

Industrial and household energy
consumption and air pollution in
developing countries: a case from
Georgia

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CONTENT

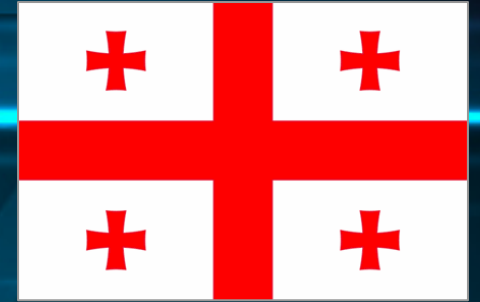
- About Georgia
- Energy Sector
- Generation of Electricity
- Energy Consumption
- Air pollution

LOCATION





ABOUT GEORGIA



- **Capital:** Tbilisi
- **Date of Independence:** April 9, 1991
- **Size:** Approximately 69,875 square kilometers
- **Ethnic Groups:** In early 1990's Georgians 70,1%, Armenians 8,1%, Russians 6,3%, Azeris 5,7%, Ossetians 3%, Abkhazians 1,8%, other nations 5%
- **Official Language:** Georgian language (the group of Caucasian languages, different from Indo-European and Turkish languages)
- **Religion:** Georgian orthodox 65%, Russian orthodox 6,3%, Muslims 11%, Armenian apostolic 8%, Catholics 6%, other confessions 3,7%

HISTORY

- It's a very long time that a human lives on the territory of Georgia. Here, near town Dmanisi, was found the remainder of the fossil human (*Homo ex gr. erectus*) the age of which is Plio-Pleistocene (approximately 1,8 million years).
- Figure of Lion. 23rd century B.C.
Tsnori, Kakheti
- Golden Cup. 19th - 18th centuries B.C.
Tsalka, Trialeti.



GOLDEN ERA

David IV the Builder (1073-1123) was the king of Georgia from 1089 to 1125. He was sixteen years old when he took the reins of power. Due to his wise policy he managed to enhance devastated Georgia to the highest level of political and economic stability. King David liberated Georgia from the conquerors, cleared the capital of Georgia Tbilisi from the Islamic invaders, extended the borders of the kingdom, strengthened



the state order as well as the ecclesiastical. David IV built Gelati Monastery and founded Gelati Academy, one of the most important hearths of Georgian culture. He created a poetic masterpiece "Galobani Sinanulisani" ("Psalms of Regrets")

The Georgian Orthodox Church canonized King David.



Queen Tamar

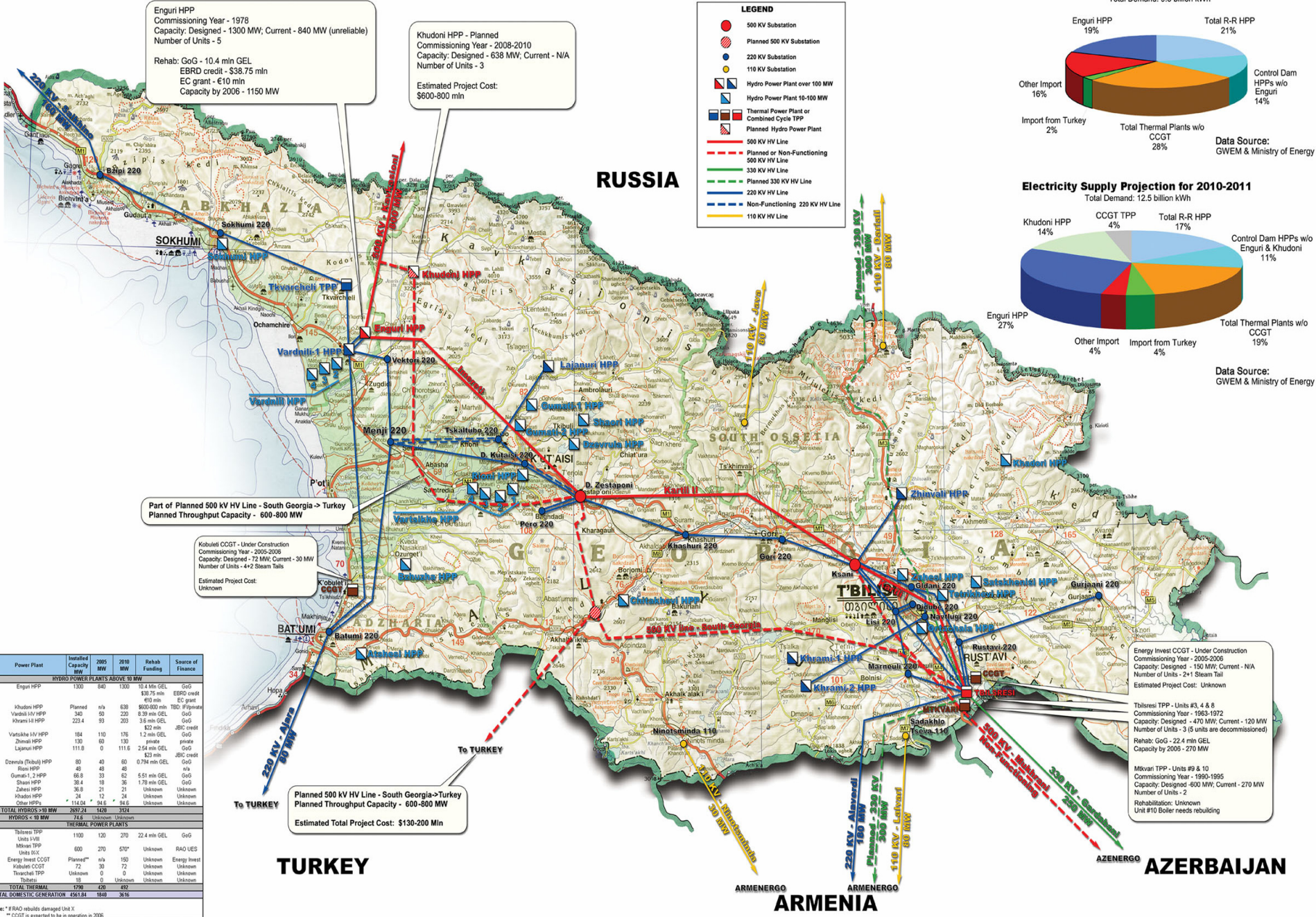
(approx. 1160-1213).

The daughter of George III came to the throne in 1184.

In the reign of Queen Tamar Georgia reached the highest level of

political strength economical and cultural development. A lot of churches and monasteries were built. Queen Tamar patronized and supported centers of Georgian culture scientist, poets, artists. The Georgian Ortodox Church canonized Queen Tamar.

POWER SUPPLY OF GEORGIA



Enguri HPP
Commissioning Year - 1978
Capacity: Designed - 1300 MW, Current - 840 MW (unreliable)
Number of Units - 5

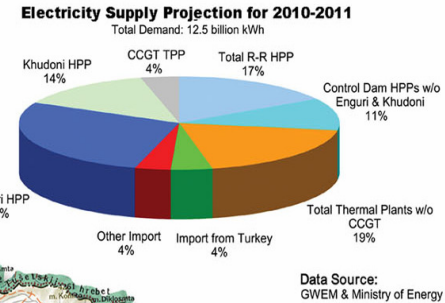
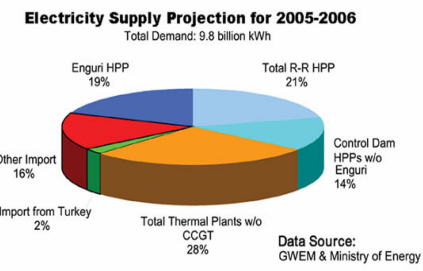
Rehab: GoG - 10.4 mln GEL
EBRD credit - \$38.75 mln
EC grant - €10 mln
Capacity by 2006 - 1150 MW

Khudoni HPP - Planned
Commissioning Year - 2008-2010
Capacity: Designed - 638 MW, Current - N/A
Number of Units - 3

Estimated Project Cost:
\$600-800 mln

LEGEND

- 500 KV Substation
- Planned 500 KV Substation
- 220 KV Substation
- 110 KV Substation
- ▣ Hydro Power Plant over 100 MW
- ▣ Hydro Power Plant 10-100 MW
- ▣ Thermal Power Plant or Combined Cycle TPP
- ▣ Planned Hydro Power Plant
- 500 KV HV Line
- - - Planned or Non-Functioning 500 KV HV Line
- 330 KV HV Line
- - - Planned 330 KV HV Line
- 220 KV HV Line
- - - Non-Functioning 220 KV HV Line
- 110 KV HV Line



Part of Planned 500 KV HV Line - South Georgia -> Turkey
Planned Throughput Capacity - 600-800 MW

Kobuleti CCGT - Under Construction
Commissioning Year - 2005-2009
Capacity: Designed - 72 MW, Current - 30 MW
Number of Units - 4+2 Steam Tails

Estimated Project Cost:
Unknown

Planned 500 KV HV Line - South Georgia->Turkey
Planned Throughput Capacity - 600-800 MW

Estimated Total Project Cost: \$130-200 Min

Energy Invest CCGT - Under Construction
Commissioning Year - 2005-2006
Capacity: Designed - 470 MW, Current - N/A
Number of Units - 2+1 Steam Tail

Estimated Project Cost: Unknown

Tbilisi TPP - Units #3, 4 & 8
Commissioning Year - 1963-1972
Capacity: Designed - 470 MW, Current - 120 MW
Number of Units - 3 (5 units are decommissioned)

Rehab: GoG - 22.4 mln GEL
Capacity by 2006 - 270 MW

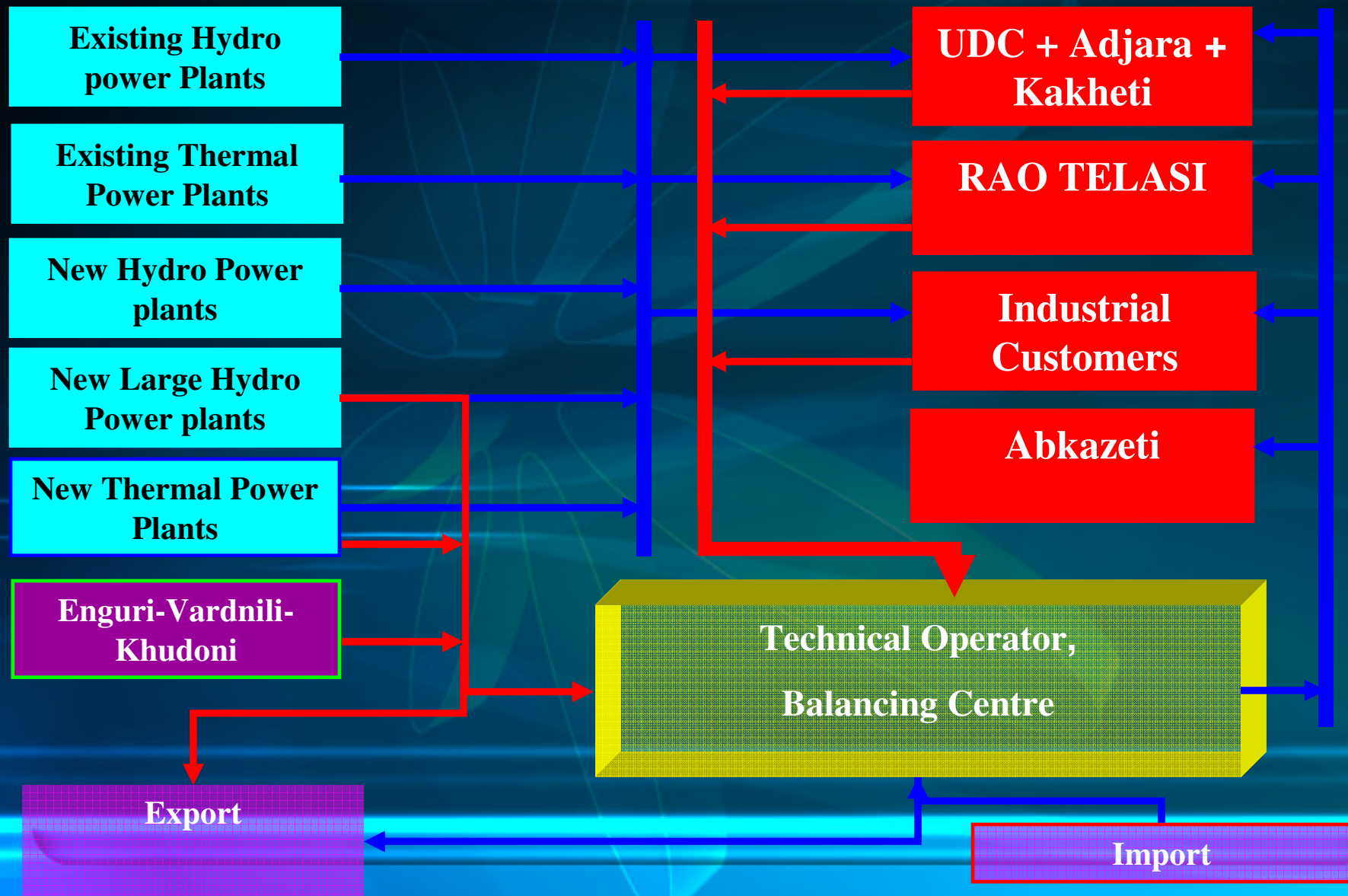
Mtkvari TPP - Units #9 & 10
Commissioning Year - 1990-1995
Capacity: Designed - 600 MW, Current - 270 MW
Number of Units - 2

Rehabilitation: Unknown
Unit #10 Boiler needs rebuilding

Power Plant	Installed Capacity MW	2005 MW	2010 MW	Rehab Funding	Source of Finance
HYDRO POWER PLANTS ABOVE 10 MW					
Enguri HPP	1300	840	1300	10.4 mln GEL	GoG
Khudoni HPP	Planned	n/a	638	\$600-800 mln	EBRD credit
Vardoli 1st HPP	340	50	200	8.39 mln GEL	GoG
Vardoli 2nd HPP	223.4	93	203	3.6 mln GEL	GoG
Vartskala 1st HPP	184	110	176	1.2 mln GEL	GoG
Zhvani HPP	130	60	130	123 mln GEL	GoG
Lapani HPP	111.8	0	111.6	2.54 mln GEL	JBC credit
Dzhenal (Tbilisi) HPP	80	40	60	0.794 mln GEL	GoG
Rioni HPP	40	40	40	n/a	GoG
Gumisi 1, 2 HPP	66.8	33	62	5.51 mln GEL	GoG
Shani HPP	38.4	18	36	1.78 mln GEL	GoG
Zakati HPP	36.8	21	21	Unknown	Unknown
Khudoni HPP	24	12	24	Unknown	Unknown
Other HPPs	114.04	94.6	94.6	Unknown	Unknown
TOTAL HYDRO > 10 MW	287.24	140	310.4		
HYDRO < 10 MW					
Tbilisi TPP	1100	120	270	22.4 mln GEL	GoG
Mtkvari TPP	600	270	570*	Unknown	RAO UES
Units 9&10	Energy Invest	n/a	150	Unknown	Energy Invest
Vidzbi CCGT	72	30	72	Unknown	Unknown
Tskhovet TPP	0	0	24	Unknown	Unknown
Tbilisi	18	0	Unknown	Unknown	Unknown
TOTAL THERMAL	1790	420	897		
TOTAL DOMESTIC GENERATION	4561.84	1849	3616		

* If RAO rebuilds damaged Unit X
** CCGT is expected to be in operation in 2006

POWER MARKET STRUCTURE



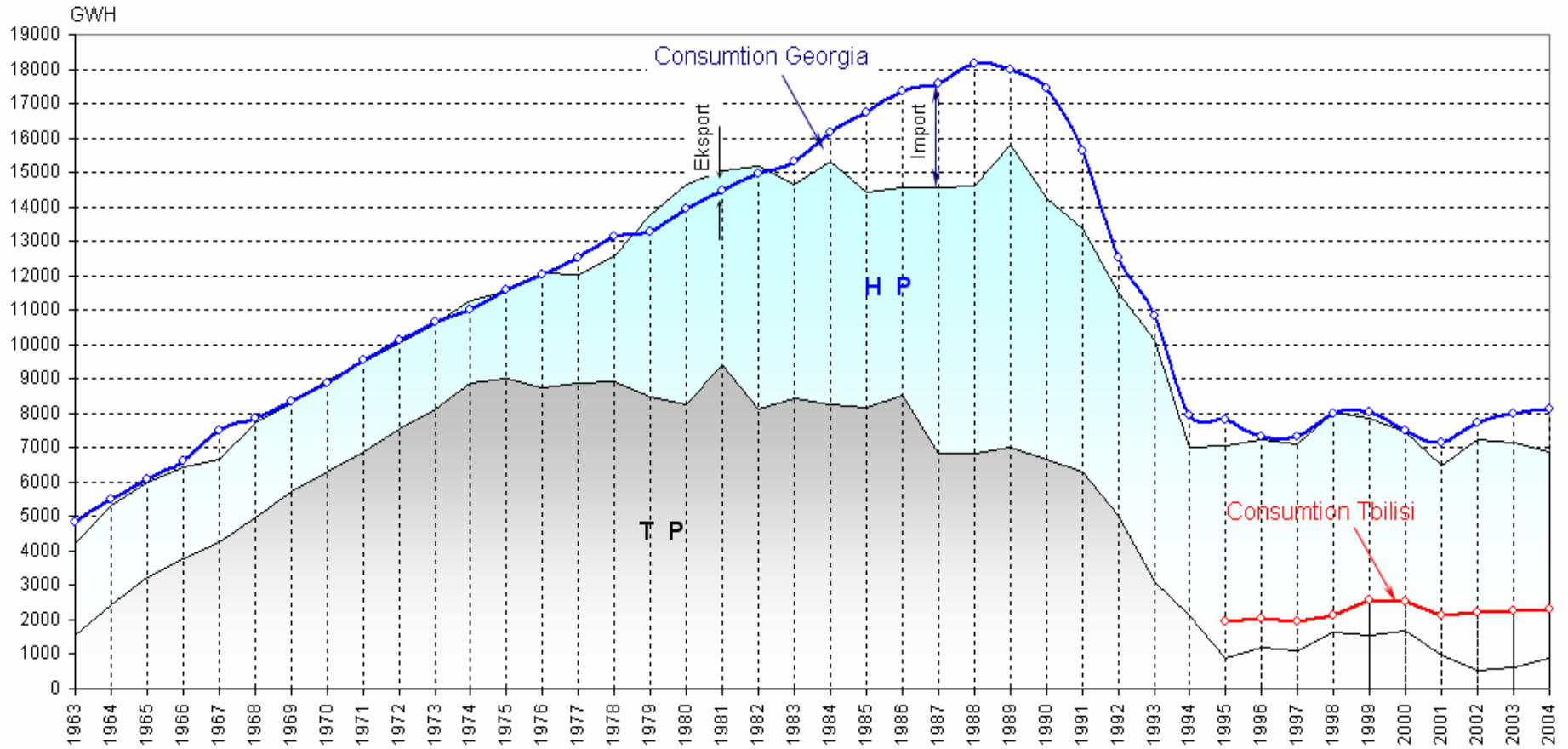
MAP OF GEORGIAN POWER SYSTEM



GENERATION CAPACITIES

- **Hydro Power Plants**
 - Largest HPP Enguri – 1300 MW
 - Medium HPPs – 80 MW-220 MW
 - Small HPPs – 0,9 MW-38,4
- **Thermal Power Plants**
 - Tbilisresi – 240 MW (1963)
 - Mtkvari – 300 MW (1990)
 - Gas Turbine - 110 (2006)

	Out of them		+Import -Eksport	Tbilisi	(GWH)																																																																																																																																																																																																																									
	HES	TES			Consumption	Generation	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004																																																																																																																																																																														
	2677	1541	616		4834	4218	1541	166		5498	5332	2446	62		6004	6004	3231	173		6445	6445	3753	809		7487	7487	4274	136		7733	7733	4954	37		8315	8315	5727	-55		8898	8898	6319	60		9538	9538	6867	102		10113	10113	7538	38		10664	10664	10626	-251		11018	11018	8880	19		11569	11569	9027	-63		12016	12016	8756	517		12536	12536	8880	563		13125	13125	8901	-479		13270	13270	8469	-741		13927	13927	8266	-540		14494	14494	9426	-234		14965	14965	8118	669		15315	15315	8437	823		16158	16158	8275	2327		16735	16735	8175	2807		17370	17370	8513	3056		17595	17595	6852	3563		18157	18157	6847	2156		17969	17969	7033	3203		17443	17443	6645	2241		15610	15610	6322	999		12500	12500	5003	714		10836	10836	3092	922		7952	7952	2119	752		7826	7826	866	83		7314	7314	1186	182		7303	7303	1128	2146		7994	7994	1634	-30		8024	8024	8024	2585		8020	8020	1538	144		7876	7876	1538	2528		7466	7466	1698	2148		7156	7156	965	2198		7713	7713	513	2251		7977	7977	635	2309		8119	8119	874



OIL & GAS EXPLORATION & TRANSPORTATION



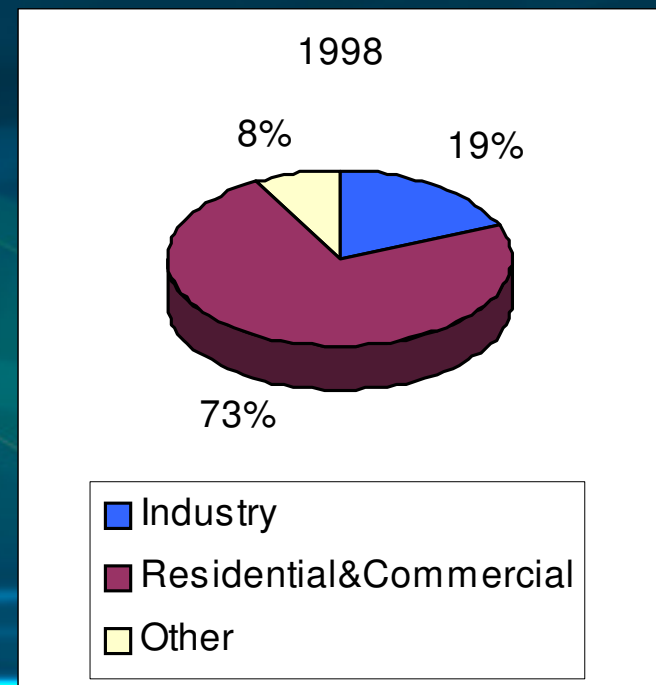
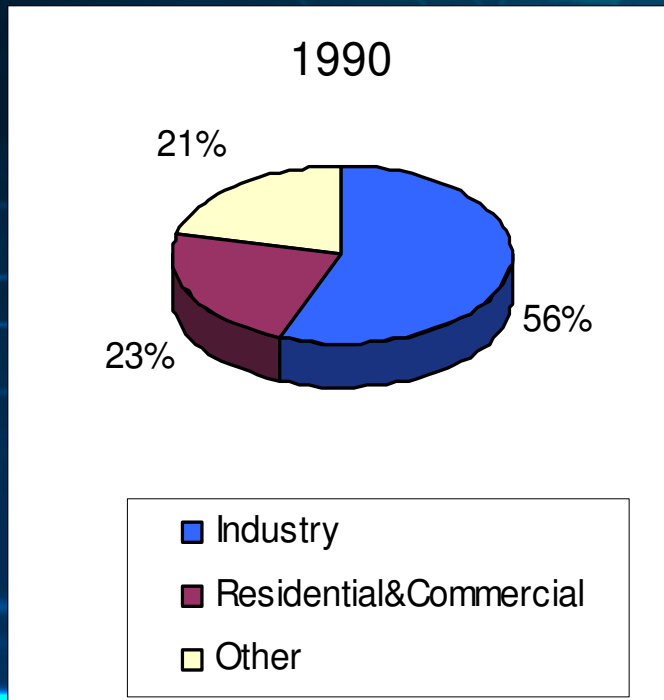
MAIN GOALS OF THE ENERGY POLICY

- Diversification of the supply sources of power carriers;
- Fully meet energy demand of industry and population;
- Achievement of independence and sustainability of the power sector;
- Provision of energy security (technical, economical and policy factors)

ENERGY CONSUMPTION

In 2005 from total consumption:

- Industrial Consumption – 25%
- Household Consumption – 75 %



AIR POLLUTION

Sources of Air Pollution

- Transport
- Industry
- Energy Sector

EMISSIONS FROM VEHICLES

- In 1991 – 70 % of total air emissions
- In 2004 – 91 % of total air emissions including:

Dust – 31 %

SO₂ – 37 %

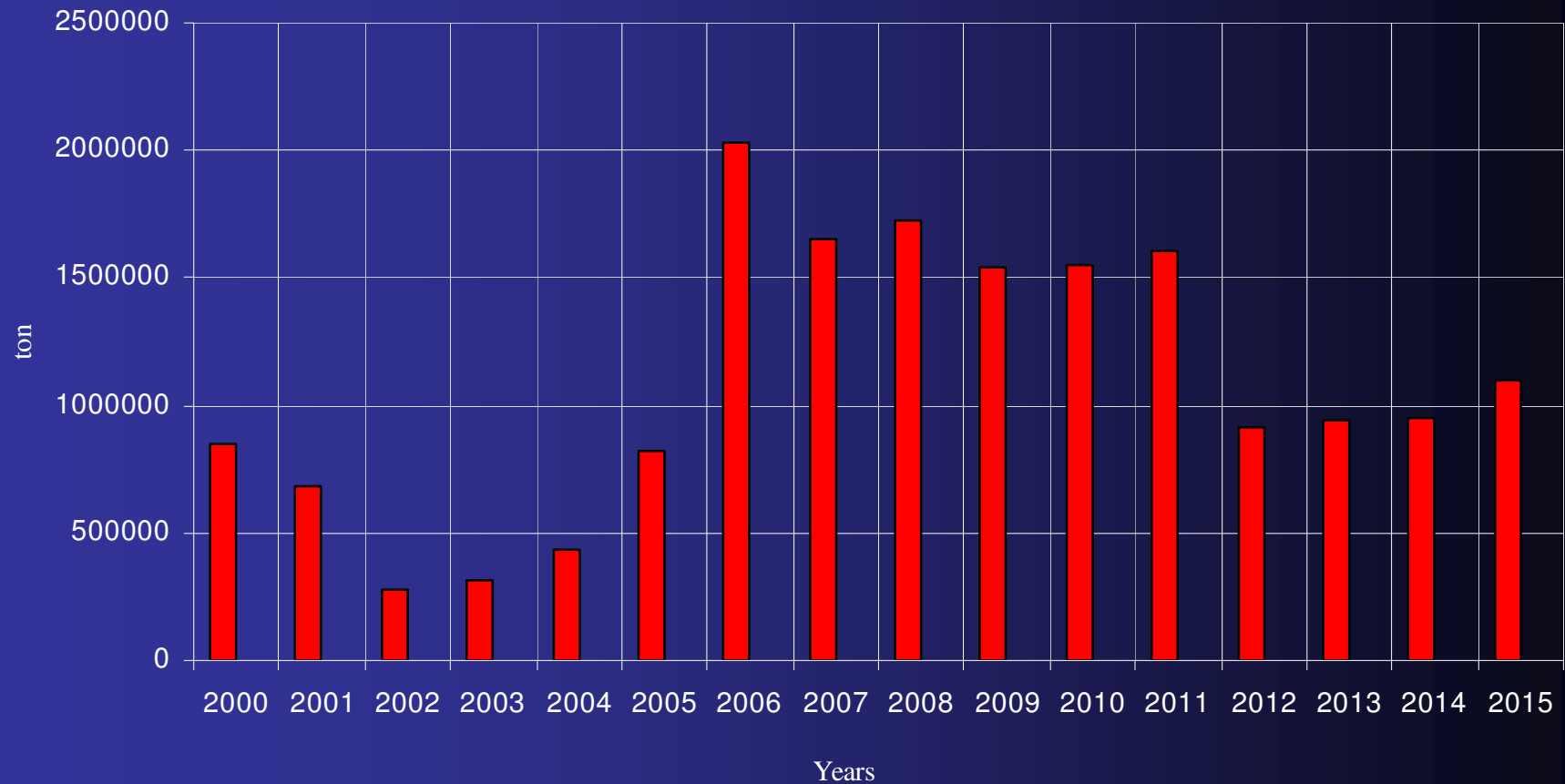
NO_x – 82 %

CO - 98 %

Emissions from Industry

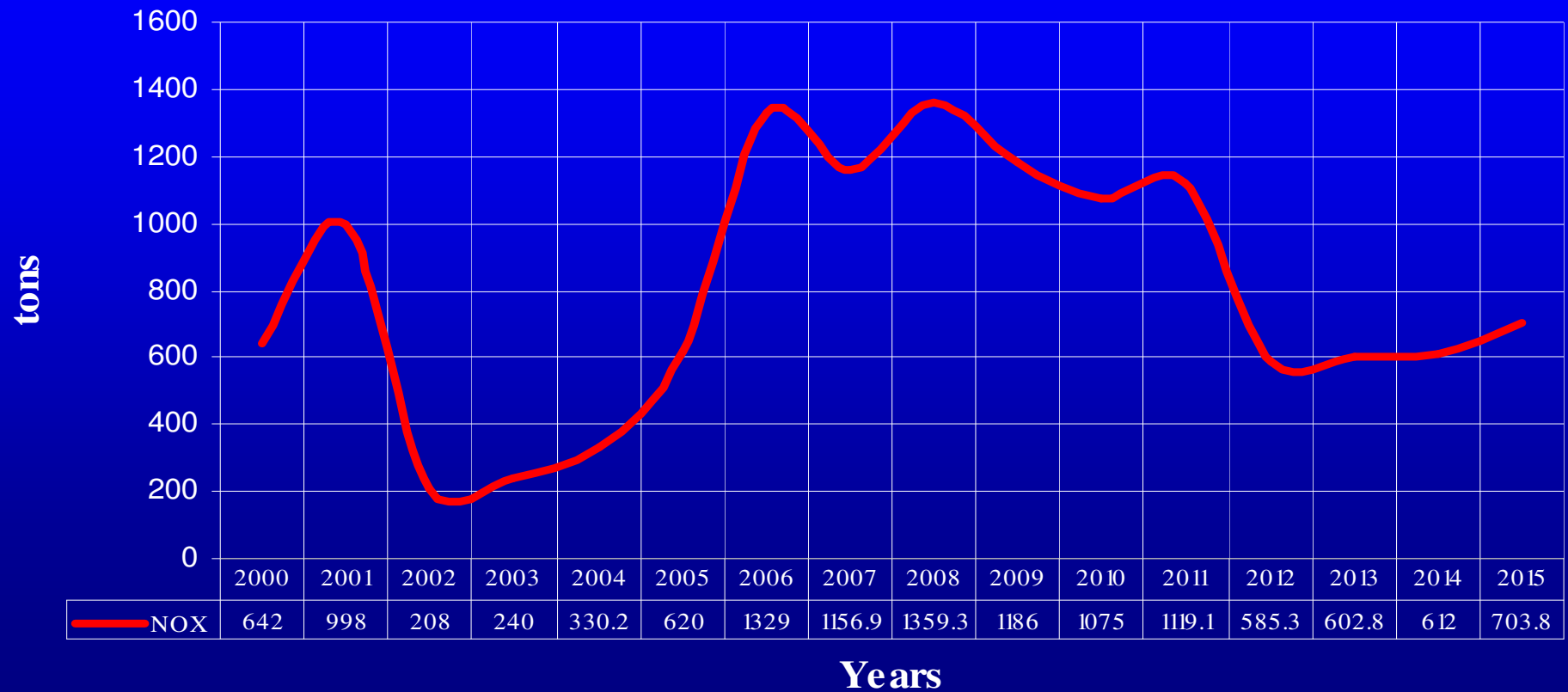
1. Thermal power station in Gardabani (near Tbilisi);
2. Thermal power station in Tkvarcheli;
3. Oil refinery in Batumi;
4. Metallurgical plant in Rustavi;
5. Ferro-manganese alloys plant in Zestafoni;
6. Chemical plant in Rustavi;
7. Truck manufacturing plant in Kutaisi;
8. Cement plant in Kaspi;
9. Cement plant in Rustavi.

CO2 EMISSIONS FROM THE ENERGY SECTOR



EMISSIONS FROM THE ENERGY SECTOR

Emissions of NO_x



POLLUTION FROM INDUSTRY, 2004

- Number of emitting companies – 153
- Total number of emitting sources – 693
 - Including organized emission – 563
 - With cleaning equipment - 307

EMISSIONS IN 2004

Name of the pollutant	Emission from stationary sources	Emission to the air	Limit of emission	% of caught emission
Total	57295.933	24113.254	81969.016	57.9
Including: solid substances	34492.158	4922.012	41202.461	85.7
including: dust	29577.425	4587.154	40735.386	84.5
Manganese and its combination	0.002	0.002	0.003	0.0
Soot-dross	9.193	9.193	9.663	0.0
Vanadium pentoxide	0.033	0.033	0.137	0.0
Other solid substances	4905.505	325.63	457.272	93.4

Name of the polutant	Emmission from stationary sources	Emission to the air	Limit of emission	% of caught emission
Gas and liquid substances	22803.775	19191.242	40766.555	15.8
including: sulphur anhidride	914.672	914.672	2352.000	0.0
Carbon	12140.224	9498.322	20414.349	21.8
Nitrogenoxides (with NO2 calculation)	2816.401	2086.349	9379.875	25.9
Hydrocarbons	6583.362	6583.362	8350.103	0.0
Sulphic acid	0.012	0.012	-	0.0
Fluorine compounds	0.518	0.518	2.196	0.0
Amonia	192.673	15.892	26.217	91.8
Toluidine	0.121	0.121	-	0.0
Xylene	3.091	3.091	31.100	0.0
Ethanol	2.107	2.107	3.048	0.0
Formaldehyde	0.024	0.024	-	0.0
Phenol	0.005	0.005	-	0.0
Aerosol	0.009	0.009	0.010	0.0
Cianide	63.636	0.068	0.133	99.9
Benzol	1.833	1.833	-	0.0
Other gas and liquid substances	85.087	84.857	207.524	0.3
Carbon dioxide	1187550.662	1187550.662	3648303.776	0.0