Situation énergétique de la Turquie

Place du nucléaire

G. Cognet

Conseiller nucléaire près l’Ambassade de France en Turquie

SFEN-PACA

Aix en Provence – 20 avril 2016
**General Data**

**Surface**: 769 630 km²

**Population**: 75 M

**GDP**: 621 Billion EUR

**GDP/capita**: 8161 EUR

**Growth**: 2,5 %

**Public debt**: 34.5 % of GDP

---

**TARGETS 2023**

<table>
<thead>
<tr>
<th>Category</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>84 M</td>
</tr>
<tr>
<td>GDP</td>
<td>1818 Billion EUR (2000 Billion$)</td>
</tr>
<tr>
<td>GDP/capita</td>
<td>22700 EUR (25000 $)</td>
</tr>
<tr>
<td>Growth</td>
<td>8 %</td>
</tr>
<tr>
<td>Export</td>
<td>450 Billion EUR (500 Billion$)</td>
</tr>
</tbody>
</table>

---

**Source**: Eurostat

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**Membership**

- **UNO**: 1945
- **OECD**: 1960
- **NATO**: 1952
- **NPT Signatory**: 1969 (signed), 1979 (ratified)

---

2013

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**SNR – Ankara**

**SFEN-PACA**

20 avril 2016
GDP Evolution

- Dynamic economic growth: 5.2% between 2002 and 2012
Evolution of Population

Year

Population (millions)


Ref: TÜİK

2023 84millions
2013 energy data

- **Primary energy production**: 32.315 Mtoe
  - Solid fuel: 15.64 Mtoe
  - Crude Oil: 2.48 Mtoe
  - Natural gas: 4.42 Mtoe
  - Nuclear energy: 0 Mtoe
  - Renewables: 13.72 Mtoe

- **Net import of primary energy**: 90.78 Mtoe

- **Final energy consumption**: 82,94 Mtoe

- **Total electricity production**: 240.15 TWh

Fossil fuels represent 88% of primary energy, among which 70% is imported.

**Gross Inland Consumption**

- **Total**: 120.29 Mtoe
  - Solid fuels: 31.83%
  - Petroleum products: 0%
  - Gases: 28.95%
  - Nuclear: 0%
  - Municipal wastes (non-RES): 11.9%

*Source: Eurostat*
Distribution of fossil fuel energies

Coal and Lignite sources distribution in 2013

1.6% of world reserves of lignite

Total coal plant installed capacity is about 12500 MW

24.8% of electricity output from coal in 2013

Proven reserves
- 13.4 GT of lignite
- 0.5 GT of hard coal

Sources: MENR and Euracoal
Natural Gas energy source

Natural gas imports by origin, 2014

*CAGR : Compound Annual Growth Rate

Sources: MENR and Eurostat
Crude oil energy source

Production and demand of oil

Crude oil imports by origin, 2014

- Iran 29.7%
- Saoudi Arabia 11.5%
- Russian Federation 3.5%
- Others 15.2%
- Kazakhstan 8.7%

Source: Eurostat
Distribution of wind and solar energies

Wind energy distribution

Total wind power installed capacity is about 2959 MW in 2013, essentially in Western part (source EWEA)

Solar energy distribution

High solar energy potential, essentially in the South.

4% of electricity output from renewables in 2013 (source MENR)
Total hydraulic installed power is about 25000 MW, essentially in the southeastern part of Turkey, especially in the Euphrates and Tigris basins. Total potential is 35000 MW (135 TWh).

24.8% of electricity output from hydraulic in 2013 (source MENR)
The annual electricity demand growth rate is 7-8%.

Ranking second in the World after China.

Electricity production
Target 2023: 500 TWh

Source: MENR
Energy sources for electricity production

Distribution of electricity generation

Year 2014: 252 TWh

- Natural Gas: 47.9%
- Coal: 30.2%
- Hydro: 16.1%
- Geothermal & Wind: 4.3%
- Fuel-oil and others: 1.5%

Sources: Eurostat

Renewable Energy Capacity

- 2013 Electricity demand: 246 TWh
- 2023 Electricity demand target: 500 TWh
- Electricity supply potential from renewable energy sources: 230 TWh

An important contribution of fossil fuels (about 80%), a potential from renewables insufficient

Source: Republic of Turkey Ministry of Energy and Natural Resources
Le programme nucléaire turc

Une ambition contrainte
<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>TAEK, Atomic Energy Commission, established</td>
</tr>
<tr>
<td>1960</td>
<td>ÇNAEM, Çekmece NRTC established</td>
</tr>
<tr>
<td>1962</td>
<td>TR-1 research reactor</td>
</tr>
<tr>
<td>1976</td>
<td>Site licence for Akkuyu granted by TAEK</td>
</tr>
<tr>
<td>1977-1980</td>
<td>The tender cancelled</td>
</tr>
<tr>
<td>1982</td>
<td>TAEK becomes Turkish Atomic Energy Authority (Law N° 2690, 1982)</td>
</tr>
<tr>
<td>1984</td>
<td>TR-2 research reactor</td>
</tr>
<tr>
<td>1982-1985</td>
<td>The tender cancelled</td>
</tr>
<tr>
<td>1999</td>
<td>SANAEM, Sarayköy NRTC established</td>
</tr>
<tr>
<td>1996-2000</td>
<td>The tender cancelled</td>
</tr>
<tr>
<td>2007</td>
<td>Nuclear Energy Law</td>
</tr>
<tr>
<td>2010</td>
<td>The tender cancelled</td>
</tr>
<tr>
<td>2010</td>
<td>First NPP Project (IGA signed with Russian Federation)</td>
</tr>
<tr>
<td>2013</td>
<td>Second NPP Project (IGA signed with Japanese Government)</td>
</tr>
</tbody>
</table>

Nuclear in Turkey: a rather long story

2 NPP projects launched
# La période des ambitions

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>A new law on construction and operation of NPP’s</td>
</tr>
<tr>
<td>March 2010</td>
<td>Sinop NPP Negotiations with Korea (KEPCO)</td>
</tr>
<tr>
<td>May 2010</td>
<td>IGA with Russia for Akkuyu NPP</td>
</tr>
<tr>
<td>November 2010-March 2011</td>
<td>Sinop NPP negotiations with Japan</td>
</tr>
<tr>
<td>October 2011</td>
<td>Sinop NPP negotiations with EDF (France)</td>
</tr>
<tr>
<td>April 2012</td>
<td>Sinop NPP negotiations with CANDU (Canada)</td>
</tr>
<tr>
<td>March 2012</td>
<td>Sinop NPP negotiations with China</td>
</tr>
<tr>
<td>3 May 2013</td>
<td>IGA has been signed with Japan</td>
</tr>
</tbody>
</table>

- **Aims to facilitate private sector investments for building and operating NPP’s**
- **Allows public private partnership (PPP) model**
- Joint Study Report
- Fukushima accident
- Withdrawal of TEPCO from the project
- Negotiations with Toshiba

**Flags:**
- South Korea
- Russia
- Japan
- France
- Canada
- China
- France
La période de l’engagement

A third project is on the way: On Nov. 24, 2014, Westinghouse, SNPTC (China's State Nuclear Power Technology Corporation) and Turkish power company Elektrik Üretim AŞ (EÜAŞ) have signed an agreement to start exclusive negotiations to develop and construct a four-unit nuclear power plant.
# Overview on the 2 first projects

<table>
<thead>
<tr>
<th></th>
<th>Akkuyu</th>
<th>Sinop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contractor</strong></td>
<td>Rosatom (100%)</td>
<td>Consortium : [Itochu, MHI, ENGIE] (51%), EÜAŞ (49%)</td>
</tr>
<tr>
<td><strong>Estimated cost</strong></td>
<td>20 Billion USD</td>
<td>22 Billion EUR</td>
</tr>
<tr>
<td><strong>Reactor type</strong></td>
<td>VVER-1200 (AES-2006)</td>
<td>ATMEA-1</td>
</tr>
<tr>
<td><strong>Number of units</strong></td>
<td>4 units (1200 MWe each)</td>
<td>4 units (1120 MWe each)</td>
</tr>
<tr>
<td><strong>Signature of IGA</strong></td>
<td>May 12, 2010</td>
<td>May 3, 2013</td>
</tr>
<tr>
<td><strong>Model &amp; PPA</strong></td>
<td>BOO &amp; 15 years for %50 of electricity (12.35 US cents/kWh)</td>
<td>BOO+PPA 20 years for all of electricity (~10.80 US cent/kWh including 0.3 cent/kWh for RW&amp;D, but plus fuel)</td>
</tr>
<tr>
<td><strong>Operation lifetime</strong></td>
<td>60 years</td>
<td>60 years</td>
</tr>
<tr>
<td><strong>Beginning of construction work</strong></td>
<td>2016 → 2017 ?</td>
<td>2019</td>
</tr>
<tr>
<td><strong>Commissioning of units</strong></td>
<td>2019-2022 → 2023-2026</td>
<td>2023 ? - 2028</td>
</tr>
<tr>
<td><strong>Waste management, SF &amp; decommissioning</strong></td>
<td>Responsibility of project company</td>
<td>Ultimate waste: Responsibility of Turkey Decommissioning: project company</td>
</tr>
</tbody>
</table>

IGA = Inter-Governmental Agreement; HGA = Host Government Agreement; MoC: Memorandum of Cooperation
The Akkuyu site

14/04/2015: First concrete
Akkuyu project milestones

- 1976- Site License
- 2010: IGA between Turkey and Russia
- 2010: Establishment of Project Company
- 2011: Site was allocated to Project Company
- 2013: Site was promulgated as a Private Security Zone
- December 2014: Positive result for EIA
- December 2014: Site parameters submitted to TAEK and Application for Construction License
- 27/01/2015: Akkuyu company project (AKKUYU NÜKLEER ANONİM ŞİRKETİ) and TETAS, the Turkish electricity wholesale company, reached agreement and signed PPA Term Sheet
- 14/04/2015: First concrete for Akkuyu Port and hydro technical structures
- 25/06/2015: Pre-license for electricity generation from EMRA
- As of today 2.9 bn$ already invested in the Akkuyu Project by Russian Federation
- 317 students send to Russia for nuclear engineering training and education (but Russian University unilaterally cancelled its partnership agreement with Turkish Universities)
Initial schedule of the Akkuyu project

Pre-construction
- 12.5.2010: Establishment of Project Company
- 2011: Positive EIA Result
- 2011: IGA signed

Construction
- 01.12.2014: Application of Construction Licence
- 27.01.2015: Construction Licence
- 2016: Electricity Generation Licence and PPA
- 2017:
  - Reactor 1: 2021
  - Reactor 2: 2022
  - Reactor 3: 2023
  - Reactor 4: 2024

Operation

Issues with 3 Turkish laws: Olive trade regulation law, Seacoast regulation law and Nuclear Framework law
Akkuyu Project implementation scheme

Potential Shareholders

Shareholders

- Obtaining licenses and permits
- Project management
- Fund raising
- Contracts execution
- Operation & Maintenance
- Decommissioning and waste disposal

EPC

- EPC is broken down to multiple lots (up to 14).
- Atomstroyexport is the EPC integrator of the Project

Rusatom Overseas

Developer

Rusatom Overseas - 74,91%
Rosenergoatom – 21,95%
Atomstroyexport – 2,27%
INTER RAO UES – 0,82%
Atomenergoremont – 0,025%
Atomtechenergo – 0,025%

Shareholders

EPC

Capital markets / Commercial banks

Debt financing

Source

AKKUYU NÜKLEER ANONİM ŞİRKETİ

Republic of Turkey

Construction site
Project warranties and permits

TETAS

Power Purchase Agreement (PPA)

Large consumers

Sale and purchase of remaining power

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supply Contract

TVEL Fuel Company

Large consumers

Sale and purchase of remaining power

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supplyContract

TVEL Fuel Company

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supply Contract

TVEL Fuel Company

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supply Contract

TVEL Fuel Company

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supply Contract

TVEL Fuel Company

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supply Contract

TVEL Fuel Company

Potential Shareholders

Equity Financing

Capital markets / Commercial banks

EPC

Debt financing

Source

TEŞAS

Fuel supply Contract

TVEL Fuel Company
The Sinop site

- Site allocated by the Ministry of Energy and Natural Resources (MENR)
- Located on the Inceburun peninsula in the Sinop Province in northern part of the Republic of Turkey
- Overall investigations being performed in a radius of 40 km around the site with more detailed investigations in the 10 km radius
- Issues with two Turkish laws: The Seacoast regulation law and the Nuclear Framework law
Sinop project milestones

- 03/05/2013: IGA was signed between Turkey and Japan
- 15/07/2014: MENR obtained Preliminary site permission for 60 months
- 01/09/2014: Data collection for EIA and site works began
- 01/04/2015: IGA*, MoC* (including HGA*) ratified by the Turkish Parliament
- 31/07/2015: IGA came into force and technical feasibility stage was started for 18 months
- 10/08/2015: Cabinet Decree for «Establishment of Abroad Company by EÜAŞ
- 06/10/2015: Abroad company of EUAS (EUAS International ICC) was officially created

Next step

- Implementation agreement
- Shareholder agreement
- Establishment of the Project Company: EÜAŞ and Consortium MHI, Itochu, ENGIE

*: IGA = Inter-Governmental Agreement; HGA = Host Government Agreement; MoC: Memorandum of Cooperation
Feasibility study (start 31/07/2015; 18-24 months): the technical, economic and financial feasibility of the project must be demonstrated.
Sinop Project implementation scheme

Build-Own-Operate (BOO) with 20 years PPA (100%) and non-recourse financing

---

**Turkish Govt.**

**TETAŞ**
(Turkish Electricity Trading and Contracting Company)

**TEİAŞ**
(Turkish Electricity Transmission Company)

**TAEK**
(Turkish Atomic Energy Authority)

**MoEU**
(Ministry of Environmental and Urbanization)

---

**International Consortium**
(MHI / ITC / ENGIE)

51%

**EÜAŞ**
49%

---

**Project Company**
(Turkey)

---

**EPC**

**EPC Consortium**

**Sub-Contractors**

---

**JBIC**

**NEXI**
(Banks)

---

**HGA**: Host Government Agreement

**PPA**: Power Purchase Agreement

**JBIC**: Japan Bank for International Cooperation

**NEXI**: Nippon Export and Investment Insurance

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**TBD**, **TBD**, **TBD**

---

**Insurances**, **Fuel**, **O&M services**

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SNR – Ankara

SFEN-PACA

20 avril 2016

26
La période des contraintes

- Public Acceptance
- Seismic risk
- Capacity of TAEK
- Lack of nuclear law and regulation
- Human resources
- Localization
Public acceptance

- No strong organized opposition to nuclear
- Rather important local opposition because of activism groups
- Opposition to nuclear results more of:
  - political reasons than for ideological ones
  - the choice of sites which are considered as very touristic
- Not enough explanation/advertisement from companies and government
Last earthquakes in Turkey

- High severity and high frequency
- 113 events with M>=7 in the last 400 years (one event per 4 years)
Note: Most of Turkey is susceptible to amplification of ground motions due to soft surface geology and deep sedimentary basins.
Seismic design of Atmea-1

- Symmetric layout of safety related buildings to avoid twist deformation of buildings under earthquake loadings
- Large rectangular basemat (Fuel -, Reactor -, Safeguard Buildings) to improve seismic stability
- Japanese design and construction experiences against earthquake were fully implemented in ATMEA1 design
Main Functions
- Regulatory
- Research and Development
- Utilization

Headquarter
- Regulatory units
- Coordination units
- Administrative units

Research and Training Centers
- Research and development units
- Nuclear and radiation facilities

Atomic Energy Commission
- Decision body on policy and licensing issues

Advisory Council
- Advisor to the AEC and the President

Advisory Committee on Nuclear Safety
- Advisor in licensing of nuclear installations
**HR Planning – Technical Positions**

* Assumes Akkuyu and Sinop NPP projects are implemented as planned

24 recommandations, 15 suggestions et 5 remarques qui relèvent des bonnes pratiques.

➢ "Le Gouvernement turc devrait clarifier les rôles et les responsabilités en matière de développement de la politique nucléaire entre MENR/NEPID et TAEK."

➢ "Le Gouvernement turc devrait terminer l'élaboration des règlements visant à clarifier la portée et les modalités de gestion des déchets radioactifs et du démantèlement."

➢ "La Turquie devrait veiller à ce que la loi générale de l'énergie nucléaire soit promulguée dès que possible et, réponde de manière adéquate à un certain nombre de questions importantes."

➢ "La Turquie devrait promulguer la loi sur la responsabilité civile pour les dommages nucléaires."

➢ "Le Gouvernement turc devrait garantir l'indépendance des fonctions de réglementation, y compris au cours de la procédure d'autorisation."
Human resources

1. Identifying the gap between current capabilities and the requirements – use of the NPHR Modelling Tool

2. Establishment of National Nuclear Training Center for Technicians/Engineers

3. Establishment of Research and Development Center

4. Establishment of Testing Laboratories

Human Resource Planning

- 330 nuclear engineers graduated from Hacettepe University
- 350 engineers employed by TAEK
- 294 students study nuclear engineering at MEPHI (600 in total)
Localization

Main Road Map


2. On-site survey were carried out in the light of collected data. As a result of the survey current capacity will be revealed

3. Determining the gap between current status and the target

4. Developing capacity improvement plans

5. Implementation Projects
Company Inventory Form

Fields of Activity

Number and Qualification of Personnel

Quality Documents

Machine Inventory

Facilities

Design Capability
Main Results of On-site Company Survey

- Collected data from 546 Turkish companies so far.
- In order to determine the capability of Turkish national industry to manufacture nuclear power plant equipment, on-site inspections are on-going under coordination of MENR, with the cooperation of universities, chambers of industry and regional development agencies in the light of data collected via “Company Inventory Form”
Location of companies

546 companies

- Ankara
- İstanbul
- Kocaeli
- Adana
- Bursa
- İzmir
- Hatay
- Kahramanmaraş
- Konya
- Manisa
- Mersin
- Aksaray
- Antalya
- Aydın
- Balıkesir
- Bolu
- Çorum
- Edirne
- Eskişehir
- Samsun
- Sivas
- Uşak

SNR – Ankara            SFEN-PACA            20 avril 2016
Certificates of companies

- GOST: 76
- ASME: 72
- ISO 9001: 282
- AQAP 2110: 11
- AS 9100: 15
- ISO 14001 ve 18001: 152
- CE, TSE Sertifikaları: 136
### Manufacturers

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALVES</td>
<td>36</td>
</tr>
<tr>
<td>PUMPS</td>
<td>22</td>
</tr>
<tr>
<td>MECHANICAL</td>
<td>83</td>
</tr>
<tr>
<td>LABARATORY</td>
<td>20</td>
</tr>
<tr>
<td>I&amp;C</td>
<td>41</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>105</td>
</tr>
<tr>
<td>HVAC</td>
<td>39</td>
</tr>
<tr>
<td>ELECTRIC&amp;ELECTRONIK</td>
<td>48</td>
</tr>
<tr>
<td>PIPING AND FITTINGS</td>
<td>49</td>
</tr>
<tr>
<td>PRESSURIZED VESSELS</td>
<td>56</td>
</tr>
</tbody>
</table>
Some Turkish companies already cooperate with international NPP suppliers

- Russian company Power Machines which produces turbine and generators signed a cooperation agreement with a Turkish Company in Ankara to manufacture sub-systems of turbine and generators for NPPs.

- A Turkish Company is working for supplying steel pipes to NPPs mainly in England and other foreign countries. This company have ASME NPT certification.

- Turkish companies are working with Czech and Slovakian companies to supply steel pipe fittings and pumps for nuclear power plants.
Il est encore trop tôt pour savoir si la Turquie réussira son programme nucléaire, mais si parfois l’ambition peut tirer la réalité, heureusement souvent la réalité rattrape les ambitions !

Yavuz Sultan Selim Bridge
(Third Bosphorus Bridge)

When completed, it will be the longest combined motorway/railway bridge in the world.

Kanal İstanbul

According to Mr. Erdoğan, this canal will overshadow the canals of Suez and Panama by the traffic

3rd Istanbul Airport

It is planned as the largest airport in the world with a 150 million passenger annual capacity
Merci pour votre attention

Gerard.Cognet@cea.fr

http://www.cea.fr