

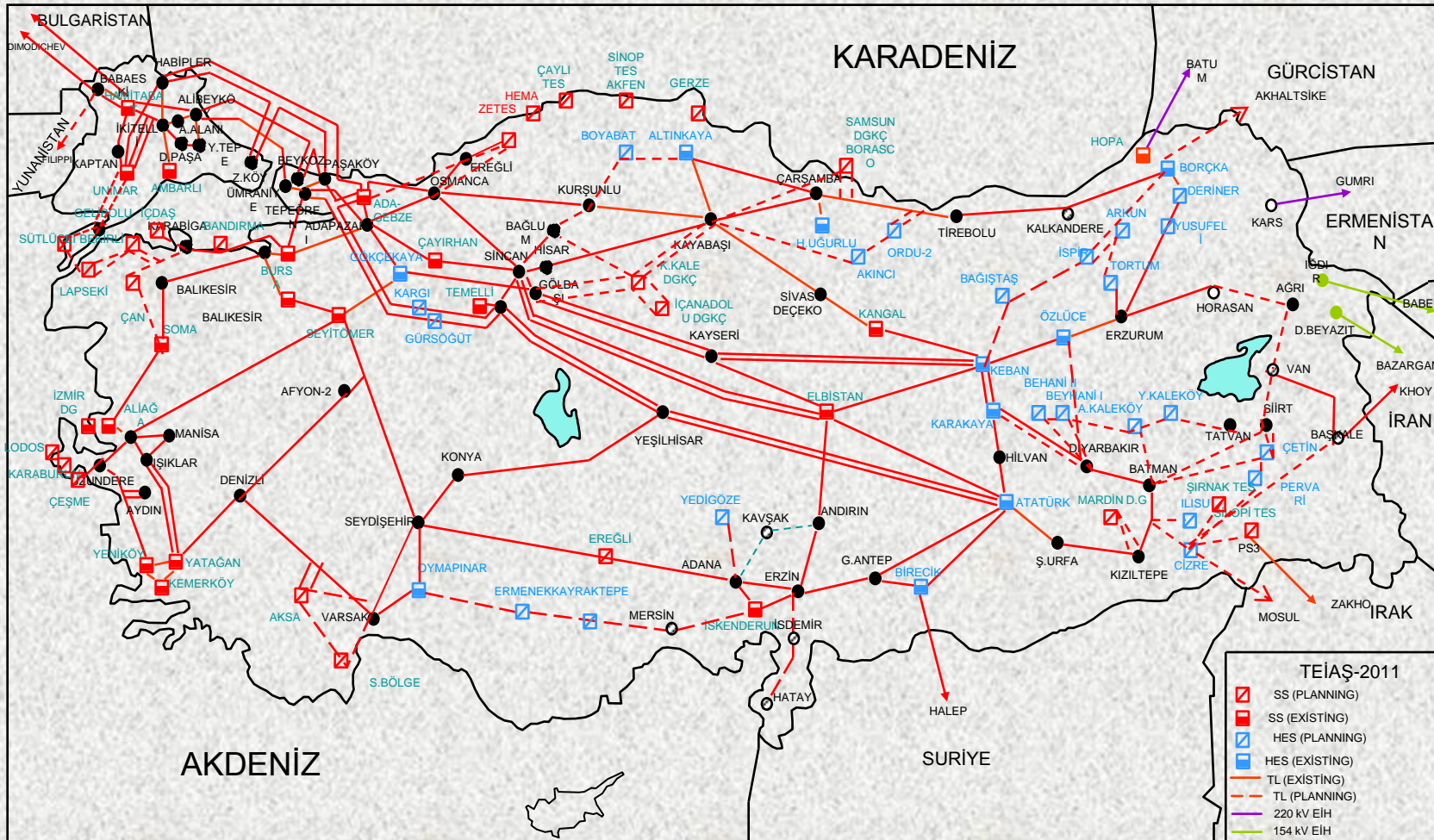


GRID ACCESS AND INTEGRATION OF RENEWABLE ENERGY RESOURCES (RES)

TURKISH ELECTRICITY TRANSMISSION
CORPORATION
(TEİAŞ)



400 kV Network





- NUMBER OF SUBSTATIONS

- 400 kV	78
- 220 kV	2
- 154 kV	520
- 66 kV	14
TOTAL:	614 (103.100 MVA)

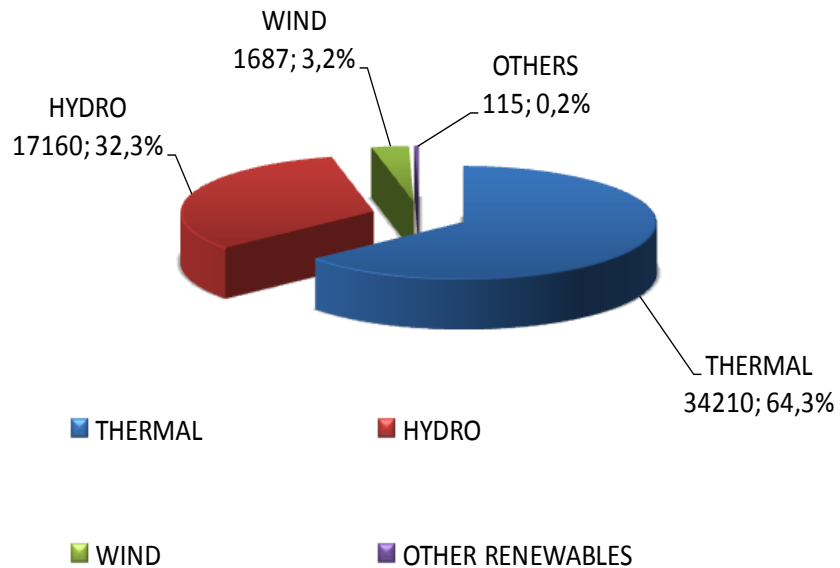
LENGTH OF TRANSMISSION LINES

- 400 kV	15830 km
- 154 kV	32513 km
- 220 kV	85 km
- 66 kV	508 km
- 154 kV and 400 kV cable length	220 km
- TOTAL	49159 km



INSTALLED CAPACITY & PEAK LOAD

INSTALLED CAPACITY (DECEMBER 2011)



Installed Capacity : 53.235
MW

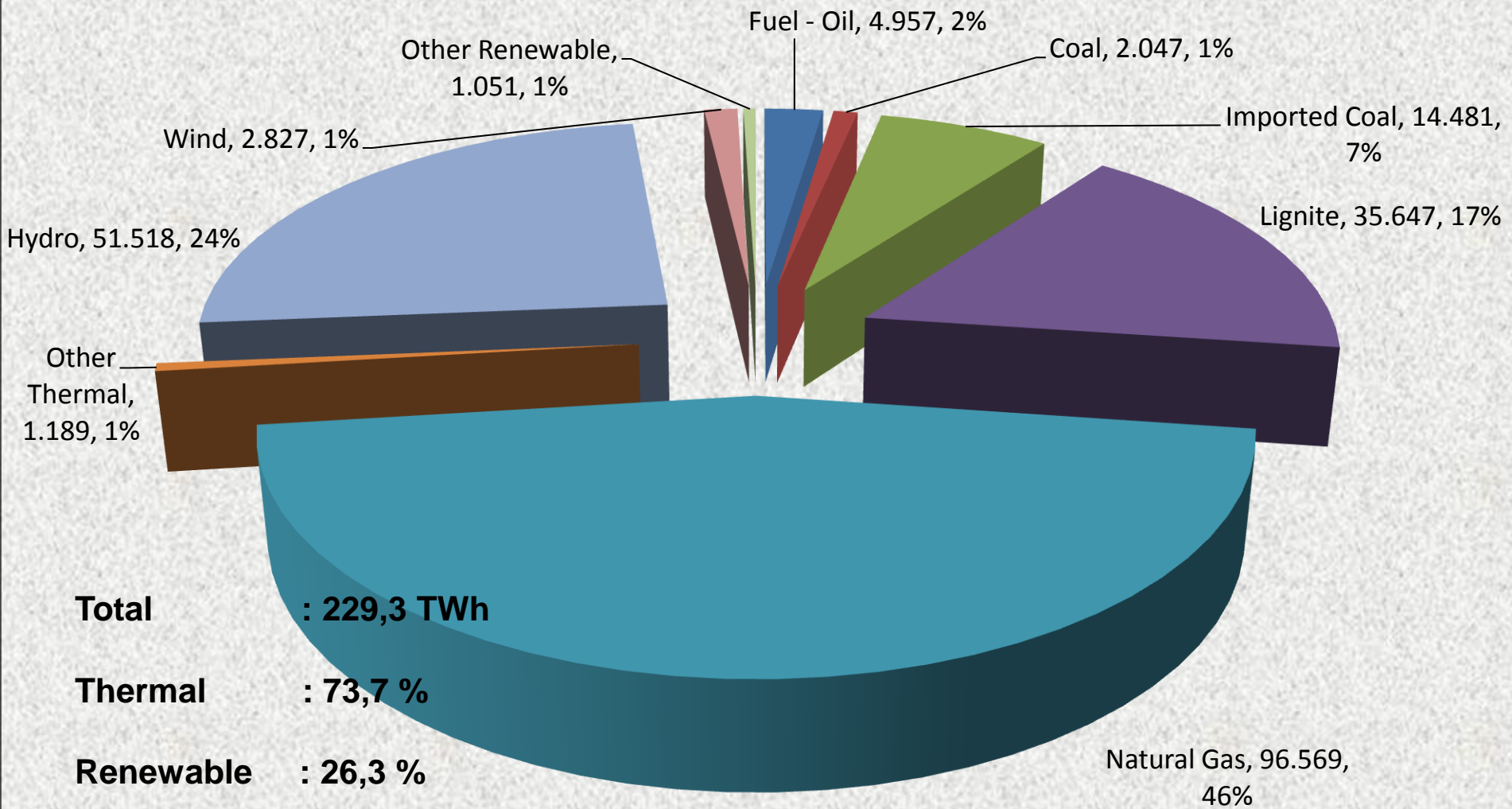
Renewable(hydro,wind,geo.) : 36 %
Thermal : 64 %

Peak Load (2010) : 33.392
MW

Peak Load (2011 July) : 36.122
MW



GENERATION FOR 2011

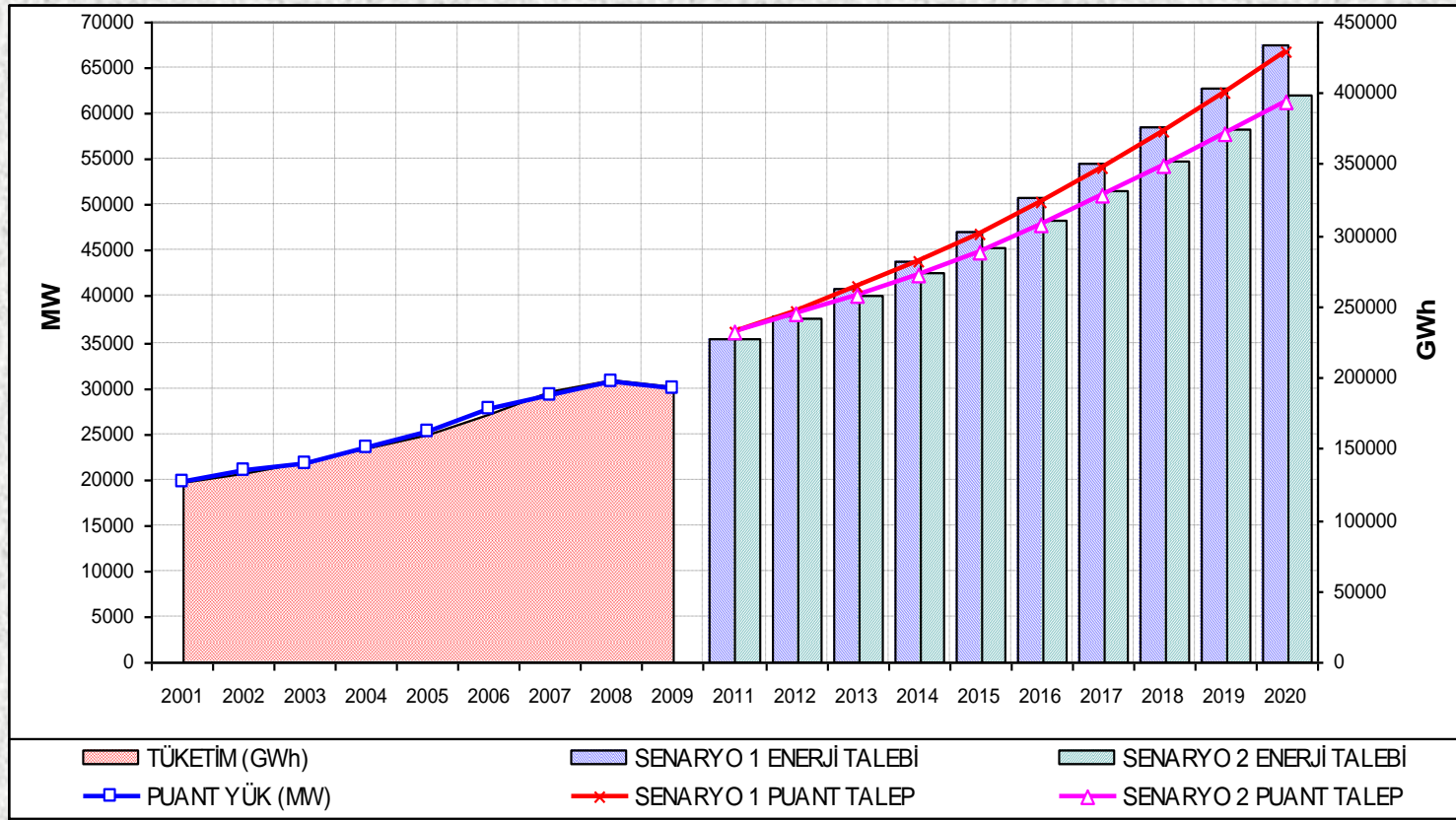




	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Consumption (TWh)	114,0	118,5	128,3	126,9	132,6	141,2	150,0	160,8	174,6	190,0	198,1	194,1	210,4	228
Increase (%)	8,1	3,9	8,3	-1,1	4,5	6,5	6,3	7,2	8,6	8,8	4,3	-2,0	8,4	9,0



PEAK LOAD AND ELECTRICITY CONSUMPTION 2001-2020



In the Generation Capacity Projection study covering between years 2010 and 2020,

- Peak Demand 66,845 MW (high scenario)
 61,340 MW (low scenario)
- Installed Capacity 66,407 MW (high scenario)
 64,593 MW (low scenario)

The installed capacity reserve is enough until 2019 but in order to not to face with energy deficit; after 2016 new generation additions are needed.



POWER PLANTS CONNECTION REQUESTS(December 2011)

POWER PLANTS CONNECTION REQUESTS	HPP	WPP	TPP		TOTAL
			NGCCP	Other	
CAPACITY APPROVED BY TEİAŞ	4.741	2.528	24.250	7.838	39.357
CAPACITY HAS BEEN LICENCED BY EMRA	10.114	5.066	5.765	2.715	23.660
CAPACITY HAS CONNECTION AGREEMENT BY TEİAŞ	6.473	3.464	5.715	6.391	28.267
TOTAL	21.328	11.058	35.730	16.944	85.060

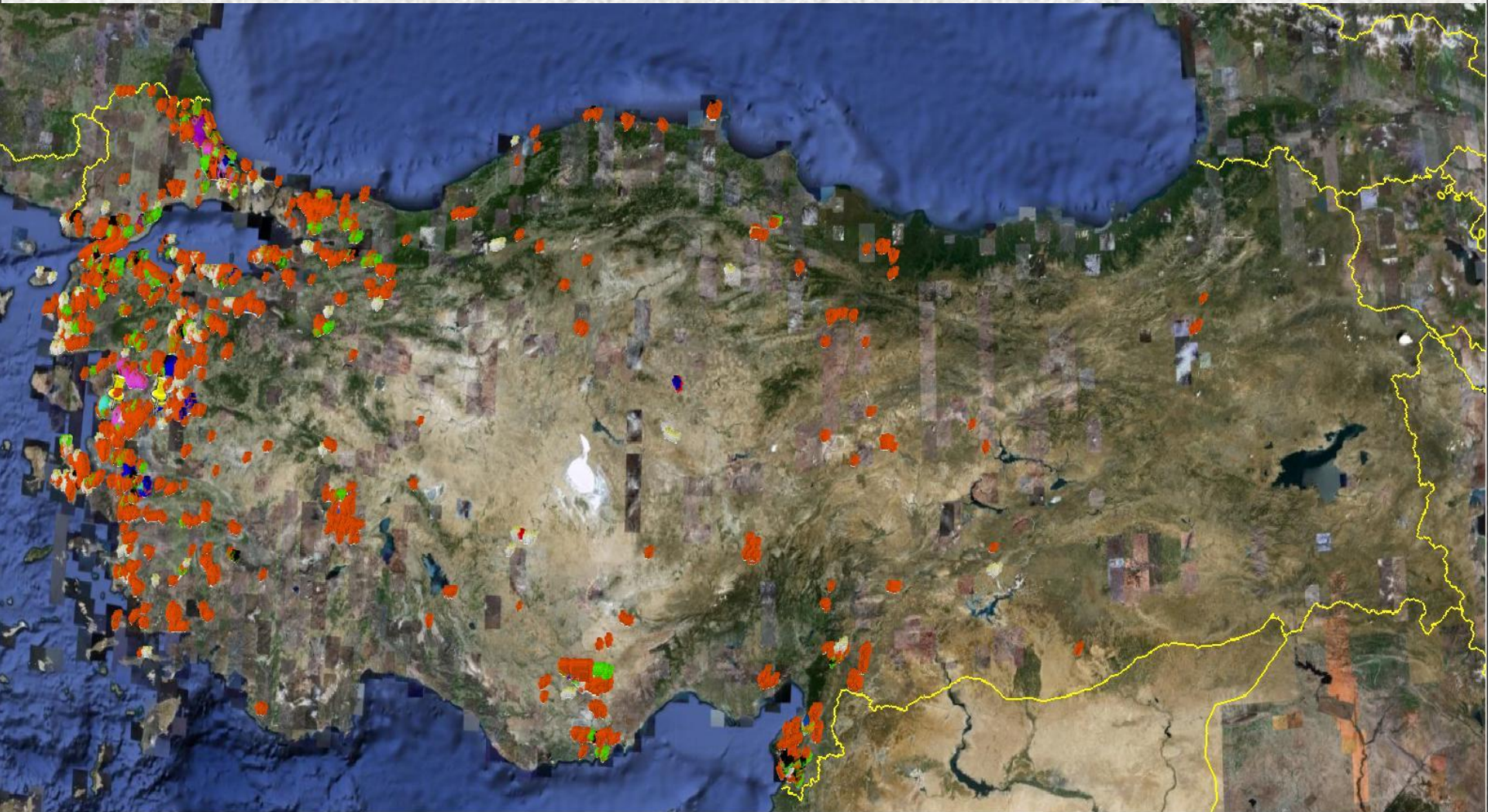


- Brief history of interconnection queue
- Wind Planning and Integration to Grid Process by TEİAŞ
- Main Challenges while planning
- Queue Management
- Recent Situation for Wind Generation in Turkey
- Regulations related with renewables
- Tariff Policy
- Solar Energy
- Hydro Generation
- Effects of ENTSO-E interconnection to the penetration of wind power plants in Turkish Power System
- Future Efforts
- Wind Power Monitoring and Forecast



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Wind Power Plants





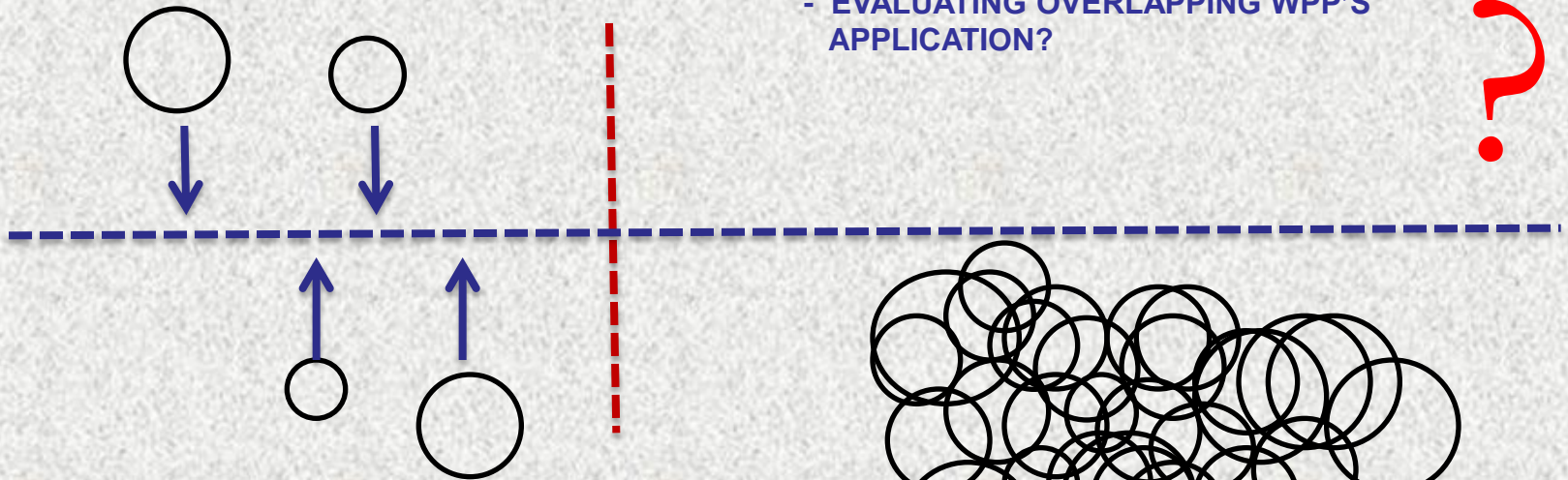
Brief History of Interconnection Queue

- TOTAL AVAILABLE WIND POWER CAPACITY
CAN BE CONNECTED TO THE GRID?

- EVALUATING OVERLAPPING WPP'S
APPLICATION?



1 NOVEMBER 2007



**SINGULAR APPLICATIONS
AND LICENCE – CONNECTION TO THE GRID
3500 MW CAPACITY ALLOCATED**

First WPP commissioned in: 1998
The WPP's in operation are: 1687 MW
Current Licensed wind generation: 5066 MW
Date: 1th November 2007 (new process started)
Number of the wind pp's: 722
Total capacity: 78.000 MW

**TOTAL OVERLAPPING
APPLICATIONS 78.000 MW**



WPP PLANNING AND INTEGRATION PROCESS TO THE GRID

- Turkish Electricity Transmission Corporation responsible from the WPP integration studies and to define the available capacity for connecting wind generation
- According to the results of load flow, contingency analyses and short circuit power calculations, the estimation for capacity for each substation and each region which will be available for connecting wind generation are defined by TEİAŞ
- Concentrated small wind generations in one region are collected in one substation (example: Çeşme Region)
- We have a specific grid code which defines the connection criteria for wind generation but it will be revised for future power system conditions.



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ÇEŞME REGION WIND PROJECTS: 460 MW

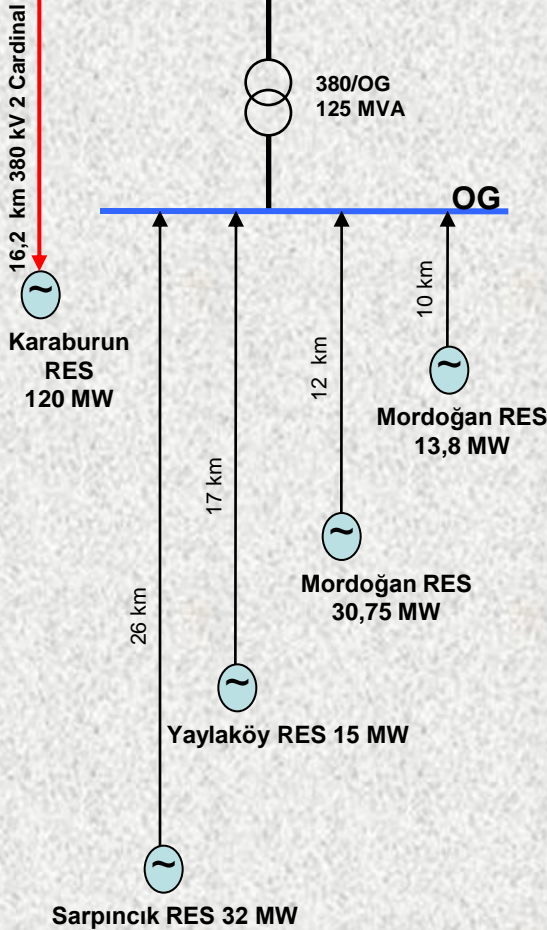
21 km 380 kV 3 Cardinal

21 km 380 kV 3 Cardinal

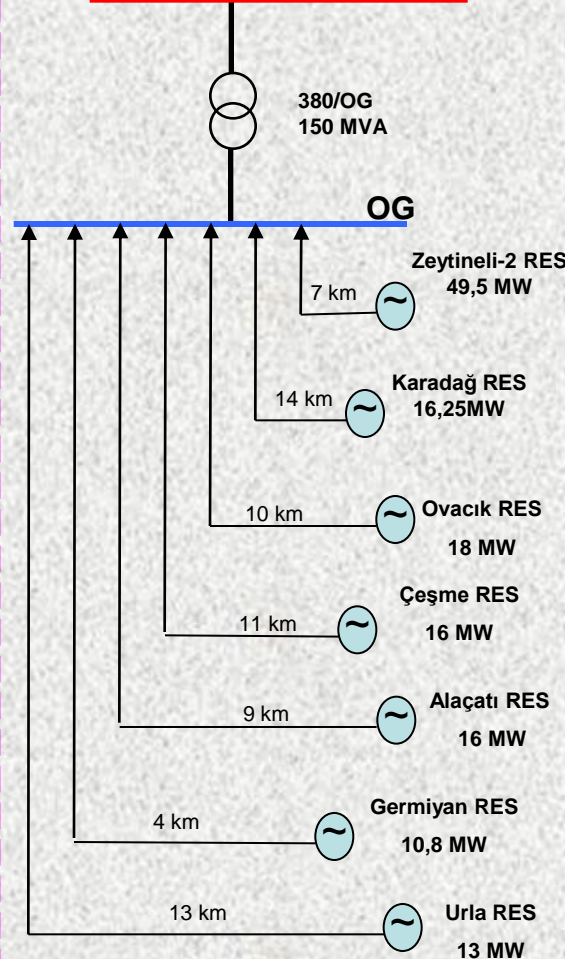
380/OG kV
Karaburun SS

380/OG Çeşme
HAVZA SS

380/154 kV
Uzundere SS

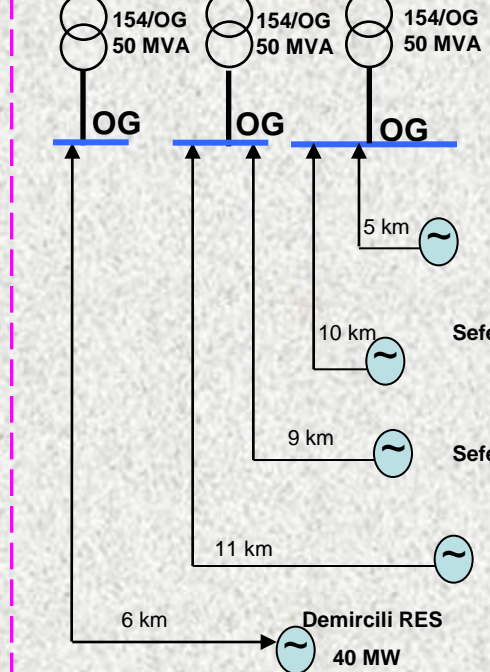


SS TOTAL CAP: 211,55 MW



SS TOTAL CAP: 139,55 MW

154/OG URLA
HAVZA SS



SS TOTAL CAP: 109 MW



WPP PLANNING AND INTEGRATION PROCESS TO THE GRID

AVAILABLE WIND POWER CAPACITY CAN BE CONNECTED TO THE BUSBARS?

According to the Transmission System Supply Reliability And Quality Regulation in the third section Generation Connection Principles - Design Principles of Generation Facility Switchyards defined that “Connection of generation facility based on wind energy is permitted for a capacity up to 5 % of the system short circuit power at the connection point ”

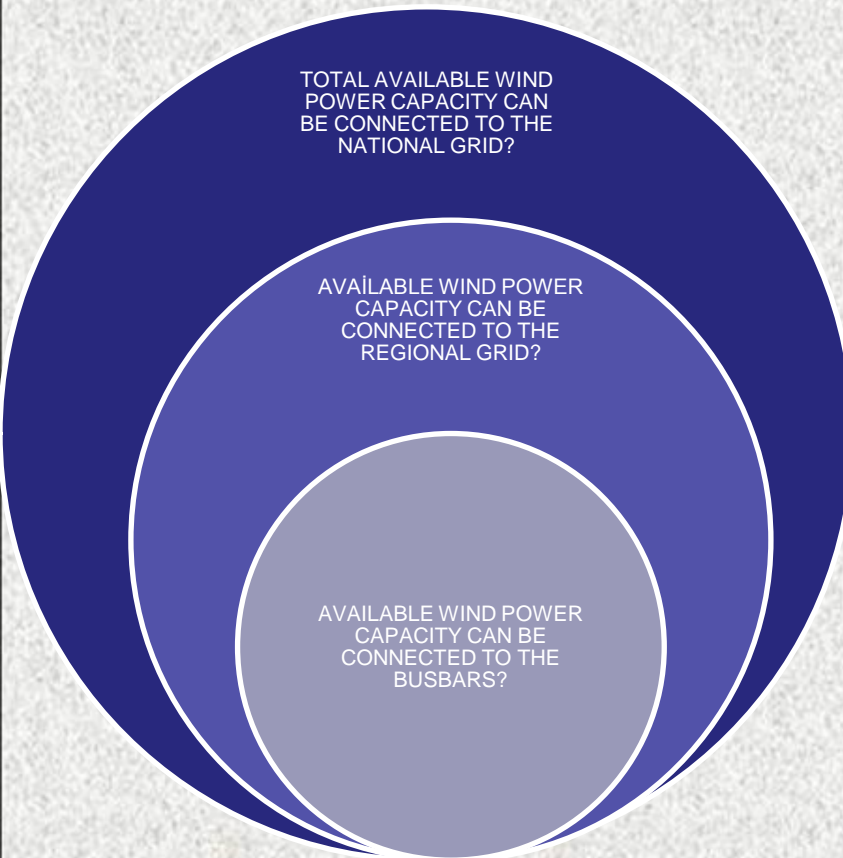
For example, A substation, minimum 3 ϕ Short Circuit Power is
 $S_k = 3000 \text{ MVA}$
Available wind power capacity for this busbar is
 $3000 \times 5 / 100 = 150 \text{ MW}$

- New regulation which will be published in the near future, IEC 61400 standards are applied to determine available wind power capacity



WPP PLANNING AND INTEGRATION PROCESS TO THE GRID

TOTAL AVAILABLE WIND POWER CAPACITY CAN BE CONNECTED TO THE GRID?



THE FACTORS
THAT LIMIT THE
CAPACITY OF THE
AVAILABLE WPP
CONNECTION TO
THE NATIONAL
GRID

- GENERATION-CONSUMPTION BALANCE
- FREQUENCY RESERVE

THE FACTORS
THAT LIMIT THE
CAPACITY OF THE
AVAILABLE WPP
CONNECTION TO
THE REGIONAL
GRID

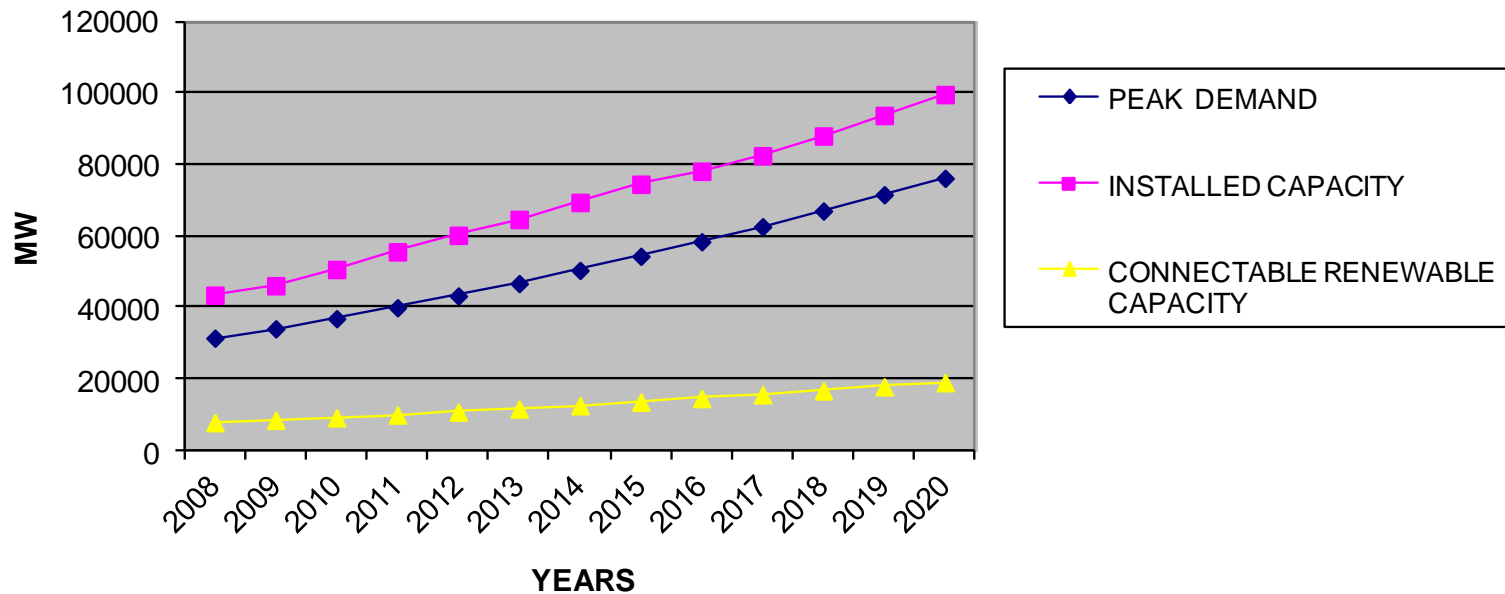
- VARIATIONS OF POWER FLOW
- REGIONAL ENERGY QUALITY
- ADDITIONAL INVESTMENTS

FACTORS THAT
LIMIT THE
CAPACITY OF THE
AVAILABLE WPP
CONNECTION TO
THE BUSBARS

- ENERGY QUALITY
- SHORT CIRCUIT POWER ON MEDIUM VOLTAGE LEVEL



**INSTALLED CAPACITY AND PEAK LOAD OF TURKEY ACCORDING TO THE YEARS
AND AVAILABLE RENEWABLE CAPACITY CAN BE CONNECTED TO THE SYSTEM**

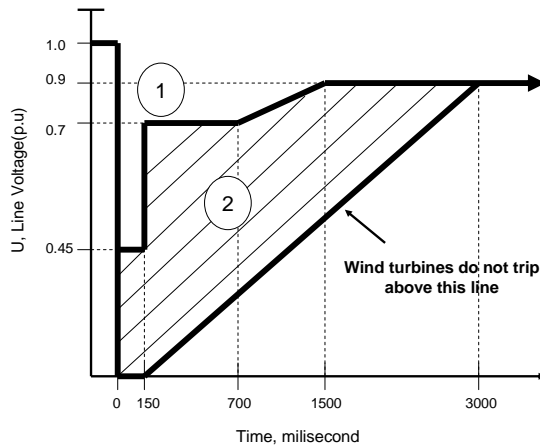




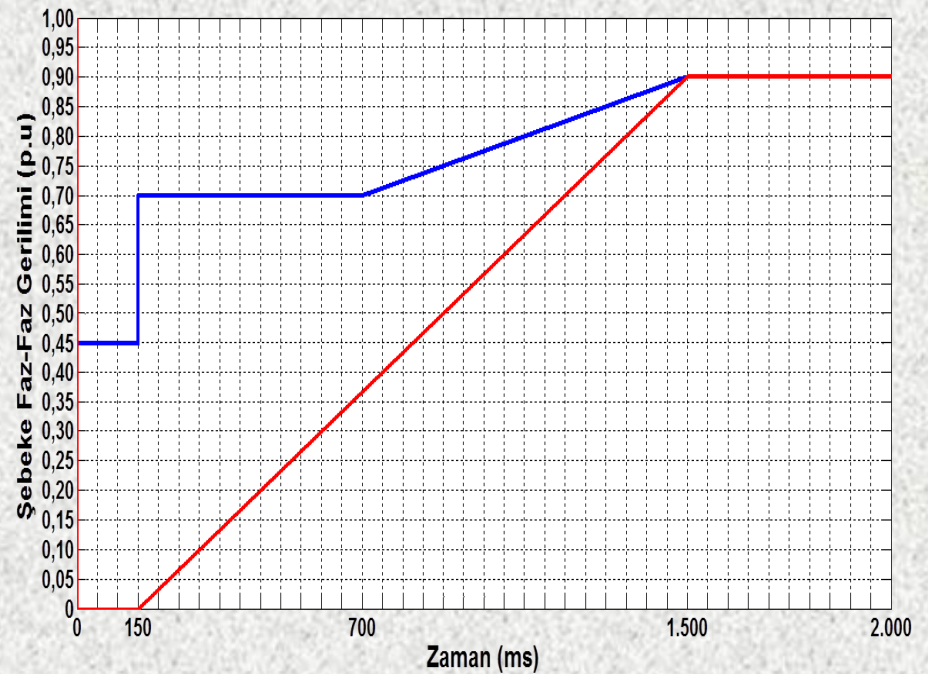
WPP INTEGRATION PROCESS TO THE GRID

FAULT RIDE THROUGH CAPABILITY of WPPS

Existed regulation Annex-18



New regulation for wind



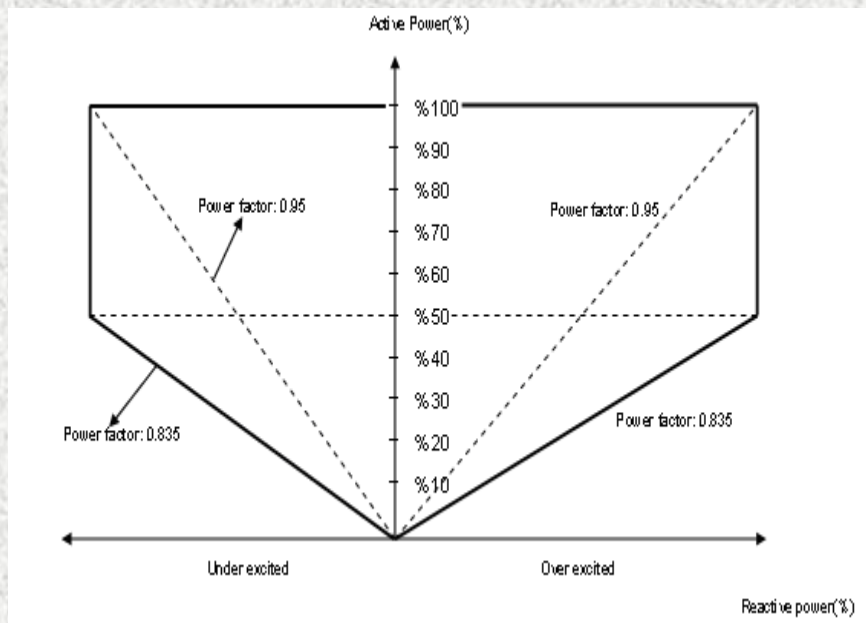
Taking into consideration the international applications and the power system requirements the new scheme is proposed which says that “The wind turbines will not give any reaction up to 10% of the grid voltage oscillations at the connection point to the grid. For the voltage oscillations more than this limit, for each 1% changes in nominal voltage, the reactive current support is required which is at least equal to 2% of the nominal current.. The reactive support should be realized in 20 millisecond and it should continue for 1.5 seconds.”



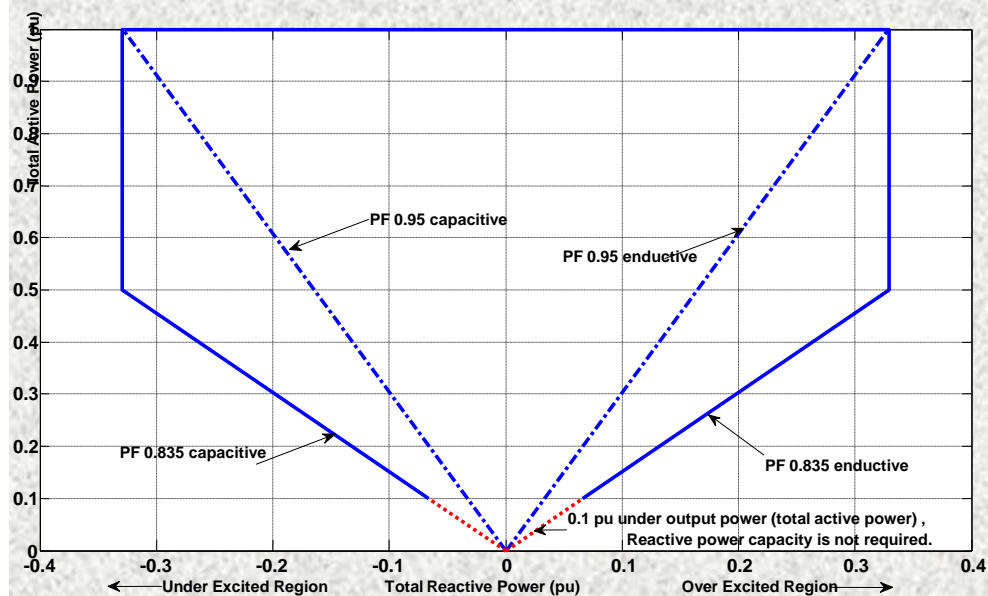
WPP INTEGRATION PROCESS TO THE GRID

REACTIVE POWER CAPABILITY

Existed regulation Annex-18



New regulation for wind



Taking into consideration the international applications and the power system requirements the new scheme is proposed which says that “At the connection point to the grid in the voltage limits between 0.95-1.05 pu, the wind power plants will be able to operate for the power factor values in the region defined with the bold lines.”



- Available system reserve
- The required reinforcements for connecting WPP's into power system.
- The difficulty to guess their production time of wind power plants.
- Who pays the investments and how it will be recovered
- Beside load flow, voltage profile, short-circuit and contingency studies; the %5 of the short circuit power of the substation which WPP will be connected is applied as a restriction criteria in order to keep the overall system security by now.
- Detailed dynamic studies for determining the connection capacities are going on.

- *Process:*

1. The available capacity of substations for connecting wind powerplants are published by TEİAS.
2. WPP applications are forwarded to TEİAS for studying connection opportunities.
3. TEİAS gives its comment concerning the availability. If the application is alone in the substation, EMRA gives license to those applications.
4. If there are multiple applications in one substation, bidding process is done by TEİAS to determine the owner of the capacity.
5. After taking license the investor sign a connection agreement with TEİAS.
6. Project will be approved by MENR. After the realization of the project System Usage Agreement will be signed by TEİAS.



QUEUE MANAGEMENT OF WIND POWER PLANTS

- According to the system available capacity for connecting wind generation which is equal to 8474 MW
- A bidding code was prepared by TEİAŞ which includes the requirements for the applications.
- According to the bidding document; the wind owner which will get the right to use the open capacity has to pay an amount to TEİAŞ for 20 years since connecting to the system which is equal to the amount which will be calculated for per kWh generation of the wind power plant.



- *Principle of connection cost sharing between TSO and investor:*

If the investor pays for the connection line then the TSO will pay back to the investor this amount in 10 years from the investment budget.

Otherwise, TSO will put the required investment for the connection of the power plant in it's yearly investment plan (will be approved by state planning organization) and these procedures takes approximately 3-5 years for bidding (plus constructing period)



Recent Situation for Wind Generation in Turkey

- 3500 MW of wind applications has been licensed by EMRA
- 1687 MW is in Operation
- 8474 MW capacity for bidding process
- The amount of the available wind generation capacity can be connected to the system until 2013 is 12000 MW
- In the strategy document it is foreseen that the total wind generation capacity will reach to 20.000 MW until 2023.
- Applications of 71 have capacity around 2246 MW are alone at the selected substations licensing process is going on for these applications.
- For the multiple applications, the bidding process has been finalized in September 2011 and WPP's with 5500 MW total capacity get right to connect to Turkish Power System.
- Number of Substations are 87
- Invited Companies are 596
- Winner Companies are 147





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Regulations related with renewables

The law (no:5346) for the “Utilization of Renewable Energy Sources for the Purpose of Generating Electricity” issued in 2005.

The Grid Code for the Wind Power Plants has been prepared by TEİAŞ and approved by EMRA. The studies for revising the the grid code for wind power plants are going on.

It is officialy announced on 22 February 2012 that the wind measures taken for 1 year duration are required for the new applications to EMRA. This is also required for the solar generation.

Wind Enery Potential Atlas is ready (<http://repa.eie.gov.tr>)



INCENTIVES FOR RENEWABLE POWER PLANTS

The Turkey's Parliament approved a new law 29 December 2010, Wednesday on regulating the renewable energy resources market in Turkey. The incentives which are applied for Renewable Power Plants with the new law guarantees a price of:

- 7.3 US cents per kWh for wind energy and hydroelectric power,
- 10.5 US cents for geothermal energy and
- 13.3 US cents for energy from waste products and solar energy
- These prices will cover energy firms that are established between May 13, 2005 and Dec. 31, 2015.
- For energy purchases from companies founded later than Dec. 31, 2015, new prices defined by the Cabinet will be implemented. The prices for the new companies will not exceed the current figures, the law said.
- In the event that operators use local equipment and technology in renewables energy facilities, an additional support of 0.4 cents to 2.4 \$ per kw will be provided for a five year term to companies that started producing energy before the end of 2015.
- The surplus generation from the renewables will be bought by the distribution companies for ten years guarantee with the defined energy prices.
- The law limits the total production of licensed solar energy with 600 MW until the year of 31 December 2013 and authorizes the cabinet to determine the limits afterwards.





Connection points for Solar Power Plants

The available capacity for the connection of Solar Power plants which has total capacity around 600 MW was announced by the MENR with the inputs from TEİAŞ according to regions.

Regions	Number of substations	CAPACITY(MW)
1 KONYA	8	46
2 KONYA	5	46
3 VAN AĞRI	5	77
4 ANTALYA	6	29
5 ANTALYA	8	29
6 KARAMAN	3	38
7 MERSİN	7	35
8 KAHRAMAN MARAŞ ADİYAMAN	9	27
9 BURDUR	3	26
10 NİĞDE NEVŞEHİR AKSARAY	4	26
11 KAYSERİ	6	25
12 MALATYA ADİYAMAN	6	22

Regions	Number of substations	CAPACITY(MW)
13 HAKKARİ	2	21
14 MUĞLA AYDIN	8	20
15 ISPARTA AFYON	7	18
16 DENİZLİ	3	18
17 BİTLİS	2	16
18 BİNGÖL TUNCELİ	4	11
19 ŞİRNAK	3	11
20 ADANA OSMANIYE	4	9
21 MUŞ	1	9
22 SIİRT BATMAN MARDİN	5	9
23 SİVAS	1	9
24 ELAZIĞ	5	8
25 ŞANLIURFA DIYARBAKIR	1	7
26 ERZURUM	3	5
27 ERZİNCAN	2	3
TOTAL	121	600

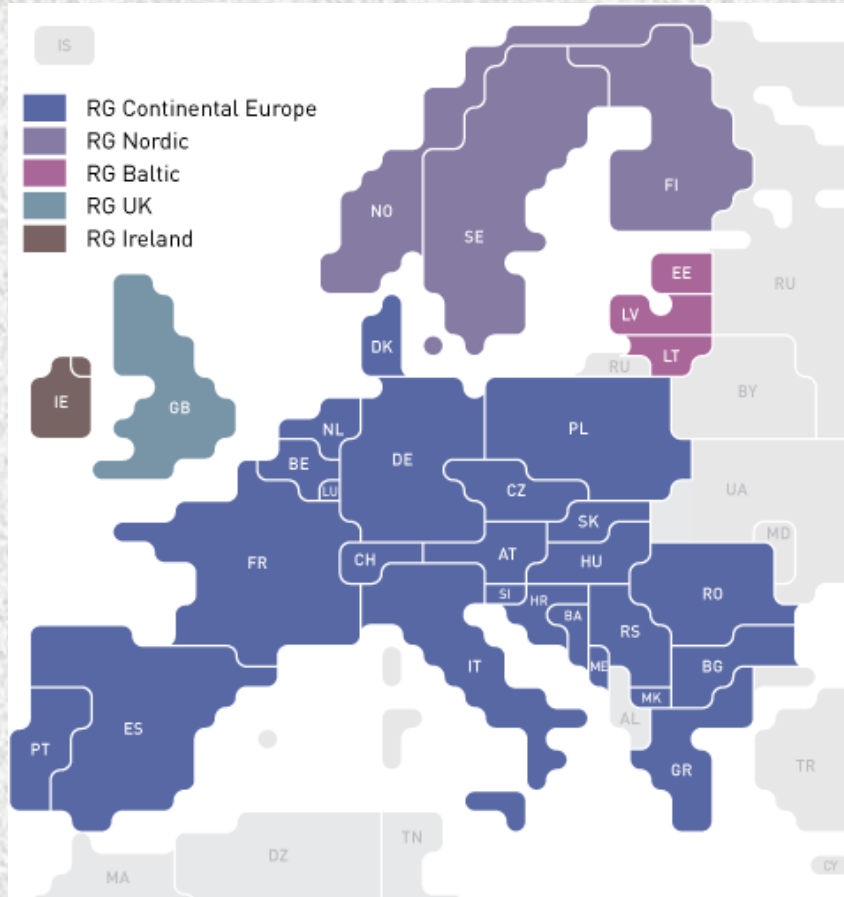
*While making applications for the available capacities, the most nearest substation will be chosen as a connection point to the power system according to the regulations



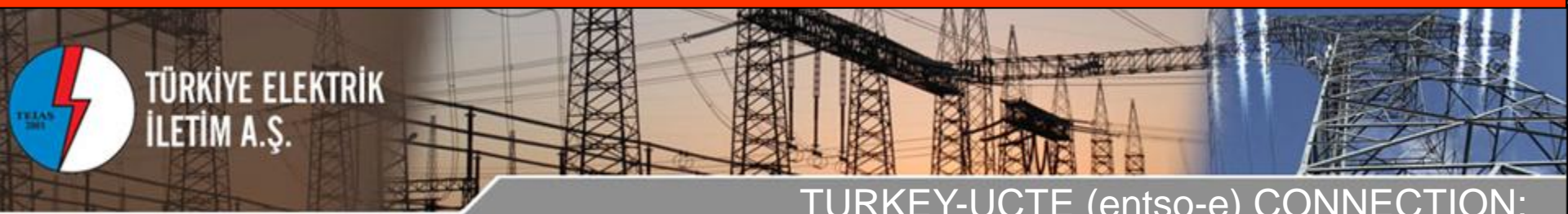
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Hydraulic Power Plants Capacities in North East Region (In Operation &Planned)





- Trial Run period started with ENTSO-E on 18th of September 2010.
- The **first phase** system stability tests approved by ENTSO-E Planary Group on 8th of February.
- Without any trade Import-Export tests for the **second phase** found successfull by ENTSO-E.
- The **third phase** (import-export with trade) related with the synchronous parallel operation of Turkey with European Power System started on 1th of June 2011 and it will be ended on September 2012.
- Trade will be limited with **400 MW** from Bulgaria and Greece to Turkey; **300 MW** from Turkey to Europe via these countries.



TURKEY-UCTE (entso-e) CONNECTION:

- What is the effect of ENTSO-E interconnection to the penetration of wind power plants in Turkish Power System?
- By the ENTSO-E interconnection primary reserve requirement of Turkish power system is decreased from 770 MW to 300 MW
 - But secondary reserve requirement did not change by the ENTSO-E interconnection and it is stayed as 770 MW.
 - Primary and secondary frequency control of System leave its place to tie line control of three 400kV interconnection lines between Turkey – Bulgaria and Turkey-Greece .
- By increasing of wind power penetration in Turkish grid the secondary reserve requirements will increase.
- Secondary reserve requirements will be performed by hydroulic and natural gas power plants that the total percentage is approximatey %70 in Turkish Power System.

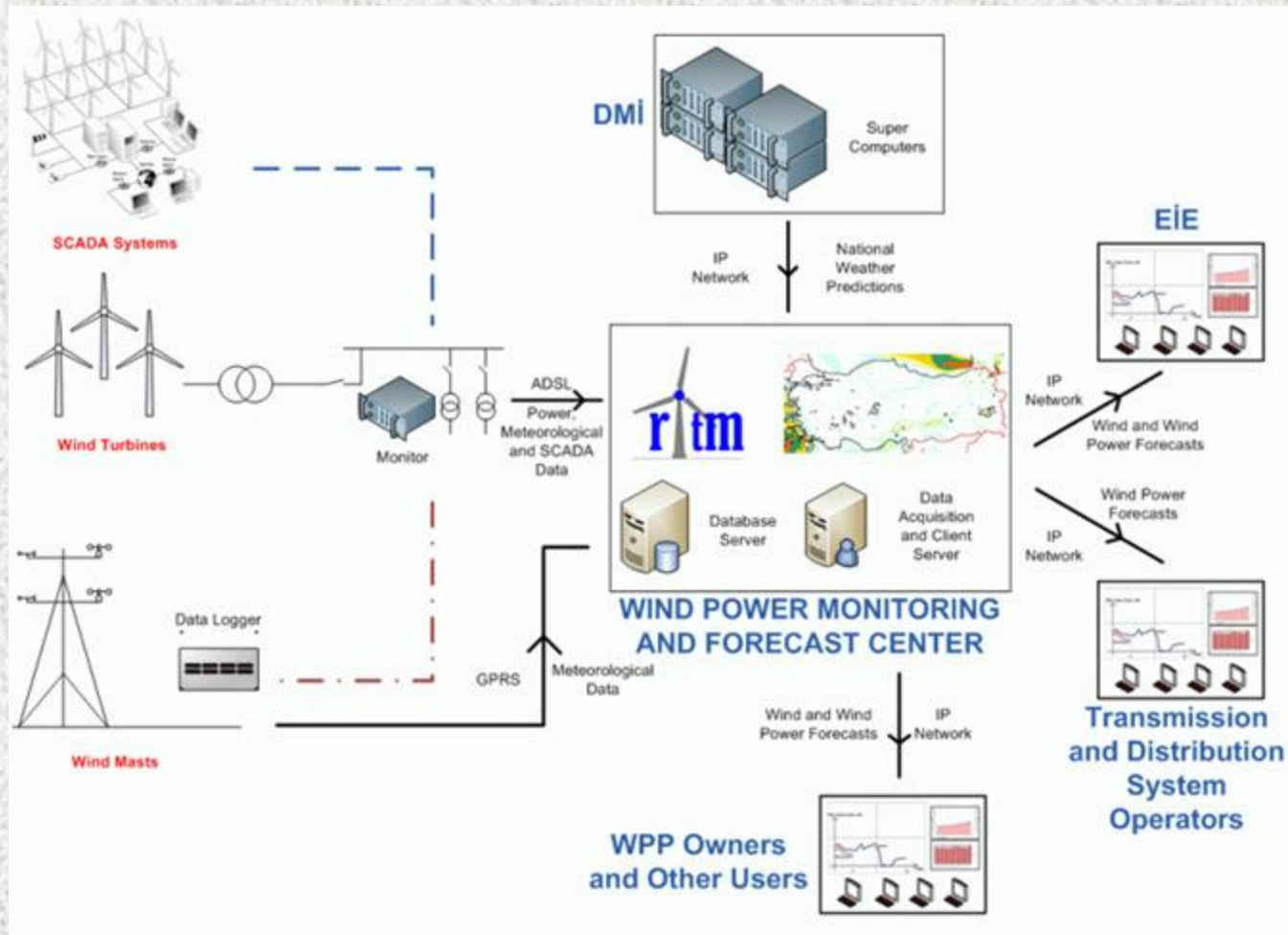


- What will be the operation problems if ~12000 MW wind power plant will be in service ?
- Wind applications are concentrated in west side of Turkey. This will cause excessive voltage changes in the region
- Effective regional voltage control
- Effective secondary reserve control
- Effective ENTSO-E interconnection tie line control will be needed
- All these issues can be managed by an effective wind forecast and monitoring system



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WIND POWER MONITORING AND FORECAST CENTER





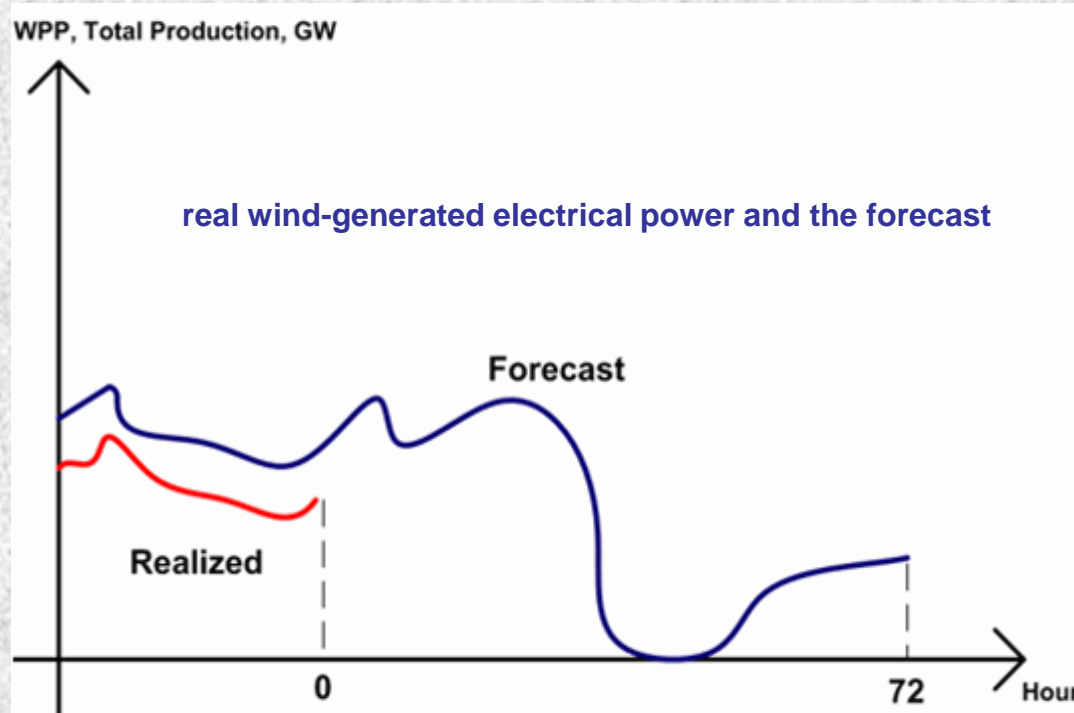
WIND POWER MONITORING AND FORECAST CENTER

- RITM Project started on 15 July 2010 with the participation of Electrical Power Resources Survey and Development Administration (EİE), The Scientific and Technological Research Council of Turkey (TÜBİTAK) and Turkish State Meteorological Service (DMI).
- **The project aims** to serve the integration of the Wind Power Plants (WPPs) into the Electricity System of Turkey. A wind power monitoring and forecast system will be developed and this system will be made widespread over the whole electricity system in the country.
- **Technical Content and Components:** The project, designed to realize large-scale electrical power generation out-of wind sources in Turkey and to define the necessary countermeasures for the integration of the WPPs into the electricity system.
- Meteorological information such as heat, wind speed, and direction at the existing WPPs are collected by the wind observation stations, whereas the "turbine status" are obtained from the SCADAs at the WPPs. Additionally, "wind power analyzers" installed at the transformer substations of the WPPs are used to measure electrical quantities such as current, voltage, and power.
- The collected data is immediately transmitted to the *Wind Power Monitoring and and Forecast Center (WPMFC)*. In addition to the data coming from the WPPs, meteorological forecasts obtained by the Turkish State Meteorological Service (DMI) are regularly served to the *WPMFC* in particular time intervals. All the data is collected through a data accumulator software at the *WPMFC* and is managed by a database system developed specifically for the *WPMFC*. Based on the systematically collected data, wind-generated power forecasts are constituted individually for all WPPs, for the next 48 hours.
- First group of WPPs participating in the Monitoring and Forecast System are 546.4 MW



Forecasting Subsystem for Electrical Power Generated from Wind

- Based on the measurement received from the WPPs and the wind forecasts of DMI, wind-generated power forecasts will be performed per-WPP, per-region, and for the whole country.
- Both 15-second forecasts and 0-72-hour forecasts will be carried out.
- Next-hour forecasts are planned to be revised per-hour, while others will be revised every 6 hours.
- Three basic forecast approaches will be used to obtain the best results: Physical approach (numerical weather predictions are used), statistical approach (forecasts based on past data and predictions), and combined approach (combination of the physical and statistical approaches).





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Thank you for your attention