European Geothermal Congress 2016
Strasbourg, France, 19-24 Sept 2016

Geothermal Energy Use, Country Update for Norway

Kirsti Midttømme[1,3], Ingvar Henne[1,2], Jan Kocbach[1], Randi Kalskin Ramstad[4,5]

[1] Christian Michelsen Research AS, 5892 Bergen, Norway
[2] Bergen University College, 5020 Bergen, Norway
[3] Norwegian Centre for Geothermal Energy Research, 5892 Bergen, Norway
[4]Asplan Viak AS Asplan Viak AS,7503 Stjørdal, Norway
NTNU Norwegian University of Science and Technology, 7491 Trondheim, Norway
Kirsti@cmr.no

Keywords: Geothermal energy, Norway, GSHP.

ABSTRACT

The emphasis on energy efficiency and new building codes that restrict the use of energy for heating have increased the interest for Ground Source Heat Pump (GSHP) systems in Norway the last decennium, but the last few years show a decline in new installations. More than 90 % of the GSHP systems utilize energy from boreholes in crystalline rock. A trend towards deeper boreholes has been seen the last 5-10 years, partially due to reduced drilling cost for deeper boreholes. The average borehole depth for systems with four boreholes or more has increased to 230 meters the last two years, and the largest GSHP systems installed in Norway in the same period have an average borehole depth of around 300 meters. Systems involving 500 meter depths have been successfully delivering heat for more than two years. So far Norway has no deep geothermal installations in operation, but Norwegian industry and research institutes are involved in international projects for deep geothermal energy.

1. INTRODUCTION

Norway comprises the western part of Scandinavia in Northern Europe. Norway's population is 5.2 million, and the country spans 13 degrees of latitude from 57° North to 71° North. Norway has a varied climate that includes coastal, high-mountain, inland and polar climate zones.

As the third largest exporter of energy in the world, and an with an electricity supply almost entirely dominated by hydropower, Norway is unique with respect to energy resources. Norway has one of the largest shares of renewable energy both in its total primary energy supply (TPES) and in electricity supply. Although energy use per capita is relatively close to the average for European countries, the electricity consumption ratio is very high (23 MWh per capita) and second only to Iceland in the world (IEA, 2011).

Buildings account for about 40% of the energy consumption. Norwegian households represent an annual stationary energy use of 45 TWh, and the public and commercial buildings consume 35 TWh. An upgrade of the buildings to the new building code standard TEK 10 is estimated to reduce the energy requirements in 2020 by 33 TWh. Near zero energy buildings have been successfully demonstrated in Norway. The technical potential for upgrading the total number of buildings to near zero energy buildings in 2040 is estimated to 65 TWh, where GSHP technology will contribute with 20-30 TWh of the saving (Enova 2012).

Norwegian industry has an ambition to gradually build an international position in renewable energy production. In addition to the established interest within offshore wind, geothermal energy has been identified as a potential business area for further growth. The aim of Norwegian industry is to utilize core expertise from oil and gas, such as geology, drilling and reservoir management, to develop the geothermal industry.

2. GEOTHERMAL RESOURCES AND POTENTIAL

Norway is located on the Fennoscandian Shield. The bedrock consists of Precambrian rocks with a belt of Caledonian rocks extending from south-western to northern Norway. Permian volcanic and intrusive rocks are found in the Oslo region. The porosity of the crystalline bedrock is low. The lithosphere is cool and thick and characterized by a low heat-flow density that is below the continental average (Kukkonen, 2002).

An overview of previous heat-flow studies is given in Pascal (2015). The first heat-flow studies in onshore Norway were conducted from 1969 until the end of the 70s, and are summarised in Heier and Grønlie (1977) and Hänel (1979). The main outcome of these previous studies was that outside areas underlain by granites with high contents in heat-producing elements (i.e. Iddefjord granite, Grönlie et al. 1980), the terrestrial heat-flow was merely low in Norway with median values of 48 and 42 mW/m^2 according to borehole and gravity probe measurements, respectively.

A revival of geothermal studies onshore Norway took place during the second half of the 2000s, led by the Geological Survey of Norway (Olesen et al. 2007) (Pascal et al. 2010). The new study involved drilling and logging of nine new boreholes with vertical depths ranging from around 600 meters to around 800 meters (Slagstad et al. 2008), and the logging of twelve pre-existing mining and geothermal boreholes with vertical depths ranging from around 300 meters to around 1000 meters (Pascal et al. 2010, 2015, Slagstad et al. 2008).

The median value for mainland Norway, as derived from the recent heat flow research works, is equal to around 58 mW/m^2, 10 mW/m^2 higher than predicted at the end of the 70s. Recent work from Maystrenko et al. (2015) also supports heat flows higher than previously claimed. They interpreted heat flow from data and investigations from three new medium deep boreholes near Bergen, Stavanger and Moss.

The archipelago of Svalbard in the Arctic Ocean is an international territory under sovereignty of Norway. All energy and heat production on Svalbard is based on fossil fuels in the form of locally mined coal or imported diesel. Svalbard is an uplifted part of the Barents shelf, situated at the northwest corner of this vast arctic shelf. The east and north of Svalbard consists of Archean to Caledonian age, heavily tectonised bedrock. Central Spitsbergen and the eastern islands of Svalbard contain a much less deformed sedimentary succession, spanning from Devonian to Recent in age (Dallmann, 2015).

Store Norske Spitsbergen Grubekompani AS is leading an ongoing research project, funded by the Research Council of Norway, investigating the geothermal potential and the possibility for utilizing geothermal energy on Svalbard (Midtømme et al, 2015). Logging data from exploratory wells for oil and gas on Svalbard drilled during a 30-year period from the 1960's to 1990's has been made available for the geothermal project. However, the quality of these old temperature measurements is uncertain. In addition, heat flow has been estimated based on investigations on two new boreholes in Adventdalen (970m depth) and Sysselmannsbreen (1020m depth). A minimum value of 80 mW/m^2 was derived from the borehole on Sysselmannsbreen (Pascal et al. 2010). Although geothermal gradients and thermal conductivities were not well established, analysis of the data gathered in the existing borehole points towards high heat-flow values.

2. GEOTHERMAL UTILISATION

So far, Norway has no deep geothermal installations in operation. Statkraft Varme AS has investigated the economic and technical potential for direct use of geothermal energy as an additional energy source in a district heating system within the framework of the project "Evaluation of the deep geothermal potential in Moss area, Østfold county". They concluded that the area had low heat-flow values, and that it would be unprofitable to invest in geothermal energy.

2.1 Ground source heat pumps (GSHP)

All geothermal installations in Norway are GSHPs. Statistics from the Norwegian heat-pump organization NOVAP shows a 30% decrease in new GSHP installations since the top year of 2011, the largest annual decrease being 15% from 2015 to 2014, corresponding to a reduction from around 3000 heat pumps to around 2500 heat pumps (see table 1). NOVAPs statistics cover approximately 90% of the Norwegian heat-pump market.

The majority of the GSHP systems in Norway are vertical closed-loop systems extracting heat and/or cold from crystalline rocks by use of borehole heat exchangers (BHE). NGU collects statistics on boreholes used for GSHPs in the GRANADA database (see Table 1), but due to partly inaccurate and delayed reporting by drillers, not all boreholes are registered in GRANADA. GRANADA borehole statistics show a similar trend to NOVAP data, with a maximum in 2011 and a significant decrease from 2011 to 2015. Note that the low value in GRANADA for 2015 is probably due to delayed reporting. The Norwegian drilling industry has been dominated by Norwegian companies, but during the last few years companies from the neighbouring countries Finland and Sweden have started getting a position in the market.

A typical Norwegian GSHP is based on one or more boreholes with depths of 50 - 300 meters. A trend towards deeper boreholes has been observed the last 5-10 years, partially due to lower drilling cost for deeper boreholes. The average borehole depth in fields with 4 boreholes or more exceeded 200 meters for the first time in 2009, and increased further to more than 230 meters in 2014 and 2015 (see Table 1). Norwegian GSHP systems with a total effective borehole length of more than 10.000 meters are listed in Table 2. From these statistics it can be seen that the largest systems installed the last two years have an average borehole depth of around 300 meters; Nygårdsporten Bergen, Røyken Rådhus and Kongsberg Kulturpark. Some isolated cases with boreholes deeper than 400 meters have been realized in Norway for test purposes. A successful two-year operation of an installation with a 500 m single U tube was reported already in 2013 (Midttømme 2013).). The drilling of two 800 m deep boreholes in Asker, close to Oslo is just started. The boreholes are expected to be finished in spring 2016. A coaxial collector will be installed in both boreholes. Temperature measurements and extensive testing, both regards drilling techniques, borehole completion and energy results, will be performed. The project in Asker is owned by the municipality of Asker, and is done in close cooperation with Båsum Boring AS. The project is funded by both Innovasjon Norge and the new technology programme by Enova. The consultant company Asplan Viak is the main adviser in the project. The Asker project also cooperates with the research project "Deep borehole heat exchanger" at KTH in Sweden.

The Norwegian standard GSHP system has a borehole diameter of 115 mm with a single 40 mm U tube installed. Some BHEs in Norway use alternative collectors, either coaxial collectors or collectors with a rougher surface that gives turbulent flow at lower flow-rates. One recent example is Killingrud skole (secondary school) (2014), a system that consists of 17 boreholes of 280 meter depth with the alternative coaxial collector "Turbo-collector" installed. Most of the BHEs in Norway are kept open with no grouting.

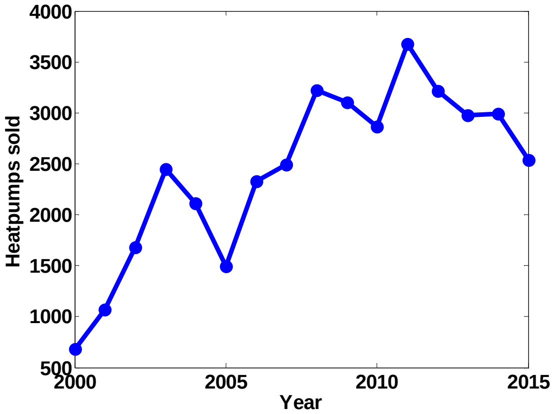

Figure 1: Heat pump sales statistics for Norway from 2010 to 2015. Source: NOVAP.

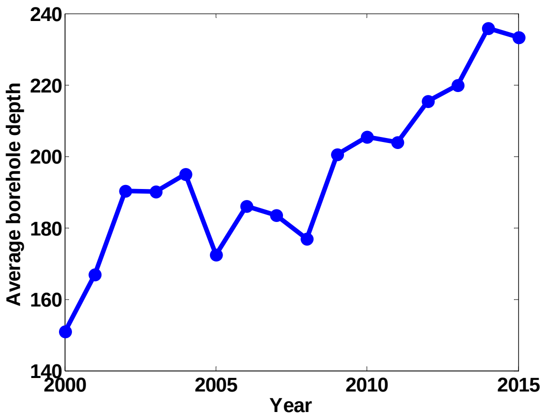

Figure 2: Average borehole depth for fields with 4 boreholes or more for Norway from 2000 to 2015. Source: GRANADA/NGU.

Table 1: Heat pump sales statistics and borehole statistics for Norway from 2000 to 2015. Source: NOVAP and NGU.

Year	Heat pumps sold (NOVAP)	Number of new GSHP boreholes (Granada)	Average borehole depth for fields with N>=4 (Granada)
2000	680	216 *	151.0
2001	1 073	293*	167.0
2002	1 683	489*	190.3
2003	2 445	996*	190.1
2004	2 111	983*	195.1
2005	1 494	1109*	172.5
2006	2 327	1489*	186.0
2007	2 492	1898*	183.6
2008	3 222	2057*	176.9
2009	3 106	2038*	200.6
2010	2 863	2924	205.4
2011	3 677	3767	203.9
2012	3 211	3153	215.4
2013	2 977	3262	219.9
2014	2 991	2672	235.8
2015	2 540	1487*	233.4

** Incomplete data before 2010 and for 2015*

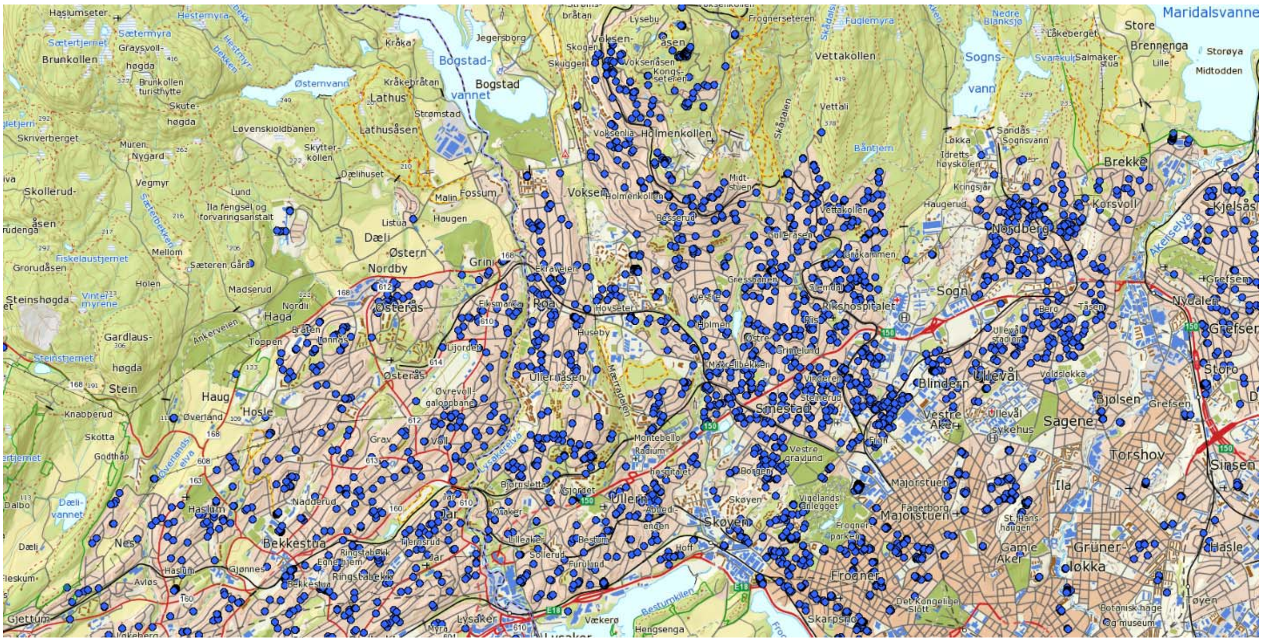

Figure 3: Visualization of BHEs in the central Oslo area from GRANADA. Source: GRANADA/NGU.

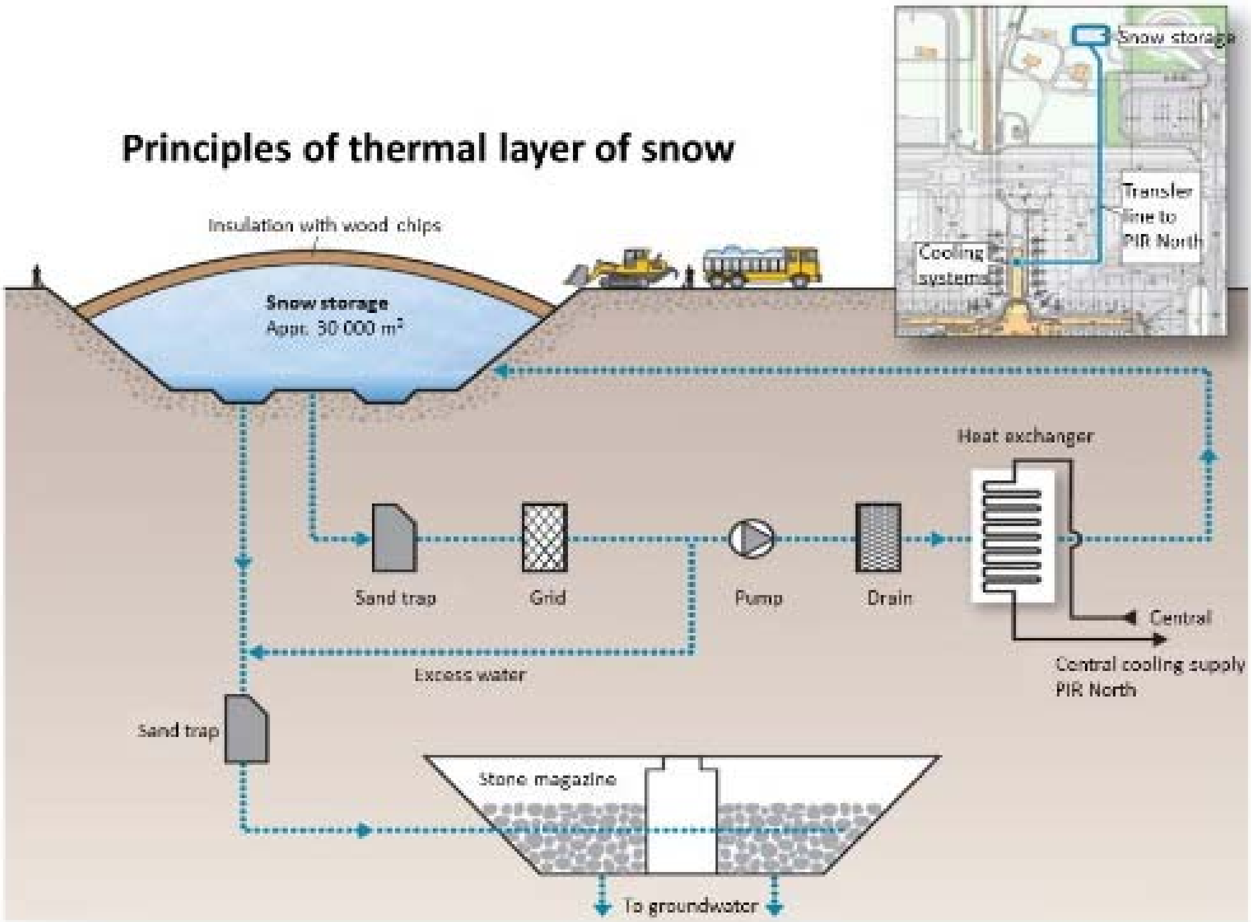

Figure 4: Revised energy system at Gardermoen international airport which includes a snow storage insulated with wood chips.

Table 2: GSHP systems in Norway with more than 10.000 effective borehole meters.

Name	Category	Number of boreholes	Average depth [m]	Effective borehole meters	Year
Ahus	Hospital	228	200	45 600	2007
Nydalen næringspark	Business park	180	236	42 500	2004
Sartor senter	Shopping centre	165	200	33 000	2013
Arcus	Industry building	91	300	27 300	2012
Sykehuset Østfold	Hospital	100	250	25 000	2013
Ullevål Stadion	Sport arena	120	200	24 000	2009
Coop Åsane	Shopping	112	212	23 744	2013
Stavanger Forum	Conference centre	85	250	21 250	2011
Haukeland universitetssjukehus	Hospital	77	250	19 250	2012
Sørlandssenteret	Shopping centre	90	200	18 000	2011
Postterminalen	Logistics	90	200	18 000	2010
Høgskolen i Bergen – campus Kronstad	University college	81	220	17 820	2013
IKEA, Oslo	Shopping centre	86	200	17 200	2009
Høgskolen i Sørøst-Norge - campus Vestfold	University College	70	244	17 110	2009
Sandefjord lufthavn, Torp	Airport	60	250	15 000	2012
Speilen Mandal	Local heating facility	90	160	14 400	2011
Nygårdsporten Bergen	Business park	48	294	14 100	2015
Ericsson-bygget, Grimstad	Business park	56	248	13 872	2002
Ramstad skole	Primary school	45	250	12 650	2012
Røyken Rådhus	Town hall	41	300	12 300	2014
Kongsberg Kulturpark	Culture park	38	300	11 369	2014
Smedvig Eiendom	Business park	54	200	10 800	2011
Bjerkvik Tekniske Verksted	Industry building	50	201	10 050	2011

2.2 Geothermal energy as part of energy systems

The use of district cooling in Norway has increased significantly since 2003, and in 2014 a total of 169 GWh of district cooling was utilized (Figure 4).

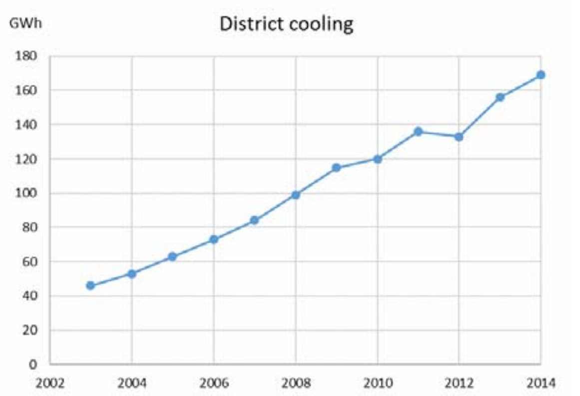

Figure 4: Development of district cooling (SSB, 2016)

The use of cooling is related to the energy efficiency of buildings. Better insulated buildings have reduced heating demand, but increased cooling demands. The largest part of district cooling production in Norway is based on heat pump systems with a large share of GSHPs. Several of these installations are UTES (Underground Thermal Energy Systems) providing district heating and cooling.

Some of the recent installations combine seasonal UTES and short-term phase change materials (PCM) for short-term energy storage.

The new campus at Kronstad for Høgskolen i Bergen (2014) utilizes a GSHP system in combination with PCM storage. The heat capacity of the 81 boreholes is about 1 700 kW, and the PCM day-storage has a capacity of 11 200 kWh. The peak load is reduced by about 50% due to the PCM-storage (Sweco, 2014).

One of the most energy-efficient office buildings in Norway is under construction by Sweco in Bergen. The expected energy demand is 50% below the requirements for Energy class A. The energy system has 15 boreholes, each of 220 meter depth. 9 of these have installed fibre-optic cables that enables monitoring of temperature profiles during operation of the system. The boreholes are utilized for both energy harvesting and storage, and distributed temperature sensing (DTS) using fibre-optic measurements will provide new knowledge on how the temperature profile in the borehole change over time.

The largest GSHP system in Norway is at Oslo Gardermoen international airport. While most systems in Norway are BTES (Borehole Thermal Energy Systems) due to the ground conditions, this is an ATES (Aquifer Thermal Energy System) that has been in operation since the airport opened in 1998, The system comprises an 8 MW heat-pump array coupled to 18 wells of 45 meter depth, 9 for extraction of groundwater and 9 for re-injection. The wells are sunk into the upper Romerike glaciofluvial sand and gravel aquifer. This system covers the total cooling requirements for the airport, of which 25% (2.8 GWh/year) is free cooling via direct heat exchange with cold groundwater, and 75% (8.5 GWh/year) is active cooling via the use of the heat pumps. The annual heating provision is typically 11 GWh. There have been some problems with clogging of the groundwater loop, and the groundwater wells and heat exchangers require cleaning every few years (Midttømme et al.2008, Eggen & Vangsnes, 2005).

The energy system at Gardermoen international airport is being revised in 2015-2016 along with an expansion of the terminal building. A 30 000 m^3 underground snow storage is established, and snow from the winter is stored for free (direct) cooling of the terminal building in the summer season (Figure 4). The annual energy saving by use of snow storage is estimated to 3 GWh/year. The energy goals for the expanded terminal building are to reduce the energy use for building purposes by 50% or 9 GWh/year, and estimated net energy use targets 147 kWh/m^2 corresponding to a Breeam EXCELLENT rating.

2.3 Passive buildings and plus energy buildings

Zero Emission/Energy Buildings (ZEB) and Plus Energy Buildings are given significant attention in Norway. In February 2009, the Research Council of Norway assigned the Norwegian University of Science and Technology to host the Research Centre (FME) on ZEB. By the end of 2017, the FME-Centre ZEB will develop products and solutions for existing and new buildings, that will stimulate market penetration of zero emission buildings related to their production, operation and demolition.

In order to achieve Zero Emission/Energy Buildings (ZEB) or Plus Energy Buildings, a combination of energy sources is generally required. Geothermal energy may be part of such an energy system, typically in combination with Photovoltaic (PV) and/or Solar Thermal (ST) energy harvesting. Excess ST-energy is stored in the geothermal reservoir, whereas batteries are required to store excess PV-energy unless individuals become prosumers and also delivers energy to the power-grid.

There are currently three ZEB-projects in Norway where geothermal energy is included or planned, two smaller projects in South-East of Norway, and one large project in Western Norway.

The multi-comfort project house in Larvik is a 200 m^2 family house. The house has a characteristic tilt towards southeast and a sloping roof surface clad with solar panels and collectors. These elements, together with geothermal energy from energy wells in the ground, is claimed to serve the energy needs of the family house and generate enough surplus to power an electric car year-round.

Skarpnes is a private flats complex in the early design phase located in Arendal. The pilot phase has 5 single family houses, whereas the total project consists of 17 villas, 20 flats and 3 townhouses. Both the villas and the apartments are planned with a combination of energy-efficient solutions that make the homes energy self-sufficient. There are PV solar cells for electricity and geothermal boreholes for heating and cooling, as well as hot-water supply. The villas have individual boreholes, and the apartments share a common borehole system.

Zero Village Bergen is a large complex with dwellings, kindergarten and business area. The first phase consists of 490 homes, with a potential of 800 units for further extensions. Two energy-system solutions are considered:

- Solar collectors, ground source heat pump and PV panels for electricity
- Solar collectors, BioCHP and PV panels for electricity

The area will share a common energy central that should provide the required annual heat energy of about 2 200 MWh and electricity of 850 MWh.

2.4 Refurbishing of buildings

Existing buildings with water-based central heating systems are in principle well prepared for instalment of GSHP, but these systems are typically designed for much higher water temperatures than a geothermal heat pump can produce efficiently. Additional heat sources are therefore normally required to cover peak loads, unless large investments are made to improve the insulation or to modify the heating systems. Individual electric heaters and/or wood stoves are typically used to provide these extra requirements. These challenges lead to a limited number of GSHP based rehabilitation projects in Norway.

3. REGULATIONS, INCENTIVES AND GENERAL CONDITIONS

The building code is the main legal instrument for improving energy efficiency. It was revised in 2007 in accordance with the EU Directive on the Energy

Performance of Buildings (2002/91 EC). New and renovated buildings are subject to stricter energy performance requirements. The requirements, denoted TEK-10, came fully into force on 1 August 2009. A new building code was planned for 2015, but the introduction of the new building code has been delayed until 2017 (TEK-17) based on strong feedback from the industry. The target level for TEK-17 is the passive house standard, or active houses producing energy.

Enova, a public enterprise owned by Ministry of Petroleum and Energy with a mission to promote environmentally sound and rational production and use of energy, conducted a study of the potential of energy efficiency in Norwegian buildings in 2012 (Enova 2012). GSHPs are regarded both economically and technically as one of the best alternatives for energy efficient heating and cooling of new large and medium sized buildings in Norway. These applications will be important in reaching national energy targets.

4. NETWORK, INDUSTRY AND INTERNATIONAL ACTIVITIES

The Norwegian Centre for Geothermal Energy Research (CGER) was established in 2009 and has 14 partners from industry, universities and research institutes. This centre aims to facilitate the exploitation of geothermal energy as a national energy source and an international business opportunity.

Norway participates in IEA and EERAs technology networks within geothermal and energy storage, and Norwegian Partners (IFE, Statoil, Sintef and IRIS) are involved in FP7 and H2020 project within geothermal energy. Norwegian participants are also involved in the European Technology Platform on Renewable Heating & Cooling (ETP-RHC).

Ross Offshore is a Norwegian company focusing on developing geothermal district heating systems in Denmark.

4. CONCLUSIONS

Ground Source Heat Pumps (GSHP) are regarded both economically and technically as one of the best alternatives for energy efficient heating and cooling of new large and medium sized buildings in Norway, and these applications will be important tools for reaching the national energy targets. Norway has no deep geothermal installations in operation, but Norwegian industry and research institutes are involved in international projects for deep geothermal energy.

REFERENCES

Dallmann, W.K.: Geoscience Atlas of Svalbard. Norwegian Polar Institute Report Series 148, Tromsø, (2015).

Eggen, G. and Vangsnes, G.: Heat pump for district cooling and heating at Oslo Airport Gardermoen. Proceedings 8th IEA Heat Pump Conference, Las Vegas, Nevada, 30 May–2 June 2005, 7 pp. (2005)

Enova: Markedsutviklingen 2015. Hovedtrender i Enovas satsningsområder (2015).

Enova: Potensial- og barrierestudie. Energi-effektivisering i norske bygg. Enovarapport 2012:01 (2012).

GRANADA, “Den Nasjonale grunnvannsdatabasen”, is available at www.grunnvanninorge.no/databaser_ngu.php

Grønlie, G., Johansen, T.E., Karlstad, B., Heier, K.S.: Prospecting for geothermal energy in the Iddefjord granite, Østfold, Norway. Norsk Geologisk Tidsskrift, 60, 263-267 (1980).

Heier, K. S. and Grønlie, G.: Heat flow-heat generation studies in Norway. In Saxena, S. K. & Bhattacharji, S. (eds.), Energetics of Geological Processes, 217-235, Springer Verlag (1977).

Hänel, R.: A critical review of heat flow measurements in Sea and lake bottomsediments. In V. Cermak and L. Rybach (eds.), Terrestrial heat flow in Europe, p. 49-73, (1979).

IEA Energy Policies of IEA Countries Norway 2011 Review. International Energy Agency.

Kukkonen, I.: Finland. In: Atlas of Geothermal Resources in Europe, European Commission (2002)

Maystrenko, Y.P., Slagstad, T., Elvebakk, H.K., Olesen, O., Ganerød, G.V., Rønning, J.S.: New heat flow data from three boreholes near Bergen, Stavanger and Moss, southern Norway. Geothermics, July 2015, Vol.56, pp.79-92.

Midttømme, K., Banks, D., Ramstad, R.K., Sæther, O., Skarphagen, H.: Ground-Source Heat Pumps and Underground Thermal Energy Storage—Energy for the future. In Slagstad, T. (ed.) Geology for Society, Geological Survey of Norway Special Publication, 11, pp. 93–98 (2008).

Midttømme, K., Müller, J., Skarphagen, H., Berre, I., Ramstad, R.K Sørheim, H.R.: Geothermal Energy Use, Country Update for Norway European Geothermal Congress 2013(2013)

Midttømme, K., Jochmann, M., Henne, I., Wangen, M. and Thomas P.J.: Is geothermal Energy an Alternative for Svalbard? EAGE Third Sustainable Earth Science Conference & Exhibition, Celle Germany, Conference Paper (2015).

Olesen, O., + 18 co-authors: Kontiki Final Report, Continental Crust and Heat Generation in 3D. NGU Report 2007.042, 438 pp. 2007.

Pascal, C.: Heat flow of Norway and its continental shelf, Marine and Petroleum Geology, 66, (2015), 956-969.

Pascal, C., Elvebakk, H., Mesli, M., Willemoes-Wissing, B., and Balling, N.: Heat flow determinations in Finnmark and Svalbard in HeatBar Final Report 2010, Basement Heat Generation and Heat Flow in the western Barents Sea - importance for hydrocarbon systems, NGU Report 2010.030, 91 pp. (2010).

Slagstad et al.: Heat-flow measurements in Late Palaeoproterozoic to Permian geological provinces in south and central Norway and a new heat-flow map of Fennoscandia and the Norwegian–Greenland Sea, Tectonophysics, Vol.473(3), pp.341-361, 2008.

Table A: Present and planned geothermal power plants, total numbers

*Geothermal power plants are not available in the country.

Table B: Existing geothermal power plants, individual sites

*Geothermal power plants are not available in the country.

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

*Geothermal DH plants and other direct use is not available in the country.

Table D1: Existing geothermal district heating (DH) plants, individual sites

*Geothermal DH plants are not available in the country.

Table D2: Existing geothermal direct use other than DH, individual sites

*Geothermal DH plants are not available in the country.

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2015 *		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2015 *	55000			3000		
Projected total by 2018						

* If 2014 numbers need to be used, please identify such numbers using an asterisk

Table F: Investment and Employment in geothermal energy

	in 2015 *		Expected in 2018	
	Expenditures ** (million €)	Personnel *** (number)	Expenditures ** (million €)	Personnel *** (number)
Geothermal electric power				
Geothermal direct uses				
Shallow geothermal				
total				

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	Yes, RCN or IN	Yes, RCN or IN	Yes, RCN or IN
Financial Incentives – Investment	Yes up to 50% from Enova	Yes up to 50% from Enova	Yes up to 30% for large and medium size installations and up to NOK 10 000 (1340 Euro) for single house installation from Enova
Financial Incentives – Operation/Production	No	No	No
Information activities – promotion for the public	No	No	No
Information activities – geological information	Existing geological information is free available from Geological Survey of Norway		
Education/Training – Academic	three of the country's eight universities teach in shallow or deep geothermal energy.		
Education/Training – Vocational	CGER organize courses and technical meetings		CGER, the drilling organizations and the heat pump organization organizes courses and technical meetings

Key for financial incentives:					
DIS	Direct investment support	FIT	Feed-in tariff	-A	Add to FIT or FIP on case the amount is determined by auctioning
LIL	Low-interest loans	FIP	Feed-in premium		
RC	Risk coverage	REQ	Renewable Energy Quota	O	Other (please explain)