Energy Forecasting Innovation Conference

Building capacity from modern Statistical Methodology

24-26 May 2022

King's College London and Online

	Tuesday 24 May	Wednesday 25 May	Thursday 26 May
Morning	**Industry Challenge** Industry speakers including representatives of National Grid ESO, EdF, SSEN and E.ON	**Innovation Showcase** Translating research into practice: academic collaborations with Shell, TNEI, and others	**Training (in-person only)** Two training courses in the use of research outputs and dedicated software: *ProbCast* and Statistical Inference with Max-Stable Processes
Afternoon	**Research** Findings of three UKRI projects presented by their leaders: Claudia Neves, Jethro Browell, and Bruce Stephen, plus invited speakers	**UKRI Workshop** Interactive workshop to define research needs, form new partnerships, and identify funding opportunities	

Sponsored by:

Multivariate max-stable processes with application to the forecasting of multiple hazards
Dr Claudia Neves, King's College London

System-wide probabilistic energy forecasting
Dr Jethro Browell, University of Glasgow

Analytical Middleware for Informed Distribution Networks (AMIDiNe)
Dr Bruce Stephen, University of Strathclyde

Claudia Neves, EPSRC UKRI
Innovation Fellow

Multivariate Max-stable Processes
with Application to the Forecasting of Multiple Hazards

Forecasting Multiple Extreme Risks

Primary assumption: real world is not independent, generalised Pareto distributed or simple!

PROBABILITY

NEW theory for Multivariate Max-Stable Processes

Pooling

STATISTICS

IMPROVED inference for extremes

Non-stationarity: space-time trend, moving threshold

APPLICATIONS

Incorporate NEW information that it was not possible to use previously

Thames Valley Project (SSENetworks),

Significant wave height data (Shell)

PROBABILITY

Flexible multivariate max-stable models

Academic Beneficiaries

Longer term impact

STATISTICS

Gain insight into potential hazards

Estimation of failure probability

EDF Energy

Ongoing

APPLICATIONS

Algorithms and software

EDF Energy, SSE Networks, Shell

R-package circularEV

Benefits of Academic-Industry partnership

- Impact
  - Most grant applications are scored based on potential impact
- Insight
  - A good industrial collaboration can result in opportunities you might not have foreseen
- Interesting Open Problems
  - New outlook to your research perhaps making it more exciting
- Data

Management

- Timescales: if there is a timescale stick be VERY open with potential delays.

2020

- Focus: the industrial collaborator has a specific problem, they are rarely interested in what might be publishable.
- Provide very clear explanations

ENGAGEMENT & KNOWLEDGE TRANSFER

KING'S College LONDON

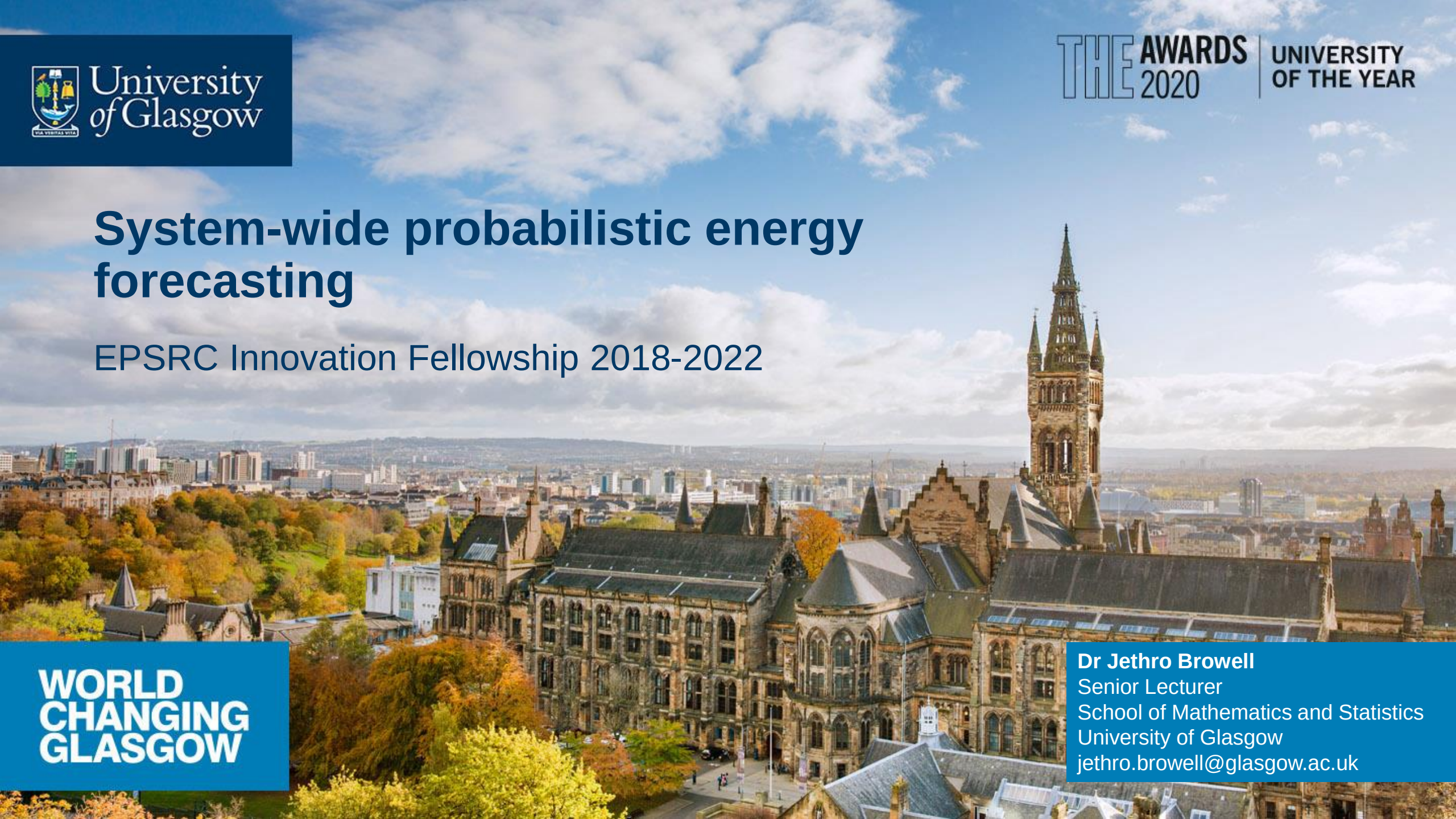
Energy Forecasting Innovation Conference
Building capacity from modern Statistical Methodology

University of Glasgow

THE AWARDS 2020 | UNIVERSITY OF THE YEAR

System-wide probabilistic energy forecasting

EPSRC Innovation Fellowship 2018-2022



WORLD CHANGING GLASGOW

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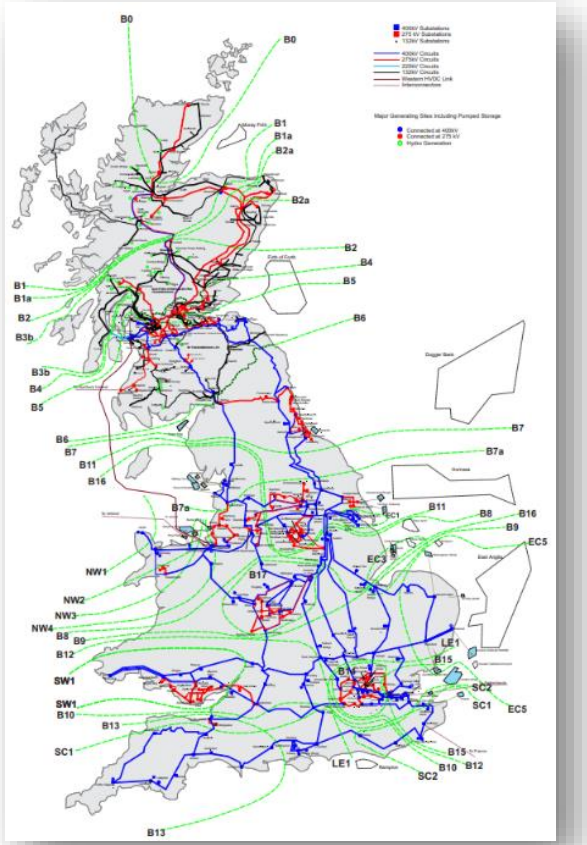
System-wide probabilistic energy forecasting

Motivation

- Energy systems operated under significant and growing uncertainty
- Necessitate that uncertainty is minimised and accurately described to achieve:
  - Efficiency/*"optimisation"*
  - Satisfy risk appetite
- Forecast uncertainty is complex but structured
  - Spatio-temporal
  - Weather and non-weather dynamics

Aims:

- Develop (some of) the statistical methods required to underpin this capability
- Establish potential value for key decision-making problems with partners



Decisions:

- Energy balancing
- Reserve
- Constraints
- Trading

All are multi-variate, spatio-temporal problems!

Innovation Fellowship EP/R023484/1

System-wide probabilistic energy forecasting

University of Glasgow

Core Fellowship Outcomes

2018-19

Wind power
- High-dimensional probabilistic forecasting
- First version of ***ProbCast*** R

2019-20

Regional net-demand
- Models for regional net-demand
- Feature engineering and gridded NWP
- Method for extremes of predictive distributions

2020-21

Applications
- Reserve and constraints
- Hydro operations (s2s)
- Energy trading

2021-22
- Current version of ***ProbCast*** R
- Methods for dynamic dependency structure
- Dissemination and engagement

Many challenges still remain!

Satellite Projects

Forecasting wind power for ancillary service provision — sse, SCOTTISHPOWER

Imperial College London — Inertia forecasting — nationalgridESO

University of Strathclyde Glasgow, University of Oxford — AMIDNe (Analytical Middleware for Informed Distribution Networks) — UKRI Engineering and Physical Sciences Research Council

Control REACT: Probabilistic forecasting in power system operations — tnei, nationalgridESO

Sub-seasonal-to-seasonal forecasting for hydropower forecasting and operations — sse

Electricity imbalance forecasting and multi-vector flexibility — sse, SCOTTISHPOWER, UKRI Engineering and Physical Sciences Research Council

Contributions from students, colleagues, and collaborators involved in these projects: Ciaran Gilbert, Leo May, Robert Graham, Thomas Alexander, David McMillan, Bruce Stephen, Matteo Fasiolo, Gordon McFadzean, Evelyn Heylen and too many more to name.

AMIDiNe: Analytical Middleware for Informed Distribution Networks

Amy Anderson[a], Jennifer Blair[a], Jethro Browell[c], Stuart Galloway[a], Ciaran Gilbert[a], Martin Higgins[b], Weiqui Hua[b], **Bruce Stephen**[a], Rosemary Tawn[a], Rory Telford[a] & David Wallom[b]

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DEPARTMENT OF ELECTRONIC & ELECTRICAL ENGINEERING

DEPARTMENT OF ENGINEERING SCIENCE

UNIVERSITY OF OXFORD

UKRI Engineering and Physical Sciences Research Council

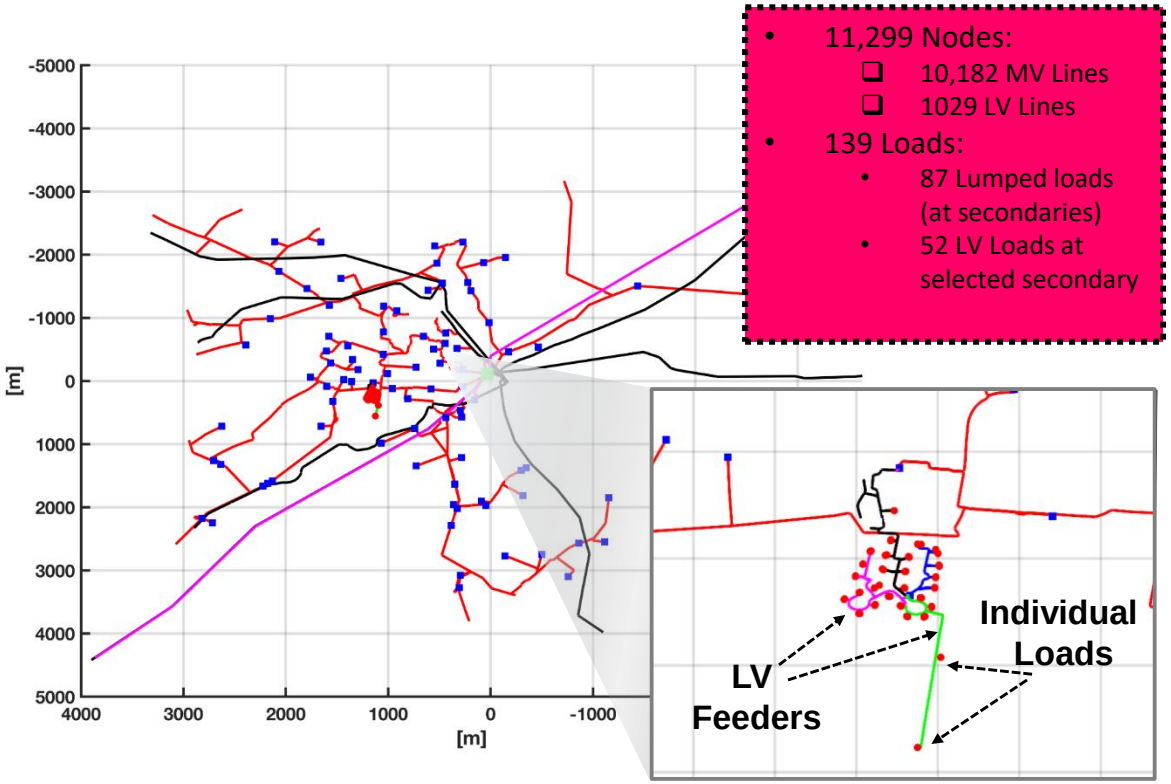
Power Distribution in Transition

AMIDiNe
Analytical Middleware for Informed Distribution Networks

- Last mile of power systems is the Distribution network:
  - Low Voltage (LV), originally intended to deliver power to end users. Nothing else.
  - Simple. No monitoring required.
- But now:
  - Low Carbon heat and transport result in higher loads on un-monitored networks
  - PV on LV networks not reported but can cause voltage issues – again, no monitoring to quantify impact
  - Transmission awareness of distribution behaviour lacking
- Do we need monitoring everywhere before we go any further with this?

Certainty and Uncertainty

AMIDiNe
Analytical Middleware for Informed Distribution Networks



- Know how the network fits together
- Well understood power systems models indicate how it will behave
- Key unknown is what the loads are and what they will do
  - LV distribution features little (no) monitoring
- Can Machine Learning models capture the load unknowns, then use power system models to estimate the remaining network parameters?

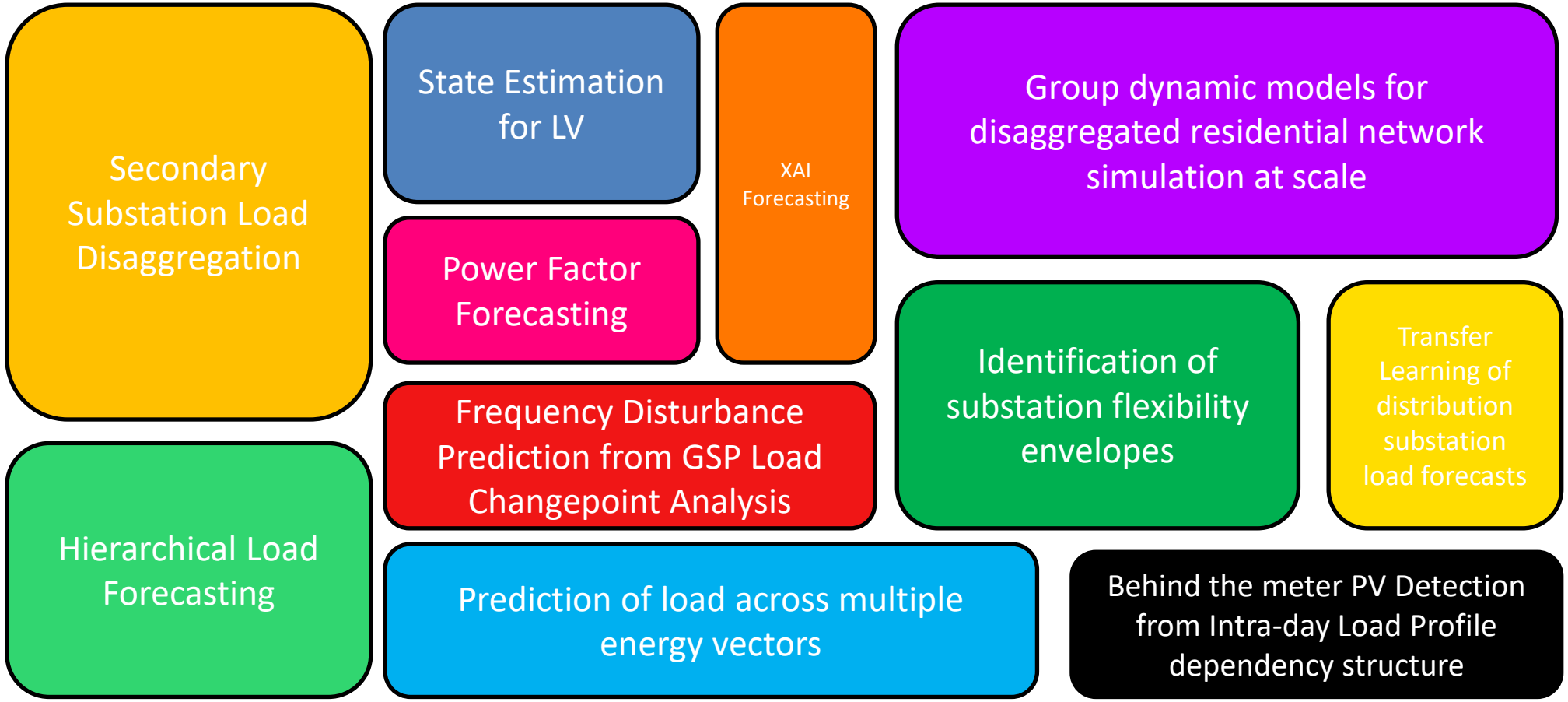
AMIDiNe

- 2 Year EPSRC funded programme of research
  - Development of tools for **managing demand uncertainties** faced by Distribution System Operators
  - Bringing together Machine Learning with Power Systems modelling
- Partners: Strathclyde (Lead), Oxford, Drax (Opus Energy), SSEN (GB DNO and TNO), Bellrock Technology, The Countinglab, PNDC + support from SERL
- **Started 1st October 2019 – now extended to September 30th 2022**
  - Additional industry funded projects pulling outputs through to higher TRL in parallel

AMIDiNe Research Themes

1. Power system observability benefits on the LV Network (Strath)
   - Voltage/demand relations
   - Loss estimates at feeder level
2. Providing load understanding and insights (Ox)
   - MPAN disaggregation (e.g. co-located generation and storage)
   - Dynamics of groups of loads
3. Transmission visibility of distribution flexibilities (Strath)
   - Hierarchical probabilistic load forecasting
   - Forecast error propagation through virtual balancing market units

Identifying Need & Ability: Analytic Sprints



Agenda: Tuesday 24 May

09.30	*Welcoming remarks, event overview, and case studies of collaboration and innovation*
10.00	*Operating the Power System in Great Britain: Forecast Development and Challenges,* Daniel Drew, NGESO
10.45	**Break**
11.15	*Use of forecast to optimise battery flexible services on constrained distribution network and provide security of supply service to DNO,* Maciej Fila, SSEN
12.00	*Using statistics to ensure energy infrastructure safety from climate change and space weather impacts,* Matthew Allcock, EDF R&D UK Centre
12.30	**Lunch**
13.30	*System-wide probabilistic energy forecasting,* Jethro Browell, University of Glasgow
14.15	*Modelling non-stationarity in asymptotically independent extremes,* Jennifer Wadsworth, Lancaster University
15.00	**Refreshment Break**
15.30	*Extreme value statistics born out of domains of attraction,* Claudia Neves, King's College London
16.15	*Statistical inference with max-stable processes,* Marco Oesting, Universität Stuttgart
17.00	**Close**

Agenda: Wednesday 25 May

9.00	*Informing the behaviour of the last mile of distribution networks,* Bruce Stephen, University of Strathclyde
9:45	*On the use of a local R-hat to improve MCMC convergence diagnostic*, Theo Moins, EDF France
10:15	*Combining numerical and statistical methods for improved anticipation of weather and climate risk in energy systems*, David Brayshaw, University of Reading
10.45	**Break**
11.15	*Use-cases for probabilistic forecasting in electricity transmission system operation*, Gordon McFadzean, TNEI Services & Owen Huxley, National Grid ESO
11.45	*Review of Low Voltage Load Forecasting: Methods, Applications, and Recommendations*, Danica Greetham, Capgemini Engineering and Stephen Haben, Energy Systems Catapult
12.30	**Lunch**
13.30	*Research and Innovation Workshop*, Facilitator: Becky Steliaros, Research in Focus Ltd • Sharing ideas and initiating discussions about future research • We hope that interactions initiated here will lead to new collaborative projects.
15:00	**Break**
15:30	Research and Innovation Workshop continued
17:00	**Close**

Agenda: Thursday 26 May

Max-stable Processes

- Instructor: Kirstin Strokorb, Cardiff University
- This course will complement the talk by Dr Marco Oesting on 24 May
- Venue: Bush House – Room 2.05, 9am-12-noon

ProbCast

- Instructors: Jethro Browell, University of Glasgow, and Gordon McFadzean, TNEI
- Venue: Bush House – Room 2.06 , 9am-12-noon
- Materials for self-led tutorial will be available soon...

In-person, registration required. Speak to the organisers at the breaks if you would like to join but are not yet registered.