OPEN
CLIMATE
FIX

Open Quartz:

Building an open source AI solar forecast for everyone

with **Rachel Tipton** and **Zak Watts**

UCL IRCAI UNESCO nationalgridESO Google.org NVIDIA ODI esa space solutions

What to expect

- About Open Climate Fix
- Why solar/renewable forecasting?
- Quartz Solar live solar forecasting service
- Open Source Quartz Solar model:
  - Model
  - Use cases & potential impact
  - Demo!!!
- Questions

```
from quartz_solar_forecast.forecast import run_forecast
from quartz_solar_forecast.pydantic_models import PVSite

site = PVSite(latitude=51.75, longitude=-1.25, capacity_kwp=1.25)

predictions_df = run_forecast(site=site, ts='2023-11-01')
```

About OCF

- Founded in 2019
- Non-profit product lab developing open-source AI solutions to decarbonise the electricity grid
- 40 years experience in AI & energy

origin

SIEMENS energy

Google DeepMind

NASA

HABITAT ENERGY

scale

IRCAI GLOBAL TOP 100 OUTSTANDING PROJECT 2022

GLOBAL TOP 100 OUTSTANDING PROJECT

AI solutions for Sustainable Development

unesco

IRC AI

OPEN CLIMATE FIX

Solution

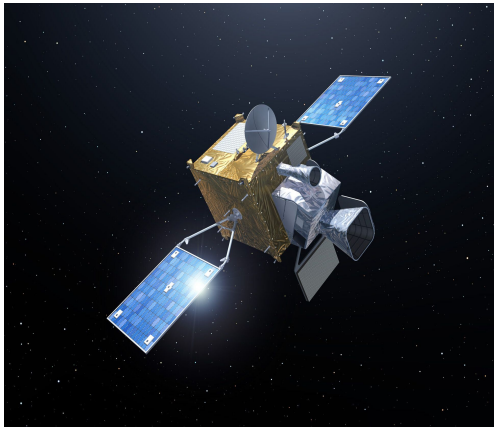
Energy Industry

Researchers

OPEN CLIMATE FIX

Photo copyright Daniel Prudek

Open Source Code and Datasets



- All code made available on **GitHub**
- Models and datasets on **Hugging Face** 🤗
  - 500 people have signed up and downloaded datasets on Hugging Face
  - URL: https://huggingface.co/openclimatefix
- EUMETSAT data on **Google Public Datasets**
  - 15 years (and dozens of TBs) of geostationary satellite data
  - Accessible in an easy-to-access format (Zarr) for machine applications
  - **16,000 downloads** of the EUMETSAT datasets

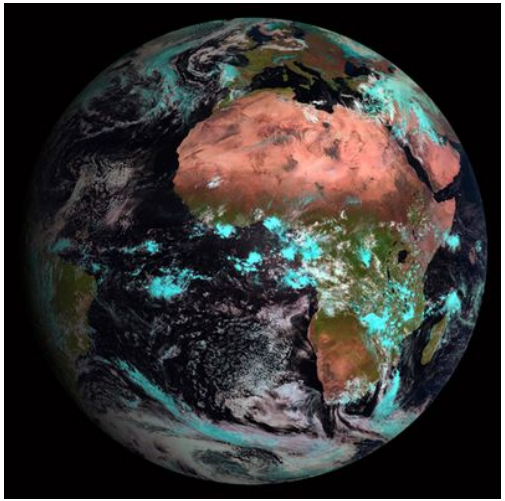
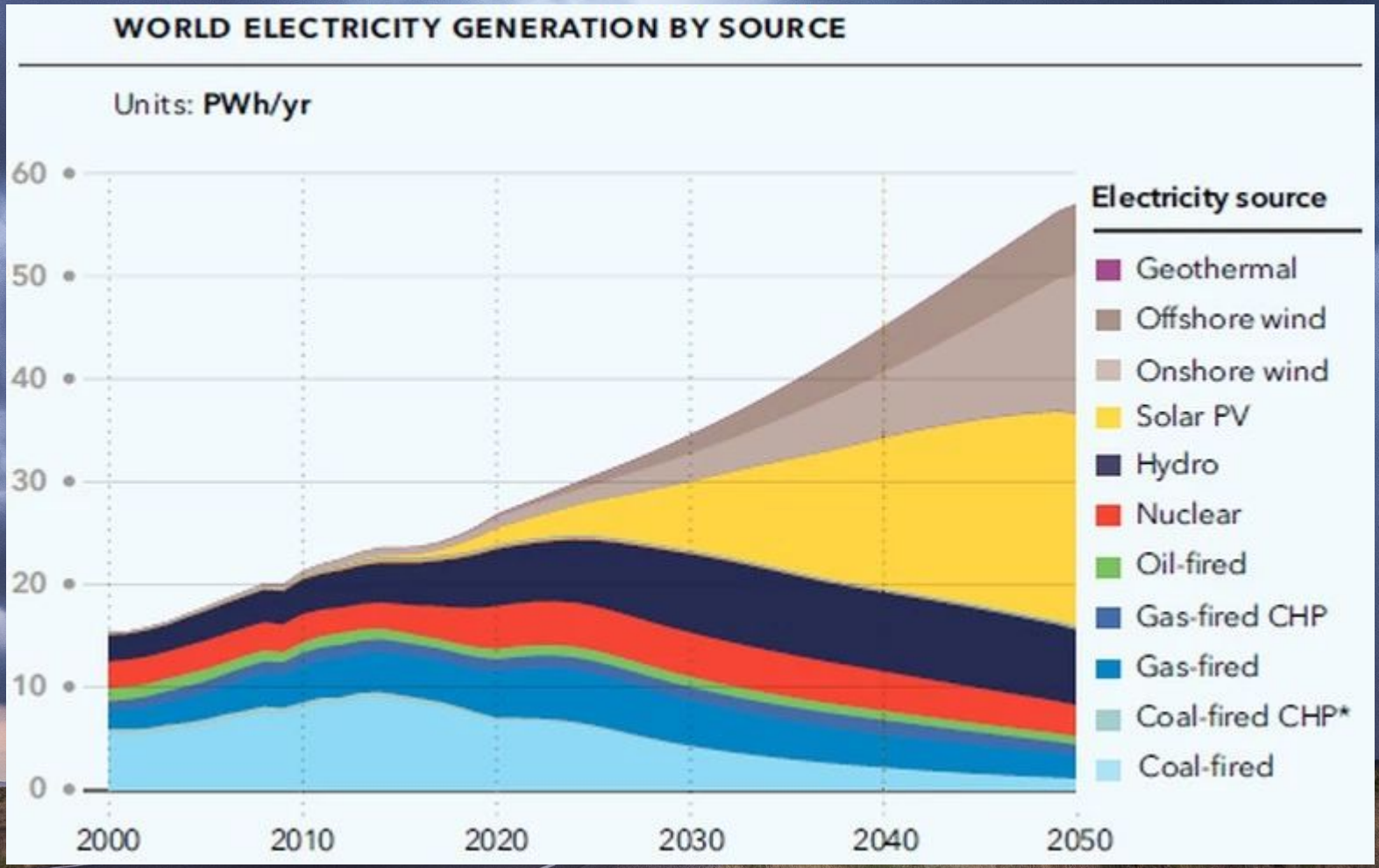


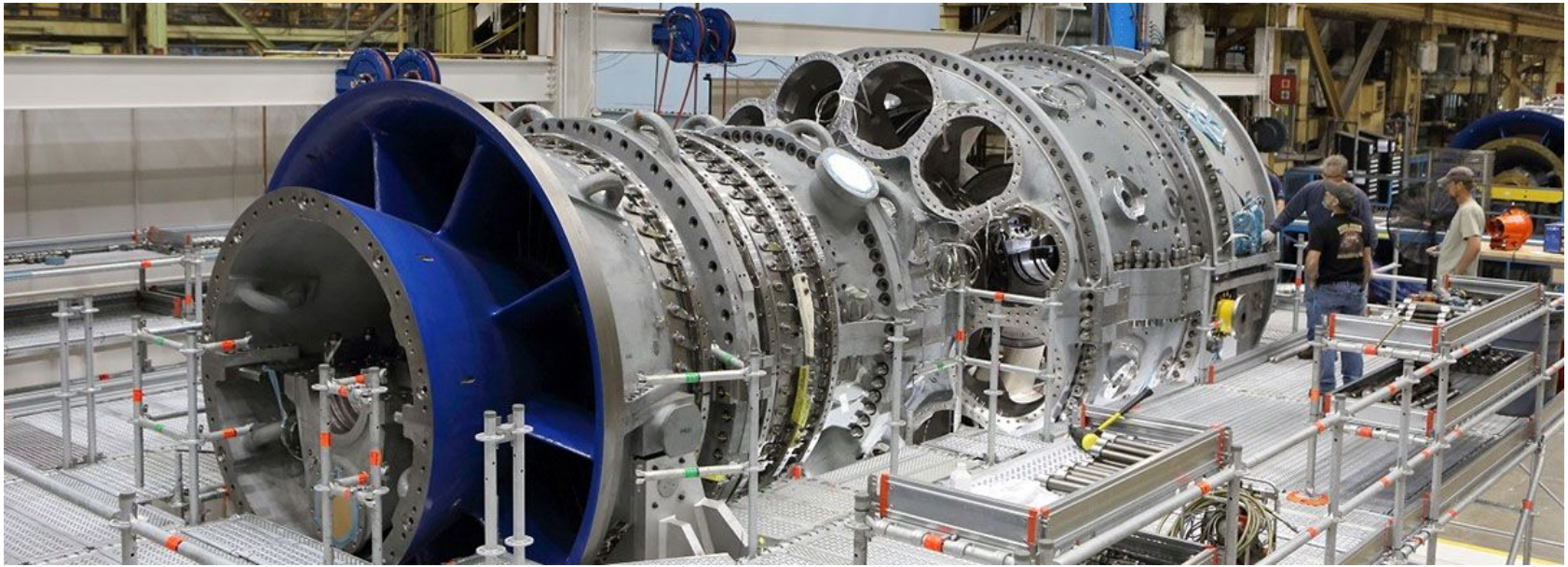
Image take from EUMETSAT's website



(RenewablesNow)

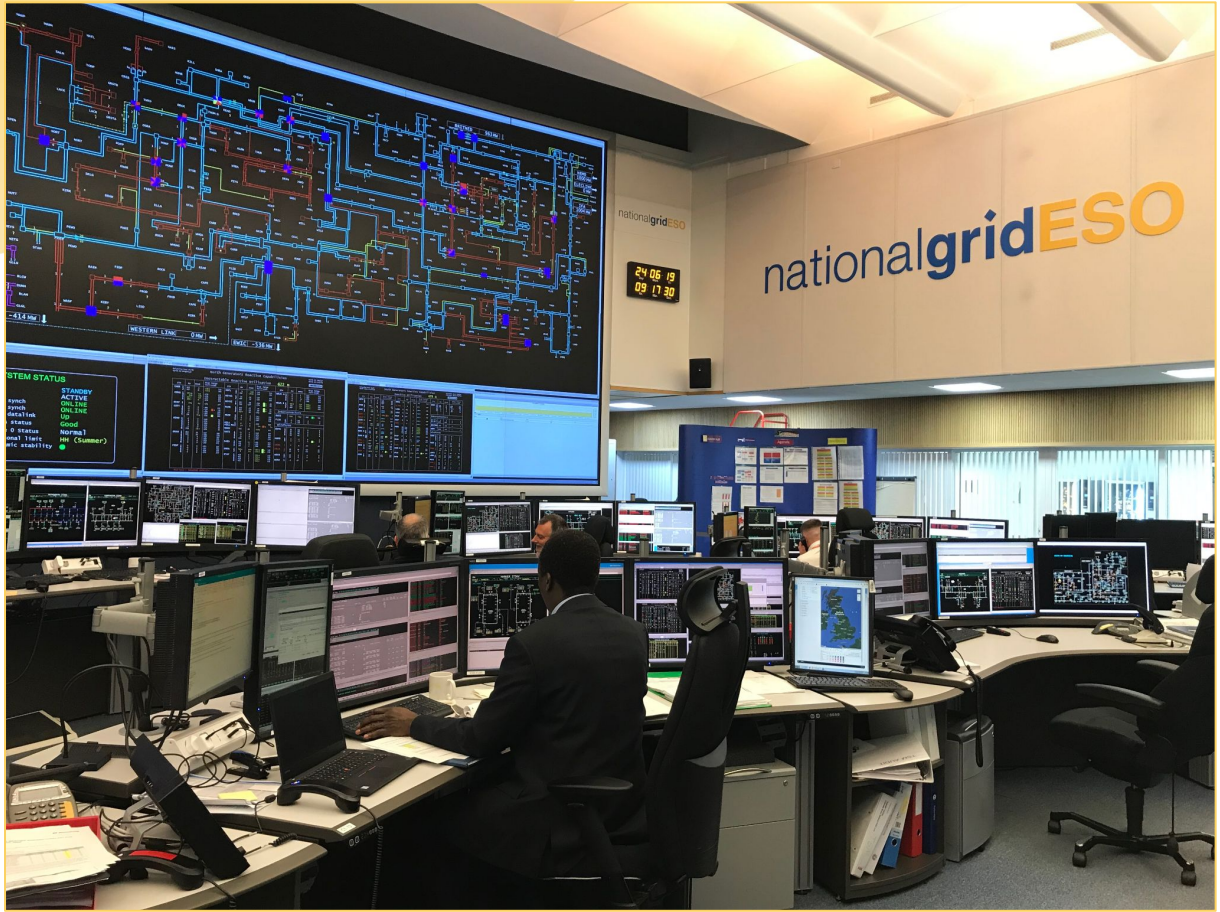
Photo by Raychel Sanner on Unsplash

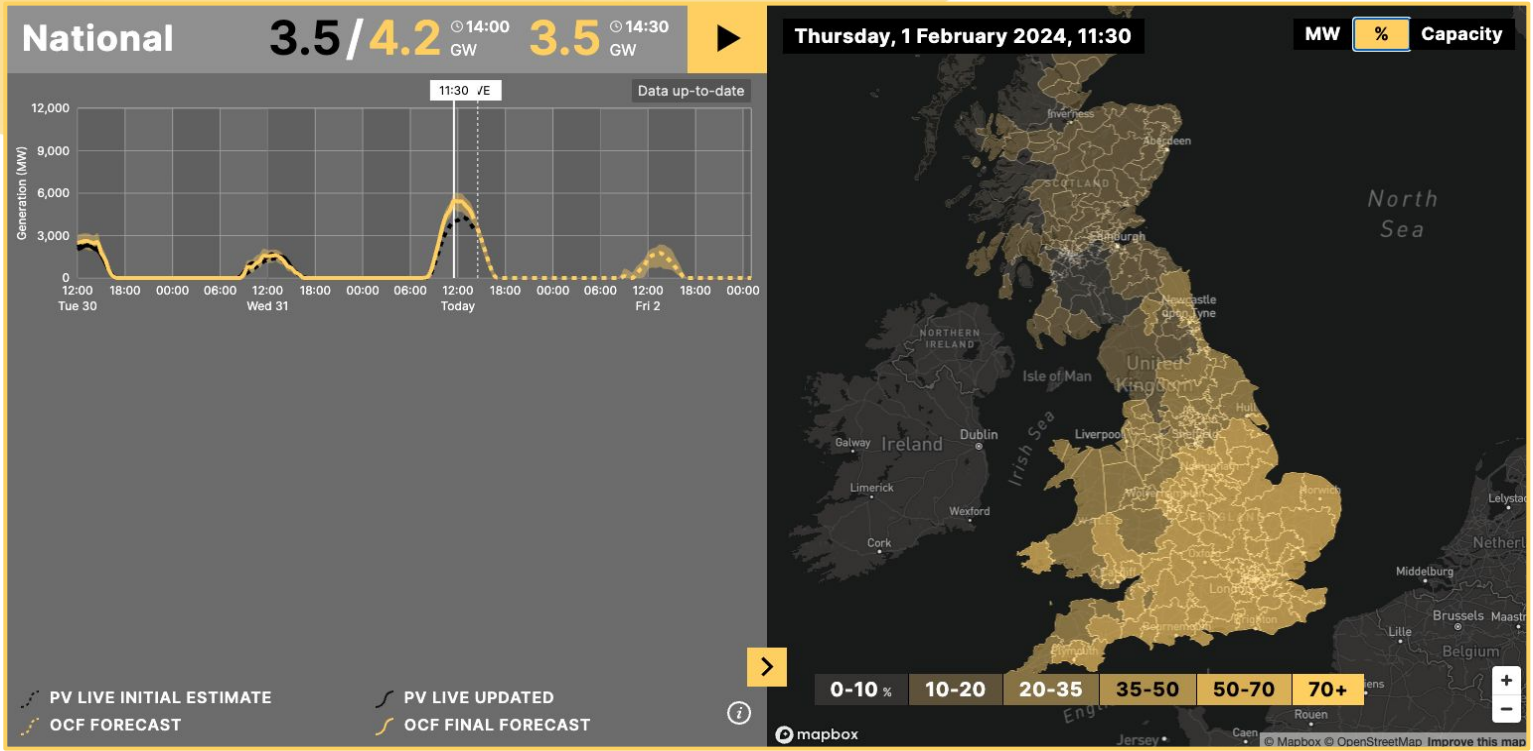
The challenge of spinning reserves

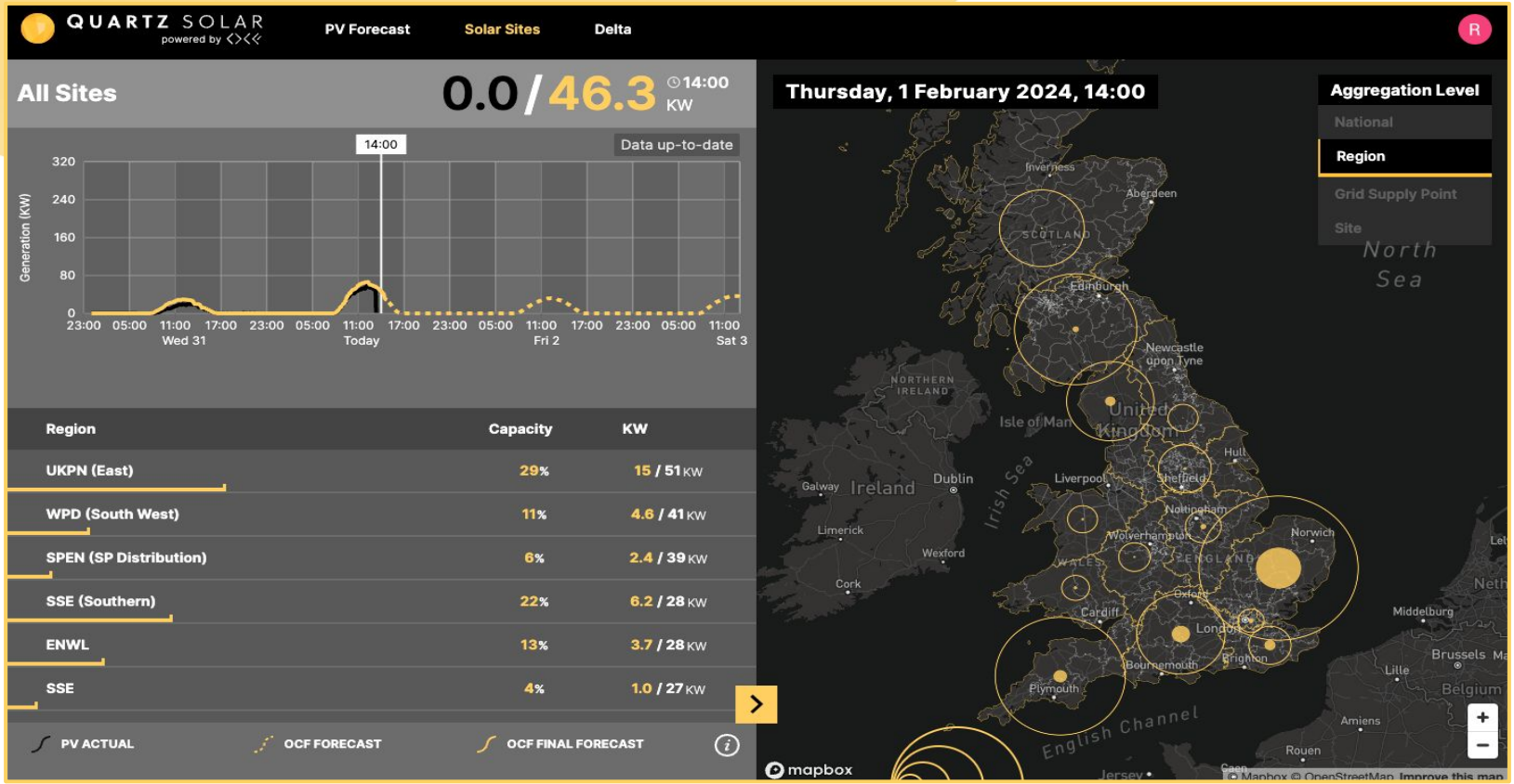


National Grid ESO

- Quartz Solar Forecast used in the control room
- Used for real-time balancing decisions
- 5 mins to 36 hours ahead
- All open source



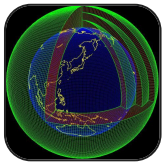

National
3.5 / 4.2 14:00 GW
3.5 14:30 GW
11:30 NOW
Data up-to-date
Generation (MW)
12,000
9,000
6,000
3,000
0
12:00 Tue 30
18:00
00:00
06:00
12:00 Wed 31
18:00
00:00
06:00
12:00 Today
18:00
00:00
06:00
12:00 Fri 2
18:00
00:00
PV LIVE INITIAL ESTIMATE
PV LIVE UPDATED
OCF FORECAST
OCF FINAL FORECAST
Thursday, 1 February 2024, 11:30
MW
%
Capacity
North Sea
Inverness
Aberdeen
SCOTLAND
Edinburgh
Newcastle upon Tyne
NORTHERN IRELAND
Isle of Man
United Kingdom
Hull
Liverpool
Galway
Ireland
Dublin
Irish Sea
Limerick
Wexford
Cork
Middelburg
Brussels
Lille
Belgium
Rouen
Caen
Jersey
0-10 %
10-20
20-35
35-50
50-70
70+
mapbox
© Mapbox © OpenStreetMap Improve this map


QUARTZ SOLAR
powered by
PV Forecast
Solar Sites
Delta
R
All Sites
0.0 / 46.3 KW
14:00
14:00
Data up-to-date
Generation (KW)
320
240
160
80
0
23:00 05:00 11:00 17:00 23:00 05:00 11:00 17:00 23:00 05:00 11:00 17:00 23:00 05:00 11:00
Wed 31
Today
Fri 2
Sat 3
Region
Capacity
KW
UKPN (East)
29%
15 / 51 KW
WPD (South West)
11%
4.6 / 41 KW
SPEN (SP Distribution)
6%
2.4 / 39 KW
SSE (Southern)
22%
6.2 / 28 KW
ENWL
13%
3.7 / 28 KW
SSE
4%
1.0 / 27 KW
PV ACTUAL
OCF FORECAST
OCF FINAL FORECAST
Thursday, 1 February 2024, 14:00
Aggregation Level
National
Region
Grid Supply Point
Site
Inverness
Aberdeen
SCOTLAND
North Sea
Edinburgh
Newcastle upon Tyne
NORTHERN IRELAND
Isle of Man
United Kingdom
Hull
Galway
Ireland
Dublin
Irish Sea
Liverpool
Sheffield
Nottingham
Limerick
Wolverhampton
Norwich
Wexford
WALES
ENGLAND
Cork
Oxford
Cardiff
London
Middelburg
Bournemouth
Brighton
Brussels
Lille
Belgium
Plymouth
English Channel
Amiens
Rouen
Jersey
mapbox
Mapbox © OpenStreetMap Improve this map

Our Live Service Models

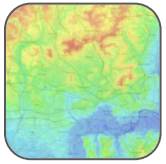
Solar PV data

Numerical Weather Predictions (NWPs)



Satellite Imagery

Topographic data



ML Model

Training data:

- ~60TB Satellite Imagery
- ~40TB NWP Forecasts
- ~10GB PV Data
- ~1GB Topographic map

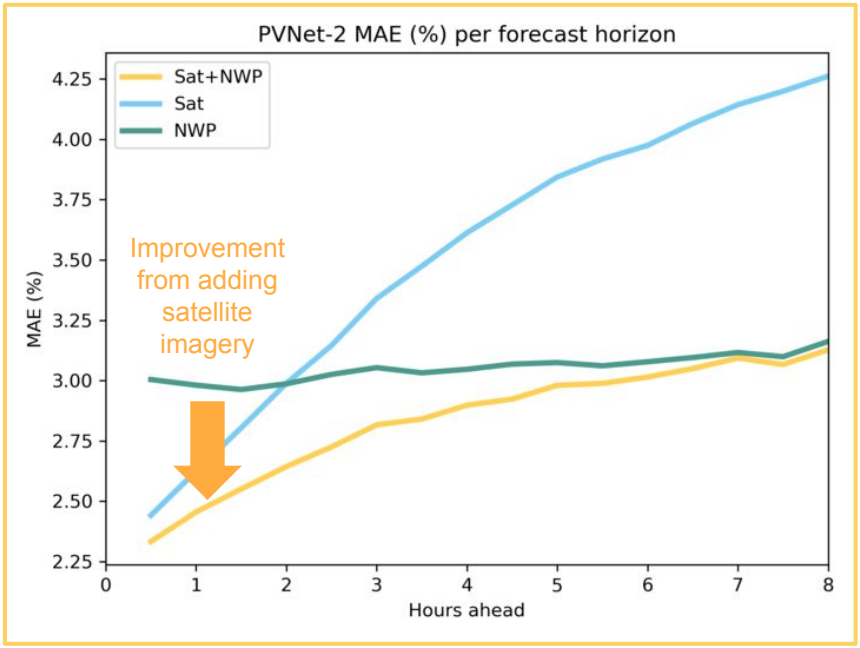
Improved solar PV generation forecast

- National
- Regional
- Individual sites

Quartz Solar Performance

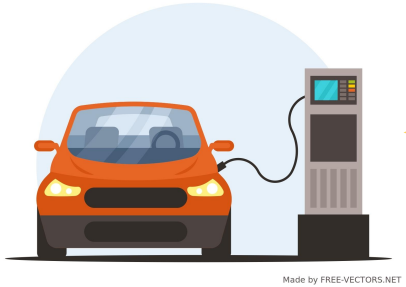
MAE (%) = Mean Absolute Error Normalised By Capacity

- **3x better** than National Grid ESO's previous forecast (2 hour horizon)
- R&D ongoing - models implemented:
  - MetNet: A Neural Weather Model for Precipitation Forecasting
  - Skilful precipitation nowcasting using deep generative models of radar
  - Temporal Fusion Transformers for Interpretable Multi-horizon Time Series Forecasting

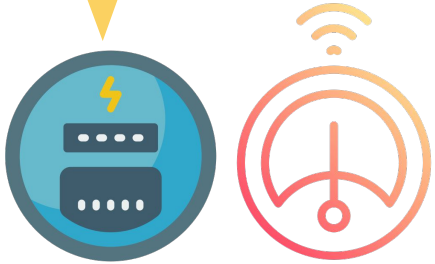


Sites Use Cases

Home Energy Management



EV Charging Optimisation



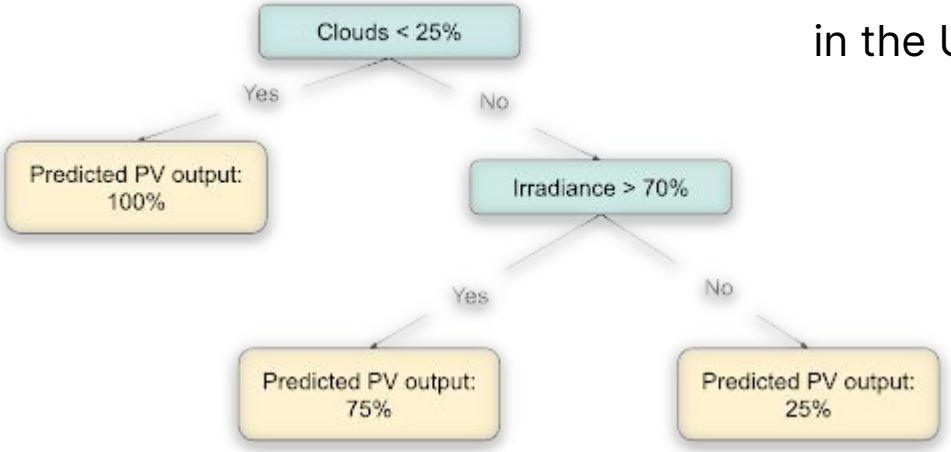
Home Energy Optimisation

Flexibility markets

Who actually uses this?

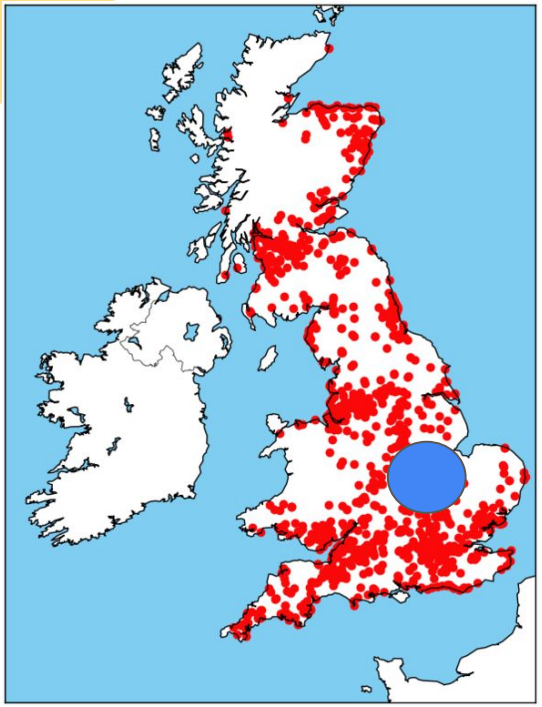
- Smart home operators
- Startups in this space
- Experts in battery optimisation
- Research and academia
- Hobbyists

Our Models - Site



Decision Tree for PV output

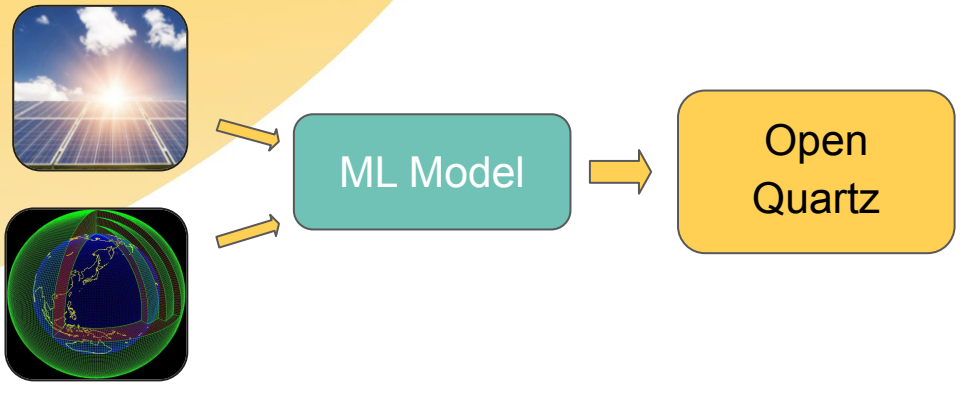
- Trained using over 1,000 household sites in the UK.



Map of UK solar sits

- Model: Gradient Boosted Tree.
  - Thousands of decisions trees.

Open Quartz



- Use open NWPs GFS + ICON
  - Cloud cover, temperature, visibility, short and long wave radiation, precipitation
  - Open Meteo
- Use a pretrained model
  - With the ability to support new models.

- Forecast **48 hours** ahead
- **15 minute** forecast resolution
- Forecast in **four lines of code**
- Embedding complex ML and data ingestion, making it accessible to anyone.
- **6% MAE**

https://github.com/openclimatefix/Open-Source-Quartz-Solar-Forecast

Open Source Solar Forecast - Demo

pip install quartz-solar-forecast

Scan QR code to go to the Quartz Solar Open Source repo.

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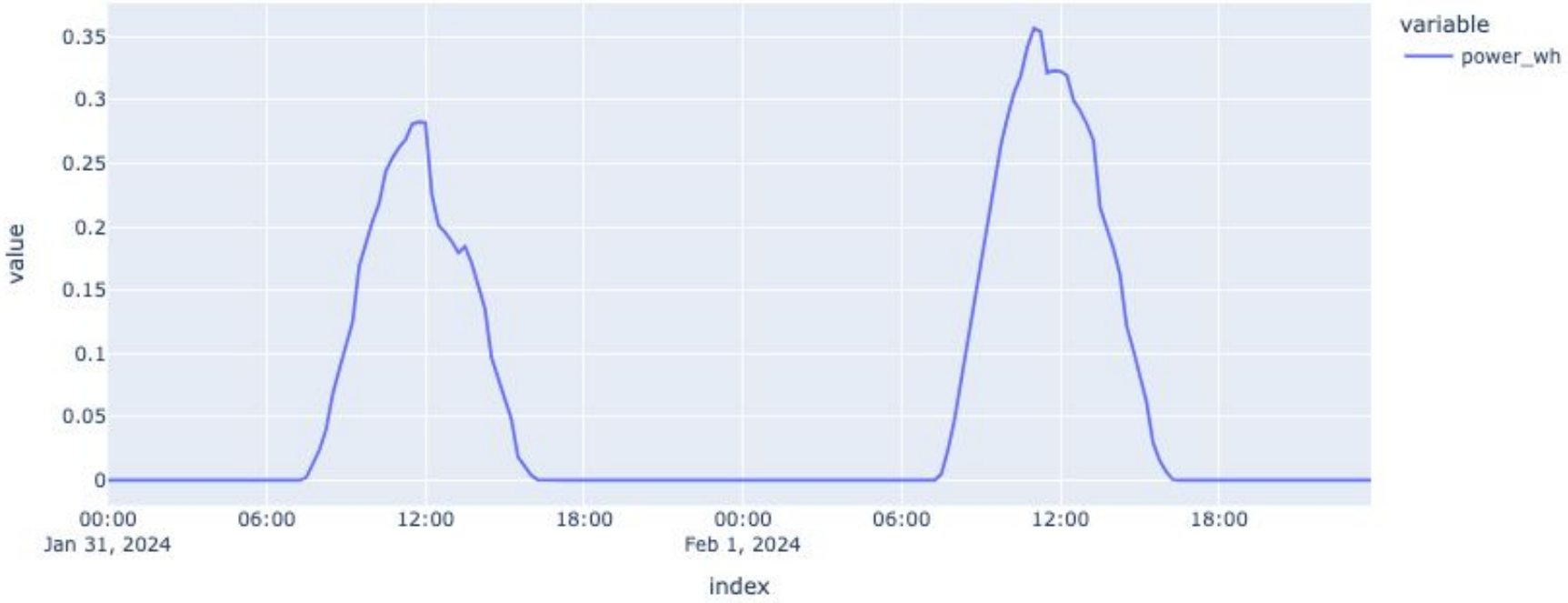
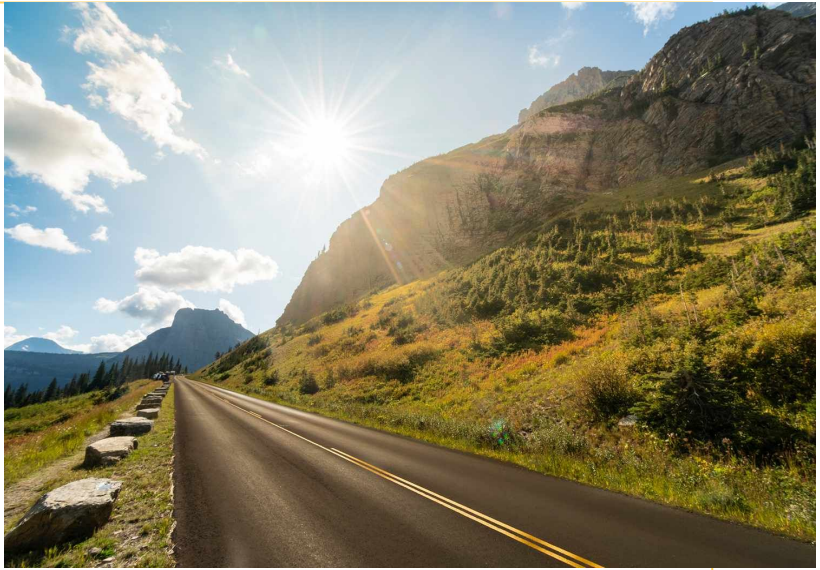

variable
power_wh
value
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
00:00
Jan 31, 2024
06:00
12:00
18:00
00:00
Feb 1, 2024
06:00
12:00
18:00
index

Quartz Open Source Roadmap

- Additional data inputs:
  - More weather data (NWPs)
  - Live PV data
  - Include tilt and orientation
- Integrating and trying out new models
- More diverse solar training datasets
- Experiment



https://github.com/openclimatefix/Open-Source-Quartz-Solar-Forecast

Questions?

Wanna get involved?

Check out ***good first issues*** on GitHub:

Rachel L'Abri Tipton
rachel@openclimatefix.org

Zak Watts
zak@openclimatefix.org

Thank you!

Merci!

Dank u wel!

Rachel L'Abri Tipton

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Zak Watts

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