TURKEY
TRANSMISSION NETWORK OPERATION AND INTERCONNECTIONS FOR REGIONAL MARKETS

Budak Dilli

05 July 2010

ELECTRICAL ENERGY AND TRANSMISSION SYSTEM

- **Energy, driving force for socio-economic and technological development**.
- **Energy supply**
  - **uninterrupted, reliable, low cost and environmentally friendly**
  - **secure**
- **Power Network:**
  - **Generation-Transmission-Distribution**
  - **Power System Control and Operation**
    - **Dispatch, control of flows, security, stability, frequency…etc.**
- **The role of transmission system**
  - **Back bone, vitally important from technical point**
  - **Getting more importance in market environment**

ELECTRICAL ENERGY AND TRANSMISSION SYSTEM

- **Role of Transmission in Internal and Regional Electrical Energy Markets**
  - **Conventional systems: Vertically integrated, monopolistic, generally state owned**
    - **Integrated system operation more easy, decisions based on only technical and economic considerations**
  - **Liberal Internal Markets: Unbundled, multi players, commercially driven**
    - **Transmission System Operators are carrying others' energy (= $$$$$)**
    - **Market operation + system operation**
    - **Non discriminatory access to the grid**
    - **Unbundled, independent from other market operations**
    - **Technically necessary ancillary services with commercial agreements**
  - **Regional Markets: multi players + multi national control centers**
    - **More Coordination, Technical+ COMMERCIAL Cross-Border exchange rules..**
- ***Without sufficient and technically viable transmission network and successful system operation, markets (internal or regional) cannot work efficiently.***

TURKEY

I. GENERAL OUTLOOK

- POPULATION (2009): 72.5 million
- GDP (per capita-2009): 8 590 US $
- Electrical energy consumption (per capita): 2200 kWh
- Installed Capacity: 45500 MW (state 53%, private 47%)
  - Thermal: 29604 MW
  - Hydro: 14802 MW
  - Other Renewable (wind, geothermal..): 1097 MW
  - Gross Generation (2009): 194,8 TWh
  - 46% state,54% private
  - 80% thermal, 20%hydro and other renewable
  - Import: 812 GWh
  - Export: 1545 GWh
  - Gross Consumption(2009): 194,08 TWh

TURKEY
II. Electricity Market Structure

STATE

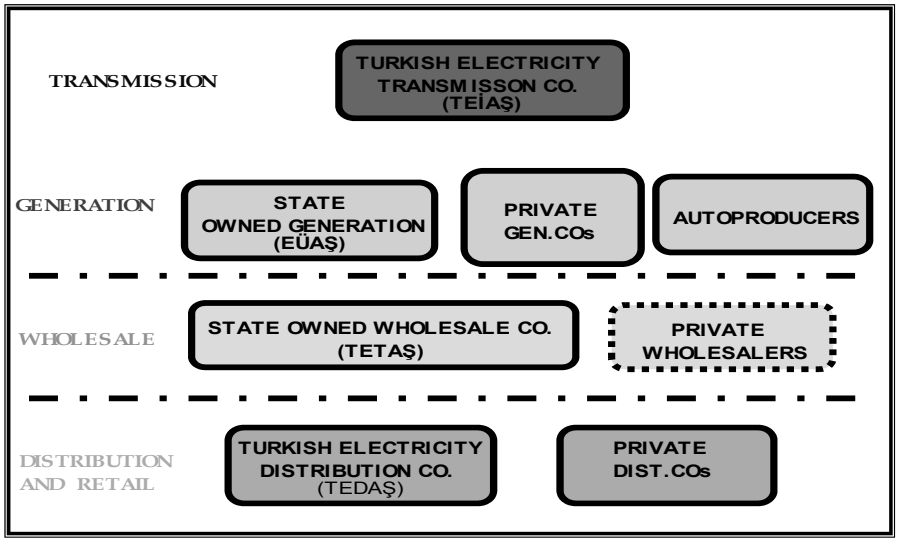
- Policy development on macro scale
  - Ministry of Energy & Natural Resources (MENR)
- Regulation, control, supervision of the markets
  - Energy Market Regulatory Authority (EMRA)
- State-owned generation and distribution

PRIVATE SECTOR

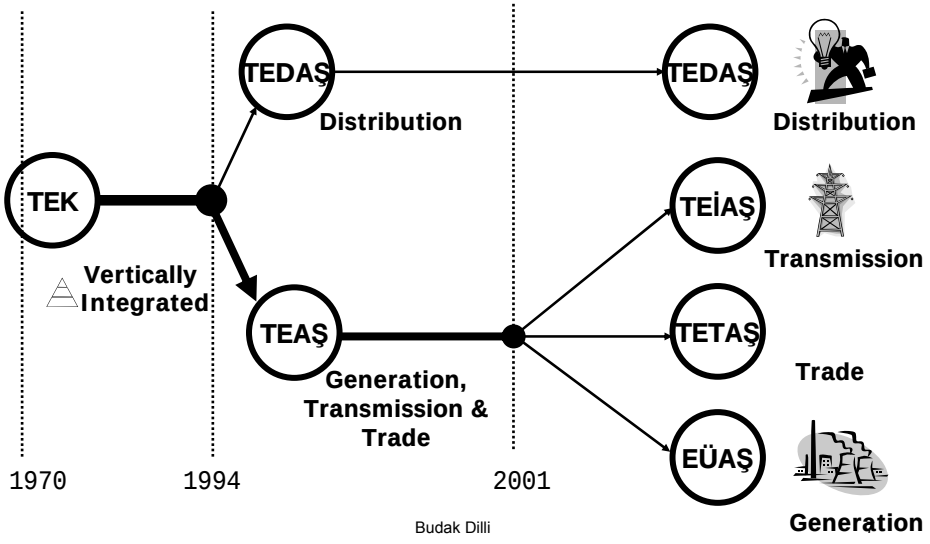
- investments
- market activities
  - Generation
  - Distribution
  - Wholesale
  - Retail
  - import
  - export.....

ELIGIBLE AND CAPTIVE CUSTOMERS

TURKEY
II. Electricity Market Structure



TURKEY
III. Unbundling

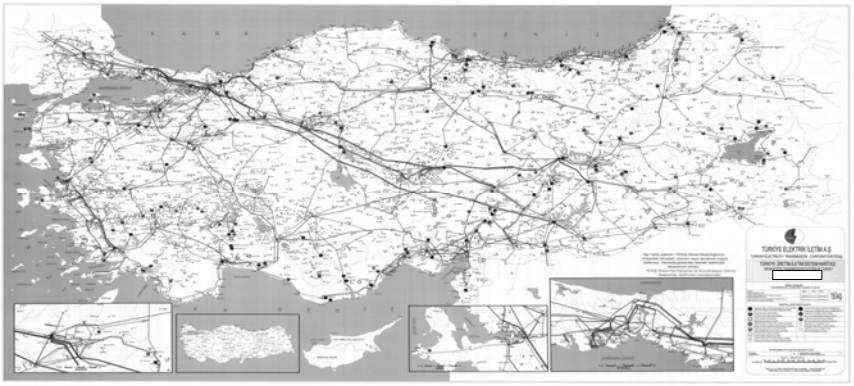


TRANSMISSION SYSTEM

Turkish Electricity Transmission Co.- TEIAŞ

- State owned
- Transmission system owner & operator (TSO)
- Market Operator
- Provision of connection to and use of transmission system services to all users without discrimination.
  - Through "Connection and Use of System Agreements"
- Monitoring real-time system reliability, purchase and provide ancillary services.
  - Through "Ancillary Service Agreements"
- International interconnection activities
  - Development of infrastructure.

Turkish Electricity Transmission Grid

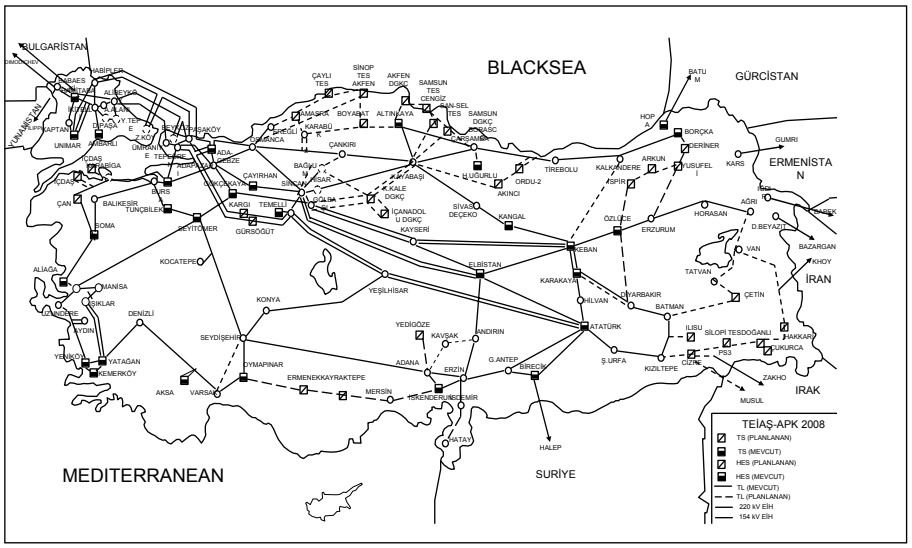


KEY

- 400 kV Substation: 75
- 220 kV Substation: 1
- 154 kV Substation: 497
- 66 kV Substation: 15
- TOTAL 587 Substation (93.226 MVA)

- 14622,9 km 400 kV OHL
- 31874,3 km 154 kV OHL
- 84 km 220 kV OHL
- 508.5 km 66 kV OHL
- 213 km 154 kV and 380 kV Cable
- TOTAL 47090,2 km Transmission Line

400 KV NETWORK

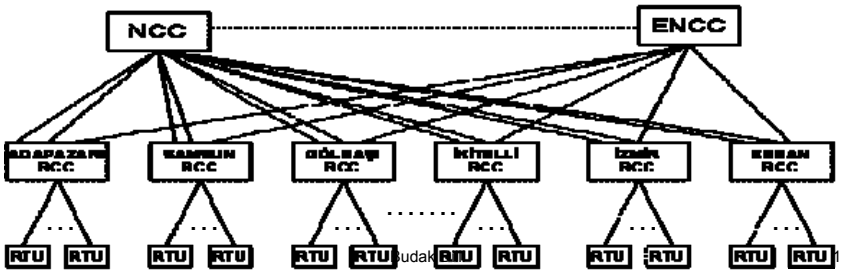


System Operation, Control and Dispatch

Control Centers

- Operation and Maintenance of the transmission lines and substations is carried by regional directories, directly reporting headquarters at Ankara.
- The Turkish transmission system is operated by the National Control Centre (NCC) and 9 Regional Control Centers (RCCs).

SCADA & Energy Management System



System Operation, Control and Dispatch

400 kV Network operations carried by National Control Center (NCC),
154 kV network is operated by Regional Control Centers

System Operation, Control and Dispatch

NCC

Market Operation

- TEIAS: Market Operator
- Day-Ahead Programming, and day ahead market operations.
  - Collecting generation and price proposals,
  - Determining economic merit order dispatch
  - Marginal pricing
- Intra-Day Balancing and Settlement
  - Balancing: Conventional, through dispatch centers
  - Settlement: Determination of commercial transactions
  - Effect of transmission system faults and contingencies.

Transmission System Development
Challenges

- Difficulty in long term network Planning and timely investment
  - Liberal market environment, generation investors are private companies. Predetermined Rules and regulations are necessary for generation Licensing.
  - Promotion of renewable generation: small hydro and wind. Hundreds of these kind, dispersed, remote locations. New transmission lines, substations, capacity increase in the existing substations. Regional and basin based planning necessary.
  - Too many small projects, financing investments for timely completion.

Transmission System Operation
Challenges

- Preserving the technical quality of the system
  - Grid Code : Set of rules for transmission system users- generators, Dis. Cos..
- Managing the effects of intermitted generation
  - Difficulty of day-ahead generation programming,
  - Balancing the supply - demand due to fluctuations of the generation, keeping the system frequency in prescribed limits.
  - New and additional control system to supervise the wind farms, forecasting the wind, keeping sufficient hot reserve.
- Determination and handling the Ancillary Services
  - Voltage Control, frequency control, hot stand-by.. etc commercial-technical agreements with system users

Transmission System Development

ANNUAL DEVELOPMENT OF TRANSMISSION LINES (km.)

YEARS	380 kV	220 kV	154 kV	66 kV	TOTAL
1980	2985.1	15.7	15490.1	2332.0	20822.8
1990	8334.3	84.6	23560.7	1408.2	33387.8
2000	12957.3	84.6	27949.9	560.9	41552.7
2009*	14622.9	84.6	31874.3	508.5	47090.3

ANNUAL DEVELOPMENT OF TRANSFORMERS IN TURKEY BY PRIMARY VOLTAGE LEVEL

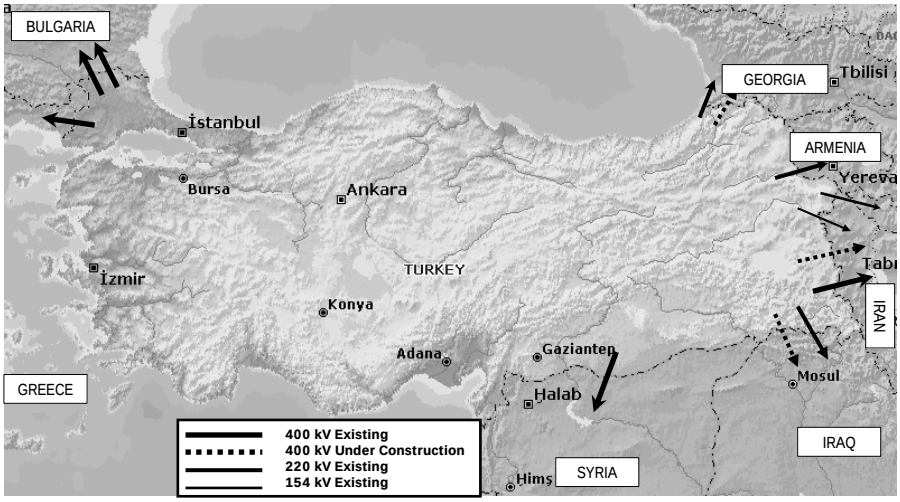
	380 kV		154 kV		66 kV and below		TOTAL	
YEARS	*NUMBER*	*CAPACITY (MVA)*	*NUMBER*	*CAPACITY (MVA)*	*NUMBER*	*CAPACITY (MVA)*	*NUMBER*	*CAPACITY (MVA)*
1980	20	3060.0	279	8067.0	295	1544.0	594	12671.0
1990	61	9410.0	531	18008.7	151	1347.0	743	28765.7
2000	106	18160.0	821	39053.9	138	1315.4	1065	58529.3
2009 *	182	34720.0	1031	57874.0	54	632.0	1267	93226.0

TRANSMISSION SYSTEM INVESTMENTS AND FINANCING

- **AMOUNT:**
  - BETWEEN 2005-2009, TOTAL TRANSMISSION LINE AND SUBSTATION INVESTMENT AMOUNT IS:

    1,2 Billion US $
- **FINANCING:**
  - **319 Million US$ - LOAN from WB**
  - **881 Million US$ - TEIAS Resources**
    - **TEIAS revenues from approved transmission tariff and connection charges.**
- **IN THE LAST TEN YEARS, TEIAS USED APPROXIMATELY 473 MILLION US$ LOAN FROM WB.**
- **FOR SOME POWER PLANT PROJECTS DEVELOPED BY PRIVATE SECTOR, POWER PLANT INVESTOR FINANCE THE TRANSMISSIN LINE AND IT IS PAID BACK FROM TRANSMISSION SYSTEM USE TARIFF IN 10 YEARS.**

ELECTRICITY INTERCONNECTIONS OF TURKEY



EXISTING INTERCONNECTIONS OF TURKEY

FROM S/S	TO S/S	U, kV	Note
Hopa (Turkey)	**Batumi (Georgia)**	**220**	**Currently Operated for Import. (Isolated Region Mode)**
Kars (Turkey)	**Gumri (Armenia)**	**220**	**Not operated.**
Iğdır (Turkey)	**Babek (Nahcievan Azerbaijan)**	**154**	**Currently Operated for Import. (Isolated Region Mode)**
Doğubeyazıt (Turkey)	**Bazargan (Iran)**	**154**	**Not operated.**
T-Connection (Engil s/s – Bagisli s/s 154 kV line) (Turkey)	**Khoy (Iran)**	**400**	**Currently Operated at 154 kV for Import. (Isolated Region Mode)**

EXISTING INTERCONNECTIONS OF TURKEY

FROM S/S	TO S/S	U, kV	Note
Karkey (Turkey)	**Zakho (Iraq)**	**400**	**Currently Operated at 154 kV for Export. (Isolated Region Mode)**
Birecik HPP (Turkey)	**Aleppo (Syria)**	**400**	**Currently Operated for Export. (Isolated Region Mode)**
Hamitabat (Turkey)	**Maritsa (Bulgaria)**	**400**	**Not Operated Yet (ENTSO /UCTE)**
Babaeski (Turkey)	**Maritsa (Bulgaria)**	**400**	**Not Operated. (ENTSO /UCTE)**
Babaeski (Turkey)	**Phillippi (Greece)**	**400**	**Not Operated. (ENTSO /UCTE)**

Future Interconnections

Turkey-Georgia:

Construction of a new 400 kV Akhaltsikhe-Borçka transmission line together with a DC Back-to-back station at Georgian side.

Turkey-Romania:

400 kV HVDC submarine cable under Black Sea with carrying capacity 600 MW and converter stations at the end points of the cable is agreed to be constructed between two countries. Feasibility Studies are ongoing.

Turkey-Iraq:

Construction of 400 kV Cizre (Turkey) - Musul (Iraq) interconnection line is under planning stage.

Turkey-Iran:

In order to improve the energy exchange between the countries a new project is under consideration by providing asynchronous connection through construction of a DC Back-to-Back station to be linked to existing 400 kV Khoy-Başkale-Van transmission line.

- Mediterranean Electricity Ring Project.
- Black Sea Electricity Ring Project.

Integration With European Internal Market via Southeast European Regional Market

Turkey-UCTE (ENTSO-E) Connection:
(Synchronous operation of Turkish Power system with Europe)

1. **Complementary Technical Studies for the Synchronization of Turkish Power System with the UCTE System** started at 2003 and finalized with success in April 2007. Within this project, required technical conditions for Turkish Power System was determined, for synchronization with the ENTSO-E Continental Europe Power System.

2. **Rehabilitation of the Frequency Control Performance of Turkish Power System for Synchronous Operation with UCTE** (started at 2007 ongoing). Within the scope of the project, Turkish Power System is being prepared for parallel operation with ENTSO-E, regarding power and frequency control, steady state and transient stability.

- Optimization and Rehabilitation work completed in many thermal (lignite and natural gas fired) and hydraulic power plants for primary and secondary frequency control.
- The existing inherent frequency control problem has already been eliminated.
- The SPS at the interface to manage extreme contingencies is implemented .
- Measures to damp the 0.15Hz inter-area oscillations implemented.
- HPP governor tunings, AVR & PSS tuning, Installation of STATCOM completed.

Integration With European Internal Market via Southeast European Regional Market

➢Tests in Island Mode of Operation were successfully performed under maximum load conditions in January 2010 and will be performed under minimum load conditions in March 2010.

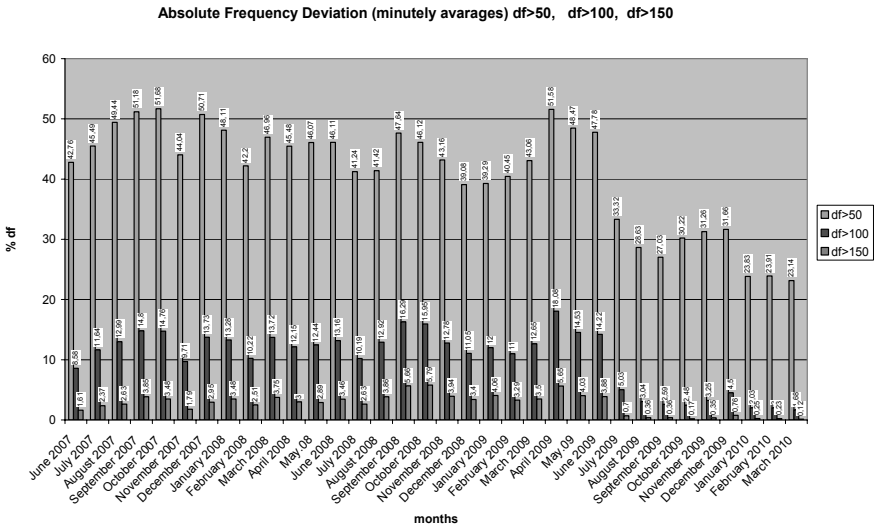
➢Trial synchronous operation with ENTSO-E Continental Europe System will start at September18.

➢After successful trial synchronous operation, Turkish transmission network will be a part of Continental European Network and Energy exchange will be possible via 3x400 kV transmission Lines.

➢Cross-Border trade rules will be in accordance with EU Internal Market Directives.

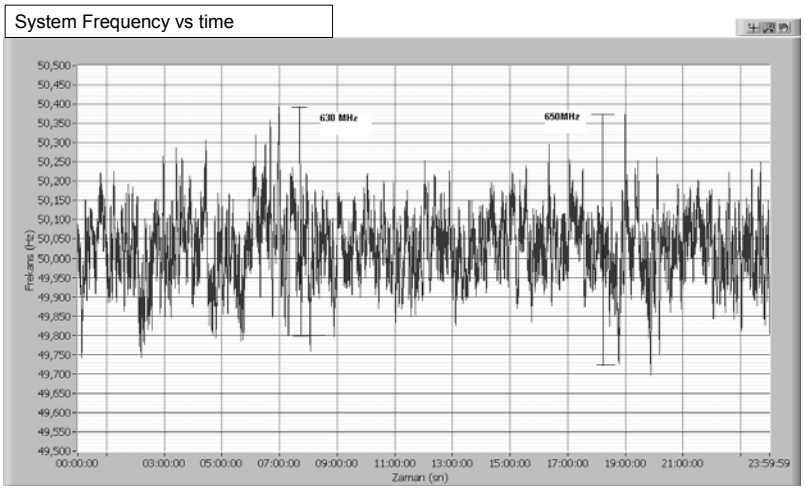
➢Coordination in regional market will be carried by Southeast Europe regional coordination center.

Frequency Deviation Improvement



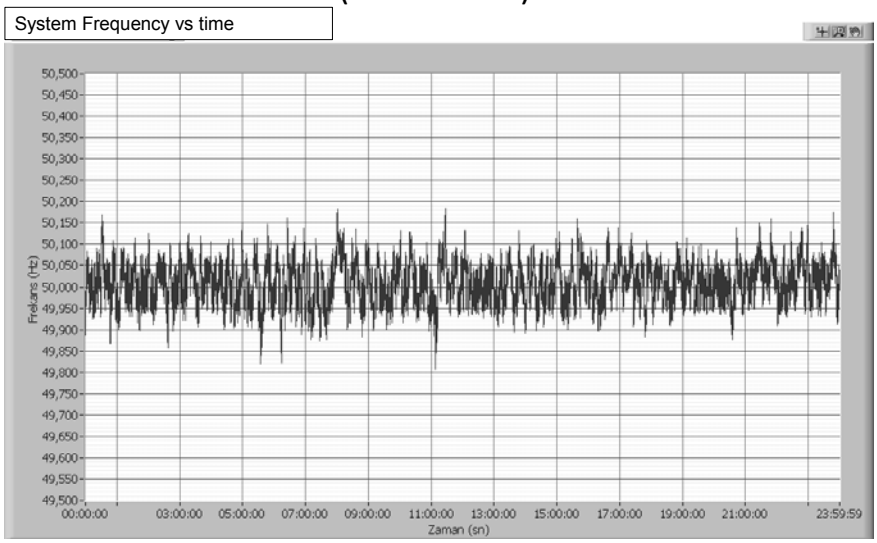
Frequency Control Performance

(11.04.2009)



Frequency Control Performance

(03.08.2009)



THANK YOU FOR YOUR ATTENTION