Geothermal heat pumps in Norway

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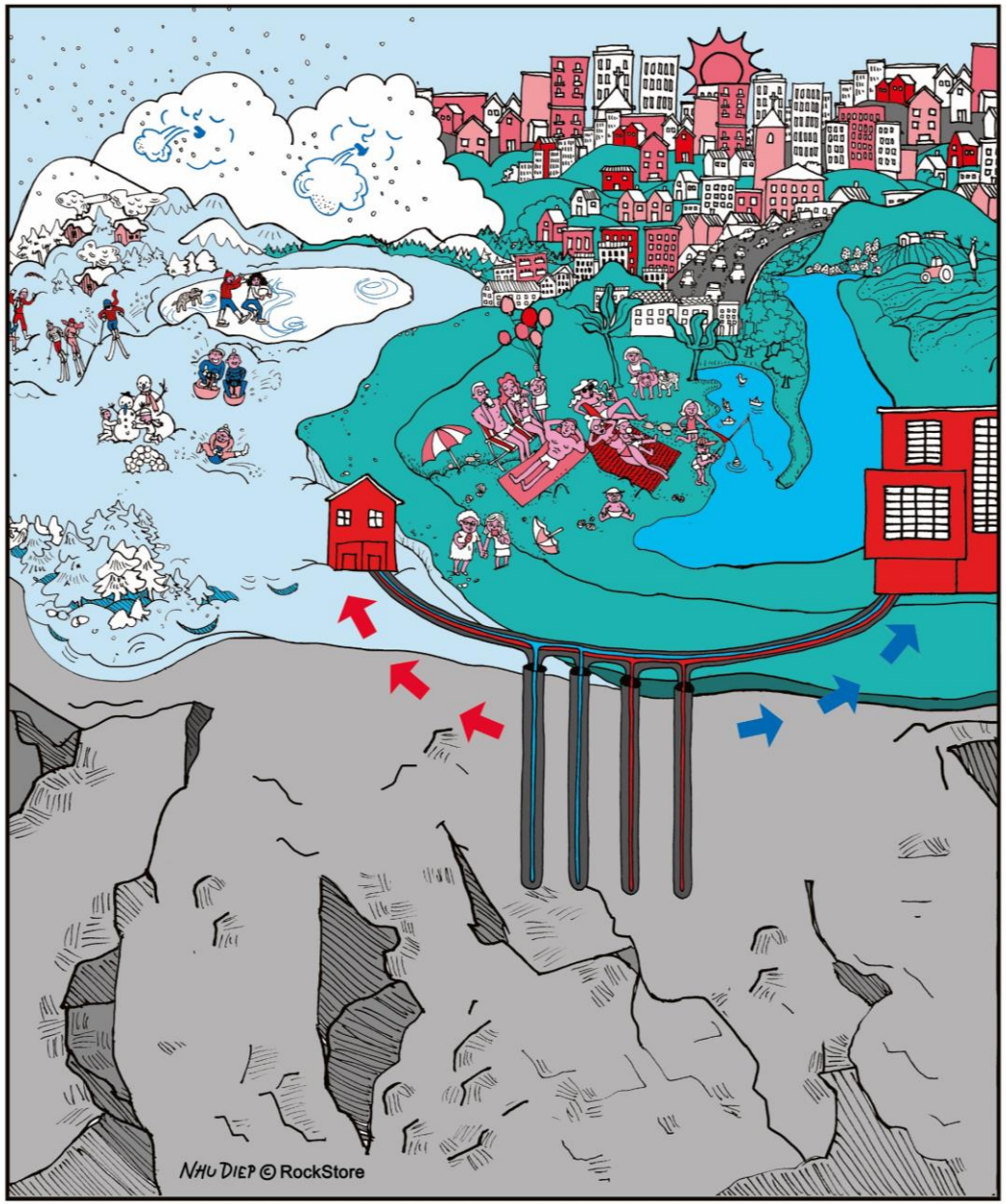
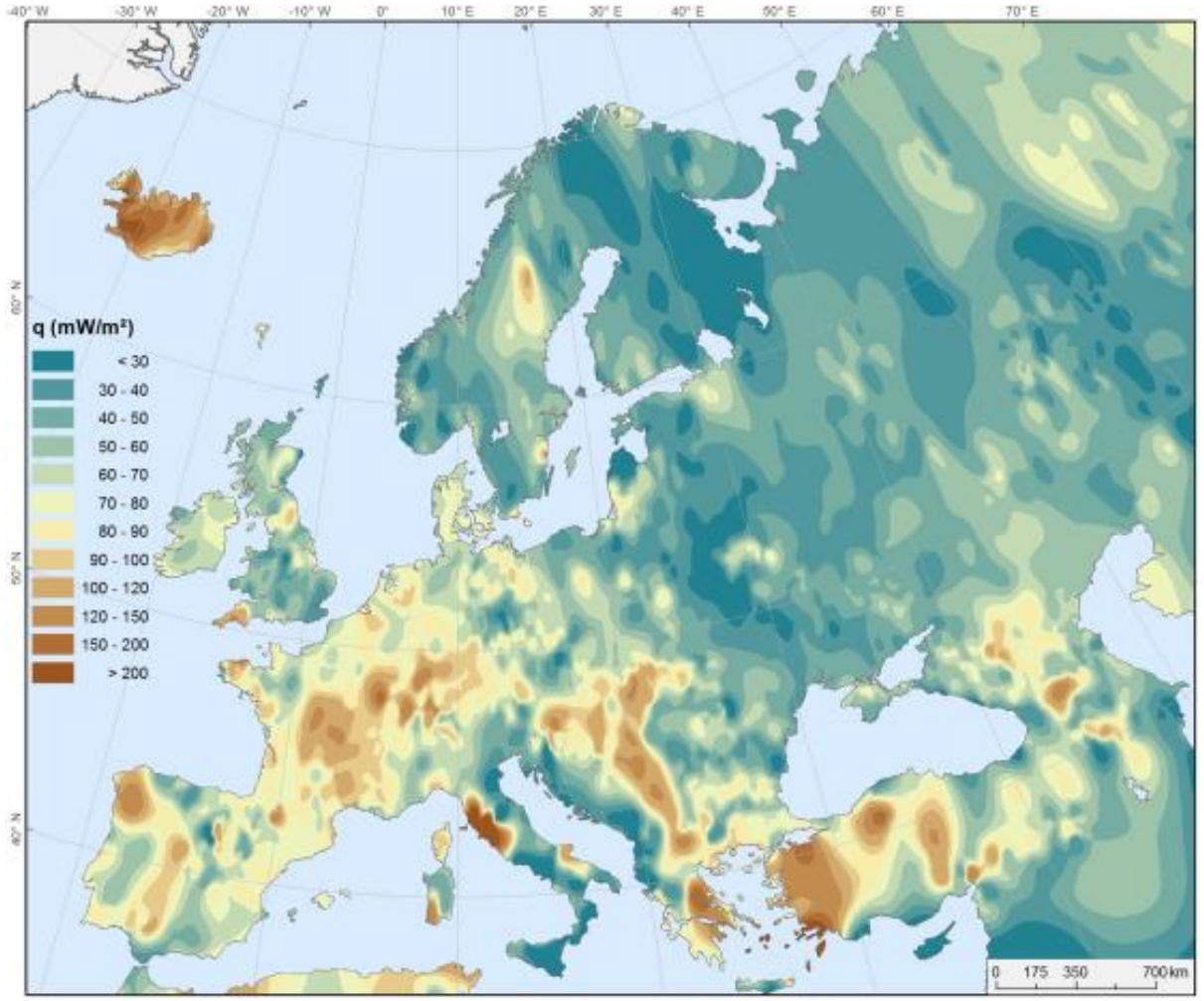
Content

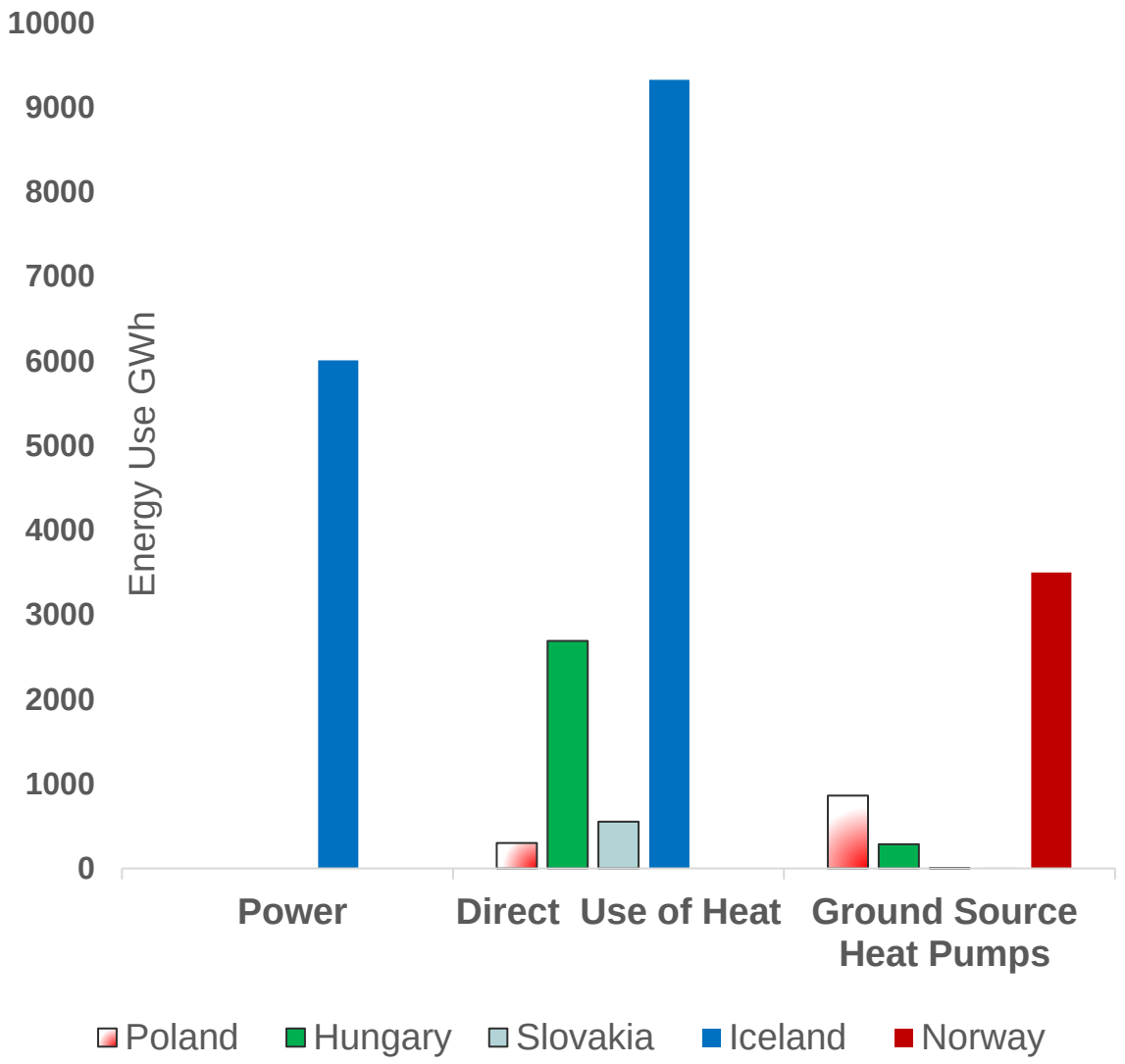
- Overview geothermal heat pumps
- IEA HPT Annex 52 Case Scandic Airport Flesland



Heat flow map of Europe & use of geothermal energy



S. Hurter, R. Haenel Atlas of geothermal resources in Europe (2002)



Geothermal Energy

	Geothermal Power		Direct Use of Geothermal Heat		Ground Source Heat Pumps		Total Geothermal Energy	
	MW	GWh/yr	MW	GWh/yr	MW	GWh/yr	MW	GWh/yr
Poland			106	300	650	861	756	1161
Hungary	3		950	2689	72	284	1025	2973
Slovakia			229	552	2	3	231	555
Iceland	755	6010	2367	9328	6	5	3128	15343
Norway			1	1	1150	3500	1151	3501

Ref. - World Geothermal Congress 2020 Country Updates

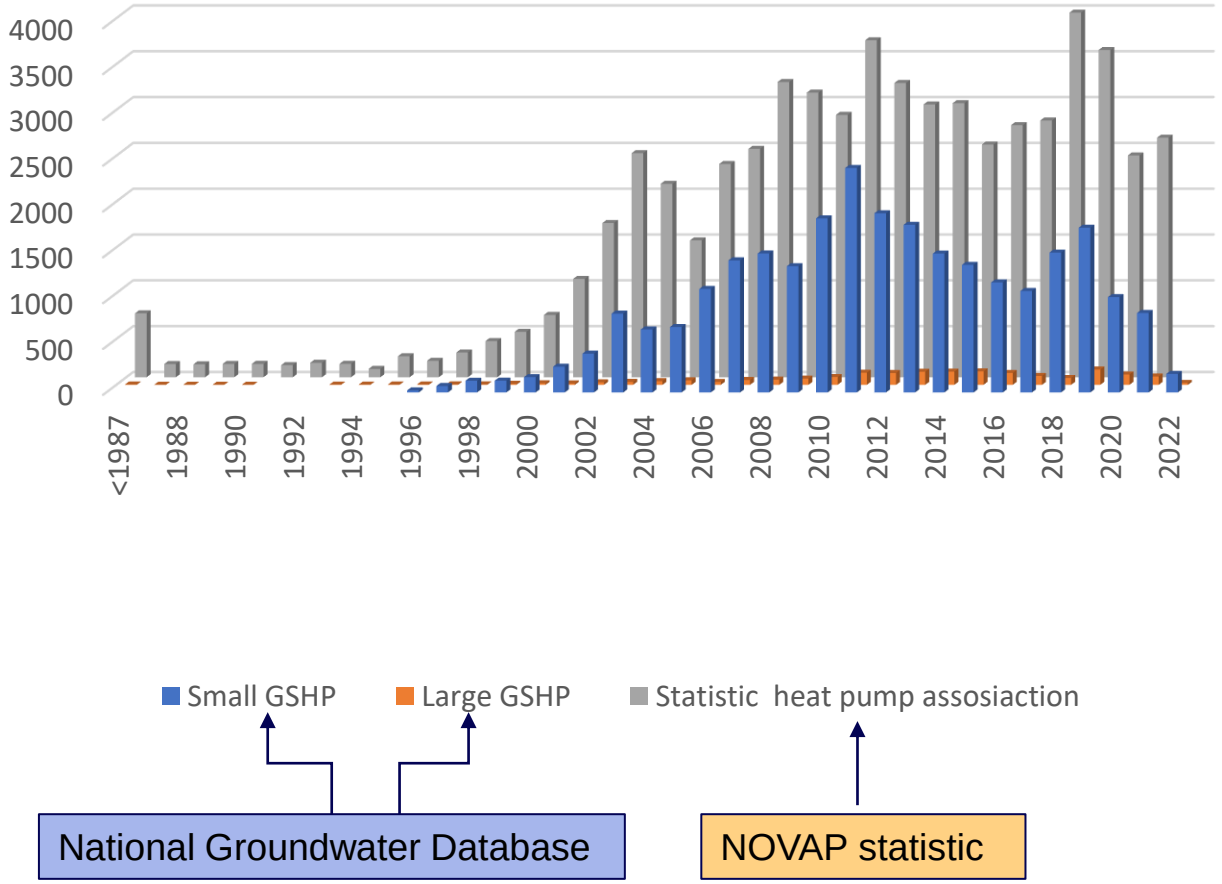
IEA Key World Energy Statistic 2021

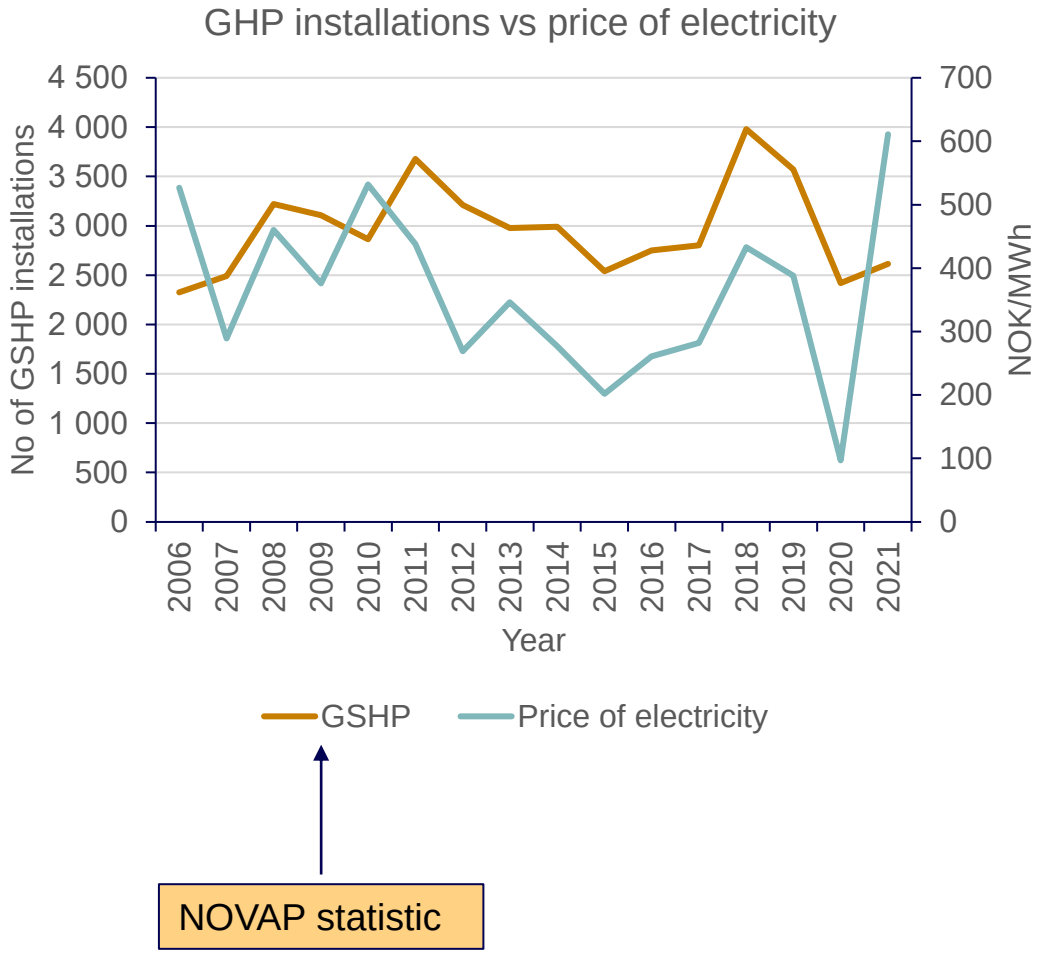
	Population (Million)	Total Energy Supply / population (GJ /capita)	Electric consumption/ population kWh / capita	CO_2 / population tCO_2 /capita
Poland	38.4	112	4316	7.49
Hungary	9.8	114	4446	4.64
Slovakia	5.5	131	5215	5.44
Iceland	0.4	697	52514	4.53
Norway	5.3	215	23762	6.52

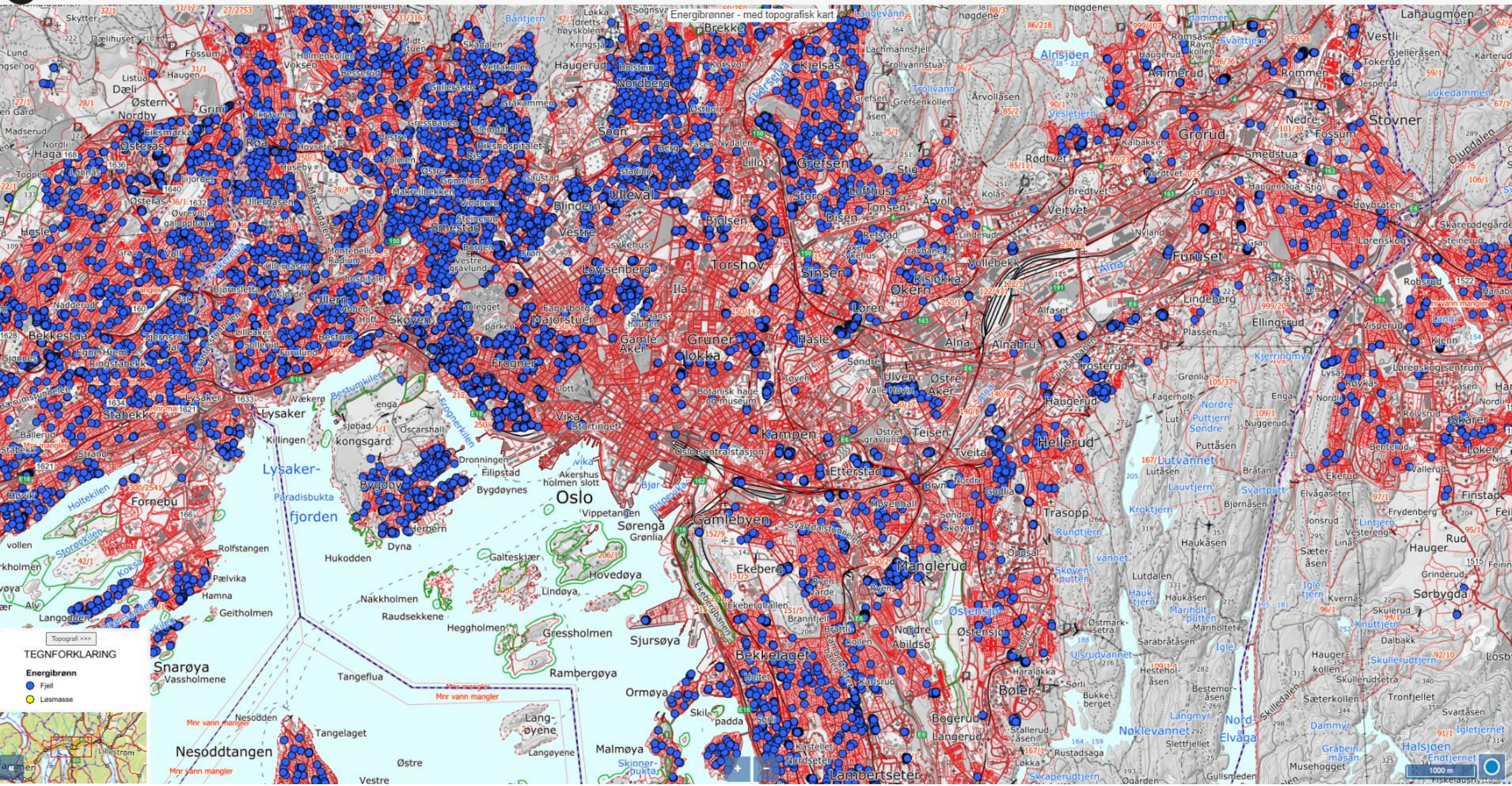
*CO_2 emissions from fuel combustion only. Emissions are calculated using the IEA World Energy Balances and the Revised 2006

Geothermal Heat Pump installations

- Installed capacity 1150 MW
- Energy use (energy saving) 3.5 TWh
- Ca 70 000 installations incl 2000 large installations >4 BHE (25 kW)



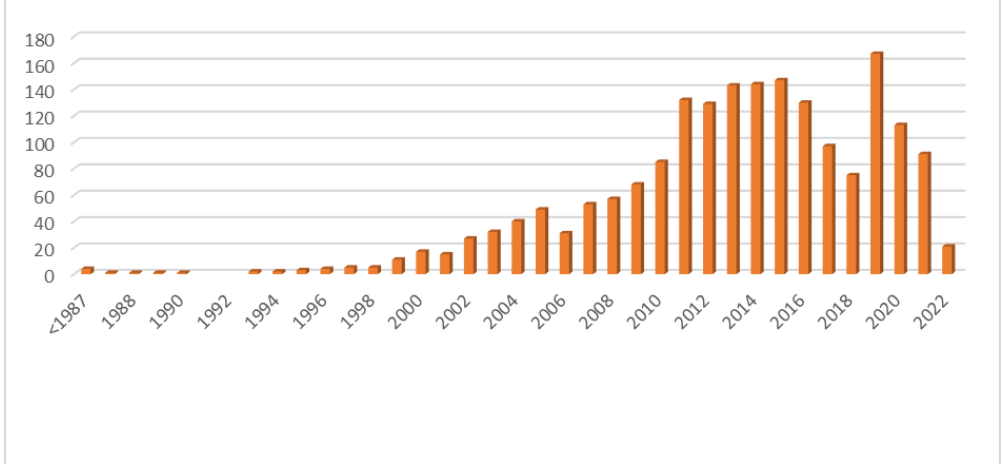


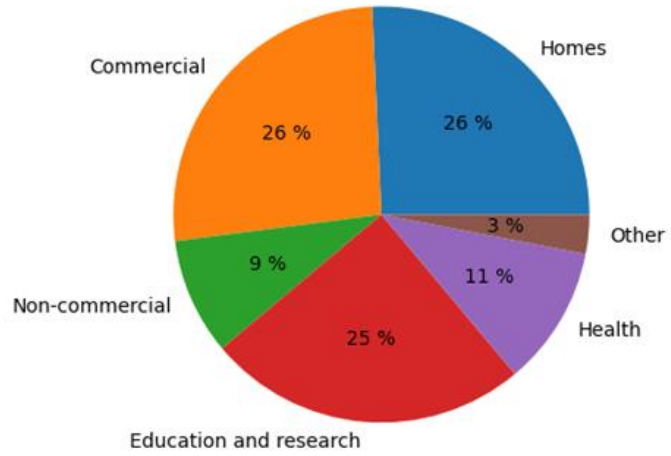

Energibrønner - med topografisk kart
Topografi >>>
TEGNFORKLARING
Energibrønn
Fjell
Løsmasse
Oslo
Lillestrøm
1000 m

Tek 17 Regulations on technical requirements for construction works

Building category	**Total net energy requirement [kWh/m² heated gross internal area per year]**
Small houses and leisure homes with more than 150 m² of heated gross internal area	100 + 1,600/m² heated gross internal area
Block of flats	95
Kindergarten	135
Office building	115
School building	110
University/university college	125
Hospital	225 (265)
Nursing home	195 (230)
Hotel building	170
Sports building	145
Commercial building	180
Cultural building	130
Light industry/workshop	140 (160)

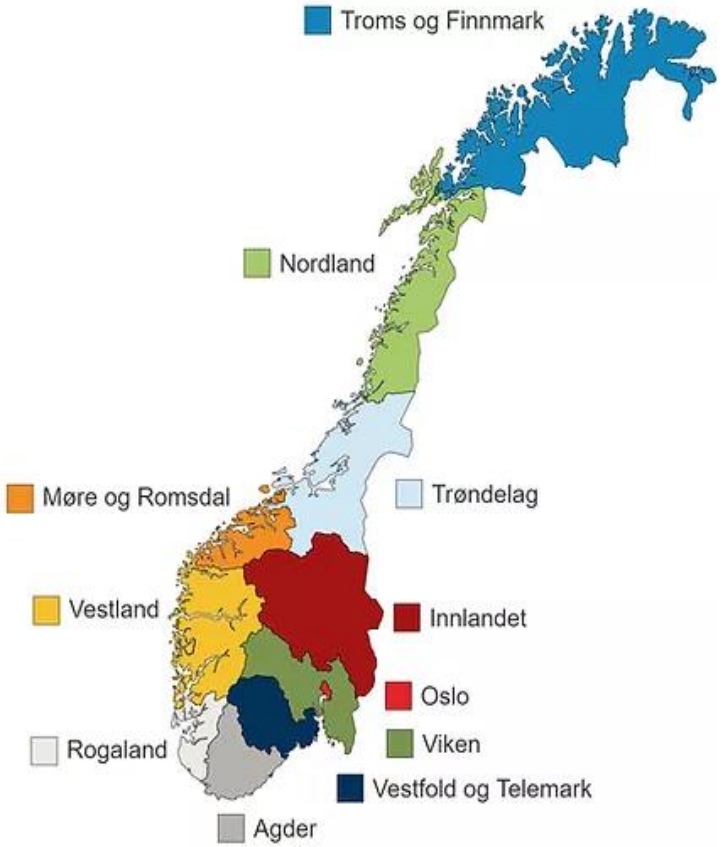
Large GHP installations





Installation	Building type	No of BHEs	Total length of boreholes -m	Year
Ahus	Hospital	228	45600	2007
Avantor- Nydalen syd	Business	180	42500	2004
Sartor senter	Mercantile	167	33268	2013
Idrettshøgskolen	Educational	97	29100	2016
Ulven borettslag	**Residential**	**88**	**27698**	**2019**
Arcus	Industrial	91	27300	2012
Sykehuset Østfold	Hospital	100	24429	2013
Stavanger universitetssykehus	**Hospital**	**96**	**24000**	**2020**
Ullevål stadion	Sport/Business	120	24000	2009
Coop Åsane	Mercantile	114	23874	2013
Marikollen ungdomsskole	Educational	85	23327	2017
Stavanger Forum	Exhibitions	85	21250	2011
Maridalsveien borettslag	**Residential**	**59**	**20727**	**2019**
Manglerudjordet borettslag	**Residential**	**67**	**20033**	**2018**
Vulkan kontorbygg	Business	68	19000	2010
Haukeland sykehus barne avd	Hospital	77	18730	2012
Ørlandet flyplass	Airport	72	18000	2016
Thon Sørlandssenteret	Mercantile	90	18000	2011
Postterminalbygget	Business	90	18000	2010
Diakonhjemmet	**Hospital**	**60**	**17865**	**2019**
IKEA Slependen	Mercantile	86	17200	2009
Universitetet i Sør Øst Norge	Educational	70	17110	2009
Vestre Billingstad, borettslag	**Residential**	**52**	**17045**	**2021**
Rælingen videregående skole	**Educational**	**51**	**16320**	**2021**
Høgskolen i Bergen	Educational	80	16000	2012
St.Hansberget borettslag	**Residential**	**45**	**15720**	**2021**

Regional variations of GHPs



Regions	Population		Single family houses		Large installations	
Inland region	**2765142**	**51 %**	**20481**	**73 %**	**1284**	**67 %**
Viken	1269230	23 %	9972	36 %	619	32 %
Oslo	699827	13 %	4177	15 %	349	18 %
Innlandet	371253	7 %	4746	17 %	167	9 %
Vestfold og Telemark	424832	8 %	1586	6 %	149	8 %
Costal regions	**1704071**	**31 %**	**4026**	**14 %**	**400**	**21 %**
Agder	311134	6 %	471	2 %	44	2 %
Rogaland	485797	9 %	1083	4 %	124	6 %
Vestland	641292	12 %	1969	7 %	144	8 %
Møre og Romsdal	265848	5 %	503	2 %	88	5 %
Middle region	**474131**	**9 %**	**2632**	**9 %**	**95**	**5 %**
Trøndelag	474131	9 %	2632	9 %	95	5 %
Northern regions	**481926**	**9 %**	**873**	**3 %**	**131**	**7 %**
Nordland	240190	4 %	501	2 %	61	3 %
Troms og Finnmark	241736	4 %	372	1 %	70	4 %
Total	**5425270**	**100 %**	**28012**	**100 %**	**1910**	**100 %**

- Norway has several climate zones with combinations of costal, inland, polar and mountain climate
- The distance to Sweden seems to be a factor in the prevalence of GHPs
- Based on data from National Groundwater data base

Norway

Monitoring project – **Scandic Flesland Airport**

IEA HPT Annex 52

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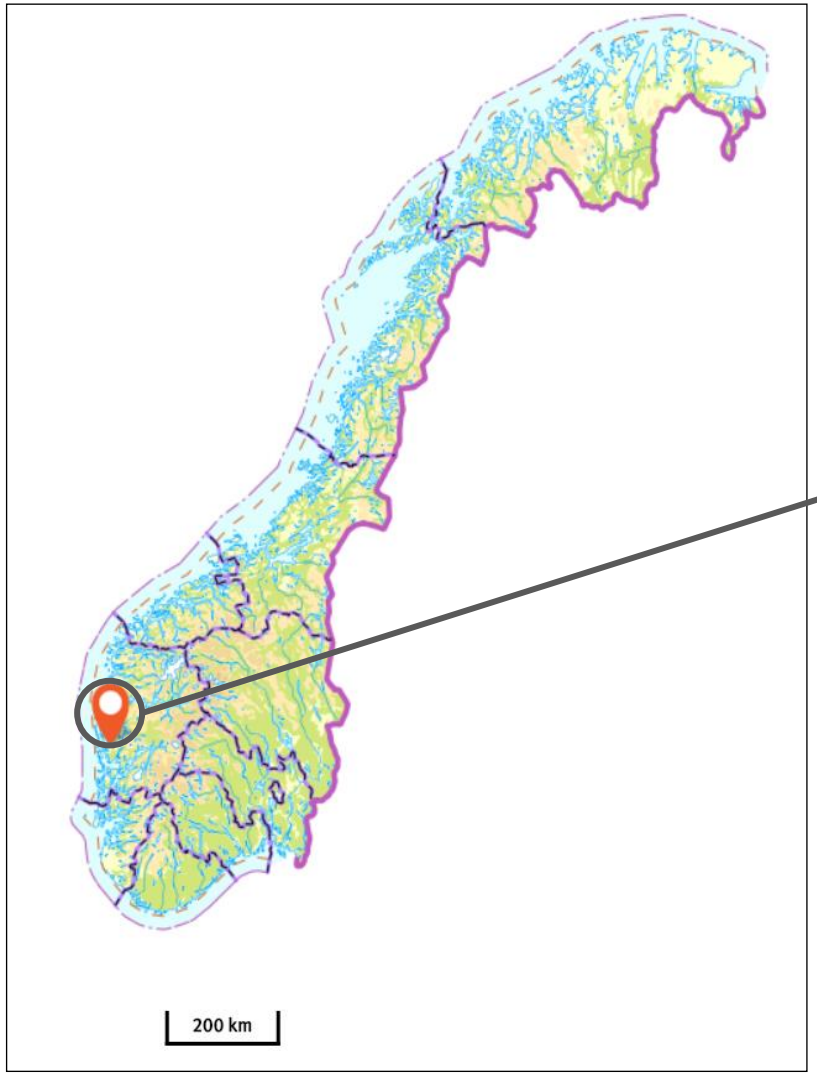
Location of the building

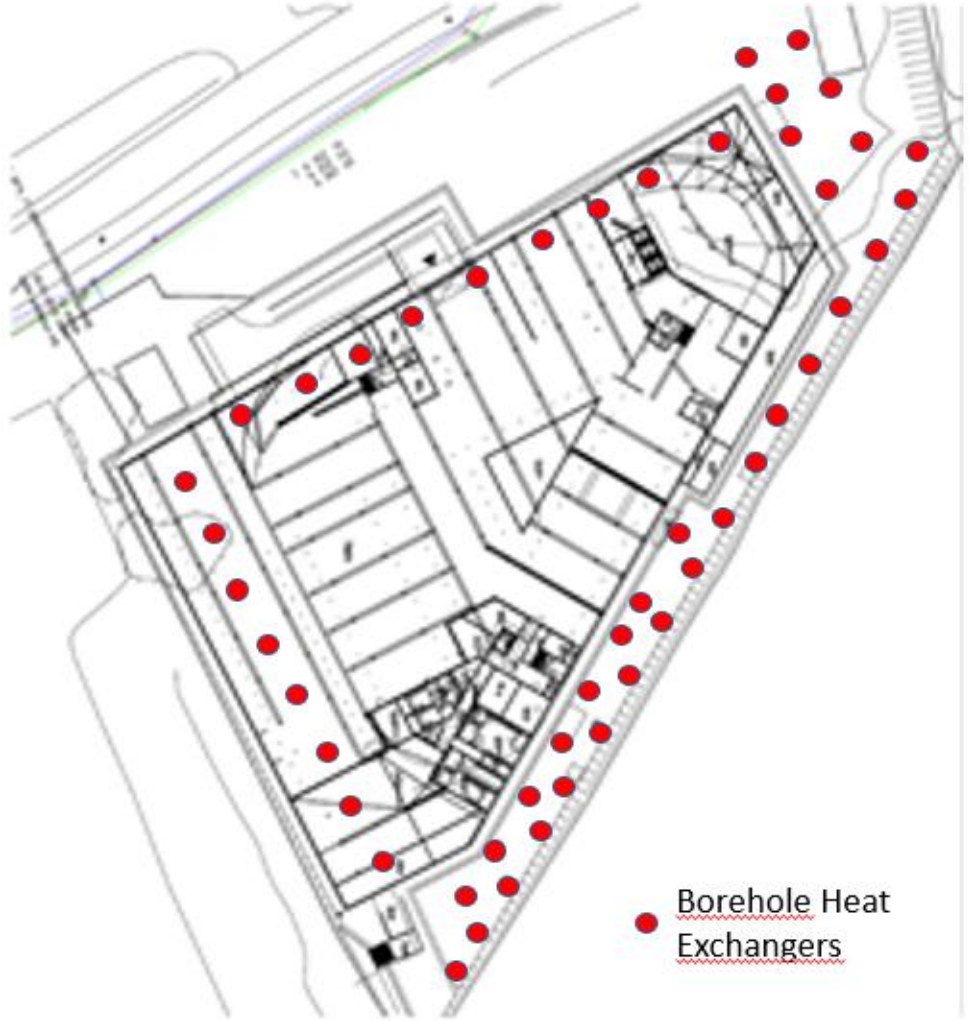


- Bergen Airport Flesland
- Vestland Region, Norway
  - 60°17 North,
  - 40 m above sea level
  - Coastal climate

Building with borehole heat exchangers

Scandic Flesland Airport/ – Bergen	
Year (building)/GSHP	(2017)/2017
Net floor area	18 000 m²
Heating load	1386 MWh/a (77 kWh/m²a)
Cooling load	132 MWh/a (7 kWh/m²a)
	4 floors, conference hotel

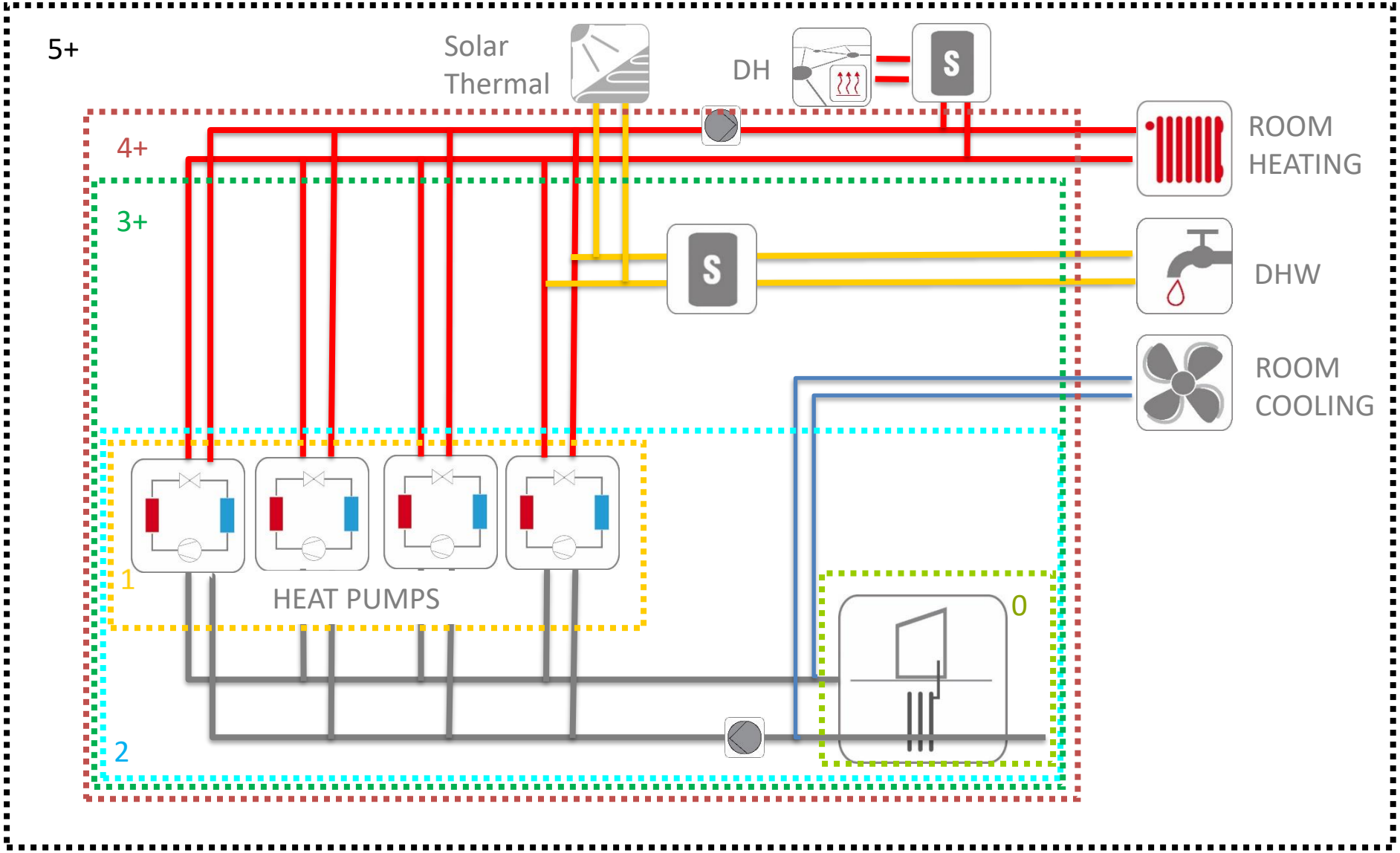
Building with borehole heat exchangers



	Scandic Flesland Airport /Bergen
Quantity	50
Length of borehole	200m
Overall length	10 000 m
System type	CentralHP
Heat pump	4 of two-stage brine-water-HP
Nominal capacity	4 x (2x40) = 320 kW_h / 600 kW_c

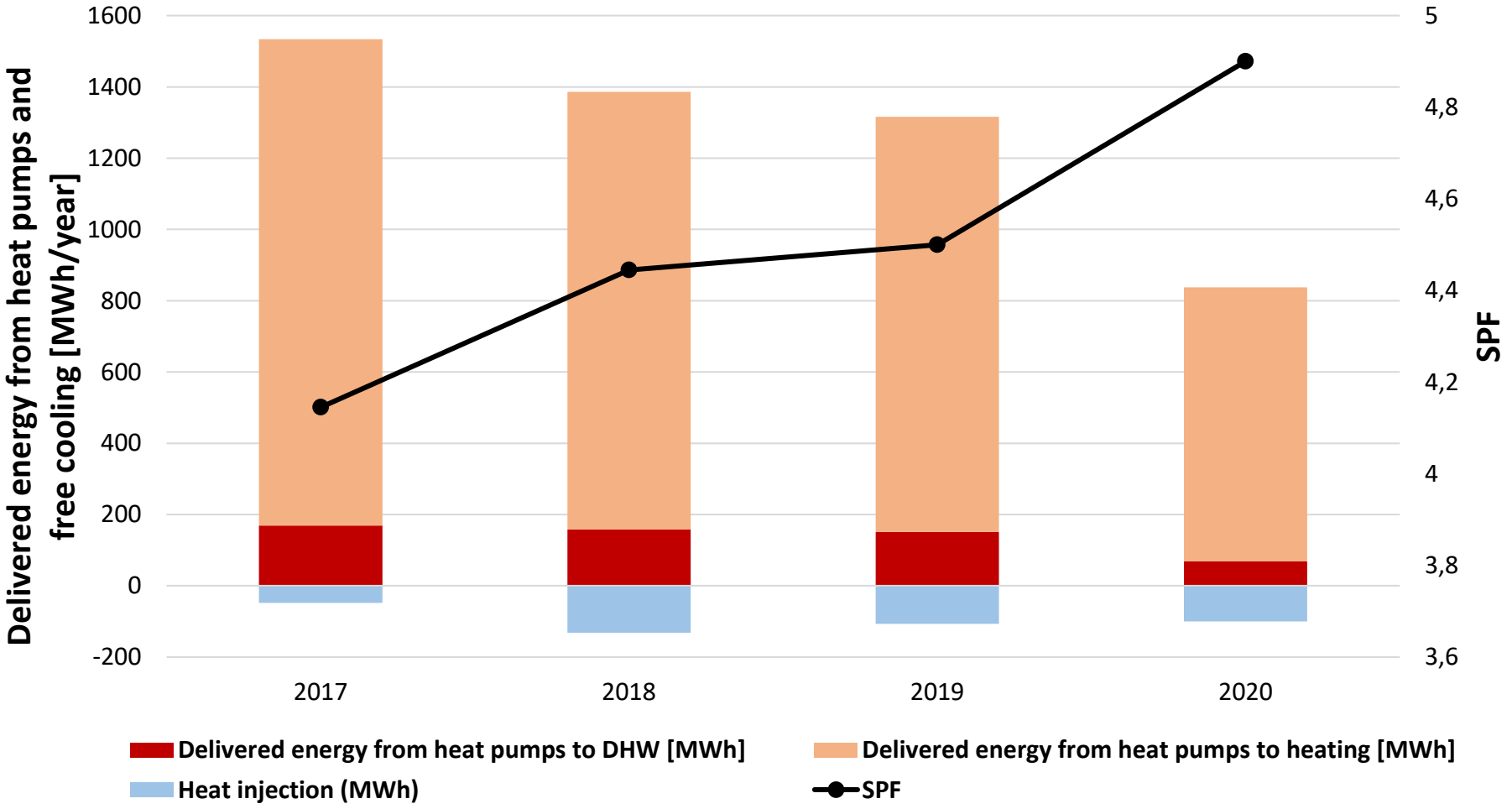
- **Boreholes**
  - Located based on available area
  - Double U-pipes with d=32mm
- 60 m^2 **solar thermal collectors** to support DHW heating
- **District heating** as back-up

Simplified schematic – Scandic Flesland Airport



Pictograms by TU Braunschweig IGS, used with permission within the course of IEA HPT Annex 52

Annual delivered energy from heat pumps and free cooling



In 2020: low visitor load; closed hotel or reduced operation since March 2020

Performance study and life-cycle cost analysis of a ground-source heat-pump system in a commercial building in Norway

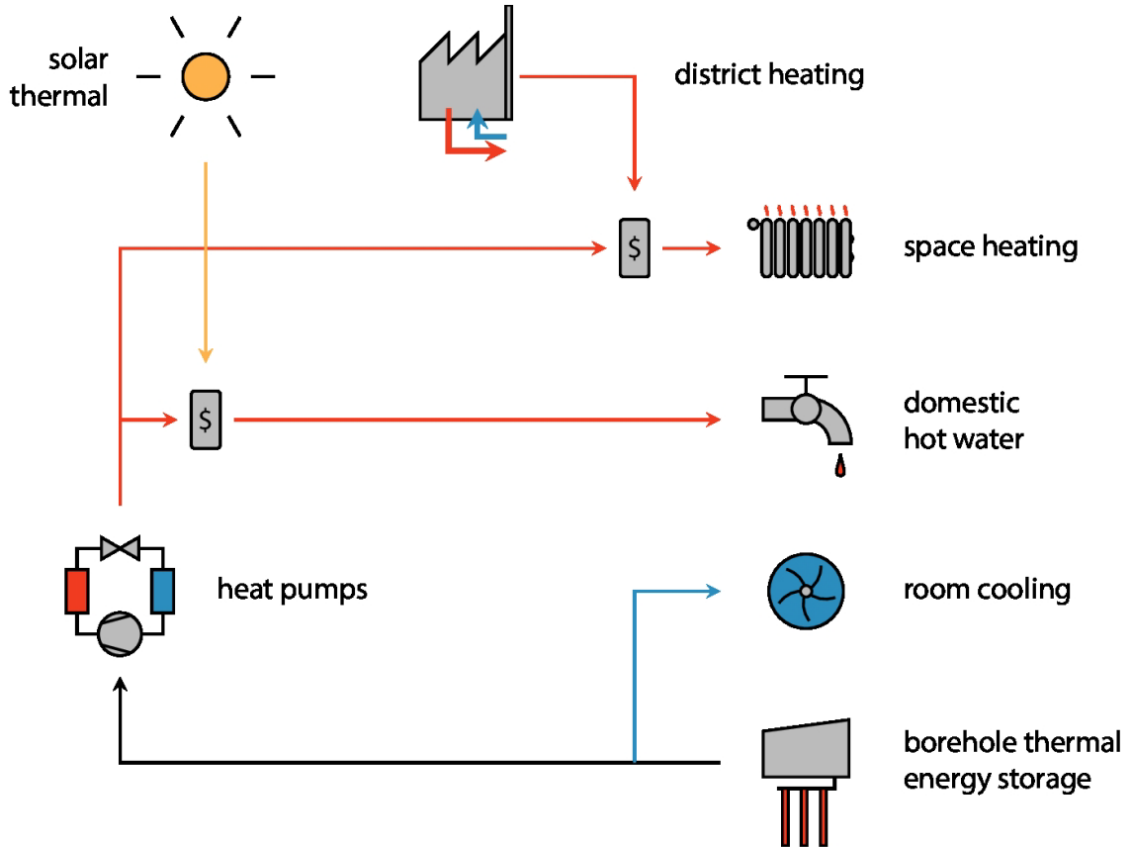
Manuscript accepted for Science and Technology For Built Environment

Comparison of three energy systems

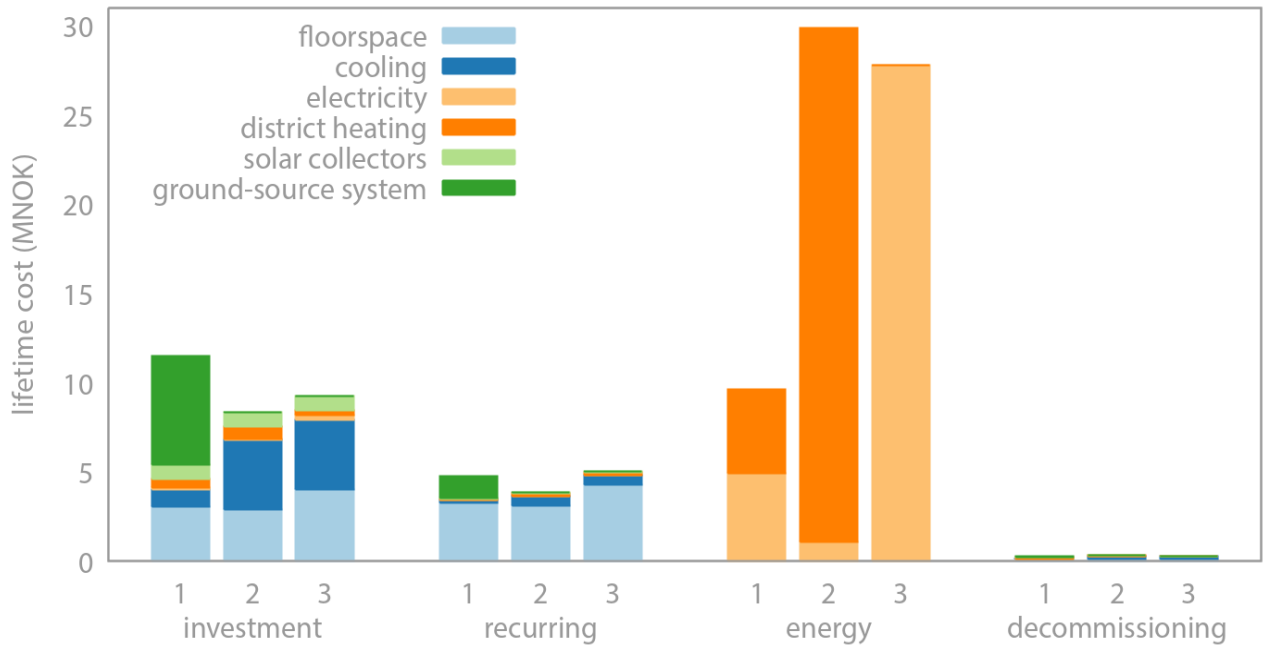
1 Existing energy system with GSHP and BTES

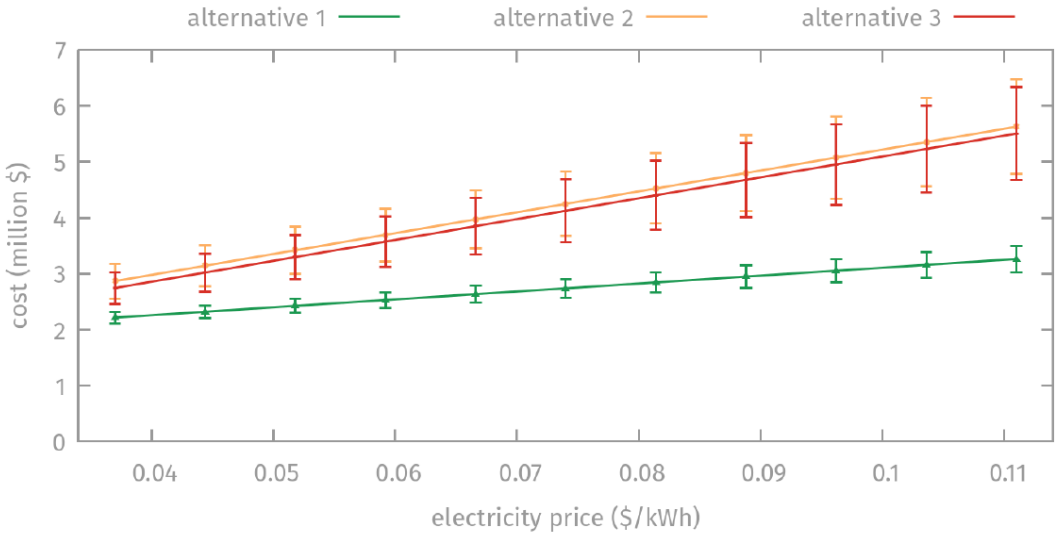
2 District heating and dry cooler system

3. Electricity for heating and cooling



Results





- The life-cycle costs for the as-built system are considerably less than the alternatives.
- The solar thermal collectors are not a profitable addition to the energysystem due to their high cost and low production of hot water.

Summary

- The prevalence of GHP is steadily increasing a larger increase is expected due to increased electricity prices.
- The life-cycle costs for the as-built GHP system at Scandic Airport Flesland are considerably less than the alternatives.

Thank you. Takk. Merci. Gracias. Obrigado.

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