

AKKUYU Nuclear Power Plant (NPP) (VVER – 1200 - 4 x 1000 MW) Model Diagram





Establishment of the Company

<u>Ownership:</u>

Only Russian equity, but the Company is allowed to make partnership with the local financial resources in Turkey.

- The shareholders of Akkuyu NPP JSC are:
 - Rosenergoatom Concern OJSC (92.85%);
 - Inter RAO UES JSC (3.47%);
 - Atomstroyexport JSC (3.47%);
 - Atomenergoremont OJSC (0.1%);
 - Atomtekhenergo JSC (0.1%).
- According to the Agreement, foreign investors are allowed to buy a stake of no more than 49% in the company's share capital at any time.



Location of AKKUYU NPP

Adana Airport Adana

Osma

Iskender

40

Hata

OOP

Akkuyu NPP Icel Akkuyu Ngs Bilgilendirme Merkezi

Erdemli

Sillifke

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Plant Field





Establishment of the Company

- According to the Agreement, provisions the Russian side registered a Project Company Akkuyu NPP JSC (AKKUYU NGS ELEKTRIK ÜRETIM ANONIM ŞIRKETI- APC) in Turkey on December 13, 2011.
- The Company undertakes the responsibility for designing, constructing, maintaining, operating and decommissioning of the plant for 60 years and TETAŞ will be the energy purchasing party for the first 15 years.



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Basic Project Features

- First Nuclear Power Plant in Turkey
- Design: AES-2006 series (VVER 1200), 4 Units
- Total capacity: 4800 MW (Gross output)
- Construction period: 2011 2023
- Total Project cost: ~ \$ 20 B
- Generation output: ~ 35 B kWh/year
- Opportunity for foreign investors participation: up to 49% shares
- BOO Model (Build-Own-Operate)



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Advantages

- Profit from electricity sales after pay back period
- Revenue guarantee for Project investors – PPA
- Usage of Proven technology
- Operational experience
- Sustainable operation and availability of fuel; spare parts and maintenance services
- Involvement of Turkish industry and Turkish personnel in construction and operation of NPP
- Decommissioning





Disadvantages

- Need to forecast long-term electricity price
- The Project Company bears all risks
- Possibility of unpredictable growth of the construction costs due to economic and political force majeure
- Difficulty to find investors





Generation Projects Licenced by EMRA

Percentage of	Thermal (MW)				Hydroelectric Renewables (/IW) Total (MW)		Percentage in the			
Completion (%)	Natural Gas	Import	Domestic	Waste	Total	(MW)	Wind	Geother	Others		Tota	l (%)
		Coal	Coal	Disposal				mal				
0-10	10.401	3.586	1.604	654	16.245	7.954	4.563	6	72	28.840	66,96	
10-20	1.560	1.200	135		2.895	1.323	601	77		4.896	11,37	
20-30	867				867	1.265	190			2.322	5,39	
30-40	370				370	558	224	36	2	1.190	2,76	
40-50					-	223	29			252	0,59	87,07
50-60					-	123	68	224	2	417	0,97	
60-70	850				850	386	103			1.339	3,11	
70-80	128		450		578	259	27		2	866	2,01	
80-90	139		290		429	738	132			1.299	3,02	
90-100	162		339	270	771	711	135	24	7	1.648	3,83	12,93
Total	14.477	4.786	2.818	924	23.005	13.540	6.072	367	85	43.069	100,00	100,00
Capacity Factor	85,00	85,00	80,00	80,00		42,00	32,00	80,00	25,00			
Annual Generation (Billion kWh)	107,80	35,64	19,75	6,48	-	49,82	17,02	2,57	0,19	239,25		
Annual Gas Consumption (bcm)	19,08											
Payment to be made (USD)	7.154,58											



Demand Balance Suppl Yıl Düşük Senaryo Yüksek Senaryo Talep (GWh) Talep (GWh) Artış (%) Kurulu Güç (MW) Kurulu Güç Kurulu Güc Artış (%) Kurulu Güç Artışı (MW) (MW) Artışı (MW) 65.480 2014 256.661 4,20 1.436 256.661 4,20 65.480 1.436 2015 268.724 4,70 72.439 6.959 277.194 8,00 72.439 6.959 2016 74.700 2.261 74.700 279.473 4,00 294.934 6,40 2.261 2017 290.093 3,80 75.900 1.200 313.515 6,30 75.900 1.200 2018 304.017 4,80 76.320 420 333.267 6,30 76.320 420 2019 319.218 5.00 77.520 1.200 353.929 6.20 77.820 1.500 2020 334.860 4,90 78.720 1.200 375.873 6,20 79.320 1.500 2021 349.929 4,50 81.120 2.400 396.170 5,40 81.720 2.400 2022 365.326 83.520 2.400 417.563 5,40 84.120 2.400 4.40 2023 381.400 4.40 85.920 2.400 439.964 5,36 86.520 2.400 2024 398.182 4,40 88.320 2.400 462.998 5,24 88.920 2.400 2025 415.702 4,40 90.320 2.000 487.537 5,30 90.920 2.000 2026 92.320 5,20 433.992 4,40 2.000 512.888 92.920 2.000 2027 453.088 94.320 2.000 539.559 5,20 2.000 4,40 94.920 2028 96.320 2.000 567.616 5,20 2.000 473.024 4,40 96.920 2029 98.320 2.000 597.132 5,20 98.920 2.000 493.837 4,40 2030 515.566 4.40 100.320 2.000 628.183 5,20 100.920 2.000



Payments of Turkey to Oil and Gas in 2023

Total Electricity Generation in 2014 (Billion kWh)		
Electricity Generated by Gas fired Power Plants in 2014 (Billion kWh)		
Percentage of the Electricity Generated by Gas fired Power Plants in 2014 (%)		
Mevcut Tüketim (bcm)	48,50	
Gas Tariff (Gazprom) in 2014 (USD/1000 m3)	375,00	
Payment made for total Gas Consuption in 2014 (Billion USD)	18,19	
Gas Consumed for Electricity Generation in 2014 (bcm)	21,51	
Gas Consumed by Consumers other than Electricity Generation in 2014 (bcm)		
Gas to be Consumed by Power Plants Licenced by EMRA up to now (bcm)	19,50	
Gas Consumption other than for Electricity in 2023 (bcm)		
Increase in Gas Consumption until 2023 (bcm)		
Total Extra Gas Consumption in 2023 (bcm)		
Payment to be made total Gas Consuption in 2023 (Billion USD)		
Payment made to oil in 2014 (Billion USD)		
Payment to be Made total Gas and Oil Consuption in 2023 (Billion USD)		

Opinions – Views (1/2)

- Turkey cannot go on consuming gas in that way, with such a sharp slope of increase in consumption,
- Some of the plants licenced by EMRA have a serious risk of not being able to sign GSA (Gas Sales Agreement) with the gas suppliers, i.e. they may not be able to find gas to burn,
- Thus, some of the gas fired plants, except those supported by Gasprom-linked local supplier companies, may not even have the chance of being installed,



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Opinions – Views (2/2)

- Even if they could find the change of being installed, it is quite uncertain, whether they could be able to find gas to burn at reasonable prices, as prices tend to increase, progressively,
- It can be said that Turkey has reached the end of road for generating electricity by gas fired power plants,
- Even in the first quarter of 2015, some gas fired power plants have decided to discontinue and put the plants on sale in the secondary-hand market.





Basic Principles implemented by Turkey in AKKUYU Project The First Principle;

Nuclear electricity is the most attractive solution for the countries;

- with no significant fossil-based resources lying underground to be burned for electricity,
- importing a large amount of natural gas for electricity and making siginificant payment for that, <u>(Turkey imported 48 bcm gas in 2014, 5th</u> <u>largest in the World, and paid 60 billion USD for oil and gas)</u>.
- with extensive public protests made by environment activists for domestic and import coal and hydroelectric power <u>(Nuclear Power</u> <u>Plants do not have CO₂ emissions)</u>



Basic Principles implemented by Turkey in AKKUYU Project

- Turkey aims to obtain only long-term reliable electricity with reasonable price, not the nuclear technology,
- Turkish side will not participate to the investment in any way, thus, allowing the Company to recover all fixed costs through the tariff,
- The plant will be operated by Russian technical staff, like some other plants in Turkey, owned and operated by German and American Managements ^(*)

(*) Gas fired plants in Kaklık, Denizli and Adapazarı



Basic Principles implemented by Turkey in AKKUYU Project

- \circ Percentage of the fuel cost (UO₂) in the overall wholesale electricity tariff does not exceed 10 %,
- Thus, a 100 % increase in the fuel cost will result in 5-10 % increase in the overall wholesale electricity tariff,
- Thus, nuclear electricity is more stable against price fluctuations in the World,
- Gas prices on other hand, has 90 % influence on the overall wholesale electricity tariff,



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Turkey's Nuclear Power Programme

Basic Principles (Continued)

expects to have Turkey a powerful plant, with 4800 MW rating and 35.7 billion kWh capacity, to be committed at the bottom of the "Load Duration Curve", operating competitively in the wholesale market, with reasonable market prices after the 15 year agreement has been expired.





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Law No. 5710 – Determination of the Winner Firm

- Article 3.4 Tender is announced to public and followed by the buyer Company: TETAS^(*).
- Article 3.5 Candidates are evaluated and the winner Firm^(**) is determined and announced by TETAS.

TETAS is granted with authority of making Electricity Sales Agreement (ESA) with the Company by the Council Ministers.

(*) Government owned wholesale company responsible for trading electricity generated by Government owned power plants or those with Electricity sales Agreenet (ESA), (**) ROSATOM, Russia



Law No. 5710 – Electricity Sales Agreement (ESA)



The winner Company (ROSATOM) is granted with licence by EMRA (Energy Market Regulatory Authority).

Electricity Sales Agreement is signed between the buyer company (TETAS) and the winner Company for 15 years period.

Rated Power of the Plant 4 x 1200 = 4800 MWin total, each unit to be put in service progressively, starting from 2020.



Price Profile



Price profile is "Front-loaded" with a descending characteristics in 15 years, starting from 15.3 Cents/kWh with an average value of 12.30 Cents/kWh.

(The curve is an illustration, as the actual curve has not been officially published)



Status of the Company after the 15 Years of Agreement Period

VVER – 1200 Steam Turbines

Commercial status of the company will be reduced to "Generation Company acting in the Competition-Based Market"

The Company is allowed to make trading activity in the wholesale market with respect to the competition-based market prices for the remaining 25 years, following the 15 years of agreement period.

Status of the Company after the 15 Years of Agreement Period

Reactor Building

The duration of operation of the plant is expected to be 40 years, although it is inofficially declared to be 30 year.

The company will be highly competitive in the wholesale market after the 15 years of agreement period has been expired, as all the fixed costs will be recovered within the agreement period.

The company will have 25 more years of competition-based commercial activity in the wholesale market.

Date of Commissioning

Steam Generator

Date of commissioning of the first unit of plant has been recently postponed to year 2022, due to long delays in the formal procedures, although it has been initially decided as 2020.

Guaranteed Percentages of Purchasing

Unit	Rated Power (MW)	Purchasing Guarantee (%)	GNCA – 1389 Reactor Coolant Pump
1	1200	100,00	
2	1200	70,00	
3	1200	50,00	
4	1200	50,00	
1	Average	70,00	

The Company is allowed to sell the excess generation in the market

Capacity Factor of AKKUYU NPP

Capacity Factor of VEER-440 Lovisa NPP (Finland) in Years

Capacity Factor of AKKUYU NPP

Capacity Factor of AKKUYU will not be less than those of predescents, i.e. LOVISA in Finland installed by ROSATOM.

Thus, the Capacity Factor can safely be assumed as 85 %

Annual Generation Capacity of AKKUYU NPP

1.200
4
4.800
8.765
85,00
35,76
255,00
14,02

Annual Generation Capacity of AKKUYU NPP:

$P_{total} \times d \times c \times 1000$

where, P_{total} is the total rated power, d is annual duration, 8760 hours, c is capacity factor, 85 %,

Thus, yeilding 35,76 billion kWh / year, which makes 14,02 % of the overall demand.

Purchasing obligations to be Imposed on the Retail and Wholesale Companies

Retail and wholesale companies will be obligated to trade the nuclear electricity with respect to the formula;

Share of Retail and Wholesale Company = Consumption of the Company x Nuclear Electricity Consumption of Turkey

Further details on the purchasing obligations to be imposed on the retail and trading companies will be developed and outlined in a regulation to be issued by the Ministry of Energy and Natural resources (MENR)

Financial Profile of the Investment

Rated Power/Unit (MW)	1.200
No of Units	4
Rated Power of the Project (MW)	4.800
Overnight Cost/kW (USD/kW)	3.340
Total Overnight Cost (Million USD)	16.032
Interest Rate (Libor + Spread) (%)	5,50
Total Interest during the 7 year Construction Period (M USD)	4.209
Total Financial Cost of the Investment (Million USD)	20.241
Return Period (Years)	9
No. of Return Payments / Year	12

Financial Profile of the Investment

Monthly Return Payment (Million USD)	238,04
Commercial Capacity Factor (Percentage of Purchasing) (%)	70,00
Annual Duration of Operation (Hours)	6.135
Annual Generation sold to TETAS (billion kWh)	29.45
Monthly Generation sold to TETAS (billion kWh)	2.45
Capacity Cost (Cent/kWh)	9,699
Fuel Cost (Cent /kWh) (UO ₂ - Uranium Fuel, 140 USD/Lb)	0,760
National Radioactive Waste Disposal Foundation (Cent/kWh)	0,150
Plant Decommisioning Foundation (Cent /kWh)	0,150
Operation and Maintanance Expenditures (Cent/kWh)	1,280
Cost of Wholesale Electricity (Cent / kWh)	12,039

Total Interest during the is year construction Period						
Years	Percentage	Loan (Million USD)	Interest (Million			
	of Loan (%)		USD)			
1	10	1.603	728,94			
2	15	2.405	911,04			
3	15	2.405	738,18			
4	15	2.405	574,33			
5	15	2.405	419,02			
6	15	2.405	419,02			
7	15	2.405	419,02			
Total	100	16.032	4.209,53			

Decommissioning Costs (Million USD)

Rated Power/Unit (MW)	1.200
No of Units	4
Rated Power of the Project (MW)	4.800
Overnight Cost/kW (USD/kW)	3.340,00
Total Financial Cost of the Investment (Million USD)	20.241,53
Ratio of Decommissioning Cost to Overnight Cost (%)	15
Total Decommissioning Cost during the Commercial Life (Million USD)	2.404,80
Commercial Life (Years)	40,00
Decommissioning Cost / Year (Million USD)	60,12
Annual Generation Capacity (billion kWh)	29,45
Total generation during the Commercial Life (billion kWh)	1.178,02
Decommissioning Cost / kWh (Cent/kWh)	0,20
Annual Decommissioning Cost with 0,15 Cent / kWh (Million USD)	44,18
Total Decommissioning Cost within the Commercial Life with 0,15 Cent / kWh (Million USD)	1.767,02

SINOP Project

Sinop Project is rather new with almost no information has been published officially.

- Intergovernmental Agreement between Turkey and Japan was signed in May 2013.
- The Project Site is Sinop, Northern Part of Turkey, near the Black Sea.
- Contracting Companies are MITSUBISHI Heavy Industries Inc, ITOCHU and GDF Suez - AREVA (France),

SINOP Project

Sinop Project is rather new with almost no information has been published officially.

- $\circ \qquad \text{Rated Power is } 1120 \text{ x } 4 = 4480 \text{ MW},$
- Duration of Agreement is 20 Years,
- Capital share of the Turkish Side (EUAS) is 49 %,
- Average price of electricity is 10.38 Cents / kWh, and the studies for technical feasibility are still ongoing and negotiations between EUAS and the Japanese Consortium for establishing Project Company have not been finalized yet.
- No further information is available

Project Site

Furkish Students in Program Nuclear Engineering Training in Russia

