Scenarios for MARKAL Studies in Turkey

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Total energy consumption-Turkey

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TURKISH ENERGY GENERATION

- Natural gas: 49%
- Lignite: 20%
- Fuel Oil: 4%
- Coal: 6%
- Imported coal: 6%
- Geothermal: 0%
- Wind: 0%
- Hydro: 19%
- LPG: 0%
- NAFTA: 0%
- Other: 0%
- Ren+waste: 0%

INSTALLED CAPACITY OF TURKEY

<table>
<thead>
<tr>
<th>Source</th>
<th>Turkish Electricity Transmission Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutions</td>
<td>GEOTHERMAL</td>
</tr>
</tbody>
</table>
| Electricity Generation Co. Inc. | 8,690.9 | 10,897.3 | 453.0 | 20,041.2 | 49.2%
| Other public sector generation companies | 3,849.0 | 52.7 | 58.6 | 3,975.3 | 9.8%
| TOOR | 620.0 | 30.1 | 650.1 | 1.6%
| Mobile | 262.7 | 262.7 | 0.6%
| BOO | 6,101.8 | 6,101.8 | 15.0%
| BOT | 1,449.6 | 772.0 | 210.0 | 2,449.0 | 6.0%
| Private generation | 8.0 | 3,163.8 | 356.0 | 1,096.6 | 8.9%
| Autonomous producers | 0.7 | 3,013.2 | 540.0 | 1,238.2 | 8.9%
| TOTAL | 23.0 | 42.7 | 27,151.0 | 12,262.0 | 1,130.5 | 128.2 | 40,737.3 | 100.0%

Share (%) | 0.1 | 0.1 | 66.6 | 30.1 | 2.8 | 0.3 | 100.0%
## Average Energy Prices

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Unit price</th>
<th>Thermal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas (industrial use)</td>
<td>0.18 €/m³</td>
<td>8250 kcal/m³</td>
</tr>
<tr>
<td>Coal Soma (industrial use)</td>
<td>0.105 €/kg</td>
<td>5400 kcal/kg</td>
</tr>
<tr>
<td>Coal Import Lignite (industrial use)</td>
<td>0.136 €/kg</td>
<td>6500 kcal/kg</td>
</tr>
<tr>
<td>Fuel Oil (industrial use)</td>
<td>0.315 €/ft</td>
<td>9200 kcal/ft</td>
</tr>
<tr>
<td>Fuel Oil (retail sale)</td>
<td>0.546 €/ft</td>
<td>9200 kcal/ft</td>
</tr>
<tr>
<td>LPG (industrial use)</td>
<td>1.08 €/ft</td>
<td>11000 kcal/ft</td>
</tr>
<tr>
<td>Diesel Fuel (industrial use)</td>
<td>1.09 €/ft</td>
<td>10200 kcal/ft</td>
</tr>
<tr>
<td>Diesel Fuel (retail sale)</td>
<td>1.298 €/ft</td>
<td>10200 kcal/ft</td>
</tr>
<tr>
<td>Petrol (retail sale)</td>
<td>1.5 €/ft</td>
<td></td>
</tr>
</tbody>
</table>

## Electricity Prices

### A) Dual Term Tariff

<table>
<thead>
<tr>
<th>Industry</th>
<th>Active Energy</th>
<th>11/22</th>
<th>22/06</th>
<th>06/17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Province with Priority</td>
<td>0.0597 €/kWh</td>
<td>0.00146 €/kWh</td>
<td>0.0035 €/kWh</td>
<td>0.0057 €/kWh</td>
</tr>
<tr>
<td>Other Provinces</td>
<td>0.0637 €/kWh</td>
<td>0.01014 €/kWh</td>
<td>0.0035 €/kWh</td>
<td>0.00605 €/kWh</td>
</tr>
</tbody>
</table>

### B) Single Term Use

<table>
<thead>
<tr>
<th>Industry</th>
<th>Active Energy</th>
<th>11/22</th>
<th>22/06</th>
<th>06/17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Province with Priority</td>
<td>0.0597 €/kWh</td>
<td>0.1143 €/kWh</td>
<td>0.0061 €/kWh</td>
<td>0.0662 €/kWh</td>
</tr>
<tr>
<td>Other Provinces</td>
<td>0.0744 €/kWh</td>
<td>0.1259 €/kWh</td>
<td>0.0061 €/kWh</td>
<td>0.0706 £/kWh</td>
</tr>
<tr>
<td>Province with Priority</td>
<td>0.0742 €/kWh</td>
<td>0.1127 €/kWh</td>
<td>0.0068 €/kWh</td>
<td>0.0668 €/kWh</td>
</tr>
<tr>
<td>Other Provinces</td>
<td>0.0763 €/kWh</td>
<td>0.1256 €/kWh</td>
<td>0.0084 €/kWh</td>
<td>0.0714 €/kWh</td>
</tr>
</tbody>
</table>
Official Targets

- Building 5000 MW Nuclear
- Building Lignite Thermal Power Plants with capacity > 1000 MW
- Full utilization of hydraulic resources
- Installation of minimum 3000 MW wind turbines
- Full utilization of geothermal resources

Contribution of renewable energy sources to total energy consumption-Turkey
Wind Potential of Turkey: The northwest Turkey, including the area around the Sea of Marmara and the western coast and southeastern Anatolia have been identified as most promising locations for wind power generation.

Technical Potential: 88,000 MW
Economic Potential: 10,000 MW
Problems about wind energy based generation facilities

- Financial problems
- Construction and permission period is long
- Insufficiency in transmission infrastructure
- Turbine supply. Excessive demand and turbine prices increase about 20% in the past 2 years.

Market Players Operating Wind Farms 120MW

- Market Players Operating Wind Farms
  - Demirer & Enercon - Çeşme 2006
    - 32.65%
  - Demirer & Ado - Intepe 2006
    - 25.32%
  - Bilgin - Bandırma 2006
    - 24.99%
  - Demirer & Enercon - Bozcaada 2000
    - 8.50%
  - Demirer - Çeşme 1997
    - 1.25%
  - Sunjüt - İstanbul 2002
    - 1.25%
  - Güçbirliği - Alacati 1998
    - 6.00%
  - Altınyunus Hotel 1990
    - 0.05%
How many kWh’s can be produced in Turkey with wind energy?

As viewed by Erol Demirer
As an Investor

Vice President, EUROSOLAR Turkey
www.eurosolar.org.tr
Limits of wind energy

- Wind
- Land / offshore area
- Electrical network
- Investing environment

Electrical Network

- App. 5000MW wind farms can be integrated to the existing network
- Until efficient and economical energy storage system are developed
Cost break out

Wind

Natural Gas

Effects of High Investment and no fuel cost

- High employment
- Independent of oil price fluctuation
- Independent of foreign suppliers
- More dependent on investment environment and interest rates
Hydro Power

Turkey is largely dependent on hydropower to meet its electricity needs and 40 percent of its total installed capacity is hydroelectric. The current total capacity of hydroelectric plants is 12.4 GW. This capacity is projected to rise to 18.8 GW in 2010.
Hydroelectric Potential of Turkey

Gross potential: 433 billion kWh/year,
Technical potential: 216 billion kWh/year
Economic Potential: 126 billion kWh/year

Utilization rate: % 36

Development of Hydroelectric Generation

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>18</td>
</tr>
<tr>
<td>1970</td>
<td>725</td>
</tr>
<tr>
<td>1980</td>
<td>2131</td>
</tr>
<tr>
<td>1990</td>
<td>6764</td>
</tr>
<tr>
<td>2000</td>
<td>11175</td>
</tr>
<tr>
<td>2007</td>
<td>13392</td>
</tr>
</tbody>
</table>
126 billion kWh/year economical hydroelectrical potential current phases

Share of Small Hydro is about 3 %

2004 Generation costs of solar electricity from large central PV power station (5 MWp)

- System costs: 4 €/Wp
- Capital investment payback time: 20 years
- Interest rate: 3%
- Inflation: 2%
- Yearly maintenance costs 1% of the investment
- Mounting at an optimum angle
Solar Thermal and solar PV Technical Potential in Turkey

<table>
<thead>
<tr>
<th>Residences</th>
<th>Office and Service Buildings</th>
<th>Industrial Buildings</th>
<th>Total Building Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>324 km²</td>
<td>37 km²</td>
<td>33 km²</td>
<td>394 km²</td>
</tr>
</tbody>
</table>

potential for PV Installed power is 25 625 MWp
Annual energy production 32.671 GWh
This shows that we can supply 26% of the consumption of the year 2002 by PV systems

GEOTHERMAL POTENTIAL MAP FOR TURKEY

Geothermal Facilities

- Gürmat A.Ş. Güzelyurt-Ayvatlar / 17.5 MW
- Gürmat A.Ş. Kırıkkale-Dinar / 6 MW
- Menderes A.Ş. Ayvatlar-Yur vault / 7.5 MW
- Elektrik Güzelyurt A.Ş. Denizli-Aydın / 15 MW
- Bereket A.Ş. Denizli-Sarayköy / 6.85 MW

- Finished
- Under Construction

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Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy

- National Programme, Energy chapter
- Published in Official Gazette on May 18, 2005
- Facilities based on RES commissioned before 2011
- 2 types of support
  1. Investment period
     - Land, investment
  2. Operation period
     - Purchase guarantee (Distribution companies holding retail sale license)
     - Price Guarantee (Turkish average wholesale electricity price-between 5 and 5.5 eurocents/kWh)
Renewable Energy Law, as passed by the Turkish Parliament on 10th May 2005

- Turkish Wind Energy Association (TÜREB)
  www.ruzgarenerjisibirligi.org.tr

- The purpose of this law is to expand the utilization of renewable energy sources for generating electric energy, to benefit from these resources in a secure, economic and qualified manner, to increase the diversification of energy resources, to reduce greenhouse gas emissions, to assess waste products, to protect the environment and to develop the related manufacturing industries for realizing these objectives.

c) Until the end of 2011, the applicable price for electricity to be purchased in pursuance with this Law is Turkey’s average wholesale-selling price, as determined and published by EMRA for the year before.

- “The Average Wholesale Price of Electricity in Turkey” means the average of the wholesale prices of electricity, calculated by EMRA and applied annually in the country

- At the beginning of each year, the Council of Ministers is entitled to raise this price by 20%.
Renewable Energy Law of Turkey

- allows the wind produced electricity to be supplied to the grid
- Pays only the average market price of electricity purchase
- Provides conditions for implementation only in best wind potential sites
- Does not support PV Implementation and wind energy in less favourable sites
- Needs to be improved

Legal Basis

- Related legislation for construction, environment, expropriation, etc.
- Renewable Energy Support Law, Law No.: 5346
- Energy Market Law, Law No.: 4628
- Electricity Market Regulation
Investment Models

1. **Generation**
   According to Article 17 of the License Regulation, the generation licensees may engage in the activities of construction and commissioning of generation facilities, electricity generation, sale of the generated electricity to consumers.

2. **Autoproduction**
   According to Article 33 of the license regulation, autoproducer licensees may engage in the establishment of generation facilities in order to meet their own needs and, in cases of excess generation, the sale of up to 20% of the generated electricity to other licensees and eligible consumers.

Arguments for Renewables

- High costs
- Intermittent supply
- Access to grid
## RENEWABLE ENERGY LICENSE STATUTE

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Application</th>
<th>Assessment</th>
<th>Approval</th>
<th>License</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIND</td>
<td>1</td>
<td>20.00</td>
<td>54</td>
<td>1,957.06</td>
<td>7,861.39</td>
</tr>
<tr>
<td>GEOTHERMAL</td>
<td>5</td>
<td>82.00</td>
<td>5</td>
<td>82.00</td>
<td></td>
</tr>
<tr>
<td>WASTE GAS (LFG)</td>
<td>3</td>
<td>26.20</td>
<td>4</td>
<td>14.26</td>
<td>40.46</td>
</tr>
<tr>
<td>WASTE GAS (GASIFICATION)</td>
<td>1</td>
<td>0.59</td>
<td>1</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>BIOGAS</td>
<td>2</td>
<td>7.00</td>
<td></td>
<td></td>
<td>14.00</td>
</tr>
<tr>
<td>BIOMASS</td>
<td>3</td>
<td>10.00</td>
<td>2</td>
<td>7.00</td>
<td>17.00</td>
</tr>
<tr>
<td>BIOMASS+SOLAR</td>
<td>5</td>
<td>129</td>
<td>2</td>
<td>2,057.64</td>
<td>2,057.64</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5</td>
<td>129</td>
<td>2</td>
<td>2,057.64</td>
<td>8,005.29</td>
</tr>
</tbody>
</table>

### License Applications for Hydroelectric Generation

- **Application 60-100**
- **Application 20-30**
- **Application 15-20**
- **Application >100**
License Applications Wind (6700 MW)

- SAGAP: 8%
- Deryalar: 8%
- AS-Makinsan: 6%
- Borasco: 5%
- Ataseven: 4%
- GY Danışma: 4%
- Others: 41%

Granted Licenses Wind (1420 MW)

- Germania Windpark: 20%
- BOST A.B.: 15%
- Kazanc Holding: 9%
- Deryalar Holding & Affiliates: 8%
- AS Makinsan: 7%
- Others: 34%
12 000 MW

Applications based on wind energy taken on November 1, 2007

- 761 applications
- 78000 MW
- 171 applications more than 100 MW
- 1 application for 3000 MW in İzmir

<table>
<thead>
<tr>
<th>Province</th>
<th>#</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>İzmir</td>
<td>113</td>
<td>12748,4</td>
</tr>
<tr>
<td>Bulkesir</td>
<td>86</td>
<td>8626,1</td>
</tr>
<tr>
<td>İznel</td>
<td>32</td>
<td>7799,2</td>
</tr>
<tr>
<td>Çanakkale</td>
<td>92</td>
<td>7712,4</td>
</tr>
<tr>
<td>İstanbul</td>
<td>47</td>
<td>7313,4</td>
</tr>
<tr>
<td>Kirklareli</td>
<td>44</td>
<td>5565</td>
</tr>
<tr>
<td>Hatay</td>
<td>63</td>
<td>5023,5</td>
</tr>
</tbody>
</table>
Solutions and Opportunities

- EU parliament’s resolution “2004/2153 (INI)” demands 20% of renewables in 2020, leading to approximately 12,000 MW of wind power in Turkey.
- Short-term: Wind power plants will play a major role in closing the electricity supply gap from 2007 to 2014, leading to investment opportunities of more than 6 billion €.
- Medium-term: “20% of renewables in 2020” obligation by EU, leading to investment opportunities of more than 12 billion €.

Scenarios for MARKAL Studies in Turkey

- 5000 MW Nuclear
- Internalisation of external costs of fossil fuel utilisation in Turkey (thermal power plants with capacity > 1000 MW)
- 100% renewable Energy Integration
- Cancellation of the Take or Pay Natural Gas agreements (%0 - %20-%40-%60-%80 electricity from natural gas)
- 20% from nuclear, lignite, renewable, natural gas and hydro
- 78 000 MW wind farm license application (%20-%40-%60 wind generated electricity)
- Functional Renewable Energy support Law
- Priviliged Partnership Scenario
- Cancellation of Customs Union Agreement
- Functional energy efficiency support law
Energy Scenario 2050 - Primary Energy Consumption

Source: K. Lehmann, Wuppertal Institute for Climate, Environment, Energy

- Coal
- Petroleum
- Nuclear
- Gas
- Water
- Wind
- Sun
- Biomass

Savings and Efficiency

1990 2000 2010 2020 2030 2040 2050