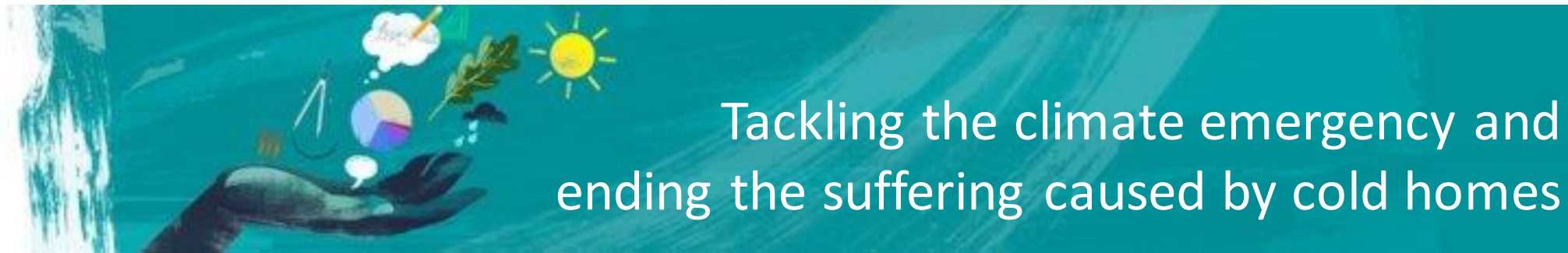




Solar potential modelling for household and community solar

Centre for Sustainable Energy



Tackling the climate emergency and ending the suffering caused by cold homes



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 - fuel poverty has been replaced by energy justice.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.



Some of our projects

LUC
centre for sustainable energy

Stroud District Renewable Energy Resources Assessment

A report by the Centre for Sustainable Energy and Land Use Consultants for Stroud District Council

Version: Final 1.2
Date of issue: 21st November 2019

Helping Liverpool council develop its 2030 Net Zero Action Plan
26 May 2022

Liverpool City Council has revealed their 2030 Liverpool Net Zero Action Plan, which sets out how the city can become a net zero city by 2030.

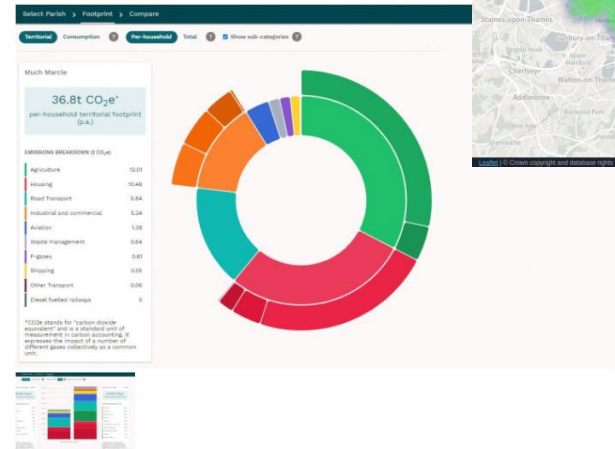
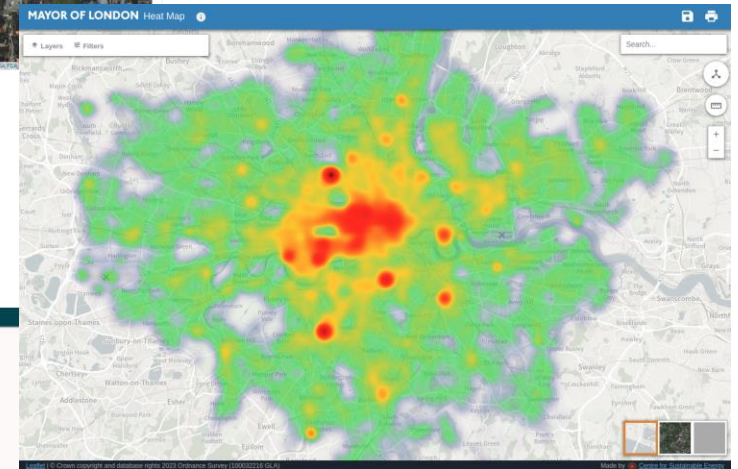
The Centre for Sustainable Energy (CSE) worked alongside Etonnia to provide the technical modelling and assessment for the decarbonisation of heat in buildings, energy supply, transport, and waste in Liverpool. In parallel, the team undertook the analysis of non-technical factors and the stakeholder engagement, which were crucial to developing Liverpool's net zero roadmap. The final strategy also provides recommendations for the city's climate resilience and low carbon economy. At CSE, we have the tools, resources, and expertise to carry this through successfully, having developed strategies to support the net zero ambitions of several local authorities.

Local Area Energy Planning: The Method

FINAL REVIEW DRAFT 30 July 2020

Centre for Sustainable Energy and Energy Systems Catapult
For Ofgem

Date: 28/07/2020
Document reference: LAEP Method Final Review Draft for release 30 July 2020
Revision: Final Review Draft
Prepared for: Ofgem





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
 - CO₂ savings
- Note: The householder wizard covers the whole of mainland GB. We show as little OS data as possible to minimize royalties paid.



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

generated by PV per year [?](#)

£338


total yearly savings

£5,478

estimated installation cost [?](#)

16 year


payback period

 **449 kg CO₂ 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](#)



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

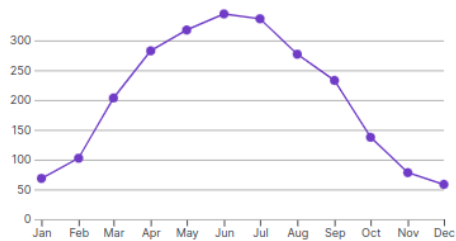
2,439 kWh/year estimated generation

14.6 m²

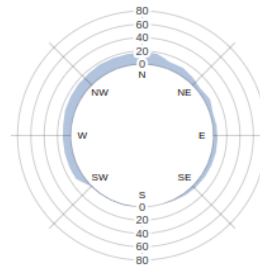
146° aspect (SE)

30° slope

Estimated kWh produced by month



Shading



Costs and Savings Calculator



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

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 - +

Annual electricity consumption

3500 - 3999 kWh

Low

Average

High

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

2,439 kWh

generated by PV per year ?

£338

total yearly saving

£5,478

estimated installation cost ?

16 year

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!



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

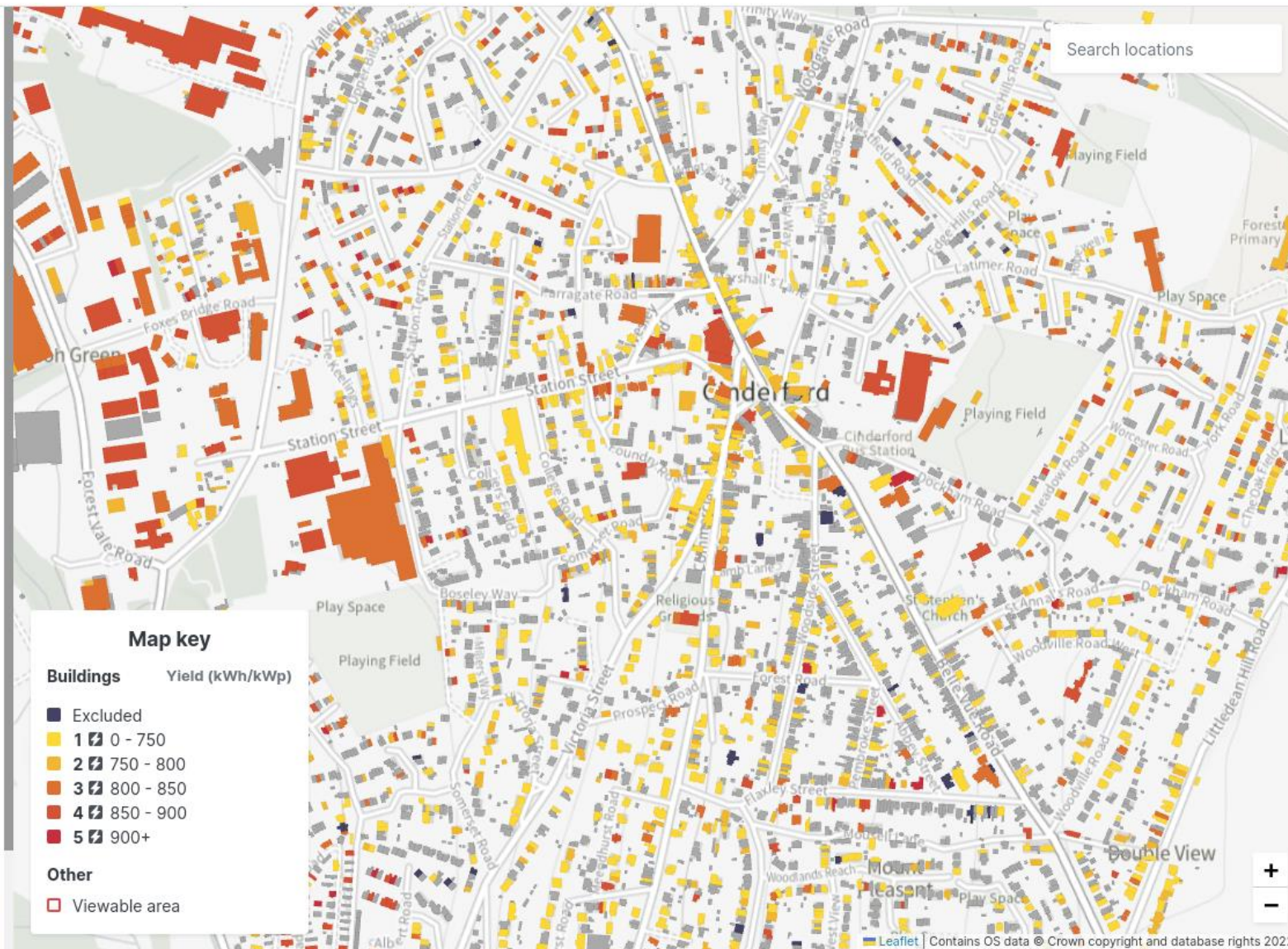
Licensing and attributions

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... under the Open Government Licence





← 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	★★★★★
localhost:8080 876 kWh p.a. 1 kWp 1 array 3 panels		





What FOSS4G did we use?

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





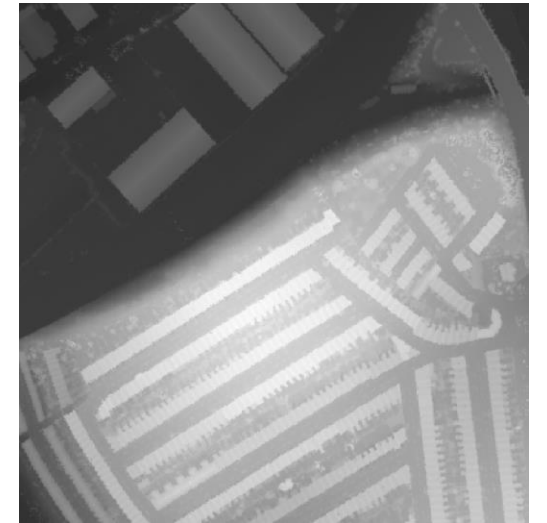
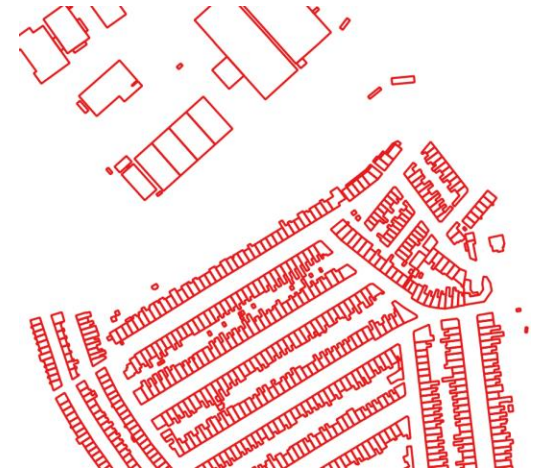
The Solar Wizard Model

- 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





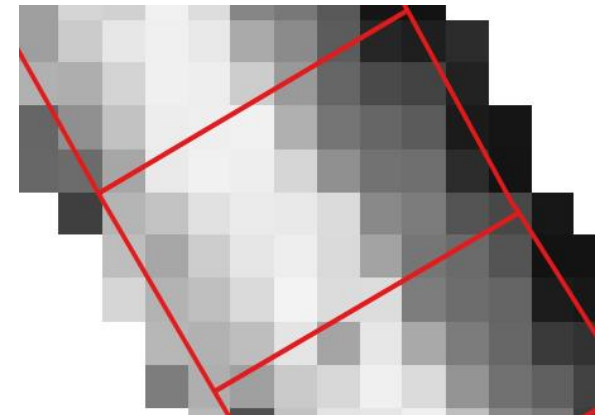
Model overview

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



PVMAPS

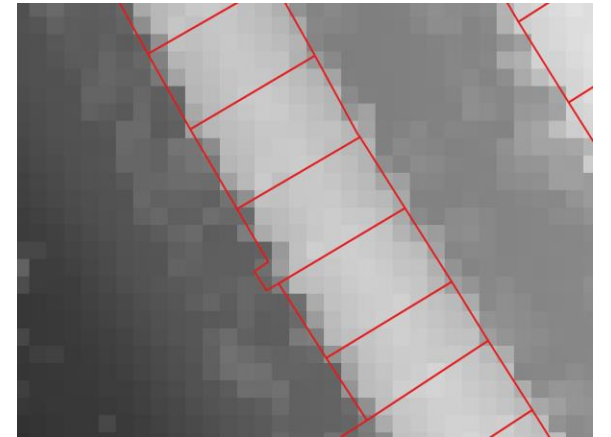
- Open-source
- Raster-based program built as a GRASS plugin
- But – which areas of the roof are actually suitable for PV?





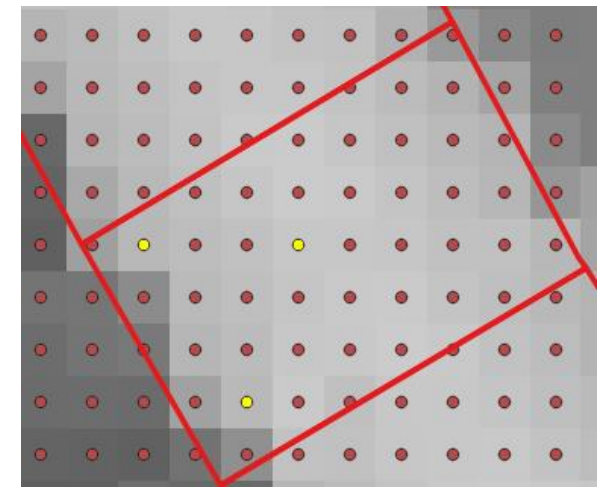
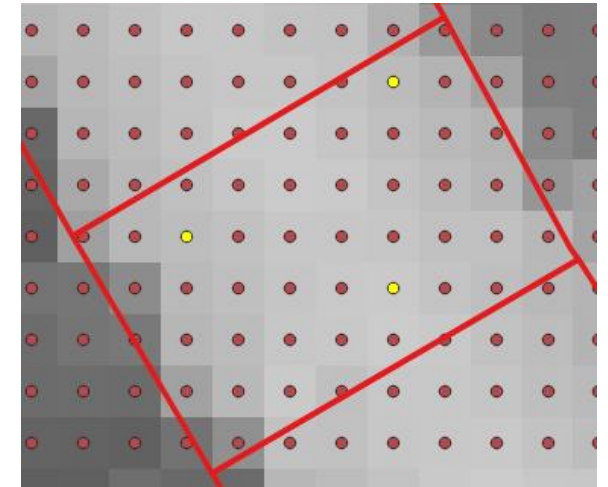
Roof plane detection

- 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)



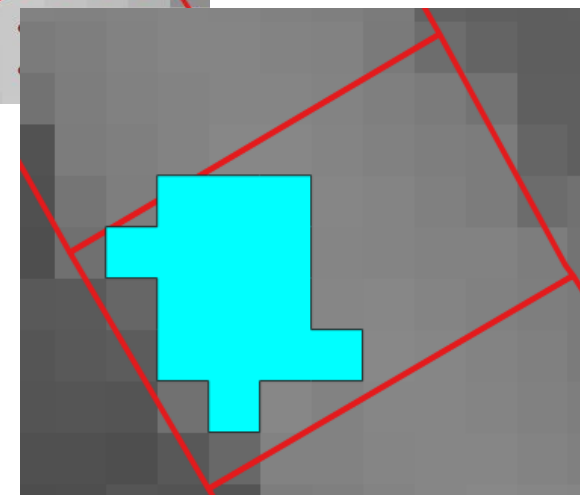
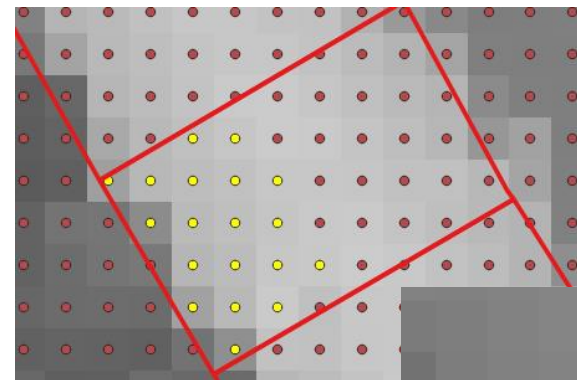
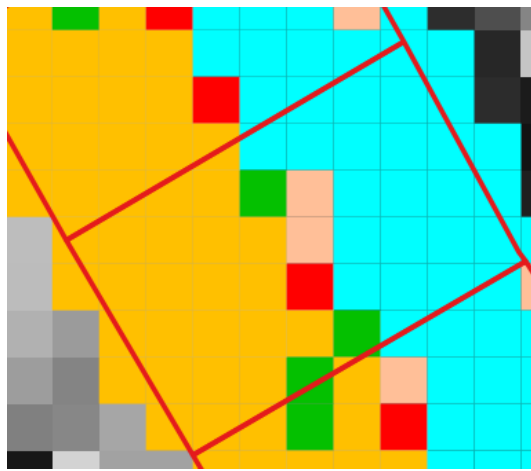
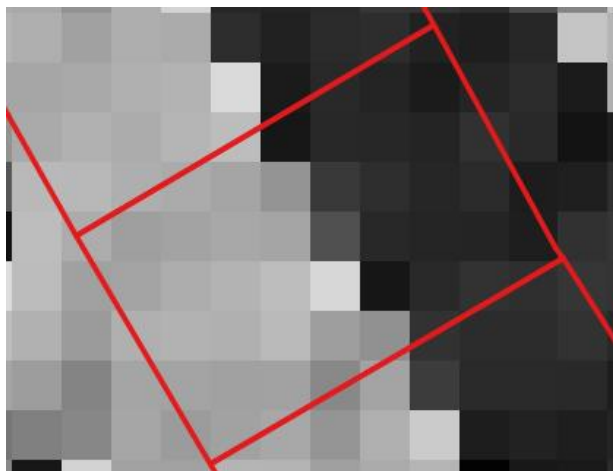
RANSAC

- 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 thatand repeat the above for a given number of trials.
- The problem – 46 pixels intersect this building, so there are 15180 potential combinations...



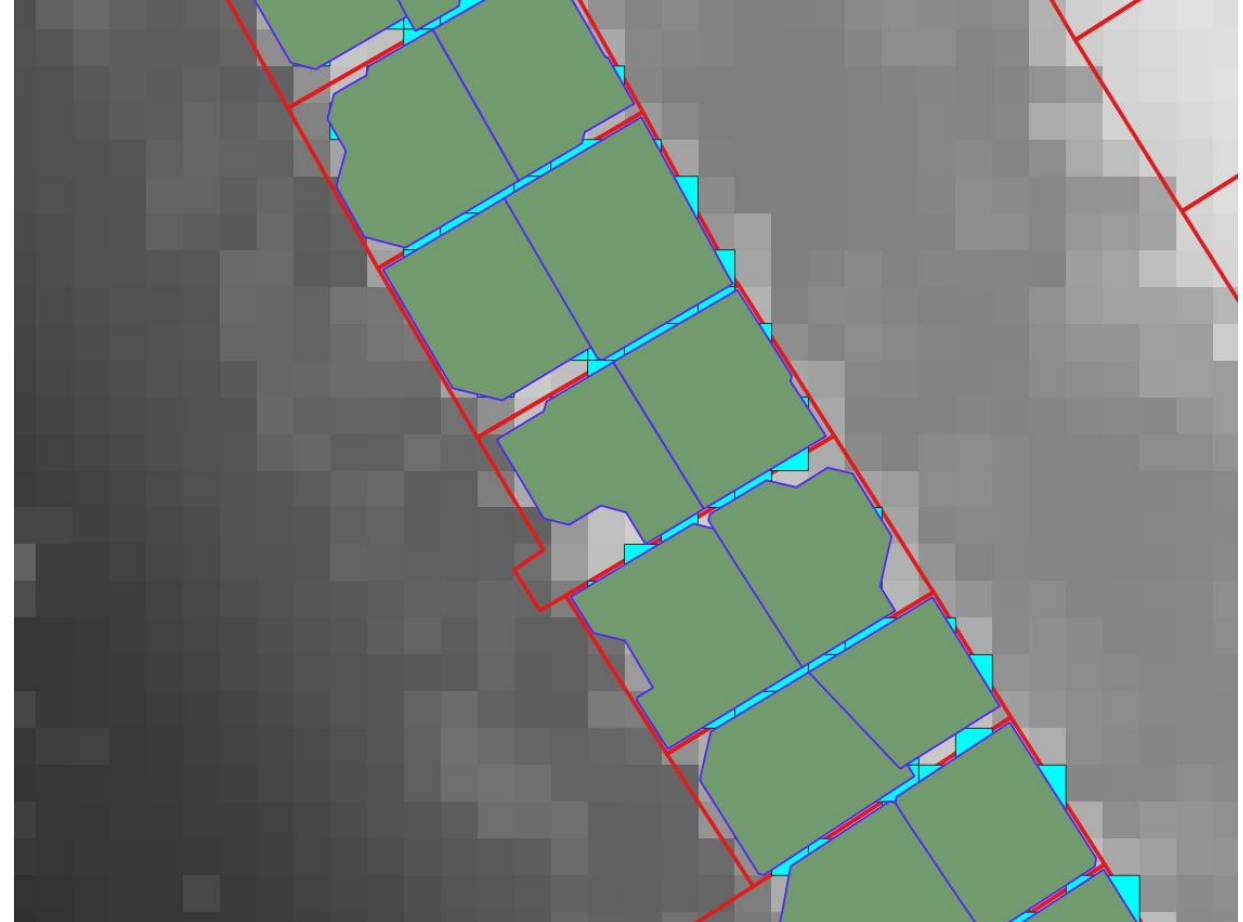
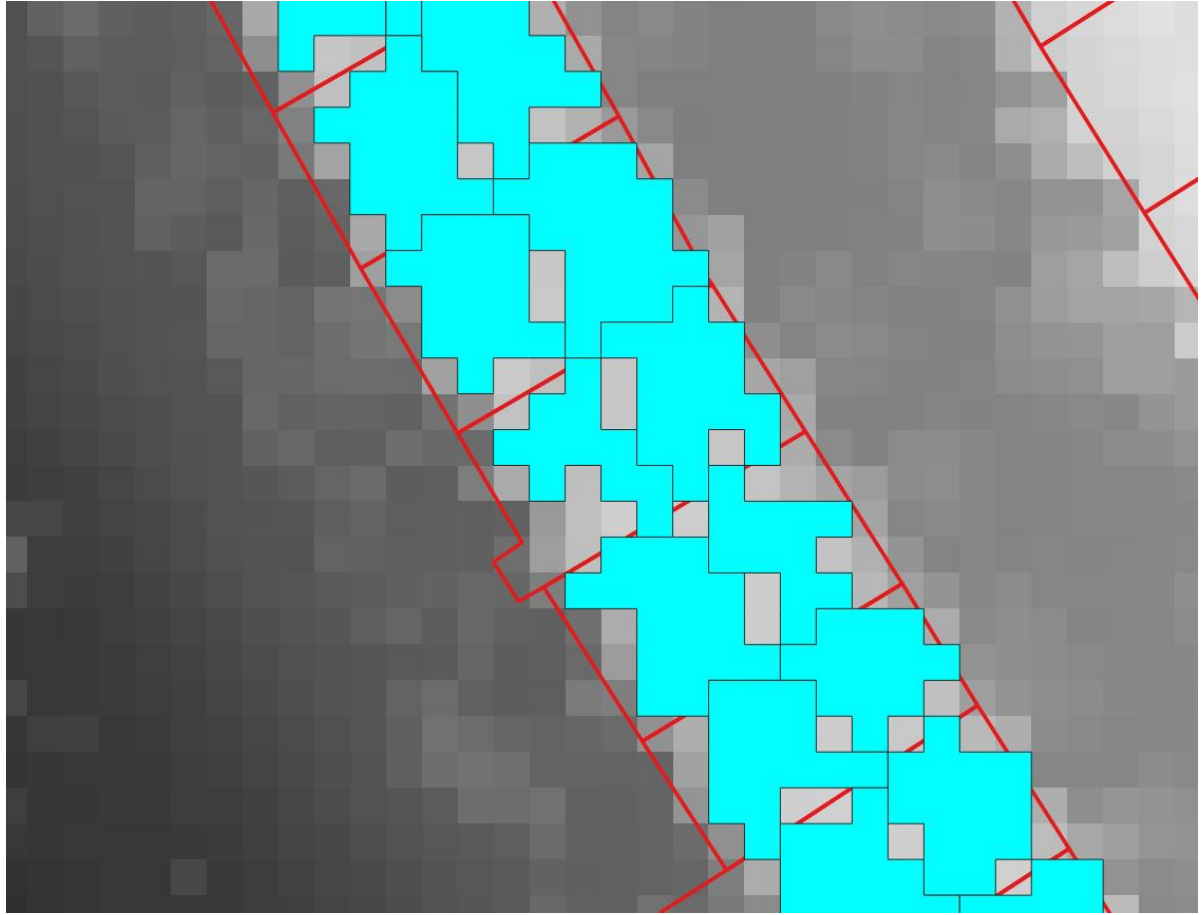
Deterministic Sample Consensus?

- 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/>

The screenshot shows the homepage of the Centre for Sustainable Energy. At the top left is the logo. A teal banner contains the text "The charity supporting people and organisations across the UK to tackle the climate emergency and end the suffering caused by cold homes", along with "Donate" and "Need energy advice?" buttons. A navigation menu includes "Research & Consultancy", "My community", "My home", "Resources", "About us", "News", and "Search". A large hero banner features the text "Tackling the climate emergency and ending the suffering caused by cold homes" over a background image of hands holding a green pepper. Below this are three dark blue cards: "My home" with a piggy bank icon, "My community" with a steaming mug icon, and "Research & Consultancy" with a pie chart icon. Each card includes a brief description and a "More Info" button.

 centre for sustainable energy

The charity supporting people and organisations across the UK to tackle the climate emergency and end the suffering caused by cold homes

Donate  Need energy advice? 

Research & Consultancy ▾ My community ▾ My home ▾ Resources About us ▾ News Search 🔍

Tackling the climate emergency and ending the suffering caused by cold homes

My home

Energy advice to help save money on your bills and improve your home.

[More Info →](#)

My community

We support local communities to tackle the climate emergency and make the energy system better.

[Find out more →](#)

Research & Consultancy

Our research supports better energy policies and more effective action to cut carbon emissions and fuel poverty.