



TPIC

GEOHERMAL FIELD SERVICES



Turkish Petroleum International Company

NOVEMBER 2013



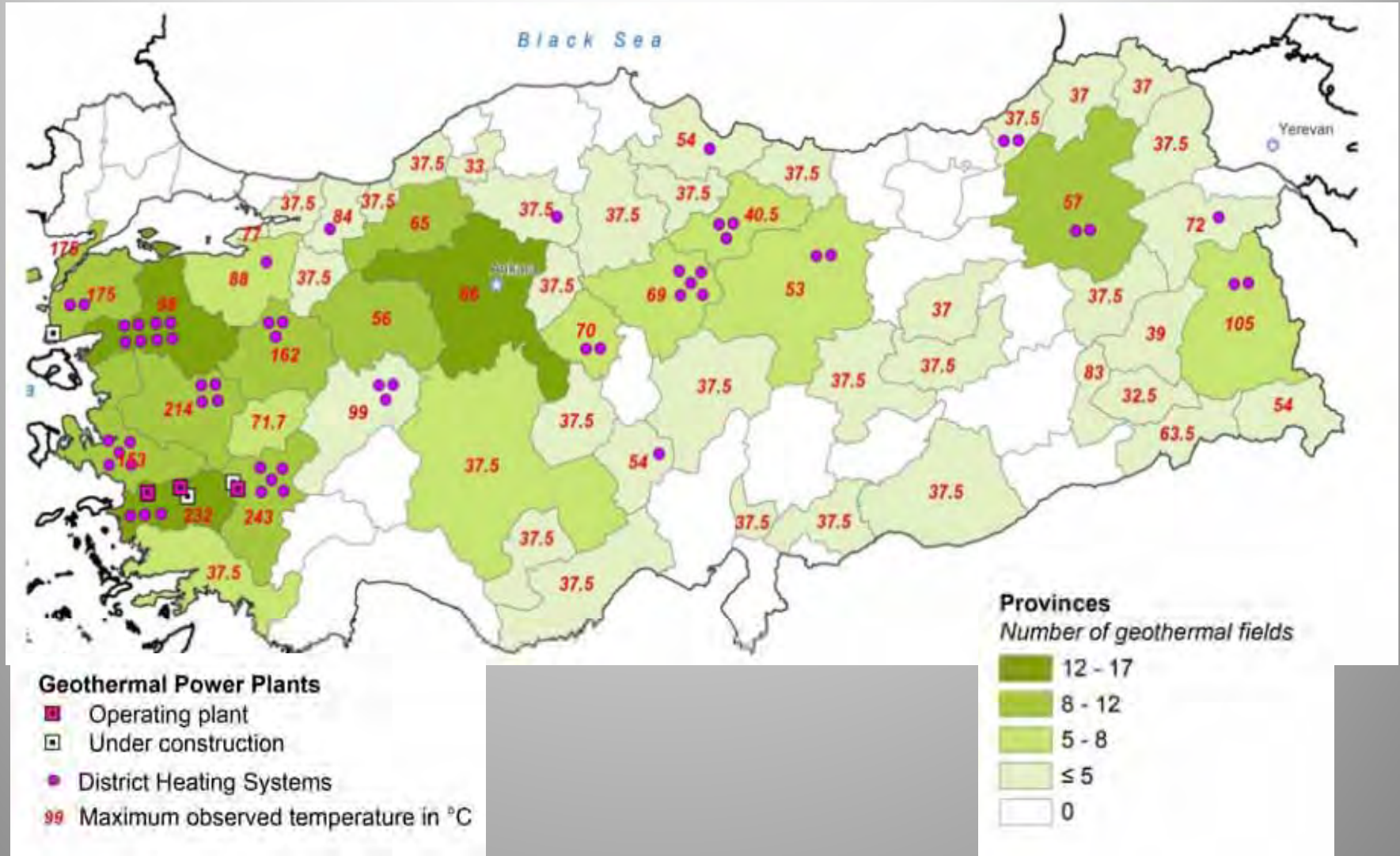
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✓ **OUTLINE**

- 1. Geothermal Fields & Energy Outlook of Turkey**
- 2. Geothermal Market in Turkey**
- 3. Exploration & Drilling Projection of TPIC**

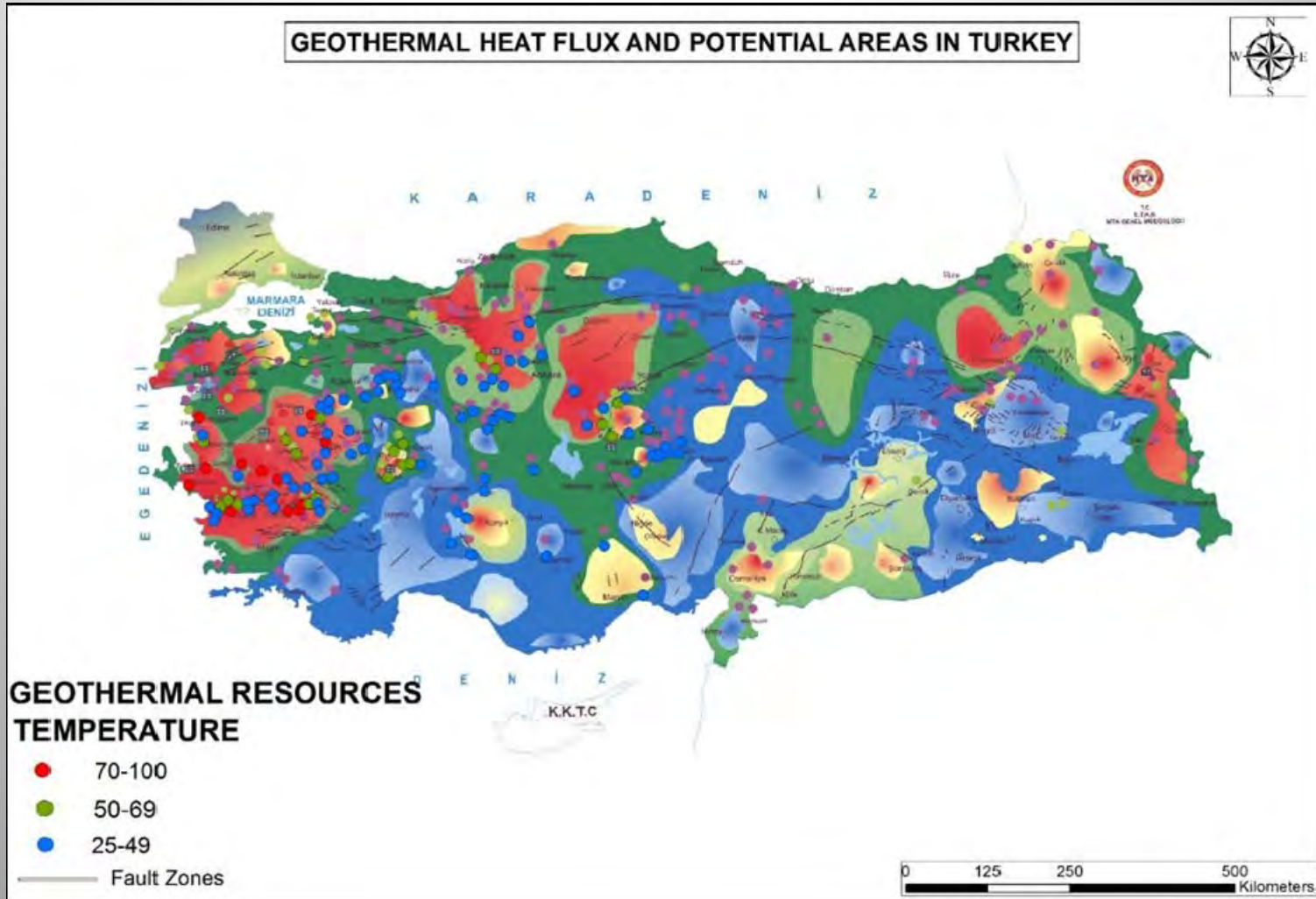


Geothermal Fields in Turkey



- 3 Types Of Temperature Data – Hot Spring Discharges, Chemical Geothermometry and Measured Downhole Temperatures





Significant fields;

- Büyük Menderes, Küçük Menderes ve Gediz Grabens in Aegean region,
- North Anatolian Fault,
- East Anatolian Fault and Central Anatolia.

Heat Flow & Downhole Temperatures In Western Turkey



Heat flow, Western Turkey



Geothermal Power Plants

- Operating plant
- Under construction

Heat Flow in mW/m^2 and depth in meters

- ≥ 200
- 110 - 200
- 65 - 110
- 40 - 65
- ≤ 40

- ▲ Quaternary Volcanoes
- Faults

Geologic Domains

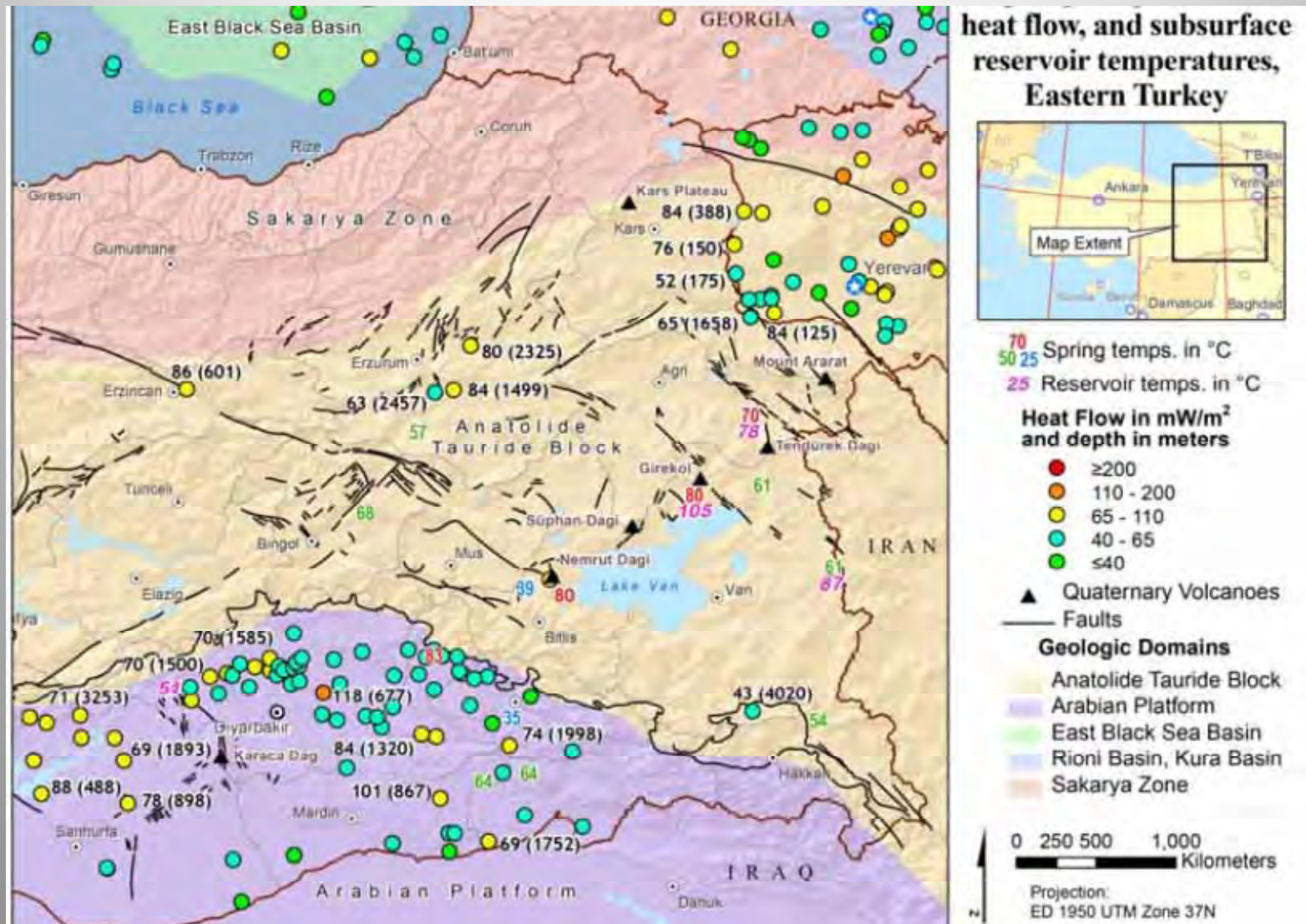
- Anatolide Tauride Block
- Istanbul Zone
- Rhodope-Strandia Massif
- Sakarya Zone
- Thrace Basin

0 250 500 1,000 Kilometers

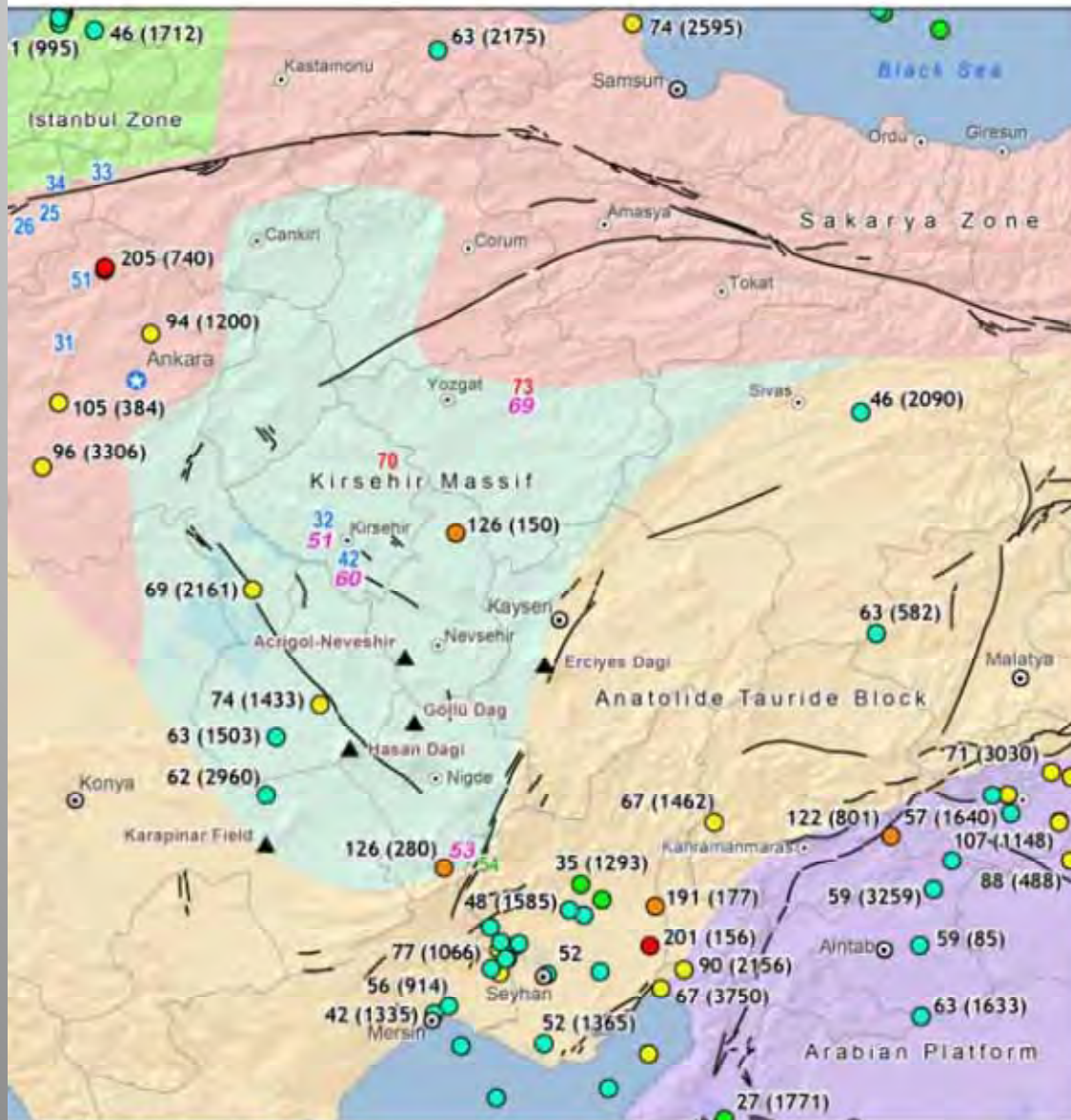
Projection: ED 1950 UTM Zone 35N



Heat Flow & Downhole Temperatures In Eastern Turkey



Heat Flow & Downhole Temperatures in Central Turkey



Spring temperatures, heat flow, and subsurface reservoir temperatures, Central Turkey



70
50 25 Spring temps. in °C
25 Reservoir temps. in °C

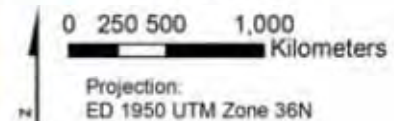
Heat Flow in mW/m² and depth in meters

- ≥200
- 110 - 200
- 65 - 110
- 40 - 65
- ≤40

- ▲ Quaternary Volcanoes
- Faults

Geologic Domains

- Anatolide Tauride Block
- Arabian Platform
- Istanbul Zone
- Kırşehir Massif
- Sakarya Zone



History of Geothermal in Turkey

1. Turkey holds the 7th rank all around the world for its Geothermal Potential.
2. The first geothermal energy researches were carried out in Izmir/Balçova in 1962 by MTA. Still in Balçova, approximately 35000 residences' heating needs are covered by Geothermal facilities.
3. The first well for geothermal energy production was drilled in 1968 in Denizli /Kızıldere (511 m, 198 oC)



- ▶ World's annual geothermal energy production is **9700MW** and Turkey's potential part is **31.500MW**.
- ▶ Much of this potential is of relatively low enthalpy that is not convenient for electricity production ~ **1500 MW**.
- ▶ Potential geothermal energy for electricity production is; **1700 MWe** and thermal capacity is accepted as **19 000- 35000 MWt** . (*Satman A., 2009*)
- ▶ Total installed capacity for electricity is **600 Mwe**.
- ▶ Turkey provides heating for about **1200 hectares** of greenhouses & heating for **100.000 residences** in 15 localities.
- ▶ Turkey is on the **5th** rank in heating and thermal springs.
- ▶ Today, Turkey's electric production of Geothermal Energy is a total of **%0,2**

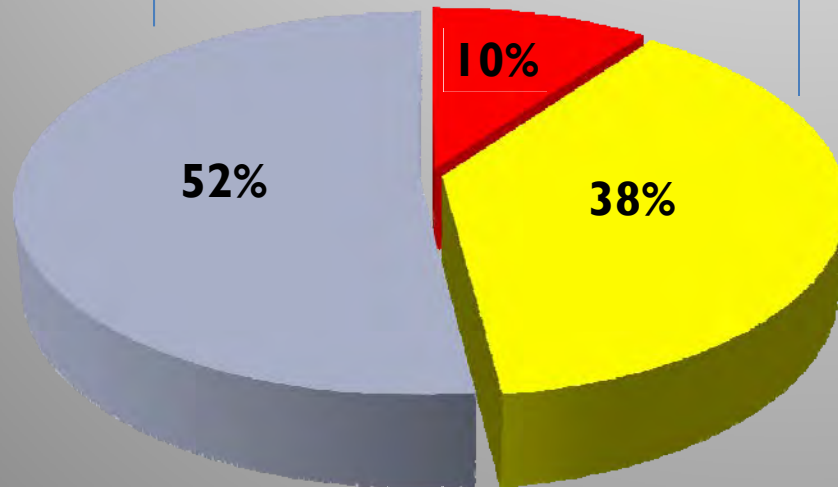
SOURCE	Hydroelectric Stations	Natural Gas	Coal Energy	Wind Mills	Geothermal
%	35	31	20	4	0,2

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Energy demand (GWh)	132553	141151	150018	160794	174637	190000	198085	194079	210434	229319
Increment (%)	4,5	6,5	6,3	7,2	8,6	8,8	4,3	-2,0	8,4	9,0



Distribution of Geothermal Use in Turkey

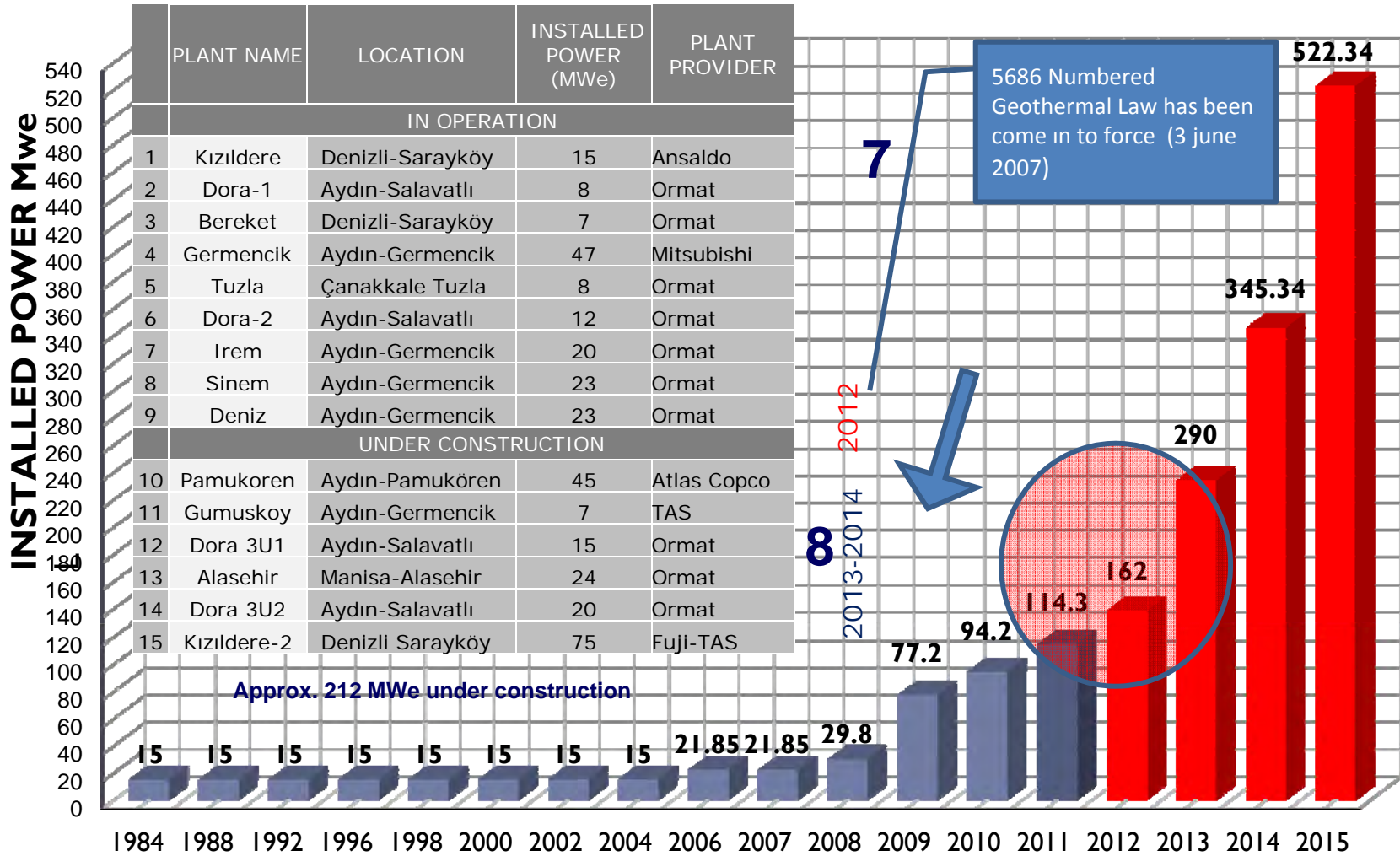
- Direct usage in houses- 38%
- Thermal heating and spa - 52%
- Electricity production- 10%



JANUARY 2013		
Electricity production	165	MWe
House heating	88,000 ~ 805 Mwt	House equivalence
Greenhouse Heating	2,585,000 (~506 MWt)	m ²
Thermal spa	325 (~550 MWt)	Pc
CO ₂ production	160,000	Tons



Actual & Future Projection of Geothermal Electric Production, January 2013



Today; regarding the limitations arisen from 5346 and 5686 Numbered Geothermal Laws, institutional investors, are interested with more than 3500 licenses, in this source of renewable energy risky of its exploration phase. Currently, capacity of active power stations is 165 MWe, that is assumed to increase up to 600 MWe's. Until 2023, installed capacity is targeted to reach 1000 through ongoing projects.



TPIC IN GEOTHERMAL PROJECTS

- Up to 2007, there were 10 wells drilled by private companies other from MTA which were to be used in the production of electricity projects .
- In 2007 TPIC started to work in geothermal field service by working for Gürmat/Güriş. 9 geothermal drilling field services were given to Gürmat between 2007-2008 in Aydın/ Germencik.



Data for Geothermal Electricity Production & Drillings

YEARS	POWER (MWe)	NUMBER OF DRILLING WELLS	TOTAL NUMBER OF DRILLING WELLS	NUMBER of DRILLINGS TPIC
2007 – 2009	77		150	13
2010–2012 (present)	165	150	300	47
2013 – 2015	522	300	600	60*
2016 – 2023	1000	800	1400	150*
2023 –	2000	1000	2400	250*

* estimated values

*Republic of Turkey Ministry of Energy and Natural Resources; it is targeted to have 600 MWe power up to 2023.
(Tpic data)*



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GEOHERMAL FIELD SERVICES



GEOHERMAL DRILLING				
YEAR	COMPANIES	WELLS	RIGS	TOTAL(M)
2007	1	2	1	3694
2008	2	6	1	13239
2009	1	3	2	6317
2010	3	13	2	27991
2011	5	20	3	40359
2012	6	17	3	42188

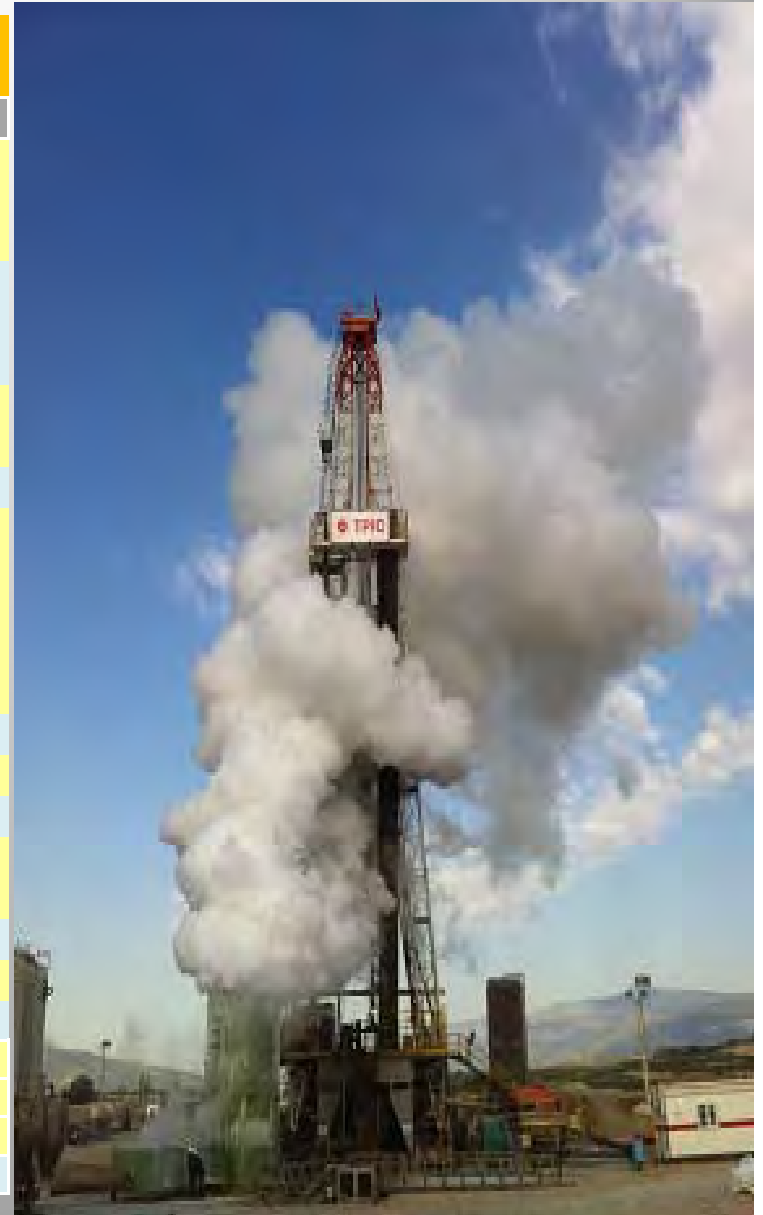
GEOHERMAL WORK OVER					
COMPANY	2010	2011	2012	2013	TOTAL WELL
Gürmat/Güriş		4			4
Zorlu	3				3
Santral/Sanko		1			1
MasPo				4	4
Total WO	3	5		4	12

GEOHERMAL WELL TEST				
COMPANY	2011	2012	2013	NUMBER OF TESTS
Zorlu	2			2
Santral/Sanko	1	2		3
MasPo		3	4	7
Mis/Soyak	6	2		8
Aytemiz	1			1
Çelikler	7	28	12	47
Total Test	17	35	16	68



Active Rigs in Geothermal Projects (August 2013)

#	RIG	Location	Capacity	Operator	Company
1	F-320/5	Manisa	6210 m/2000 HP	TPIC	Maspo
2	F 200/11	Aydın	4000 m/1350 HP	TPIC	Gürmat
3	F200/10	Aydın	4000 m/1350 HP	TPIC	Gürmat
4	MR8000	Manisa	4300 m/1080 HP	MAPEK	Türkerler
5	MR8000	Manisa	4300 m/1080 HP	MAPEK	Karadeniz
6	Not Specified	Manisa	2000 m/1080 HP	MAPEK	Türkerler
7	MR8000	Aydın	4300 m/1080 HP	MAREN	Maren
8	MR8000	Aydın	4300 m/1080 HP	MAREN	Maren
9	IDECO H44	Aydın	3000 m / 750 HP	POLMAK	
10	F. Cooper LTO-750	Aydın	2500m/750 HP	AME	Maren
11	Wilson 75	Aydın	2500m/900 HP	AME	Çelikler
12	NAT 80 B	Aydın	3500 m/1000 HP	AME	Çelikler
13	F200	Aydın	4000 m/1350 HP	AME	Merve
14	Nat 32	Aydın	not specified	AME	Zorlu
17	BD125	Denizli	1600 HP	DEĞİRMENCİ	Değirmeci
18	Gefco 185 K	Konya	2000m/600 HP	GM Müh	Hateks
19	MR6000	İzmir	2000 m/540 HP	MTA	
20	IDECO 202	Ağrı	3200m/620 HP	ARAR	
21	IDECO H 44	Ankara	2700/912 HP	ARAR	
22	Not Specified	Manisa	2000m/600 HP	Merty	SIS
23	Not Specified	Manisa	2000m/600 HP	Petrogaz	YDA
24	Not Specified	Simav	2000m/600 HP	Umran Boru	Umran
25	Not Specified	Aydın	2500 m/1000 HP	Viking	Maren
26	Not Specified	Aydın	2500 m/1000 HP	Viking	
27	Not Specified	Aydın	2500 m/1000 HP	Protek/BM	BM
.+6 Domestic manufactured rigs					



Notes

- Old fashioned Drilling equipment
- Waste of time due to import procedures,
- Procurement procedures,
- Budget limitations due to being a state-owned company,
- Resource risks
- Cost variability of developing geothermal resources
- Size and temperature
- Average well productivity
- Drilling success rate
- Long term reservoir behavior
- Offset developments (multiple resource users)
- Scaling, non-condensable gases and make-up wells
- Grid connection adequacy, distance and cost
- Schedule risks (delays)
- Plant performance



Notes

- Permitting and Environmental Impact Assessment
- Zoning and land use
- Resource ownership and access
- Permits for drilling, construction and operation
- Schedule delay due to permitting and approvals
- Stability of renewable and geothermal policies
- Regulatory approval of rates and PPA tariffs
- Macroeconomic risks (growth rates, inflation, currency risks, power demand)
- Power sector risks
- Creditworthiness of off-taker
- Longevity of favorable feed-in tariffs, tax incentives, etc.
- Attracting equity investment
- Obtaining project finance



What to do?

- Government funding for early exploration (MTA)
- Government undertaking discovery and confirmation drilling
- Cost-shared discovery and confirmation drilling
- Risk pooling through multiple projects
- By developers
- By investors / financiers
- Insurance against well productivity risk
- Loan guarantees



THANK YOU