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Geothermal Energy Utilisation - Ireland Country Update

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ABSTRACT

Geothermal energy in Ireland is dominated by the exploitation of low temperature resources for space heating using heat pumps. Domestic ground source heat pumps installations for space heating and domestic hot water are the principal application despite a decline in the number of domestic installations between 2010 and 2014.

The slower but steady increase in the number of heat pump units installed in Ireland between 2010 and 2014 accounts for a total of 177 MWt installed capacity (a 13 MWt increase from the WGC 2010 report). The recent difficult economic situation and the end of the dedicated financial support for domestic ground source heat pumps has resulted in fewer systems being installed during this period, with the main deployment attributed to large scale open and closed loop ground source systems with individual installed capacities of up to 2 MWt in size.

Since the initial exploration drilling on the southern margin of the Dublin Basin, the deep geothermal energy sector has progressed very slowly. Despite encouraging results from 2D seismic reflection surveys at the Newcastle project and planning for the first deep geothermal electricity plant being granted in late 2010, the lack of subsidies for geothermal electricity generation and the holdup in the implementation of a legislative framework for licensing deep geothermal resource exploration and development have stalled the sector. Extensive research aimed at better understanding deep geothermal resources in different geological settings in Ireland is being undertaken.

A number of initiatives to stimulate a sustainable future development of the shallow geothermal energy sector in Ireland are being implemented. These are aimed at tackling some of the barriers to the future development of the geothermal sector that have been identified. Technical guideline documentation and new interactive mapping of the shallow geothermal resources and their potential for deployment in Ireland are being developed with a view to providing standards for system installation and increasing public awareness amongst users and local authorities about shallow geothermal energy potential. The structure of a national database of ground source systems is being developed with a view to improving the reporting of shallow geothermal energy installations in Ireland. New comprehensive training initiatives and certification for industry stakeholders involved in design and installation of systems are currently being undertaken.

1. INTRODUCTION

The thermal energy use in Ireland (excluding energy produced from electricity for space heating) accounts for 34% of the gross final energy consumption in 2011, with 45% of the thermal energy usage accounted for by the residential sector. The contribution of the RES-H sector in Ireland stands at 5.2% in 2013, with a national target of 12% set for 2020 (SEAI, 2013).

The National Renewable Energy Action Plan (NREAP) for Ireland (DCENR, 2010) sets targets for the energy produced from heat pumps (including geothermal, aerothermal and hydrothermal) of 84 ktoe by 2020 with an expected average increase of between 6 to 7 ktoe. No deep geothermal targets for renewable heating and cooling have been included and a target of 5MWe installed capacity by 2018 with no additional increase by 2020 has been set.

The first progress report results for energy from heat pumps for 2009 and 2010 suggests that energy produced from heat pumps in Ireland was ahead of targets for this period despite industry market sector figures showing a higher potential contribution.

The NREAP targets set for the total contribution for district heating and cooling from renewable energies projects and projects an expected energy consumption of 131 ktoe by 2020. The NREAP progress reports published in early 2013 suggested that little or no contribution is being met through district heating.

The Strategy for Renewable Energy 2012-2020 (DCENR, 2012) identified district heating as one of the technologies for addressing the heat energy demand in Ireland and meeting renewable energy targets.

Despite not being specifically identified as one of the preferred technologies in current government strategy documents, geothermal energy has a significant role to play in contributing to the roll out of district heating in Ireland and the extent of this contribution may be further developed following the ongoing review of the national Climate Change Strategy (in press).

2. GEOTHERMAL RESOURCES IN IRELAND:

Ireland is characterised by Precambrian to Lower Palaeozoic crystalline basement formations overlain for most of the central part of Ireland by Upper Palaeozoic formations of Upper Devonian and Lower Carboniferous age and comprising shales, limestones and sandstone lithologies (figure 1). Karstification of the Lower Carboniferous lithologies is extensive and for the most part buried due to a relatively thick Quaternary aged overburden cover.

The structural geological conditions in Ireland are controlled by the Caledonian and Variscan orogenies. Both of these events resulted in the development of large scale north-east south-west trending fault structures parallel to the Iapetus Suture and similar east west trending structures along the northern boundary of the Variscan front in the south western part of the country.

The presence of 42 warm springs across Ireland is largely associated with the occurrence of these regional fault structures concentrated in areas to the south of the Iapetus suture zone where Lower Carboniferous lithologies are present.

Temperatures of between 13°C and 24.7°C from the warm springs have been recorded as part of extensive research since the early 1980s. Hydrochemical and isotope studies have demonstrated that whilst there is evidence of deeper than average circulation of groundwater occurring as a result of up to ten geological settings of the warm springs (Aldwell & Burden, 1986), these deep circulation pathways remain poorly understood.

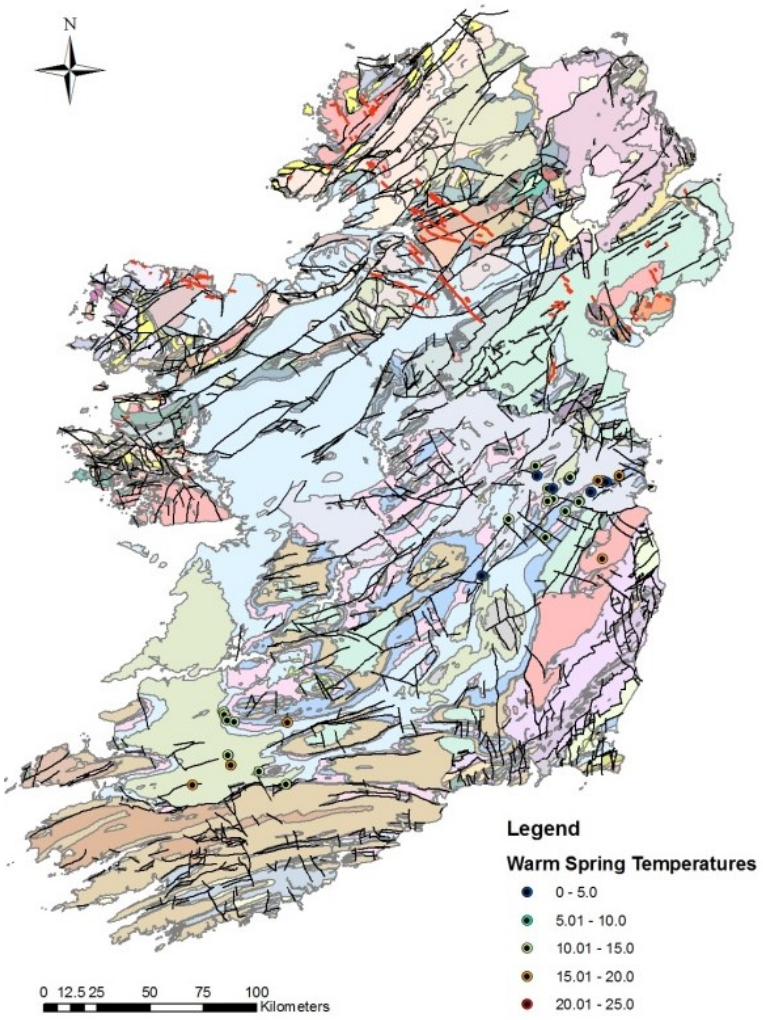

Figure 1: Bedrock Geological Map of Ireland (GSI, 2006) & location of warm springs.

Ireland's intraplate geological setting is such that geothermal resources are classified as low enthalpy with lower average geothermal gradients of approximately 10°C/km recorded in the south to higher gradients (figure 2) in the north east and in Northern Ireland where values of up to 35°C/km are observed (Goodman et al., 2004).

Northern Ireland has a number of sedimentary basins. The Mesozoic Rathlin, Larne and Lough Neagh Basins have been explored in the past because of their potential to contain oil and gas reserves and as part of early geothermal energy research projects by the UK Department of Energy. These three basins contain in excess of 3,000 m of Permo-Triassic sediments (McCann, 1991) where the highest measured temperatures at depth have been recorded. The North-West Basin in the southwest of Northern Ireland contains a similar thickness of Carboniferous sandstones, shales and limestones (Mitchell, 2004).

Shallow geothermal energy resources are favoured by the Irish climate that is dominated by warm and mild maritime conditions. Relatively consistent, year round soil temperatures and frequent rainfall keeping moisture in the ground maintains soil as an excellent conductor, allowing heat to move towards a thermal collector system. These conditions are particularly suited for horizontal closed loop systems.

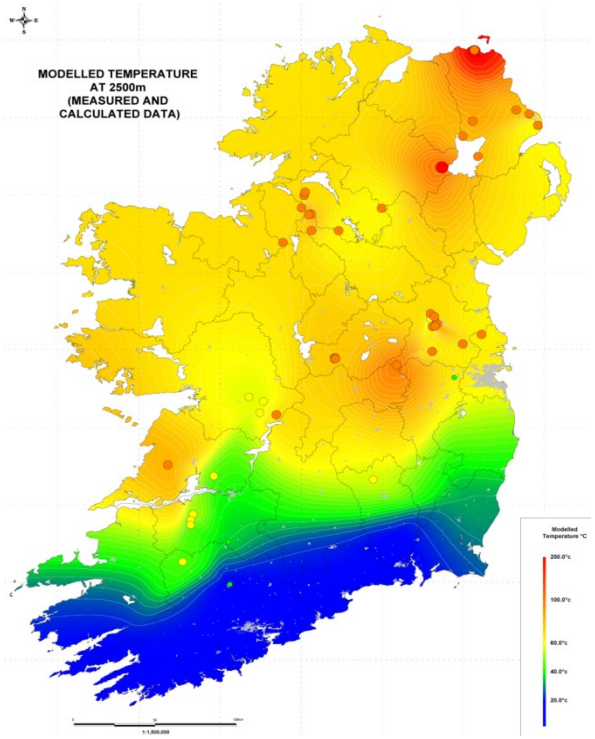

Figure 2: Modeled Temperature at 2,500m (Goodman, et al. 2004).

3. SHALLOW GEOTHERMAL ENERGY UTILISATION:

The shallow geothermal energy utilisation in Ireland had a very high growth rate until 2009. The installed capacity for ground source heat pumps between 2010 and 2012 totalled 178 MWt installed capacity with a thermal energy usage for heating of 834.8 TJ/yr and 37.08 TJ/yr for cooling (Table 1). No installations for direct use or electricity generation are in place in Ireland.

The lack of a dedicated database for reporting the number and characteristics for the installation of shallow geothermal energy systems in Ireland, has made it difficult to determine exactly both the market conditions in terms of the contribution of ground source heat pumps to renewable heating and cooling at a national level and the increase in installed ground source systems since the data collected since 2009. Whilst, information on large scale commercial systems is readily available (see table 1) and has significantly improved reporting of ground source systems, domestic system installation is less well quantified.

Figures published by the Heat Pump Association for Ireland in 2013 show a total number of ground source installed units of 1,501 between 2010 and 2012, representing approximately an average 37% of all heat pumps installed in Ireland over the three year period. (Mulvihill, 2014). Whilst the overall number of heat pumps in Ireland is now estimated at 18,403 units, installation of ground source heat pump units has remained relatively stable between the 2010 and 2012. Table 2 provides a summary of ground source heat pump installations over the last 10 year period.

Table 1: Geothermal (Ground-Source) Heat Pumps as of 30 October 2014 in Ireland (2013 data not available).

Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Residential											
New Units	546	990	1300	1900	2205	2673	2751	922	1293	989	916
Cumulative Units	546	1536	2836	4736	6941	9614	12365	13287	14580	15569	16485
Total Installed Capacity (MW)	**8**	**23**	**43**	**71**	**78**	**117**	**148**	**162**	**178**	**190**	**201**
Commercial											
New Units	5	10	50	100	220	268	306	103	144	239	334
Cumulative Units	5	15	65	165	385	653	959	1062	1206	1445	1445
Total Installed Capacity (MW)		**1**	**2**	**7**	**15**	**25**	**38**	**42**	**48**	**57**	**67**
Total											
New Units	551	1000	1350	2000	2425	2941	3057	1025	1437	1228	1389
Cumulative Units	551	1551	2901	4901	7326	10267	13324	14349	15786	17014	18403
Total Installed Capacity (MW)	**8**	**24**	**45**	**78**	**93**	**142**	**186**	**204**	**226**	**247**	**268**

Table 2: Heat Pump Installations in Ireland (HPAI, 2014).

Locality	Ground or Water Temp. (°C)[1)]	Typical Heat Pump Rating or Capacity (kW)	Number of Units	Type[2)]	COP[3)]	Heating Equivalent Full Load Hr/Year[4)]	Thermal Energy Used (TJ/yr)	Cooling Energy (TJ/yr)
Domestic Installations Nationwide	10	15	16845	H/W/V/O	3.5	1800	1169.52	
Dolmen Centre, co. Donegal	10	45	1	H	3.5	1363	0.16	
Tralee Motor Tax Office, Co Kerry	10	120	1	H	3.5	1922	0.59	0.24
SHARE Hostel, Cork	15	120	1	W	3.5	1363	0.59	
UCC Glucksman Gallery, Cork	15	200	1	W	3.65	1922	1.38	0.40
Fexco HQ, Killorglin, Co Kerry	11	310	1	W	3.65	1922	2.15	0.62
Glenstal Abbey, Co Limerick	10	150	1	W	3.5	1363	0.74	
Musgrave HQ, Cork	10	160	1	V	3.65	1922	0.80	0.32
Killarney International Hotel, Co Kerry	11	60	1	W	3.5	1363	0.29	
Cork Co Council Environmental Labs	11	90	1	W	3.5	1363	0.44	
Cliffs of Moher Visitor Centre, Co. Clare	10	160	1	H	3.5	1363	0.56	
Killorglin Town Centre, Co Kerry	11	160	1	W	3.65	1922	1.11	0.32
Fermoy Leisure Centre, Co Cork	11	160	1	W	3.5	2725	1.57	
Tory Top Road Library, Cork	13	80	1	W	3.5	1363	0.39	
Coraville, Blackrock, Cork	13	36	1	W	3.5	1363	0.18	
Castleisland, Co Kerry	11	135	1	W	3.5	1363	0.66	
ESB Administration Offices, Cork	13	250	1	W	3.65	1922	1.73	0.50
Cork County Library, Cork	13	450	1	W	4	560	0.91	0.91
Swedish Ambassador's Residence, Dublin	12	21	1	V	3.5	1363	0.07	
Cowper Care, Kilternan, Dublin	8	100	1	V	3.5	1363	0.35	
Cowper Care, Rathmines, Dublin	8	66	1	V	3.5	1363	0.23	
Cowper Care, Dublin	11	86	1	V	3.5	1363	0.30	
Vista Health Care, Naas, Co Kildare	10	400	1	W	3.65	1922	2.77	0.81
UCC Western Gateway IT Building, Cork	15	1000	1	W	3.65	1922	6.92	2.01
Athlone City Centre Retail Complex, Westmeath	10	2786	1	W	3.65	1922	19.28	5.61
Lifetime Lab, Cork	12	70	1	W	3.5	1363	0.34	
Bagenalstown Swimming Pool, Co. Carlow	11	18	1	W	3.5	1363	0.09	
Croi Anu Creative Centre, Co. Kildare	10	8	1	H	3.5	1363	0.03	
Rathmore Community Childcare, Co. Kerry	11	12	1	V	3.5	1363	0.04	
Treacys Hotel Co. Wexford	11	450	1	V	3.65	1922	2.26	0.91
Fairy Bush Childcare Centre, Co Roscommon	11	23.5	1	V	3.5	1363	0.08	
Tinnypark Nursing Home, Co. Kilkenny	10	32	1	H	3.5	1363	0.11	
Goretti Quinn Creche, Co. Kildare	11	12	1	V	3.5	1363	0.04	
CloCeardlann na gCnoc, Co. Donegal	10	18.3	1	H	3.5	1363	0.06	
St John's National School, Co. Mayo	10	14.2	1	H	3.5	1363	0.05	
Dubin Dockland Development Authority	12	17.5	1	H	3.5	1363	0.06	
Dunmore House Hotel, Co. Cork	11	18	1	W	3.5	1363	0.09	
Comhaltas Cosanta Gaeltachts Chuil Aodha, Cork	11	16	1	V	3.5	1363	0.06	
David Cuddy, Rathbranagh, Co. Limerick	11	11.5	1	V	3.5	1363	0.04	
Skeaghanore Farm Fresh Duck, Co. Cork	11	12	1	V	3.5	1363	0.04	
Kanturk Sheltered Housing, Co. Cork	11	8.3	1	V	3.5	1363	0.03	
Comhlacht Forbartha an Tearmainn, Co. Donegal	11	33.6	1	V	3.5	1363	0.12	
Feohanagh Special Needs Housing, Co Limerick	11	17	1	V	3.5	1363	0.06	
CLS Rosmuc, Co. Galway	10	19.8	1	H	3.5	1363	0.07	
Vicarious Golf, Co. Wicklow	10	13	1	H	3.5	1363	0.05	
Inis Oirr Health Centre, Co. Galway	10	12	1	H	3.5	1363	0.04	
Children's and Adults Respite Centres, Co. Galway	11	21	1	V	3.5	1363	0.07	
Kilcurry Community Development, Co. Louth	11	17	1	V	3.5	1363	0.06	
Ardara Community Childcare, Co. Donegal	11	22.1	1	W	3.5	1363	0.11	
Seawright Swimming School Co. Cork	11	31	1	W	3.5	1363	0.15	
Cope Foundation, Bandon, Co. Cork	11	30	1	V	3.5	1363	0.11	
Parklands Apartment Development, Co. Wicklow	11	40	1	V	3.5	1363	0.14	
Ballyconnell Central National School, Co. Cavan	11	12	1	V	3.5	1363	0.04	
James B Joyce & Co, Co. Galway	11	18.3	1	V	3.5	1363	0.06	
Poor Clare Monastery, Co. Louth	11	18	1	W	3.5	1363	0.09	
Tralee Community Nursing Unit, Co. Kerry	11	100	1	V	3.5	1363	0.35	
Brook Lodge Hotel, Co Wicklow	10	134	1	H	3.5	1363	0.47	
Hudson Bay Hotel, Athlone, Co. Westmeath	11	132	1	W	3.5	1363	0.65	
Hotel Europe, Killarney, Co. Kerry	10	110	1	W	3.5	1363	0.54	
Rathass Housing Estate, Tralee, Co. Kerry	8	70	1	H	3.5	1363	0.25	
Whites Hotel, Wexford	10	21	1	H	3.5	1363	0.07	
Belinter Hotel, Navan, Co. Meath	10	306	1	H	3.65	1922	1.54	0.62
Bellview Woods Childcare, Killarney, Kerry	8	30	1	H	3.65	1922	0.15	0.06
D&G Electrinics Ltd, Castleisland, Co Kerry	8	21	1	H	3.5	1363	0.07	
Oilgate Nursing Home	8	100	1	V	3.5	1363	0.35	
Youghal Town Hall, Co Cork	8	21	1	V	3.5	1363	0.07	
Borris Nursing Home	14.65	74	1	W	3.8	3276	2.28	
Moypark Estate, Co. Limerick	9	140	1	V	4.1	1872	0.71	
Kilboy House, Tipperary	9	120	1	V	4.1	1872	0.61	
Vistakon Irleand, Limerick	12	890	1	W	5	4800	1.58	23.74
IKEA, Dublin	10	2000	1	V	3.5	1800	9.26	
Wonder Years Childcare Rossbrack, Manorcunningham Co.	8	43.6	1	H	4	1872	0.22	
Ballyroan Library, South Dublin	9.8	60	1	V	4.1	1872	0.31	
Cowper Care, Kilternan, Co Dublin	8	80	1	V	3.5	1872	0.39	
Mallow Swimming Pool, Co. Cork	15	100	1	W	3.5	4250	1.06	
Offaly Co. Council Ofices, Tullamore, Co. Offaly	10	105	1	W	3	1872	1.32	
TOTAL		265538.70					1240.54	37.08

The shallow geothermal energy market in Ireland remains dominated by the installations in the residential sector (85%) with lower uptake in the commercial and industrial processes sector (14% and 4% respectively) with systems of intermediate installed capacity between 10kW and 20kW installed as the most widespread (Figure 3).

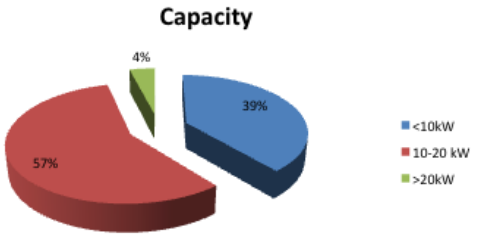

Figure 3: Average Ground Source Heat Pump Installed Capacity (SEAI, 2011).

Large scale, ground source systems are dominated by the installation of open loop collectors, with the majority of systems being installed ranging between 100kW to 250kW in size for heating and cooling applications. The completion of more recent larger scale systems with installed capacities >1MW have become more frequent, with some of these including closed loop multiple borehole collectors.

An example of one of these is the Athlone shopping centre, comprising an open loop system of 13 wells drilled to a depth of 70 m in gravel of which 8 wells are used to deliver up to 167 l/s with the rest used for re-injection. The system is used for space heating and cooling using a district heating scheme.

The cooling load peak is 1,870 kW for the shopping centre and 900 kW for the hotel. Discharge water is returned to the gravel beds through recharge wells located around the perimeter of the basement carparks. The system is monitored and controlled by a Building Management System which has the ability to archive key operating parameters and energy flows (Allen et al. 2013).

Figure 4: Vistakon Plant Room (Burgess, 2013).

The Vistakon geothermal heat rejection plant in Limerick is another example of a recent large scale open loop commercial system installation in Ireland. The project involves the use of groundwater as a cooling resource to minimise electrical load demand, save energy and reduce carbon dioxide emissions. It involves abstraction of some 30l/s (2,592 m^3/day) of groundwater from two on-site boreholes. The water is used in a once-through, non-product contact, cooling system and recharged to the local river system (Jones, 2013). The open loop system has an installed capacity of 890 kW of cooling (figure 4).

The IKEA store in Ballymun (Dublin) opened in late 2010 is one of the first operating examples of a large closed loop commercial system being installed in Ireland. The ground source collector comprises 158 boreholes drilled to a depth of 90m located below the customer car park. The system provides heating and cooling to the 30,600m^2 store and has a total installed capacity of 2 MW_{th} (Finnegan, 2011).

4. DEEP GEOTHERMAL ENERGY DEPLOYMENT:

Deployment of deep geothermal energy resources in Ireland has been slow to date. Since the completion of geothermal exploration wells in 2009 at Newcastle, South County Dublin, the potential for harnessing deep geothermal resources from the margin of the Dublin Basin has been further explored. A 2D seismic reflection survey (figure 5) and a VSP survey undertaken in late 2010 with the support from the Sustainable Energy Authority of Ireland helped identify potential reservoir targets at the base of the Carboniferous sequence at a depth of 4,000 m, with the best of these located along the northern margin of the Blackrock to Newcastle Fault line. On the back of these results, GT Energy applied for planning permission for a 4.5 MWe geothermal electricity plant at Newcastle. The proposed geothermal electricity plant comprises a production and a re-injection well as well as an air cooled, modular, Organic Rankine Cycle plant.

Figure 5: 2D Seismic Acquisition in Newcastle, South County Dublin.

Since planning was granted for the project in late 2010, the lack of a REFIT tariff for geothermal electricity generation and the lack of a suitable legislative and regulatory framework for the development of deep geothermal energy resources has prevented the project from progressing beyond the planning stage.

The Geothermal Play Fairway Analysis study (Goodman et al., 2011) profiled the geothermal resource development risk in different basin areas of Ireland. This 'All Island' study highlighted the presence of basin areas as having low geothermal energy development risk. These include three Mesozoic Basins in Northern Ireland (Rathlin, Lough Neagh and Larne) and18 Carboniferous Basins and Sub-basins of the midlands, east, west and south west of Ireland (East Dublin Basin, Portarlington Trough, Dangan Trough, Clare Basin, Limerick Basin, North Cork Mallow Basin, Carrick-on-Suir Syncline, West Leinster Basin). These areas were highlighted as having the greatest geothermal potential where hot fluids have migrated a relatively short distance from a deep geothermal heat source and are trapped in Mesozoic and Carboniferous reservoirs overlain by an insulating cover of shaley or other low conductivity rock types.

Geothermal potential from buried granites, with sufficient insulating cover rocks was also identified and a lower development risk category was attributed where deeply penetrating and suitably fractured major structural zones that may have acted as migration pathways for deep hydrothermal fluids from a deep heat source to a shallower geothermal reservoir.

Some of the areas identified are the subject of more extensive research being undertaken by the IRETHERM project. The current estimated total value of investment in the geothermal sector in Ireland between the period of 2010 to 2014 is US$34M, with US$ 3.8M of this in direct research and development of deep geothermal resources in Ireland through the IRETHERM project. The remaining US$ 30.2M is estimated as private sector investment in ground source systems (table 4).

Table 4: Total Investments In Geothermal in (2014) US$, Ireland.

Period	Research & Development Incl.	Field Development Including Production	Utilization		Funding Type	
			Direct	Electrical	Private	Public
	Million US$	Million US$	Million US$	Million US$	%	%
1995-1999	0.2		0.5		70	30
2000-2004	1		16		80	20
2005-2009	7.5		225		90	10
2010-2014	3.85		30.2		90	10

The allocation of professional personnel to geothermal activities in Ireland has decreased since the WGC2010 country update, mainly due to the economic downturn and lack of investment in the sector which resulted in a marked decrease of ground source heat pump professionals and a move of deep geothermal development companies overseas. Table 5 below summarises the current estimated personnel for the 2010 to 2014 reporting period.

Table 5: Allocation of Professional Personnel to Geothermal Activities (Restricted to personnel with University degrees), Ireland.

Year	Professional Person-Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
2010	5	2	3			150
2011	3	0	9			60
2012	3	0	9			40
2013	3	0	9			36
2014	3	0	9			36
Total	17	2	39			322

5. LEGISLATIVE AND REGULATORY FRAMEWORK:

5.1 Geothermal Development Bill:

The Draft Geothermal Development Bill (the Bill) defines geothermal energy in Ireland and vests ownership of geothermal energy in the State, giving practical effect to the assertion of ownership of natural resources in the Constitution (King, 2011). The Bill

covers the exploration and development of deep geothermal energy resources in Ireland (excluding aspects such as district heating, market regulation and health and safety).

An extensive consultative process started in 2008 in advance of the drafting of the general scheme of the Bill and included web-based consultations, two national workshops and meetings with industry stakeholders. Draft Heads of the Bill completed in July 2010 have been submitted to the Government for approval and referred to the Attorney General and the Parliamentary Counsel for detailed drafting alongside the proposed new Minerals Development Bill. This consultation process is ongoing and publication of the Bill is expected in the near future.

5.2 Shallow Geothermal Energy Resource Project

The aim of the shallow geothermal energy project is to provide a sustainable platform for development of the ground source heat pump sector in Ireland through collaboration with government departments and agencies, geothermal industry stakeholders (e.g. Geothermal Association of Ireland, International Association of Hydrogeologists - Irish Group, Heat Pump Association of Ireland), local authorities, appropriate academic institutes and consultants (e.g. geological drilling, hydrogeological, architects). The project is led by the Groundwater Section of the Geological Survey of Ireland (GSI) which has been involved with geothermal resources since the 1960s.

In line with other ongoing European initiatives, the first part of the project is aimed at developing a national database of installed ground source heat pump systems. The objective of these data will be to characterise existing operating heat pump installations and to provide a framework for recording future heat pump installations and their associated subsurface collectors which is currently not in place and makes the estimation of shallow geothermal energy contributions at local and national level difficult.

Two guideline documents are being prepared to cover the sub-surface aspects of shallow geothermal energy installations for horizontal collectors and vertical collectors and their construction. These comprise a technical guideline manual for system completion, promoting best practice methodologies and procedures for suitably trained professionals to install shallow geothermal energy systems in the context of the current environmental and building regulations. The second manual, aimed at homeowners, is being developed to assist with the choice of shallow geothermal energy systems installation, and to provide advice on procedures and methodologies that would be associated with each phase of an installation as well as demonstrating the benefits of shallow geothermal energy systems compared to other renewable and fossil fuel fired heating systems.

A set of national collector suitability maps for closed loop horizontal, closed loop vertical and open loop collectors are also being developed. The maps are being generated using subsurface data currently available at GSI and in collaboration with other government agencies and research institutions that are compiling geothermal resource information. The maps will be available as screening tools for decision maker and end user highlighting possible collector deployment options at a national scale. This information is expected to be publicly available through the GSI online data viewer, facilitating the understanding of the potential for deployment of geothermal resources.

6. BARRIERS TO DEPLOYMENT:

Financial support mechanisms that were in place for the installation of domestic geothermal heating systems were withdrawn. The unforeseen immediate cessation of this financial support resulted in a marked decrease of domestic system installations and unfortunate closure of many geothermal energy installation businesses. This is reflected in the figures outlined in this country update. Current financial support measures specific to GSHPs are currently not available. Despite this, the introduction of the carbon tax which places an extra cost on fossil fuels such as gas or oil has facilitated the reduction of payback periods to less than 10 years for systems that replace oil or LPG fuelled heating (Burgess 2011).

The main barrier to the development of deep geothermal energy resources in Ireland remain the lack of specific legislation allowing developers to obtain licenses for resource exploration and development. In addition, financial support for geothermal electricity generation has still not been considered by government through the REFIT scheme despite a target of 5 MWe installed capacity by 2020 being set as part of the NREAP for Ireland.

The lack of policy strategy to address the heat market and the potential contribution that district heating and renewable technologies including geothermal can contribute to addressing 47% of Ireland's energy demand are still missing.

The lack of technical best practice guidelines for the installation of shallow geothermal energy systems in Ireland is currently being addressed by the Geological Survey of Ireland. This will facilitate the sustainable development of shallow geothermal energy resources in Ireland.

Public awareness and information including the lack of information on the potential for installing ground source heat pumps and potential for harnessing deep geothermal energy to meet a part of Ireland's heat demand has been identified as a significant barrier to development. Despite some guidance documents from SEAI being made available to explain the use of the technology, not many data are available to promote subsurface conditions that are adequate for the deployment of GSHP systems. Similarly, several studies have been completed on the deep geothermal potential and on-going research through the IRETHERM project aims to provide a better understanding and promotion of Ireland's deep geothermal potential.

This information is essential to both the end users and the general public, but also to the local authorities and government agencies who are tasked with setting strategic local and national objectives for the deployment of renewable energy resources including shallow and deep geothermal resources alike.

Dedicated training and certification for key contractors involved in the installation of GSHP systems is currently being undertaken through the FETAC level 6 certification scheme. This allows trades such as plumbers, electricians and refrigeration engineers to be trained and certified to install shallow geothermal energy systems. However there are no dedicated training or certification courses

for contractors responsible for the design, completion of ground works and drilling associated with the completion of thermal energy collectors.

Dedicated courses on project management and ground source heat pump system design are only available through dedicated university courses at Galway Mayo Institute of Technology, University College Cork and University College Dublin. However professional certification for trades, often tasked with designing systems or involved in the construction aspects of ground source heat pump systems, is currently not available. The Geotrainet programme to some extent fulfilled this role by providing an integrated training initiative for installers, drillers and designers. However a new national certification training initiative combined with the second Geotrainet programme will be required to promote a sustainable development of the shallow geothermal energy sector in Ireland.

7. ON GOING RESEARCH & PROJECTS:

The IRETHERM project is a four and a half year, all island, academic-government-industry collaborative project between DIAS, UCD, UCC, GSI, GSNI, and SLR Consulting to develop a strategic and holistic understanding of Ireland's geothermal energy potential.

The project aims to deliver integrated models of new and existing geophysical and geological data to image aquifers and granitic bodies in the depth range of 0 to 5 km. The project is focussing on eight "type" geothermal areas across 10 targets (figure 6) with a comprehensive program of electromagnetic field surveys to identify those geological settings/localities that present the greatest opportunity for harnessing deep geothermal energy. These include:

- the Permo-Triassic Basins of Northern Ireland,
- radiogenic granites,
- warm-spring lineaments,
- high heat-flow/temperature anomalies recorded as part of compiled in the Geothermal Energy Resource Map of Ireland,
- deeply penetrating, significant fault zones,
- gravity anomalies of unknown origin,
- areas of current seismicity,
- basal sediments of the Carboniferous and Devonian successions.

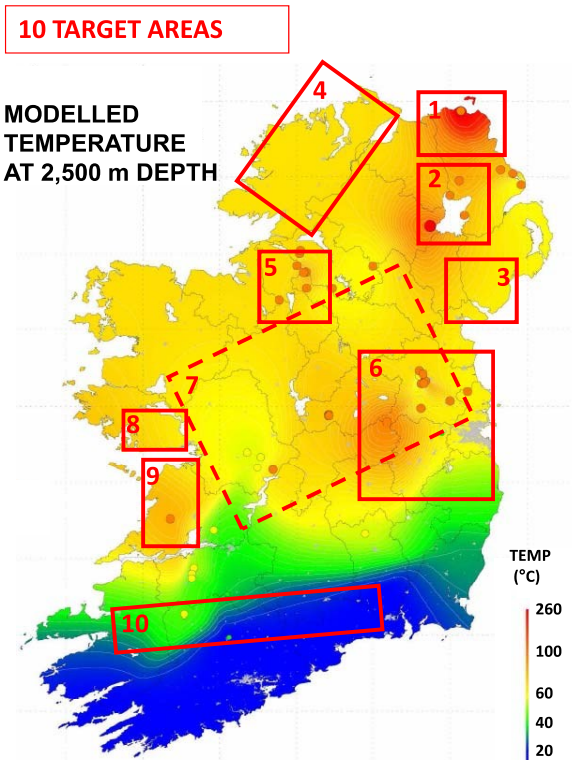

Figure 6: IRETHERM Target Areas (Muller et al., 2012 & Goodman, 2004).

New borehole temperature and heat flow measurements and analyses of radiogenic element compositions of an island wide suite of multi-depth crustal samples are being undertaken to derive the first 3-D model of Irish crustal heat production. Thermal variations modelled using these new crustal heat production constraints with existing constraints on lithospheric structure will determine the origin of the regional variation in heat flow and identify high temperature anomalies at upper crustal levels for immediate and future targeting.

Two initial field campaigns in 2011 and 2012 have yielded promising results for some of the 10 areas targeted and further results are expected during the course of 2013 and 2014 once the new data have been integrated and modelled.

The NAG-TEC project is a co-operation between Geological Surveys and oil companies (Northeast Atlantic Geoscience - NAG initiative) aimed at developing a new Tectono-stratigraphic Atlas of the North-eastern Atlantic. This will address the tectonic development of the Northeast Atlantic in a unified manner. The data compilation will deliver a quantitative analysis of key basin parameters, the regional correlations of key stratigraphic units, unconformities and geologic formations, an understanding of the connectivity and similarities between known prospective regions and unexplored areas, as well as a comprehensive analysis of conjugate margin pairs. The analysis of these basin parameters includes a study of heat flow and temperature distribution across the region. Historical heat flow values for onshore Ireland were compiled as the Geothermal Energy Resource Map of Ireland Atlas (Goodman et al., 2004) and are currently the subject of further research by the IRETHERM consortium. The NAG-TEC project is undertaking studies of temperature data from 18 offshore oil exploration wells, with the hope that new heat flow data can be produced for offshore Ireland. These data will then be incorporated into a regional compilation as a chapter in the Atlas and result in a series of maps, most likely with the following information: heat flow, temperature at 1,000 m, temperature at 2,000 m, thermal gradient and data coverage (Judge, 2013).

The REGEOCITIES project kicked off in May 2012 and is aimed at removing the legal and regulatory barriers to the application of geothermal heat pump systems in Europe. The project intends to build on existing knowledge and experience of EU Member States where the geothermal heat pump sector is mature (Germany, France, Denmark, Sweden) and develop general guidelines and recommendations for policy and regulation of geothermal energy systems in European cities, regions and Member States. Smoother policy should contribute to European sustainability objectives and help Member States achieve 2020 renewable energy targets. As part of the project objectives, Regeocities will deliver recommendations for a common regulatory framework template for shallow geothermal systems and provide a database structure for recording the installations of systems. It will also facilitate the reporting of the contribution from shallow geothermal energy as part of the NREAP targets as well as the inclusion of shallow geothermal energy as part of Sustainable Energy Action Plans and Renewable Energy Strategies. Dedicated training programmes for policy makers and local authorities will be delivered during 2014.

The GeoDH project is focussing on increasing the market penetration of geothermal district heating systems in several Member States analysing the market conditions in countries with a mature geothermal district heating sector such as Germany, France, Italy and transition countries where there is a growth in the sector such as Hungary, Slovenia, Slovakia, Czech Republic, Poland, Denmark, then using the experience from these countries to facilitate development in new upcoming markets such as The Netherlands, UK, Ireland, Bulgaria, and Romania. The project promotes the use of geothermal energy sources through district heating and cooling systems by proposing the removal of regulatory barriers, developing innovative financial models and by training technicians and increasing awareness among decision-makers.

The Tellus Border project is an EU Interreg IVA project in the border counties of Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth using coupled airborne geophysical and ground based geochemical surveys for mapping the geological environment. The data from the Tellus Border project will be combined with the previously acquired Tellus data in Northern Ireland to produce Ireland's first cross-border geo-environmental maps to support sustainable management of the environment and natural resources, including geothermal energy. Radiometric survey results previously acquired in Northern Ireland identified elevated concentrations of radionuclides K, Th, U in the Mourne Granites and how calculated radiogenic heat localised in the area shows potential for a deep hot dry rock geothermal source (Glennon et al., 2012). The new Tellus Border geophysical magnetic and radiometric data was released on 5th February of this year. Topsoil geochemical data is available to view from the Tellus Border viewer and will be released for download throughout 2013 (Glennon, 2013).

In 2011, an all Island (North and South) competition was held to find the domestic installation of the year. The GAI organised and held this competition to promote those examples of geothermal energy installations that were operating effectively and providing comfort to the home-owners. There were 4 installations deemed worthy of recognition and the benefits were measured and benchmarked with reference to the Building Energy Rating system in place for homes in Ireland. (Burgess 2011).

The Geothermal Association of Ireland held a similar competition in 2013 for non-domestic installations to promote excellence in the industry and four winners in different categories were announced at the national conference in November 2013 and include The Cliffs of Moher Visitors Centre, Borris Nursing Home, Wonder Years Child Care and Vistakon Ireland.

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