XD Consulting
Sustainable Energy Engineers

Lisdoonvarna Failte

Renewable Energy Feasibility Study

Introduction

- Study commissioned by the Western Development Commission on behalf of Lisdoonvarna Failte, February 2019
- Funding by the LECO project under the Northern Periphery & Artic Programme of the European Union
  The LECo project supports small communities in becoming self-sufficient regarding energy.
- Study performed by XD Sustainable Energy Consulting Ltd.
  XDC is a multi-disciplinary consulting engineers specialised in energy efficiency and renewable energy.

WDC
WESTERN DEVELOPMENT COMMISSION
COIMISIÚN FORBARTHA AN IARTHAIR

Northern Periphery and Arctic Programme
2014–2020

EUROPEAN UNION
Investing in your future
European Regional Development Fund

LECo
Local Energy Communities

Objectives

Overall objective:

Feasibility study on the potential for renewable energy at the following sites:

- Creche, Pavilion
- Dance Hal, Pump House, Bath House/Spa Well
- 50 acres of associated woodlands.

Specific Objectives:

- Determine the potential for renewable energy considering existing & forecasted energy usage and site constraints.
- Concept & preliminary design for potential renewable energy systems, and lifecycle cost analysis
- Assess the need for an environmental impact assessment (EIA) and estimate costs
- Review funding opportunities & recommend action plan

Methodology

- Survey of all sites and associated buildings
- Collect energy usage data and relevant documents
- Determine energy requirements (electrical & heating) at each facility and associated expenditure
- Forecast future energy requirements at Spa Wells site considering anticipated redevelopment
- Identify potential renewable energy opportunities at each site, and where relevant energy efficiency opportunities
- Preliminary sizing and configuration of proposed renewable energy systems, with performance specifications
- Estimate potential renewable energy outputs & energy savings, and associated CO_2 emissions reduction
- Conduct lifecycle cost analysis of each project, using discounted cash flow analysis over its lifetime
- Review funding opportunities for the proposed projects
- Where appropriate review key constraints from a planning & environmental impact assessment
- Recommend action plan for the implementation of the proposed projects
- Document the study findings and underlying analysis in an MS Excel Spreadsheet
- Prepare a report (MS Powerpoint Presentation herewith) and present to steering committee (date to be agreed)

Please note all costs & revenues mentioned in the following financial analyses are inclusive of VAT

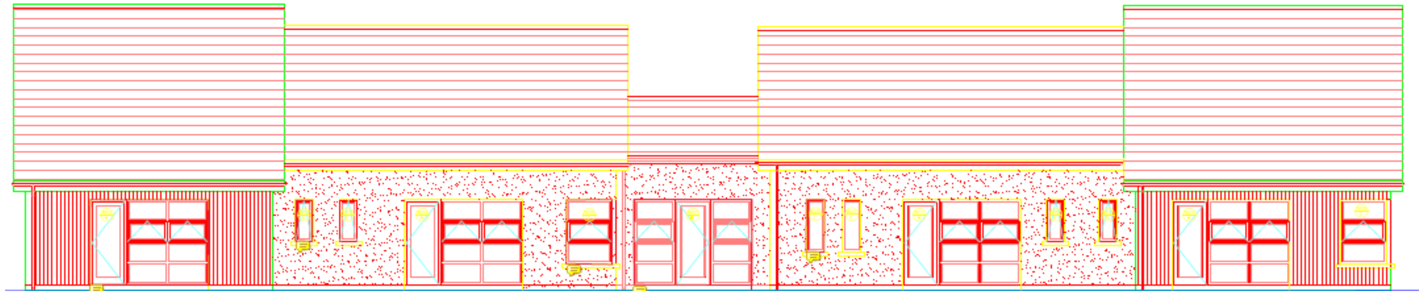
Creche

Walk through audit

Retrofit options

Renewable energy opportunities

Energy performance



Fabric energy performance:

- Insulation: roof 100-150 mm glass wool insulation, walls 60 mm PIR insulation, floor 100 mm PIR insulation
- Airtightness assumed at 10 m3/m2,hr as per Building Regulations standard
- Double glazed windows, PVC frames

Existing building services with renewable heating:

- 12 m2 solar thermal combi-system (domestic hot water + space heating)
- 2 x 11 kW air source heat pumps
- 800 litres buffer tank
- Domestic hot water (DHW) tank 150 litres with immersion heater
- Underfloor heating throughout the building

Estimated heat demand & heat load (based on DEAP(*) analysis):

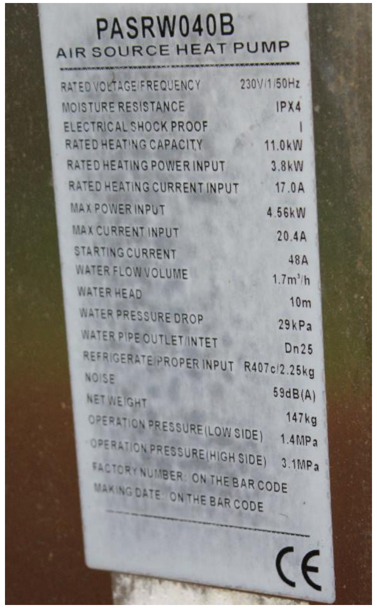
- Heat load (max heat output for space heating): 15 kW
- Estimated annual space heating requirement: 29,000 kWh/yr
- Estimated DHW requirement: 2,500 kWh/yr

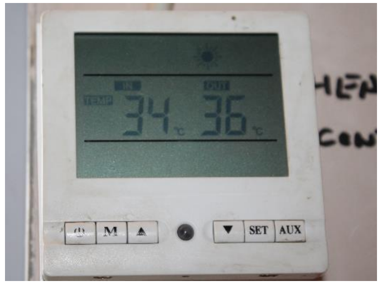
Current Energy Consumption (based on bill data for 2018):

- Total electricity usage: 40,640 kWh/year
- Electricity usage for heating (heat pump + immersion): 31,360 kWh/yr
- Other electricity usage (lighting, appliances, IT, etc.): 9,280 kWh/yr
- Energy expenditure (including fixed charges): 6,460 euro/yr

(*) DEAP is the official software for domestic BER assessment.

Existing ASHP Polar Bear 2 x 11 kW units





Assessment from visual inspection:

- Heavy icing of evaporator (air-to-refrigerant heat exchanger)
- De-icing of evaporator not effective
- Poor after-sale service, difficulty to maintain
- Basic heat pump controls, not integrated with central heating system controls
- No modulation and/or master/slave operation mode between the two heat pumps
- Very little temperature difference between flow and return to/from heat pumps

Assessment from energy usage data:

- Estimated heating requirement 31,500 kWh/yr based on DEAP analysis
- Estimated electrical usage for heating: 31,360 kWh/yr based on bills analysis
- Estimated current Coefficient of Performance COP(*) just above 1, not much better than direct electrical heating

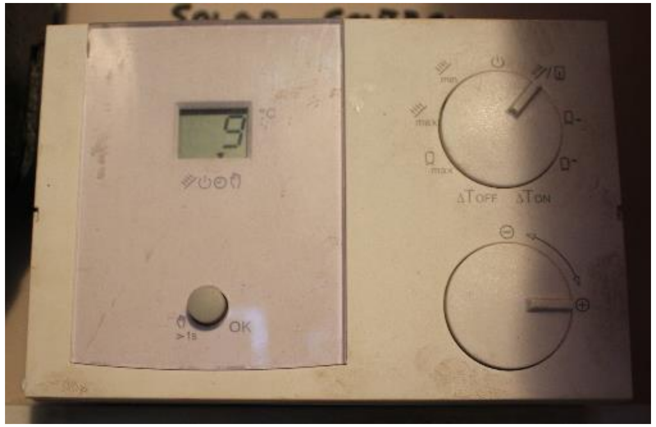
Overall, poor quality heat pump with low operating performance.

Solar thermal system

No clear signs of disrepair. Not active at time of inspection, likely due to overcast day (no solar gain available).

Pumping station in plant room

Flat plate collectors, estimated 12 m2 aperture area



Simple temperature differential controller

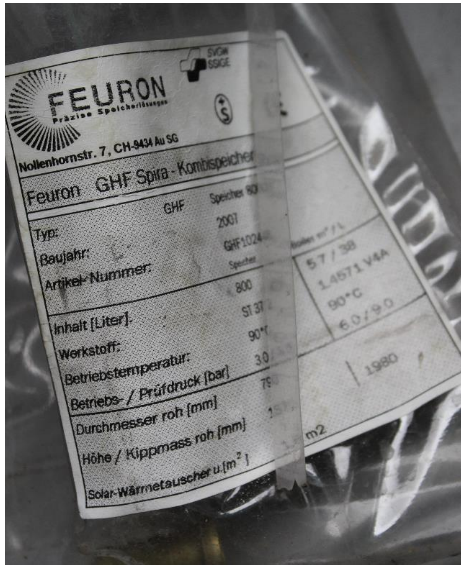
Maintenance works recommended:

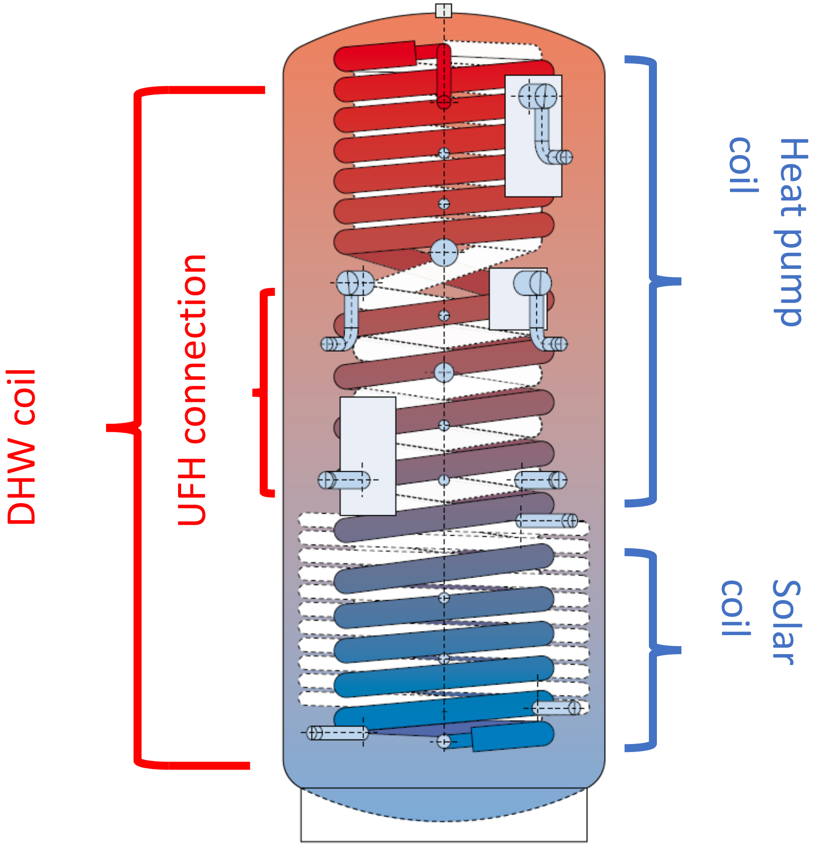
- Check temperature sensor connections & readings
- De-air the solar fluid circuit
- Check proper solar fluid flow in the circuit
- Check antifreeze properties of the solar fluid
- Check system works properly on sunny day

Buffer tank

Feuron GHF Spira, 800 litres
Datasheet & installation guidelines not available.

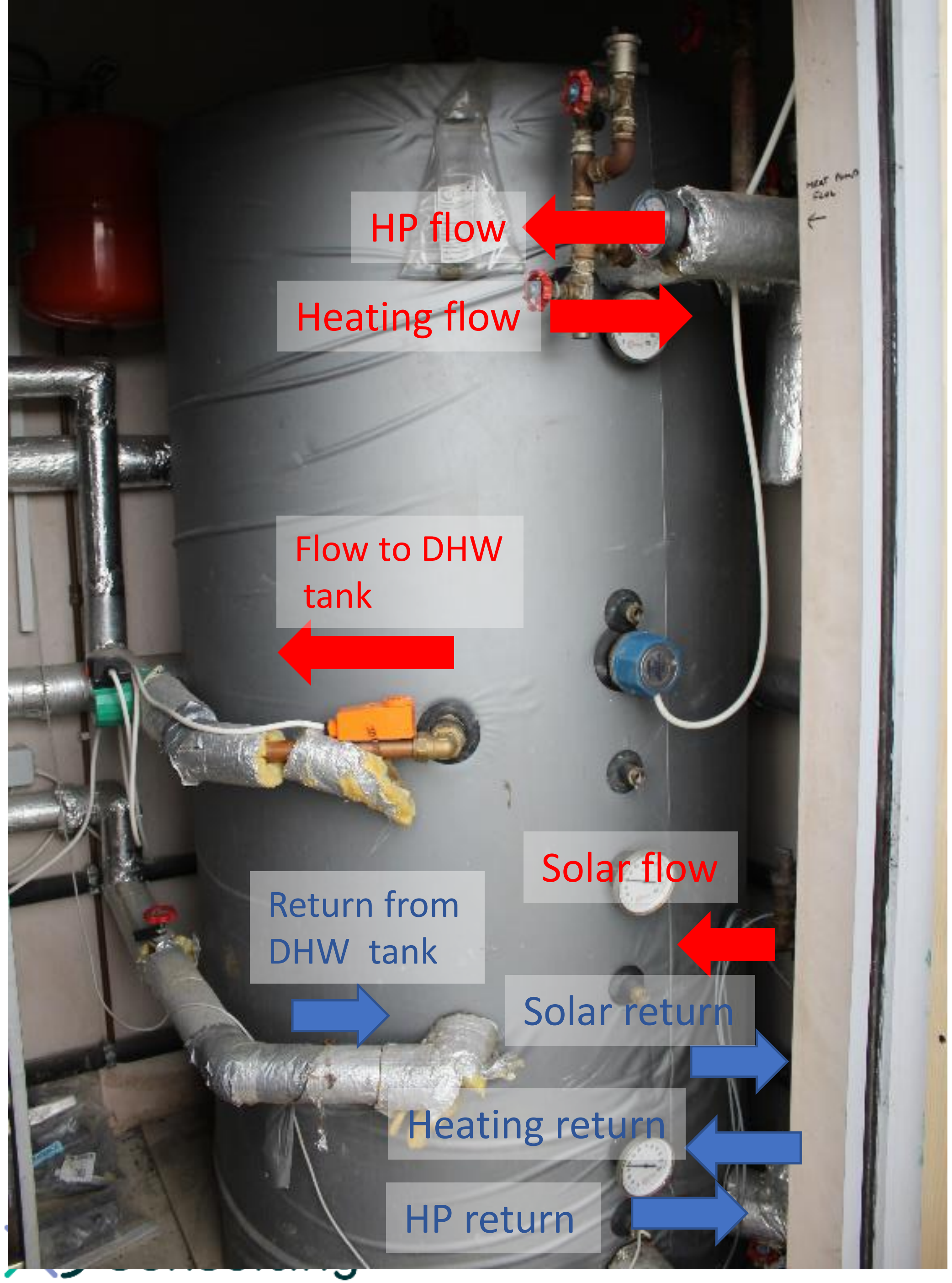
Schematic based on SPIRA
[WPS-Kombispeicher]() (to be confirmed)





Buffer tank designed to:

- Store heat from the solar thermal system produced during the day
- Store heat produced by heat pump (preferably at night w. cheaper electricity) & reduce compressor cycling
- Achieve good temperature stratification in the tank:
  - Highest temp at top for DHW (say 40-60 C)
  - Medium temp at middle for UFH (say 30-40 C)
  - Low temp at the bottom for max solar collector efficiency



Buffer tank actual plumbing

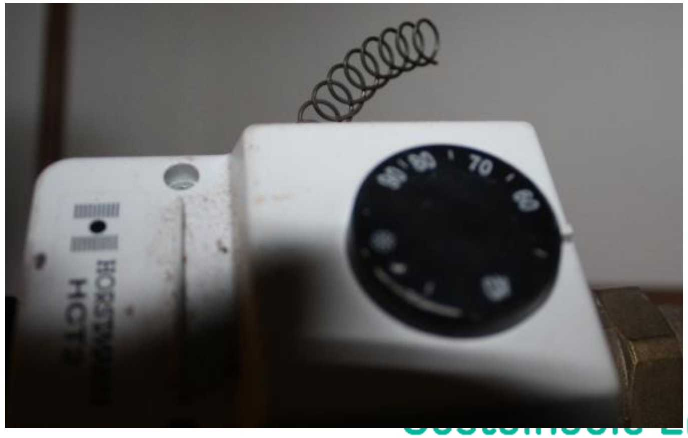
Issues include:

- No stratification of temperature
- Overall tank temperature regime dictated by heat pump flow and return, with minimal delta T from top to bottom of tank
- Solar thermal (ST) operating inefficiently, with likely minimal contribution
- Flow and return to DHW tank taken at low temperature, so heat pump (HP) and ST contribution to DHW heating is limited, even during summer
- UFH flow and return connections at top and bottom of tank, not taking advantage of potential temperature stratification
- Insulation deficient around a number of connections
- Control system and strategy unclear, likely to lead to inefficiencies, incl.:
  - Use of (cheaper) night-time electricity to charge the buffer tank for daytime heating may not be maximised
  - HP working regardless of solar thermal contribution to heating requirement

DHW tank & controls

Timing of immersion heating and heat supply from buffer tank seemed to coincide:

- immersion heating likely to leak into space heating
- (cheaper) night time electricity usage not maximised

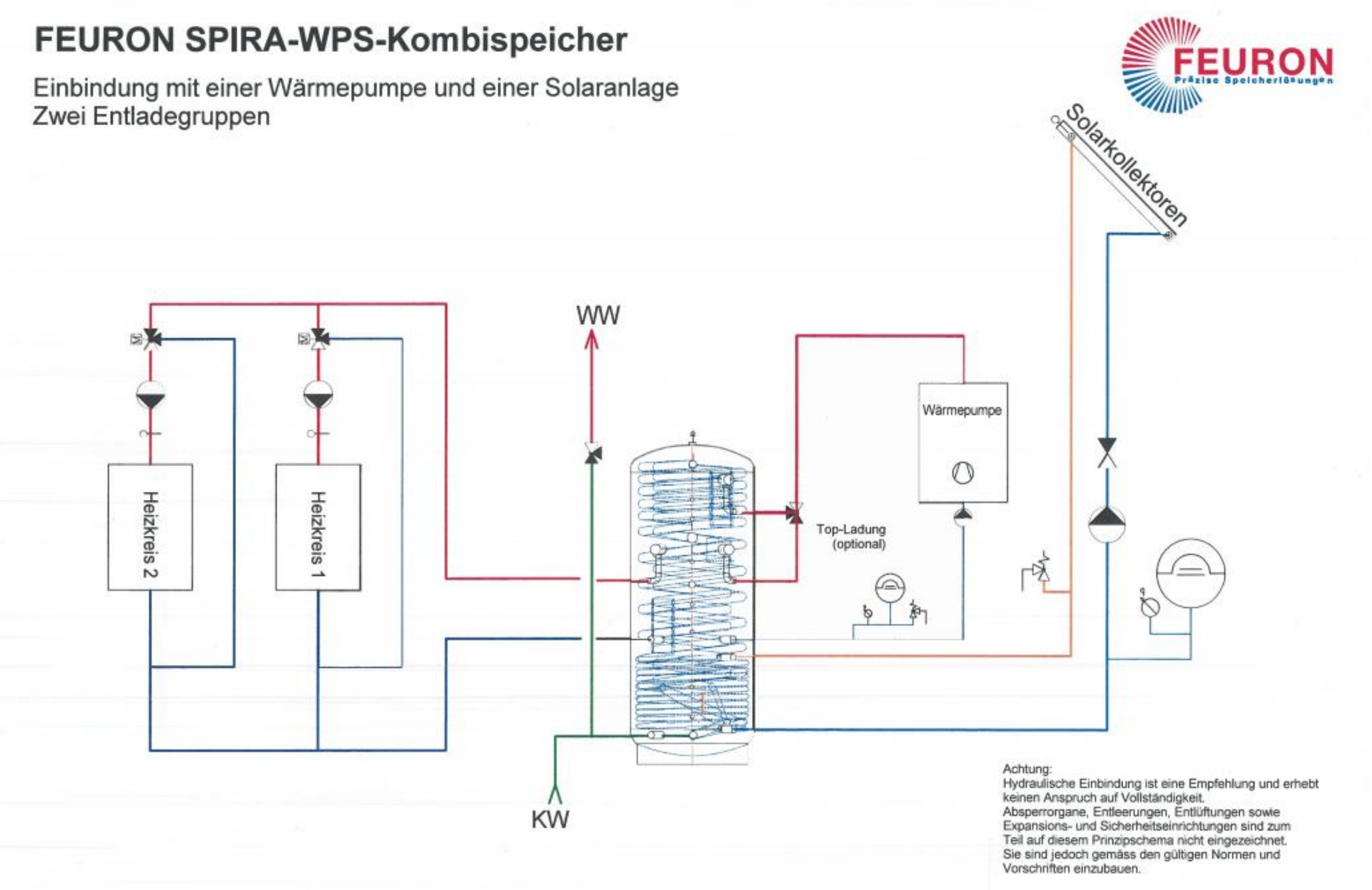


Central Heating Controls

- Central heating controls appear to provide time, temperature and zone control.
- Two types of thermostats installed, with one (Aquatech) appearing redundant.
- Systemlink's SystemLex installed but no clear overall integration of the control strategies between key elements of the system (heat pump, solar thermal, UFH, DHW tank, etc.).
- No energy usage and ambient conditions (room temperature, DHW temperature, etc.) monitoring
- Not clear if weather compensation

Upgrades to creche & heating system to include:

- Replacement of air source heat pumps with 1 or 2 new, efficient units:
  - total capacity 15-18 kW
  - Modulating (inverter-driven compressor)
  - Target system seasonal COP of min. 3
- Upgrade of controls and control strategy:
  - integrated digital controller
  - cloud-based interface
  - Full zone & temperature controls with weather compensation
  - Monitoring of energy usage & ambient conditions
- Reconfiguration of buffer tank plumbing and general repairs, to comply with manufacturer's recommended layout
  (see herewith for Spira-WPS-Kombispeicher, for illustration purposes)
- Add 300 mm of attic insulation (preferably cellulose insulation) to all attic spaces and ensure Part F Building Regulations requirements for roof ventilation are met.
- Improve airtightness of the building:
  - identify and remedy air leakage sources (ducts, wiring, pipework penetrations)
  - adjust windows and doors' seals and closing mechanisms



Cost/benefit analysis of creche upgrades

DEAP software analysis	*Before retrofits*	*After retrofits*	*units*	*Change (%)*
Estimated heat pump COP	1.3	3.5		
Space heating:				
Space heating requirement:	33408	26304	kWh/yr	21%
Electricity usage heat pump - Space heating	25698	6414	kWh/yr	75%
DHW heating:				
Baseline DHW heating requirement:	6234	2094	kWh/yr	66%
Direct electrical heating - DHW	3740	0	kWh/yr	100%
Electricity usage heat pump - DHW	1918	1565	kWh/yr	18%
Total electricity usage for heating	31357	7979	kWh/yr	75%
Total electricity usage excl. heating	9281	9281	kWh/yr	0%
Total electricity usage	**40638**	**17260**	**kWh/yr**	**58%**
CO2 emissions	17861	7434	kgCO2/yr	58%
BER rating (*)	C3	A3		

(*) BER rating before and after indicative only of energy performance change. Calculated with DEAP model for domestic BER while creche is non-residential building.

Proposed energy conservation measures	**Reduction in heat demand (kWh/yr)**	**Electricity savings (kWh/yr)**	**Electricity savings (€/yr)**	**Capital cost (€)**	**Payback (years)**
Fabric Upgrades					
Upgrade attic insulation (+300 mm)	6408	4929	657	3670	5.6
Improve airtightness to 5 m3/m2,hr @ 50Pa	1300	1000	133	1500	11.3
Heating system upgrades					
Improve primary pipework insulation	300	231	31	200	6.5
Retrofit solar water heating system & controls	5264	4049	539	2000	3.7
Replace air source heat pumps & overall controls		14148	1884	13908	7.4
Total		**24357**	**3244**	**21278**	**6.6**

Small-scale Wind Power

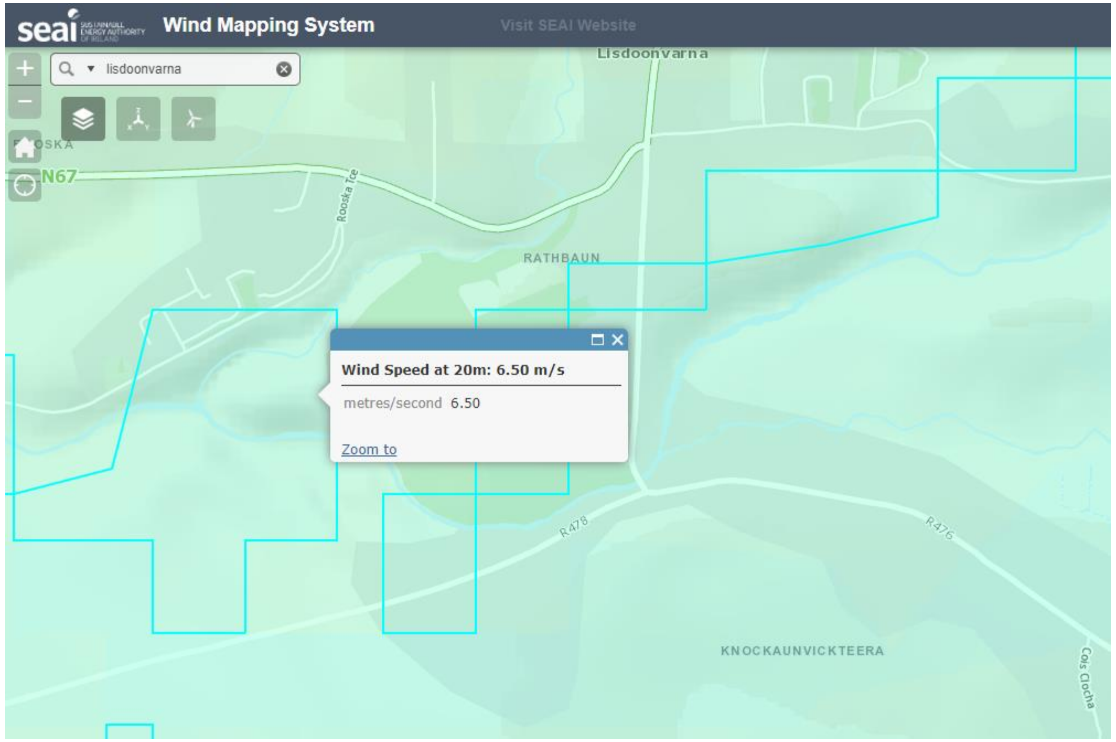
Preliminary feasibility study

Specifications:

• Nominal capacity @ wind speed of 12 m/s:	6 kW
• Average wind speed @ 20 m above ground:	6.5 m/s
• Rotor diameter	5.6 m
• Potential annual electricity output (kWh/yr):	16,000
• CO_2 emissions avoided ($kgCO_2$/yr)	6,544

Lifecycle cost analysis:

• Capital cost (estimated based on €1.6/W installed):	€30,000
• Electricity saving/revenue (at 13 cents/kWh):	€2,080
• Simple payback period:	14 years
• Net Present Value:	negative
• Internal Rate of Return:	4%
• Potential renewable energy penetration	93%



Electrical usage at creche after upgrades:

Electricity for heating = 7,980 kWh/yr
Other electricity usage = 9,280 kWh/yr

Spa Wells

Site & buildings

Wood Heating Potential

Solar PV Potential

Hydropower Potential

General Location

Consulting

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Buildings/facilities at the site

Pump House, 90 m2

Old bath house, 231 m2

Maiville House, 200 m2

Dance Hall/Theatre, 207 m2

Current & forecasted energy requirements

- Current energy usage is very limited (electricity only, 5660 kWh/year, €2400/year mostly in standing charges) and seasonal. As it is, investment in renewable energy solutions are not recommended.
- Future energy usage anticipated to grow significantly considering the proposed regeneration project for the Spa Wells site as per the Rural Regeneration & Development Fund Application
- Future thermal energy and electricity usage predicted on the basis of CIBSE TM46 benchmark for energy consumption in non-residential buildings, using indicative floor area provided for the relevant buildings
- This forecast energy usage is indicative only and need to be confirmed on the basis of detailed design of the renovation works to be undertaken, using best practices in terms of energy conservation
- Proposed renewable energy solutions hereafter are only for illustrating potential opportunities in the context of a successful regeneration project and fully operational facilities at the site.

Wood Heating Potential

Wood Heating @ Spa Wells

- Forecast heating demand (MWh/yr) based on CIBSE TM46 benchmarks:
  - Bath house 61
  - Dance Hall 33
  - Pump House 14
  - Maiville House 29

  Total 137

- Mini district heating with 55 kW wood chip boiler & buffer tank supplying base load, with oil boiler for peak load/back up.
- **Financial feasibility:**
  - Capital cost estimate: €67,000 (incl.VAT)
  - Wood fuel cost @ 4 cents/kWh: €5,500/year
  - Savings (kerosene @ 9 cents/kWh): €9,000/year
  - Simple payback period: 7 years
  - Net Present Value: €55,500
  - Internal Rate of Return: 11%

Wood fuel potential of 50 acres site

Coppice woodland management system:

- Short rotation forestry: tree is cut back periodically to stimulate new growth (between 3 & 10 years harvesting rotation, average 8 years)
- Benefits:
  - Increased woodfuel production
  - Dense cluster of shoots around stem great habitat for birds and small mammals
  - Trees maintained in juvenile stage result in exceptional longevity
  - Healthy root system protects against erosion
  - (Indefinite) carbon storage in the root system
- Potential yield:
  - Oak 2-4 tonnes per hectare per year over a 30 year rotation
  - Sweet chestnut up to 10 tonnes/ha/yr over a 15 yr rotation
  - Mixed species 3-5 tonnes/ha/yr or 45-75 tonnes at year 15 and 90-115 tonnes at year 30
  - Hazel 25 tonnes/ha at year 10 of a rotation
  - Source: http://smallwoods.org.uk/our-work/woodland-products/a-brief-history-of-coppicing/
- Wood fuel potential, based on mixed species coppice stand:
  - 4 tonnes (50% moisture content) per ha x 20 ha (1 acre = 0.405 ha) x 2.23 MWh/tonne (NCV, 50% MC) = 446 MWh/year
  - Forecasted wood fuel demand for spa wells buildings = 151 MWh/year
  - Wood fuel potential on site = 3 times
  - Projected wood chip cost = 3 cents/kWh (€1,510/year saving from buying wood chips or €9,060/year by replacing kerosene)

Solar PV Potential

Theoretical feasibility study

Specifications:

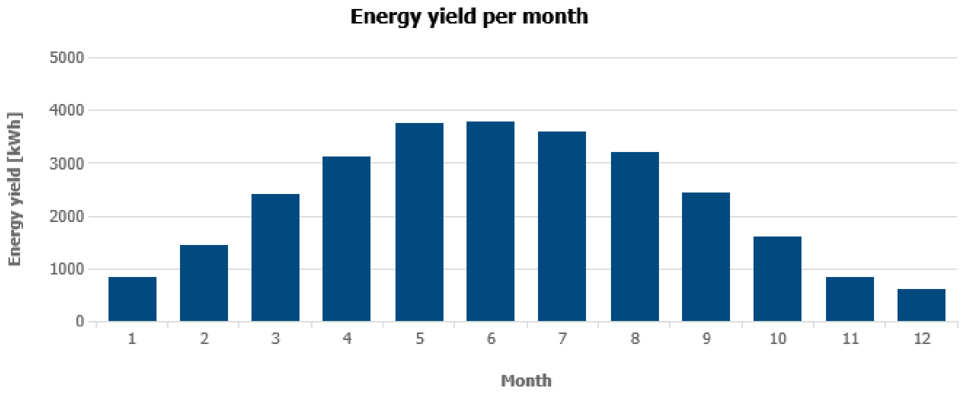
- Roof mounted (theatre), panel area (m2): 210
- Orientation +55 deg (W/S-W) Inclination 30 deg
- Installed capacity (monocrystalline, kWp): 30
- Potential annual electricity output (kWh/yr): 27,450

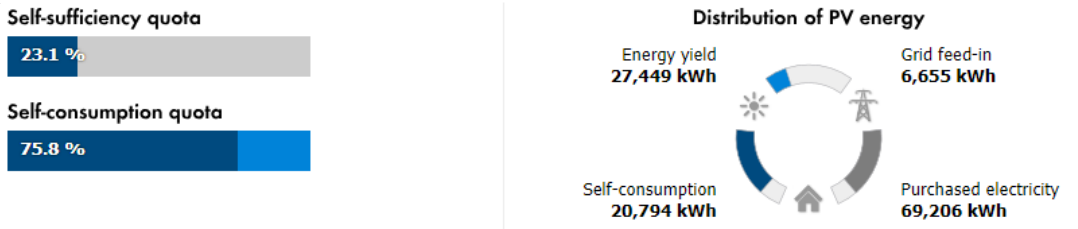
Lifecycle cost analysis:

- Capital cost (estimated based on €1.6/W installed): €48,000
- Electricity saving/revenue (at 17 cents/kWh): €4,526
- Simple payback period: 11 years
- Net Present Value: €33,350
- Internal Rate of Return: 9%
- Potential renewable energy penetration 31%

Potential electrical usage at the site:

Electricity consumption (kWh/yr)	Current (based on bills)	Estimated based on TM46
Bath house	0	56,595
Dance Hall	2,159	14,490
Pump House	3,488	6,300
Maiville House	0	12,600
Total	***5,647***	***89,985***





Hydropower Potential

Rivers at the site

Gowlaun River

Aille River

GeoHive OSI map with contours

Potential flow estimates provided by Dr. Henry Tiernan, NUIG (email of 7 March 2019)

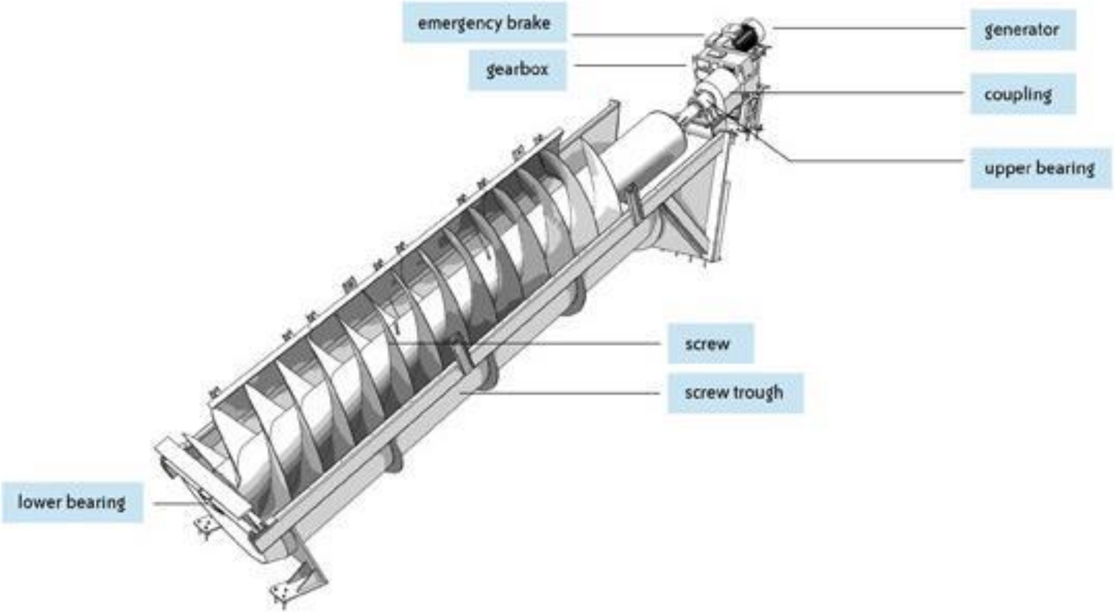
The 50%-ile flow is: 0.552 m^3/s (cumecs)

The 95%-ile flow is: 0.082 m^3/s

The 5%-ile flow is: 3.82 m^3/s

These estimates are based on a catchment area of 28.1km^2, with an average annual rainfall of 1479mm/yr.
Stream length is 23.4km, with a drainage density of 0.8 and a slope of 5.3%.

Screw turbines for low head hydropower projects



- Benefits include fish friendly, easier implementation, self-regulating to water flow change, low maintenance costs, low risk of clogging, efficient, long life.
- Key requirements: 1.5 m minimum head, access rights to water source, distance to grid connection < 500 m.
- Potential capacity (kW) = head (m) x flow (m3/s) x 7.2
- Capital cost range = €3,000 to €5,000 per kilowatt installed

Theoretical feasibility study

Specifications:

- Flow (50% percentile, estimated, m3/s) 0.552
- Head (assumed, m) 2
- Operational hours 4380
- Nominal capacity (kW) 8
- Potential annual electricity output (kWh) 34,800

Lifecycle cost analysis:

- Capital cost (estimated based on €5/W installed): €40,000
- Electricity generated revenue (at 13 cents/kWh): €4,526
- Simple payback period: 9 years
- Net Present Value: €33,800
- Internal Rate of Return: 10%
- Potential renewable energy penetration 40%

Potential electrical usage at the site:

Electricity consumption (kWh/yr)	Current (based on bills)	Estimated based on TM46
Bath house	0	56,595
Dance Hall	2,159	14,490
Pump House	3,488	6,300
Maiville House	0	12,600
Total	***5,647***	***89,985***

Key steps in hydroelectric project development

- Check with the local fisheries officer if rivers subject to migratory fish and other restrictions. Restrictions for migratory fish can make a hydropower project unviable
- Survey rivers for flow and head (more info). The higher the head, the lower the cost per kW of power installed and the easiest to develop from a fisheries point of view
- Investigate environmental impact of the proposed project and check requirement for Environmental Impact Assessment with local authorities
- Investigate the options for connecting to the electricity grid
- Conduct technical and financial feasibility study, considering revenue models from the electricity generated
- Conduct permitting process as required (fisheries, planning, grid connection) in parallel with stakeholders' consultation
- Detailed design and engineering of hydropower plant and associated civil works

Pavilion

Walk through audit

RE potential

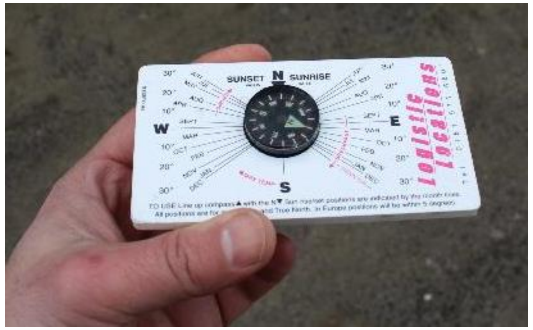
Solar PV preliminary feasibility study

Potential for renewables

- Heating demand:
  - Kerosene usage = 3150 litres (2018) = 32,571 kWh/yr
  - Intermittent space heating (2-3 hours for the hall, mostly for evening use) and intensive.
  - Substantial domestic hot water (DHW) demand in summer in particular.
- Substitution of existing oil boiler with renewable heating (e.g. wood boiler or heat pump) would be economical (high capacity estimated @ 130 kW, low operating hours estimated < 1000 hours).
- DHW demand profile suitable for solar energy application.
- Roof area with suitable orientation too far and difficult access for solar water heating.
- Solar PV deemed preferable renewable application, using DHW tanks as energy store in conjunction with electricity self-consumption.
- Potential south facing roof area on pavilion = circa 250 m2

Solar PV Potential

Preliminary feasibility study



Specifications:

- Roof mounted (theatre), panel area (m2): 245
- Orientation +55 deg (W/S-W) Inclination 35 deg
- Installed capacity (monocrystalline, kWp): 35
- Potential annual electricity output (kWh/yr): 34,560
- Selfconsumption for electricity (kWh/yr) 7,060 (valued @ 17 cents/kWh)
- Selfconsumption for DHW (kWh/yr) 27,500 (valued @ 11 cents/kWh, based on kerosene @ 9 cents/kWh & 85% efficiency)

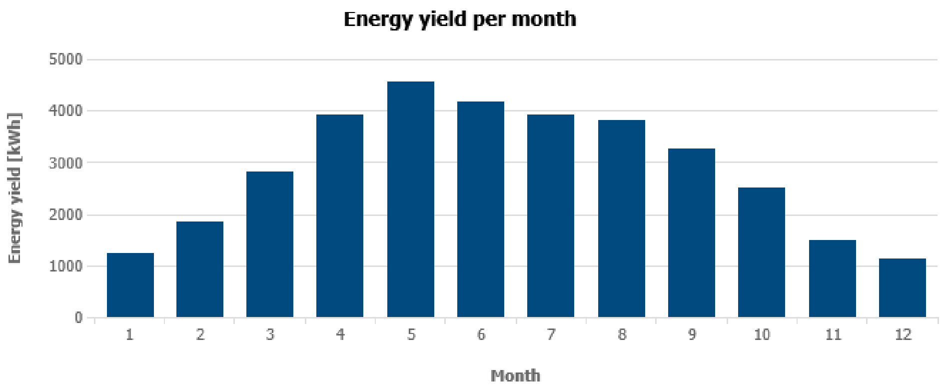
Potential electrical usage at the site:

Electricity = 15,840 kWh/yr

DHW heating requirement = 25,830 kWh/yr

Lifecycle cost analysis:

- Capital cost (estimated based on €1.6/W installed): €56,000
- Electricity saving/revenue (at 17 cents/kWh): €5,430
- Simple payback period: 10 years
- Net Present Value: €45,000
- Internal Rate of Return: 10%
- Potential renewable energy penetration 88% (electricity + DHW heating)



Summary & Action Plan

Register of energy efficiency and renewable energy opportunities

Funding opportunities

Overall action plan

Register of Opportunities

Site/Measures	Thermal energy saved (kWh/yr)	Electricity Saved/generated (kWh)	CO2 avoided (kgCO2/yr)	Capital Cost (euro)	Savings (euro/yr)	Simple Payback (years)
Creche						
Attic insulation		4,929	2,016	3,670	657	5.6
Airtightness		1,000	409	1,500	133	11.3
Retrofit solar water heating system & controls		2,280	933	2,200	304	7.2
Replace air source heat pumps & overall controls		16,148	6,604	13,908	2,151	6.5
Small-scale wind system		16,000	6,544	30,000	2,080	14.4
Pavilion						
Solar PV system		34,577	10,317	56,000	5,431	10.3
Spa Wells						
Wood Heating System	120,828		31,053	67,554	9,046	7.5
Solar PV system		27,450	8,505	48,000	4,404	10.9
Hydropower Plant		34,816	14,240	39,744	4,526	8.8
Total across sites	***120,828***	***137,200***	***80,620***	***262,575***	***28,732***	***9.1***

All costs & revenues mentioned in the following financial analyses are inclusive of VAT
Potential grants are not included in capital cost estimates

Planning & EIA requirements

Planning requirements for the following proposed solutions:

- **Small Scale Wind at the sports grounds:**
  A planning exemption applies to small scale wind turbines with a mast height of 10 m and a rotor diameter of 6 m (1kw - 10kw). ***We recommend a mast height above 20 m for better efficiency***
- **Solar PV on the pavilion & dance hall:**
  A planning exemptions applies to Solar PV systems installed on non-residential buildings if panel area is under 50 sq. m (and representing less than 50% of the total roof area). ***Proposed systems are significantly over that limit***
- **Wood heating system:**
  Planning is likely to be required for the construction of the wood heating plant (including plant room, wood chip storage silo, etc.) considering access for fuel deliveries, potential noise and air/water emissions
- ***Hydropower plant:***
  Planning is likely to be required for the proposed hydropower plant

An EIA is possibly required for the following proposed solutions:

- ***The hydropower plant at the Spa Wells***
  Estimated cost of EIA studies to be confirmed following an initial screening. See Central Fisheries guidelines for small hydropower projects

SEAI Community Energy Grant 2019

By bringing together groups of buildings under the same retrofit programme, communities projects **facilitate community-wide energy improvements** more **efficiently and cost effectively** than might otherwise be possible.

Types of projects funded:

- Community benefits
- Mix of solutions
- A clear road map
- Innovation
- Project ambition
- Justified energy savings
- An ability to deliver the project

Funding levels (up to):

- Residential:
  - Private, fuel poor: 80%
  - Private, non-fuel poor: 35%
  - Local authority: 35%
  - Housing association: 50%
  - Deep retrofit (A3): +15%
- Non-Residential:
  - Not-for-profit/community: 50%
  - Public/Private: 30%
  - Public exemplar: 50%

To Find out more: call 1850 927 000 and check https://www.seai.ie/grants/community-grants/

SEAI Accelerated Capital Allowance Scheme

- The ACA is a tax incentive aimed at companies paying corporation tax, sole-traders and non-corporates. The scheme allows them to write off 100% of the purchase value of qualifying energy efficient equipment against their profit in the first year of purpose
- Solar PV, wood heating systems, heat pumps can qualify for the scheme provided the equipment is registered on the Triple E Register

To find out more: https://www.seai.ie/energy-in-business/accelerated-capital-allowance/

Next steps for creche & pavilion projects

- Design and detailed specification of upgrade works, prepare tendering package, including supply & installation with provisions for future repair & maintenance
- Check with local authority for planning permissions requirements and apply accordingly
- Competitive tender to trusted specialist contractors, with a proven ability to provide repair and maintenance services
- Secure funding for the project & manage administrative requirements
- No planning permission requirement anticipated
- Proceed with works, with appropriate inspection and commissioning procedures
- Ensure proper installation handover, with full documentation pack (datasheets, manuals, warranties, etc.) and user training
- Conduct/contract regular maintenance operations

The steps above, from start to commissioning of the proposed projects, can be undertaken within a one-year period. Timing of works should consider the requirements of funding programmes and associated deadlines for application and works completion

A similar approach applies to the Spa Wells proposed renewable energy projects, to be implemented as part of the overall site regeneration

For more information

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