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Valve Jacket Case Study - Charlestown Shopping Centre

Date: 29th June 2018

Results

91,200 **Payback in 4 Months**

Kwh Annual Energy Saving

KEY POINTS

Total #23 insulation jackets deployed	**Plant Rooms were heat metered**
Non-invasive installation	**Increased safety levels in Plant Rooms**
Payback in 4 months	**Simple and easy replicable project**
Notable heat reduction in Plant Rooms	**91,200 kWh Annual Energy Saving**

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1. Summary

This report shows the savings achieved after installing insulation jackets on the district heating system in Charlestown, Finglas, Co. Dublin. Part of the district heating system had sufficient heat sub-metering to allow saving calculations from a small sub-set of the total number of valve jackets installed. No other energy saving measure was deployed at the time on this discreet area.

2. Background

Facility Description

Charlestown is a mixed use development in Dublin 11 comprising of 285 apartments with an 18,800 sq meter shopping centre, underground car parking and roof top gardens. The anchor tenant is Dunnes Stores with a footprint of 7,600 sq meters.

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3. Systems

District Heating System

Charlestown uses its own district heating system, which sources heat in the most environmentally aware manner possible.

Electricity and heat are generated using an ENER-G 225kW Combined Heat and Power (CHP) plant, which delivers low carbon heat and electrical energy directly into the complex. During cold months when more heat is required, a 1 MW wood pellet boiler and standby 1 MW gas boilers are used to provide additional back-up.

A district heating system then delivers the generated heat and hot water to the anchor tenant, retail units and the apartment blocks.

The system delivers hot water to the 285 apartments. Hot water is pumped to the apartment cores 24/7/365 irrespective if it is required. In summer, about 50% of the thermal energy used is billed, in winter this rises to about 70%.

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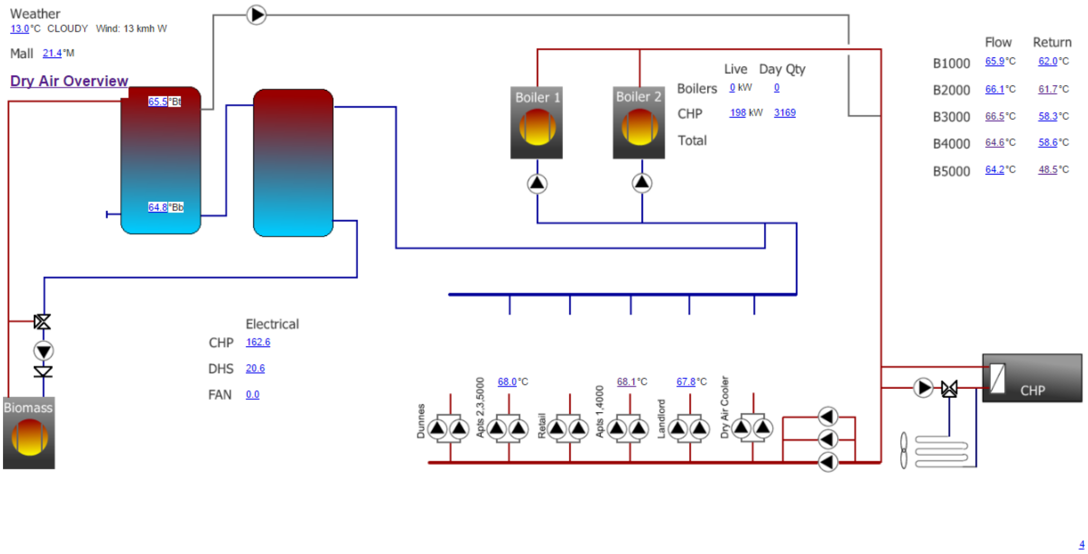
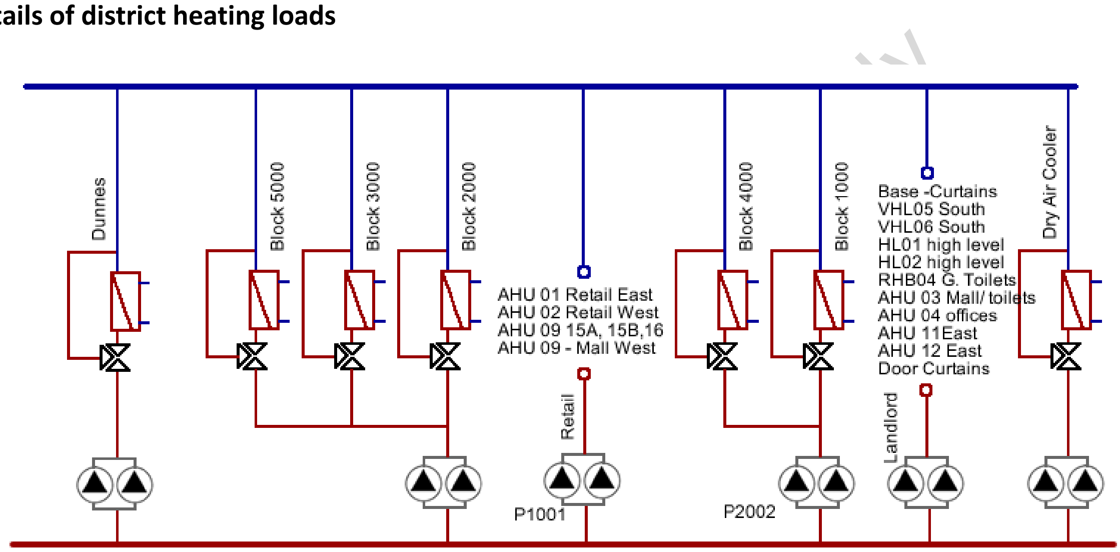
Heating Scematic



Details of district heating loads



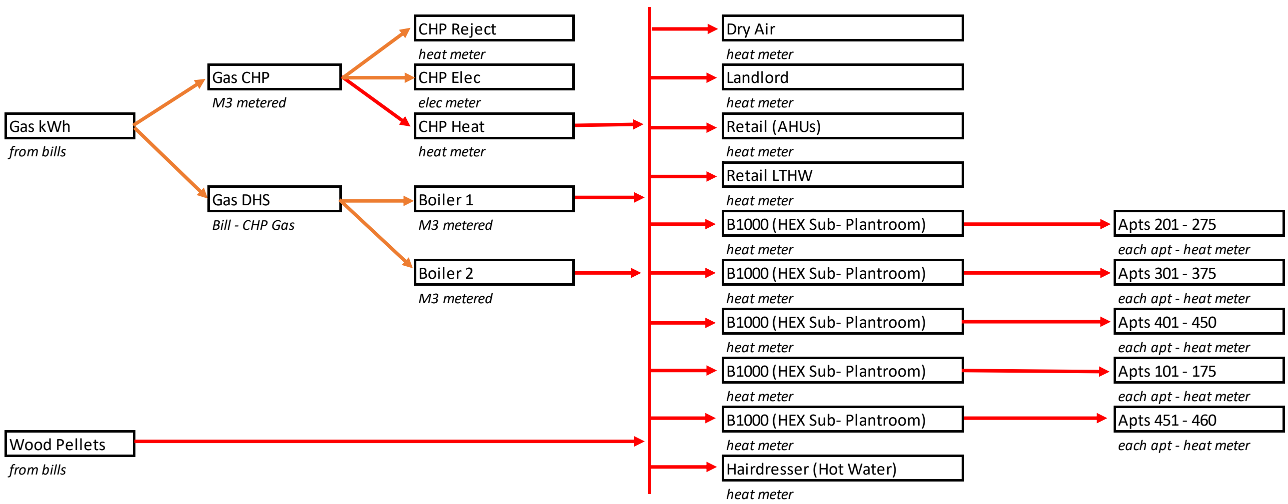
1. Anchor Tenant, controlled by Dunnes BMS.
2. Sub plant Room B1000
3. Sub Plant Room B2000
4. Sub Plant Room B3000
5. Sub Plant Room B4000
6. Sub Plant Room B5000
7. Retail Circuit (Air handling Units)
8. Landlord (Warm Air curtains, Air Handling Units & Hot Water)
9. Dry Air cooler (heat / cooling source for Air conditioning equipment in Retail units)

Sub Plant Rooms B1000 to B5000

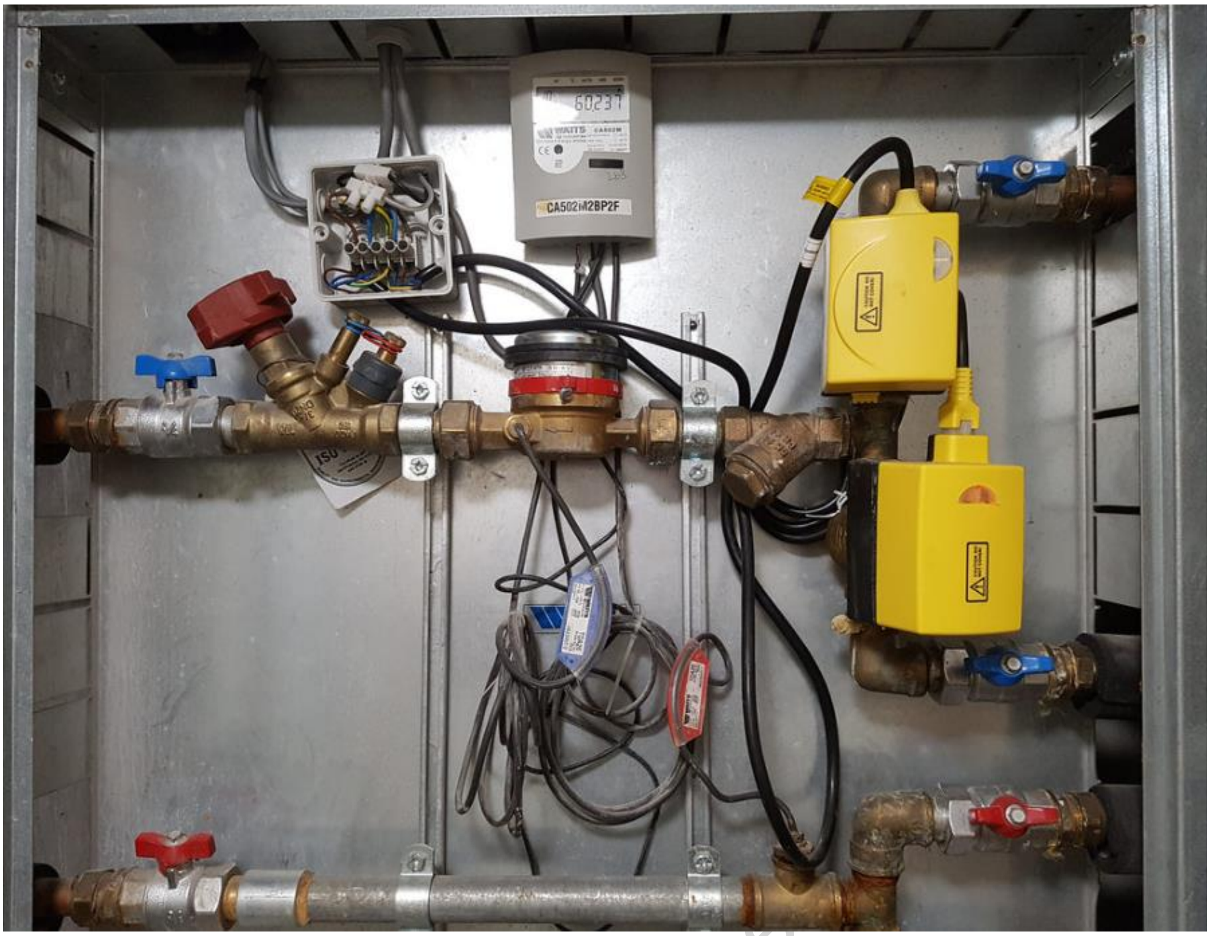
A heat exchange system feeds hot water to 285 Apartments. There is a double Wilo pump controlled on a Variable Speed Drive with a 3000 litre expansion vessel to accommodate thermal expansion in the system. LPHW is delivered to each apartment which is then used to heat copper calorfiers or radiators within each apartment. Thermostats and a multichannel time-clock is used by the resident to control heat delivery into each apartment. Heat is to each apartment is metered just outside the apartment. Individual apartments do not have their own heat exchanger.

Metering

There is extensive metering in Charlestown. Residents are billed every 2 months, using a remote M-BUS meter reading and datalogging system, system reads are taken and logged on the 1st of every month.

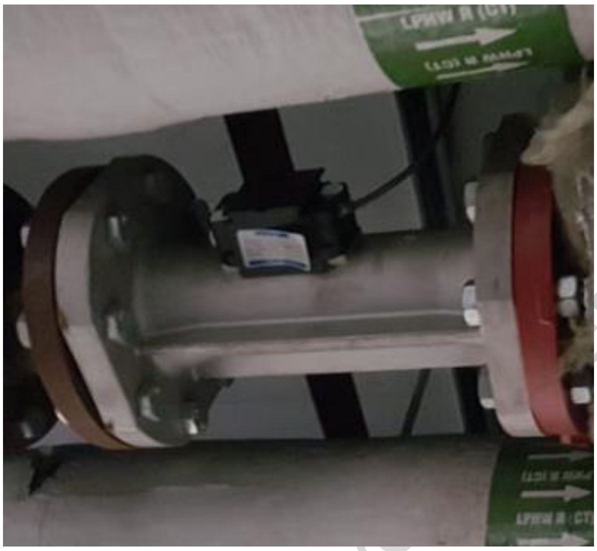


Heat meters are installed as per the diagram above. These are read manually every month as part of plant checks. The heat meters in the sub plant rooms B1000 to B5000 are installed on the secondary and are measuring the flow and return temperatures to the apartment risers. These measurements are then used to calculate heat.



Apartment Heat Interface unit with heat meter.

Kamstrup heat meter used in Charlestown



Ultrasonic flow measurement

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Valve covers added to DHS.

The awkward pipe work, which included meters, strainers, heat exchangers, control valves and flanges throughout the DHS were uninsulated.

1. Missing Valve covers (control valves, BFVs, Lever Valves) - 40
2. Heat Meters (ultrasonic) – 15
3. Strainers – 15
4. Heat Exchangers – 5
5. Flanges – 36

Within the B1000 to B5000 sub plant rooms, 23 jackets were added to the secondary (metered) side of the heating system supplied by GEM www.insulationjackets.ie

The heat savings from the 23 jackets could be isolated from the overall savings as historical heat metering is present on the overall heat into the sub-plant room as well as the heat usage by the apartments connected to these sub-plant rooms.

Empirical guide to heat loss

Published guide tables give heat loss (w/M) for straight pipe work at the different sizes and operating temperatures (see below). These table are also utilised to calculate losses for awkward pipe work such as valves. An exposed valve is deemed to lose the equivalent amount of heat as 1 meter of straight pipework for the similar listed diameter.

		Temperature Difference(°C) (65 °C to 15 °C = 50 Kelvin difference)											
(mm)	*(inch)*	50	60	75	100	110	125	140	150	165	195	225	280
15	1/2	30	40	60	90	130	155	180	205	235	280	375	575
20	3/4	35	50	70	110	160	190	220	255	290	370	465	660
25	1	40	60	90	130	200	235	275	305	355	455	565	815
32	1 1/4	50	70	110	160	240	290	330	375	435	555	700	1000
40	1 1/2	55	80	120	180	270	320	375	420	485	625	790	1120
50	2	65	95	150	220	330	395	465	520	600	770	975	1390
65	2 1/2	80	120	170	260	390	465	540	615	715	910	1150	1650
80	3	100	140	210	300	470	560	650	740	860	1090	1380	1980
100	4	120	170	260	380	585	700	820	925	1065	1370	1740	2520
150	6	170	250	370	540	815	970	1130	1290	1470	1910	2430	3500
200	8	220	320	470	690	1040	1240	1440	1650	1900	2440	3100	4430
250	10	270	390	570	835	1250	1510	1750	1995	2300	2980	3780	5600
300	12	315	460	670	980	1470	1760	2060	2340	2690	3370	4430	6450

In general, when empirical tables are utilised, the normal calculated pay back scenarios for insulation jacket projects deployed on 24/7/365 heating systems yield a payback of between 8 – 12 months (depending on operating temperatures and pipe-work sizes etc).

Listed below are the 23 items which were covered on the secondary heating system at Charlestown with heat loss calculations using the empirical table.

B1000			2πRH - 1 meter
Item	**Number**	**Size (mm)**	**Surface Area Equivalent M^2 Empirical rule**
Strainer	1	150	0.942
Control Valve	1	150	0.942
BFV	1	150	0.942
Flange	1	150	0.942

B2000

Item	Number	Size	Surface Area Equivalent M^2 Empirical rule
Strainer	1	100	0.628
Control Valve	1	75	0.471
BFV	1	75	0.471
Flange	1	75	0.471

B3000

Item	Number	Size	Surface Area Equivalent M^2 Empirical rule
Strainer	1	75	0.471
Flange	1	75	0.471
Control Valve	1	75	0.471

B4000

Item	Number	Size	Surface Area Equivalent M^2 Empirical rule
Control Valve	1	75	0.471
Strainer	1	75	0.471
Control Valve	1	75	0.471

B5000

Item	Number	Size	Surface Area Equivalent M^2 Empirical rule
Lever Valve	1	60	0.3768
Meter	1	60	0.3768
Lever Valve	1	60	0.3768
Lever Valve	1	60	0.3768

Plate Heat Exchange		Surface		Equiv. pipe length
Sondex S22 1-G	1200 x 550 x 600	3.42	m^2	3.63 meters of 150 DN
No ID Plate	450 x 250 x 400	0.785	m^2	2.08 meters of 60 DN
Sondex SQA 1-G	700 x 450 x 500	1.78	m^2	3.78 meters of 75 DN
Sondex AS	1025 x 550 x 600	3.0175	m^2	6.41 meters of 75 DN
Sondex AS	1025 x 550 x 600	3.0175	m^2	6.41 meters of 75 DN

Total equivalent meters		**Heat loss (empirical rule) Watts**	**Expected kWh heat loss per Annum**
DN150	7.63	1,297	11,363
DN100	1.00	120	1,051
DN75	16.82	1,569	13,747
DN60	6.08	456	3,997
			30,159

Before and After Comparisons.

Heating degree days for each given month were plotted against monthly kWh combined totals for B1000 –B5000 for the pre and post installation periods. A comparison was also made for the energy used by the apartments during the same periods to ensure that savings attributed to the jackets were not caused by a reduction in energy use by the apartments for whatever reason.

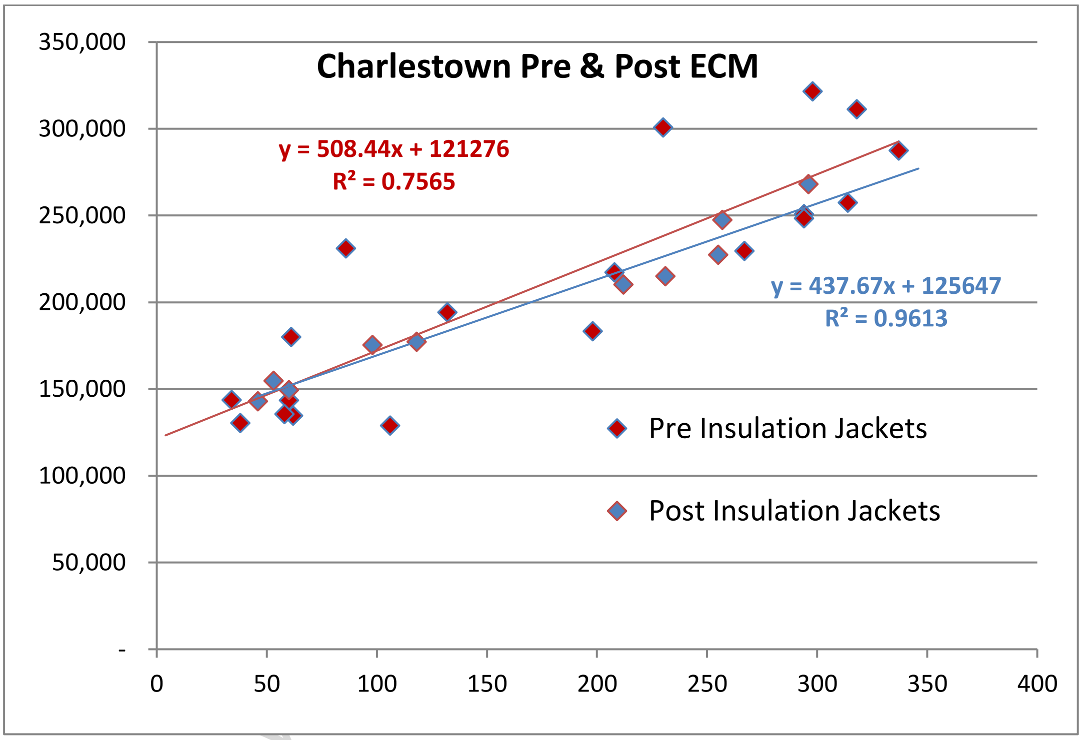
Before jackets installed. (kWh measured and added for each sub-plant room).

Month	HDD	kWh
Jan-15	337	287,590
Feb-15	318	311,293
Mar-15	298	321,693
Apr-15	230	300,843
High outlier		
Jun-15	86	231,033
Jul-15	61	179,974
Aug-15	62	134,618
Sep-15	106	128,973
Low outlier		
Nov-15	198	183,291
Dec-15	208	217,285
Jan-16	294	250,840
Feb-16	314	257,430
Mar-16	294	248,450
Apr-16	267	229,533
May-16	132	194,131
Jun-16	60	143,532
Jul-16	38	130,485
Aug-16	34	143,766
Sep-16	58	135,627
Oct-16	146	182,404

After jackets installed. (kWh measured and added for each sub-plant room).

Month	HDD	Actual kWh	Expected kWh	Difference
Dec-16	257	247,551	251,945	-4,395
Jan-17	296	268,125	271,774	-3,649
Feb-17	255	227,402	250,928	-23,526
Mar-17	231	215,001	238,726	-23,725
Apr-17	212	210,339	229,065	-18,726
May-17	118	177,174	181,272	-4,098
Jun-17	60	149,457	151,782	-2,325
Jul-17	46	142,947	144,664	-1,717
Aug-17	53	154,718	148,223	6,495
Sep-17	98	175,404	171,103	4,301
Oct-17	123	197,870	183,814	14,056
Nov-17	265	217,731	256,013	-38,282
Totals			**2,227,365**	**-91,197**

Summary **-4.09% Annual Saving**
-91,197 kWh Annual Saving



The regression equation of the line prior to the deployment of the Insulation Jackets (ECM) is used to calculate the expected consumption that would have occurred had the installation not taken place i.e. the expected kWh. The expected monthly totals were subtracted from the actual monthly totals to give the saving difference for each given month. Total savings were calculated at 91,197 kWh.

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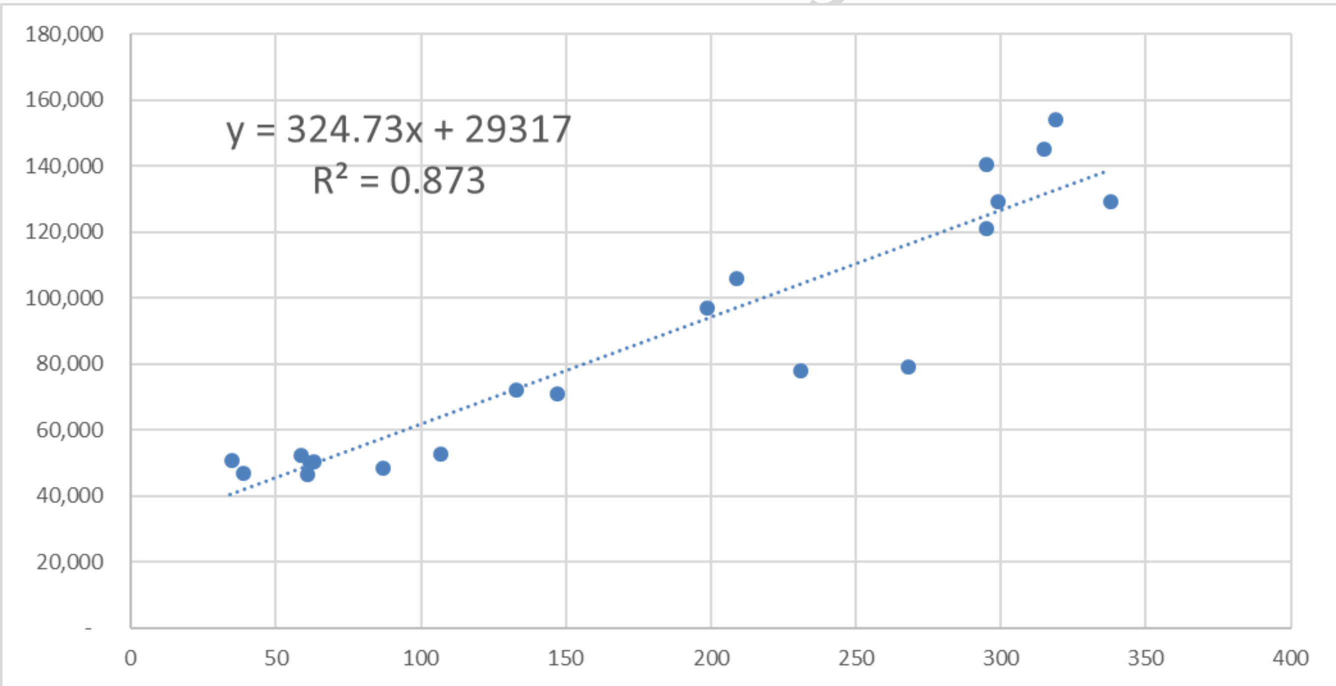
Energy metered to Apartments before Jackets Installed.

Month	HDD	kWh - billed
Jan-15	337	130,000
Feb-15	318	155,000
Mar-15	298	130,000
Apr-15	230	78,900
High outlie	176	
Jun-15	86	49,327
Jul-15	61	50,608
Aug-15	62	50,996
Sep-15	106	53,646
Low outlier		
Nov-15	198	97,938
Dec-15	208	106,544
Jan-16	294	141,199
Feb-16	314	145,927
Mar-16	294	121,903
Apr-16	267	80,000
May-16	132	73,000
Jun-16	60	47,071
Jul-16	38	47,717
Aug-16	34	51,674
Sep-16	58	53,111
Oct-16	146	71,668



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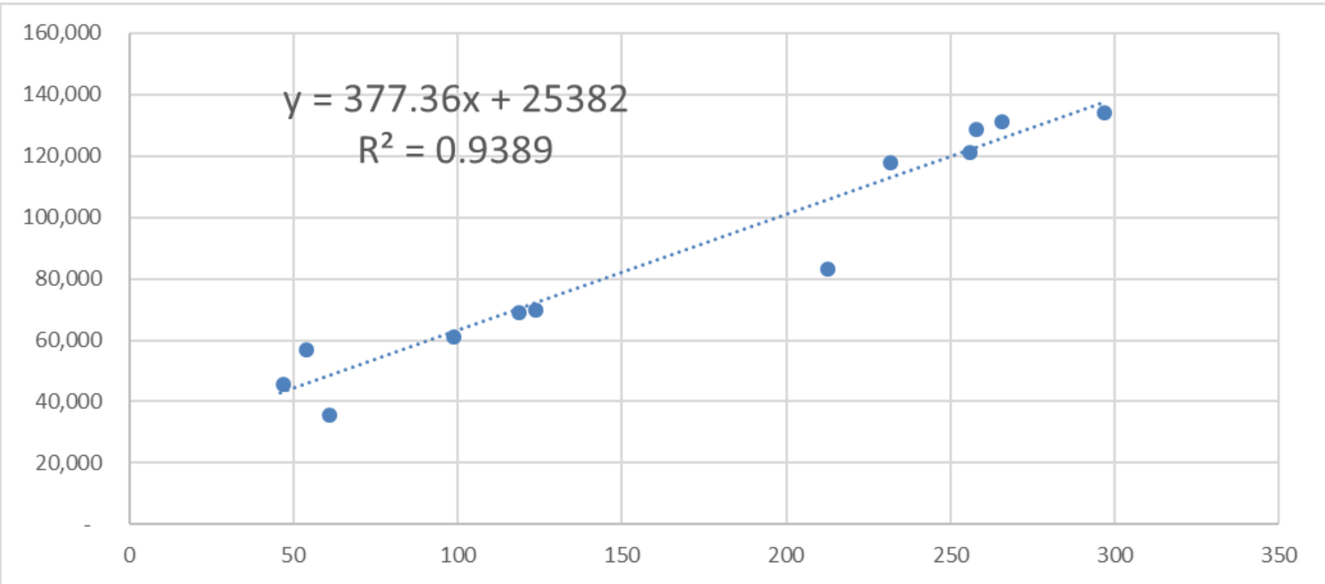
Energy metered to Apartments after Jackets Installed.

Month	HDD	kWh - billed
Dec-16	257	129,650
Jan-17	296	135,124
Feb-17	255	121,853
Mar-17	231	118,620
Apr-17	212	84,178
May-17	118	69,915
Jun-17	60	36,317
Jul-17	46	46,447
Aug-17	53	57,700
Sep-17	98	62,046
Oct-17	123	70,563
Nov-17	265	132,167



Equivalent Values on "Average Year" – Met Eireann Values

DEGREE DAYS BELOW 15.5 DEGREE CELSIUS FOR DUBLIN_AIRPORT

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2018	316	339	348	223	143	72	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2017	304	259	243	224	134	66	52	58	103	136	271	317	2167
2016	303	321	299	278	142	70	45	41	65	157	296	272	2289
2015	336	322	301	246	185	101	77	73	115	168	206	213	2342
Mean	316	289	274	223	155	84	46	51	88	165	245	308	2243

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Before

	HDD	324.73	29317
Jan	316	131932	
Feb	289	123164	
Mar	274	118293	
Apr	223	101732	
May	155	79650	
Jun	84	56594	
Jul	46	44255	
Aug	51	45878	
Sep	88	57893	
Oct	165	82897	
Nov	245	108876	
Dec	308	129334	
	Total	**1,080,498**	

After

	HDD	377.36	25382
Jan	316	144628	
Feb	289	134439	
Mar	274	128779	
Apr	223	109533	
May	155	83873	
Jun	84	57080	
Jul	46	42741	
Aug	51	44627	
Sep	88	58590	
Oct	165	87646	
Nov	245	117835	
Dec	308	141609	
	Total	**1,151,380**	

6.5% extra energy billed to (and used by) apartments after jackets installed. This is despite less energy metered to the upstream sub-plant rooms.

The savings are three time higher than what would be expected using the empirical guide. (30,159 kWh savings expected, with an excess of 91,197 kWh savings achieved).

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GEM Thermal Jacket Specification

GEM Jacket Fabric:

Jacket outer and inner cloth: 40/40 ‘E’ Glass fabric, two sides coated with a flame retardant, chemical resistant and pigmented, alkali free, silicone polymer.

Fabric Colour: Grey or Silver

Fabric weight: (480 grms/M^2)

Fabric Thickness: (0.50 mm)

Fabric Temperature Resistance: for continuous uses up to 220 ºC

GEM Fabric Stitching:

Description: Kevlar coated stainless steel sewing thread

Temperature Resistance: The steel core can withstand prolonged temperatures of 1100°C without high strain and 600°C with mechanical strain

GEM Jacket Pull Chord:

Description: Nomex™ pull chord

Detail: 8 plait braided chord from spun Nomex™ yarns

Temperature Characteristics: Nomex™ is an inherently flame retardant fibre that enables the product to withstand higher temperatures before degradation. Charring begins at 370°C. There is little or no melting and in the absence of a flame source, no flaming up to 500°C.

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GEM Fabric Infill:

Description: Stone wool mat

Thickness: 50mm

Nominal Density: 80 kg/M³

Reaction to Fire: Reaction to Fire, Euroclass A1 EN 14303:2009 (EN 13501-1)

Thermal Conductivity: **At 50°C**, 0.043 W/MK EN 14303:2009+A1:2013 (EN 12667)

At 100°C, 0.047 W/MK EN 14303:2009+A1:2013 (EN 12667)

At 150°C, 0.055 W/MK EN 14303:2009+A1:2013 (EN 12667)

Maximum Service Temperature: 550°C

GEM Insulation Jackets Installed:

www.insulationjackets.ie

All GEM covers are bespoke. A number of measures are taken from the exposed valve to ensure a 50mm overlap to the adjacent straight insulated pipe-work or cladding.

All protrusions, pins, packing glands, screws and levers etc. are noted and recorded so as to allow for cut outs during manufacture. All jackets are made in one piece where feasible.

Larger jackets have supportive quilting pins inserted to maintain the integrity of the jacket infill. Insulating infill with more than one piece has staggered joints to prevent hot spots occurring.

GEM Jacket Benefits:

- Good mechanical wear resistance
- Resistant to most chemical attacks
- No combustible
- Easily cleaned
- Quick fitting and easy release
- Noticeable drop in operating temperature of plant room
- Increased protection from heat fatigue
- Increased safety protection from burns and protrusion hazards
- Increased temperature protection of vulnerable micro electronics

Conclusion:

Bespoke thermal insulation jackets provide a logical and simple energy conservation measure with multiple applications when applied to HVAC systems. This case study has examined the savings in a continuously operated hot water system at 65° C.

This case study would suggest that the accepted empirical guide is firmly on the conservative side of actual savings.

It would further suggest that many plant rooms with exposed valves etc. are losing far more heat that would have been expected using the commonly accepted empirical guide.

Note:

This Charlestown Energy Upgrade Project which was part of a comprehensive programme of energy upgrades and was grant aided through the SEAI EXEED programme. Excellence in Energy Efficiency Design (EXEED) enables organisations establish a systematic approach to design, construction, and commissioning processes for new investments and upgrades to existing assets. The Certified program aims to influence and deliver new best practices in energy efficient design management. EXEED designs, verifies, and manages optimum energy performance and management at the earliest stages of the lifecycle.

SEAI currently provide an EXEED grant scheme up to the value of €500,000 per year per project.

https://www.seai.ie/grants/business-grants/exeed-certified-grant/ for more information.

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