Ducannon Fort – Sustainability Strategy

Final Report

Date	Report Revision	IN2 Project Ref.
14.07.2023	Rev04	G2303

Prepared for

URBAN SCALE INTERVENTIONS

Document Control

Date of issue 09.08.2023

Compiled by CC

Authorised by GP

File name G2303 Duncannon Fort - Final Report

Report History

01/06/2023 – REV01 – Preliminary Report

06/07/2023 – REV02 – Preliminary Report

14/07/2023 – REV03 – Final Report

09/08/2023 – REV04 – Final Report

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1. Executive Summary

This document serves as guidance for the Urban Scale Interventions team to carry out a site inspection and provide the IN2 Sustainability team with the required information and documentation to carry out the sustainability.

The scope will be framed around the 2030 and 2050 goals and the study should cover the following points:

- **Energy Feasibility Analysis:**
  - Identify site energy profiles.
  - Available energy networks & sources.
  - Potential for decarbonization & renewables.
- **Sustainability Analysis:**
  - Natural existing habitat and restoration potential.
  - Site connectivity.
- **The report will conclude with a summary in SWOT table format:**
  - Strengths
  - Weaknesses
  - Opportunities
  - Threats

Coordination

2. Design coordination

For the purpose of coherence and coordination, the naming convention utilised for this analysis will be based on that described by Urban Scale Impact in their document *DCF-USI-PP-AR-0002-A.Duncannon Fort - Building & Structure Key & Initial Analysis*.

See image below for clarity.

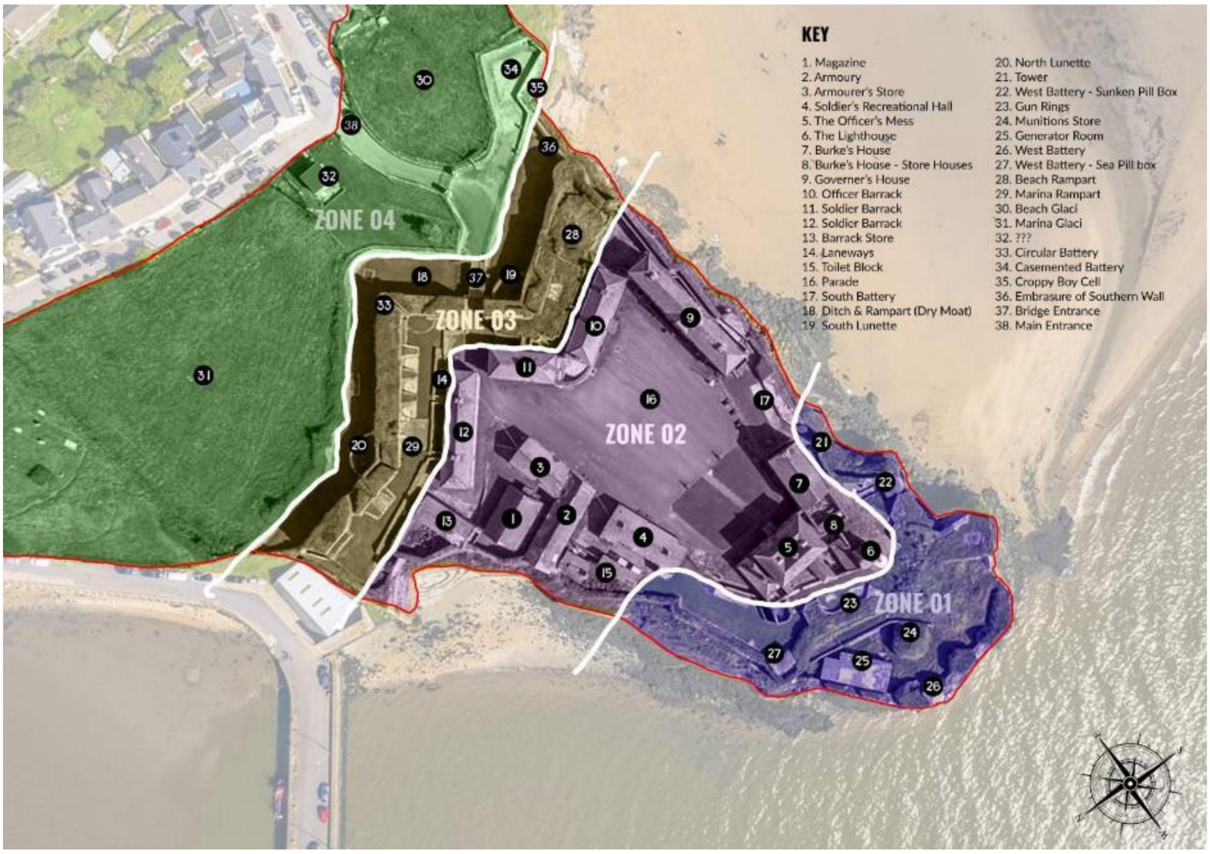

Figure 1. Coordinated naming convention and site zoning.

Energy Strategy Opportunities

3. Energy feasibility

The EU Commission has set its course towards a carbon neutral Europe by encouraging its constituent member states to define their approach to a NetZero economy. This accompanied by the EU Taxonomy tool. Renovation of existing buildings (europa.eu)

As such, the Republic of Ireland responded with their Climate Action Plan 2023 (yearly iteration). This plan sets down the objectives of 2030 and 2050. Hence, halving the countries current carbon emissions by the end of this decade and becoming carbon neutral by 2050.

The plan includes the intent to supply the electricity grid with at least 80% renewable sources by 2030. Furthermore, all new dwellings shall be Nearly Zero Energy Buildings (NZEB) by 2025 and Net Zero Emission Buildings by 2050. However, heritage buildings are not obligated to abide by the 2030 or 2050 defined thresholds. See extract of the local building regulation below.

> **0.6 APPLICATION TO BUILDINGS OF ARCHITECTURAL OR HISTORICAL INTEREST**
>
> **0.6.1** Part L does not apply to works (including extensions) to an existing building which is a "protected structure" or a 'proposed protected structure" within the meaning of the Planning and Development Act 2000 (No. 30 of 2000).

Figure 2. Extract from ROI energy performance building regulations, Part-L.

To ensure a coordinated transition towards a Net Zero Emissions future, the approach shall always address energy consumption the following order:

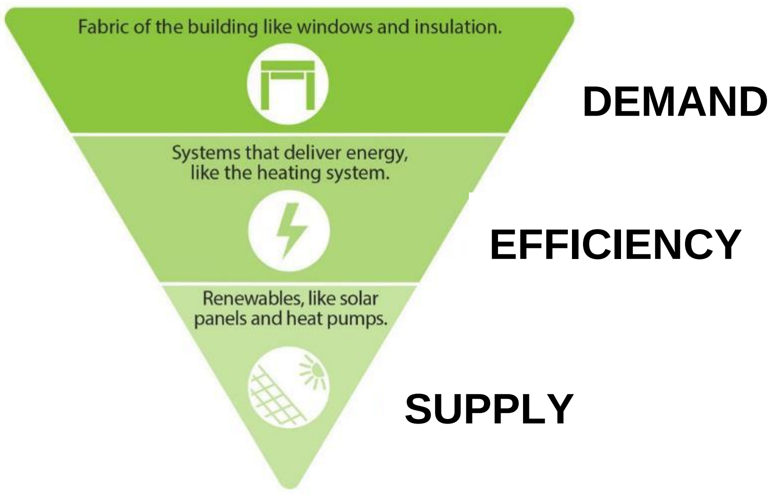

Figure 3. Energy efficiency best practice approach (Lean, Clean, Green).

Demand would address the needs the building has to meet its users comfort requirements. These are typically the following: light, temperature, and fresh air.

Efficiency would refer to the techniques and technologies put in place to meet the abovementioned demands. For example, heating via heat-pumps and underfloor heating system; lighting with a maximised natural lighting strategy; or ventilation, when possible, via natural ventilation.

Supply refers to the energy source that will be feeding techniques and technologies put in place to meet the demands. Some examples could be, PV solar panels or other renewable energy sources.

3.1 Site energy profiles

3.1.1 Current site energy profile

Current site's energy needs have not been assessed due to lack of evidence. Therefore, only recommendations can be provided for the improvement of existing building conditions. The recommendations have been defined under 3.1.3.

3.1.2 Improving Energy Performance of Historic sites

Traditional buildings are constructed from different materials and in different structural forms compared with modern buildings and perform differently. So, they need a special approach because traditional forms of building construction take up moisture from their surroundings and release it depending on environmental conditions. They usually heat up and cool down more slowly and changes if not correctly undertaken, can lead to problems of overheating, moulds, and ill health.

To tackle these challenges, it is recommended to adopt the whole building approach which is an understanding the building in its context to find balanced solutions to save energy, sustain heritage, and maintain a comfortable and healthy indoor environment.

The goal of retrofitting historical buildings is to achieve a responsible and balanced approach by combining three key impacts: energy and environment, building health, and heritage preservation. This approach takes into consideration both the benefits and costs associated with the retrofit process.

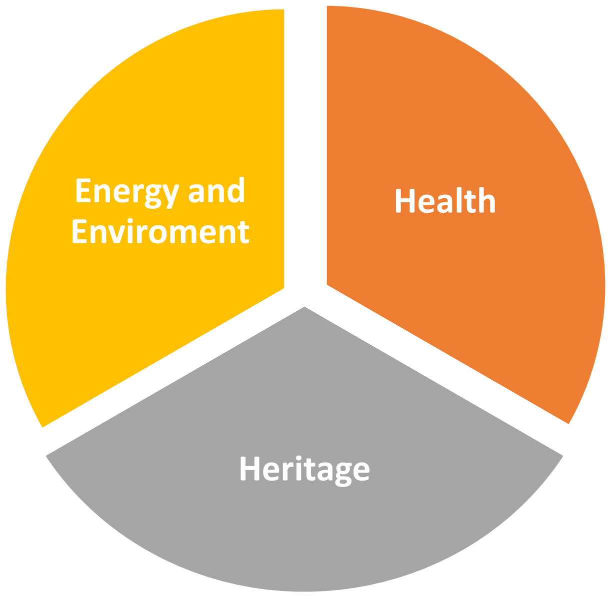

Figure 5. Key Impacts of Responsible Retrofit.

The whole building approach depends on continuously questioning what is required and why, and weather the goals are achievable and when planning for energy efficiency improvements using a whole building approach, several factors should be considered:

Context:

The current situation of the building and an assessment of the potential for improvements.

- Location/ orientation
- Form and condition
- Heritage/community

Fabric:

The design of the building envelope and the physical properties of the construction materials.

- Insulation (in exterior walls, roofs, storage areas and foundation walls). Insulation for walls can range from 0.27 W/m²K to 0.55 W/m²K and the target maximum values for insulating the floor can range from 0.15 W/m²K to 0.36 W/m²K.
- Windows (glazing and shutters should be noted) Maximum Window U value 2.8 W/m2K (and double glazed)

Services:

Assessments should identify fuel sources and the type, size, age, and condition of all the energy-consuming services and equipment. Furthermore, the way the engineering services are controlled and operated should also be reviewed and any defects that need to be rectified and opportunities for improvement should be highlighted.

- Heating / cooling
- Ventilation (Airtightness test must be carried out in buildings) and all new permanent ventilators should be tested to EN 13141-1.
- Renewable energy technologies
- Lighting (LED luminaires and lamps installed must be in accordance with local regulation)
- Hot water supply (The recommended temperature for hot water supply in domestic settings is typically around 55-60 degrees Celsius)
- Equipment and appliances

People:

- The number of people in the building
- The technical services and equipment they require (it will impact the energy consumption).

To implement practical energy efficiency improvements, it is suggested to refer to a checklist provided by Historic England.org, which offers a comprehensive overview, the LETI Retrofit Guide and the SEAI Retrofit Advisor's suggested values. However, it is important to acknowledge that the priorities may vary depending on the specific circumstances of each individual case.

3.1.3 Proposed refurbishment performance targets

All new developments must comply with the most ambitious energy efficiency standards, ensuring NZEB performance by 2030 and net zero by 2050. Heritage buildings on the other hand are not bound by these requirements. Nevertheless, it is recommended that their Energy Use Intensity (EUI) be minimised as much as possible. A recommended target performance for building retrofits with constraints is a EUI of **<60kWh/m2·year** (based on LETI Retrofit Guide). Heritage buildings are classed as constrained retrofit developments under the LETI guidance. To achieve this target the following design criteria shall be used for all proposed retrofit projects:

Building element	Retrofit actions	LETI best practice: Constrained retrofit	LETI best practice: Unconstrained retrofit (Cool Temperate Climate)	LETI best practice: Unconstrained retrofit (Cold Climate)	LETI exemplar: All retrofit types
Walls					
Cavity	External, cavity or Internal insulation[1]	0.24 W/m².K	0.18 W/m².K	0.12 W/m².K	0.15 W/m².K
Solid Uninsulated	External or Internal insulation[1]	0.32 W/m².K	0.18 W/m².K	0.12 W/m².K	0.15 W/m².K
Timber Frame	External or Internal insulation[1]	0.21 W/m².K	0.18 W/m².K	0.12 W/m².K	0.15 W/m².K
Roofs					
Cold	Insulate	0.12 W/m².K	0.12 W/m².K	0.10 W/m².K	0.12 W/m².K
Warm / Flat	Insulate	0.22 W/m².K	0.12 W/m².K	0.12 W/m².K	0.12 W/m².K
Floors					
Suspended Timber	Insulate between joists	0.20 W/m².K	0.18 W/m².K	0.12 W/m².K	0.15 W/m².K
Solid Uninsulated	Excavate and insulate below	0.80 W/m².K	0.15 W/m².K	0.10 W/m².K	0.15 W/m².K
Windows and doors					
Windows	Improve/replace	1.30 W/m².K	1.00 W/m².K	0.80 W/m².K	0.80 W/m².K
Doors	Replace	1.00 W/m².K	0.80 W/m².K	0.80 W/m².K	0.80 W/m².K
General envelope					
Thermal Bridging	Mitigate where possible	0.10 W/m.K	0.10 W/m.K	0.10 W/m.K	0.08 W/m.K
Airtightness	Draught-proofing, sealing of chimneys and vents	3.0 ach@50Pa	2.0 ach@50Pa	2.0 ach@50Pa	1.0 ach@50Pa

1 - Where internal wall insulation is used, there could be a significant risk of interstitial condensation. To minimise this risk, the post-retrofit U-value should be no better (lower) than those shown for constrained retrofits above. Furthermore, in areas where insulation can not fully cover the original wall, the approaching insulation should be tapered or reduced. See Annexes C and H for more information.

Figure 4. Extract from the LETI retrofit design criteria for the building envelope.

		LETI best practice			LETI exemplar
Building element	**Retrofit actions**	**Constrained retrofit**	**Unconstrained retrofit** (Cool Temperate Climate)	**Unconstrained retrofit** (Cold Climate)	**All retrofit types**
Systems					
Systems and appliances	Fossil fuel free home	Fossil fuel free	Fossil fuel free	Fossil fuel free	Fossil fuel free
Ventilation Type	Install upgraded ventilation system	MVHR[2]	MVHR	MVHR	MVHR
Lighting Power	Replace lamps and fittings	50 lm/W	100 lm/W	100 lm/W	100 lm/W
Hot water					
Hot Water Tank	Increase or replace insulation	1.5 W/K	1.5 W/K	1.5 W/K	1.5 W/K
Primary Pipework	Insulate all pipework	90% of pipework insulated	90% of pipework insulated	90% of pipework insulated	90% of pipework insulated
Shower Demands	Low flow fittings	16 litres/pers.day	16 litres/pers.day	16 litres/pers.day	16 litres/pers.day
Other Demands	Low flow fittings	9 litres/pers.day	9 litres/pers.day	9 litres/pers.day	9 litres/pers.day
Renewables					
Photovoltaic Generation[3]	Rooftop installation	0 % of roof area covered in PV panels	40 % of roof area covered in PV panels[4]	40 % of roof area covered in PV panels[4]	40 % of roof area covered in PV panels[4]

2 - If not possible use demand control dMEV or demand control cMEV. Refer to Annex D.

3 - Our modelling has assumed that the vast majority of homes will be fitted with a heat pump. A heat pump will realise more hot water from a PV system than a solar thermal system, given the same amount of solar radiation (due to the effect of the heat pump's COP). Furthermore, once the hot water tank has reached its target temperature, the solar thermal panels are doing nothing. In contrast, PV can power other things and also feed back into the grid (if you do not need the power). Thus, we have focused on PV. If, however, a heat pump is not installed and roof mounted panels are considered, solar thermal is a more efficient way of generating hot water and can typically provide up to 50% of a home's hot water demand.

4 - Maximise renewables where conditions are suitable to support solar generation – i.e. unshaded roofs (flat/pitched south, east, or west facing)

Figure 5. Extract from the LETI retrofit design criteria for building services.

According to the proposed retrofit performance targets, the new site would be expected to consume the following:

Energy Use Consumption Proposed					
Nº	**Name**	**Surface area (m2)**	**Proposed use**	**New Dev. EUI (kWh/m2·year)**	**New Dev. Energy Use (kWh/year)**
1	Magazine	70	Museum	60	4200
2	Armoury	128	Hostel Accommodation	60	7680
3	Armourer's Store	67	Office (tourist info center)	60	4020
4	Soldier's Recreational Hall	138	Community Space	60	8280
5	The Officer's Mess	272	Café/Restaurant	60	16320
6	The Lighthouse	0	NA	60	**0**
7	Burke's House	166	Restaurant + mirador	60	**9960**
8	Burke's House - Store Houses	92	NA	60	**5520**
9	Governer's House	388	Museum	60	**23280**
10	Officer Barracks	226	1/2Retail GF + 1/2Residential 1st Floor	60	**13560**
11	Soldier's Barracks 1	128	1/2Retail GF + 1/2Residential 1st Floor	60	**7680**
12	Soldier's Barracks 2	238	1/2Retail GF + 1/2Residential 1st Floor	60	**14280**
13	Barrack Store	102	Residential	60	**6120**
15	Toilet Block	23	WC	60	**1380**
Total		**2,038**			**122,280 kWh/year**

Figure 6. Proposed refurbishment's new energy use intensities.

Based on the proposed energy use targets for retrofit building projects, the site would be expected to consume an estimated **122.3MWh per year**.

This path would certainly ease the road to decarbonisation through the right type of passive and technological solutions.

Note, the proposed Energy Use intensity is very ambitious for a heritage site like the Fort. An in-depth, case by case approach is strongly recommended to better assess each building's energy performance potential.

3.2 Decarbonization & Renewables

3.2.1 Site decarbonisation

According to the local authorities the site is only connected to the electricity network and currently has no access to other sources of energy via an established infrastructure.

Given the lack of external units, this leads us to believe the site is either not heated or heated by direct electric radiators. This solution is cost effective for spaces with low use. However, as the objective of this Masterplan is to reinvigorate the Duncannon Fort site by increasing use and visitors, these services solutions are obsolete and draining to the power grid.

The increased need in heating (potentially for cooling) should be addressed via the appropriate wholistic and carbon free solution. It is recommended that a Heat-Pump Solution be addressed for this project to ensure meeting the site's thermal requirements.

Heat-pumps may be of multiple sorts:

Air-Source Heat-pump – potential for the site and most used solution.

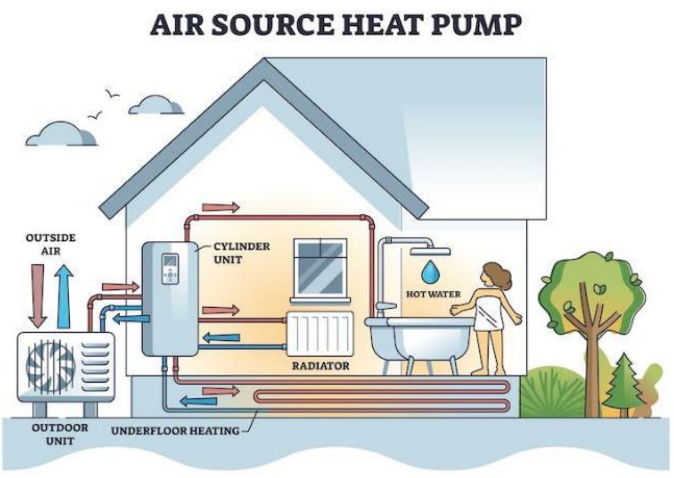

Figure 7. Illustration of an air source heat-pump.

Water-Source Heat-pump: optimal for the site as the water source is directly next to the site. The area is rich in natural heritage and spectacular landscapes, situated directly adjacent to the River Barrow and River Nore Special Area of Conservation.

Given the protected nature of the waterfront, this approach is likely to require higher levels of planning authority permissions and/or stricter technical requirements. At this point, it is not possible to assess the level of difficulty. However, this is considered a relatively low impact measure once in place.

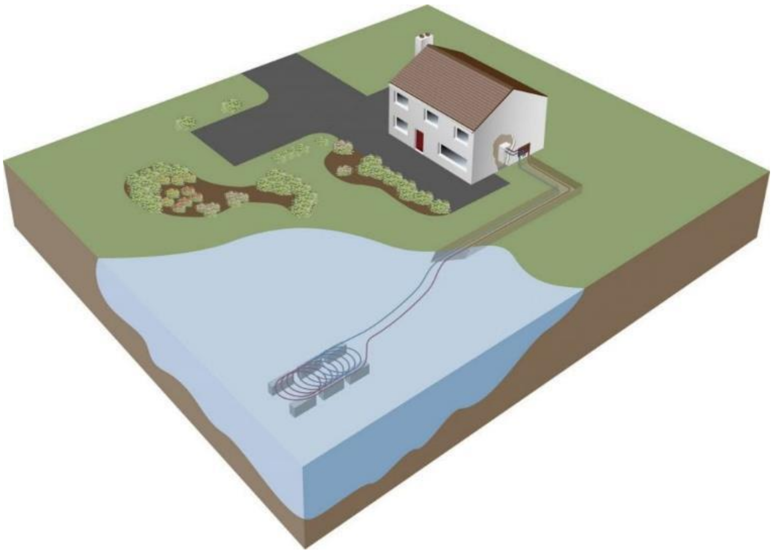

Figure 8. Illustration of a water sourced heat-pump.

Ground-Source Heat-pump: *discarded for this site as excavation and earthworks would be required.

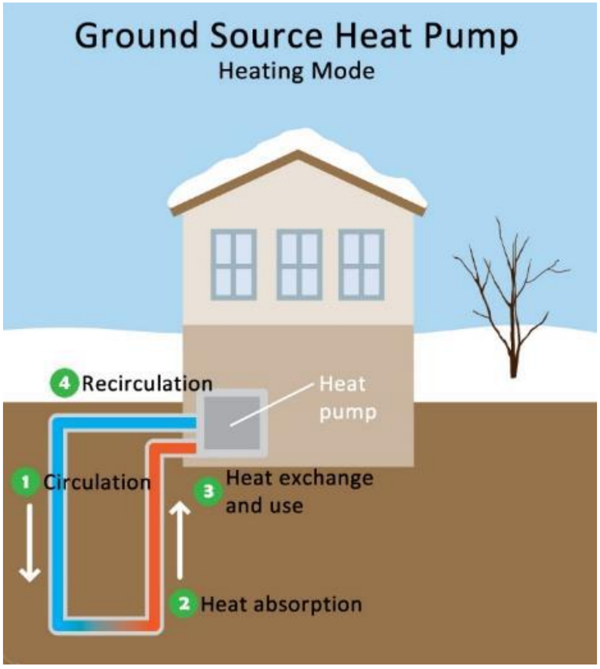

Figure 9. Illustration of ground source heat-pump

3.2.2 System Configuration Options

Tapping the energy from the estuary would allow the heat-pump to optimally run in winter and passively source cooling during the warmer season.

Two major system configurations options are available for the site:

- Centralised System
- Decentralised System

The centralised system solution would always be the preferred one as it allows for flexibility at the source of cooling/heating of the site. It would be possible, when the time comes and an alternative heating source is discovered to simply upgrade the existing unit, update certain equipment, or completely replace it without intervention on the rest of the site's thermal network.

This solution is the most suitable to a water source heat-pump as access to the estuary can be limited to a single external "unit" and located somewhere on-site next to the water source.

However, the biggest drawback of this solution is the need for excavation. These works must be carried out to lay down the main thermal distribution pipework on site at the risk of finding historical artifacts.

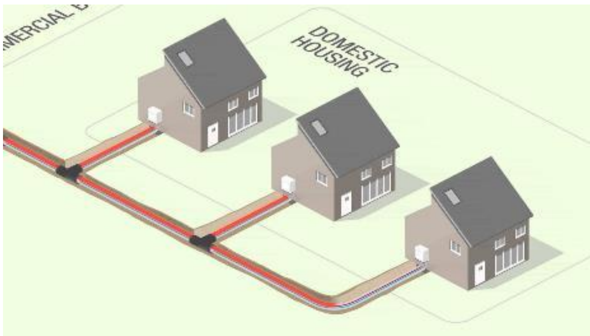

Figure 10. Illustrated trench solution for thermal distribution in centralised system.

Two options for the plant room have been identified:

- Option 1. The old generator room.
- Option 2. The current toilet facilities.

The old generator room, as shown on the image below offers the advantage of having sufficient floor area for the required technical equipment and is located directly next to the water. However, its location within the Duncannon Fort site also makes it difficult to introduce a thermal distribution network without major civil works.

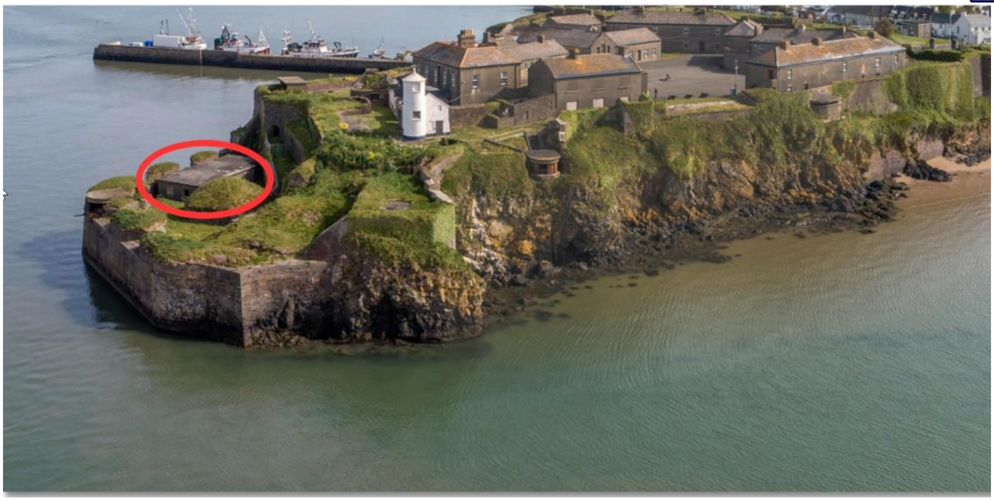

Figure 11. Proposed location of plant room in Generator room within site.

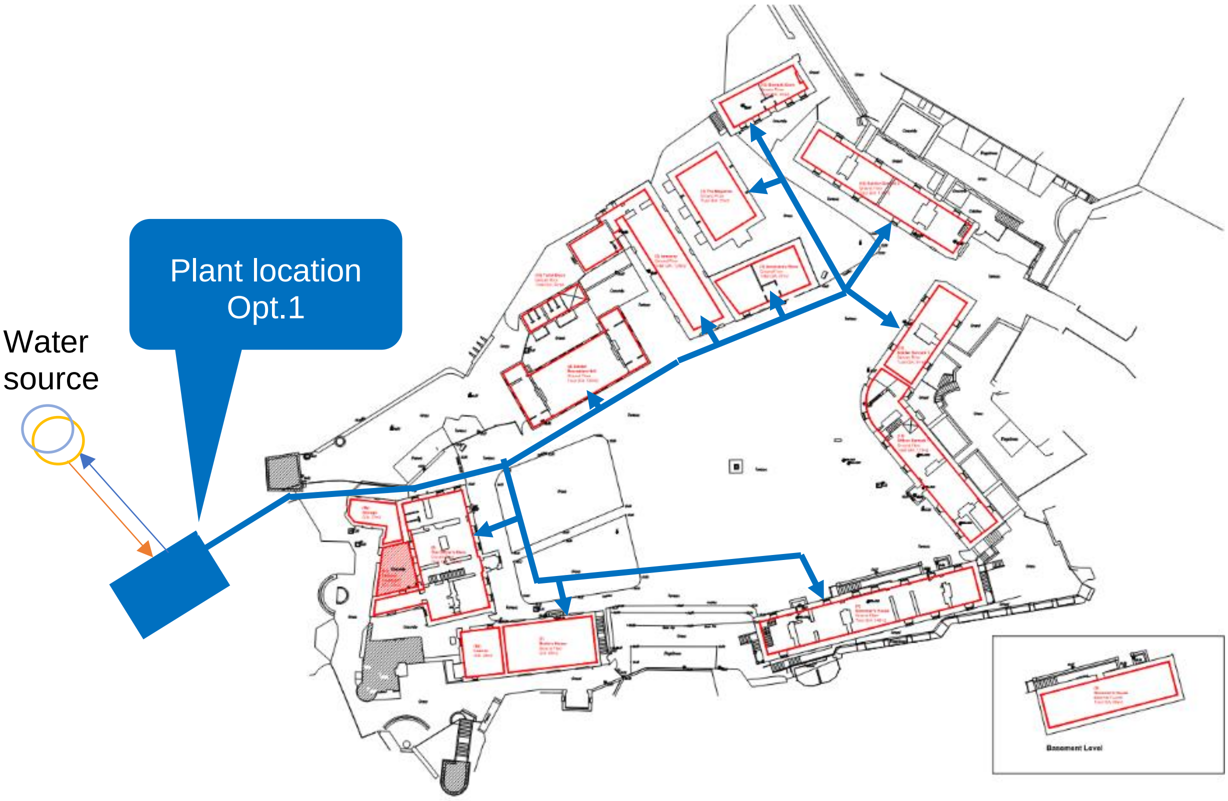

Figure 12. Layout of centralised system solution with proposed plant location as per USI recommendations.

The current toilet facilities would be in direct proximity to the buildings connected to the thermal energy network, hence reducing the need for excavation works in comparison to the previous option. The building is hidden from visitors' views and is in close proximity to the water. However, there is limited space for equipment.

Figure 13. Proposed location of plant room in current toilet facilities.

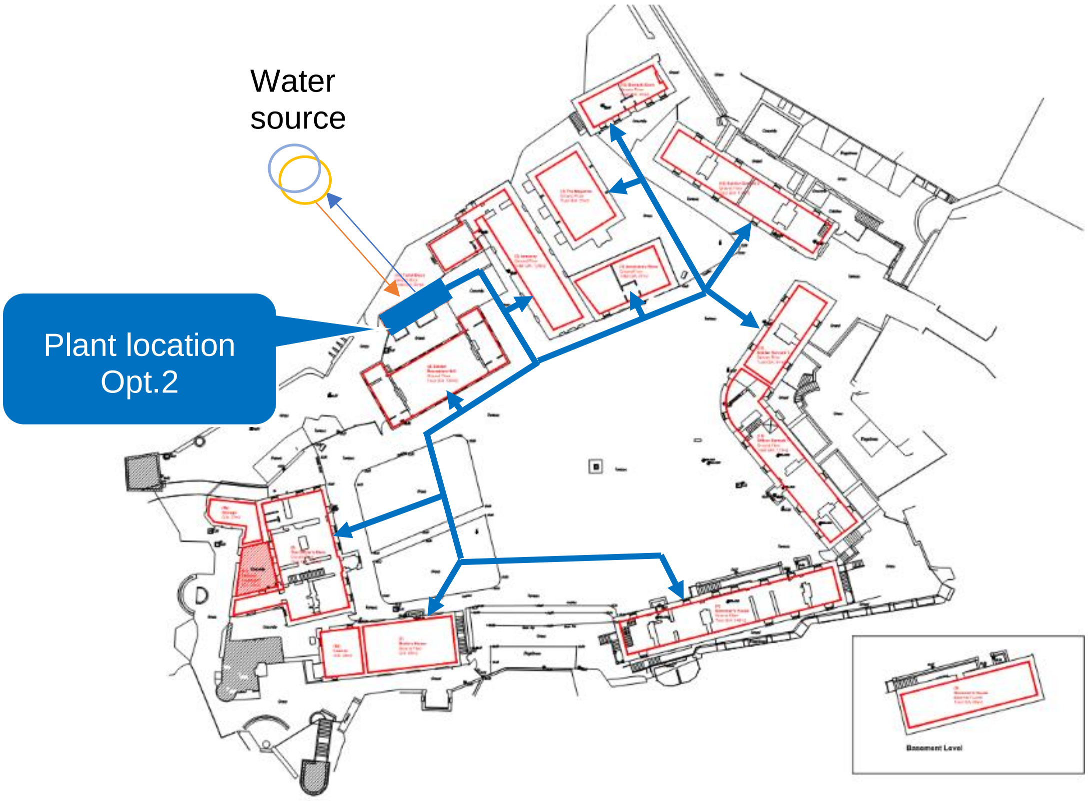

Figure 14. Layout of centralised system solution with proposed plant location as per USI recommendations.

It is estimated that for a site of this size and designed respecting the site's retrofit development guidelines, at least **50m²** of sheltered space shall be allocated to the plant room. The proposed toilet location may be too small on a single level but could be extended to 2 levels to accommodate full size equipment. The old generator room is likely to better accommodate the necessary equipment.

An air-source heat-pump would be louder and more visually impacting. The external units can be considerable in size.

The decentralized solution is that where each individual building supplies itself with its own thermal production source. For a sustainable solution this would be a set of air-source heat-pumps.

This approach would eliminate the need for digging on site and reduce the risk for project works stalling due to artifacts found during excavation. This solution would avoid the need to reach the water for a source of energy and would still have a good energy efficiency. Another advantage of this solution is the flexibility. Down time operation of one unit will only impact the affected building.

However, it would require a large number of units with numerous external units to be placed around the site with potential for considerable aesthetic impact.

Figure 15. Layout of decentralised solution for heating and cooling.

According to the preliminary assessment, only an electrical power supply is available to the site. This limits the options to electric solutions for thermal production.

3.2.3 Photovoltaic potential

The site is in one of the highest yield points in the Republic of Ireland for PV electricity production. An estimated potential of approximately 1000 kWh of electricity production per kWp of installed PV panels. See extract below of PV's potential yield.

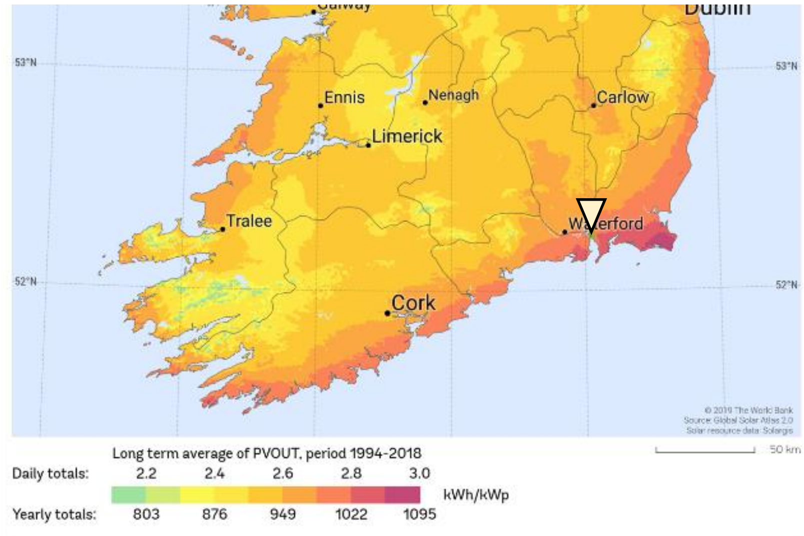

Figure 16. Extract form globalsolaratlas.info.

Based on the current site layout and available roof surface area, the Duncannon Fort has the potential to generate **78.3 MWh** of electricity a year through solar PV panel installations.

The overall estimated rooftop area available for PV installation has been considered to be around **660m²**. The areas were estimated based on the available site plan views of the site. The **185** number of PV panels was estimated assuming an arrangement factor of **0.8**. The orientation of each of the roof slopes implies a further reduction factor dependent on deviation from south facing.

Hence, actual available surface area may differ from reality, impacting the final result. These values are to be used as a potential rather than instruments for financial and economic project viability. To do so, a more detailed calculation should be carried out.

Figure 17. Potential of existing case scenario.

Nº	Name	Surface area m²	Nº of Panels	Orientation	PV Panel yield kWh/year	PV Shingle yield kWh/h
1	Magazine	57	16	SE	6888	2755
2	Armoury	82	23	W	6365	2546
3	Amourer's Store	49	14	SE	6027	2411
4	Soldier's Recreational Hall	70	20	W	5535	2214
7	Burke's House	53	15	S	8303	3321
9	Governer's House	101	28	S	15498	6199
10	Officer Barrack	75	21	SW	9041	3616
11	Soldier Barrack	47	13	SE	5597	2239
12	Soldier Barrack	88	25	SW	10763	4305
13	Barrack Store	38	10	SE	4305	1722
Total		660	185		78,320	31,328

Figure 18. Summary table of estimated potential PV installation on existing buildings.

This estimate is based on the following type of PV panels: Tiger Neo N-type 78HL4-BDV 605-625 Watt, by JinkoSolar.

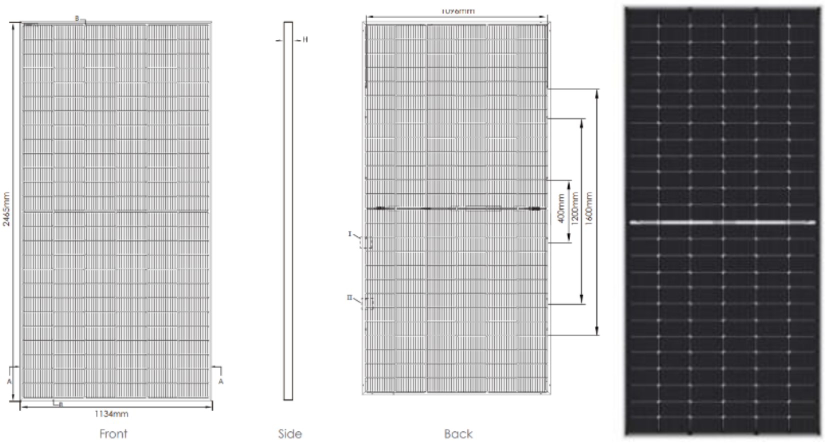

Figure 19. Dimensions of selected PV-panels.

Alternatively, the lesser energy performing solar PV solution, but also less aesthetically disrupting option would be that of the PV shingles or tiles. This solution would be 30 to 40% less efficient than the aforementioned PV panels.

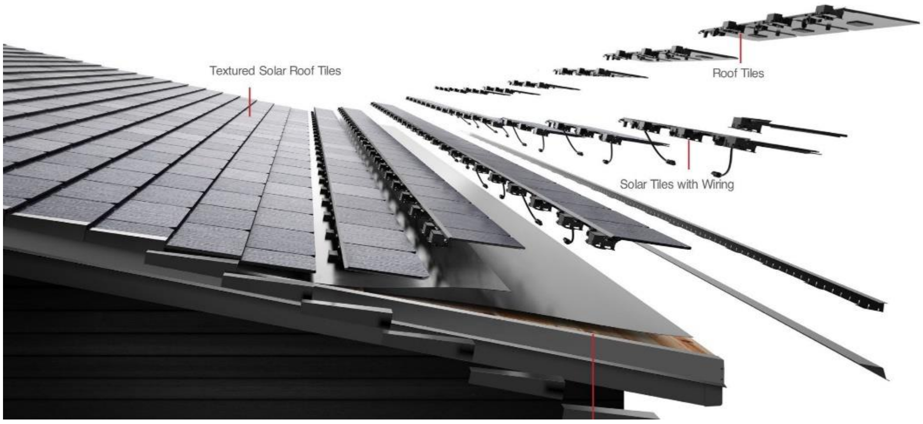

Figure 20. Tesla PV tiles solution example.

Other disadvantages to this this technology are the potential for maintenance, cost and local availability.

3.2.4 Wind potential

The potential for wind power capture in the area is high with a stable prevailing wind direction, particularly at 150m height installations. An estimated 1131W/m^2 of blade catchment area.

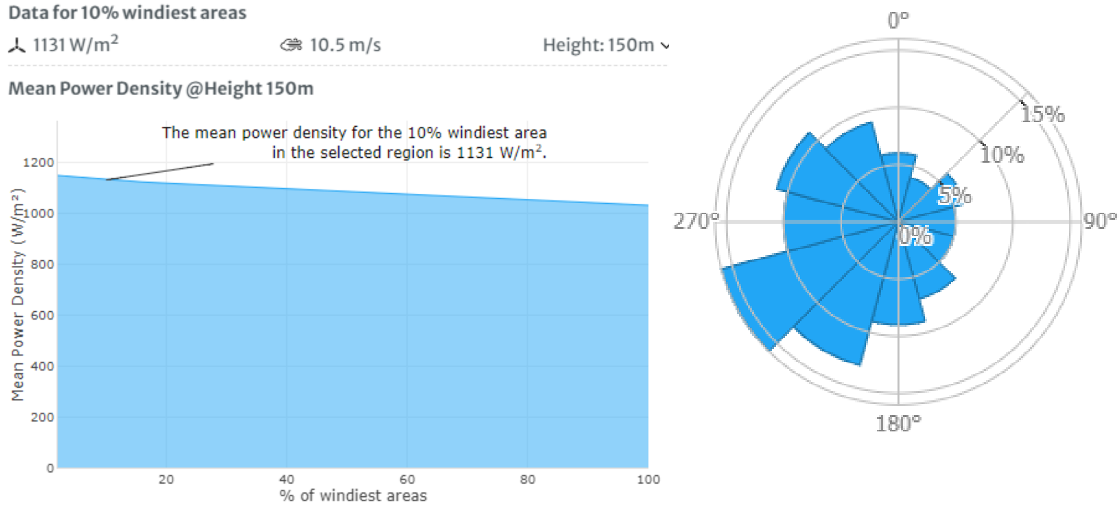

Figure 21. Power yield potential at 150m height installations.

However, given the nature of the project the installation of such aesthetically obtrusive element would not be considered feasible. A recommendation could be to relocate such power generation off-site, away from the Fort and support the locality's needs for electricity.

Alternatively, a lower height element solution could be envisaged with an indicative power yield at 10m of 428W/m^2 of blade catchment area.

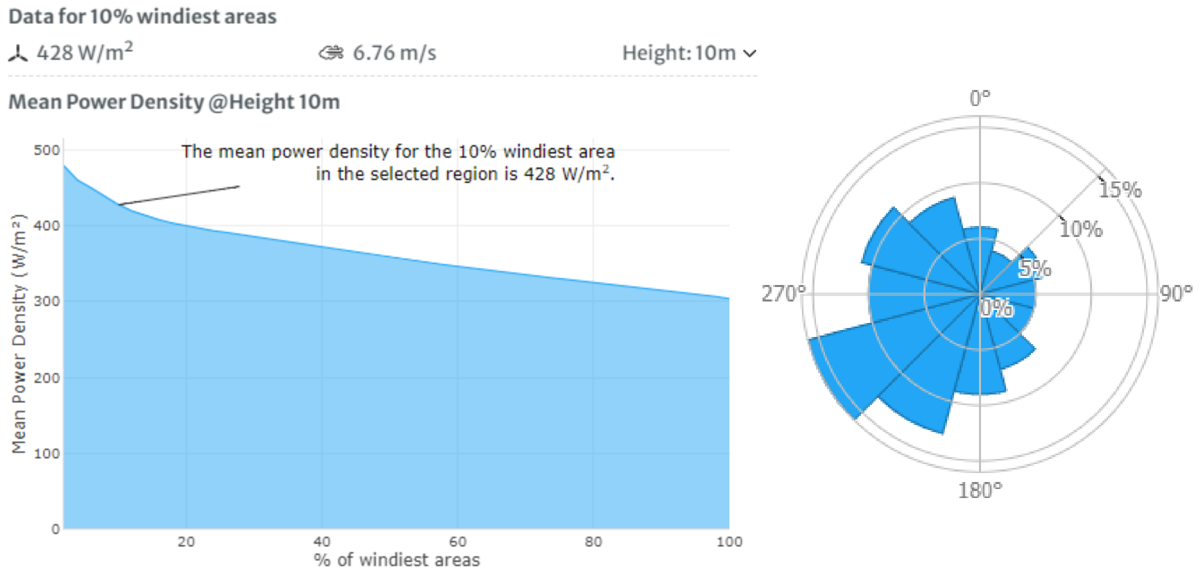

Figure 22. Potential power yield at 10m height.

Wind production remains the least preferable solution for renewable sources due to its aesthetics impact, acoustic nuance, and high investment cost.

Figure 23. Wind turbine in nature.

3.2.5 Other renewables

The potential for biomass, biogas or other renewable energy sources should be investigated during a more detailed analysis of the site. The site is surrounded by vast amounts of agricultural fields that could provide the necessary ingredients to develop such alternative solutions locally. Similarly, the nearby estuary could be a source of biomass such as algae or other types of water culture that would increase the space for habitat, provide food alternatives and heat the site.

Strengths
Weaknesses
Opportunities
Threats

5. SWOT

The redevelopment of the Fort presents an excellent opportunity for Duncannon to reanimate the town's commerce, attractivity and environmental agenda.

The following is a summary of critical points that will need to be taken into consideration for this process.

SWOT analysis of Duncannon Fort	
Strengths	**Weaknesses**
• Attractive heritage site • EU/local funding for sustainable development • Site location and beauty • Rehabilitation potential	• Heavy local motorised vehicle traffic • Limited intervention potential on heritage site • Limited of financing capability from local council
Opportunities	**Threats**
• Reducing energy profile of existing site • Increasing economic attractiveness of local community • Restoring natural habitat of locality • Reestablishing commercial and touristic links between local counties • Putting Duncannon Fort on the Map	• Dependence on large number of stakeholders (councils, communities, groups…) • Impact of refurbishment works on local community and natural habitat

IN2 Engineering

Unit E&F Mount Pleasant Business Centre

Ranelagh, Dublin D06 P5N8

+353 (0)1 496 0900 | info@in2.ie | www.in2.ie