Geothermal Energy in the Irish Context

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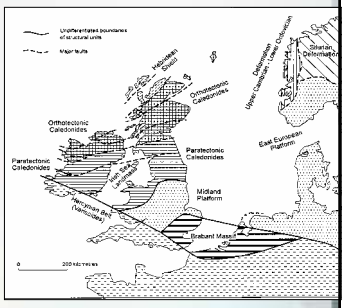
Principles of Geothermal Energy and its Usage

- heat in the Earths crust from 3 primary sources:
  - heat transfer from the Earths interior to its surface
  - radiogenic heat generated by radioactive isotopes
  - surface absorption of solar radiation
- heat reservoirs – rock, soil, water, air
- heat transfer media – water, air
- two types of usage of geothermal energy:
  - direct usage – space heating, industrial processes, horticulture, fish farming etc.
  - indirect usage – conversion to electricity – requires temperatures > ~100°C
- traditional approach to exploiting geothermal energy:
  - locate hot shallow magmatic rock source with overlying aquifer, or deep aquifer containing hot groundwater
  - extract hot or superheated groundwater (steam)
  - generate electricity or connect to building heating systems

Irelands Tectonic Setting

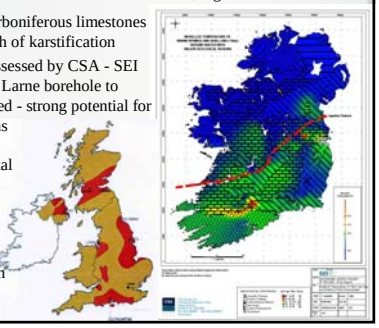
Ireland has no long tradition of exploiting geothermal energy – reasons are:

- Ireland lies far from any plate boundaries
- Ireland lies outside any active or recently active tectonic zones
- geothermal gradients relatively low - range from 15º–20ºC/km in Republic - up to 30ºC/km in northeastern part of Northern Ireland
- no young Neogene magmatism – Tertiary magmatic activity in NE Ireland
- no porous Mesozoic or Tertiary sedimentary rocks except in NE
- exploitable high enthalpy geothermal resources as yet unproven - good potential in Larne and Rathlin Basins of NE Ireland



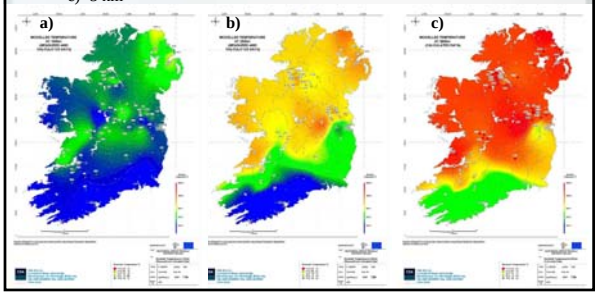
Geothermal Resources

- 42 warm springs – only 1 exploited – Mallow spring heats municipal swimming pool – first exploitation of geothermal energy in Ireland
- groundwater in porous Mesozoic sandstones of NE Ireland, e.g. Sherwood Sandstone
- groundwater in karstified Carboniferous limestones – quantity dependent on depth of karstification
- deep geothermal resources assessed by CSA - SEI and Interreg projects – 1982 Larne borehole to 2880 m - T's of 88°C recorded - strong potential for direct use heating applications – electricity generation less likely - T's borderline – capital costs high
- low grade heat in shallow groundwater of buried valley gravel aquifers
- low grade heat in soils – main exploitation of geothermal energy in Ireland

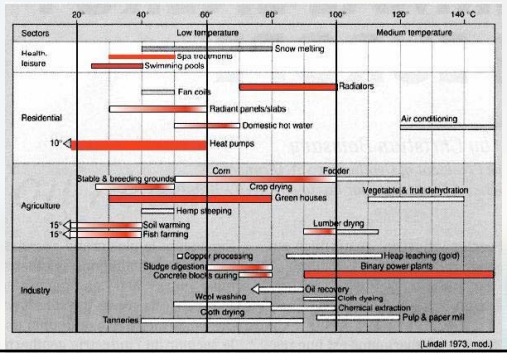


Geothermal Resources

- all Ireland modelled temperature distribution for depths of
  a) 1 km
  b) 2.5 km
  c) 5 km

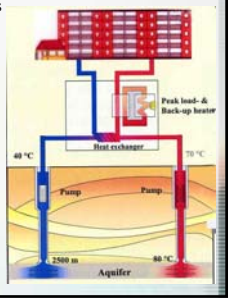


Geothermal Direct Use Applications



District Heating Schemes

- Southampton district heating system based on hot groundwater at 76°C in Sherwood Sandstone – 22 l/sec pumped from depth of 1700-1800 m – no reinjection
- Paris - 41district heating schemes – saline waters at 80ºC pumped from depths of ~2,500m - re-injected at 40 ° C via inclined boreholes to same aquifer - distance of 1km away at depth
- Potential for district heating scheme for Belfast and other urban areas in Antrim and N. Down

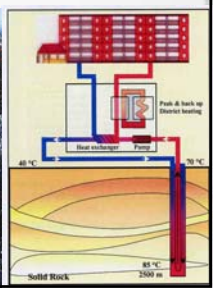


How Southamptons district heating works

Deep Geothermal Heat Exchanger (GHE)

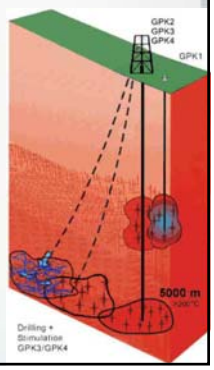
- Aachen University of Technology (RWTH Aachen), Germany installing GHE to provide geothermal energy for heating and cooling of its students' service centre
- single well system with water circulating in a self-contained cycle in the annulus and central production pipe of well
- well 2,535m deep – to provide 480 kW maximum at minimum temperature of 70°C

Design: Pape & Fritzer



Hot Dry Rock (HDR) Systems

- boreholes drilled to 5km depth into crystalline rock - usually relatively radioactive granitoids - temperatures of up to 250°C may be expected
- to generate permeability - rock artificially fractured by explosive, chemical or hydraulic means
- water pumped down borehole, exchanges heat with volume of artificially fractured rock – pumped back up second borehole
- capital costs enormous – several million euro
- several projects undertaken - Los Alamos, USA; Soultz-sous-Forêts, France; Cambourne School of Mines, Cornwall; Switzerland; Germany; Australia; Japan to name a few – none on stream yet



Low Enthalpy Geothermal Energy

- utilises heat pump technology
- 2 main heat sources:
  - groundwater
  - soil

Well Yield (l sec^{-1})	Groundwater Temperature (°C)	Temperature Reduction in the Heat Pump (°C)	Nominal Geothermal Heating Resource (kW)
20	13	8	672
5	25	20	420

Groundwater

- volume more important than temperature - nominal geothermal heating resource extractable from a high yield, low temperature source greater than from a low yield warm source (1.6 times for example shown)
- shallow groundwater beneath cities and towns warmed by 'heat island' effect of urban areas – temperatures raised by up to 5°C – greatly increases the nominal geothermal heating resource

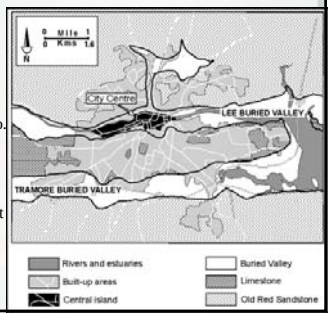
High Yield Aquifers

- gravel aquifers, e.g. buried valleys
- karstified limestones

no need to reinject – adequate surface recharge

Buried Valley Gravel Aquifers

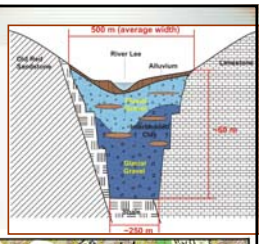
- buried valleys formed during peak Pleistocene glaciation -15-18,000 years ago - sea level an estimated 130m lower than present
- buried valleys infilled with glaciofluvial gravel – itself a significant geological resource
- due to their high porosity/ permeability contain considerable readily extractable quantities of groundwater – important aquifers
- as many as 8 already identified in Co. Cork – most important Lee Buried Valley - underlies Cork
- sufficient groundwater in gravel and karst aqufers underlying Cork to heat almost the whole city by geothermal energy
- cost of exploitation minimal – shallow borehole and a heat pump

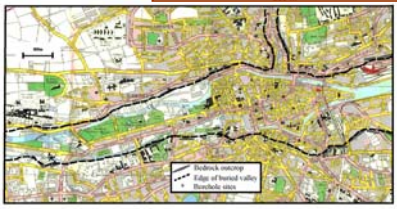


Lee Buried Valley

- 60 km long x 0.5 km wide – up to 140 m deep – stepped profile
- hydraulic conductivity of gravels

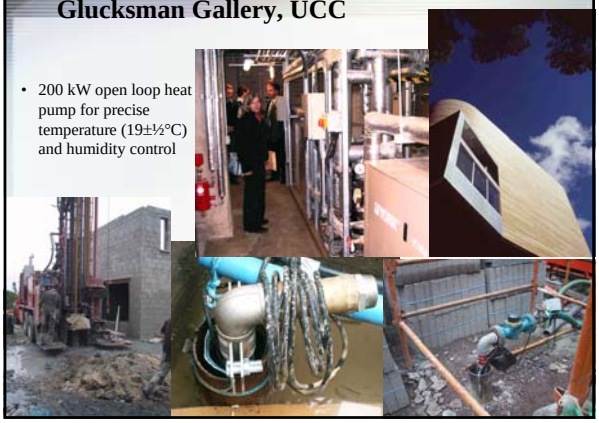
  $k = 5\text{-}7 \times 10^{-3}$ m/sec
- several geothermal space heating projects completed or in progress
- Glucksman Gallery
- Lifetime Lab
- Environmental Research Institute, UCC
- Cork City Hall extension





Glucksman Gallery, UCC

- 200 kW open loop heat pump for precise temperature (19±½°C) and humidity control

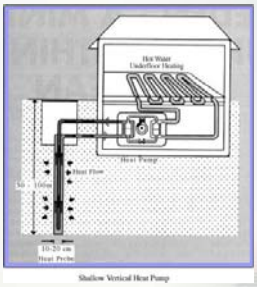


Ground Source Heat Pump Systems

- source media – rock or soil
- 2 types of collector system:
  - vertical closed loop heat exchanger
  - horizontal closed loop heat exchanger

Vertical Loop Heat Exchanger

- shallow vertical closed loop exchanger consist of single lined or partially-lined borehole 50-100m deep into rock – collector fluid within closed loop production pipe inside outer sleeve, or production pipe cemented into unlined borehole with high conductivity cement



- most common type of system in Sweden and Switzerland
- not common in Ireland -innovative 50kW scheme at Ballymena, Co. Antrim - field of ten 100m boreholes with closed loop heat exchangers to heat the new Museum and Art Gallery

Ground Source Heat Pump Systems

Horizontal Closed Loop Heat Exchangers

- array of flexible pipes laid horizontally in soil at shallow depth (0.2-1 m)
- collector fluid in closed loop system connected to heat exchanger

- most common type of system in Ireland - ~ 1500 installations – both private dwellings and public buildings
- area required for array – generally taken as 2 x floor area of building - rule of thumb based on experience abroad – need for more accurate estimate based on data for Irish soils and climatic conditions

Killavullen House, North County Cork

Current Geothermal Utilisation in Ireland

- mainly Ground Source Heat Pumps
- 1500 domestic installations (approx)
- 30 large scale installations (approx)
- total installed capacity - ~ 20 MWt
- thermal energy consumption - ~ 62 TJ/year
- capacity factor - 0.102
- growth rate ~ 45%/yr
- 3 domestic suppliers/installers in 2000, over 15 in 2005

Ongoing Geothermal Research in Ireland

- high temperature geothermal resources – CSA/Conodate
- tepid and warm water hydrogeothermal sources, buried valleys, GSHP collectors – UCC Geothermal Research Group
- GSHP collector performance – GMIT
- efficiency of GSHP systems - CIT

Geothermal Association of Ireland (GAI)

voluntary organisation - formed in January 1998 - aims are:

- to promote use of geothermal energy in Ireland
- to improve understanding of the nature, production and uses of geothermal energy
- to promote best practice in the geothermal industry, in order to maintain public perception of the positive benefits of geothermal energy
- to liaise with similar interest groups, to advise and lobby government, semi-state energy agencies and developers and to maintain contacts with other renewable energy associations

- GAI is affiliated with:
  - European Geothermal Council (EGC)
  - International Geothermal Association (IGA)

GAI Membership

GAI has a wide spectrum of membership including :

- academics
- energy agencies
- local authority engineers
- geologists and hydrogeologists
- architects and building services engineers
- heat pump suppliers
- geothermal energy providers
- well drillers

- our members include the pioneers of development of geothermal energy and heat pump technologies in Ireland
- founding members had foresight to recognise the potential for the development of geothermal energy in Ireland before renewable energy came into vogue or became government policy

GAI Activities

The GAI has over the past 7 years promoted the development of geothermal energy in Ireland in the following ways :

Research

- national and international funding gained for geothermal research and demonstration projects in excess of €300,000
- publication in international journals and conference proceedings
- presentations at national and international conferences

Education

- seminars
- professional courses
- site visits
- presentations to public bodies etc.

Consultation – to national governments and local authorities

Promotion

- website
- twice yearly newsletters

Invitation to join GAI

GAI invites you to join us as a member – membership fees are very reasonable - two classes of membership are available:

- ordinary membership - individuals **€40/£28**
- corporate membership – any body that regards geothermal energy as an important part of its business **€100/£70**

your membership will help us strengthen our financial base, and allow us to expand our activities, so enabling us to represent our membership better

Contacts

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Thank you for your Attention