

The Passiv Haus combined with Solar Energy Store - the ultimate low energy combination?

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Presentation Outline

- Overview of University of Ulster
- Objectives of the Research
- Irelands first Passiv Haus Test Studio
- Theory
 - Method of analysis
 - Winter space heating demand and Solar Resource
- Practice
 - The Passive House Installation being monitored
 - Inter Seasonal Thermal Energy Storage considerations
- Summary & Conclusion

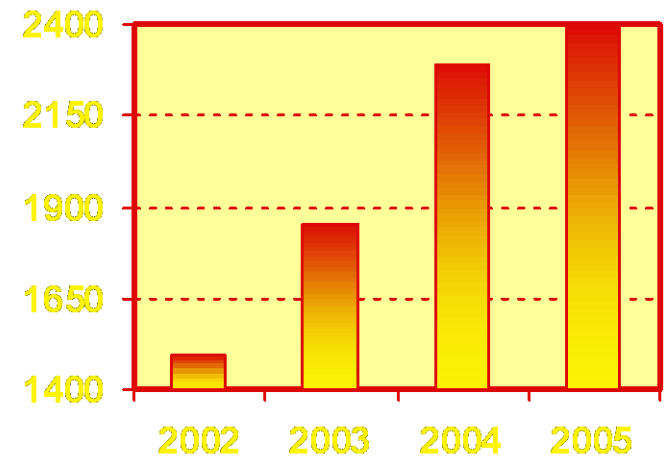


University of Ulster – Jordanstown Campus



University of Ulster 8th most popular University in UK (UCAS)

- UCAS Applications increasing
- Largest University in Ireland - 24,244 students
- International Reputation in research
- “Excellence” in teaching - 545 Degrees
- Graduate employment well above national average
 - 90.1% UU Graduates in employment.
- Complete student experience



Centre for Sustainable Technologies

- Advanced Glazing Systems
- Photovoltaic (PV) facades
- Advanced Integrated collector/storage solar water heaters
- Solar Energy systems for rural applications
- Sensible Heat storage
- Rational use of Energy in buildings



The Research Laboratories



Objectives of my Research

- Research is in the area of Thermal Energy Storage in the built environment
- This is being applied to The Passiv Haus Standard
- Focus on:
 - 1. Reducing Summer Overheating using PCM
 - 2. Reducing heating requirements using Seasonal Sensible Heat Storage



Ireland's First PH Test Studio



- Available for Joint Research projects
- Designed using PHPP
- Constructed & Tested
 - Airtightness
 - HRV calibration
 - Light Transmission of window
- Constructed in PCMExpress
- Validation of PCMExpress for
 - Base Case
 - Following incorporation of PCM



Matching Space Heating Demand and Solar Resource

The Theory



Method of analysis

- Passive House Planning Package (PHPP) based analysis
- Validated PHPP model for actual Passiv Haus constructed in Galway validated by German Passiv Haus Institute
- Space Heating from “Monthly Method” worksheet
- Monthly solar space heating fraction calculated
 - SolarDHW worksheet gives kWh/m²
 - PHPP Conversion factor, 6m² Solar array
- House “Located” in various cities & conclusions drawn



Dublin Vs Frankfurt

Dublin	Specific Space Heating Demand						8.5 Whr/m2/a			Frequency of Overheating				0	Eff
	Months requiring heating						No. of mths where solar contributes >10% of space htg reqt							10	
	Months requiring >10kWhr htg													8	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year		
Heat Reqts	425	366	213	65	13	1	0	0	1	35	276	436	1832		
Incident Solar/m2	38	50	96	135	161	151	162	133	109	73	41	26	1174		
Net Solar Available	79	104	200	281	334	314	337	277	226	152	84	55	2444		
Surplus/deficit	-346	-262	13	215	321	313	337	276	225	117	-191	-381	612		
% of Dmd met	19	28	94	429	2591	22564	0	0	16950	439	31	13	133		

Frankfurt	Specific Space Heating Demand						16 Whr/m2/a			Frequency of Overheating				0	Eff
	Months requiring heating						No. of mths where solar contributes >10% of space htg reqt							5	
	Months requiring >10kWhr htg													7	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year		
Heat Reqts	943	594	356	53	2	0	0	0	0	76	513	890	3426		
Incident Solar/m2	34	65	96	133	155	145	162	150	120	77	43	25	1206		
Net Solar Available	72	134	200	277	323	302	338	313	249	161	89	52	2511		
Surplus/deficit	-871	-459	-156	224	321	302	338	313	249	85	-424	-838	-915		
% of Dmd met	8	23	56	524	0	0	0	0	0	212	17	6	73		



Solar Fraction for Galway PH

Location	Specific Space Heating Demand {kWh/m ² /a}	Number of Months requiring Space Heating	Number of months requiring >10kWh space heating	Number of Months with Solar Fraction >10%	Surplus (+) / Deficit (-) of Solar Energy for Space Heating {kWh}	Percentage of Space Heating Demand met by Solar {%- Annual Solar Fraction
Dublin, Ireland	8.5	10	8	10	612	133
Glasgow	15.3	11	8	9	-1040	68
Paris, France	10.8	8	7	8	285	112
Freiburg, Germany	12.3	8	7	8	37	101
Copenhagen, Denmark	18.1	9	7	7	-1293	67
London, UK	11.6	8	7	6	-146	94
Marseille, France	1.2	6	3	6	3607	1507
Vienna, Austria	13.3	7	7	6	-91	97



Revisiting Supply Vs Demand

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- Sum of monthly deficit is 1,193kWh spread over 5 months
- The summer surplus of 1,804kWh can be fed to Seasonal Store
- Note Analysis based on 6m² panels rather than installed capacity of 10.6m²



Conclusion 1

Pattern of PH space heating Demand matches Solar resource in Ireland

- Solar resource in Ireland can make a significant contribution to space heating demand given CSF's:
- The relatively long space heating season in Ireland combined with
- The relatively low maximum space heating loads



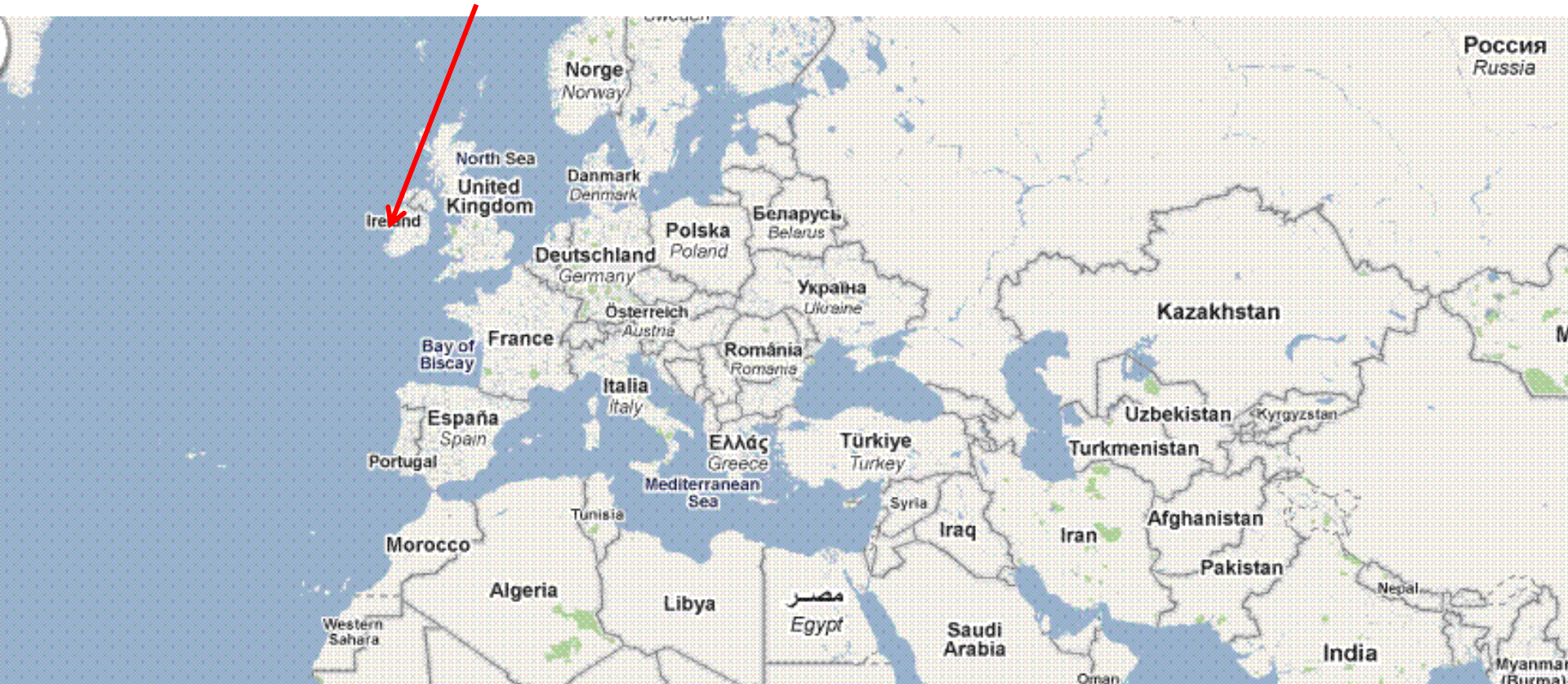
Solar combined with Passive House

In practice

Results from installation in Galway, West
Coast of Ireland



Location of Passive House





Passive House

Passive House & Solar Store in Galway, west coast of Ireland



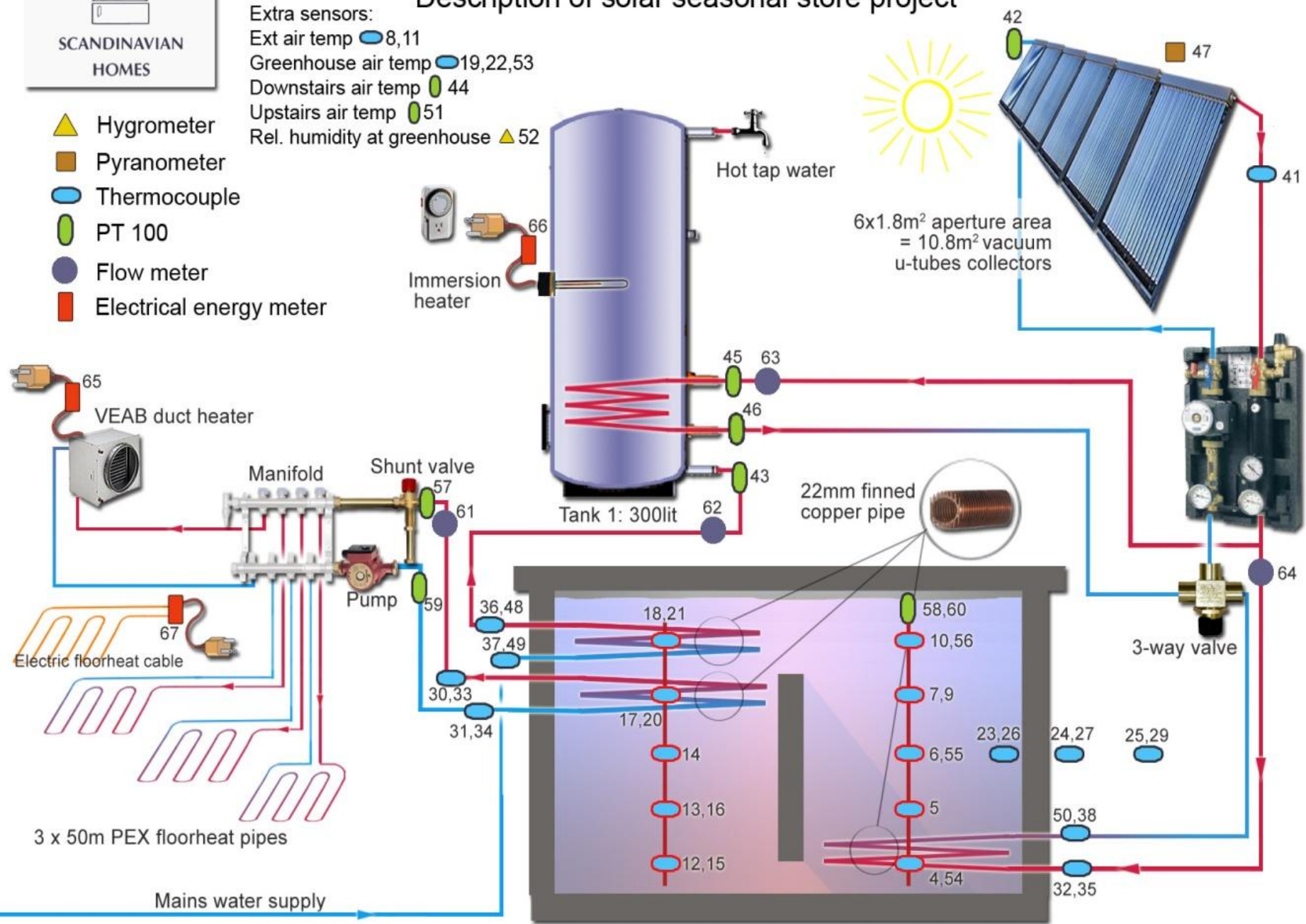
- Scandinavian Homes based in Moycullen, Ireland
- www.scanhome.ie, Lars Pettersson
- Passive House: 8.5kW/m²/a
- 10.8m² Solar Collectors
- 300 l DHW tank
- 23m³ Water Tank used as a TES medium
- University of Ulster has monitored the project since June 2009



Description of solar seasonal store project

- Extra sensors:
 Ext air temp 8,11
 Greenhouse air temp 19,22,53
 Downstairs air temp 44
 Upstairs air temp 51
 Rel. humidity at greenhouse 52

- ▲ Hygrometer
- Pyranometer
- Thermocouple
- PT 100
- Flow meter
- Electrical energy meter





Insulation
extends to
600mm



600mm
Insulation
was
applied to
top, sides
and
bottom

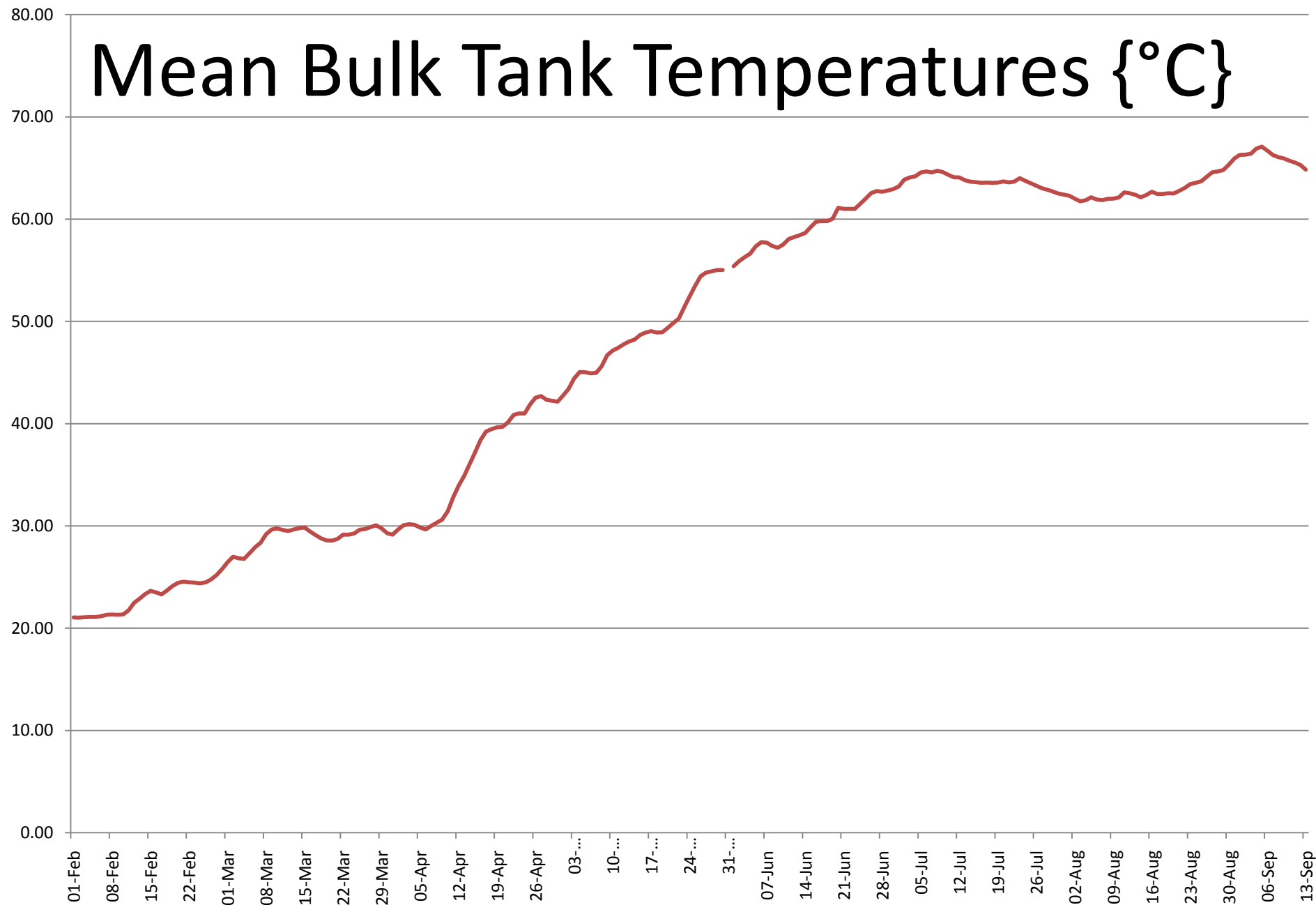


Results to date

- Tank installed June 2009
- Monitoring of 65 sensors with results output every 10 minutes
- Spreadsheet with 12,500 entries per day being analysed
- DHW Solar Fraction measured at 95% (albeit low drawdown)
- Space Heating Demand met in Nov & Dec 2009 from tank temp of 46°C
- Max Tank temperature 67°C Sept 2010, despite dullest July on record in 2010 & poor direct solar radiation in Aug 2010



Mean Bulk Tank Temperatures {°C}



Seasonal Store Performance

Month	Actual Performance									Predictions		
	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Ave MBTT {°C}	25	22.9	28.9	36.3	48.9	59.4	63.7	62.9	64.5	63	55	40
Soil Temp {°C}	10	8	9.1	11.3	14.6	18.2	19.9	20.6	19.6	19	18	17
Tank Losses {kwh}	108	107	143	180	247	297	315	305	323	317	266	166
Potential Daily Temp Loss {°C}	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.2

- Tank losses amount to 2773kWh over the year
- This compares with a useful storage of 1,500kWh
- There is a need for
 1. High Insulation levels for the Seasonal Store
 2. Correct dimensioning of Solar array
 3. Integration with low temperature heating eg HRV



Conclusion 2

Inter- Seasonal Storage can store required shortfall for winter months

- Critical Success Factors:
 - Insulation given tank losses of 60% – 70%
 - Integration with appropriate heating system which makes use of low temperatures



Summary

- University of Ulster active in Thermal Energy Storage & Passiv Haus research
- Passiv Haus Test studio available for joint projects
- Theory and practice demonstrate potential for Solar Space Heating in Northern Maritime Climate



The Passiv Haus combined with Solar Energy Store – Critical Success Factors

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