GIA CHARTERED SURVEYORS

Potential of Solar Photovoltaic (PV) in Belfast Area for the Belfast City Council

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Introduction to Project

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Introduction to Project and Deliverables

Project Aim

- Assessment of Solar Insolation of 10 Properties expressed in kilowatt hours (potential electricity generation)

Deliverables

- Two solar assessment methodologies:
  - Standard Assessment Procedure (SAP) Solar Analysis
  - Climate Based Daylight Modelling (CBDM) Solar Analysis
- Scenario modelling based on:
  - Existing electricity consumption profiles
  - PV self-consumption
  - Export tariffs
  - Carbon displacement / reduction
  - Panel performance viability thresholds
- 3D Visualisation in VU.CITY
- GIS Files
- Summary Report

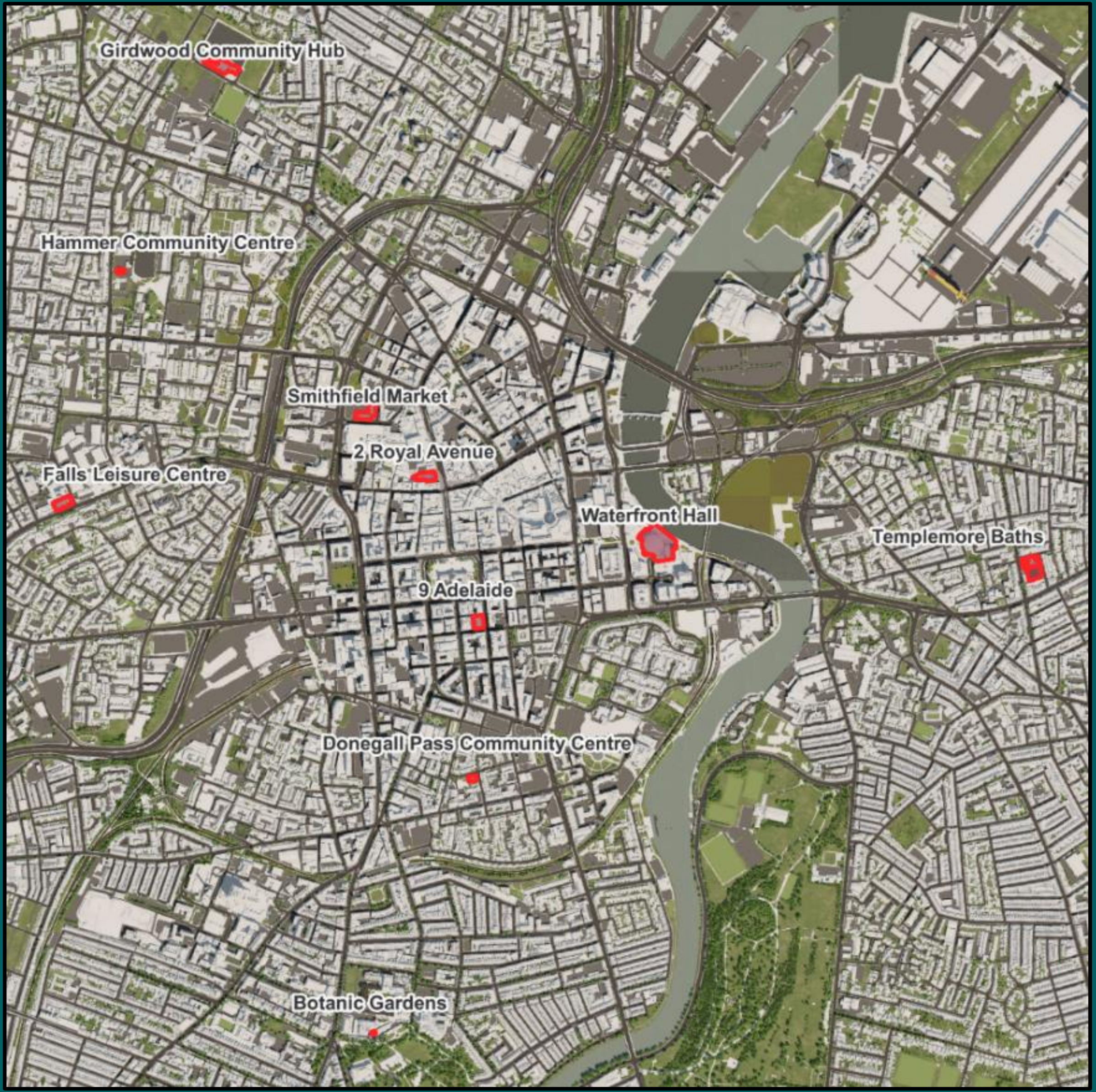

Figure 1: Map of Assessed Properties Locations

Context: Project Part of Shared Island Initiative

- Shared Island initiative involves working with NI Executive, British Government and Irish Government.
- Announced in the Republic of Ireland's Budget 2021,
- €500m in capital funding available between 2021-25.
- Ring-fenced for investment in collaborative North/South projects.
- Climate Action represents a core funding area.
- Research should inform the case for cross-border climate action partnerships.
- The initial PV scoping study will help inform a phase 2 application for capital funding to scale solar PV across Belfast (and Cork)
- Local Authorities to be seen as exemplars in making effective use of their rooftop real estate to reduce their energy costs and achieve local and national climate action targets.

Figure 2: Shared Island Initiative

What is Solar Photovoltaic (PV)?

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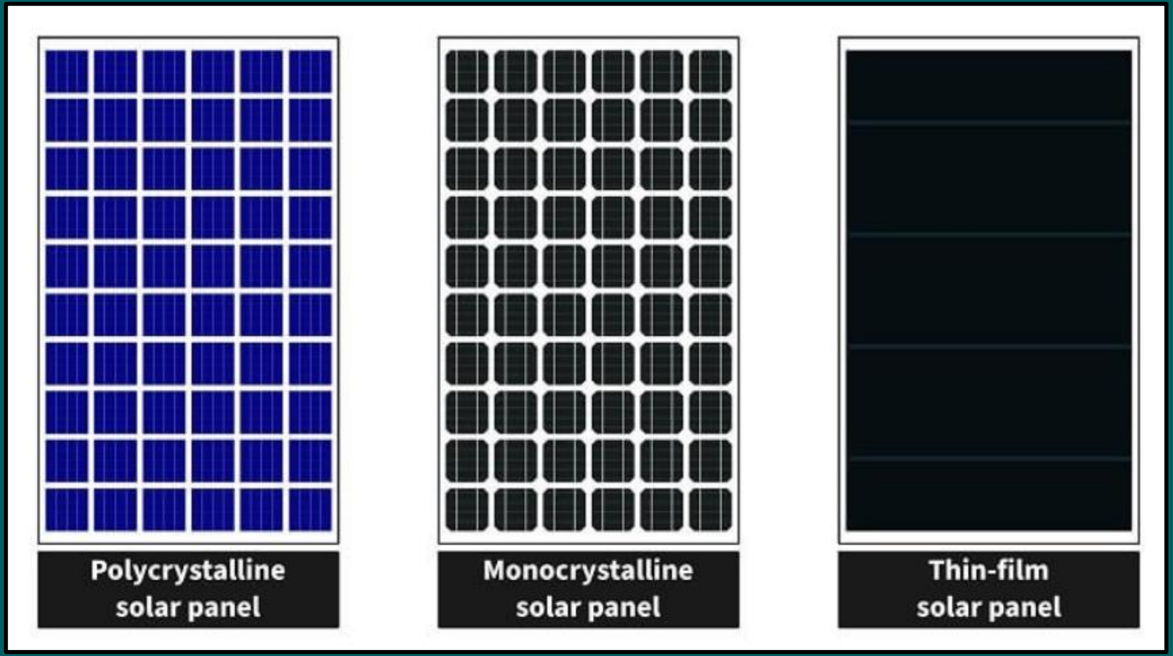
What is Solar Photovoltaic (PV)?

- Photovoltaic (PV) technology converts daylight directly into electricity.
- PV produces electricity as a result of interaction of sunlight with semi-conductor materials in the PV cells.
- It works best with direct sunshine, but also under a cloudy sky

Figure 3: Types of Solar Cells



Polycrystalline:
- Cheaper panel
- Less efficient

Monocrystalline:
- More expensive
- Most used
- Most efficient
- Our choice for testing

Thin-film:
- More adaptable to different surface geometry
- Expensive
- Less common

What is Solar Photovoltaic (PV)?

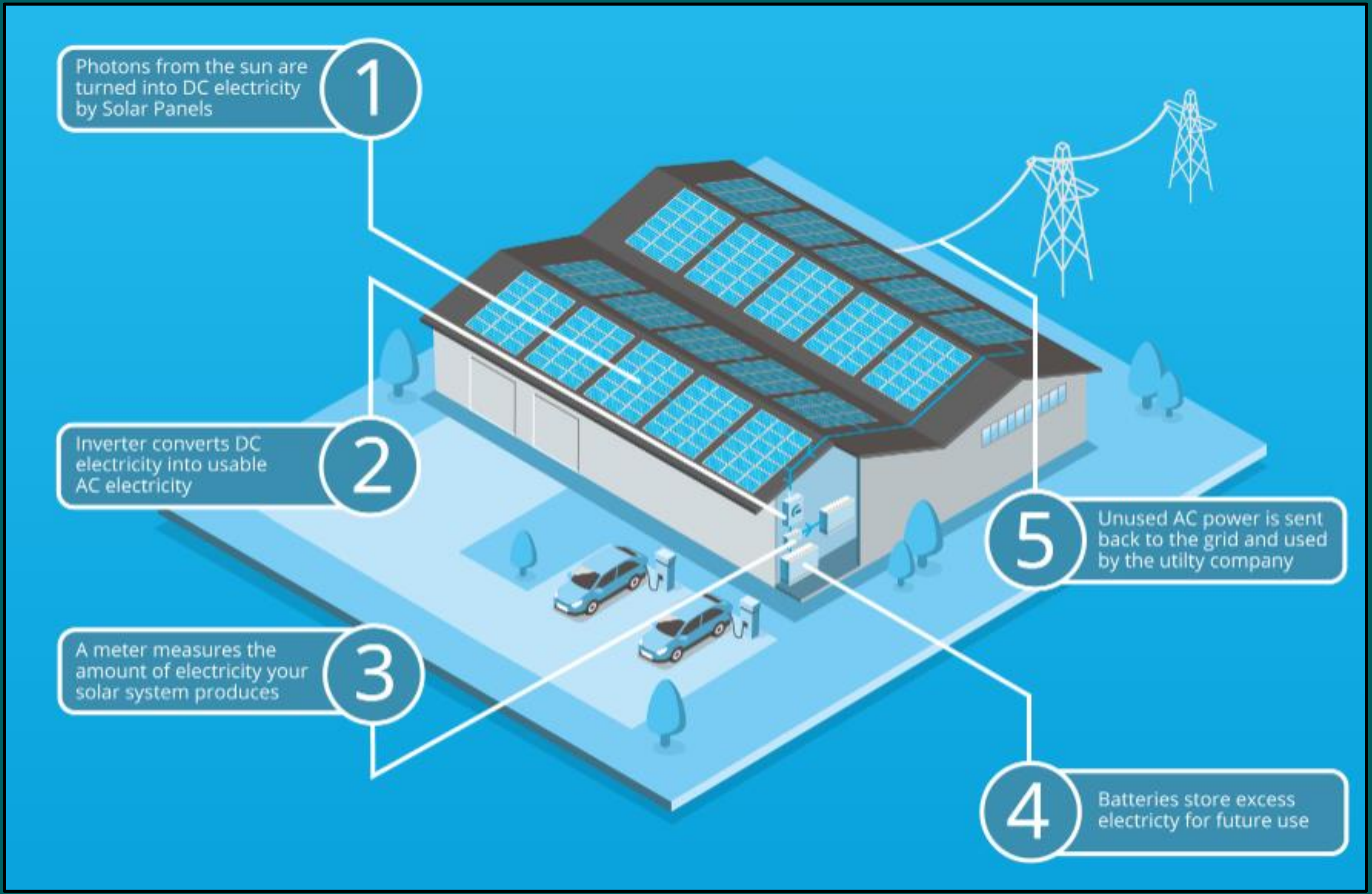


Figure 4: Solar PV System Components

Why is this project Important?

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Cost of Energy

- NI House Condition Survey (2018) estimated 160,000 households (22% of total NI households) were in fuel poverty
- Cost of energy is significant issue for NI's annual budgets
- Carbon emissions and carbon levy
- Solar PV can help tackle the issues

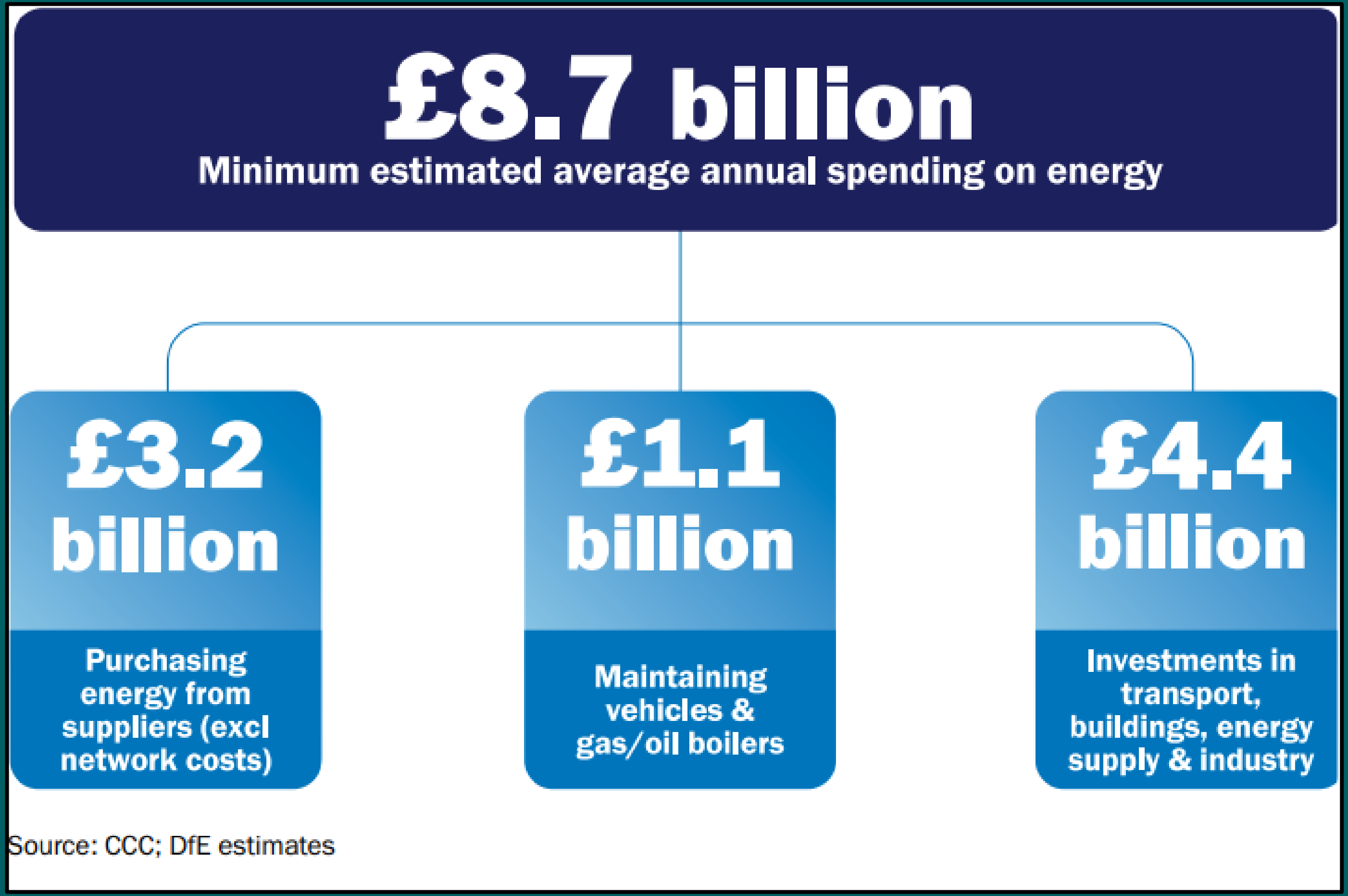
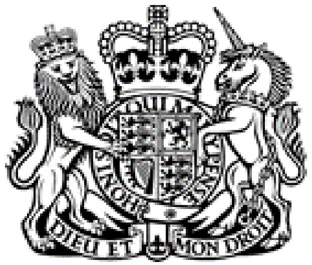


Figure 5: Cost of Energy in NI (DfE, 2021 – Path to Net Zero)

Legislation – The Climate Change Act (Northern Ireland) 2022



Climate Change Act (Northern Ireland) 2022

UK & NI Policy

Climate Change Act (2022) Northern Ireland

In June 2022 the Climate Change Act (Northern Ireland) received royal assent. The Act creates a target for net-zero greenhouse gas emissions by 2050, with bridging targets including at least a 48% reduction in net emissions by 2030.

The Act contains information about:

- Five-yearly Carbon Budgets
- Climate Action Plans
- Sectoral Plans
- Just Transition Commission
- Northern Ireland Climate Commissioner

Figure 6: Climate Act Summary

Legislative Targets:

- 100% reduction in net zero greenhouse gas (GHG) emissions by 2050.
- Interim target of at least 48% reduction by 2030.
- Article 15 of the Climate Change Act (Northern Ireland) 2022 sets the following target:

"The Department for the Economy must ensure that at least 80% of electricity consumption is from renewable sources by 2030…" (Climate Change Act (Northern Ireland) 2022).

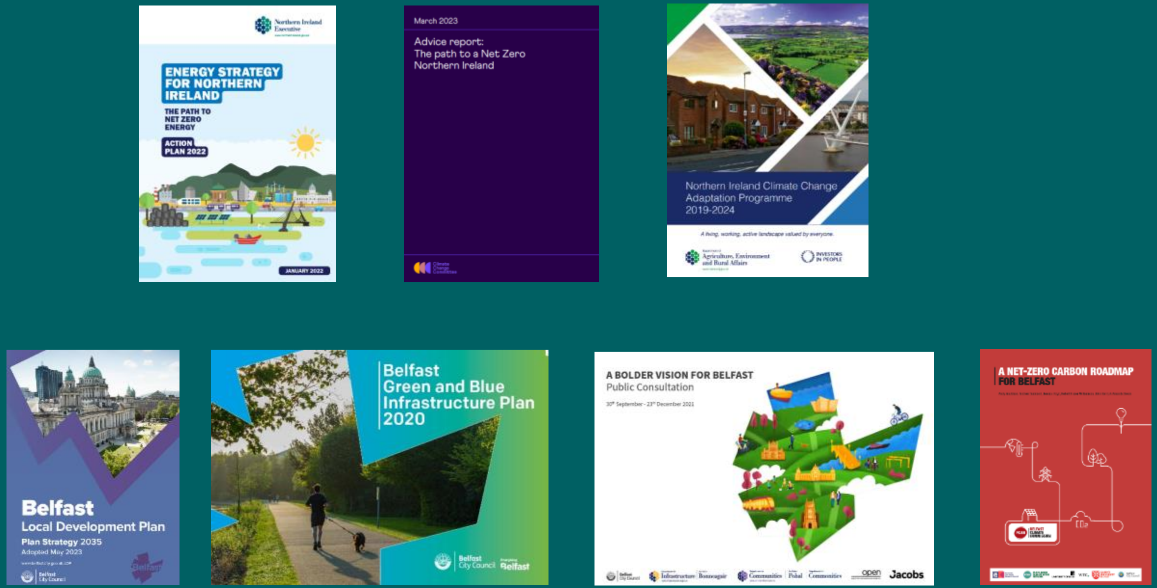


Figure 7: National and Local Documents with Climate Context

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Belfast Carbon Roadmap: Pathway to Net-Zero

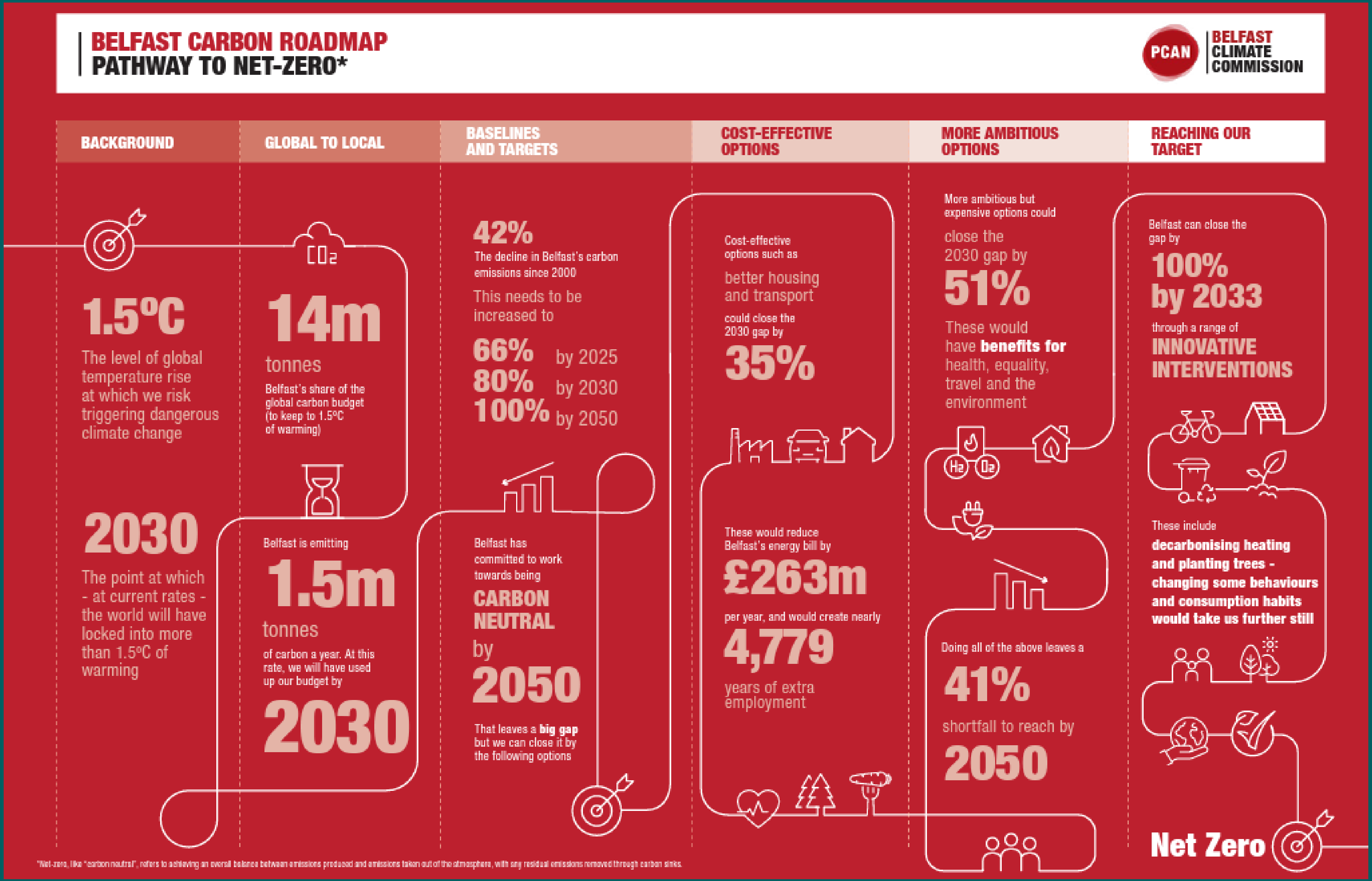

Figure 8: Belfast Carbon Roadmap Infographic

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How to understand a site(s) Solar PV potential?

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Traditional Steps to Site Performance Assessment

1. Identify site location
2. Determine whether site appraisal will be based on desktop and/ or in-person assessment.
3. Identify appropriate space for installation (roofs, open space for ground mounts, potential new structures).
4. Measure and calculate the usable space for installations
5. Calculate the inclination and orientation for roof / space.
6. Calculate the site's annual normalised solar radiation values.
7. Calculate the shading factor for the site / panels.
8. Calculate electricity (AC) output (kWh) =
   Annual AC Output (kWh) = PV kWp rating x irradiance x shade factor
9. Work out project viability

Issues

1. Surveying multiple sites locations in-person or via desktop appraisal is time consuming and costly.
2. Can make understanding property portfolio difficult

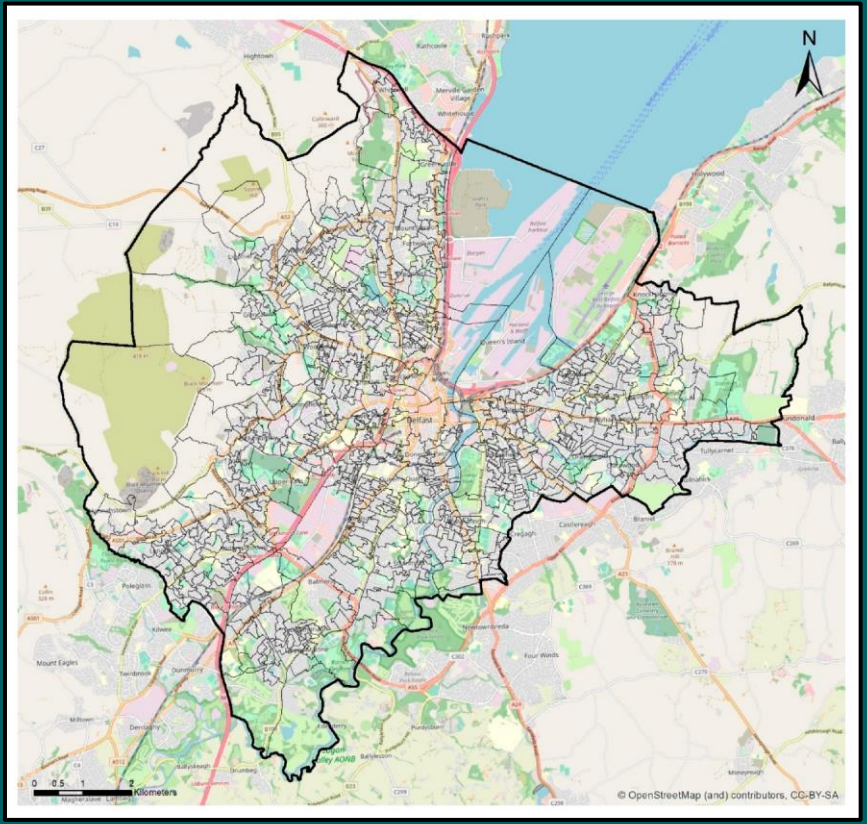

Figure 9: Belfast Boundary (Open Street Maps)

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Issues

1. Very challenging to understand and screen usable spaces.
2. What might appear to be north facing roof (many would discount) could have good radiation potential due to pitch and shading.
3. Maximise PV on usable roof space and filtering out low performing areas / panels.

Figure 10: GIA Calculations Account for Consented Surrounding Environment

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Issues

1. Hard to understand shade impact on individual panels.
2. Some approaches only consider the SF for the centre of an array or roof which leads to inaccuracies.
3. Where multiple roofs are to be used, understanding SFs accurately can be very time consuming.
4. Approaches don't consider the consented surrounding environment and future impact.
5. Getting onto roofs to calculate shading is problematic.
6. Difficulty interpreting what is near and far shading.

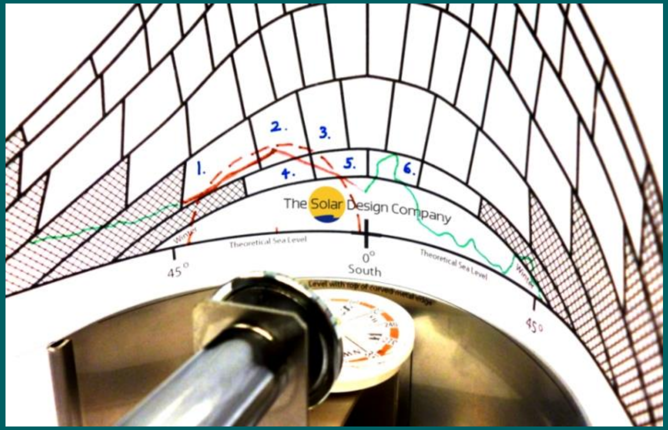

Figure 11: Solar Design Company Shade Calculation Tool

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Issues

1. Calculating the benefits (climate and financial) of PV individually relies on the complex interaction of numerous variables :
   a) irradiance and shade factor.
   b) baseline and future built and natural environment.
   c) climate factors.
   d) panel efficiency.
   e) project costs.
   f) self-consumption profiles,
   g) existing electricity usage,
   h) electricity pricing,
   i) export tariffs,
   j) PV incentives,
   k) carbon intensity,
   l) opportunity cost of PV against other investments.
   m) planning compliance.
2. Becomes more complex at scale when assessing a large property portfolio accurately.
3. Understanding options and scenarios to meet investor viability requirements.

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GIA Approach

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GIA's Approach to Solar Assessment

Figure 12: City Scale 3D Model Accurate to 15cm

GIA's Approach to Solar Assessment

Figure 13: Individual Property Scale Accurate to 15cm, includes roofscape features and Consented Environment

GIA's Approach to Solar Assessment

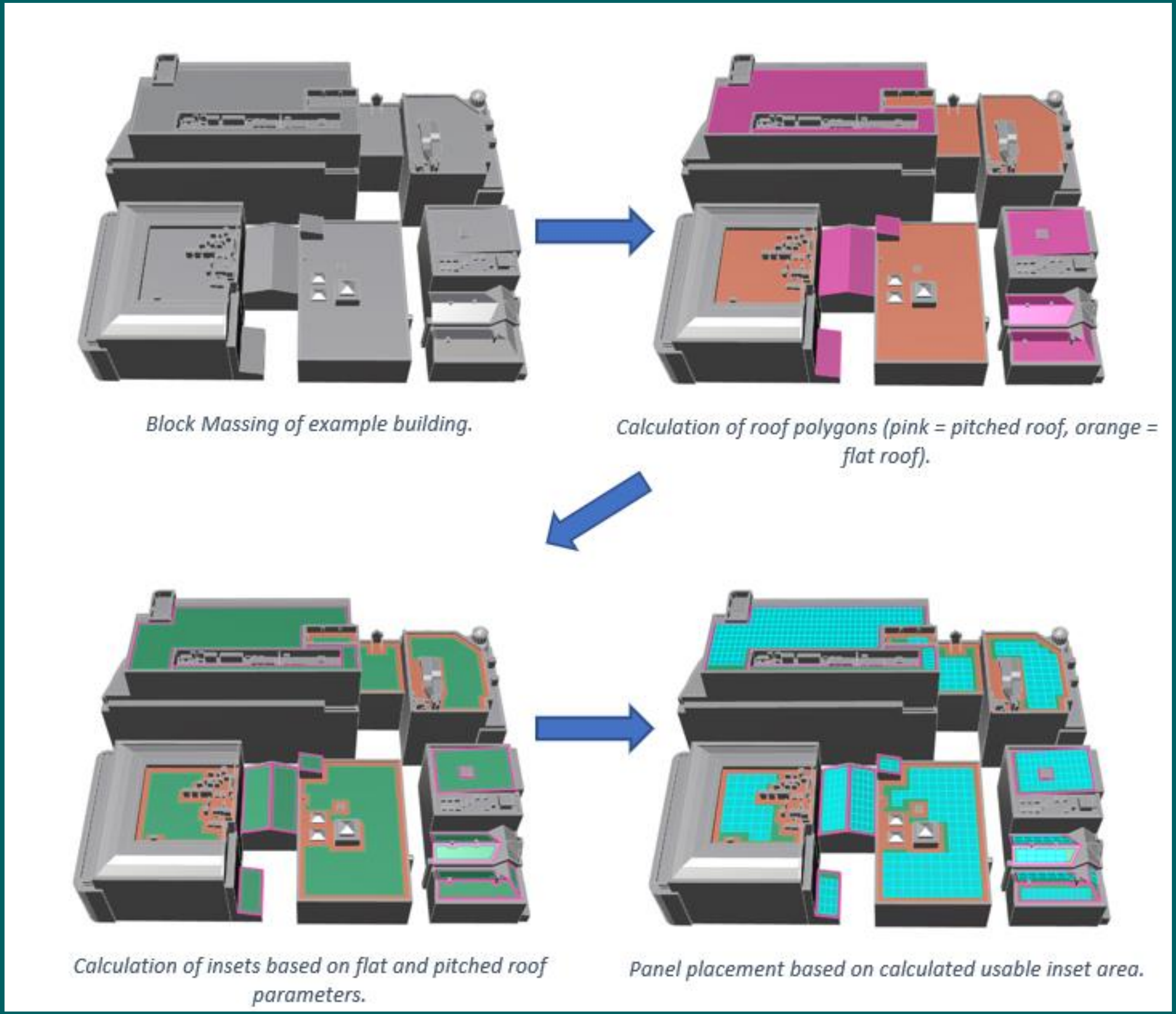


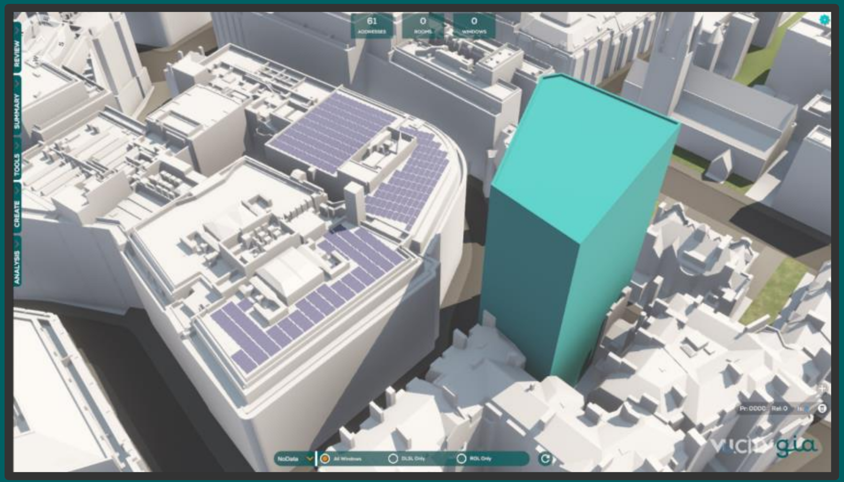
Figure 14: Calculating Roof space

GIA's Approach to Solar Assessment

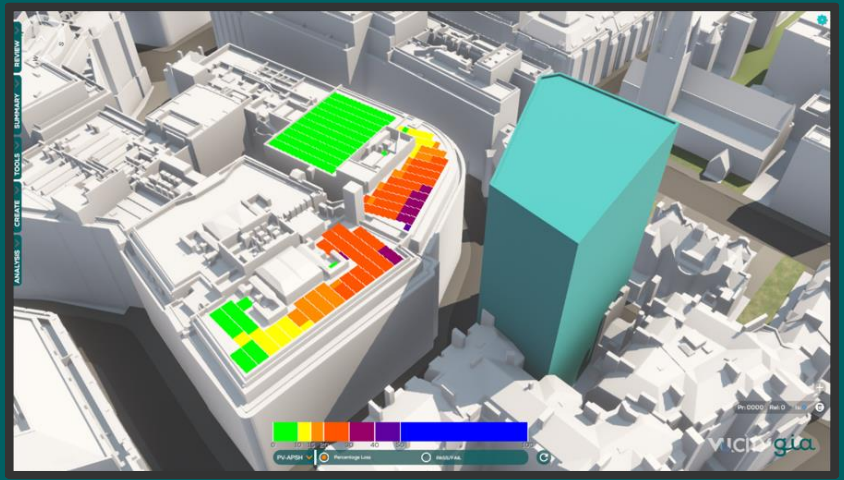
BUILDING

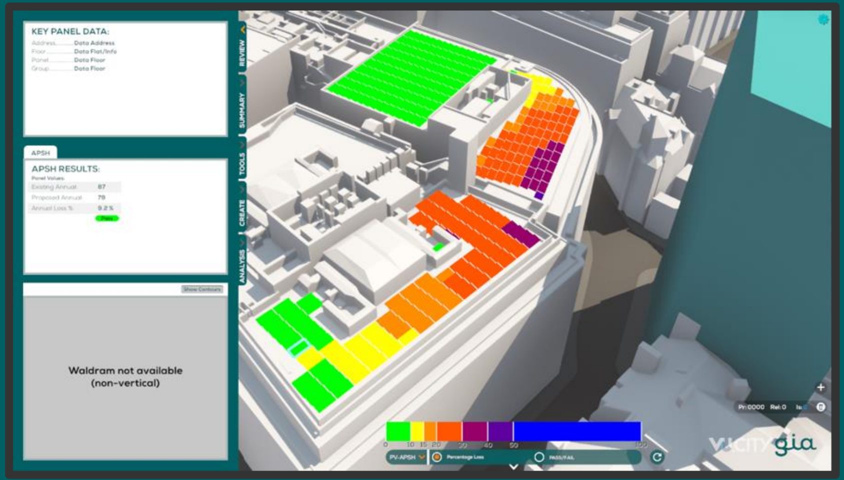
Asset is identified in VU.CITY from a list of addresses provided.

KNOWN CONSENTED BUILDING



Solar panels are algorithmically generated to fill the roof space, and consider factors such as including an offset from the roof edge for accessibility.





The panels are then assessed for solar insolation. Factors such as the impact of emerging surrounding schemes are considered.
Panels can be individually interacted with, to provide data on the potential performance on a panel by panel basis, or as an aggregate by property.

Figure 15: Staged Approaches to GIA Calculations and Visualisations

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SAP Versus CBDM Approach

SAP	CBDM
Standard approach to solar assessment	Current planning approach
EPCs based on SAP	Can still be used to influence EPCs
Shading factor less accurate (based on categories of shading)	Shading factor is calculated per individual panel
Typically filters out north facing roofs	Is run for all orientations
Based on regional insolation values	Based on local meteorological data

We believe CBDM to be the most accurate approach to assessing solar PV potential

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SAP and CBDM Context

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Summary of the Benefits of GIA's Approach

1. Accurate city-wide 3D digital model
   (trusted by local authority)
2. 15cm detail at roofscape (roof lights, chillers, plant etc)
3. Future consented buildings (and their shadows)
4. Individual panel shading assessment
5. Local climatic data files
6. Financial and environmental scenario modelling
7. Operating at scale and with greater accuracy
8. Faster and cost effective methodology
9. Daylight and sunlight expert-led approach

Assessment Results

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Input Parameters

Parameter/ Specification	Assumption
Flat Roofs (inclination)	< 2 degrees
Pitched Roofs (inclination)	> 2 degrees
Panel Dimensions	1.6m x 1.0m (L x W)
Panel Wattage (Wp)	350Wp
Panel Efficiency	22%
Panel Cell Technology	Monocrystalline
Electricity Price (£/kWh) - Commercial	£0.189 / kWh
Export Price (£/kWh) – Commercial	£0.0495 / kwh (connection agreements can limit export potential)
Generation Incentive Scheme Tariff (£/kWh)	No incentive scheme currently available in Northern Ireland.
Grid Carbon Intensity (2021)	0.346 kgCO2e/kWh
Carbon Cost of Production and Installation of PV	41 gCO2e/kWh
Scenarios Modelled	100% self-consumption, 75% self-consumption, 50% self-consumption
Panel Viability Parameter Applied	Option 1 – No parameter **Option 2 – Panel must produce a minimum of 188.17kWh / year**

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Combined 10 Sites Results

Scenario 1

- 10 properties
- 100% self-consumption and 0% export.
- PV Installed on 100% of usable roof space

Scenario 4

- 10 properties
- 100% self-consumption and 0% export.
- Panel filtering (188.17kWh/year performance threshold)

Scenario 1:	SAP	CBDM
Existing Electricity Usage (kWh)	4,403,679	4,403,679
System Size (kW)	1,172	1,172
Estimated PV Generation (kWh/Year)	781,395	711,996
No. of Panels	3,348	3,348
% Contribution to Existing Electricity Usage / Self-Sufficiency (%)	18%	16%
Estimated Carbon Emissions Savings (tonnesCO_{2e}/ Year)	268	244

Scenario 5:	SAP	CBDM
Existing Electricity Usage (kWh)	4,403,679	4,403,679
System Size (kW)	619	906
Estimated PV Generation (kWh/Year)	521,427	589,186
No. of Panels	1,768	2,588
% Contribution to Existing Electricity Usage / Self-Sufficiency (%)	12%	13%
Estimated Carbon Emissions Savings (tonnesCO_{2e}/ Year)	179	202

Example – Falls Leisure Centre

Results	SAP	CBDM
Existing Electricity Usage (kWh)	377,829	377,829
System Size (kW)	38.5	38.5
Estimated PV Generation (kWh/Year)	32,514	24,504
No. of Panels	110	110
% Contribution to Existing Electricity Usage / Self-Sufficiency (%)	9%	6%
Estimated Carbon Emissions Savings ($tonnesCO_{2e}$/ Year)	11.15	8.4

Figure 16: Falls Leisure Centre PV Potential

Example – Girdwood Community Hub

Results	SAP	CBDM
Existing Electricity Usage (kWh)	416,276	416,276
System Size (kW)	131.25	131.25
Estimated PV Generation (kWh/Year)	107,607	88,059
No. of Panels	375	375
% Contribution to Existing Electricity Usage / Self-Sufficiency (%)	26%	21%
Estimated Carbon Emissions Savings ($tonnesCO_{2e}$/ Year)	36.9	30.19

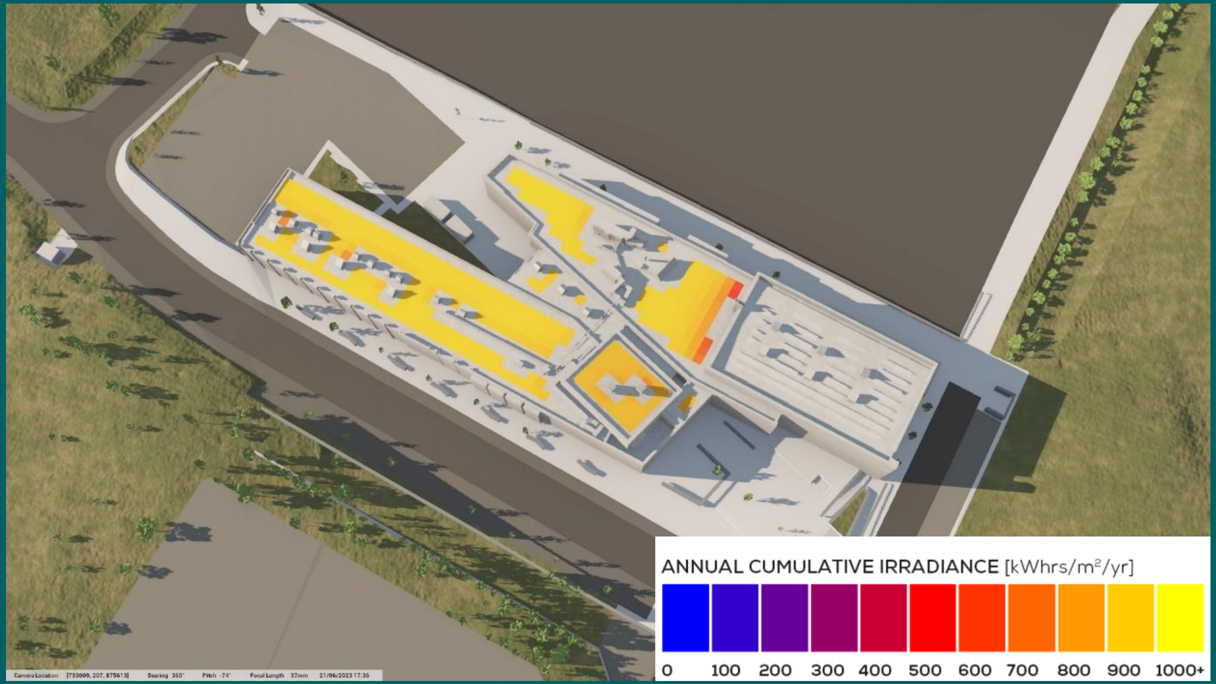

Figure 17: Girdwood Community Hub PV Potential

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Example – 2 Royal Avenue

Results	SAP	CBDM
Existing Electricity Usage (kWh)	200,000	416,276
System Size (kW)	75.95	75.95
Estimated PV Generation (kWh/Year)	34,763	33,086
No. of Panels	217	217
% Contribution to Existing Electricity Usage / Self-Sufficiency (%)	17.4%	16.5%
Estimated Carbon Emissions Savings (tonnesCO_{2e}/ Year)	11.92	11.34

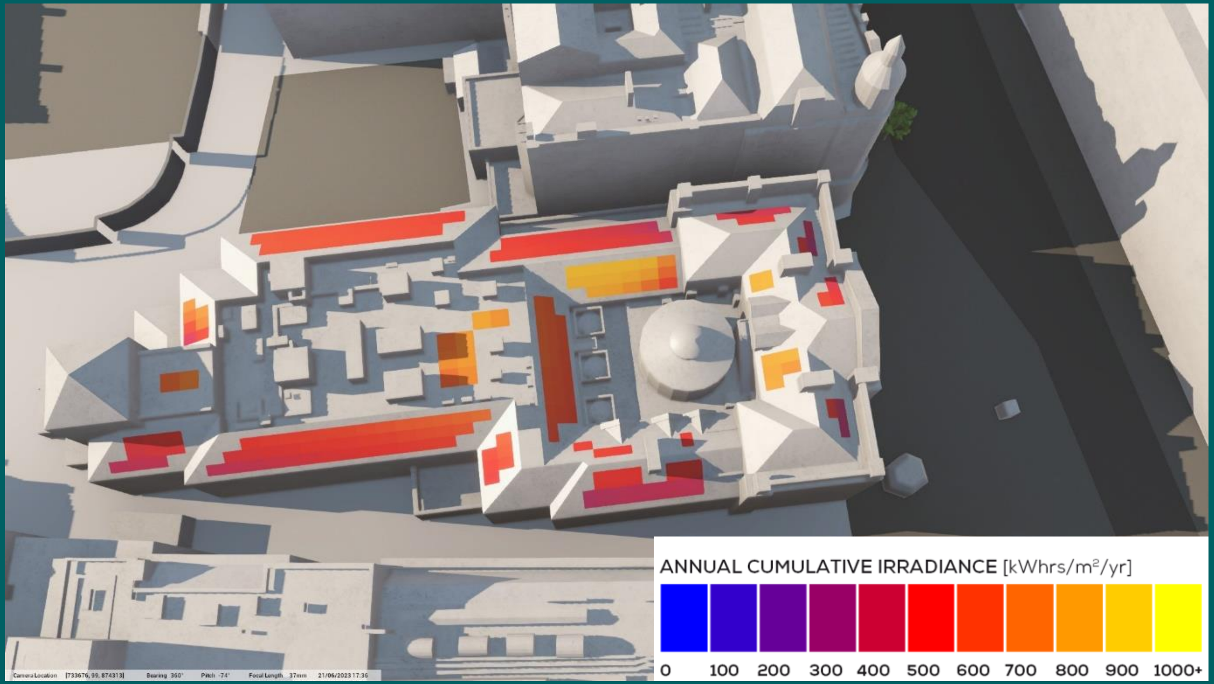

Figure 18: 2 Royal Avenue PV Potential

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Assessments Based on Future Consented Environment

Figure 19: Results in VU.CITY

Thank you

Questions?

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