Geothermal Urban Heating:

The Greater Munich Area

Dr. Erwin Knapek,
Bundesverband Geothermie

Bundesverband Geothermie

Heat Potential of Deep Geothermal Energy in Germany

Hydrothermal Aquifers (1%):	**25 EJ (without HP)**	**50 EJ (with HP)**
Cristalline (95%):	**1600 EJ (without HP)**	**2800 EJ (with HP)**
Faultzones (4%):	**60 EJ (without HP)**	**110 EJ (with HP)**
Germany in total without NRW:	**1685 EJ (without HP)**	**960 EJ (with HP)**

Jährlicher Wärmebedarf 2013: 6.3 EJ oder 1.750 TWh
Ziel bis 2050: ca. 3 EJ oder 850 TWh (95 % CO2-Reduktion)

Quelle: T. Jung et al.(2002); TAB Bericht an den Deutschen Bundestag 2003
BMWi 17.12.2014

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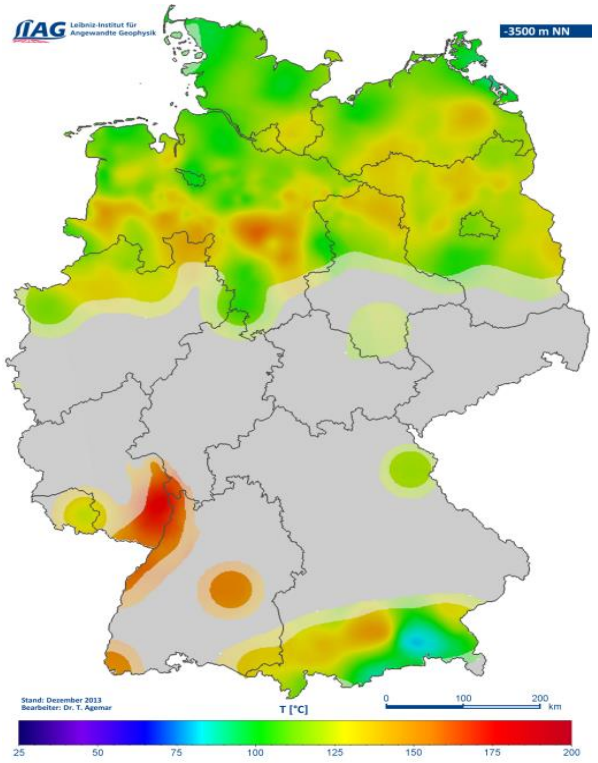
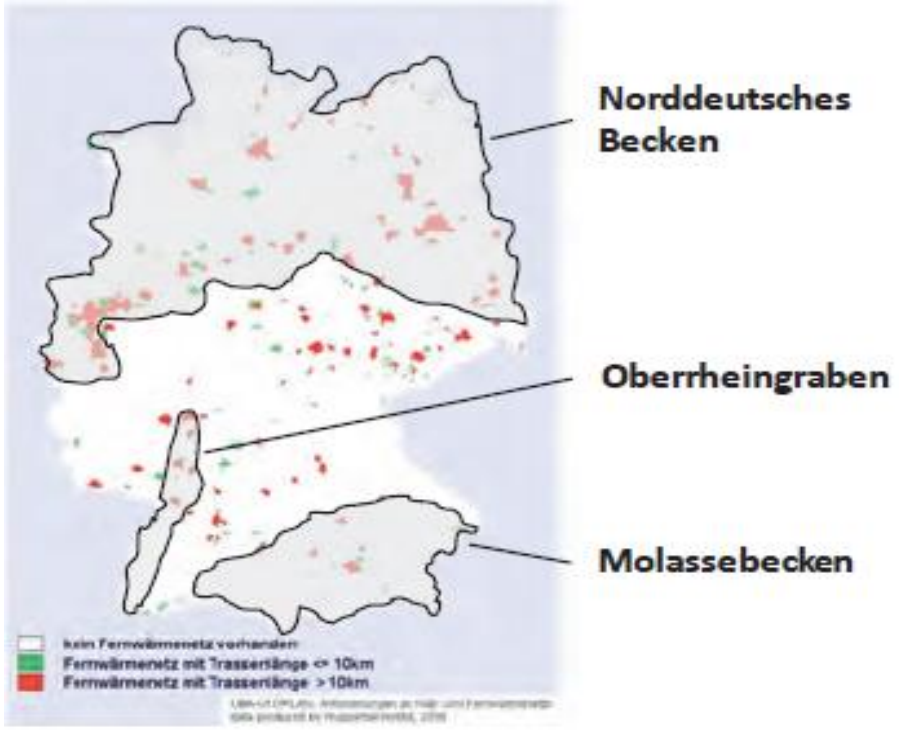
District Heating Potential of Deep Geothermal Energy in Germany

Temperatures in 3.500 m Depth

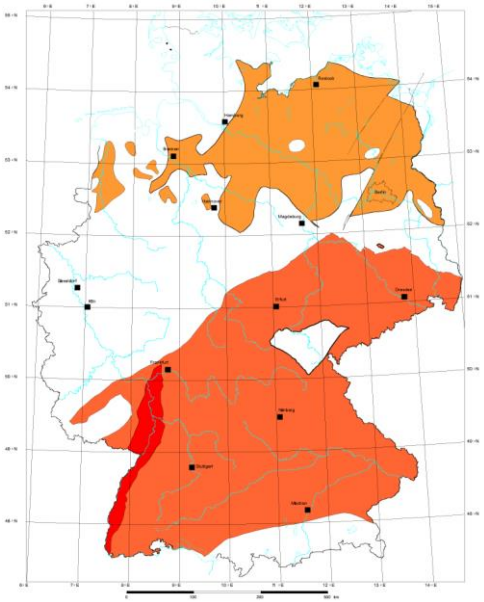


Quelle: LIAG, Leibniz-Institut für Angewandte Geophysik, Stand Dezember 2013

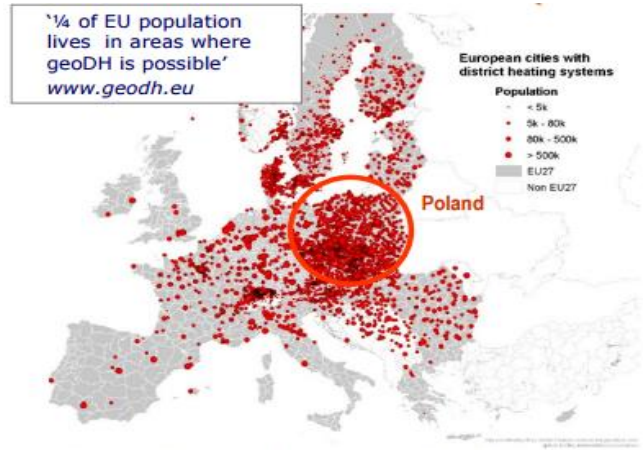
District Heating Grids in Areas of Hydrothermal Reservoirs



Quelle: Fernwärmenetze in Gebieten zur Nutzung hydrothermaler Geothermie (IFEU (Kartengrundlage aus Wuppertal Institut, DLR, IE (2007) und Kayser, Kaltschmitt (1998)) aus TRAFO , S. 81



Petrothermal Potential



District heating systems in Europe according to the current content of the HUDHC database (June 2012)

Source of map:
Persson *et al. (2012)* – HUDC Database 2012
/The Halmstad University District Heating and Cooling Database/

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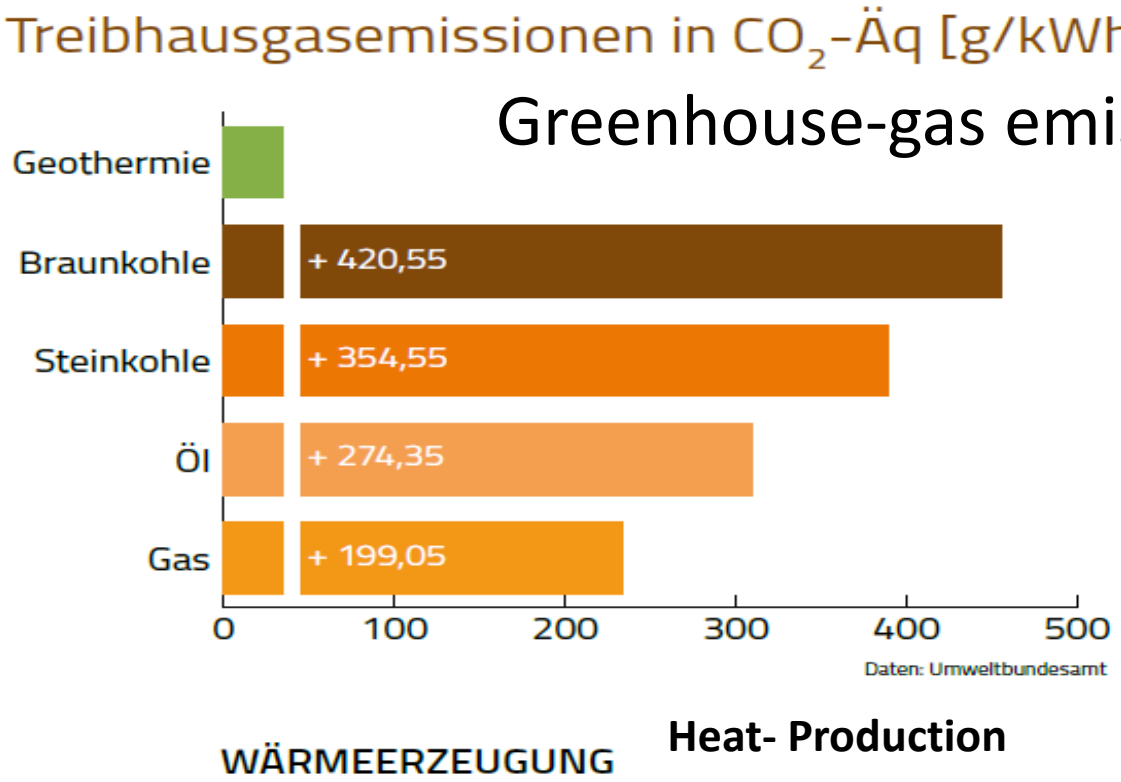
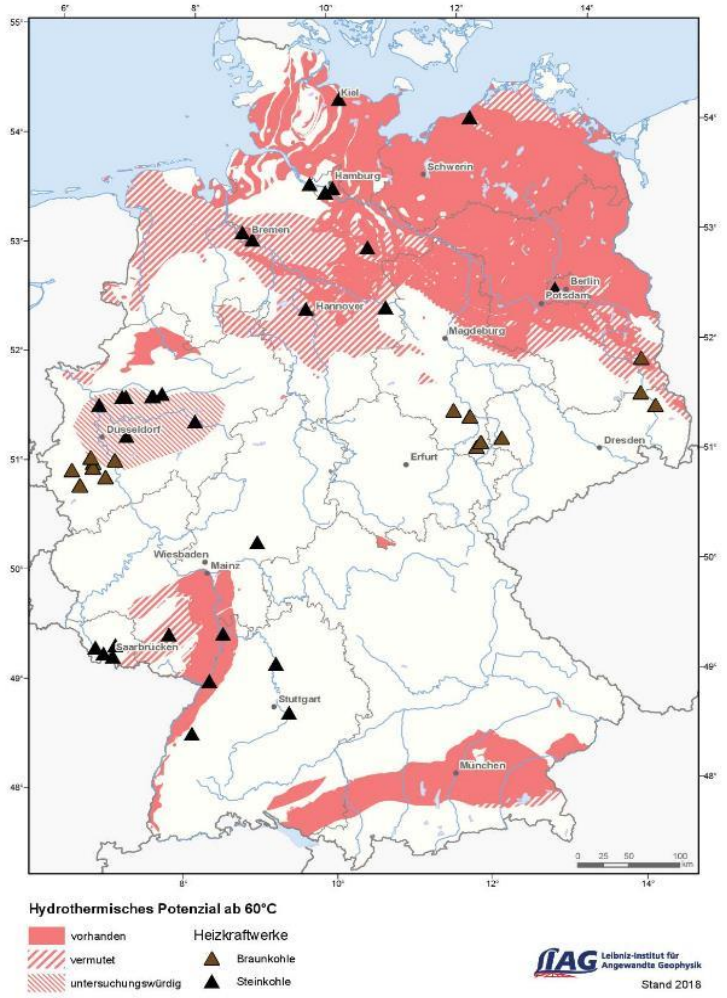
Geothermal Energy is the Best Alternative to Coal – Power - Stations



Greenhouse-gas emissions

Heat- Production



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Energy Transition must also be Heat Transition

- 54 % of the total energy consumption is heat: 2017 ca.1250 TWh
- 50% of the thermal energy is required for heating of buildings
- without geothermal energy, heat transition is not feasible
- geothermal energy is the only renewable energy that is not dependent on climate, weather and time
- Germany's fossil fuel imports cost almost 60 billion € in 2015, or around 6 % of total imports in value terms. Despite the expansion of renewable energies on the electricity market, Germany's dependence on energy imports remains constant at 70 percent.

But there exists no masterplan for a renewable heat transition in Germany as well as no masterplan for the use of geothermal energy

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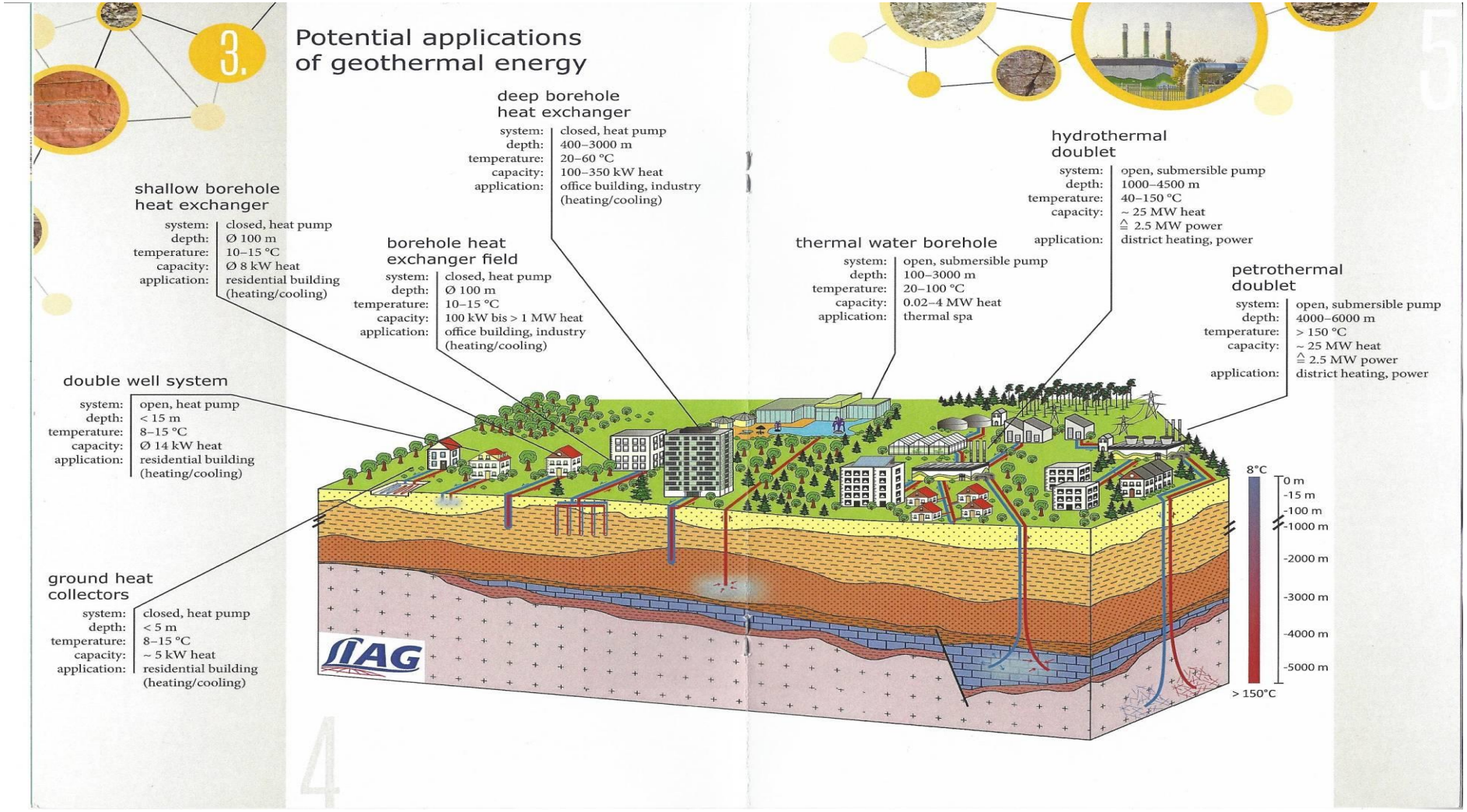
The Multiple Use of Geothermal Underground



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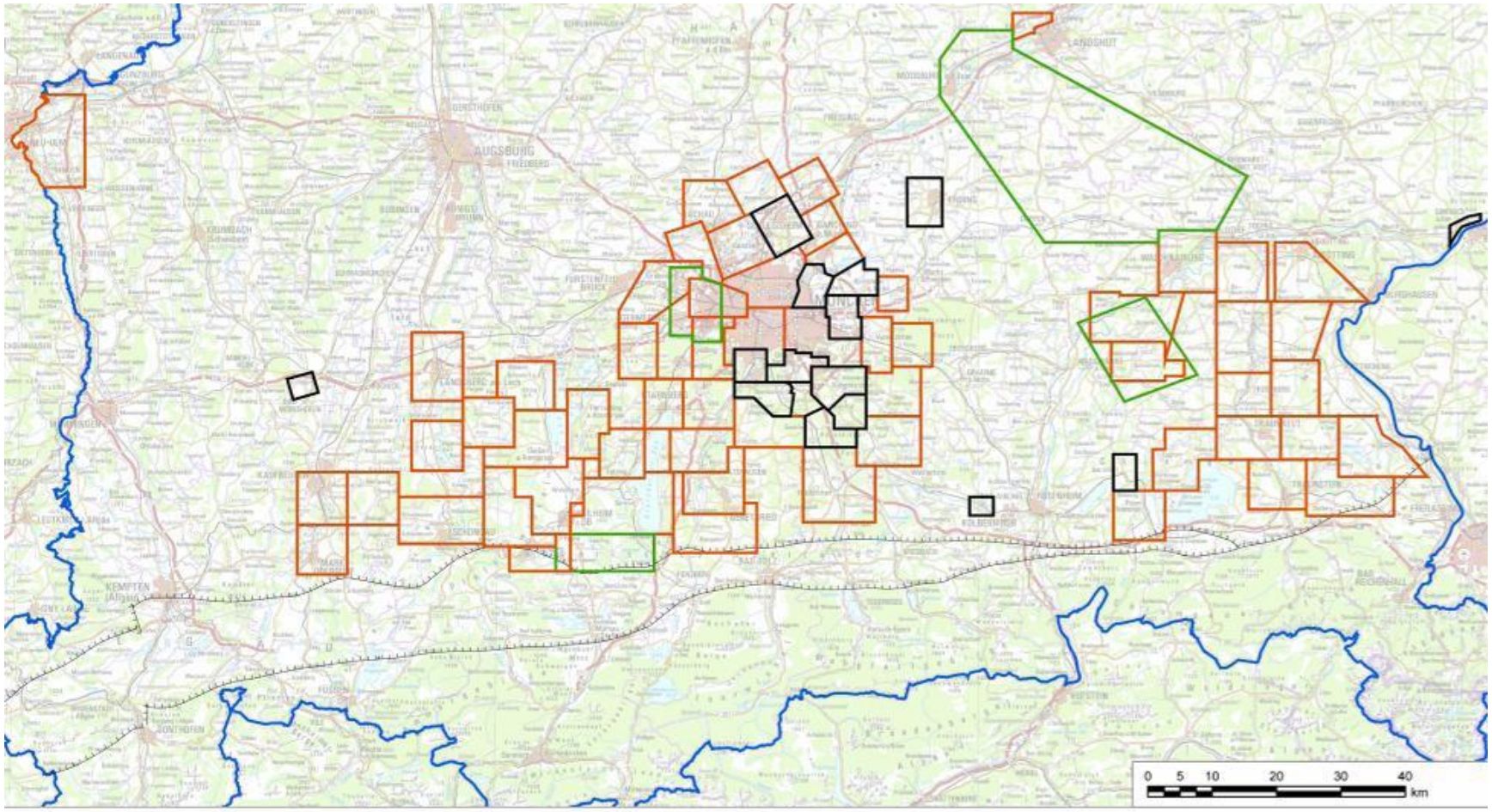
Geothermal Mining Licenses in Bavaria (2011)



Quelle: BMstWIVT 2011

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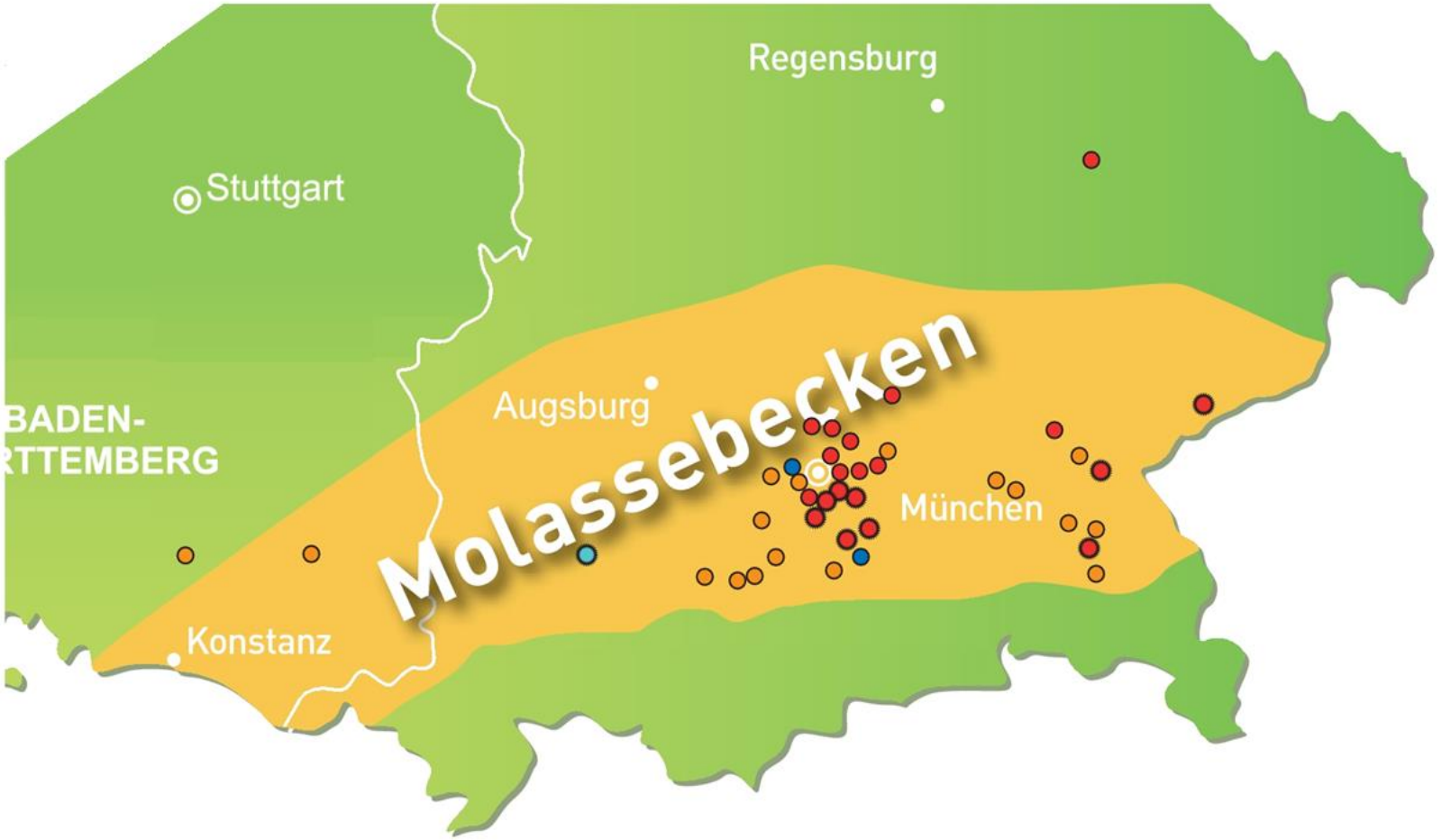
Realized Projects in Bavaria (2017)



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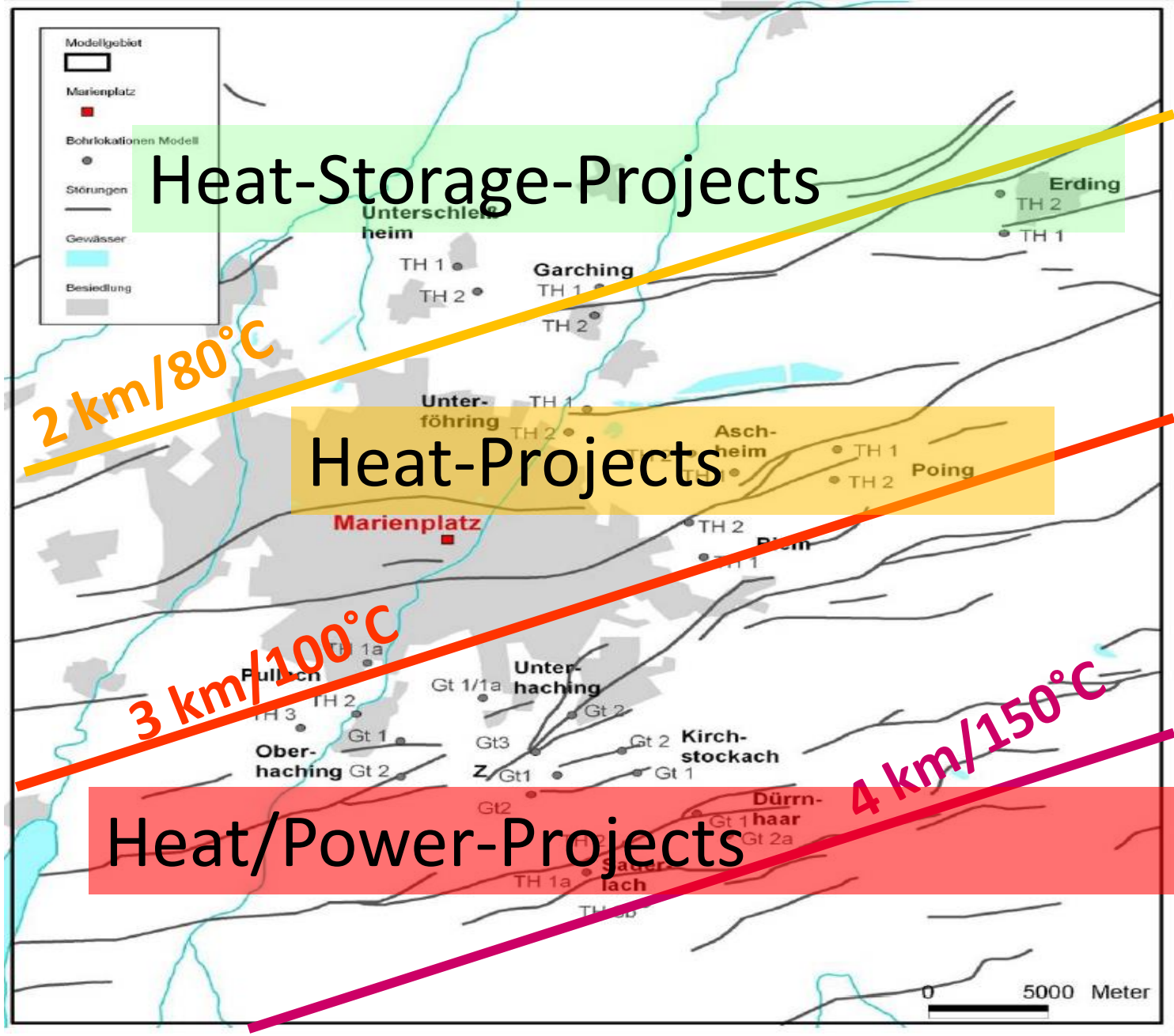
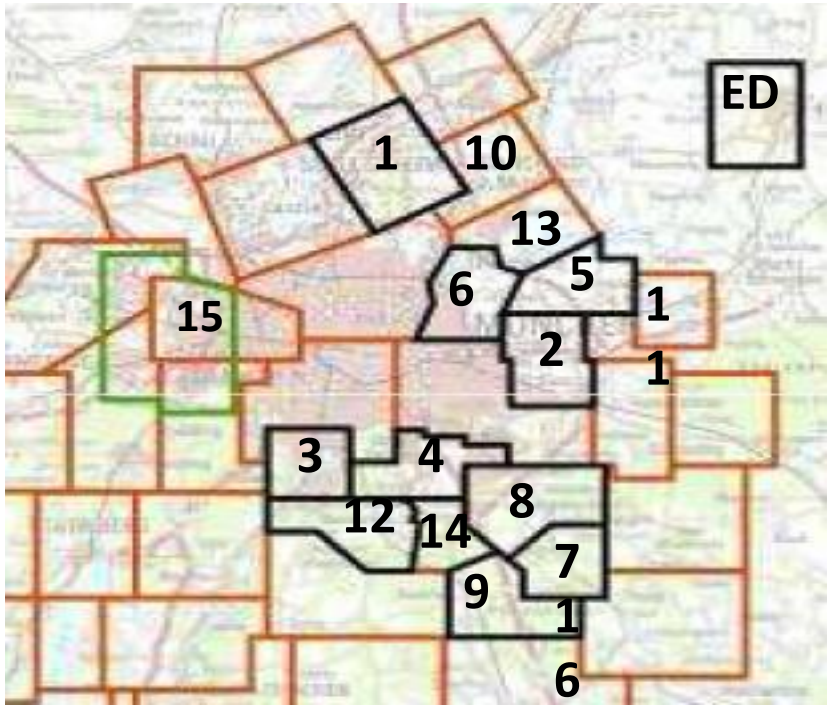
The Greater Munich Area

PROJEKT	TIEFE in m	Fließrate in l/s Temperatur in ° C
Erding	1868	48/65
Unterschleißheim	1969, 2002	100/79
Garching	2050, 1990	100/75
Unterföhring	2123, 2511	50/88, 88/93
Ismaning	1906, 2195	85/78
Aschheim	2621, 2529	55/86
Poing	2900	100/76
Riem	3020, 3747	65/94
Pullach	3371, 3443	80/100
Unterhaching	3400, 3700	150/123
Grünwald	3428, 3319	138/130
Kirchstockach	3881, 3794	126/134
Taufkirchen	3400	120 /137
Dürrnhaar	3579, 4114	100/141
Sauerlach	3733, 4450	100/138

Quelle: Inga Moeck 2015



Munich and Surroundings



1	Unterschleißheim (Wärme)	31 MWth
2	SWM München-Riem (Wärme)	10 MWth
3	Pullach (Wärme)	15 MWth
4	Unterhaching (Wärme/Strom)	38 MWth
5	Aschheim-Feldkirchen-Kirchheim (Wärme)	19 MWth
6	Unterföhring (Wärme)	20 MWth
7	Dürrnhaar (Strom)	(>45 MWth)
8	Kirchstockach (Strom)	(>45 MWth)
9	SWM Sauerlach (Strom/Wärme)	5 MWth
10	Garching (Wärme)	6 MWth
11	Poing (Wärme)	7 MWth
12	Grünwald Wärme/Strom)	40 MWth
13	Ismaning (Wärme)	7 MWth
14	Taufkirchen (Wärme/Strom)	40 MWth
ED	Erding (Wärme)	10 MWth
15	München-Freiham	10 MWth
16	Holzkirchen	25 MWth

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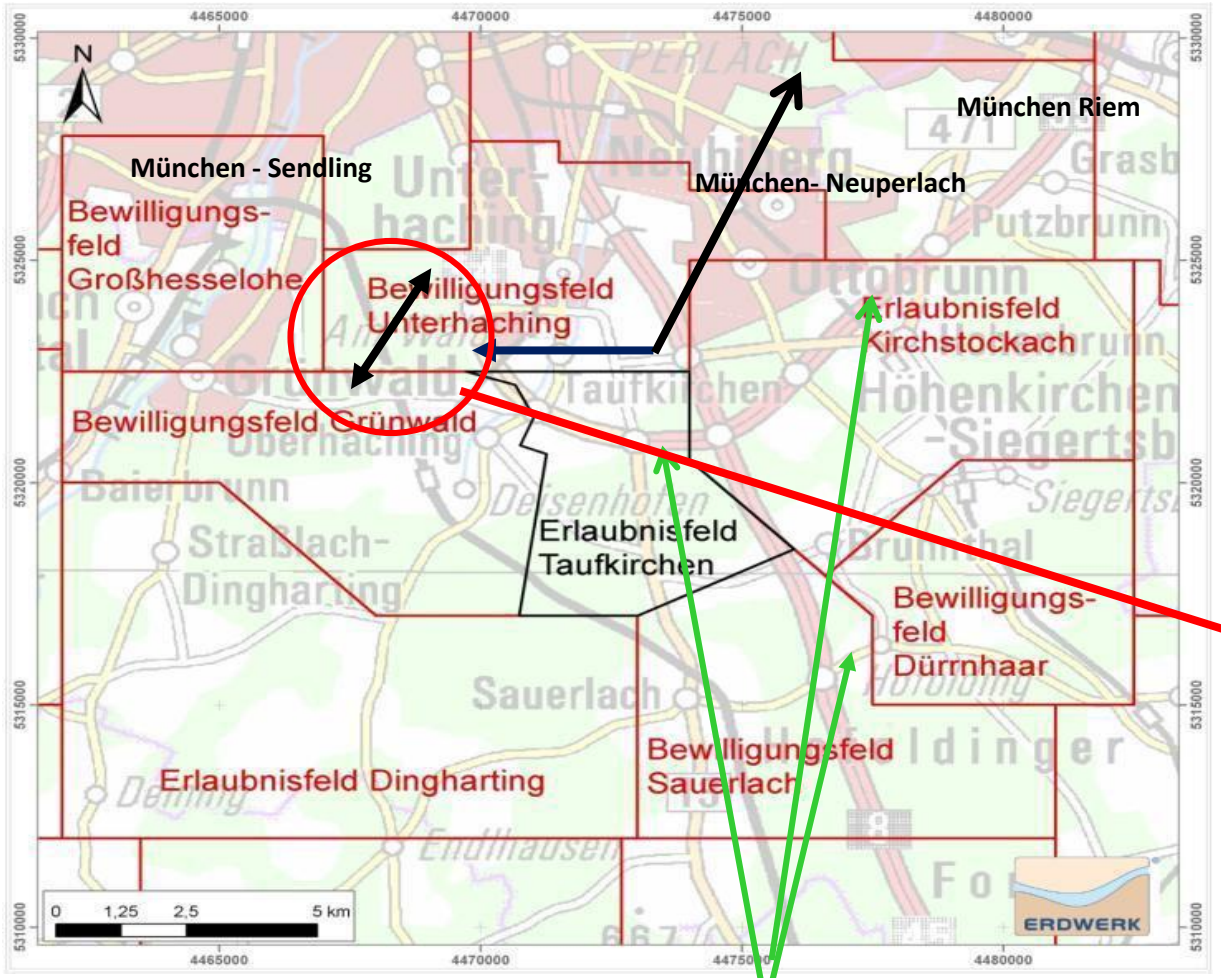
Total power: 274 MWth/364 MWth/31 MWel

Unterhaching- Grünwald: The First Interconnection of Two Geothermal Heat – and Powerplants



Heat supply

Heat and el. current

Combination with biomass-plants

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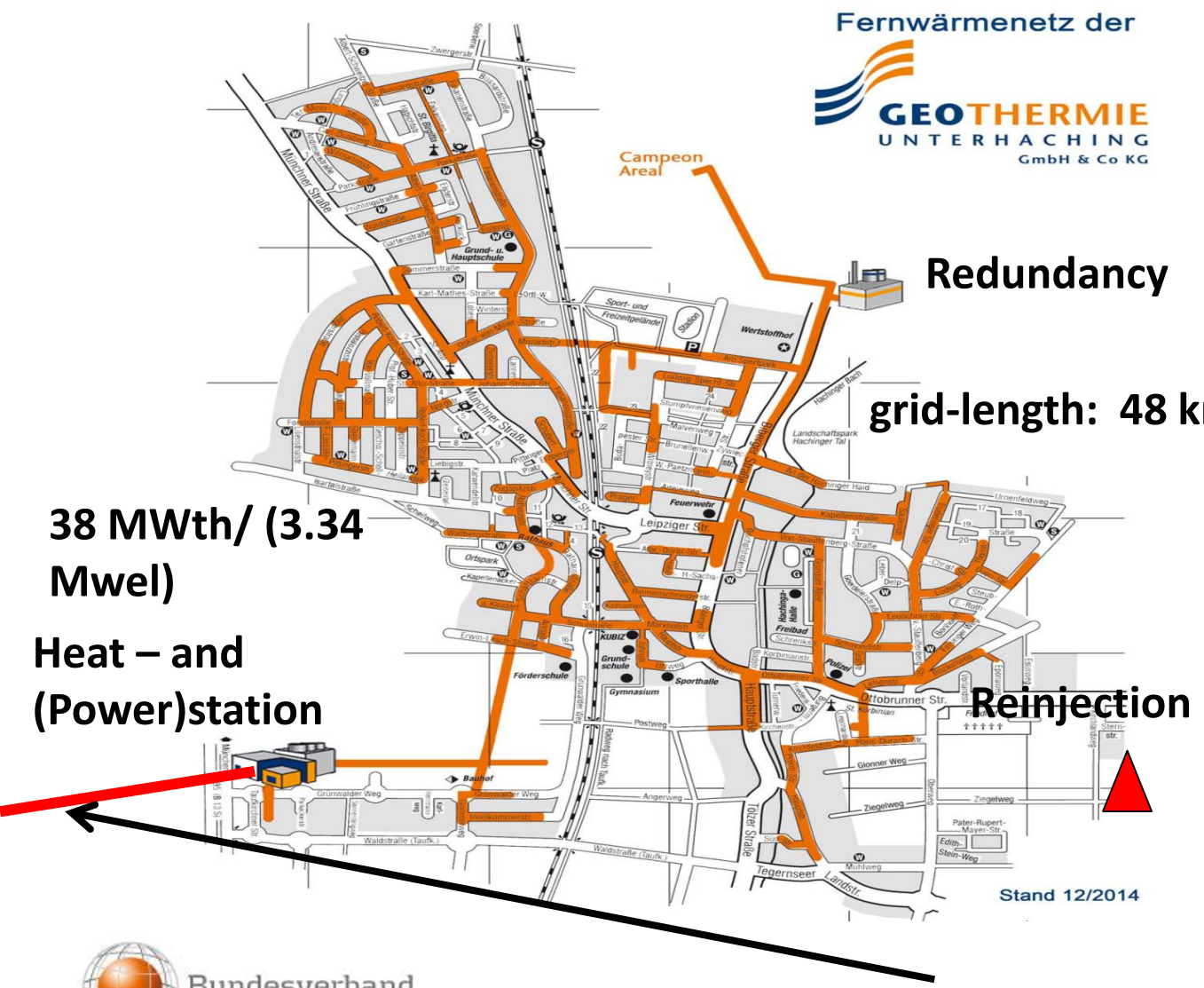
Geothermie Unterhaching GmbH & Co. KG



- Transmission line: length 5.3 km, diameter DN 250
- Power transmission: ca. 20 MWth (350t/h, at 110°/60°C)
- Volume of the transmisson line: ca. 727 m³ water – can also be used as buffer storage

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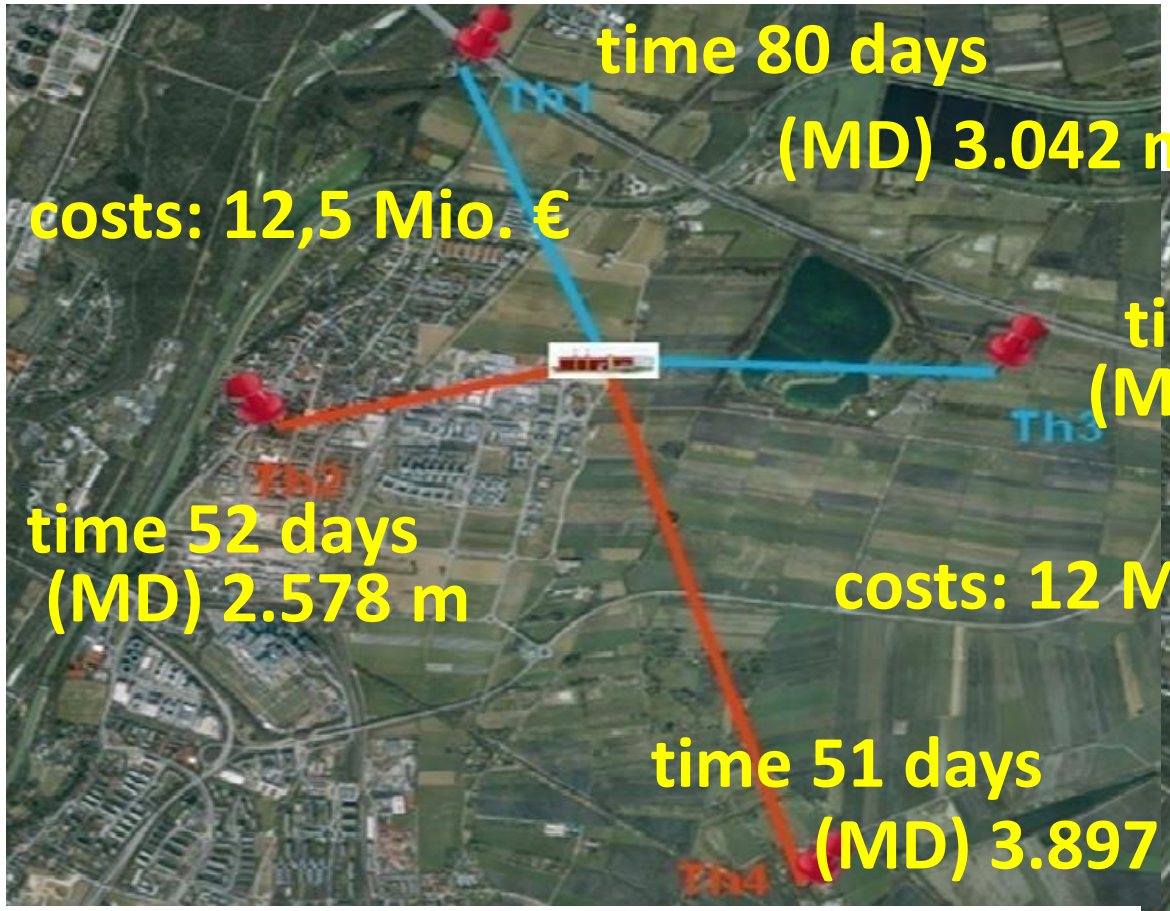
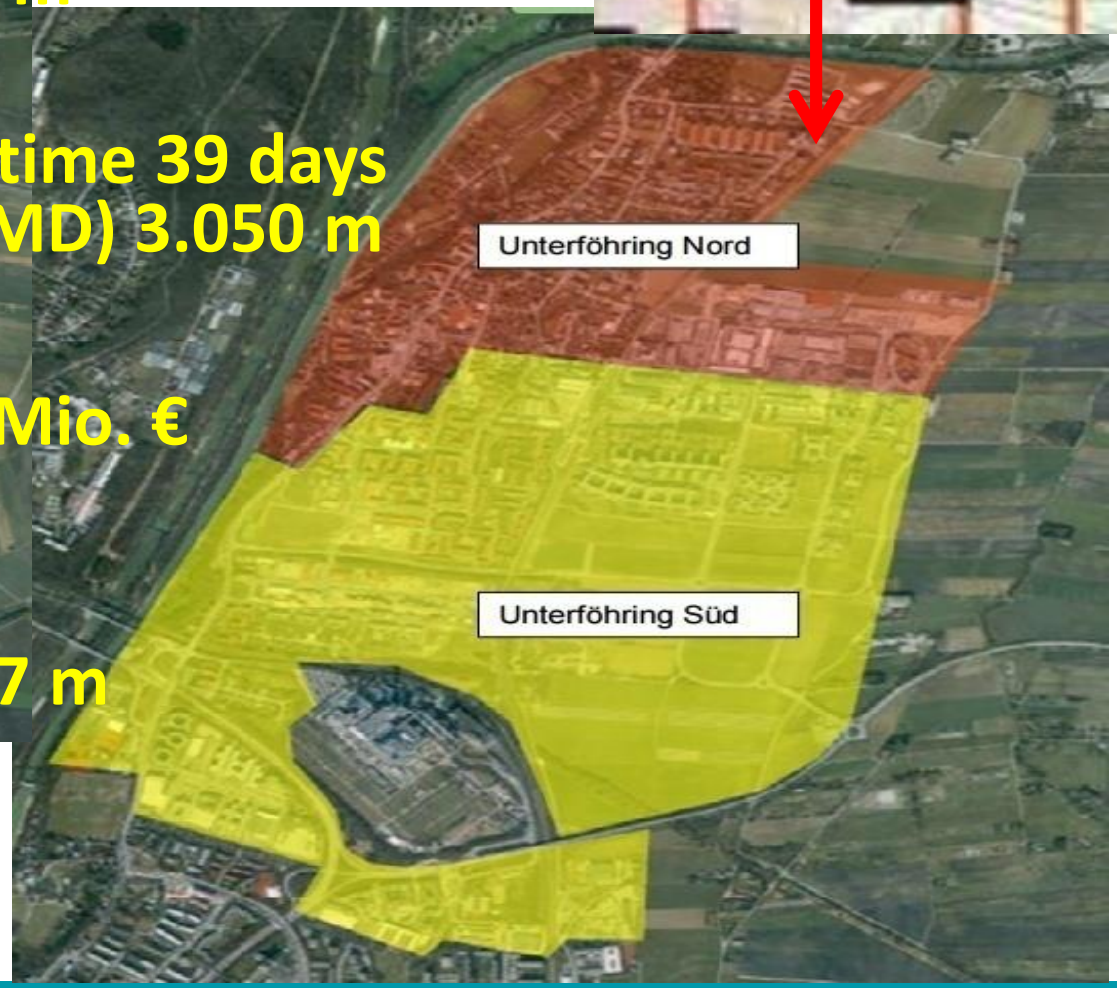
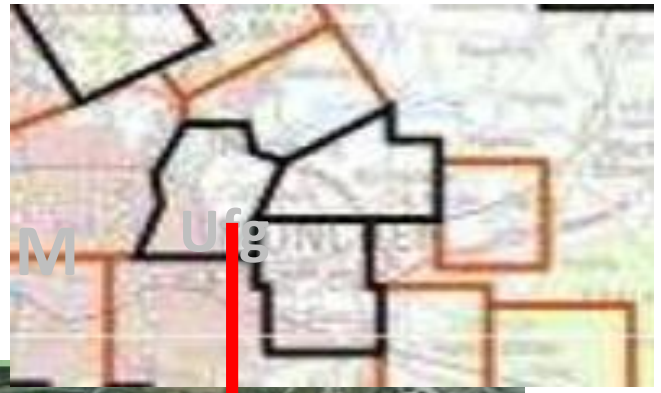
transmission line to Erdwärme Grünwald

GEOVOL Geothermie Unterföhring
2-Doublett System







Reduction of time and costs

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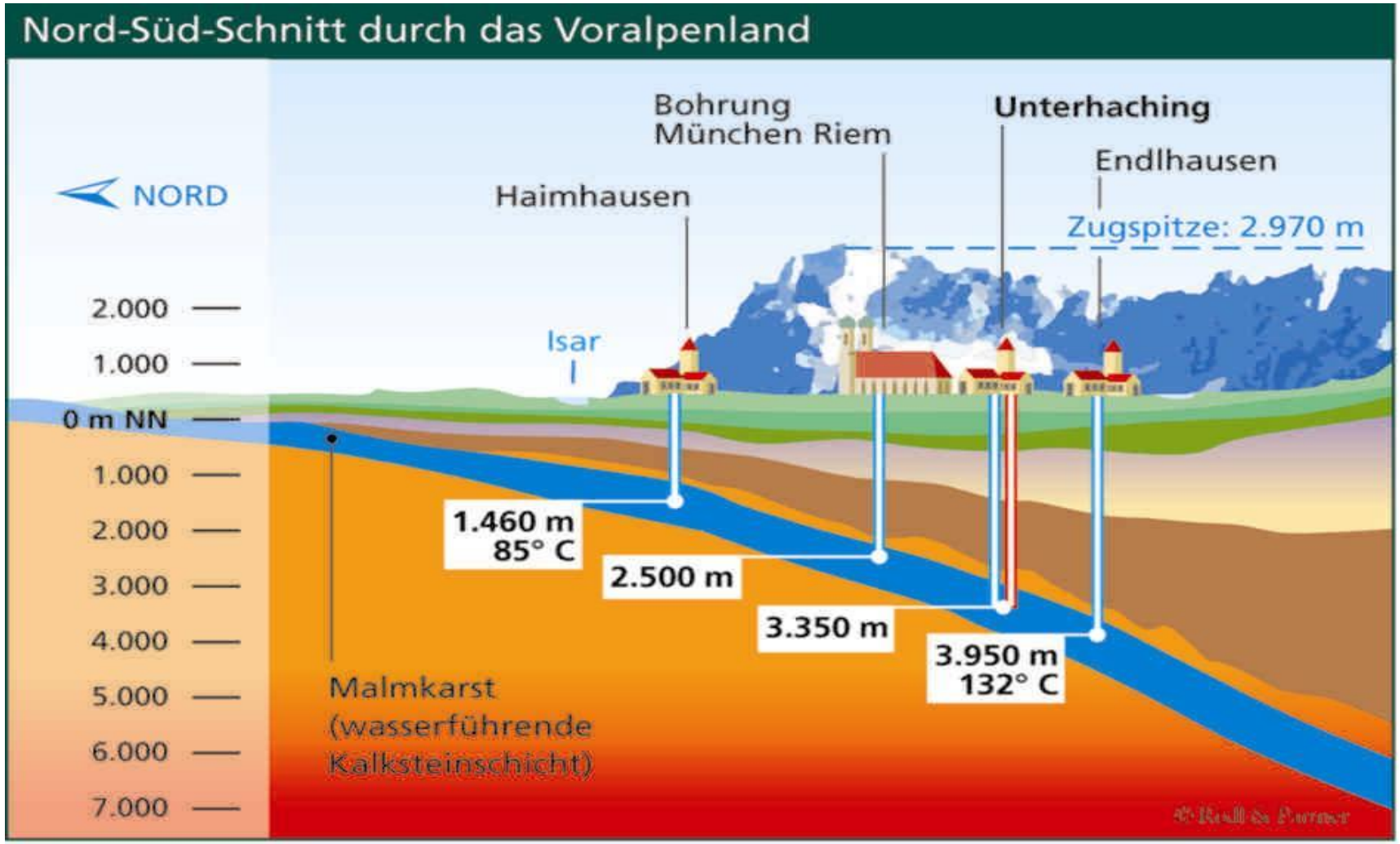
Quelle: GEOVOL 2015

Geothermics – Munich: Energy, Geology and Plants

Heat Plants
Riem
Freiham
Schäftlarnstrasse

Heat/Power Plants
Sauerlach
Dürrnhaar

Kirchstockach



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SWM Geothermal Plants in Operation

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Geothermal-Heat-Plant München-Riem

Doublett-wells **3.020 m / 2.746 m TVD**

Max. production: **90 l/s**

Temperature thermal water: 94 °C

Max. thermal power: **14 MW**

3 peak load - / redundandancy boilers (gas)

Max. connected thermal power: **34 MW**

Drilling **2003**

Launch **2004**

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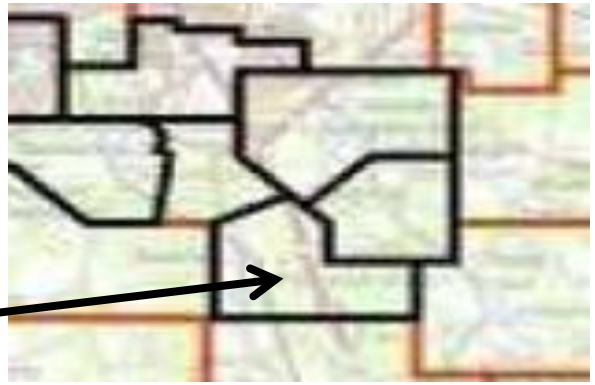
SW//M Stadtwerke München

Geothermie–Heizkraftwerk Sauerlach



Triplett system (1 production-, 2 injection - wells)

Depth of	4.757 m to 5.567 m MD
Yield:	110 l/s, 140°C
2-stage ORC-process	
Vapor - medium:	Penta-Fluor-Propan
el. power	5.100 kW
el. energy-production	40.000 MWh/a
th. power	4.000 kW
Thermal energy	4.000 MWh/a
CO_2- reduction	36.000 t/a
Drilling during	2007-2009
Construction of powerstation	beginning 2011
1. heatsupply	2012
1. power supply	2013

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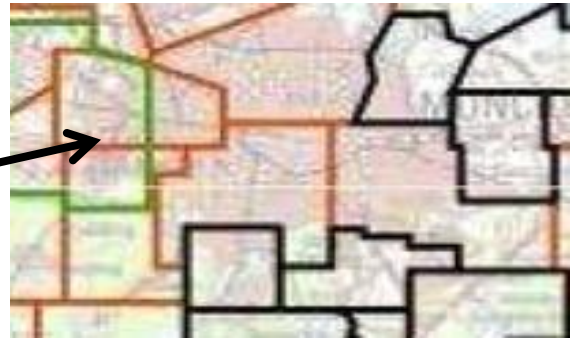
SW//M Stadtwerke München

Geothermal –Heat-Station Freiham



New city-district Freiham:
Commercial space: 110 ha, 7.500 workplaces
Living: 190 ha, 20.000 inhabitants

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SW//M
Stadtwerke München

München-Freiham

Construction drilling-place 1: 51 days

Construction drilling-place 2: 74 days

Relocation of the rig: 30 days

drilling 1: 02.10.2015 – 27.11.2015 (56 days)

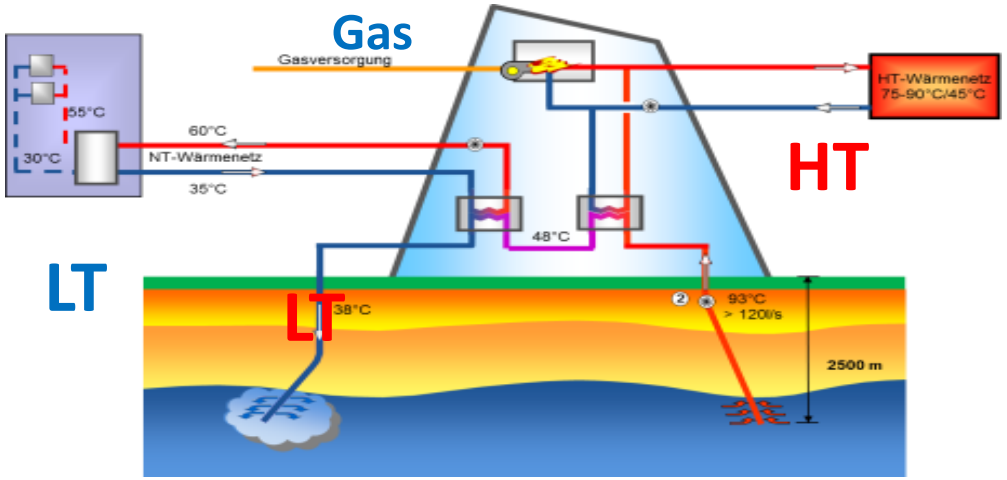
Drilling 2: 01.01.2016 – 08.02.2016 (39 days)

Th1: 91,7° C; 90 l/s

Th2: 87° C; 105 l/s

Vertical depth: 2500 m; MD ca.3000 m

Owner	Stadtwerke München
Wells	2
Launch	2016
Thermische Leistung Geothermie	20 MW
Yiled	90 l/sec, 90°C
Geological formation	Malm
TVD (depth)	2.520 m



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Vision2040

By 2040, Munich is to be the first German city, in which district heating can be obtained from 100 percent renewable energies. In order to realize this vision, the SWM will primarily focus on the further development of geothermal energy.

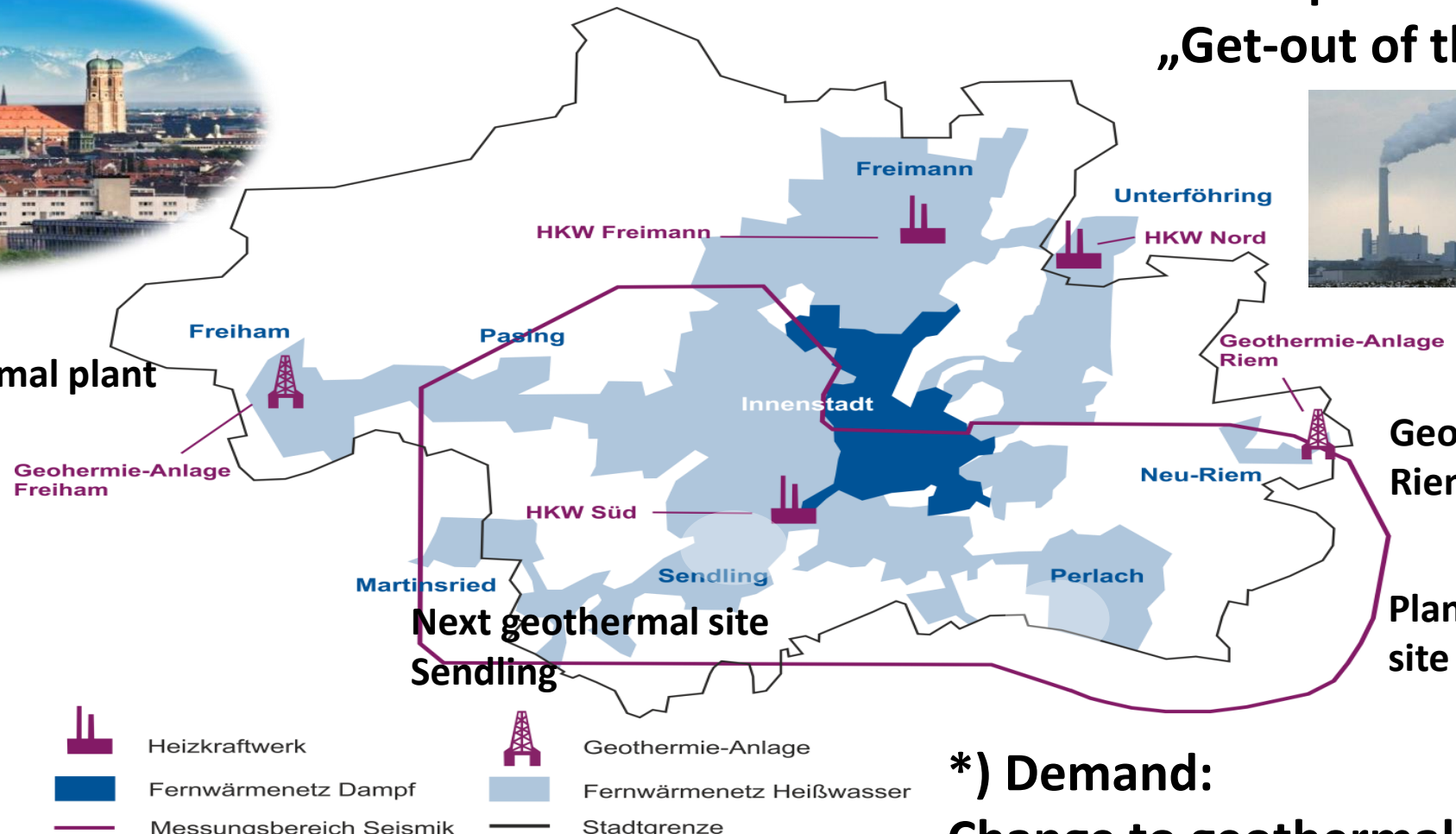
Research Project GRAME

„Ganzheitlich optimierte und nachhaltige Reservoirerschließung für tiefengeothermische Anlagen im bayerischen Molassebecken - Development of 50 MWel powerstation and of 400 MWth for district heating in Munich“

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages
ptj Projektträger Jülich Forschungszentrum Jülich
SWM Stadtwerke München
Lehrstuhl für Energiesysteme
ERDWERK Hydrogeologie · Geothermie
IAG
Bundesverband Geothermie

District Heating 2040 – 100% Renewable Energy

Public petition 2018:*)
„Get-out of the Coal“



Geothermal plant Freiham

Geothermal plant Riem

Next geothermal site Sendling

Planned geothermal site Perlach

***) Demand:**
Change to geothermal energy until 2022

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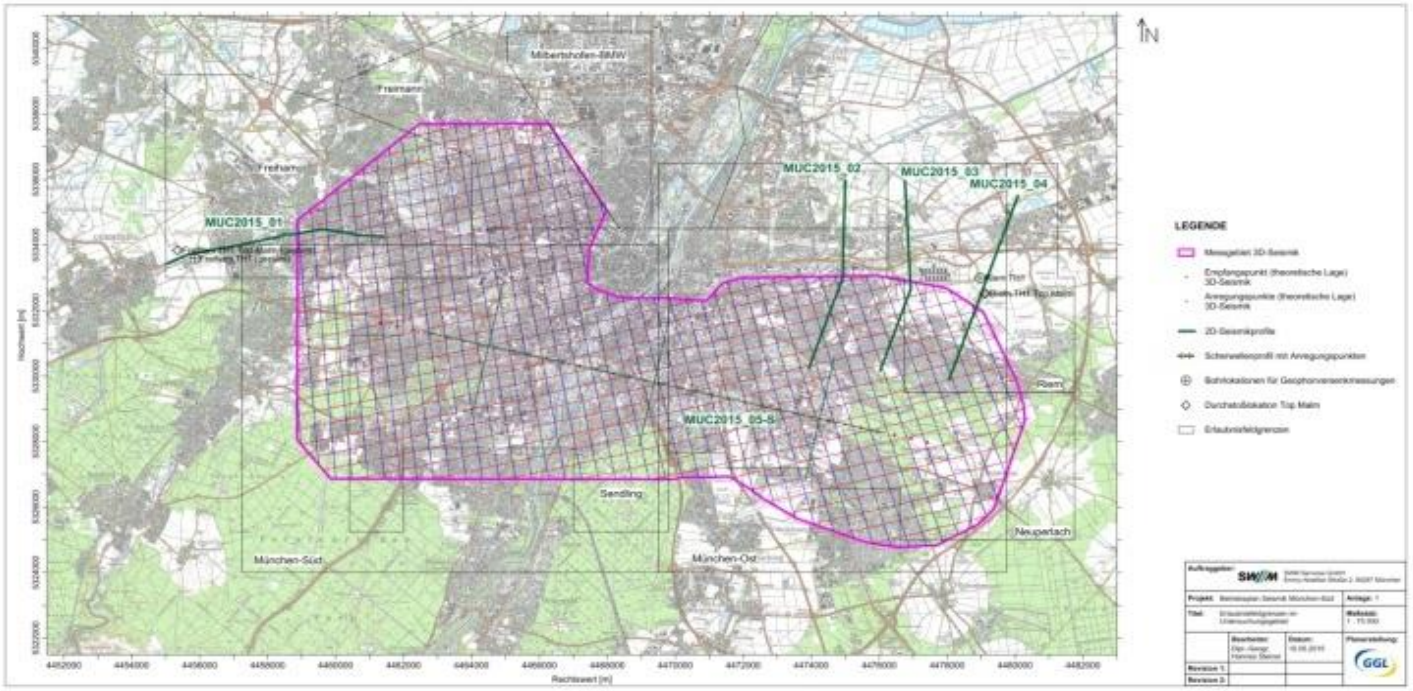
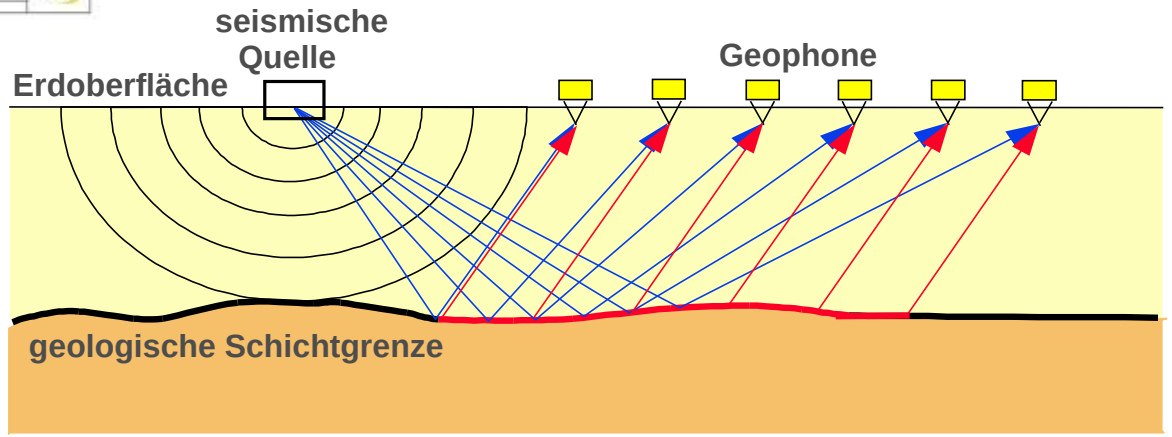
Quelle: SWM

2 D und 3 D Seismik in Munich



16 City districts
11 Communities outside M
2 State forests
8 FFH areas
13 protected landscape areas



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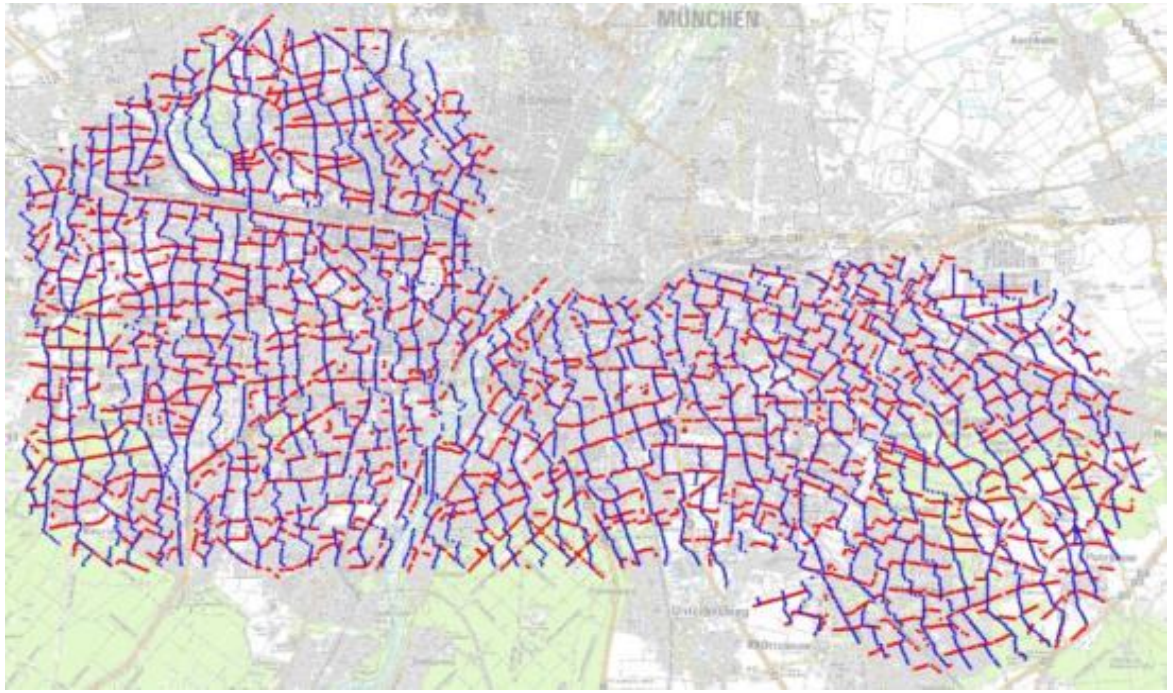
Realized 3 D-Seismik Net

6935 Vibro Points,
7469 Geophone Points,
Area 3 D Seismik 170 km^2



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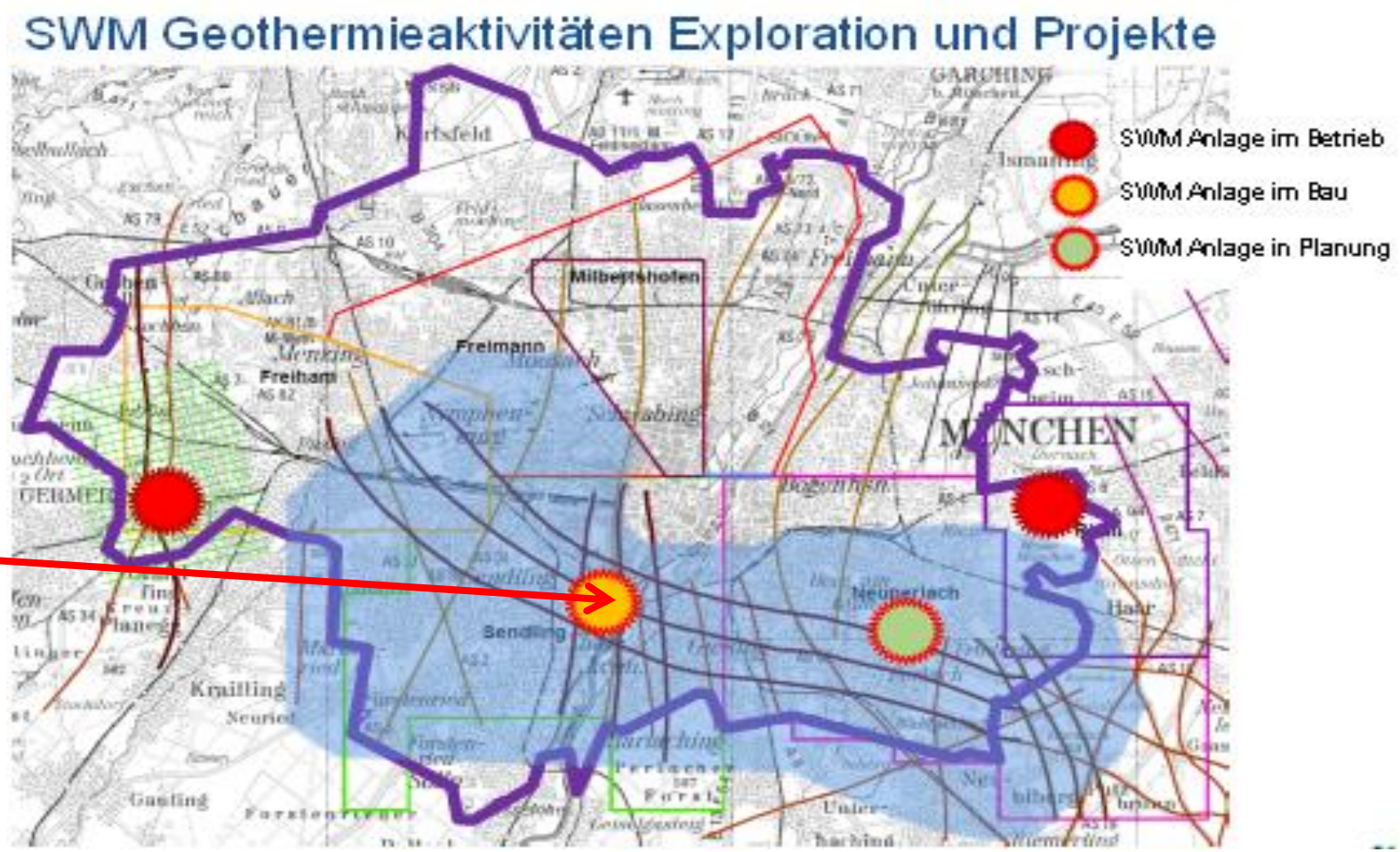
Project Schäftlarnstraße with 3 Doubletts

Quelle: SWM



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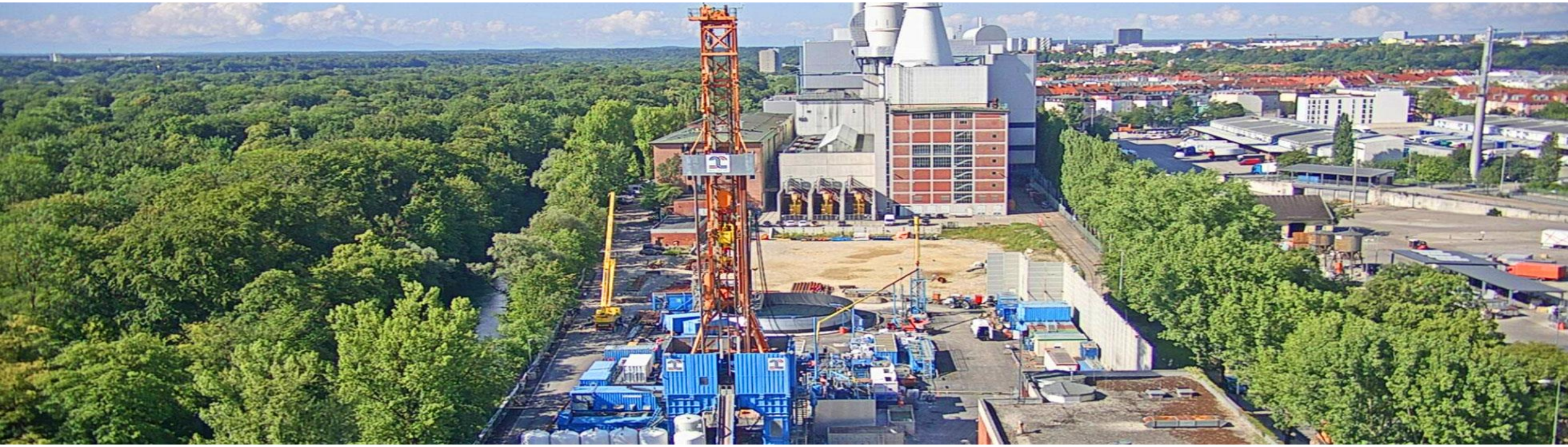
Location München-Süd



Th1: T> 100°C; production 120 l/s;

VD: 2800 m

Plan P_{th} ca. 50 MW from 2020

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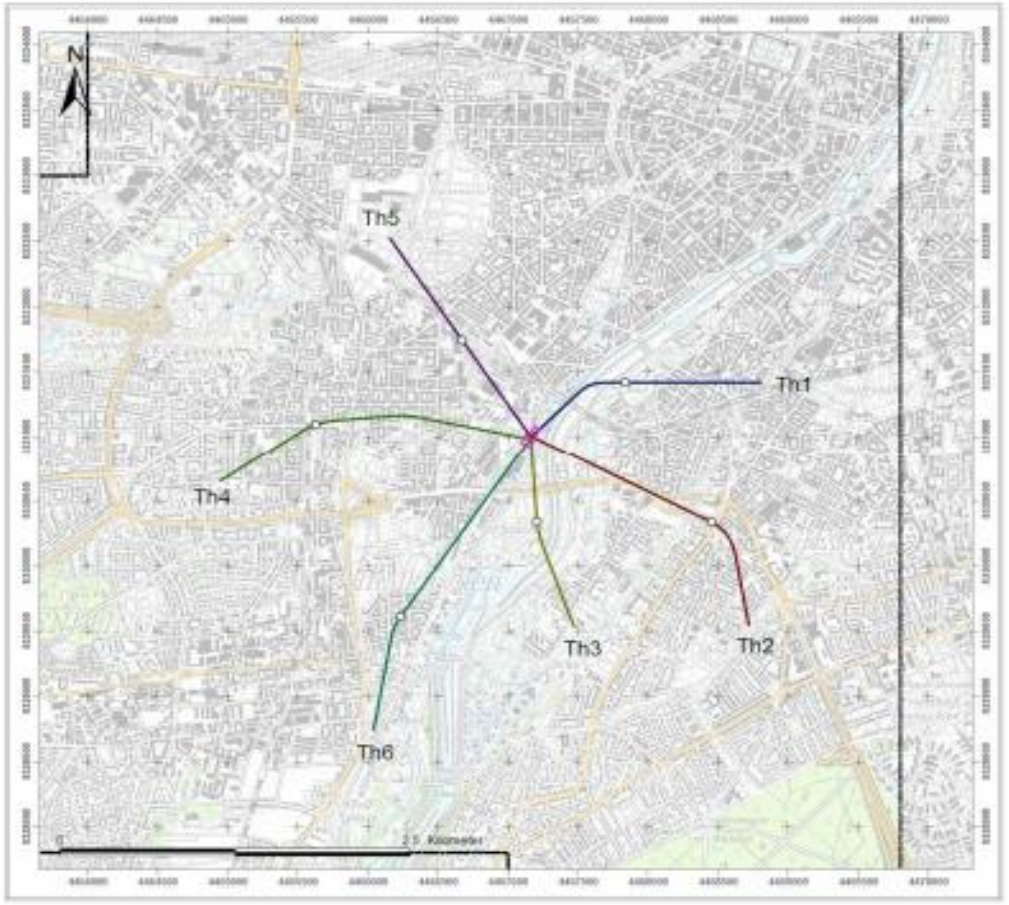
Project key figures (München, Schäftlarnstraße)

Temperature >100° C
Production (Tripeldoublet) 330 l/s
Total drilling length >24 km

Vertical drilling depth: 2,400 to 3,100 m
Borehole length: 3,700 to 4,400 m



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SWM

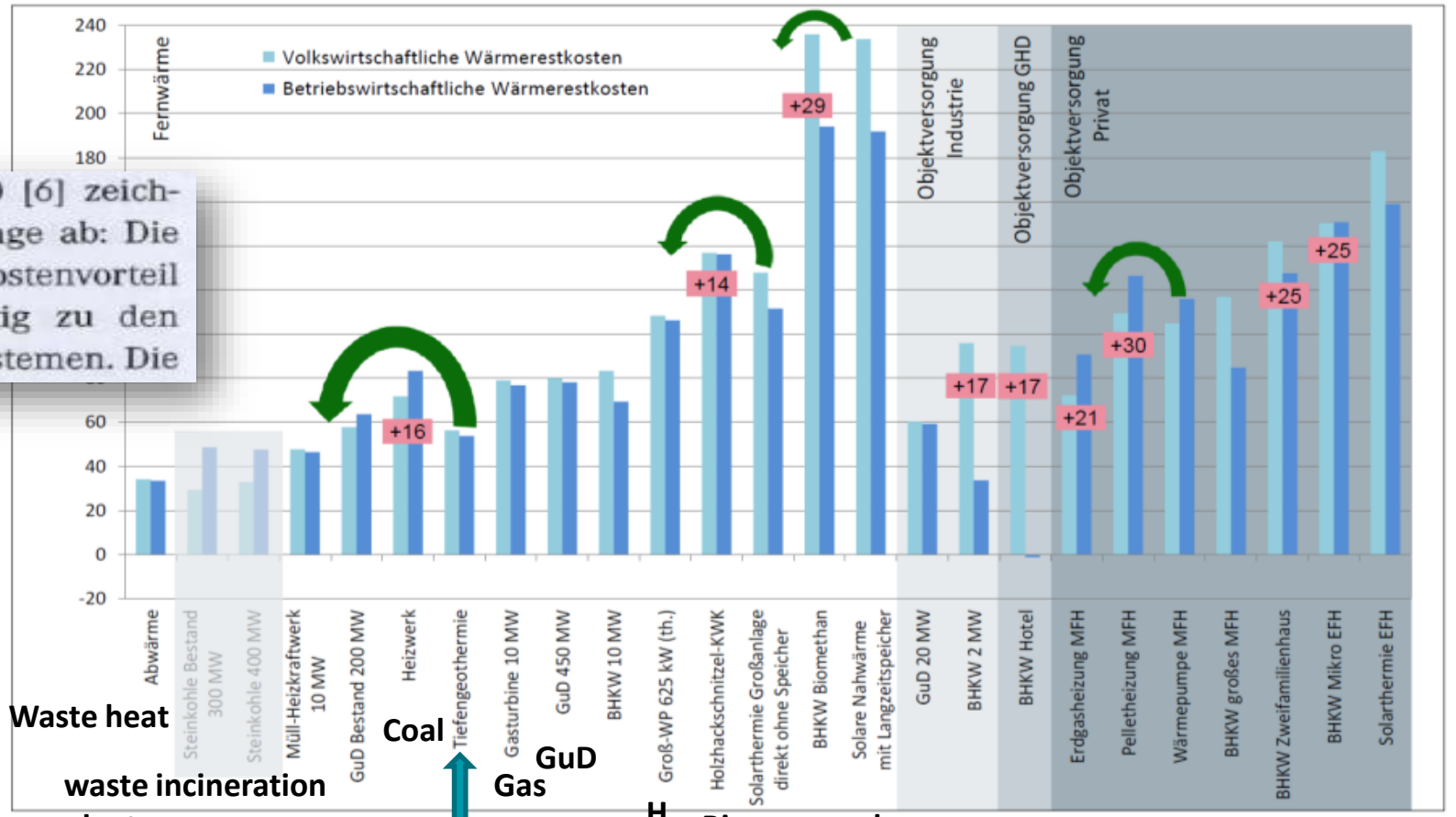
Future Heat-Prices in Munich

Entwurf eines technischen und ökologischen Strukturwandels in der Fernwärmeversorgung

Martin Greller und Florian Bieberbach

ewt 8/2015

Mit den Preisszenarien für 2040 [6] zeichnen sich folgende Zusammenhänge ab: Die Tiefengeothermie baut ihren Kostenvorteil weiter aus und gehört zukünftig zu den günstigsten Wämeversorgungssystemen. Die



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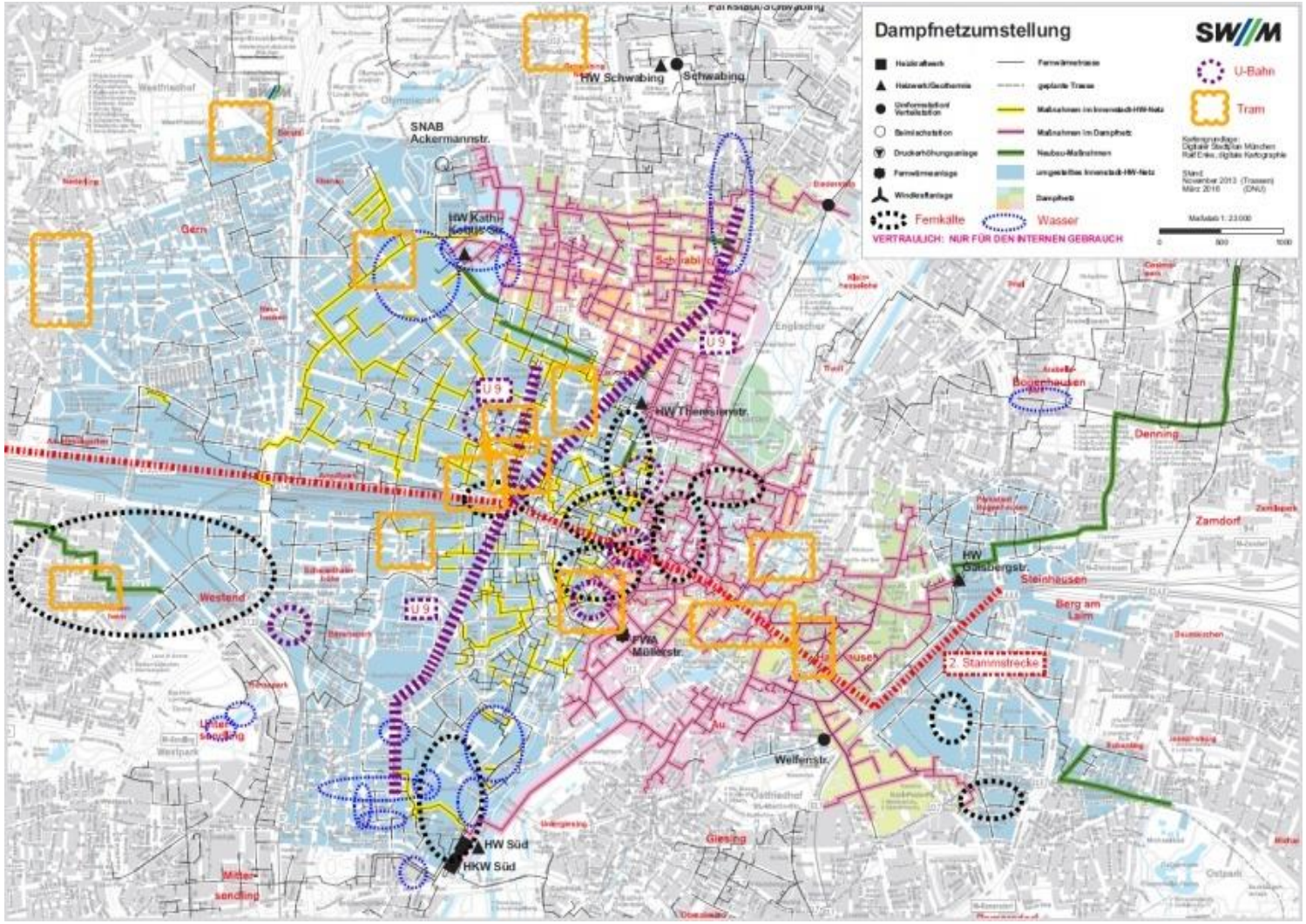
Overview of Large-Scale Construction Projects in Munich from 2017 to 2030:

The biggest challenge for heat transition is the adaptation of district heating pipelines to geothermal energy.



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Germany‘s First Geothermal Greenhouse Farming: Kirchweidach

Greenhouse:	**25 ha area; 2o Mio kg tomatos; closed water cycle (no use of groundwater); 150 jobs; saving of > 8.500 000 m³ gas; redundancy with local district heating grid.**
District Heating:	**80% connection rate; return flow for the greenhouse**
Biogas Plant:	**integration of the local biogas plant (redundancy)**
Power Plant:	**modular extension of a ORC- process (now 1.5 MW)**

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Geothermie Holzkirchen (the newest project in operation)


Quelle: Erdwerk

The subsequent short-time pumping tests resulted in a thermal water temperature of > 150 °C. A first short-term circulation stage test was carried out with a pumping and injection rate of up to 50 l/s. In mid-April 2017, the drilling rig was completely dismantled and transported away.

TH 1: 5.600 m MD

TH 2: 6.084 m MD

6.1/8" drilling diameter in the reservoir

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Geothermal Energy:

- Electrical power, heating and cooling
- Base-load energy
- Renewable, climate-friendly, sustainable
- Secure supply, non-explosive, reduces imports of fossil energy
- Prevents political pressure
- Inexhaustible reservoir
- No fluctuating fuel costs
- crisesafe
- Value added remains in the region

..and Wellness:

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We have an urgent task for the protection of future generations!!!

Thank you for your attention.

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