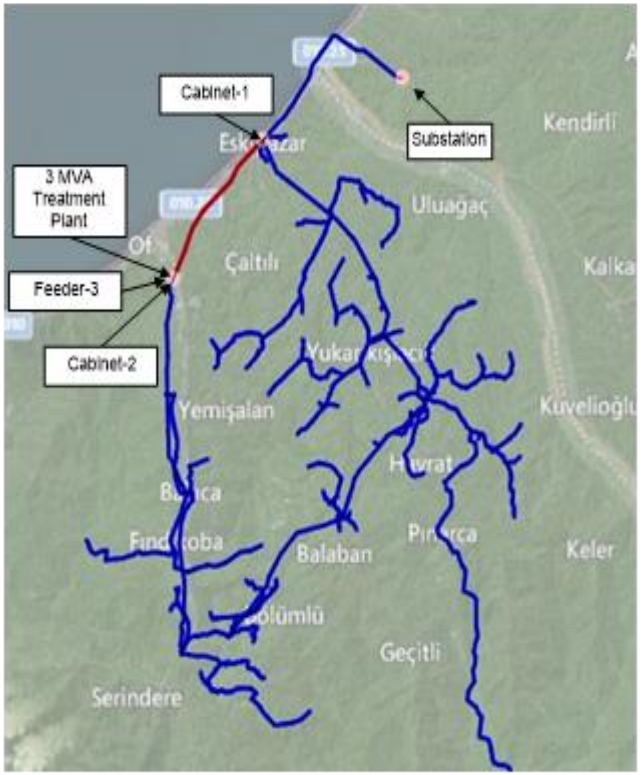


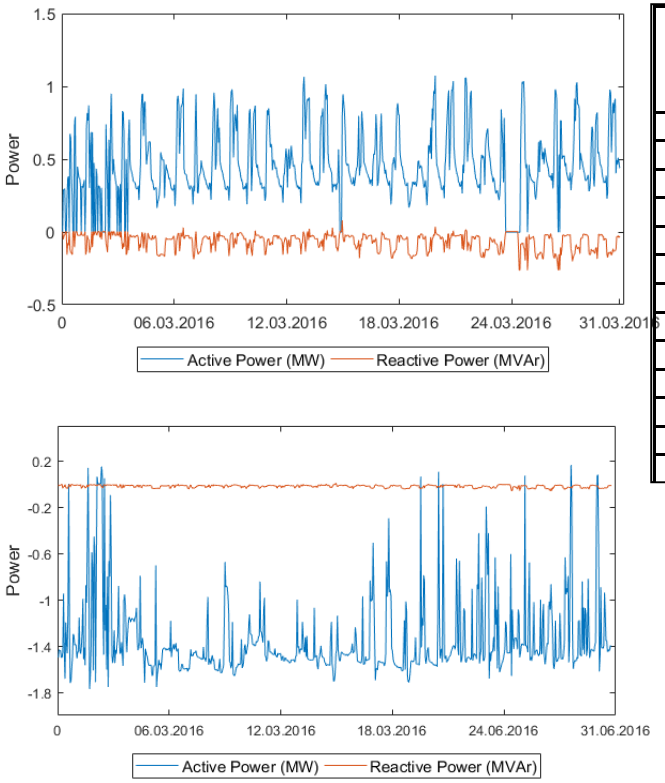






Network Analysis



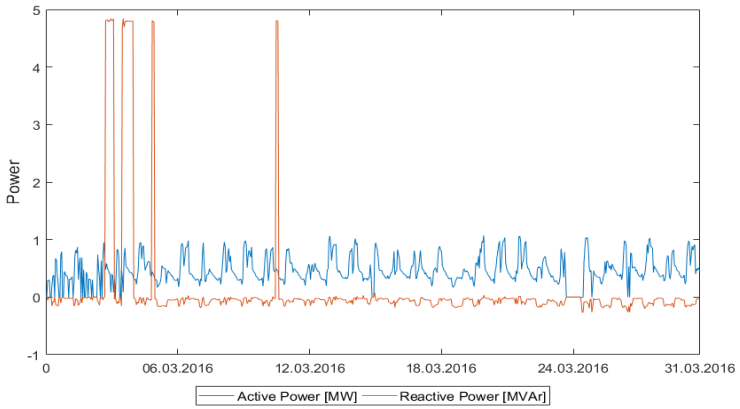


Date	Time	Present Feeder Current (A)	Current Value to Prevent Icing (A)
3.3.2016	19:00-20:00	32.21	42.91
3.3.2016	20:00-21:00	12.22	47.31
3.3.2016	21:00-22:00	14.71	61.54
3.3.2016	22:00-23:00	1.82	69.84
3.3.2016	23:00-00:00	11.63	83.93
4.3.2016	00:00-01:00	27.23	81.58
4.3.2016	01:00-02:00	28.39	79.16
4.3.2016	02:00-03:00	27.23	79.16
4.3.2016	20:00-21:00	26.71	80.58
4.3.2016	21:00-22:00	23.74	87.74
11.3.2016	21:00-22:00	25.42	76.95
11.3.2016	22:00-23:00	25.54	78.88
11.3.2016	23:00-00:00	25.42	82.69

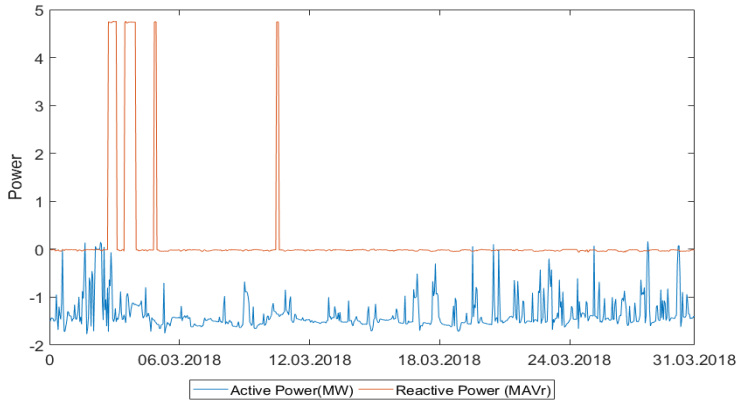
Reactor Sizing

Network Analysis (Operating Reactor)

Active and Reactive Power Values of Feeder-1 (Case-1)



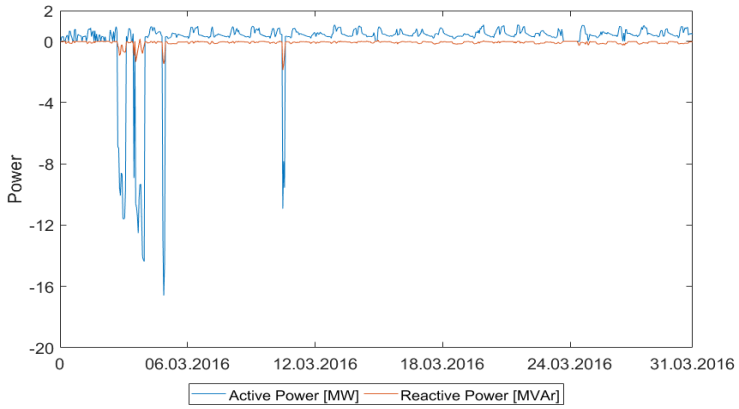
Active and reactive power values for Cabinet-2 incoming feeder (Case-1)



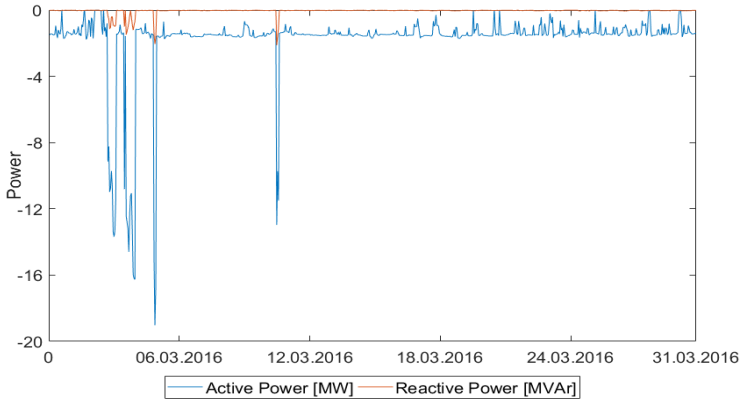
Date	Time	Present Feeder Current (A)	Current Value to Prevent Icing (A)	Case-1 Feeder Current (A)
3.3.2016	19:00-20:00	32.21	42.91	92.68
3.3.2016	20:00-21:00	12.22	47.31	87.62
3.3.2016	21:00-22:00	14.71	61.54	88.05
3.3.2016	22:00-23:00	1.82	69.84	86.69
3.3.2016	23:00-00:00	11.63	83.93	87.53
4.3.2016	00:00-01:00	27.23	81.58	91.06
4.3.2016	01:00-02:00	28.39	79.16	91.61
4.3.2016	02:00-03:00	27.23	79.16	91.06
4.3.2016	20:00-21:00	26.71	80.58	90.82
4.3.2016	21:00-22:00	23.74	87.74	89.99
11.3.2016	21:00-22:00	25.42	76.95	90.49
11.3.2016	22:00-23:00	25.54	78.88	90.53
11.3.2016	23:00-00:00	25.42	82.69	90.45

Network Analysis (Feeder-3 Shifting)

Active and Reactive Power Values of Feeder-1 (Case-2)



Active and reactive power values for Cabinet-2 incoming feeder (Case-2)



Date	Time	Present Feeder Current (A)	Current Value to Prevent Icing (A)	Case-1 Feeder Current (A)	Case-2 Feeder Current (A)
3.3.2016	19:00-20:00	32.21	42.91	92.68	167.96
3.3.2016	20:00-21:00	12.22	47.31	87.62	151.42
3.3.2016	21:00-22:00	14.71	61.54	88.05	202.39
3.3.2016	22:00-23:00	1.82	69.84	86.69	198.39
3.3.2016	23:00-00:00	11.63	83.93	87.53	178.45
4.3.2016	00:00-01:00	27.23	81.58	91.06	196.01
4.3.2016	01:00-02:00	28.39	79.16	91.61	246.15
4.3.2016	02:00-03:00	27.23	79.16	91.06	251.68
4.3.2016	20:00-21:00	26.71	80.58	90.82	225.54
4.3.2016	21:00-22:00	23.74	87.74	89.99	205.61
11.3.2016	21:00-22:00	25.42	76.95	90.49	241.12
11.3.2016	22:00-23:00	25.54	78.88	90.53	181.06
11.3.2016	23:00-00:00	25.42	82.69	90.45	211.93

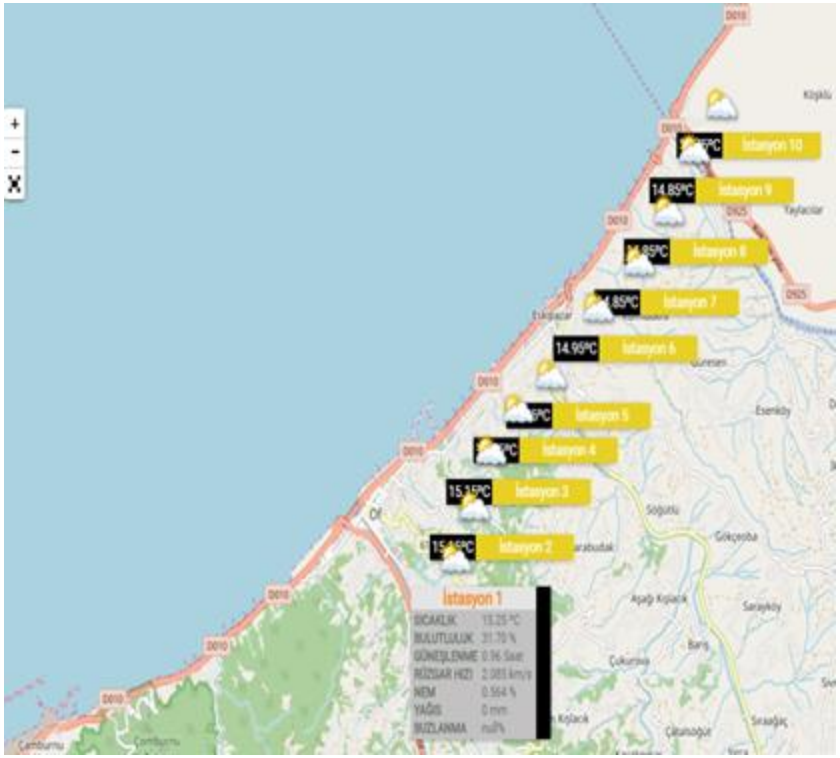
Meteorologic Observation Station

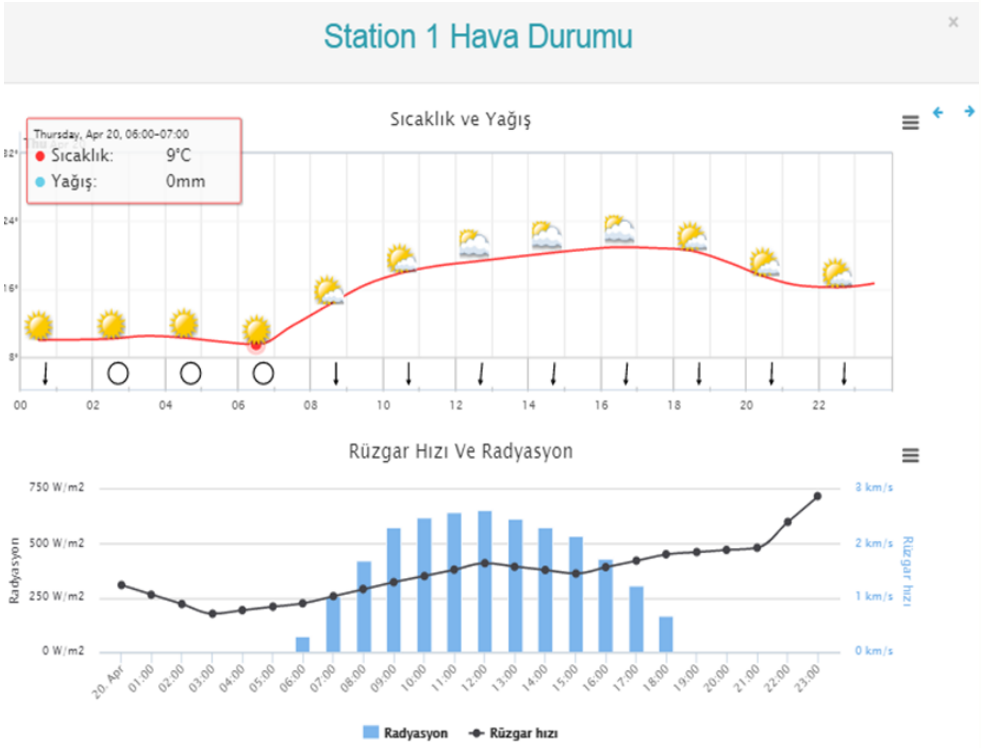




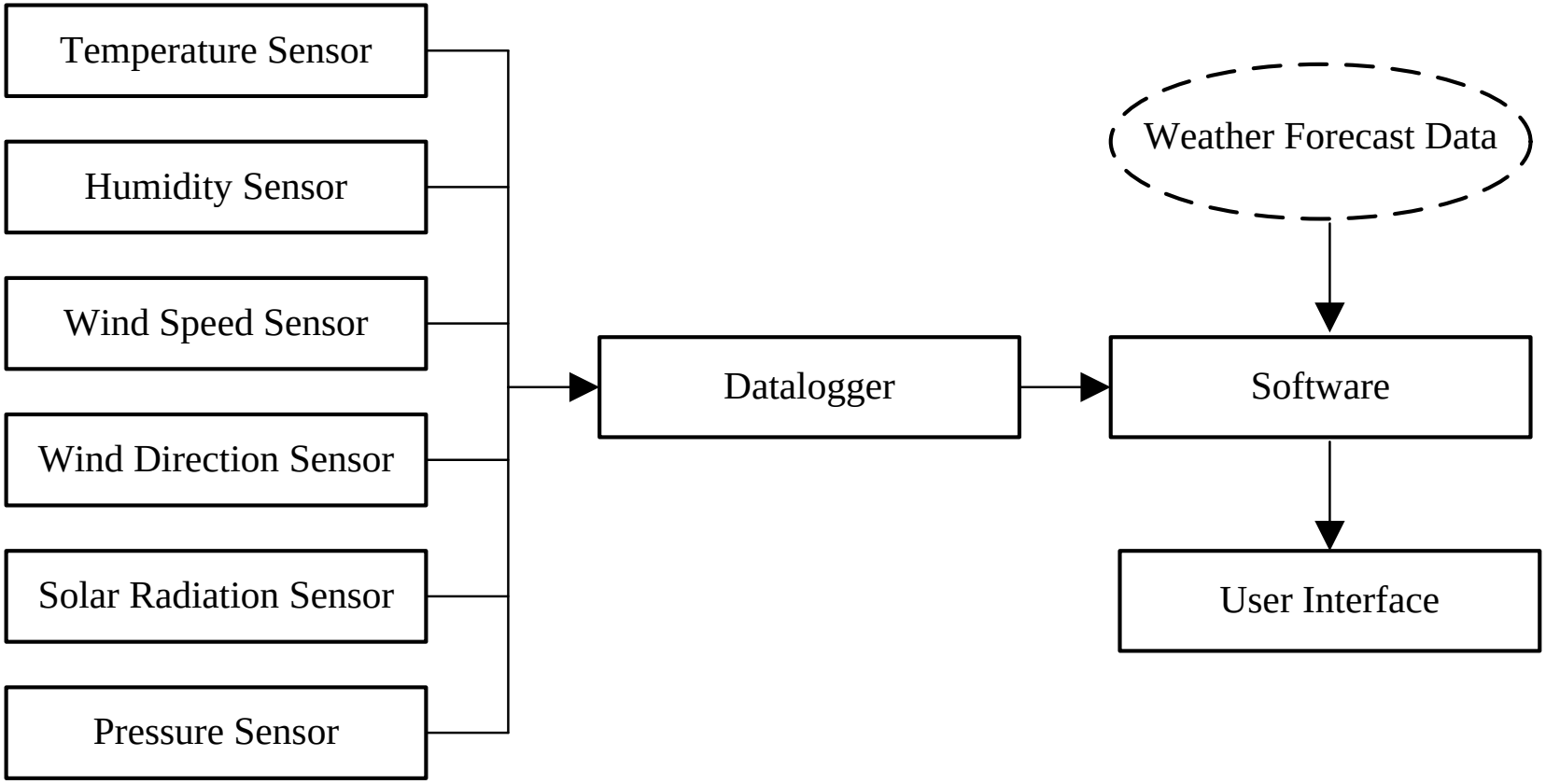


Meteorologic Forecast Data

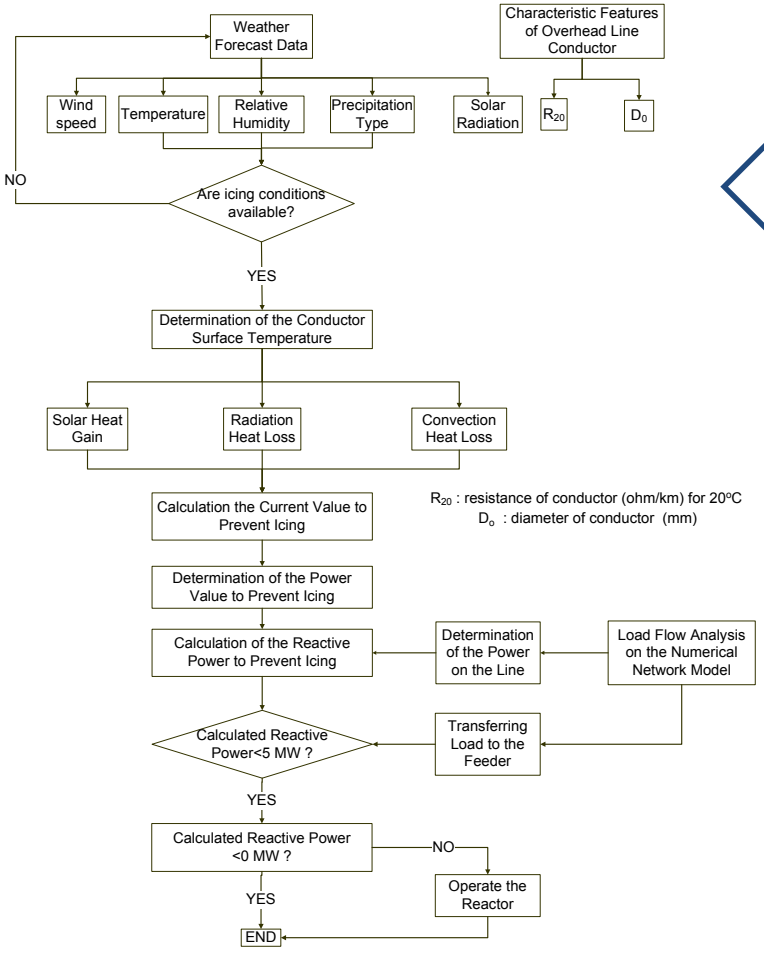




Structure

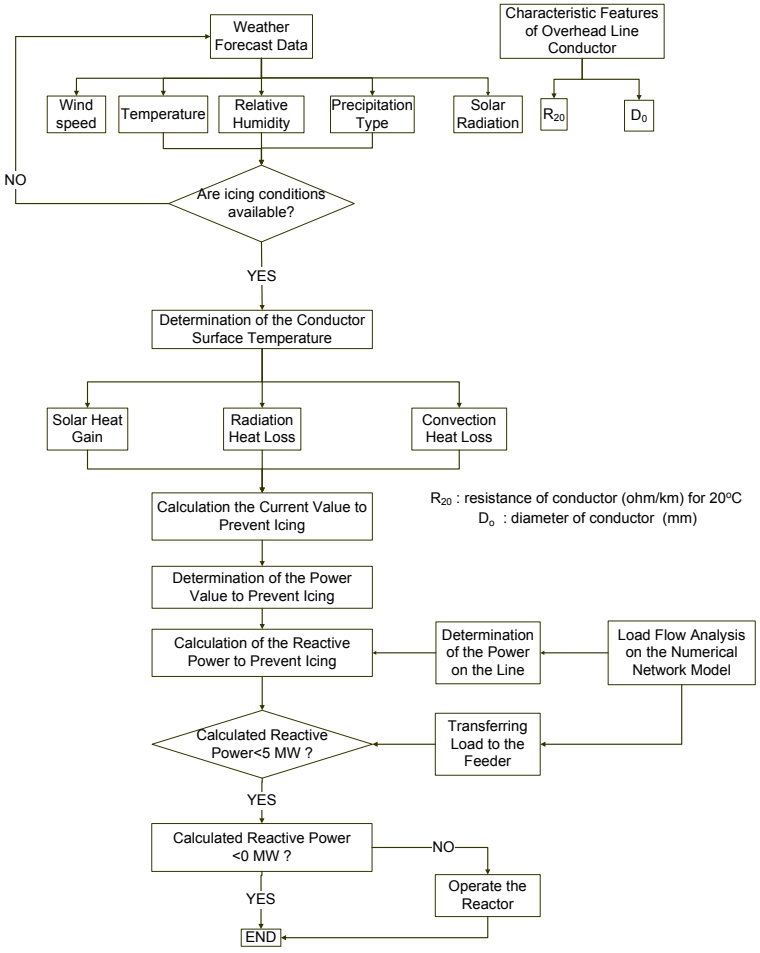

Temperature Sensor
Humidity Sensor
Wind Speed Sensor
Wind Direction Sensor
Solar Radiation Sensor
Pressure Sensor
Datalogger
Weather Forecast Data
Software
User Interface

Background Algorithm



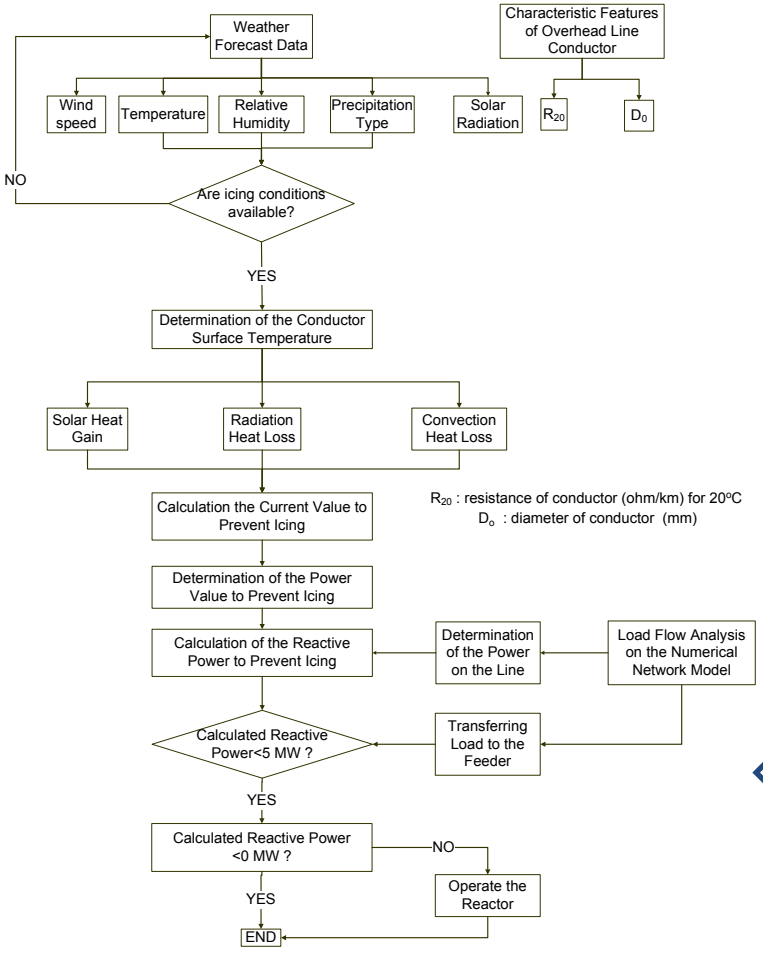
- **Meteorological Forecast Data**
- **Characteristic Features of Overhead Line Conductor**
- **Current Value**

Background Algorithm



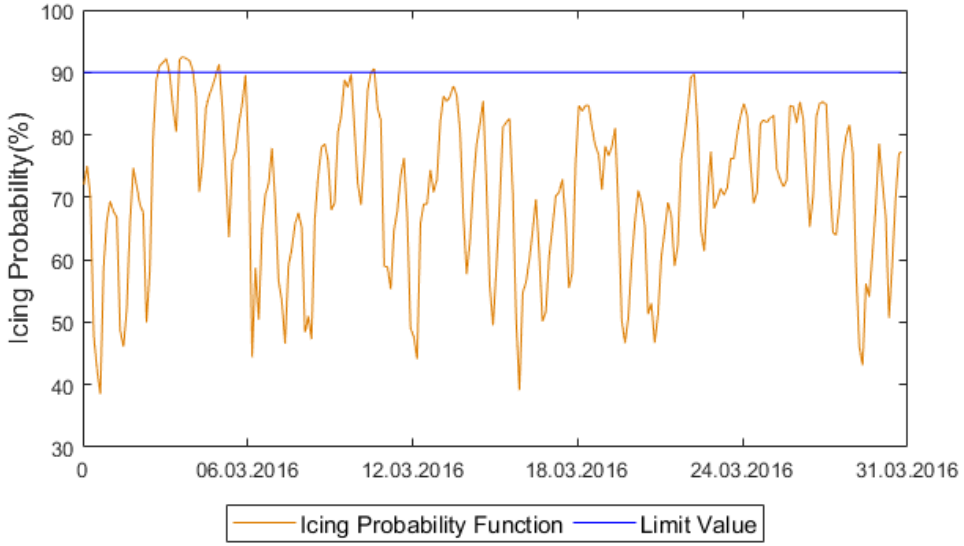
Required current values carried on the conductor are calculated to prevent icing with the developed algorithm

Background Algorithm

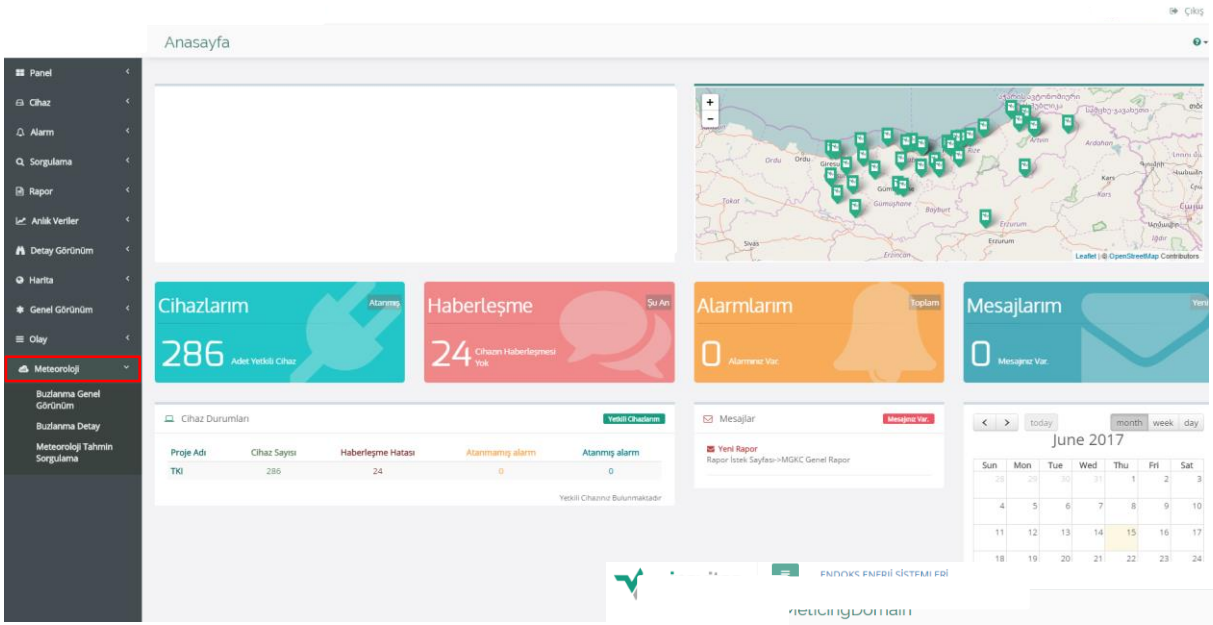


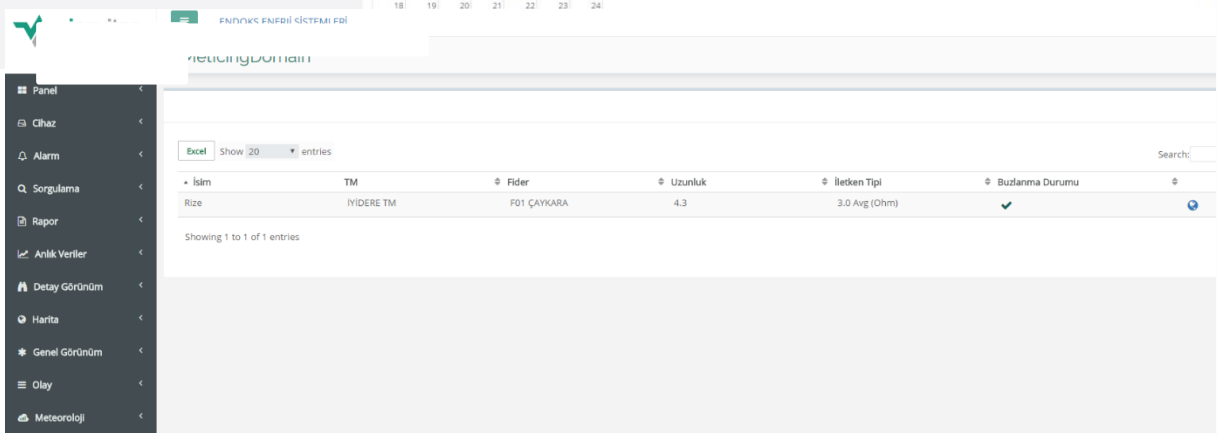
- **Current value < Prevent icing event for reqıired current**
- **Operating Reactor and Shifting Feeder**

Output of Algorithm



Developed Software





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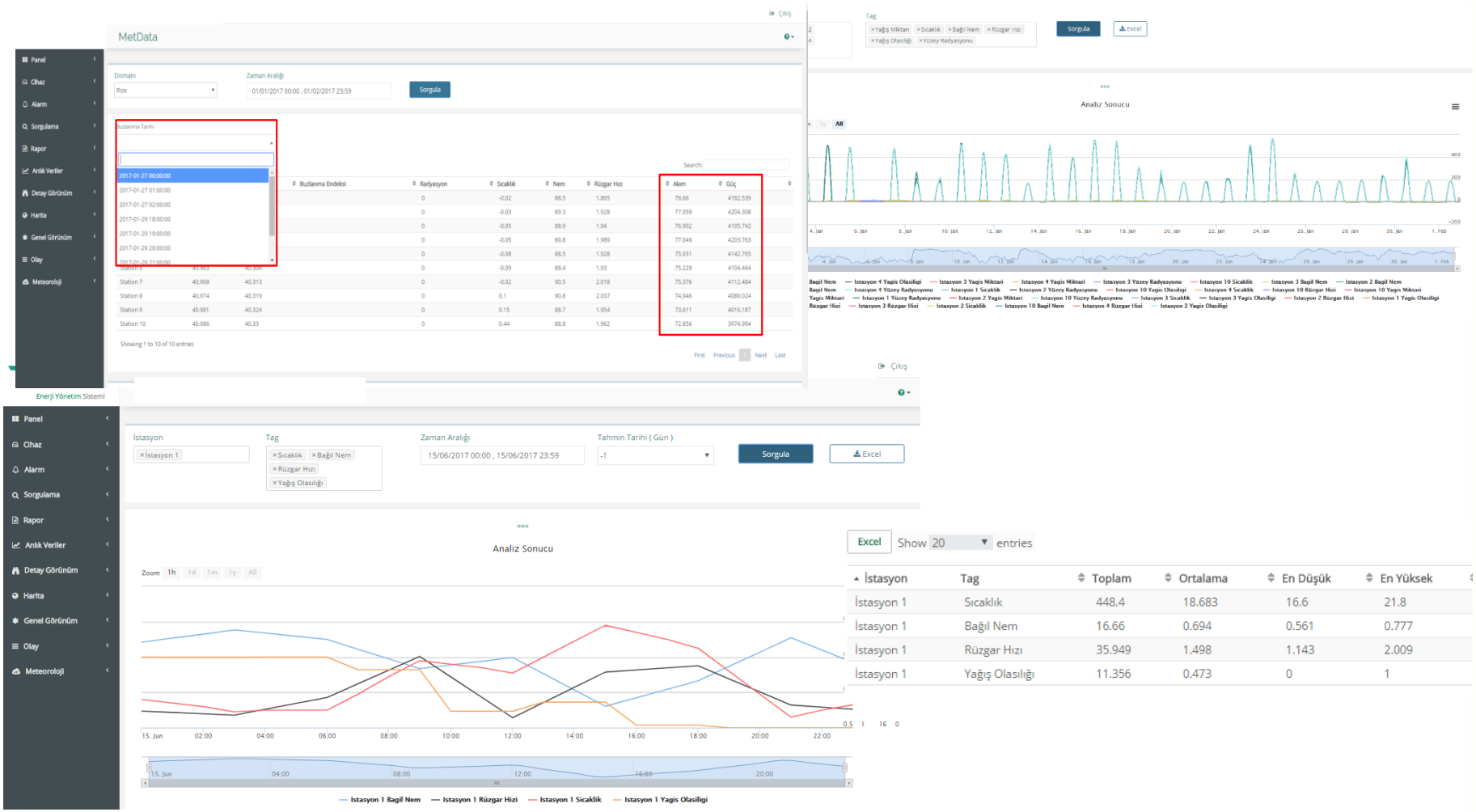

We are gratefully acknowledge **EPDK (Republic of Turkey Energy Market Regulatory Authority)** and **ÇORUH EDAŞ** for their support.

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