Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

CUH
Ospidéal Ollscoile Chorcaí
Cork University Hospital

Fuelling the Future, Heat Pumps and more

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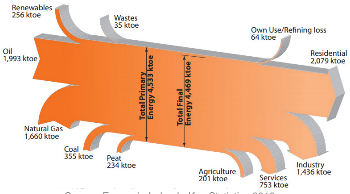
Setting the Scene

- Ireland's Import Dependence in 2013 was 89%
- Energy Flow – Thermal Uses 2013
  - Oil is the dominant fuel accounting for 44% of fuel inputs
  - Renewable energy contribution to thermal energy (RES-H) was 5.7% (2020 target is 12%)



Source: Energy in Ireland - Key Statistics 2013

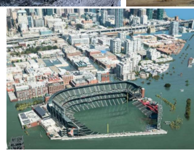
Have we reached Peak Oil?

- World Reserves
  - Conventional Oil
  - Oil sands
  - Heavy Oil
  - Extra Heavy Oil
- Total world proved oil reserves reached 1,700 billion barrels at the end of 2014 sufficient to meet 52.5 years of global production (Source: BP Global)
- New Oil and Gas Discoveries in 2015
  - Pakistan
  - Norway
  - Buru (Indonesian Island)
  - Colombia
  - Egypt (5 trillion cubic feet of gas resources and 55 million barrels of light oil)
- Shale Exploration / Fracing
- Artic Circle

What are the Drivers?

- Peak Oil or Environmental / Climate?

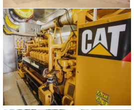



- Security of Supply / Global Instability?

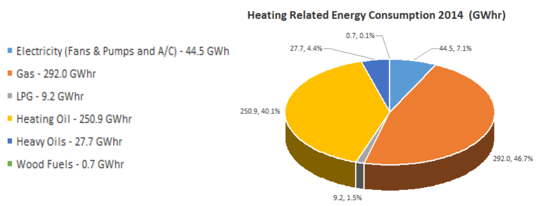
Heating Technologies

- Conventional Boiler
  - Centralised Boiler / Energy Centre
- Condensing Boiler
- Combined Heat and Power
- Biomass Boiler
- District Heating Network
- Electric Heating
- Solar Thermal
- Heat Pumps
  - Air Source, Gas Absorption and Ground Source
- Hybrid Systems

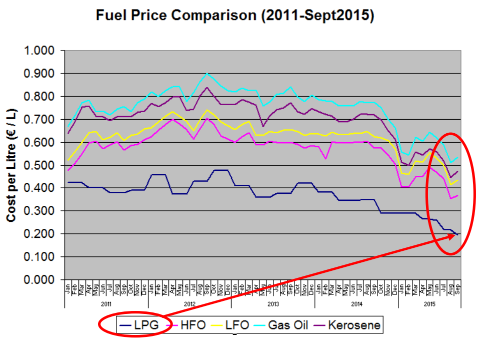



Fuel Mix

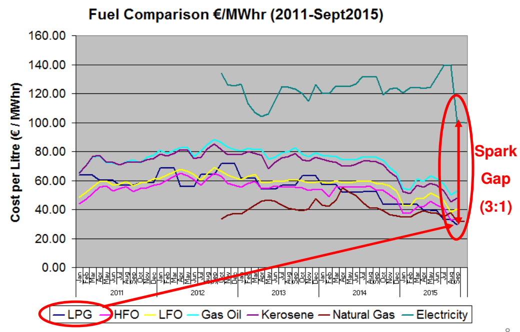
- Heating can be linked to between 65 – 75% of overall energy consumption in Hospitals



Fuel Price Comparison



Fuel Output

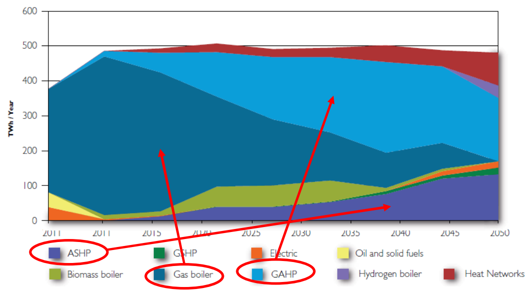


Question

- What's the right thing to do?
  A hybrid system utilising a condensing gas boiler to support an electric air to water heat pump.
- Do you pursue financial savings or carbon savings?

Future Predictions

- Modelling of Department of Energy and Climate Change (DECC UK)

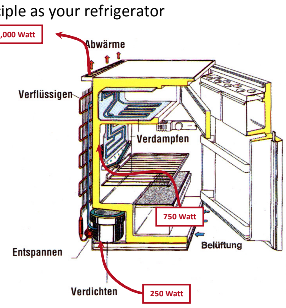


Heat Pumps

- Are Heats Pumps for the Future?
  - Favourable fuel prices
  - Improving COP
  - Legislative Drivers
    - National Renewable Energy Action Plan
    - National Energy Efficiency Action Plan
    - SI 243 of 2012 (EPBD)

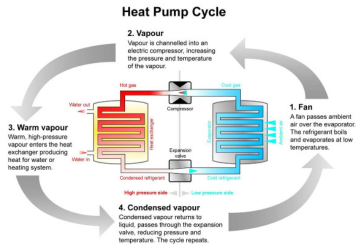
Heat Pumps

- What is a Heat Pump?
  - Basically the same principle as your refrigerator
  - But in reverse…



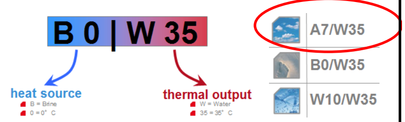
Heat Pumps

- Heat Pump Cycle



Test Standards

- EN 14511 Part 2



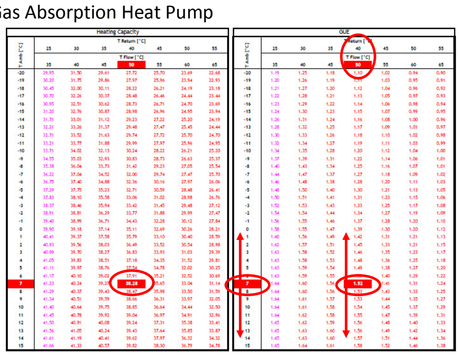
- Other Standards and Guidelines
  - BS EN 15316-4-2 2008 Heat Pumps Calculating Energy Requirements
  - BS EN 15450 2007 Design of Heat Pumps for Heating Systems
  - BSRIA BG 7 2009 Heat Pumps for Designers
  - CIBSE TM51 2009 Ground Source Heat Pumps
  - EPA – Guidance FGAS For Air Conditioning & Heat Pumps In Ireland
  - Carbon Energy Trust CE82 - A guide for specifies, their advisors and potential users
  - VDI 4640 Part 2 Ground source heat pump systems
  - SEAI Part L Compliance Guide Section 8
  - S.I. No. 151 2011 — Energy Efficient Public Procurement Regulations (Triple E Register)

Test Data

- Manufacturers Data Required when sizing units
- Heat Pump Efficiency
  - Electric: Coefficient of Performance (COP)
  - Gas Absoption: Gas Utilisation Efficiency (GUE)

Test Data

- Gas Absorption Heat Pump



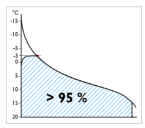
Sizing the Heat Pump

 OR 

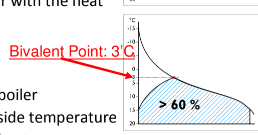
Heating Load	Boiler η	Boiler Gas Input	GAHP η	GAHP Gas Input	GAHP Fuel Saving	System
100 kW	90%	111.1 kW	1.52	65.8 kW	41%	A7/W50
100 kW	90%	111.1 kW	1.31	76.3 kW	31%	A7/W60
100 kW	90%	111.1 kW	1.45	69 kW	38%	A2/W50
100 kW	90%	111.1 kW	1.21	82.6 kW	26%	A2/W60

Air to Water Heat Pump Operation

- Monoenergetic
  - Heat pump does almost all of the work
  - Secondary heat generator: immersion heater
  - Air/Water is heating up to the bivalence-point [outside temperature between -5C and 0C].
  - Immersion heater is active together with the heat pump from the bivalence-point



- Bivalent
  - Heat pump does most of the work
  - Secondary heat generator: oil/gas boiler
  - Air/Water is operating to a set outside temperature and from this point the secondary heat source operates
  - Heat pump can work independently or in parallel



Common Point for Queries

- Can you meet the heat demand at reduced flow rates?
- Part of retrofit project needs to include:
  - Building fabric upgrade (attic and cavity wall insulation)
  - Review seals on windows
  - Heating zone controls
- Radiator Sizing
  - Conventional Boiler

    80'C(F)/60'C(R): [(80+60)/2]-20 = 50k ΔT

    @ 50K the radiator factor is 1; 1kW = 1kW
  - Condensing Boiler

    60'C(F)/40'C(R): [(60+40)/2]-20 = 30k ΔT

    @ 30K the radiator factor is 0.51; 1kW = 0.51kW
  - Heat Pump (Electric)

    55'C(F)/45'C(R): [(55+45)/2]-20 = 30k ΔT

    @ 30K the radiator factor is 0.51; 1kW = 0.51kW

$$\Delta T = \frac{\text{Flow temp} + \text{Return temp}}{2} - \text{Room temp}$$

Temperature difference (ΔT) °C	Conversion Factor
25	0.400
30	0.510
35	0.643
40	0.759
45	0.878
50	1.000
55	1.126
60	1.254

Table 1: Conversion Factors for different temperatures

- Allow heat pumps to run longer!

How to Determine Monthly Heat Demand

- When only delivery dockets are available?

Average % Annual Heat Demand

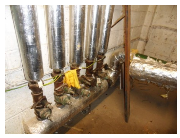
	Acute Hospitals	Community Hospitals
Jan	12.1	12.9
Feb	11.5	10.8
Mar	12.1	10.8
Apr	10.3	9.4
May	8.0	6.3
Jun	4.8	4.1
Jul	2.8	3.3
Aug	3.6	3.6
Sep	4.6	5.3
Oct	7.4	8.2
Nov	10.8	11.5
Dec	11.9	13.8

Case Study 1
Cahercivleen Community Hospital

- St Anne's
  - 33bed residential care services for older people
  - In-house catering facilities
  - Day Care Centre for local community
  - GP out of hours service (South DOC)
  - Mental Health Services Day Centre
  - Laundry (Patient's Personal Items)

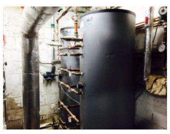
Background

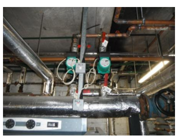
- Heating System
  - 2no 120kW boilers (duty / standby)
  - 3 stage Baltur burners
  - Hogfors boiler (end of useful life)
  - 6no heating zones
  - No zone control
  - No temperature compensation
  - Time Control (system On / Off)
  - LPHW radiators throughout
  - Boiler flow temperature 75'C



Background

- Domestic Hot Water
  - 2no 800litre storage calorifiers
  - Stored at 60'C
  - No remote temp monitoring





Background

- Building Fabric
  - 50mm cavity wall polystyrene board insulation
  - 225mm rockwool attic insulation
  - Single and Double Glazing
    - Drafts

Background

- 20,000litre bunded oil storage tank
  - LPWH and DHW
  - Oil Consumption: 77,000 litres
  - Annual Cost: €62,370
- 1,200litre gas storage tank
  - Kitchen and Laundry

Upgrade Works - Proposals

- Pump cavity walls – extruded bonded bead
- Upgrade LTHW circulating pumps
- Install temperature zone control
- Sub-divide heating circuits (including new circuit to Iveragh House)
- Install Hybrid Heating System for LPWH and DHW demand
  - 3 no. 60 kW condensing gas boilers
  - 3 no. 60 kW of air source heat pumps
  - Thermal Store – Stratified – 8,000 litre capacity

Upgrade Works - Costs

	€
Cost of Upgrade Works	184,750
SEAI Grant (BEC 2014)	92,375
Energy Credits	4,550
Cost to HSE	87,825

Project Review – Hybrid Heating

- Initial Challenges:
  - Integrating "low temperature" heat pump technology into high temperature heating systems
  - Achieving optimal heat pump performance to guarantee financial savings (incl. reduction of fossil fuel usage and CO2 emissions)
  - To provide an even and ambient temperature while reducing touch temperature of radiators.
  - Reducing the inefficiencies of storing domestic hot water at high temperatures.
  - Producing the thermal load for heating that is required in order not to over heat or under heat a building with smart control.

Project Review – Hybrid Heating

- Installation of Smart Hybrid Heating Hub

Project Review – Historical Usage

- Caherciveen (2013)
  - 77,000 litres oil per annum @ 10.169 kwhr / litre
  - Total system input: 783,013 kWhr
  - Cost per litre (2013): €0.81
  - Cost of thermal input: €62,370
  - CO_2 emissions: 201.2 tonnes per annum

Project Review – Hybrid Heating

- Caherciveen (2013)
  - Initial Analysis Period: March to August
  - 37.5% of annual heating and domestic hot water load
  - Oil consumption for period: 28,875 litres
  - Cost per litre: €0.81
  - Total Cost: €23,388.75
  - Primary Energy: 293,629.88 kWhr
  - CO_2 emissions: 75.37 tonnes

Project Review – Hybrid Heating

- Caherciveen (2015 – Post Installation)
  - Gas Usage: 7,954 litres LPG
  - Electrical Usage: 51,000 kWhr
- Gas
  - Cost per litre : €0.29
  - Cost: € 2,307
  - Primary Energy: 52,814.56 kWhr
  - CO_2 emissions: 12.1 tonnes
- Electricity
  - Cost per kWhr : €0.16
  - Cost: €8,160
  - CO_2 emissions: 26.3 tonnes

Project Review – Hybrid Heating

Caherciveen (2015 – Post Installation)

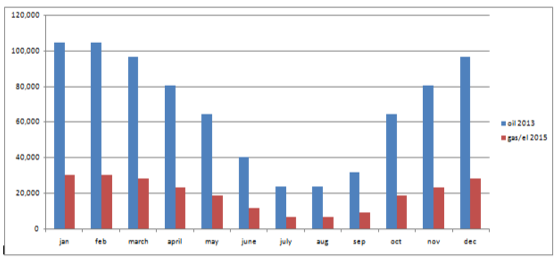
- Total Energy Cost: €10,467
- Total Primary Energy: 103,814.56 kWhr
- Total CO2 emissions: 38.4 tonnes

Project Review – Hybrid Heating

- Annualised Figures
  - Predicted annual running cost circa €25,872
    - 59% savings based on oil price 2013
    - 44% savings based on oil price 2015
  - Predicted primary energy: 275,600 kWhr
    - 65% reduction
  - Predicted CO2 emissions: 95 tonnes
    - 55% reduction

Project Review – Hybrid Heating

- kWhr Equivalent System Input

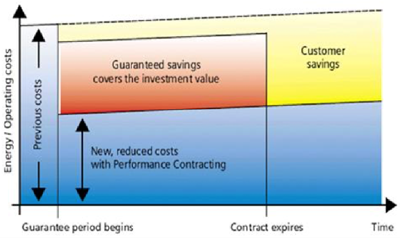


Summary

- Benefits
  - Ease of installation
  - Minimal downtime for integration
  - Small foot print required
  - Improved control and monitoring
  - Reduced CO_2 emissions
  - Reduced primary energy demand
  - Significant financial savings
  - **Payback 2.4years (5years without grant aid)**

Financing Future Projects

- National Energy Services Framework
  - Energy Performance Contracting (EPC)
  - Energy Performance-Related Payments (EPRP)
  - Local Energy Supply Contracts (LESCs)



What should we be doing?

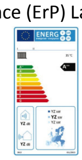
- IS 399 Energy Efficiency Design Management Review

- EPBD – SI 243 2012
  - At least considering alternative energy systems as part of design

- EU Legislative Initiatives
  - Energy Efficiency Directive – SI 542 of 2009
  - Energy Performance of Buildings Directive (Recast) – SI 426 of 2012
  - Eco Design – SI 203 of 2011
  - Eco Labelling Directive – SI 366 of 2011
  - Energy Efficiency Obligation Scheme – SI 131 2014

What should we be doing?

- Energy Performance (ErP) Label



ErP: did you know that...?

- From 26th September 2015, heating and DHW production appliances ***of up to 70 kW output must be marked with a label showing their energy efficiency*** (delegated regulation EU N 811/2013 - Energy Label).

- From 26th September 2015, heating packages ***of up to 400 kW output are required to meet the minimum energy efficiency polluting emission requirements*** (regulation EU N 813/2013 - Eco-design).

What's Coming?

- At the meeting of the European Council in October 2014, political agreement was reached on the headline targets for the 2030 Climate & Energy Framework, namely:
  (i) a reduction in greenhouse gas emissions of 40%;
  (ii) an increase in EU energy from renewable sources to 27%; and
  (iii) an indicative target of 27% energy efficiency.

- Directive 2010/31/EU (EPBD recast) Article 9 requires that *"Member States shall ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings; and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings"*.

Thank you!

"The Greenest Power is the Power you don't have to Produce."