Solar potential modelling for household and community solar

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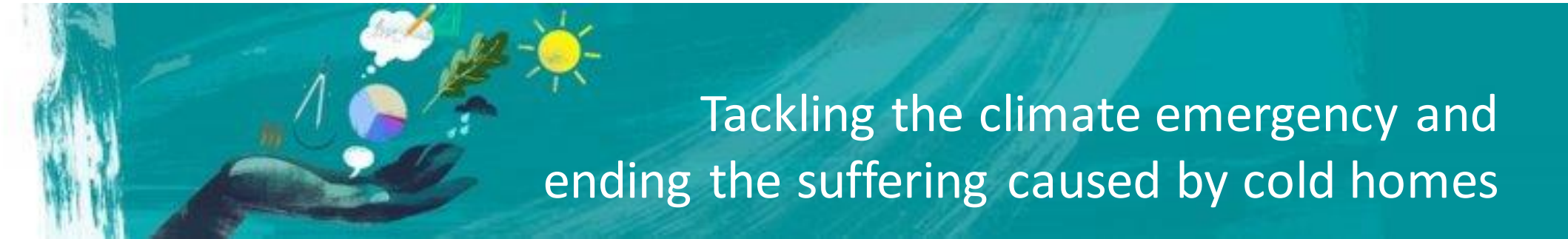

Speakers

- Mark Gibbons – software engineer, CSE
- Neil Justice – software engineer, CSE

Overview

- Who are CSE?
- What is Solar Wizard?
- The Solar Wizard interface
- The Solar Wizard model

Who are CSE?

- CSE is an independent national charity formed in 1979 with our main office in Bristol.

- Our vision is
  - a world where sustainability is second nature
  - carbon emissions have been cut to safe levels and
  - fuel poverty has been replaced by energy justice.

- We share our knowledge and practical experience to empower people to change the way they think and act about energy.

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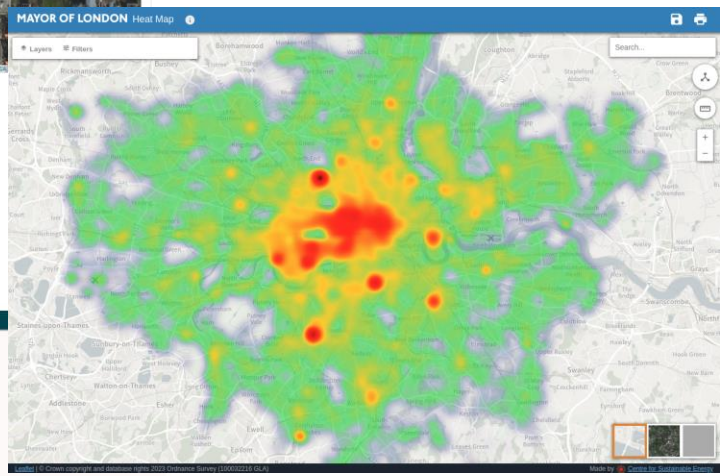
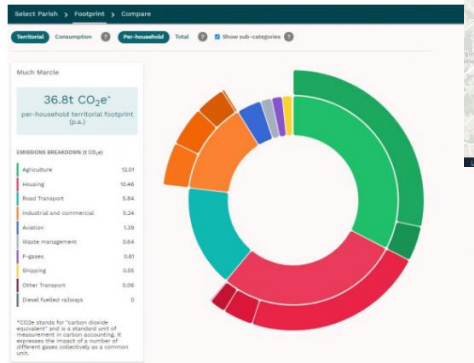
Some of our projects





Project Background

- Project funded by SBRI's Open Digital Solutions for Net Zero.
- "To develop open solutions to accelerate decarbonisation of energy in the UK".
- Our aim: to get reliable, independent solar potential data in the hands of local authorities, community groups and individuals.
- Build on existing solar model and create a user interface to present the data to the public.

Solar Wizard Overview

- Solar potential model – predicts solar potential for any rooftop.
- Web tool – show people the data in a meaningful context.
- Two main user types:
  - People who want to look at a single building (e.g. homeowners)
  - People who want to look at lots of buildings all at once (e.g. community energy groups, local authorities)

Household version

- For an individual building, shows you:
  - Estimated kWh generated p.a.
  - Estimated costs (thanks MCS)
  - Payback period
  - CO_2 savings
- Note: The householder wizard covers the whole of mainland GB. We show as little OS data as possible to minimize royalties paid.

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Solar Wizard About Try for free! Log in Sign up

Muroy, Pillowell Road, Whitecroft, LYDNEY, GL15 4RL

Very good solar potential

835 yield (kWh/kWp)

Try another building

Summary

For a household with average energy consumption:

2,439 kWh	£338	£5,478	16 year
generated by PV per year	total yearly savings	estimated installation cost	payback period

449 kg CO_2 saved per year

The figures above are based on our solar suitability model. This uses LiDAR and building footprint data for the whole of Great Britain (where there's up-to-date LiDAR coverage) to model roof layout, panel placement, shading, and solar irradiation levels for every roof in the country, and creates a suitability score for the building, each potential panel array, and each potential solar panel.

Installation details

The solar wizard PV suitability model is intended to provide an initial, high-level PV suitability check, and is not intended to take the place of a proper feasibility study. The following are some of its key limitations:

- **Predictions do not attempt to match existing installations** show more
- **Roof material assumed suitable** show more
- **Micro-inverters or power optimisers assumed** show more
- **LiDAR data limitations** show more

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Click the individual solar panels for more detail. Colour key

Whole roof | Individual panel

Very good solar potential

835 yield (kWh/kWp) (Whole installation)

9 panels

2.92 kWp installed capacity

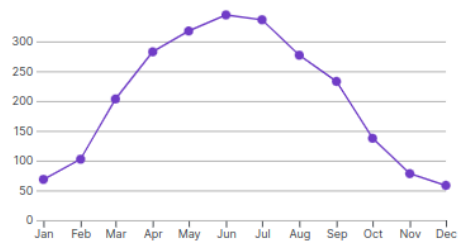
2,439 kWh/year estimated generation

14.6 m²

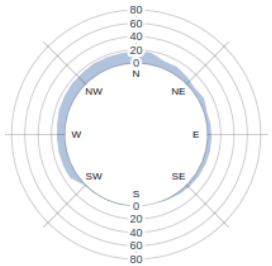
146° aspect (SE)

30° slope

Estimated kWh produced by month



Shading



Costs and Savings Calculator

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Costs and Savings Calculator

Enter details about your energy consumption to get a more accurate illustration of your potential savings.

Financial estimates show more

Occupancy type

- At home most of the day
- At home half of the day
- Out all day

Annual electricity consumption

3500 - 3999 kWh

Low Average High

Expected onsite consumption

- Use default value
- Enter custom value

You can expect to consume **30.6%** of the electricity generated on-site. The rest will be exported to the grid.

Electricity retail price

34 p/kWh - +

Electricity export price

5 p/kWh - +

With the details you have entered you can expect these costs and savings:

2,439 kWh	£338	£5,478	16 year
generated by PV per year	total yearly saving	estimated installation cost	payback period

746 kWh consumed on-site
1,693 kWh exported to grid

£254 saved on bills
£85 earned from exports

Onsite consumption percentages and cost per kW are derived from MCS data.

Large area mapping tool

- Shows large areas on a map
- Buildings are colour coded by their solar potential
- Plan is to sell it to local authorities (for a very fair price)
  - Allows LA to view the data for any building within their area
  - Opens up the data in the LA royalty-free (through their PSGA), so community groups and individuals can use the data too!
- We have two customers in the pipeline!

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Customer logo **Solar Wizard** Map Model limitations username

Map Layers

Colour scheme

- Annual output (MWh)
- Installation size (kWp)
- Yield (kWh/kWp)
- Per-panel yield (kWh/kWp)

Additional layers

- Panels
  Show example panel placement.
- Listed buildings
  Displays the grade (I, II or II*) of any listed buildings.
- Conservation areas
  Note: data on conservation areas is unavailable for some local authorities. Find out more.

View on Google Maps

Filters

Building selection

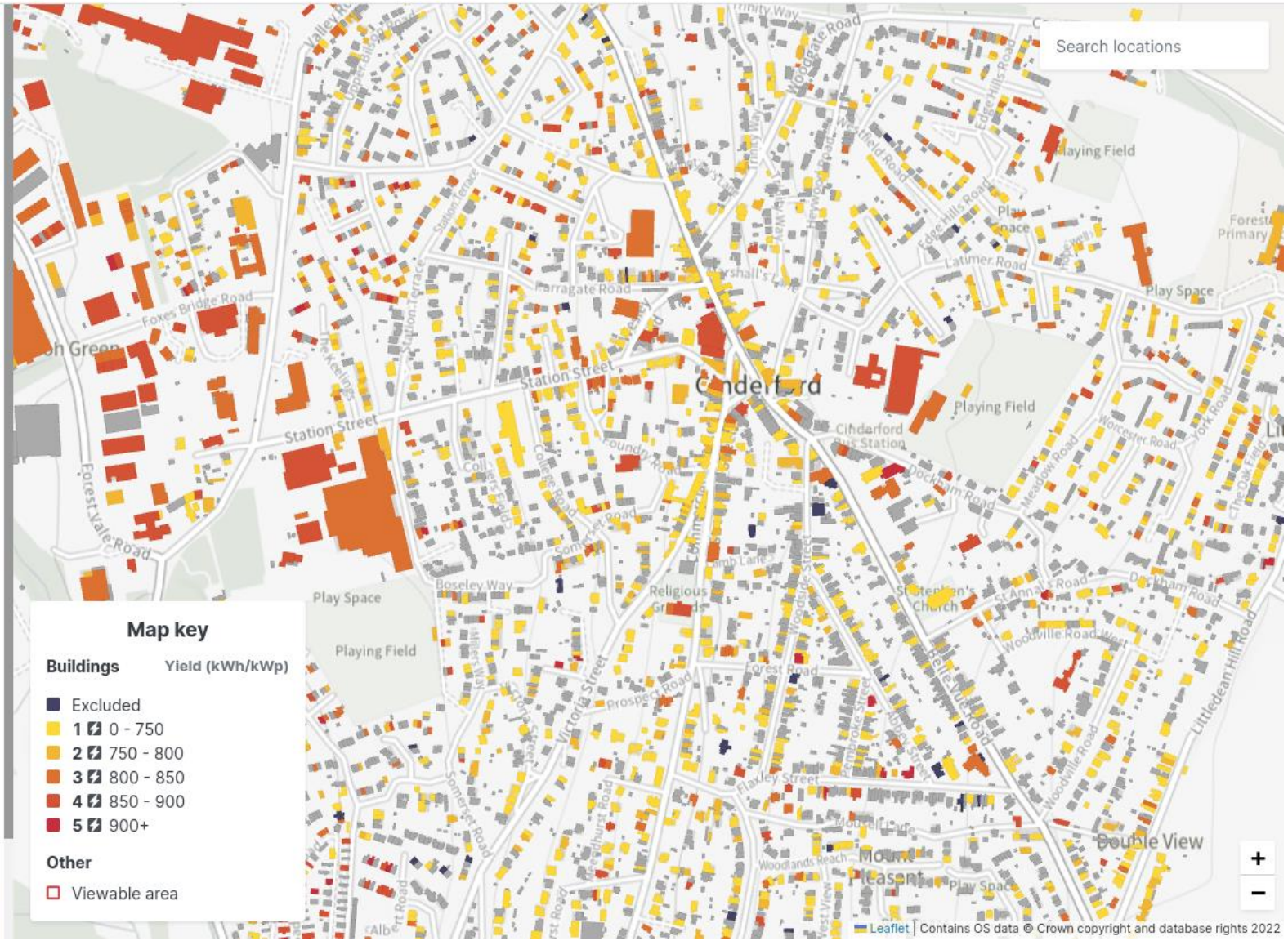
Licensing and attributions

The solar wizard was developed by CSE with funding from SBRI.

Solar Wizard PV suitability data was created using:

- Software and data from PVGIS: PVGIS © European Communities, 2001-2023

localhost:8080 ed under the Open Government Licence



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Customer logo **Solar Wizard** Map Model limitations username

← **Selected buildings**

Selection: Custom area

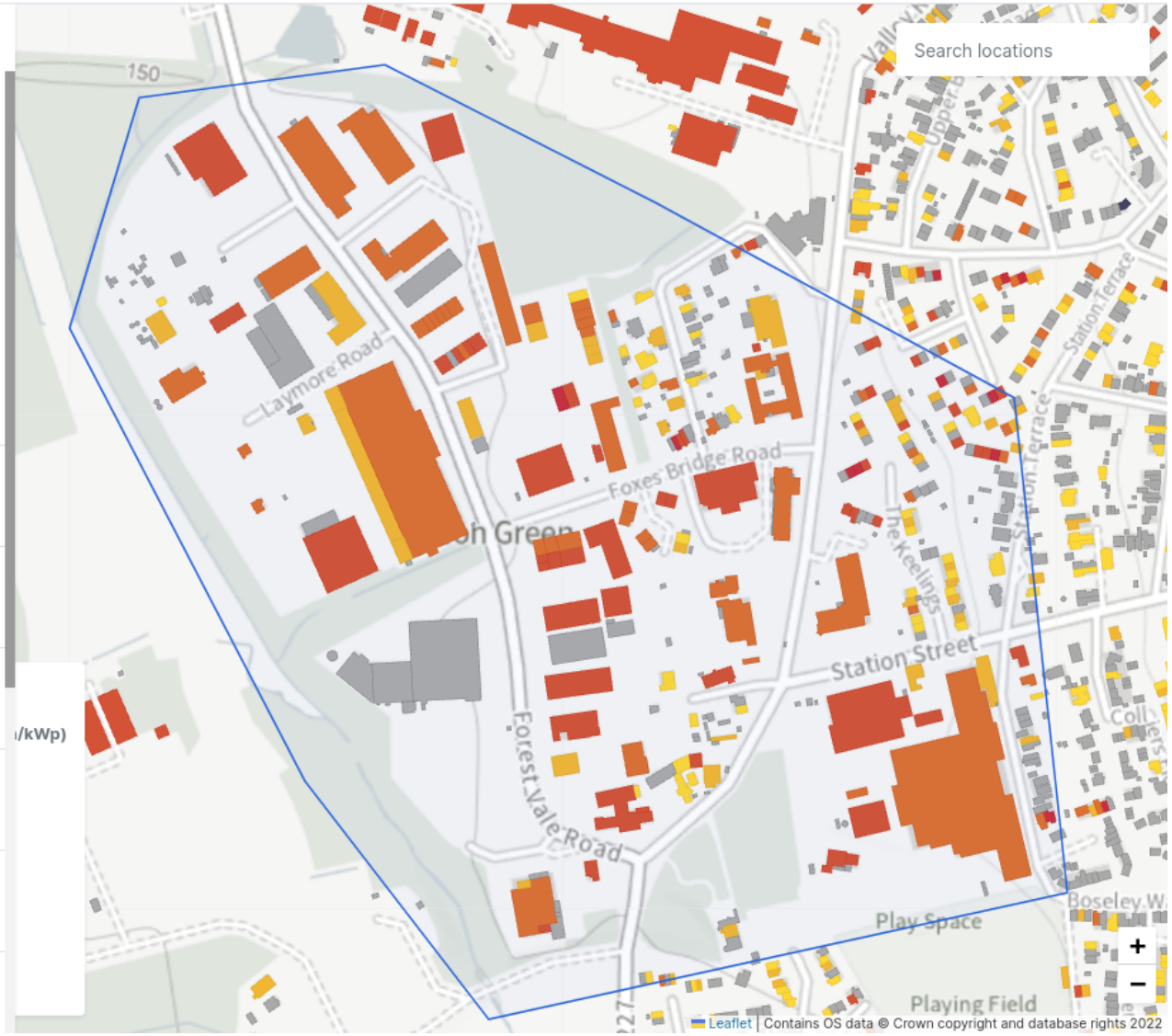
This table shows the key features of the selected buildings and can be sorted using the dropdowns below. Click on an individual building to view more information about it.

For an in-depth assessment, you can perform a financial analysis of the buildings in your selection, which allows you to specify numerous parameters such as installation costs, energy prices and thresholds for viability.

Data attribution and licenses

View full table Order by Yield (kWh/kWp) Desc

18 Barleycorn Square, CINDERFORD, GL14 2LF	938	Residential	910 kWh p.a.	1 kWp	1 array	3 panels
11 Willowdean, CINDERFORD, GL14 2NF	929	Residential	901 kWh p.a.	1 kWp	1 array	3 panels
2 Willowdean, CINDERFORD, GL14 2NF	913	Residential	1,187 kWh p.a.	1.3 kWp	1 array	4 panels
25 The Keelings, CINDERFORD, GL14 2NG	911	Residential	883 kWh p.a.	1 kWp	1 array	3 panels
22 Willowdean, CINDERFORD, GL14 2NF	907	Residential	1,179 kWh p.a.	1.3 kWp	1 array	4 panels
27 The Keelings, CINDERFORD, GL14 2NG	903	Residential	876 kWh p.a.	1 kWp	1 array	3 panels



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What FOSS4G did we use?

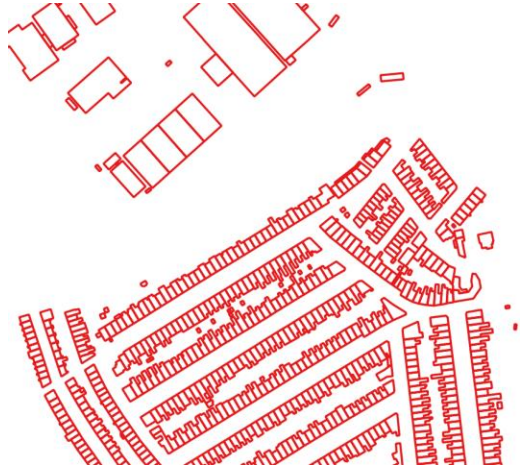
- Leaflet
- Tangrams
- (Geo)Django
- Postgres + PostGIS

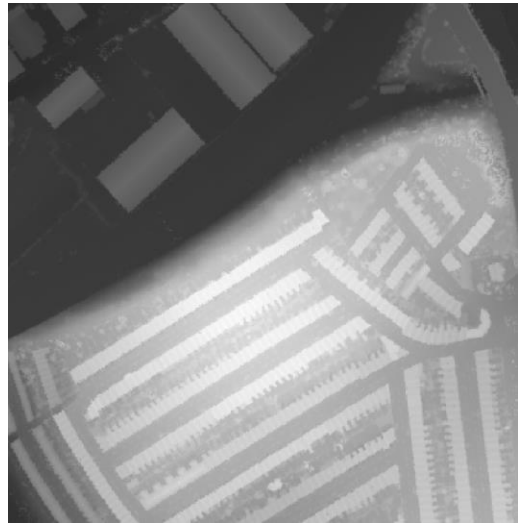
The Solar Wizard Model

- Open source: https://github.com/cse-bristol/solar-wizard-model
- Currently working on version 2 of the model
- Our goal is to be able to model all rooftops across England, Scotland and Wales

Model overview

- Inputs we have:
  - LiDAR DSM at 1m and 2m resolution
  - building footprint polygons
- Outputs we want:
  - Rooftop installation size
  - Expected monthly and annual electricity production



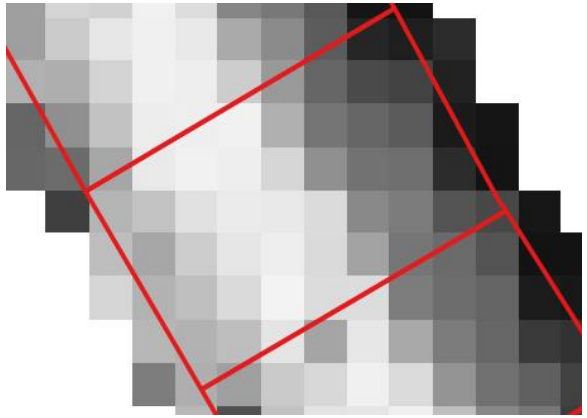


Model overview

- Data loading
- Check for outdated LiDAR
- Roof plane detection
- Roof polygon creation
- Solar potential mapping
- Data aggregation and output

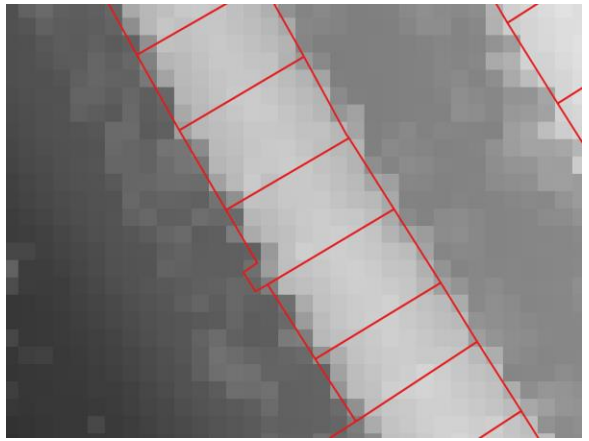
PVMAPS

- Open-source
- Raster-based program built as a GRASS plugin
- But – which areas of the roof are actually suitable for PV?



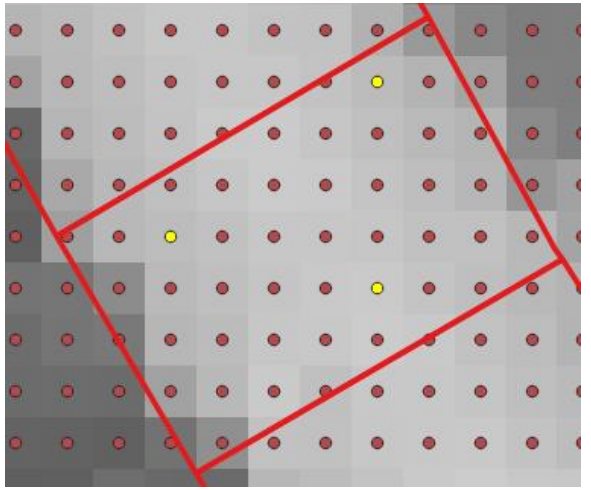
Roof plane detection

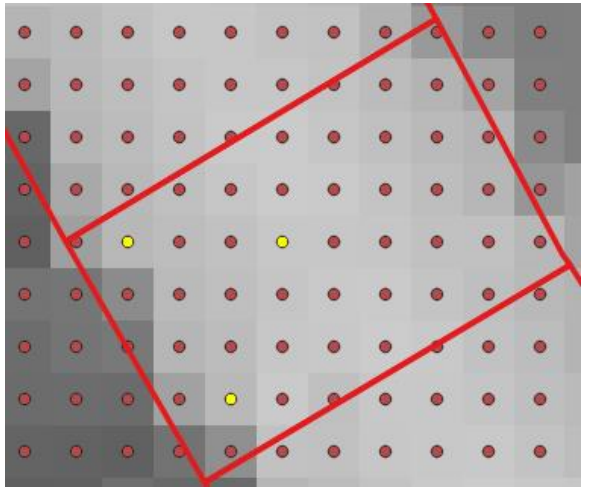
- Given a building footprint and some LiDAR, how can we work out where the different planes of the roof are?
- Our initial approach – a modified version of RANSAC based on Tarsha-Kurdi (2008)



RANSAC

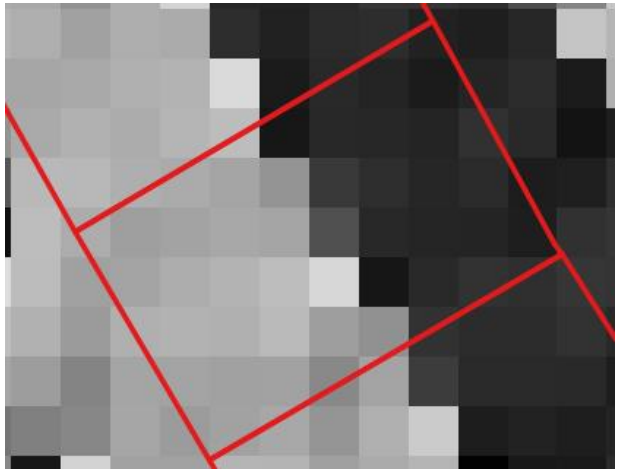
- RANSAC is a linear regression model that is intended to be robust to outliers
- RANSAC stands for RANdom SAmple Consensus - so it's a non-deterministic algorithm, and what it does is:
  - pick 3 random points from the data
  - fits a plane to those points
  - finds the other points which lie on that plane (or within a configurable distance)
  - if there are more points than the previous best plane, use that
    and repeat the above for a given number of trials.
- The problem – 46 pixels intersect this building, so there are 15180 potential combinations...

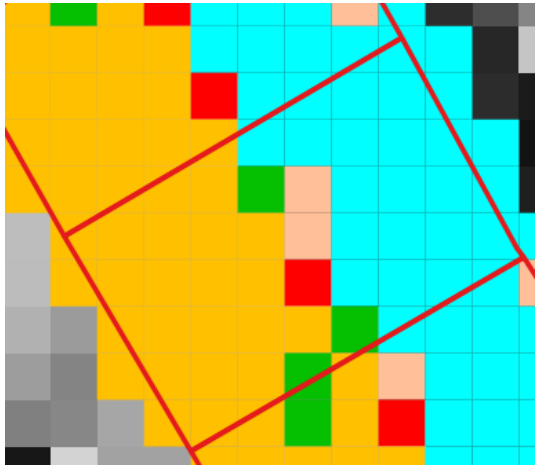


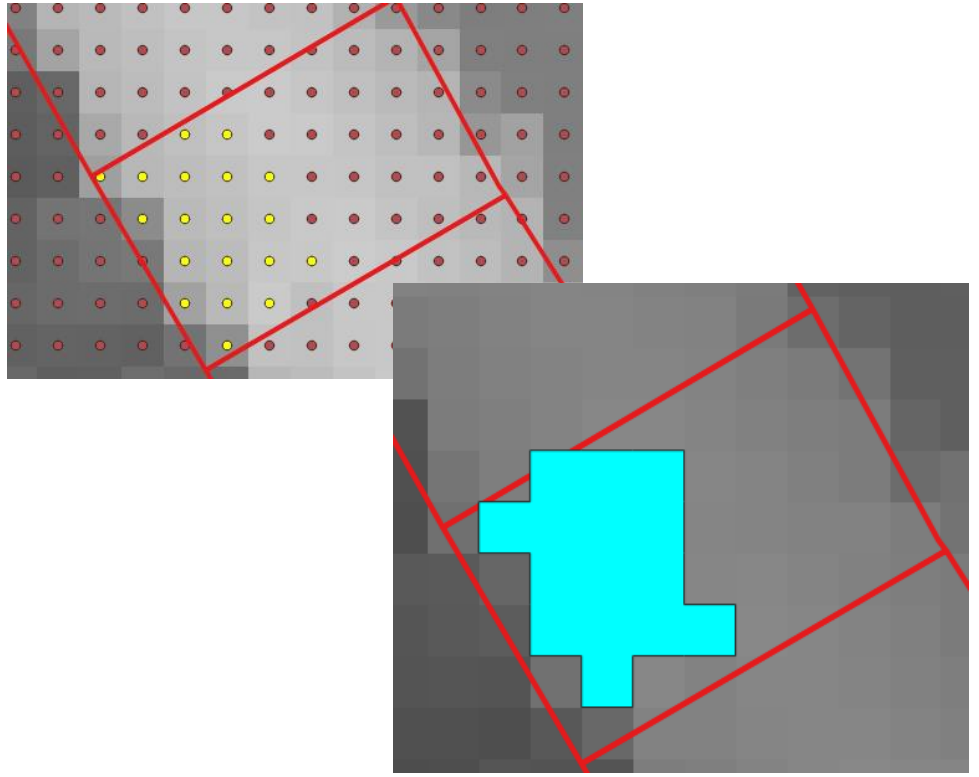


Deterministic Sample Consensus?

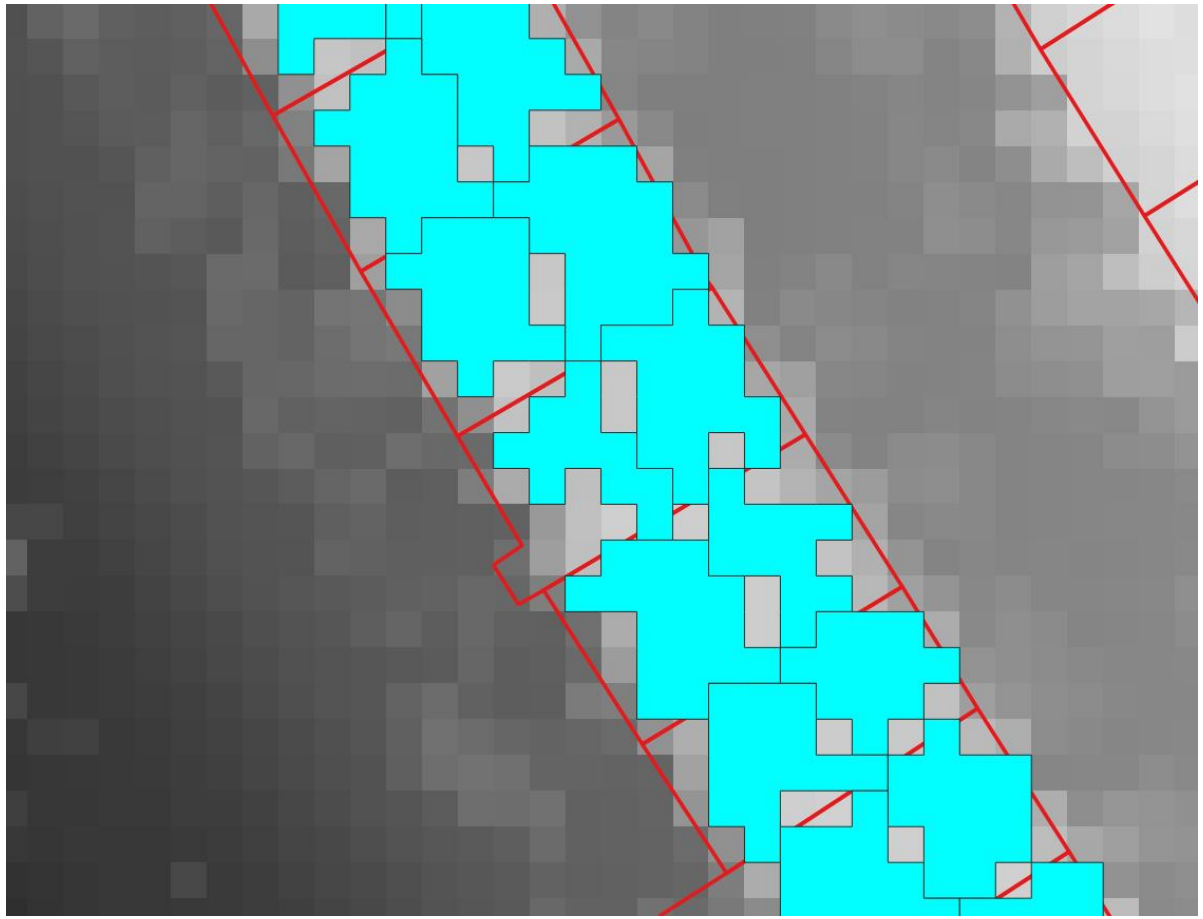
- Can we use our knowledge about what roofs tend to be like to choose better starting samples?

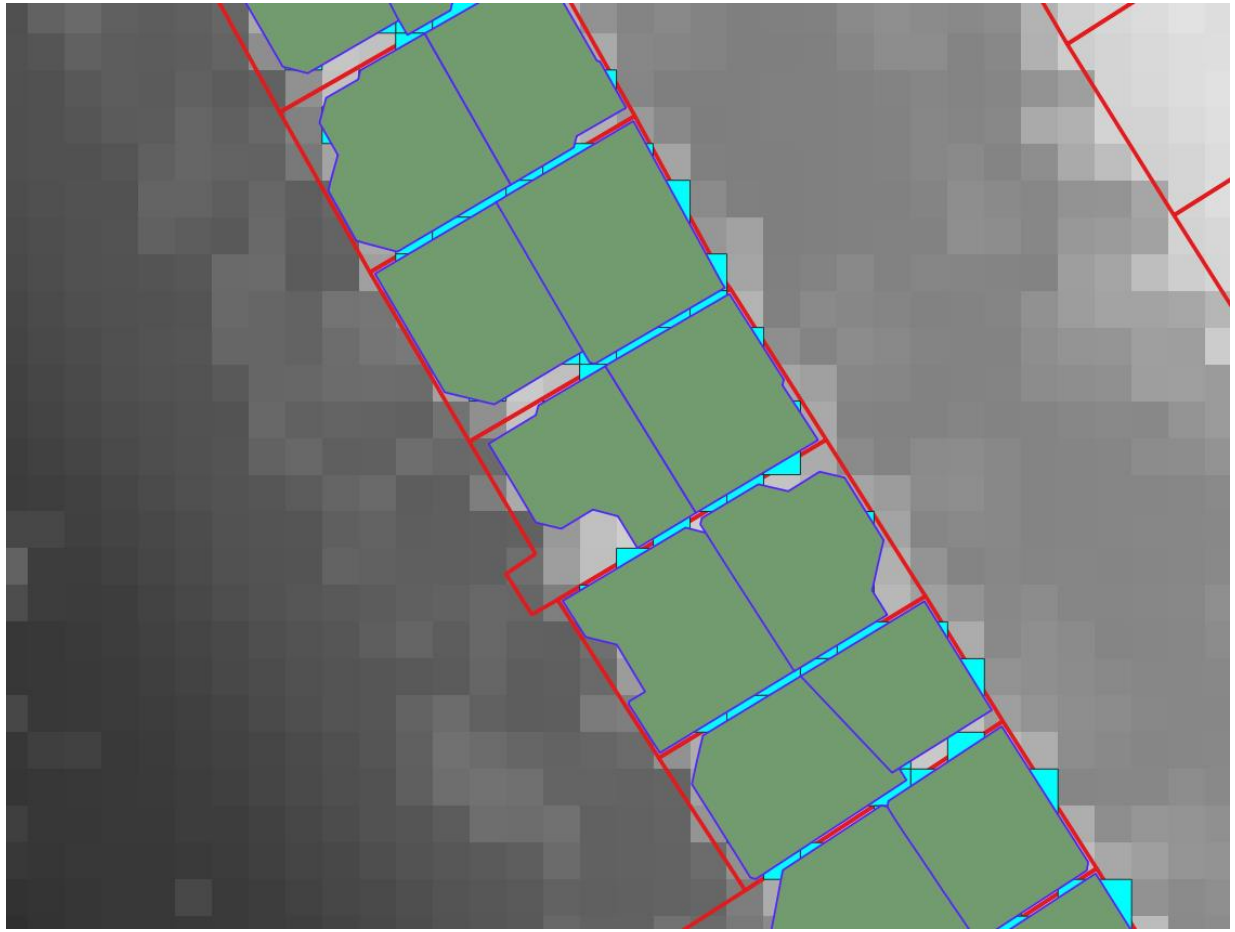






Deterministic Sample Consensus?





Tooling

- python
- shapely
- numpy
- sklearn and skimage
- postgres and postGIS
- PVMAPS
- GRASS
- GDAL
- QGIS for debugging (and making images for this presentation)

https://www.cse.org.uk/