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# Geothermal District Heating and Power Generation Experience in Turkey

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Turkey has achieved important geothermal developments in last 15 years. Since the 1960's, more than 240 geothermal fields have been discovered in Turkey.

Turkey is ranked as the 4th country in geothermal electricity generation, 1st country in geothermal greenhouse heating and 5th country in geothermal district heating (operational) in the world.

# EXISTING GEOTHERMAL USE IN TURKEY (as of September 2018)

| UTILIZATION | CAPACITY |
|---|---|
| GEOTHERMAL DISTRICT HEATING<br>(CITY, RESIDENCES) | 116.000 RESIDENCES EQUIVALENCE<br>(1033 MWt) |
| GREENHOUSE HEATING | 4,3 Million m2 (820 MWt) |
| HEATING OF THERMAL FACILITIES, SPAS,<br>THERMAL HOTELS AND TIME SHARE FACILITIES | 46.400 residences equivalence<br>(420 MWt) |
| HEAT ENERGY OF THERMAL WATER USE IN HOTELS, SPAS AND AND TIME SHARE FACILITIES | 400 GEOTHERMAL SPA<br>(1005 MWt) (18,5 Million guests/annual) |
| AGRICULTURAL DRYING | 1,5 MWt |
| GEOTHERMAL HEAT PUMP | 42,8 MWt |
| **TOTAL HEAT USE** | **3322,3 MWt**<br>**(320.000 Residences Equivalence)** |
| **TOTAL ELECTRICTY PRODUCTION** | **1200 MWe**<br>(Aydın-Germencik, Denizli-Sarayköy, Manisa-Alaşehir, Manisa-Salihli, Aydın Salavatlı, Aydın-Hıdırbeyli, Çanakkale-Tuzla vd.) |
| CARBONDIOKSITE PRODUCTION | 400.000 Tons/year |

Geothermal electricity production is 1200 MWe  (Aydin-Germencik, Aydin-Salavatli, Manisa-Salihli, Manisa-Alaşehir, Denizli-Kizildere, Aydin-Hidirbeyli, Canakkale-Tuzla, Aydın-Pamukören, Aydin- Gumuskoy and others) as of September 2018.

Liquid carbon dioxide and dry ice production factories are integrated to the Kizildere and Salavatli geothermal power plants.

Recently, Buharkent (Aydin, Limgaz-Limak) geothermal power plant has been started to operate with 13,8 MWe install capacity. Buharkent is a non artesian geothermal field, whereas the static water level is at - 260 m depth.

Geothermal water contains very less CO2 and H2S. It is not corrosive. TDS value is 3822 mg/l at first well. Electrical submersible pumps are installed at 490-600 m depth with 155 °C temperature (each 240-350 tons/h).

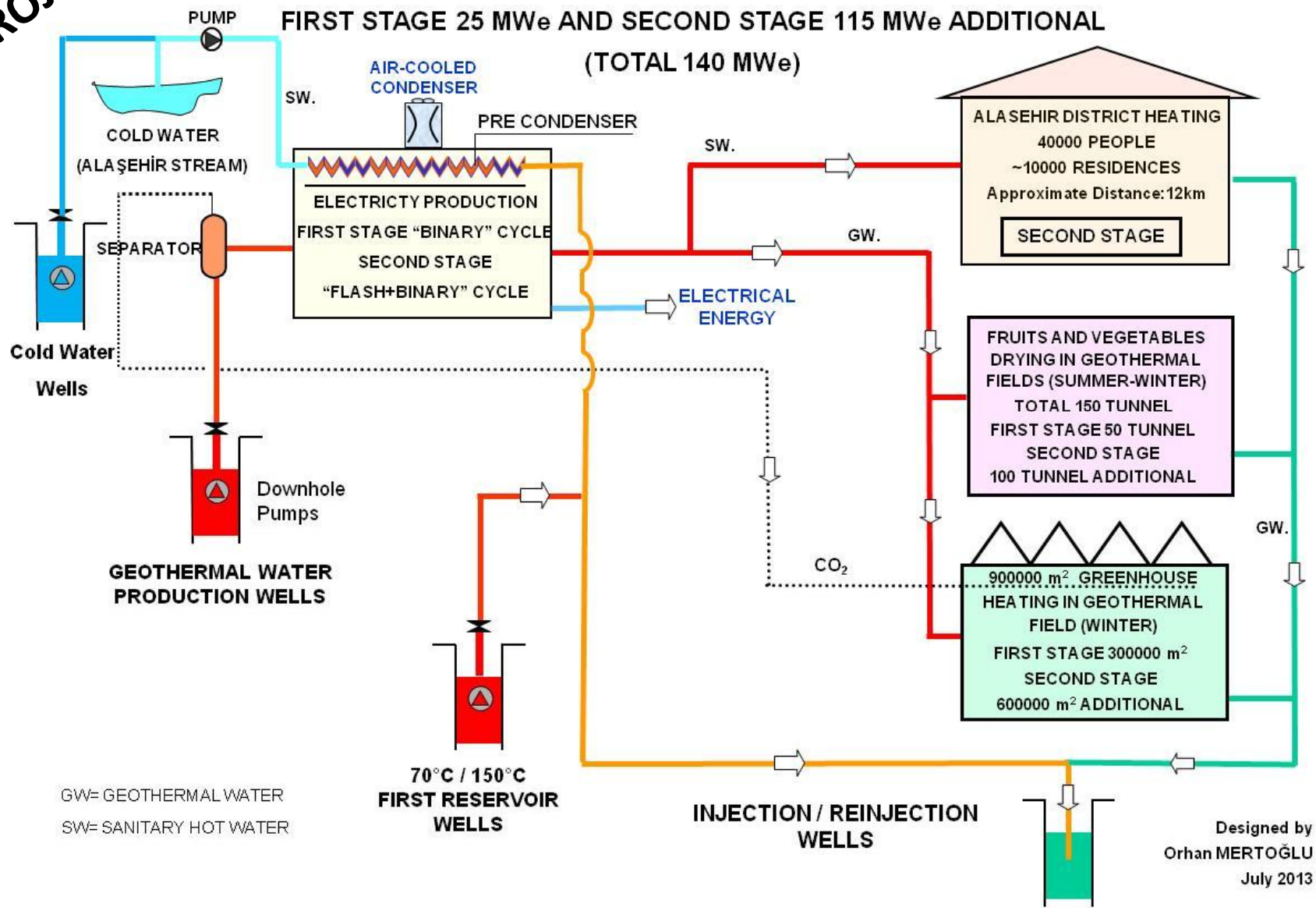
PROJECTED

# MASPO INC. (GÜRMEN GROUP)

## KAVAKLIDERE GEOTHERMAL INTEGRATED SYSTEM FLOW CHART

## FIRST STAGE 25 MWe AND SECOND STAGE 115 MWe ADDITIONAL

## (TOTAL 140 MWe)




Designed by
Orhan MERTOĞLU
July 2013

The downhole pump is operational without scaling, corrosion, gas, cavitation difficulties Buharkent power plant.

Leaving temperature from the power plant is about 70 °C. The leaving geothermal water is transferred to the reinjection wells without additional pumping by means of vakuum condition.

The first action of  the issued geothermal law and incentives was done in the World Geothermal Congress 2005 in Antalya which contributed to the increase in geothermal electricity production investments within Turkish private sector. Beside of the hydrothermal system utilization, Turkey shall give emphasize on EGS systems for future projections.

The Turkish Geothermal Association are giving emphasise and advise on the continuing of the feed in tariff which will end at the end of 2020.

Geothermal power plants are base load plants. The highest value in capacity factor is 99,4% in Germencik geothermal power plant (44,7 MWe).

The total hydrothermal possible theoretical geothermal heat potential is 60.000 MWt according to heat flow maps, measured well depth temperatures and calculations made  for 3 km depth.

Turkey's total geothermal electricity production potential (hydrothermal, 0-4 km) can be estimated as 2500 MWe (20 billion kWh/year) with existing 10,5 USDcent/kWh incentive and 10 years purchase guarantee.

The technical and economical EGS geothermal electricity production potantial has been projected as 15.000 MWe if the 15 USDcent/kWh incentive with minimum 15 year purchase guarantee would be possible.

# DISTRICT HEATING APPLICATIONS IN TURKEY

The operational capacities of some of the city based geothermal district heating systems (GHDS) existing in Turkey are as follows:

Gönen (Commissioned: 1987, 3400 residences, temperature is ~ 80°C),

Simav (1991, 12000 residences, ~120°C),

Kirsehir (1994, 1900 residences, ~57°C),

Kizilcahamam (1995, 2500 residences, ~ 80°C),

Izmir (1996, 35.000 residences, ~ 115-142°C), (250 MWt)

Sandikli (1998, 11000 residences, ~ 70°C),

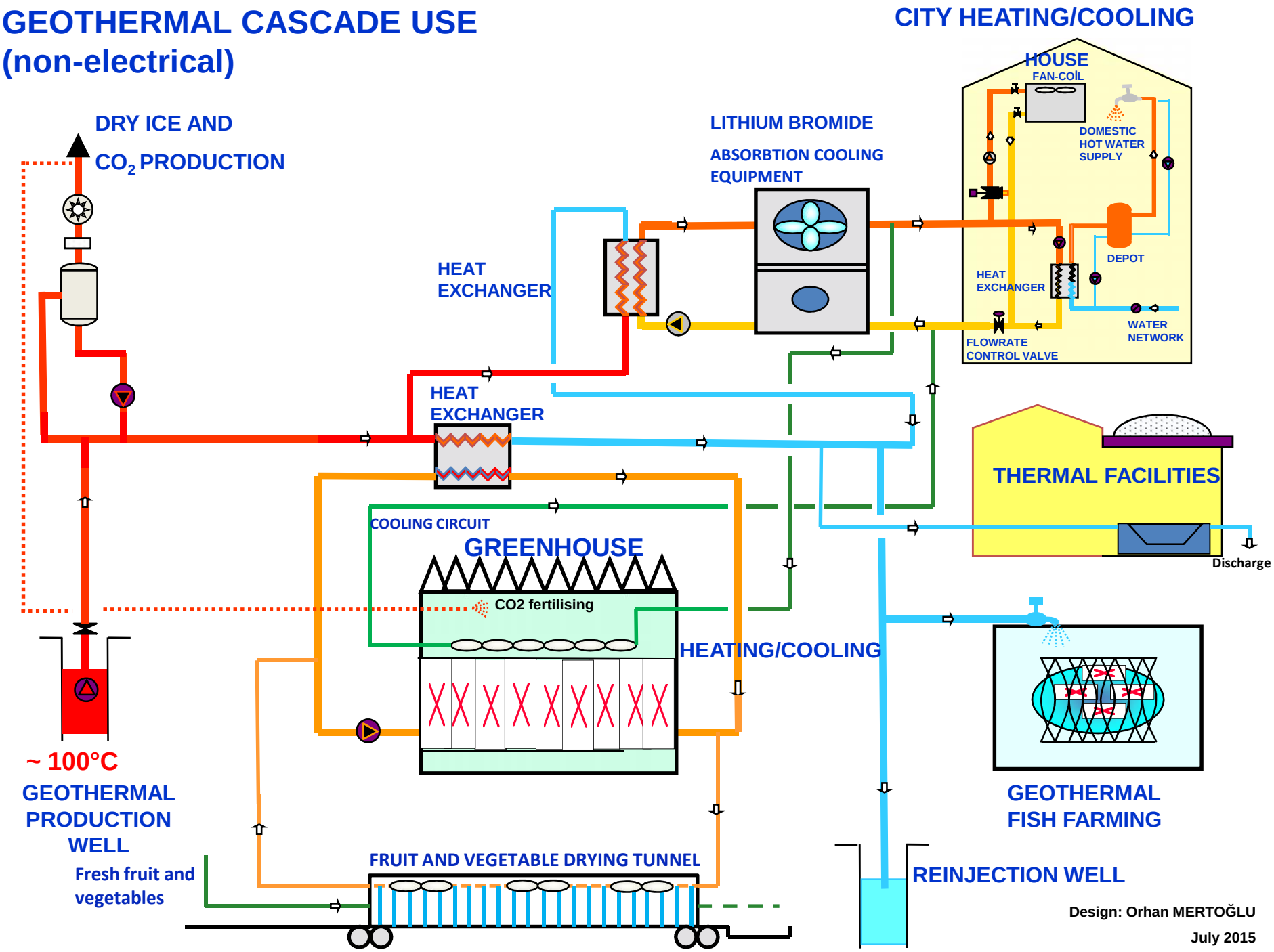
Afyon (1996, 14000 residences, ~ 95°C),

Kozakli (1996, 3000 residences, ~ 90°C),

Diyadin (1999, 570 residences, 70°C),

Edremit (2003, 6000 residences, 60 °C)

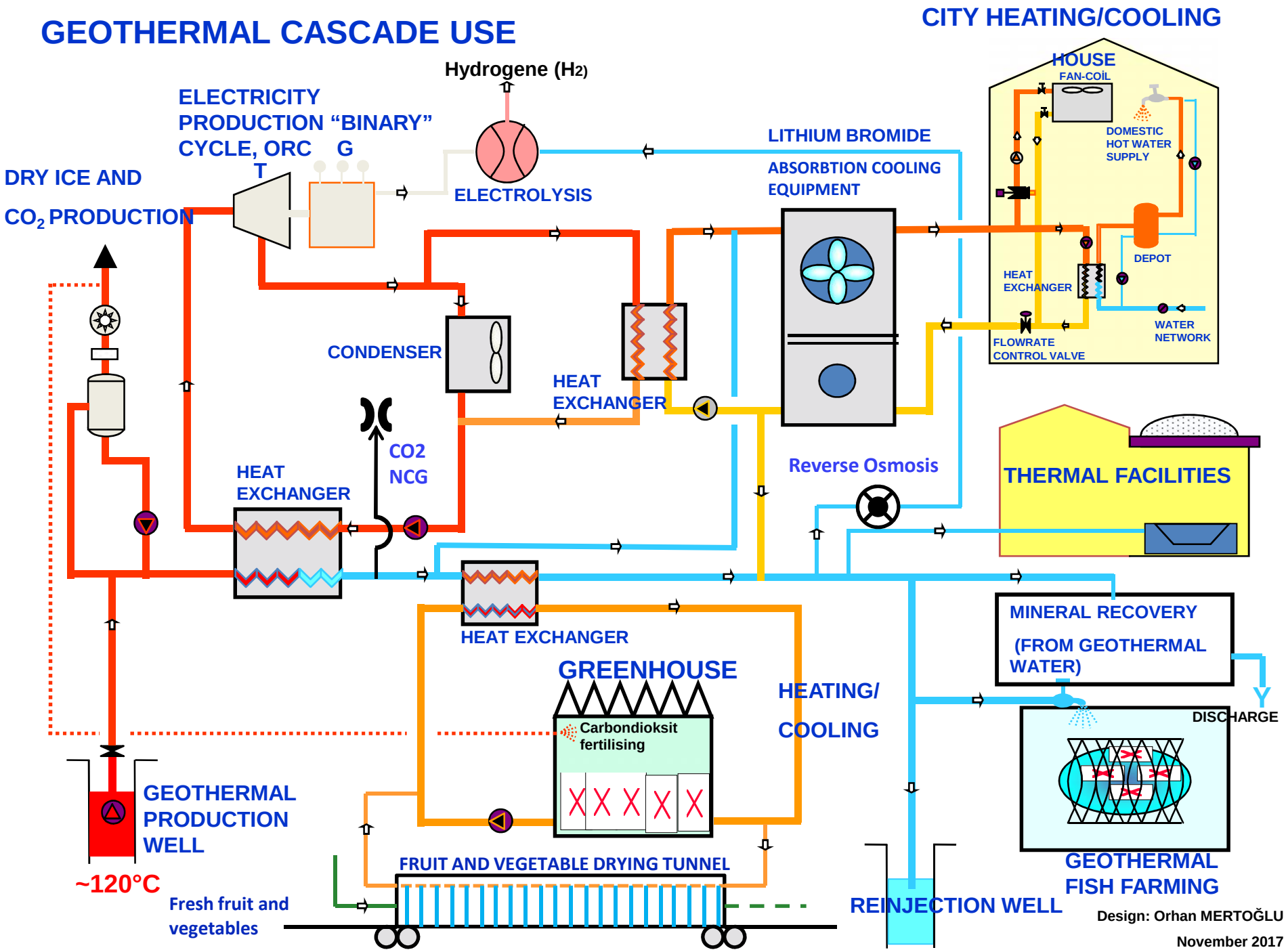
# GEOTHERMAL CASCADE USE (non-electrical)




Design: Orhan MERTOĞLU

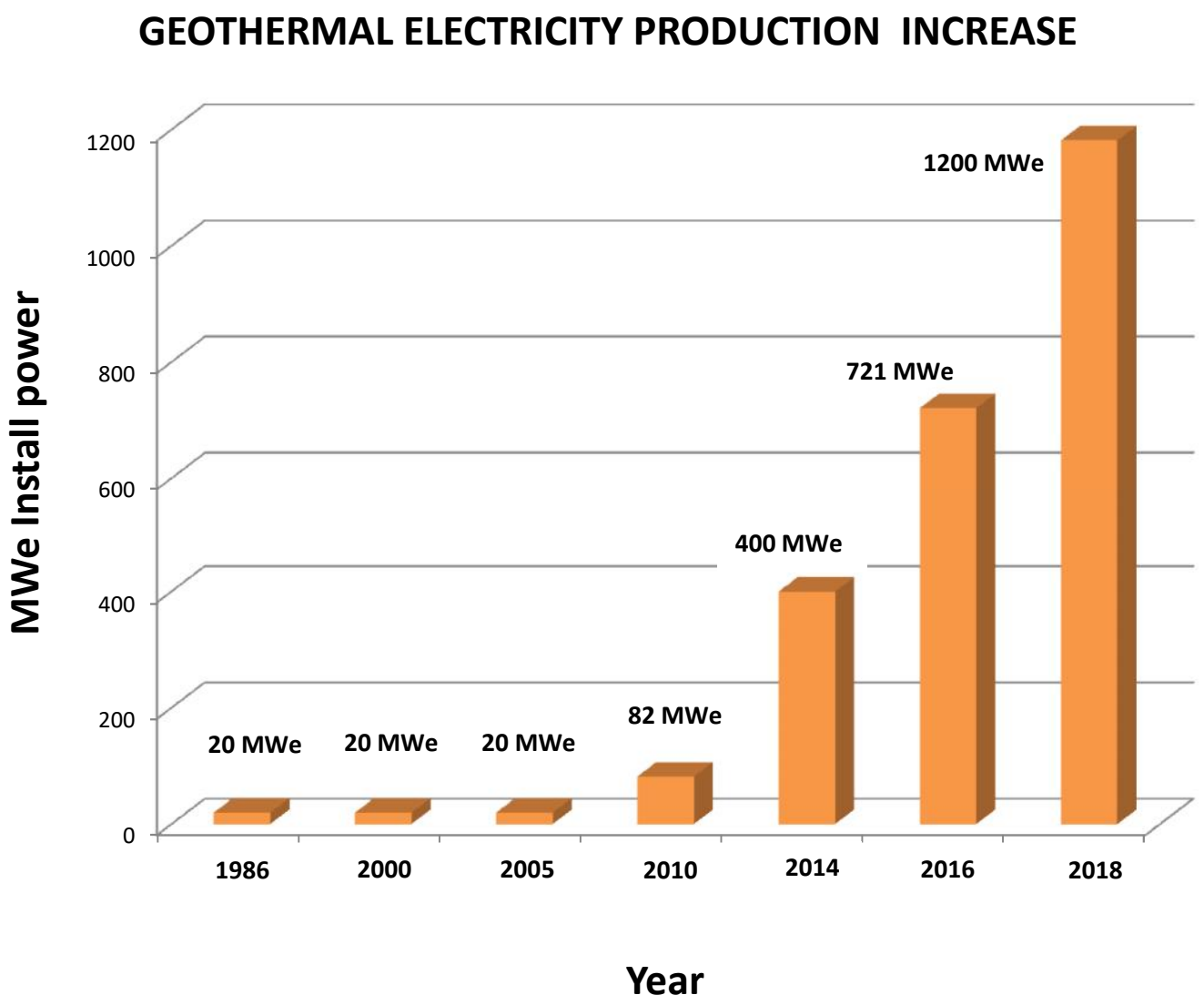
July 2015

# GEOTHERMAL CASCADE USE




Design: Orhan MERTOĞLU

November 2017


GEOTHERMAL ELECTRICITY PRODUCTION INCREASE
MWe Install power
1200
1000
800
600
400
200
0
20 MWe
20 MWe
20 MWe
82 MWe
400 MWe
721 MWe
1200 MWe
1986
2000
2005
2010
2014
2016
2018
Year

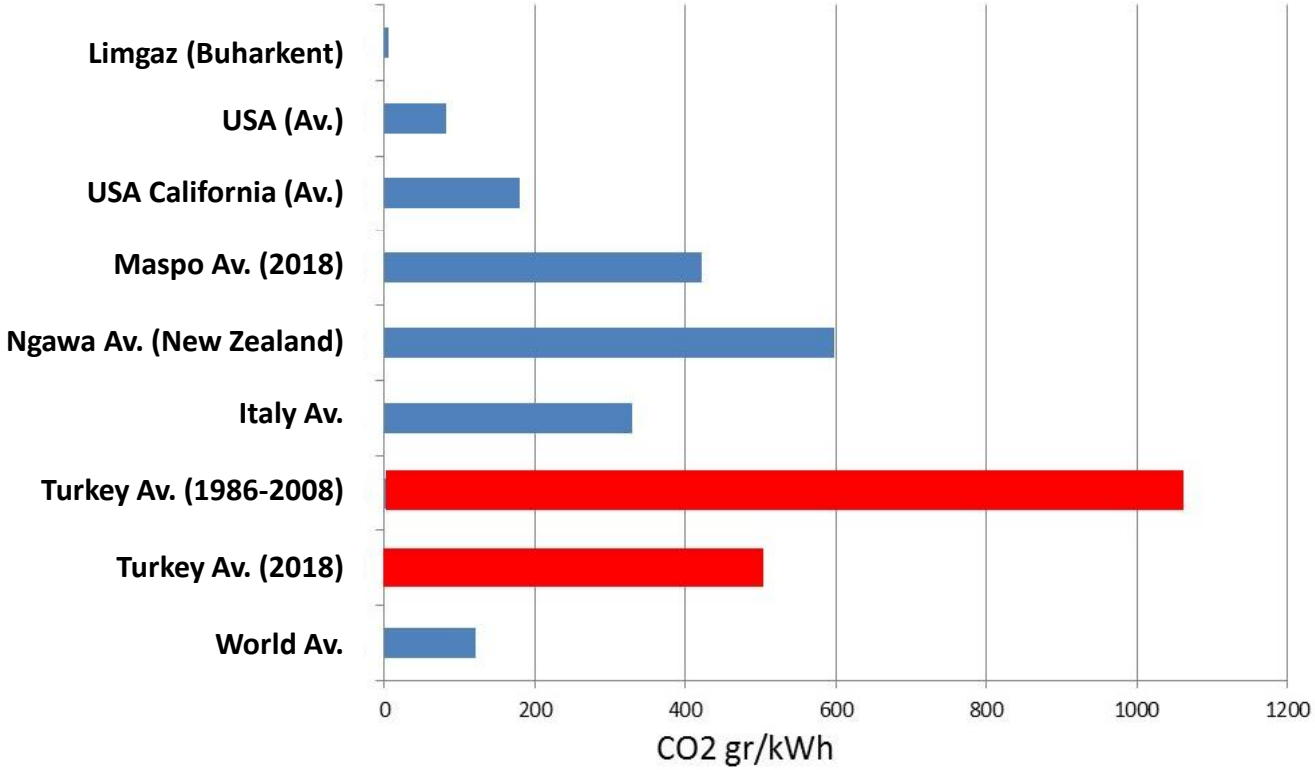
# $CO_2$ DECREASE IN GEOTHERMAL

It is known that the $CO_2$ in the geothermal fields in Turkey, are formed mostly by the marble and karbonated rocks due to the effect of the water and heat.

**Natural emission of $CO_2$**

$CO_2$ is emitting naturaly towards the atmosphere from the reservoir. The $CO_2$ emission amount is more at the fault and fracture zones. As it can be understood, this procedure is not under our initiative. It is a natural discharge of $CO_2$ and is independent to the existence of geothermal power plants.

# Comparison of $CO_2$ emissions



An important portion of $CO_2$ is emitted to the atmosphere from the geothermal wells and geothermal power plants after electricty is produced.

For this reason 50-70 % decreament in the $CO_2$ amount in 10 years in the geothermal fields in Turkey has been obtained. The decreament continues.

As the result of  oral communication with many geothermal power plant operators in Turkey, this decrease in $CO_2$ in geothermal reservoirs has been recognised.

As a natural result of $CO_2$ decrease in the geothermal fields; The downhole pump utilisation in the geothermal fields will increase with time.

# THANK YOU FOR YOUR ATTENTION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