IN ASSOCIATION WITH

SISER

Scottish Institute for Solar Energy Research

scottish renewables

SOLAR CONFERENCE & EXHIBITION

6 SEPTEMBER 2017 **EDINBURGH**

The Role of Solar in Scotland's Energy System

Jenny Hogan, Deputy Chief Executive, Scottish Renewables

Paul Wheelhouse MSP, Minister for Business, Innovation and Energy

Stuart Speake, Managing Director, Soltropy

Solar Thermal Innovation

www.soltropy.com

@SoltropyUK

SOLTROPY

Cheaper low carbon energy is essential for our future…

- Increase the use of cost effective renewable energy
  - Reduce CO2 and slow global warming
  - Fuel poverty – make energy more affordable
  - Stricter energy efficiency regulations

- Why hasn't solar thermal been used to address these problems?
  - Cost – over £4k - economics don't add up
  - Installations - complex and disruptive
  - Subsidy in UK has skewed market to PV
  - Low level of innovation

SOLTROPY

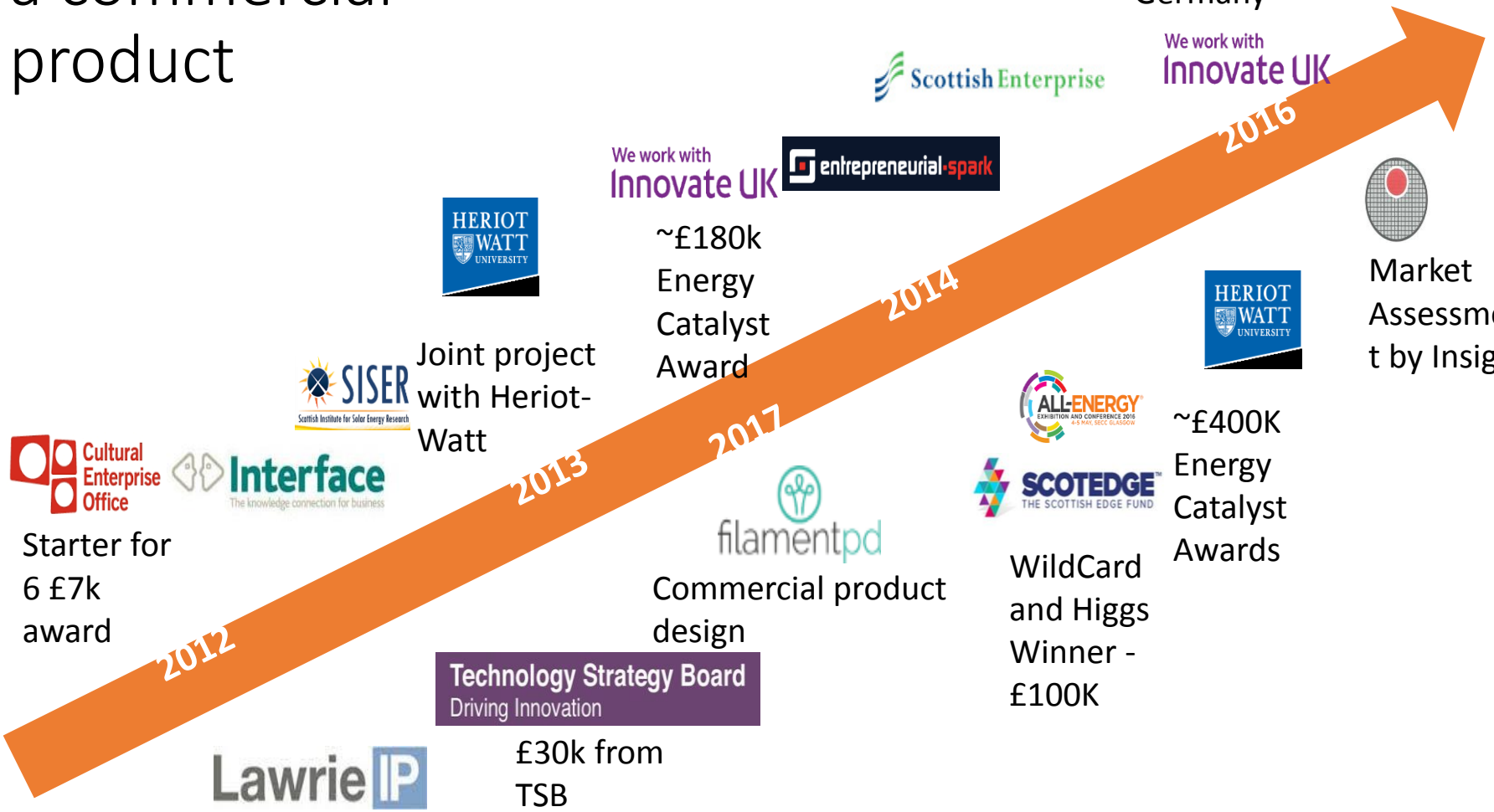
A more affordable, simpler Solar Thermal Solution….

- Ice Immune
  - System can freeze without damage
  - No need for anti freeze
- Modular
  - Evacuated tubes individually mounted to standard copper pipe
  - System customisation
- Affordable
  - Standardised mass produced components
  - Easier installation, less maintenance
  - ~50% existing system cost

SOLTROPY

Team & Traction

From an idea….to a commercial product



SOLTROPY

Working with Academia

- How – through Interface, Energy Technology Partnership (ETP), Scottish Institute for Solar Energy Research (SISER) and Innovate UK.
- Why – credibility, experts in their field, access to facilities.
- Strategy – Sort IP out first if possible, start small and build relationships and follow on with larger projects.
- Cost – typically 30% provided by company or in-kind contribution.

SOLTROPY

Market Analysis

- Through our relationship with Scottish Enterprise, earlier this year we instructed a market research assessment of the solar industry in the UK
  - In particular we were interested to find out what drives customers and installers to choose a particular renewable energy system or technology.

- Obviously it's a challenging time for the market……
  - Subsidies have been cut/reduced
  - Downturn in the economy
  - Uncertainty over the future
  - Comparatively low energy prices
  - Some reputation damage to the industry following the FIT 'boom'

SOLTROPY

But there are positives…..

- The market potential in Scotland and the UK is huge – untapped roof space everywhere
- Consumers awareness and education on renewables energy is growing (just not fast enough!!!!)

- The market drivers for renewable technology are fairly obvious:
  - System price (including installation), and payback are primary drivers (subtle comparisons in performance between systems are secondary – has to impact payback)
  - For installers, ease of installation and reliability of components are key factors
  - Commercial customers (businesses/landlords) are anxious about building efficiency legislation impacting older sites
  - Energy storage has high potential

- Solar PV and Solar Thermal need to stack up against all other renewable technologies in order to be competitive

SOLTROPY

Specifically for Soltropy's technology….

- Lower price than some competitive technology will help engage customers who have ruled out solar due to cost/payback
- Installers see potential to reduce install time & disruption
- Strong feedback that it would be an ideal solution off grid/rural customers
  - Retrofit to existing properties
- Help provide a renewable solution at 'problem sites'

Solar on every roof…….

SOLTROPY

Thank You

IN ASSOCIATION WITH

SISER

Scottish Institute for Solar Energy Research

scottish renewables

SOLAR CONFERENCE & EXHIBITION

6 SEPTEMBER 2017 **EDINBURGH**

Securing a Route to Market

Finlay Colville
Head of Market Intelligence
Solar Media

Stuart Donnelly
Solutions Consultancy Director
Schneider Electric

An Introduction to Corporate PPAs

Stuart Donnelly; Director, Solutions Consulting & Cleantech (EMEA)
Schneider Electric Energy & Sustainability Services

Life Is On Schneider Electric

Agenda

- Global Market Trends & Increased C&I activity
- What is a Corporate PPA
- Challenges & Opportunity

Leader in Strategic Advisory Services

Schneider Electric has advised on more than 2,300 MW of renewable energy PPAs

Key Drivers: A context favourable to renewable energies

Economic

Cost **-80%** Since 2008

Cost **-50%** Since 2009

Cost[1] **-70%** Since 2014

1 Cost of Li-Ion batteries, according to Stem
Source: BNEF, GTM

Operational needs

- **Grid resilience** (US & Emerging countries)
- **Access to energy** (Emerging countries)
- **Strategy and transparency** (Mature countries)

Regulation

+ 20% RE by 2030[3]

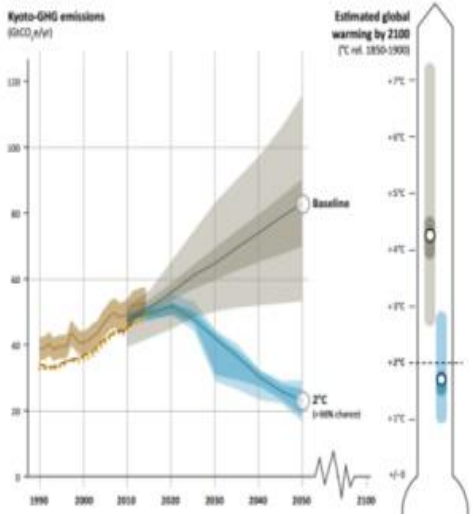
27% RE by 2030[4]

+100GW solar by 2022

RE: Renewable energy
3 Clean Power Act
4 Energy Union and Climate Policy

Global Direction

- ✓ The Paris Agreement entered into force globally
- ✓ Important efforts for reduction GHG
- → 0 net emissions around 2060 – 2080
- → 0 net emissions from fossil fuels around 2050



Voluntary corporate initiatives

- ✓ **CDP:** Carbon Disclosure Project
- ✓ **Science Based Targets:** 297 companies
- ✓ **RE100**: Over 100 Companies
- ✓ Internal price of carbon: more than 1200 companies committed to setting it

Corporations with 100% Renewable Energy commitments

There are 3 ways for Corporates to utilise renewable energy

Energy Attribute Certificates

- The way clean energy use is tracked and traded
- RECs, GOs, I-RECs, TIGRs etc
- Needed to make environmental claims
- Unbundled vs. bundled

Onsite/Distributed Generation

- Direct reduction of energy on meters
- High visual appearance for renewable energy
- Potentially difficult to achieve scale
- Virtual Net Metering possible in certain markets
- Ownership, lease, or PPA options

Offsite Generation

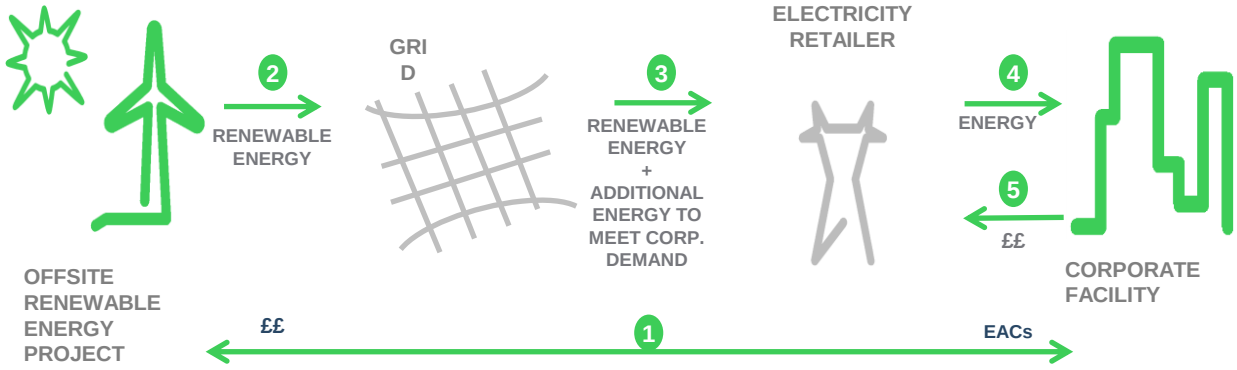
- Large scale purchases of utility-scale projects
- PPA structures (Financial/Virtual, Direct)
- Needed for companies to achieve significant goals with “Additionality”

- EACs are a flexible, and generally short-term, way companies can claim use of renewable energy.
- Onsite solutions are attractive because they offer economic opportunity in addition to environmental claims.
- Offsite generation is particularly attractive for large companies.

The Offsite Corporate PPA Opportunity

- A PPA is a long-term contract for Renewable energy and Energy Attributes
- Developers seek long-term offtake agreements from creditworthy counterparties
- PPA Prices can be interesting for Corporates
- PPA price tied to cost of finance, construction and maintenance - not market or fuel

PPA structure and advantages



1. Corporate pays developer for renewable energy in PPA and receives EACs
2. Renewable energy delivered to grid
3. Electricity retailer receives PPA renewable energy and supplements with additional grid energy to meet corporate demand
4. Electricity retailer delivers all needed electricity to corporate facility
5. Corporate pays electricity retailer service fee for delivery of renewable energy, plus costs of additional grid energy

Power Purchase Agreements (PPAs) empower organisations to:

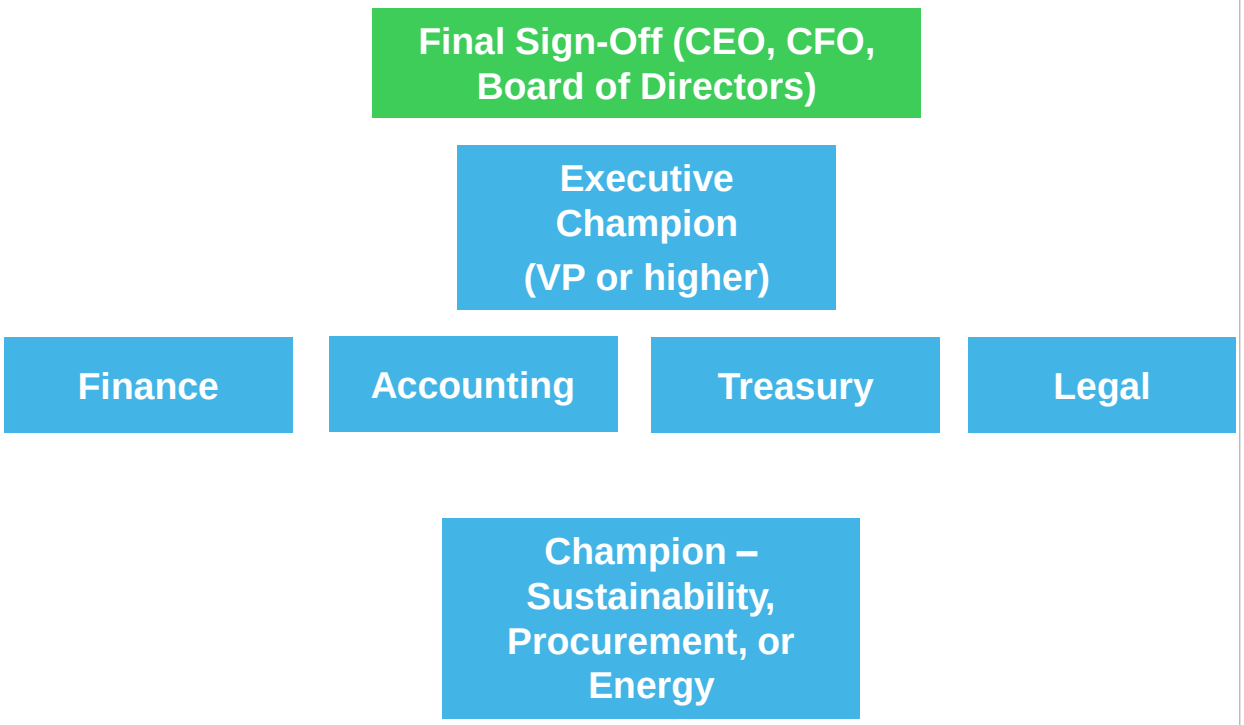
- Manage energy costs
- Mitigate conventional energy volatility
- Meet renewable energy and carbon-reduction commitments
- Stimulate the growth of clean technologies

Life Is On Schneider Electric

Corporate PPA Challenges

- **Price** – Bringing willing buyer and seller together at the right price.
- **Bankability** – The creditworthiness of the offtaker(s) is important.
- **Volume** – Sizing corporate requirements to projects.
- **Tenor** – Agreeing long-term contracts may require complex internal approvals in corporates, where energy procurement normally completed on a shorter term basis, and is not a core function.
- **Legal complexity** – Agreements may be complex to negotiate, for example clauses relating to risk, termination, curtailment etc.
- **Regulatory Issues & Accounting Treatment** – Agreements can be complex depending on structure. Consideration of OTC derivatives in relation to EMIR/MIFID II may be required. Accounting standard interaction, US GAAP / IFRS also required.

Corporate Stakeholder Engagement



- Corporate structures can be complex. Allied with a complex deal, navigating & gaining approval can require resource utilisation on all sides.
- Important to know the audience and potential challenges.
- Ensure project will address multiple goals (e.g. environmental AND economic).
- Ensure key stakeholders are at the table from the beginning—and surface all reservations or personal agendas.
- Develop clear, shared understanding of the goal.
- Assess Risk and considerations across dimensions.
- Facilitate frequent, discrete communication.

Continue the Conversation…


@SchneiderESS


Schneider Electric
Energy & Sustainability Services


Schneider Electric
Energy & Sustainability Services


http://hub.resourceadvisor.com/latest-perspectives


stuart.donnelly@ems.schneider-electric.com

Life Is On Schneider Electric

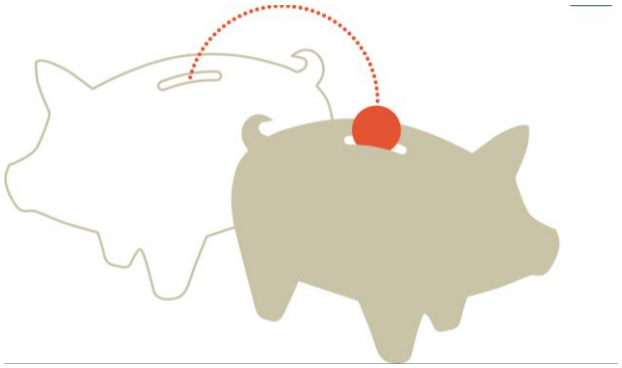
Matthew Grimwood
Partner
TLT LLP

Securing a route to market: alternative business models

Matthew Grimwood
Partner, Energy & Renewables, TLT

Subsidy free solar

- Large scale stand alone projects
- Economies of scale – infrastructure / technology
- Bankability of models: debt v equity, funding & appetite to fund
- Reconfiguring of leases for 1.2ROC projects not built-out
- Economic reliability of direct off-taker and impact on scheme / funding

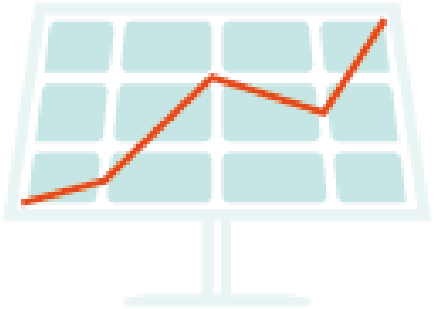


Co-location: solar + wind

- Complimentary technologies – maximise potential of natural resource and grid connection
- Shared grid connections – significantly reduces development cost for solar
- Shared infrastructure / site development reduced overall cost
- Increased output makes overall model more bankable / attractive to investors
- Potential planning benefits

Co-location: solar + storage

- Storage opening up possibility of commercial deployment of solar in Scotland Ground mounted / rooftop solar + storage
- Private wire PPA with direct off-taker. Scottish Water are using this model on treatment plants and reservoirs.
- Grid balancing services:
  - Capacity market
  - Firm frequency response
- Bankable model – guaranteed revenue streams
- Cost of technology making schemes more viable



Co-location: key issues

Project structure:

- Ownership
- Funding constraints
- Lease title documentation may restrict use, requiring legal input

Shared grid connections and other infrastructure

Impact on existing subsidies

Mitigating risks arising from a temporary loss of the shared connection

Termination of arrangement

Behind the meter: solar + storage

- Canopy solar / rooftop solar combined with energy storage
- Large energy users direct off-taker i.e. retailers / manufacturers / automotive companies / mixed-use developments / warehouses
- Reducing impact of businesses on national grid
- Ancillary grid balance services
- PPA arrangements
- Lease documentation

Behind the meter: lease considerations

- Import / export arrangements
- Electricity savings / electricity demand
- Grid connection arrangements / Co-operation
- Counterparty (landowner) insolvency risk
- Supply licence exemption rules
- Landowner’s electrical infrastructure
- On-site generation equipment

Matthew Grimwood
Partner, Energy & Renewables, TLT
matthew.grimwood@tltsolicitors.com
Direct Dial: 0333 00 60393

Andrew Bright
Director
ITP Energised

ITPENERGISED
Earth. Smart. Solutions

Alternative Routes to Market

Future options for solar energy

Andrew Bright

Director, ITPEnergised

ITPENERGISED
Earth. Smart. Solutions

About ITPEnergised

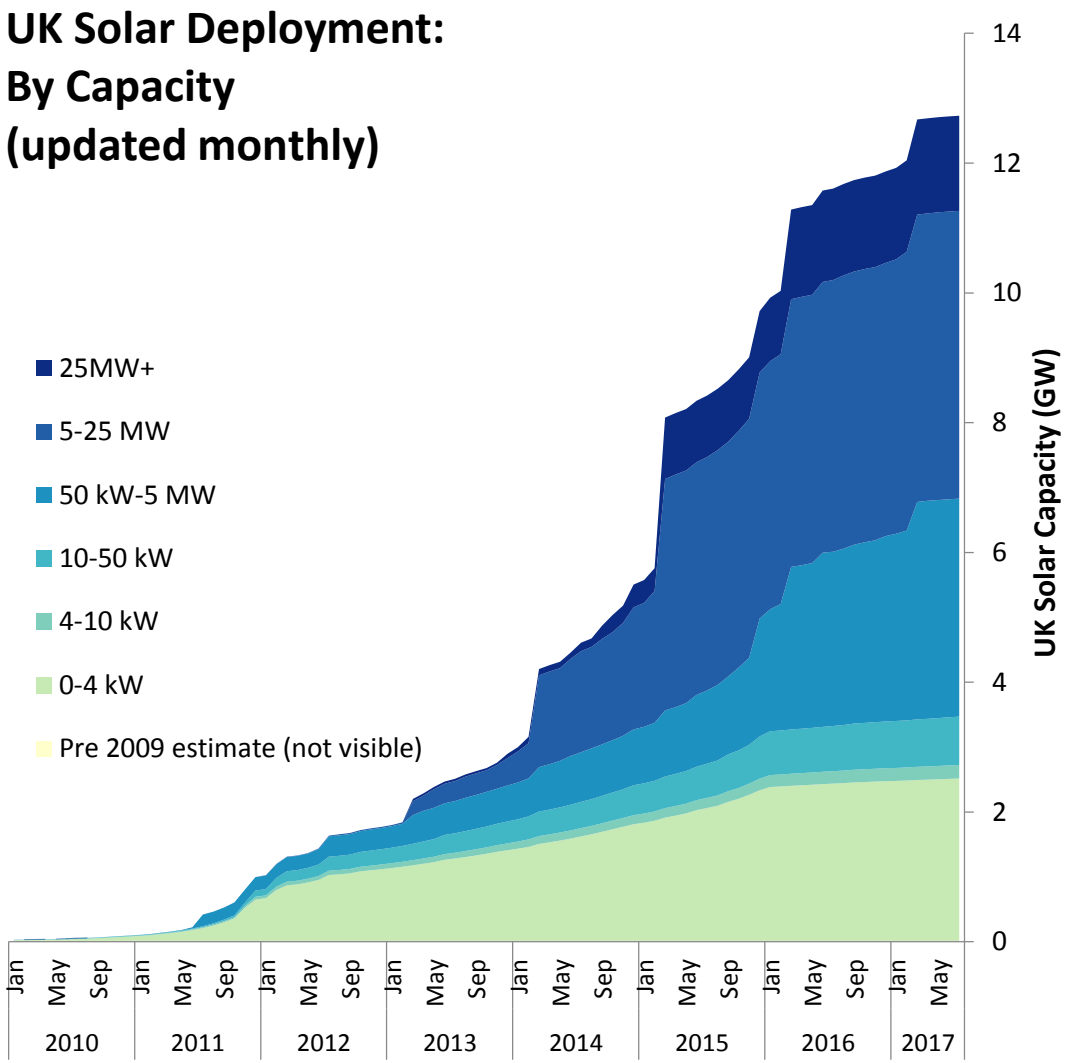
- ITPEnergised is a leading consultancy offering energy, environmental, engineering, technical advisory and renewables asset management services
- Our highly experienced team provides expert, pragmatic and commercially focused advice to our clients.
- Employees: 45 staff
- UK Offices: Edinburgh, Glasgow, London, Bristol
- Staff based in Spain, Portugal, Buenos Aries.

Overview

- Solar today
- Solar tomorrow
  - Mini-grids
  - Private wires
  - Virtual net metering

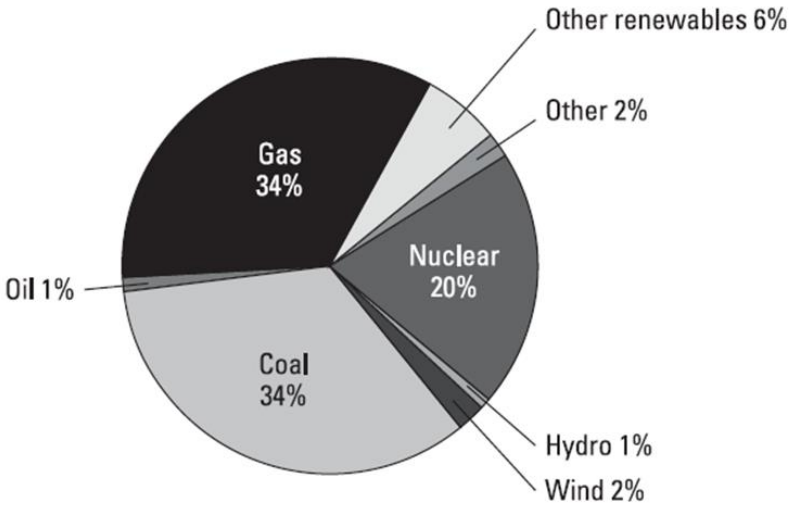
Solar Today

- July 2017, overall UK solar PV capacity stood at 12,730 MW across 922,509 installations
- 46% (5,890 MW) of total installed solar PV capacity comes from large scale installations greater than 5 MW,
- 20% (2,502 MW) coming from small scale 0 to 4 kW installations.



Source: Solar Photovoltaics Deployment in the UK, July 2017, BEIS.

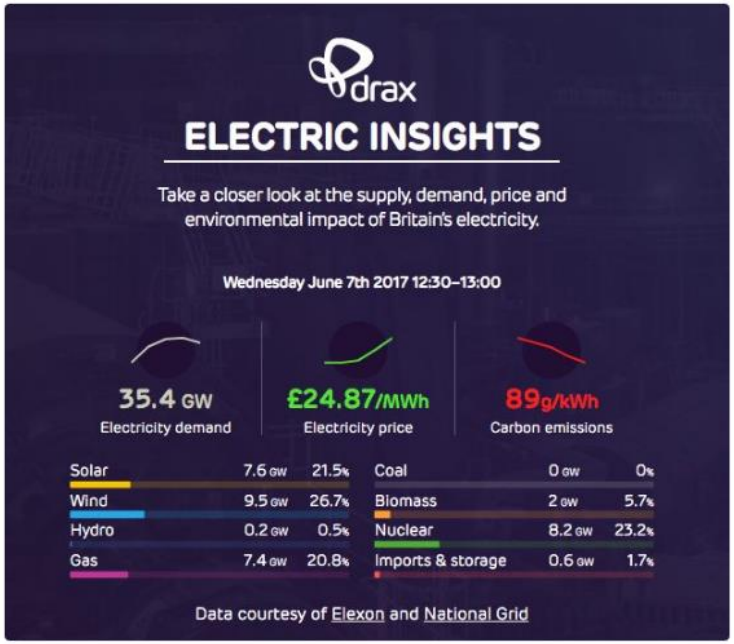
ITPENERGISED
Earth. Smart. Solutions



Source: DUKES, July 2012

Drax
@Draxnews
Follow

Britain has a new #renewables peak power record of 19.3 GW!
☀ 7.6 GW
🌲 2 GW
💨 9.5 GW
💧 0.2 GW
electricinsights.co.uk

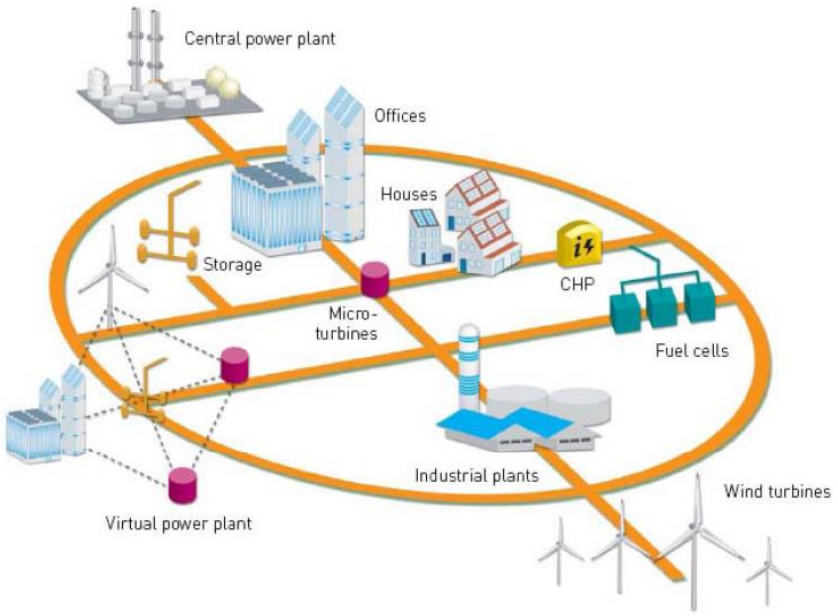


5:12 AM - 7 Jun 2017 from Drax, England

Source: Twitter @Draxnews, 7/07/17

Mini-Grid – Solar will play a key role

- Local area with clearly defined boundary
- Multiple, connected distributed energy sources
- Interconnected loads
- Controllable/optimised
- Can be grid connected or “islanded”



Source: EC research document – Vision and Strategy for Europe’s Electricity Networks of the Future

Private Wires

Poultry Farm – 5MW

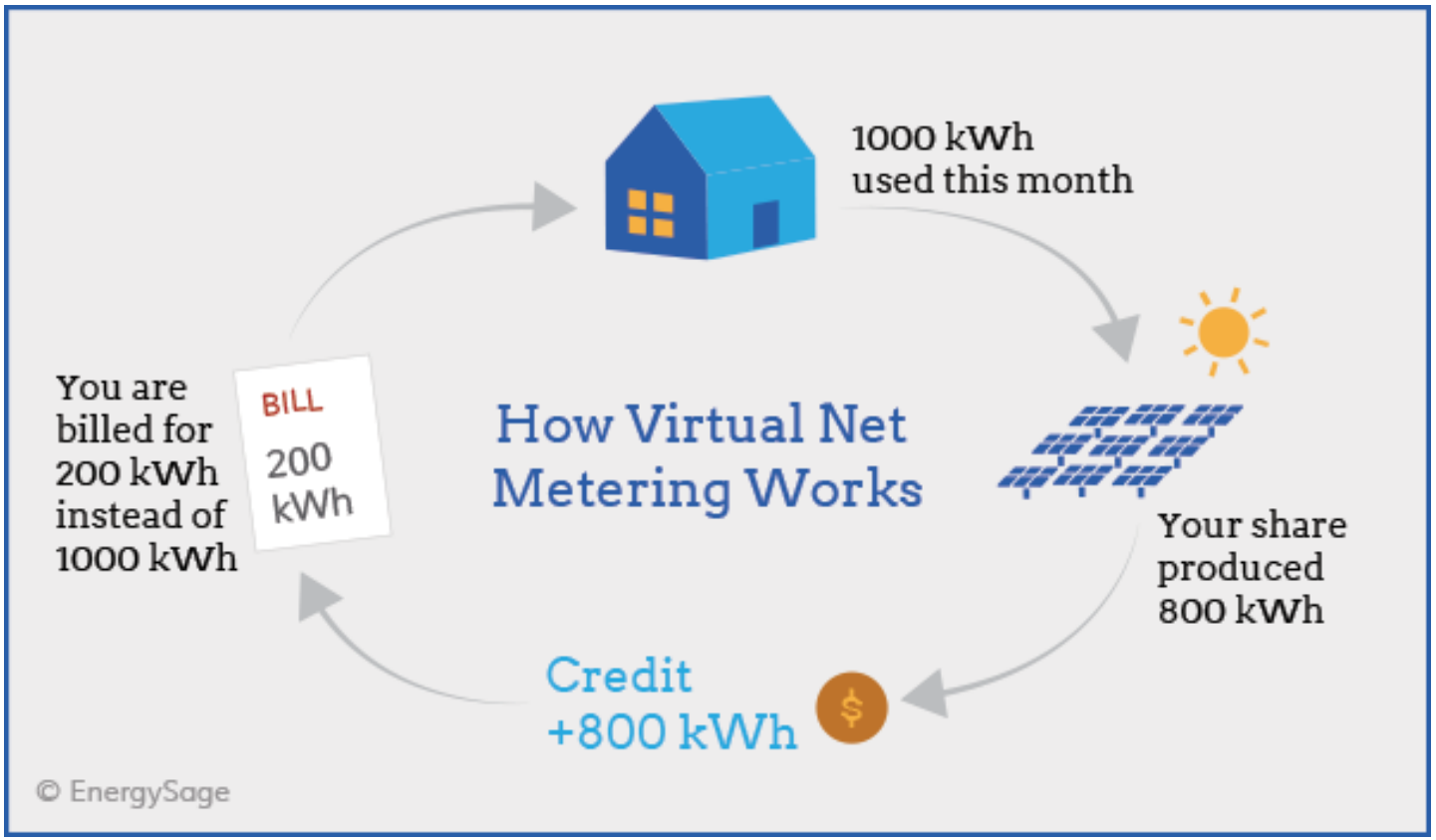
- Grid Connected PV Farm
- Feeds power into landowners poultry facility and now they are installing batteries.
- Can export from PV and is still grid connected

Water Utilities – various scales

- Example – 4000 sites to be surveyed for solar PV (ground mounted).
- Initial target of 30MW by March 2018.
- Target beyond this is not defined, but CEO has stated he wants to install as many sites as is practicable
- All Private wired with long term PPA.
- Systems optimised to reduce any export need

Emerging Models

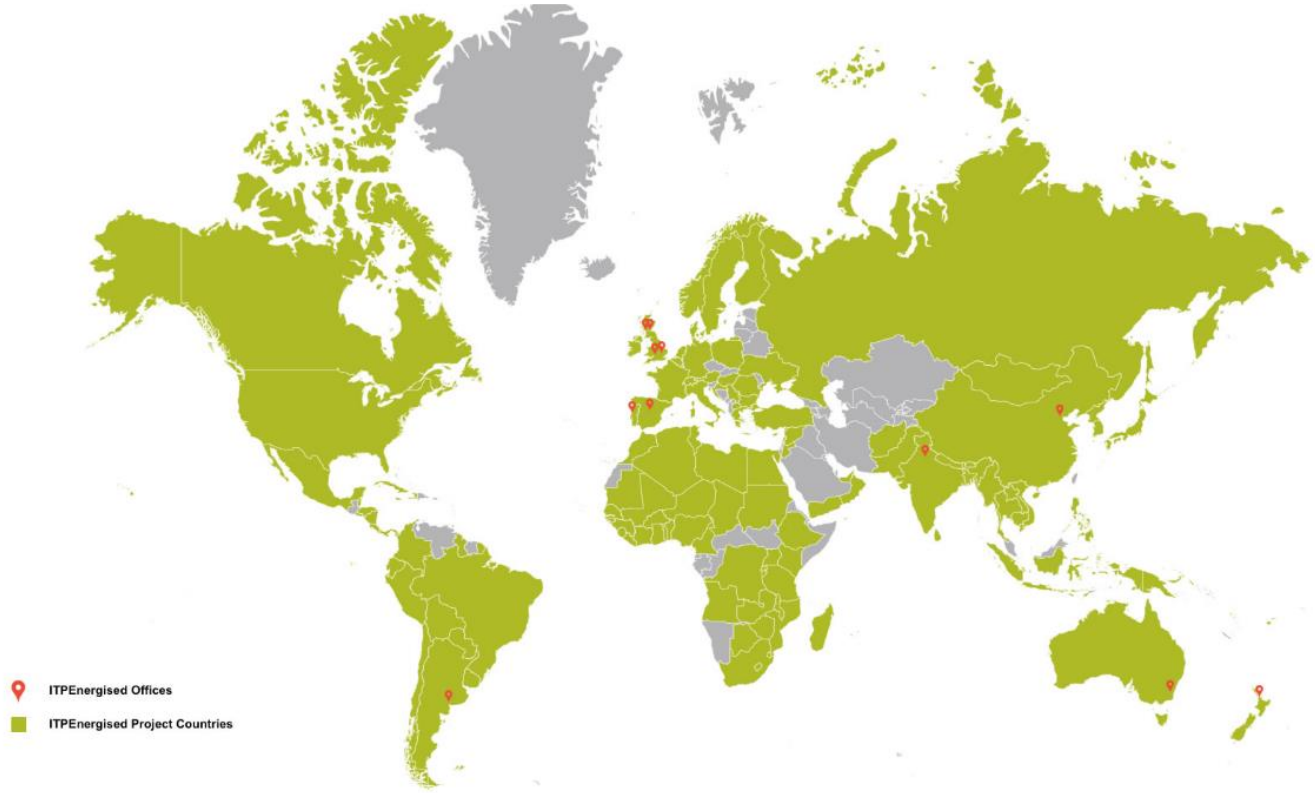
Virtual Net Metering



Source: EnergySage

Conclusions

- Solar energy will continue to grow as part of the UK energy mix.
- More solar will form part of mini-grid/islanded developments
- Private wires for industrial users will become more prevalent
- Virtual net metering could unlock community solar and create a “prosumer” market



ITPENERGISED
Earth. Smart. Solutions

Head Office

ITPEnergised
7 Dundas Street
Edinburgh, UK
EH3 6QG

T: +44 131 557 8325
E: info@itpenergised.com

Some of our clients

ITPENERGISED
Earth. Smart. Solutions

Securing a Route to Market

Finlay Colville, Solar Media
Stuart Donnelly, Solar Media
Matthew Grimwood, TLT LLP
Andrew Bright, ITP Energised

IN ASSOCIATION WITH

SISER

Scottish Institute for Solar Energy Research

scottish renewables

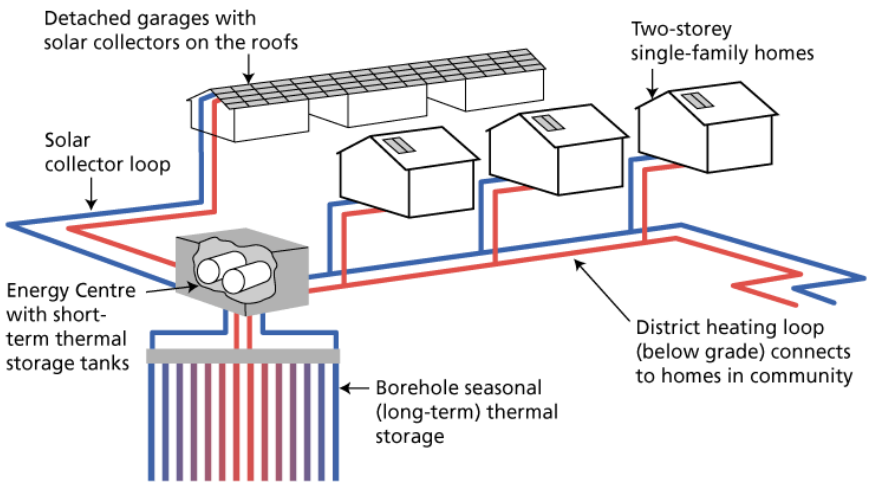
SOLAR CONFERENCE & EXHIBITION

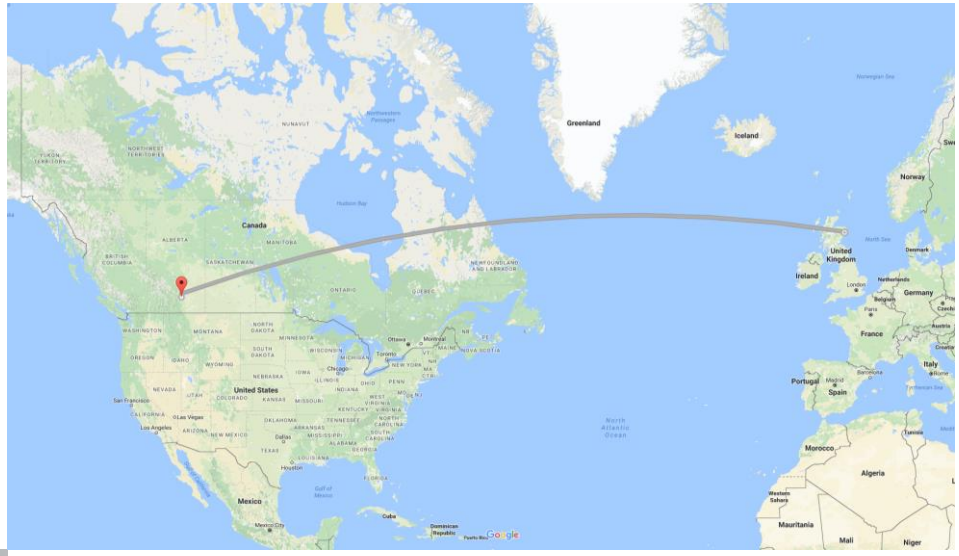
6 SEPTEMBER 2017 **EDINBURGH**

Solar District Heating in Scotland

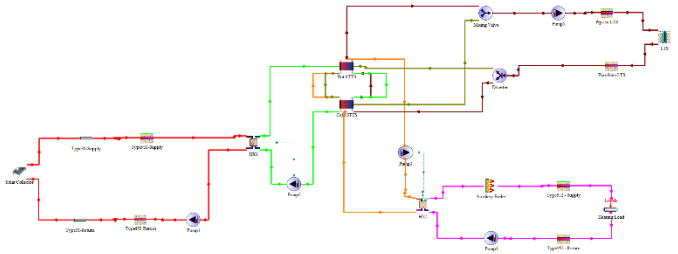
Renaldi Renaldi, Daniel Friedrich
Institute for Energy Systems, School of Engineering, University of Edinburgh

Drake Landing Solar Community, Okotoks, Canada





TRNSYS 17



- **Solar Fraction**
- **System Efficiency**
- **LCOE & $LCOE_{SolarThermal}$**

THE UNIVERSITY of EDINBURGH

Effects of Atmospheric Parameters on the Performance of Concentrated Photovoltaic Receiver

Ali O.M.Maka & Tadhg S. O'Donovan

Institute of Mechanical, Process and Energy Engineering
School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, UK

Abstract

The effect of atmospheric conditions, such as Air Mass (*AM*), Solar Irradiance and temperature, on the thermal and electrical performance of triple junction solar cells are assessed. The position of the sun in the sky has a significant effect on the Air Mass, which, in turn, changes the solar spectrum. Each layer of a triple junction cell converts a different wavelength range of the incident spectrum and therefore the cell is highly sensitive to changes in Air Mass. Spectral attenuation as the air mass increases has a significant effect on electrical conversion efficiency of triple-junction solar cells

Results

A parametric study has been conducted in COMSOL Multiphysics, for ambient temperatures ranging from 25 to 45°C and convective heat transfer coefficients ranging from 2- 3 kW/m^{2}K

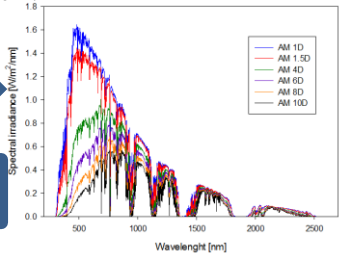
Introduction

The thermal and electrical performance of High Concentrating Photovoltaic (HCPV) modules is strongly depending on the solar cells, which, in trun is dependent on atmospheric parameters such as Direct Normal Irradiance *(DNI)* and Air Mass (*AM*). Air Mass varies significantly throughout the day, resulting in significant changes in the spectral distribution of *DNI* at the surface of the Earth [1].

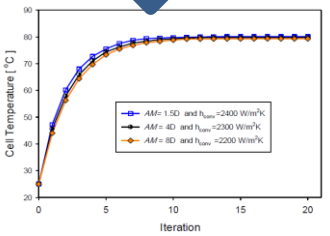
Numerical Model

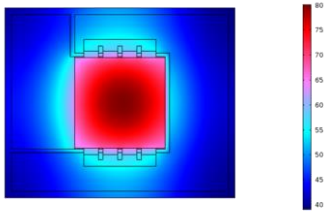
- Generates direct spectral irradiance by using version2 SMARTS model for different *AM* values.
- The electrical model of a (GaInP/GaInAs/Ge) triple junction solar cell builds in order to evaluated solar cell performance according to the changed in spectral irradiance.
- The thermal model predicts cell temperature as a function of variations of different *AM* values.

Influenc e of Air Mass on Solar Spectru m

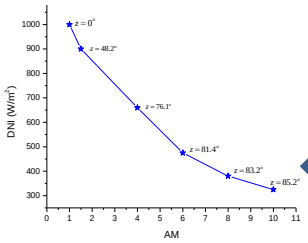


Demonstration of Integrated Numerical Modelling

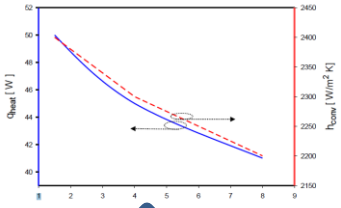




Temperature distribution on CPV Module *AM* 1.5D; Ambient =25°C; h_{conv} =2.4 Temperature kW/m²K



Influenc e of Air Mass on DNI



Effect of Air Mass on required heat dissipation and convective heat transfer

Conclusions

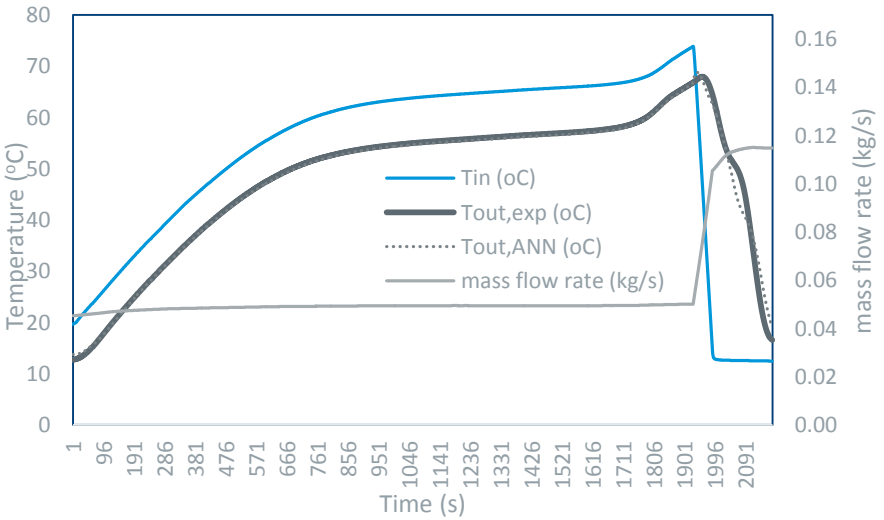
- Increasing Air Mass significantly compromises the Direct Normal Irradiance; the consequence of such is a reduction in cell performance.
- A reduced electrical conversion efficiency increases the need for effective thermal management.
- Both increasing Air Mass and Ambient temperature require higher convective heat transfer coefficients if the cell temperature is to be maintained at or below 80°C.
- While as *AM* decrease, the h_{conv} values decrease because of heat power decreases.

Reference

[1] Bett, A. W. et al, IEEE conference , Waikoloa, HI ,2006.

Distinctly Ambitious
www.hw.ac.uk

Neural network model of a latent heat thermal energy storage system



Dr Faisal Ghani
Institute of Mechanical, Process, and Energy Engineering
Engineering & Physical Sciences
Heriot-Watt

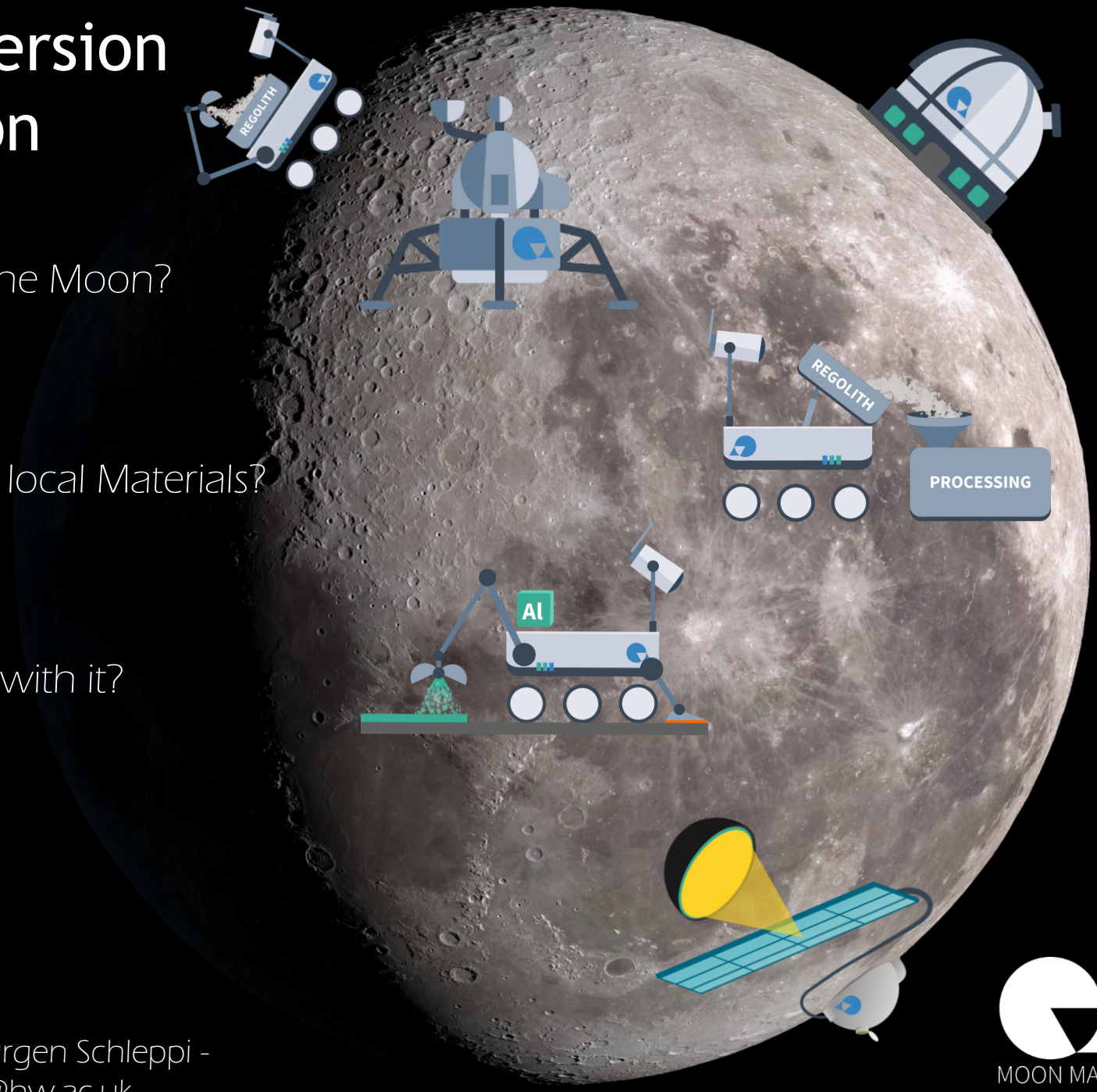
LEADERS IN IDEAS AND SOLUTIONS

Solar Conversion on the Moon

Why do we fly to the Moon?

How do we use its local Materials?

What do we build with it?



HERIOT WATT UNIVERSITY

In cooperation with

esa

by Jürgen Schleppi - js79@hw.ac.uk

MOON MADE

IN ASSOCIATION WITH

SISER

Scottish Institute for Solar Energy Research

scottish renewables

SOLAR CONFERENCE & EXHIBITION

6 SEPTEMBER 2017 **EDINBURGH**

Accessing the Network

Kerr MacGregor Award for Solar Innovation

Michael Rieley
Head of Policy
Scottish Renewables

Gerard Boyd
Commercial and Innovations Manager
SP Energy Networks

SP ENERGY NETWORKS

Accessing the Network

Gerard Boyd
Commercial & Innovation Manager

Industry Challenges

CO^2 Emission Reduction Targets

Electric Vehicle Rollout

Flexible Networks

De-centralisation of Energy

Enabling Customer Choice

- Challenging UK Carbon emission reduction targets
- No new Petrol/Diesel vehicles post 2040
- BEIS/Ofgem Smart Systems and Flexibility plan targets £40bn savings for customers
- Closure of thermal plant and increasingly decentralised energy production

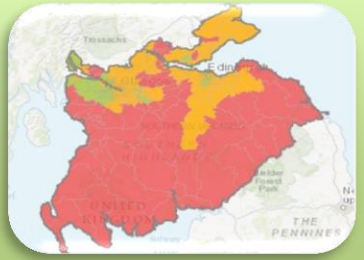
Network Challenges

Aging Network

Maintaining System Security

Flexible Networks

Network Constraints



Facilitating Storage & DER

- Requirement to manage an aging asset base that we are asking more of
- System security and increasingly Cyber security are key concerns
- With current design philosophy large elements of our network are constrained
- Strong drive from Government and Ofgem to assist in facilitating storage

Progression milestones and Queue Management

	Detail	Evidence
Milestone 1	Initiated Planning Permission	Submission of planning application / commissioning of EIA
Milestone 2	Secured Planning Permission	Permission Granted / Appeal lodged / Judicial Review launched
Milestone 3	Land Rights	Proof provided to demonstrate that land right obtained
Milestone 4	TSO Interface	Be progressing appropriate TSO process, SoW, BEGA, BELLA, etc.
Milestone 5	Progress Adoption Agreement	Design submission / adoption agreement being progressed.
Milestone 6	Commence Works	Agreed construction plan being followed
Milestone 7	Construction of Generating Activity	Completion of generation facility

Milestones developed in conjunction with ENA.

Queue Management policy developed by SPEN through extensive stakeholder engagement

Working with Scottish Renewables we have developed guidelines which determine:

- When to terminate
- When to be flexible
- When to treat as stalled

- There will be winners and losers in applying Queue Management
- Limited powers to reclaim under-utilised capacity but potential benefits of releasing
- Re-introduction of Assessment & Design fees will free up design resource

Historic design principles are based on maximum agreed export/import capacity and min/max system loading

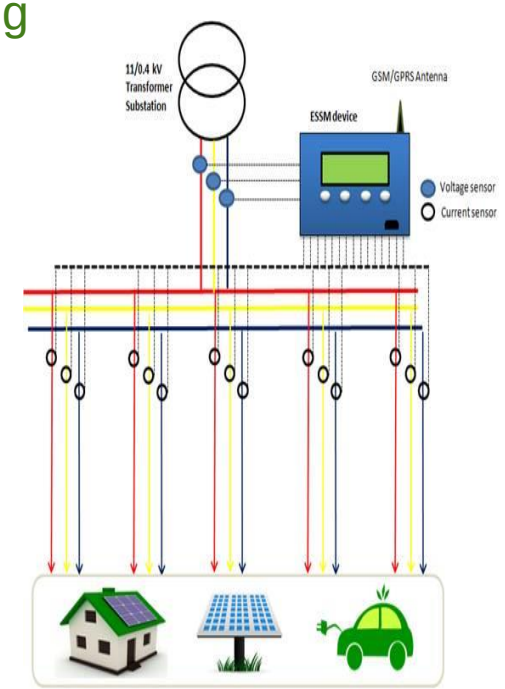
We recognise a need to change but we need to do so safely

Key to this is understanding our network and the activity on our network in real time

Key initiatives:-

- Dynamic or Enhanced thermal rating
- LiDAR – line sag -> thermal ratings
- Increased network monitoring
- Smart Meter rollout and data

Enhanced Secondary Substation Monitoring

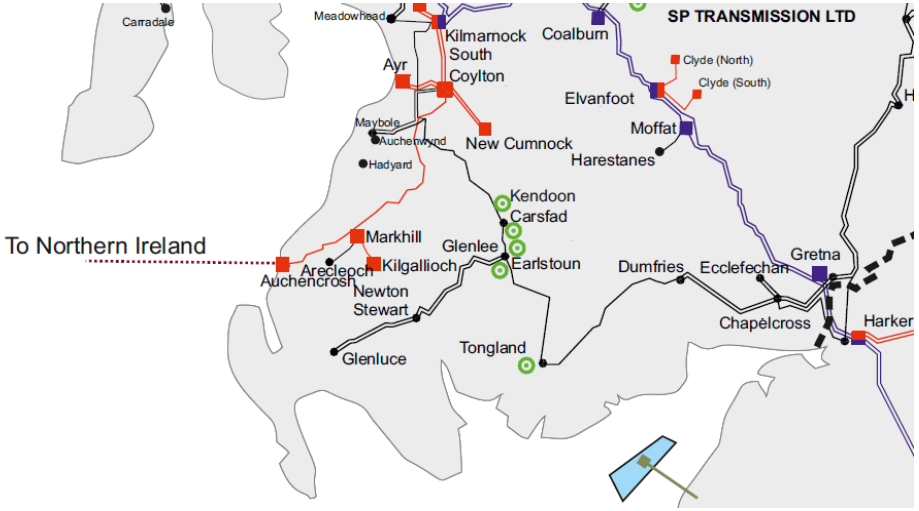


£16m Innovation Rollout Mechanism bid to significantly enhance real time network monitoring

Unlocking Capacity – Technical Solutions

Flexible solution availability

Intertrip Schemes	Export Limited	Active Network Management	Demand Side Response	Virtual Private Wire
•Offered where Firm connection not possible or prohibitively expensive •Widely available	•Export limiting devices agreed •Facilitate matching load DG connections •Widely available	•Actively Managed Connection •Available in specific network areas	•Potential to use demand turn up services to facilitate generation •Trials	•Balancing Local Generation with Local Demand •Regulatory and network charging barriers



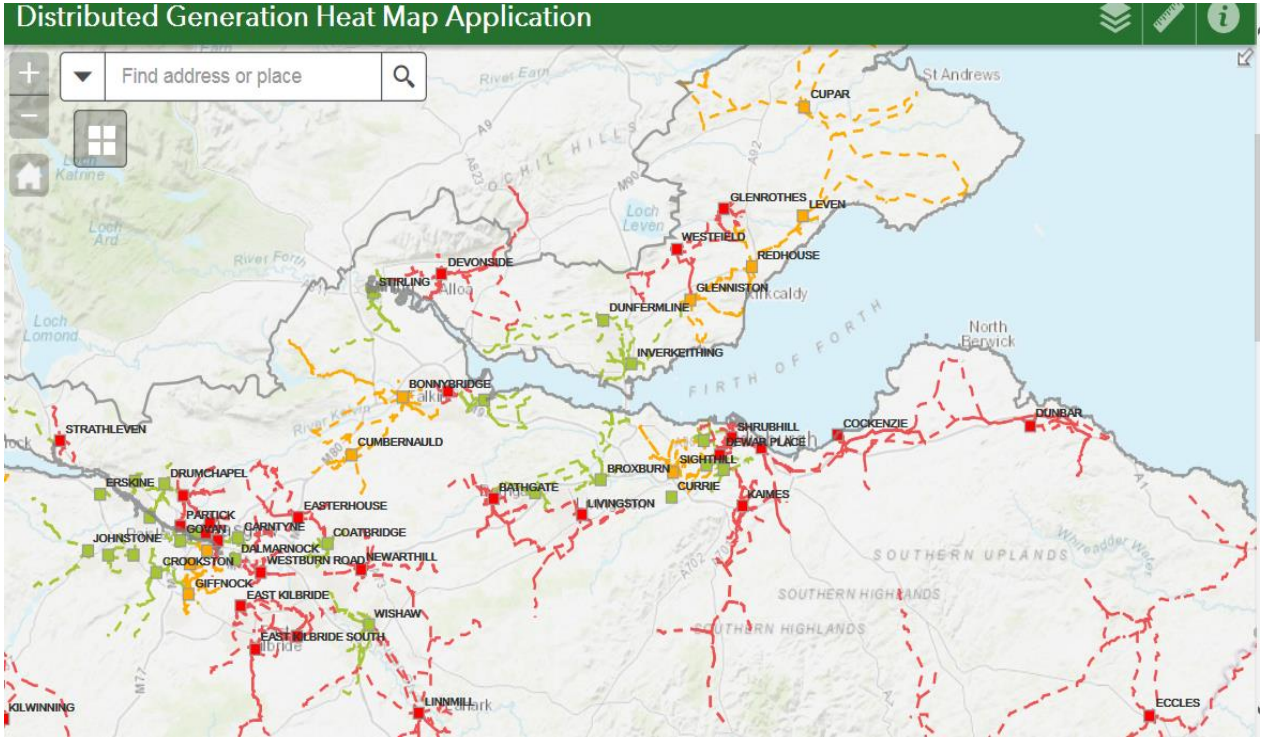
Rolling out ANM

Area	Planned Year for Roll Out[4]
Dumfries & Galloway	2019/20
Ayrshire	2020/21
Borders	2019/20
Lanarkshire	2021/22
Fife	2021/22

£8m Innovation Rollout Mechanism bid to implement wide scale ANM in D&G

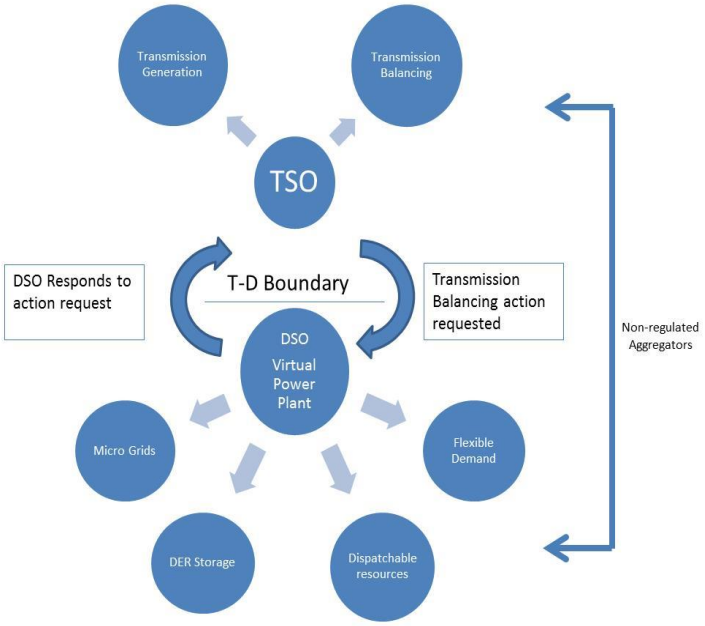
Unlocking Capacity – Transparency of Information

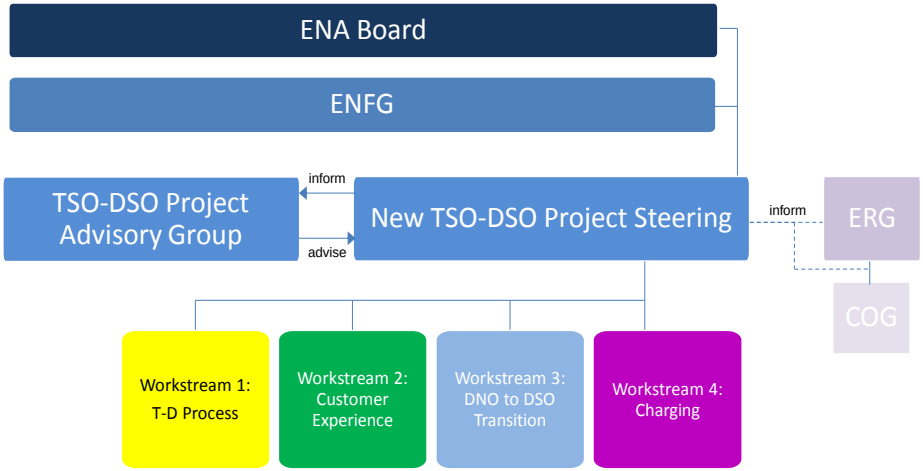
Connecting customers need the information they require to develop and submit connection applications



- We are working on near live updates to our existing heat maps
- There is a need to develop heat maps for storage applications – providing transparency for all developers
- Quote+ system in place for simpler connection applications

Development of Future role as Distribution System Operators





- DNOs developing their own strategy documents
- Industry alignment through ENA 'Open Networks' workstream
- Buy in from BEIS/Ofgem that DNOs must evolve to meet future challenges

Chris Clark
Director
Emtec Energy

Accessing the Network – The Challenges

Speaker: Chris Clark

emtec
energy & renewable technologies

About Us

Emtec Group (2003)

- Building Services
- Facility Services
- Fire Services
- Ecology
- **Energy and Renewable Technology (2011)**
- Property
- DRB UK

- Scottish Based Company
- Currently circa £60M Turnover
- We employ circa 400 people
- Living Wage Employer
- Business Insider Top 500 Companies
- London Stock Exchange 1000 Companies to Inspire Britain

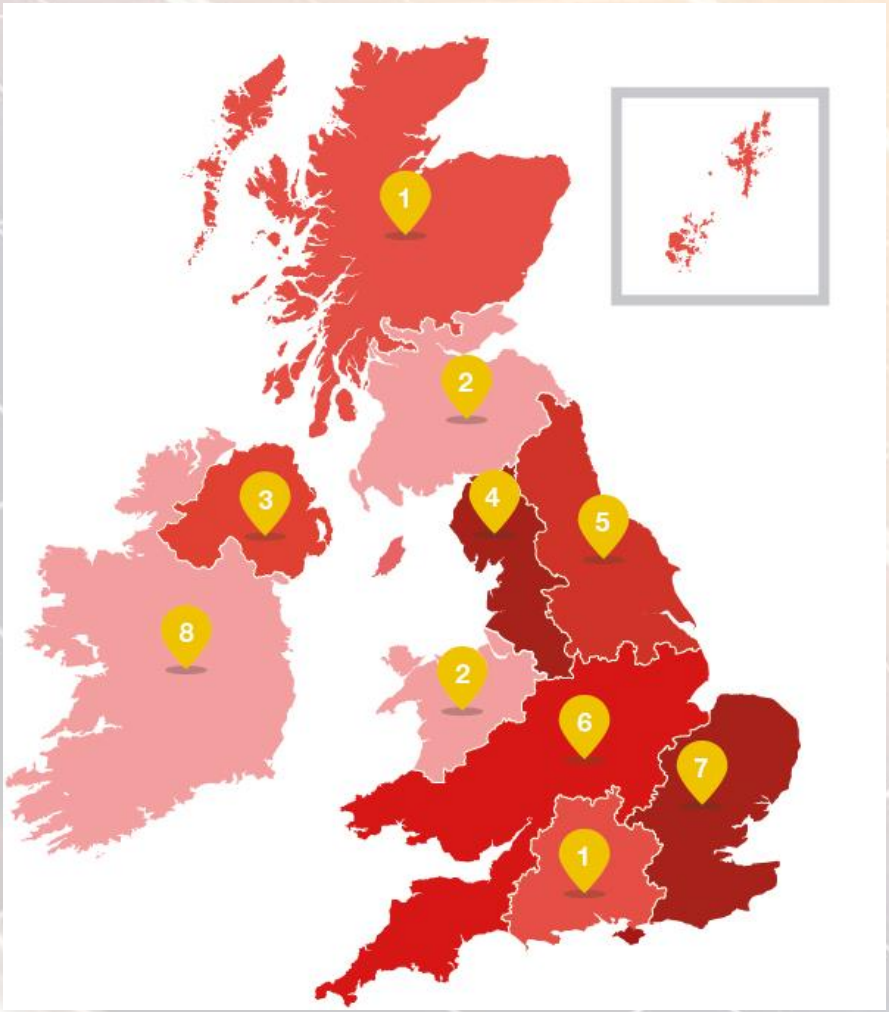
About Emtec Energy

We are energy and renewable experts focused on creating renewable technology solutions to assist in a variety of sectors. We offer a turnkey solution, from surveying and design to installation and maintenance, to enable your business or property to reach optimal energy efficiency.

We offer a wide range of energy saving and renewable technologies such as:

- Solar Photovoltaics (PV)
- Solar Thermal
- Battery Storage
- Electric Vehicle (EV) Charging
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Combined Heat & Power (CHP)
- Bespoke Energy Monitoring

Current Grid Network



1 Scottish & Southern Electricity Networks

2 SP ENERGY NETWORKS

3 Northern Ireland Electricity Networks

4 electricity north west
Bringing energy to your door

5 NORTHERN POWERGRID

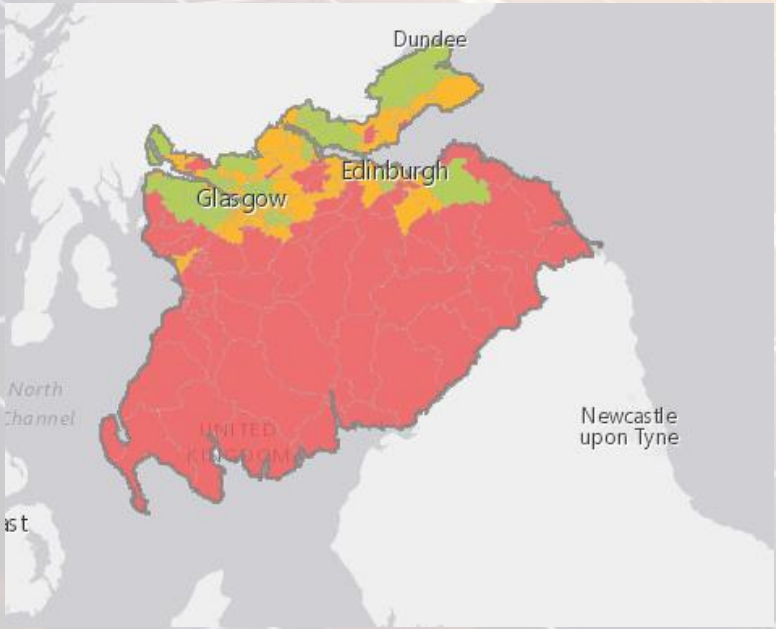
6 WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

7 UK Power Networks
Delivering your electricity

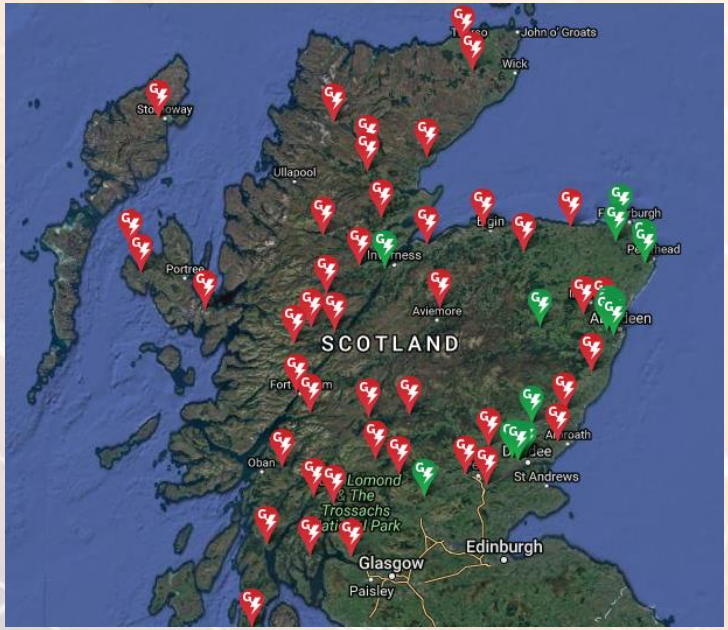
8 ESB NETWORKS

Grid connection Issues

Scottish Power: Southern Scotland



SSE Network: Highlands and Islands



Green

All operational factors are within tolerable limits. Connection opportunities may exist.

Amber

At least one factor is nearing operational limits. Network reinforcement may be required.

Red

At least one factor is close to operational limits. Installation of a local connection is highly unlikely.

Scottish Power Distribution Heat Map

- Large parts of the UK are heavily constrained for new generation, Scotland in particular.
- The heat maps clearly show Scottish Power are experiencing major issues south of the M8 corridor and pockets around Edinburgh and central parts of Scotland.
- Glasgow and the surrounding area are displayed mainly as green, however once we look closer, at Kirkintilloch for example, it is clear there are many more issues locally.
- The system does not take cognisance of faults.

Constraints calculation method

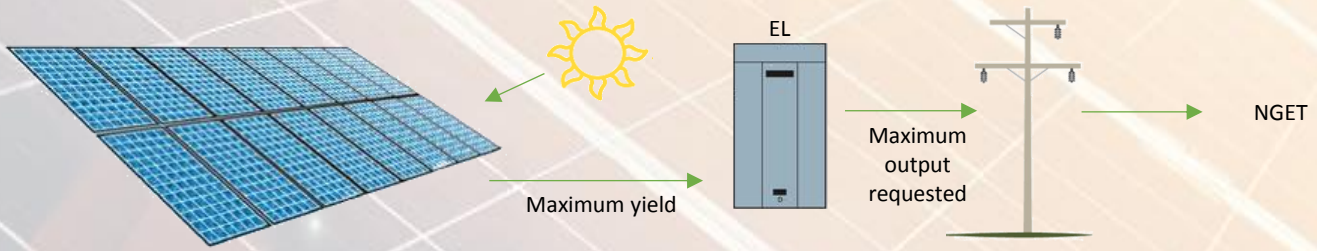
- Generation on Distribution Network running at maximum yield.
- Embedded generation running at maximum export capacity.
- All of contracted capacity has been installed.
- No diversification.

Statement of Works (SoW) and Export Limitation Devices

Distribution Network Operators (DNO) are required to submit a SoW application to NGET if a new generator installation is likely to have a significant impact on the transmission network.

This current application process is both time consuming and costly for all parties involved.

Basic ELD Structure:



Under certain circumstances, Photovoltaic (PV) systems can generate excess energy, which is then transported back to the grid.

Due to the current grid infrastructure, NGET must limit the level of electricity a generator can export.

Therefore it can be expensive to install a large PV system, as this will require an upgrade to the grid.

Export limitation devices simply restrict the generation output via a control strategy.

DNO Examples

SSE Response to a 50kW Solar PV installation

"We have run the network studies and can confirm the maximum capacity that the existing cables can take would be 38kW without costing for reinforcements of approx £15,000 to £20,000.

If you would like to change the capacity please send a new application form, type test certificates and schematic.

If we don't hear from you by the end of the week we will assume you want to proceed with the 50kW and quote accordingly"

SPEN Response to a 50kW Solar PV installation

"The connection of the proposed Development has been determined by us as having a significant effect on the GB Transmission System and as a result, upon receipt of a signed acceptance of this offer from you, we shall submit a modification application to NGET.

NGET's fee for the modification application is presently £8,500 plus vat. Where NGET notify us that significant assessment Is required, this will be classed as a "Complex Project Progression" with a fee of £16,500 plus vat being applicable"

(The above takes 6 months to complete)

An alternative to the above would be export limitation.

Not on a single occasion has any other means be identified as being flexible towards connections.

What does this mean for us

- Projects are being value engineered to remove Solar PV
- The industry is quite literally on its knees from a commercial solar perspective
- Systems reduced from 100kW to 10kW
- Loss of jobs
- Loss of Skills
- Unable to reach Scotlands Renewables targets

The Status Quo - 2030

- Domestic 0.82GW
- Commercial 0.34GW
- Ground 0.35GW
- Total 1.51GW

This equates to circa 700/800 Full Time Jobs in Scotland

STA Scotland Vision - 2030

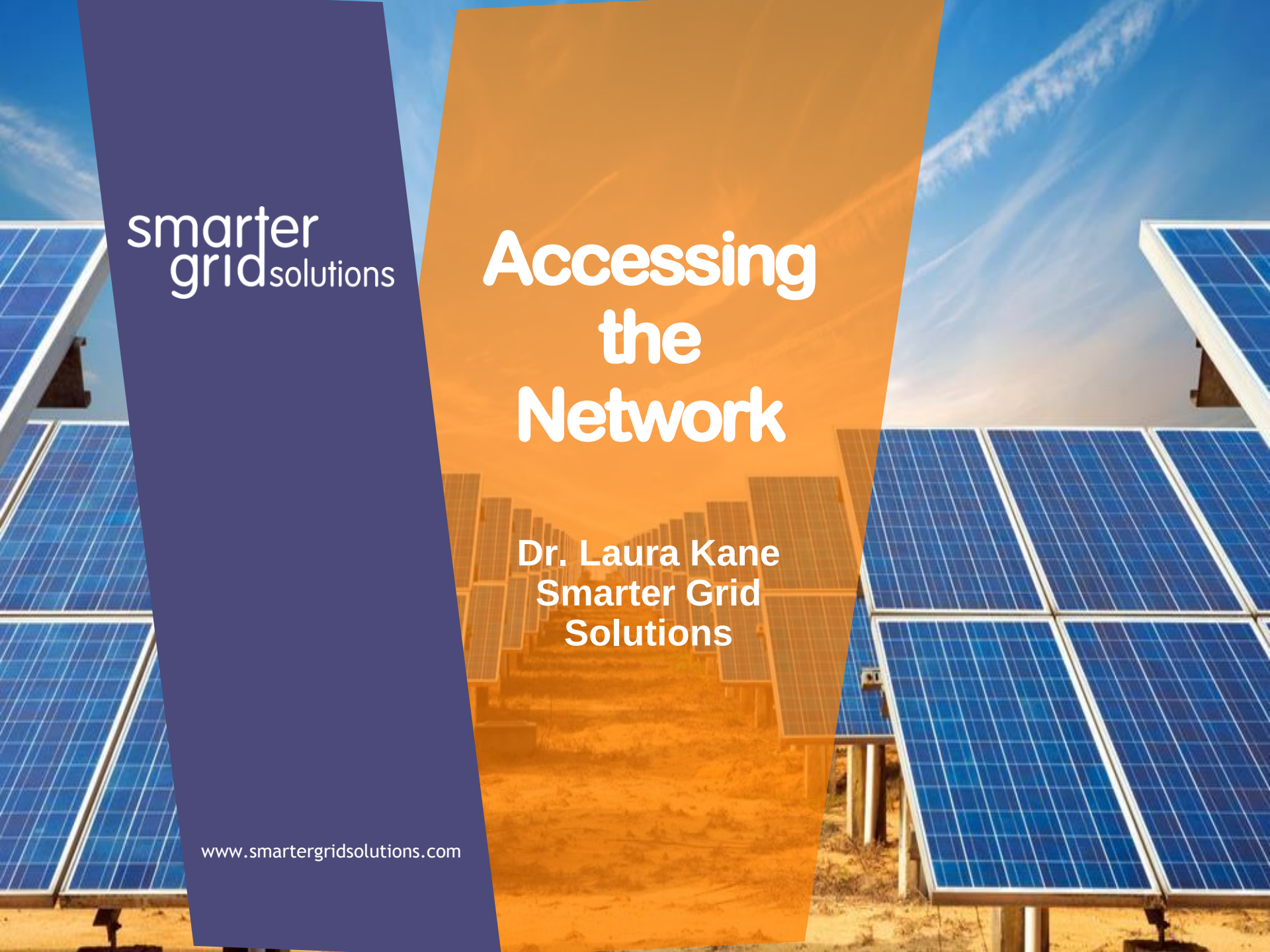
- Domestic 1.38 GW
- Commercial 3.00 GW
- Ground 2.23 GW
- Total 6.61 GW

This equates to circa 3500 Full Time Jobs in Scotland

What needs to be done?

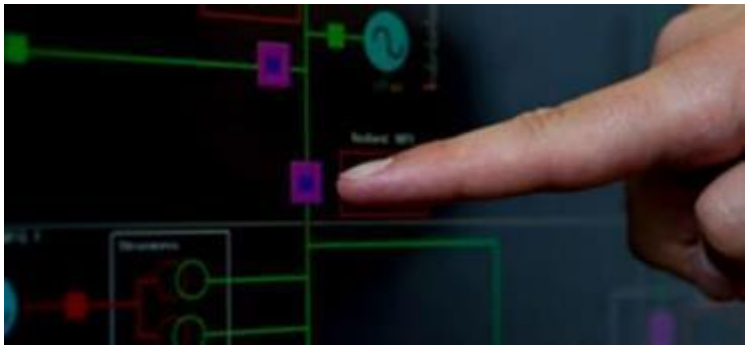
- Appropriate calculation method for grid constraints
- Diversification factors for calculation method
- Review how and where the network can be upgraded
- DNO's need to be more flexible with embedded generators
- All new buildings must have solar installed
- East, west and south facing roof space to be utilised
- Lets get serious about renewable energy and not just tick a box

Laura Kane
Senior Consultant
Smarter Grid Solutions


smarter grid solutions
Accessing the Network
Dr. Laura Kane
Smarter Grid Solutions
www.smartergridsolutions.com

Smarter Grid Solutions

- ✓ **We deliver fast-acting, autonomous, time-bounded control systems to help DNO/DSOs and developers/owners/operators to integrate and optimise DER into the wider energy system.**
- ✓ Over 10 years in development in collaboration with utility customers and one of Europe's leading power systems universities (University of Strathclyde)
- ✓ HQ in Glasgow with offices in New York, California and London
- ✓ 60+ staff dedicated to the development and deployment of Active Network Management and real-time control systems for DNOs and developers



smarter grid solutions

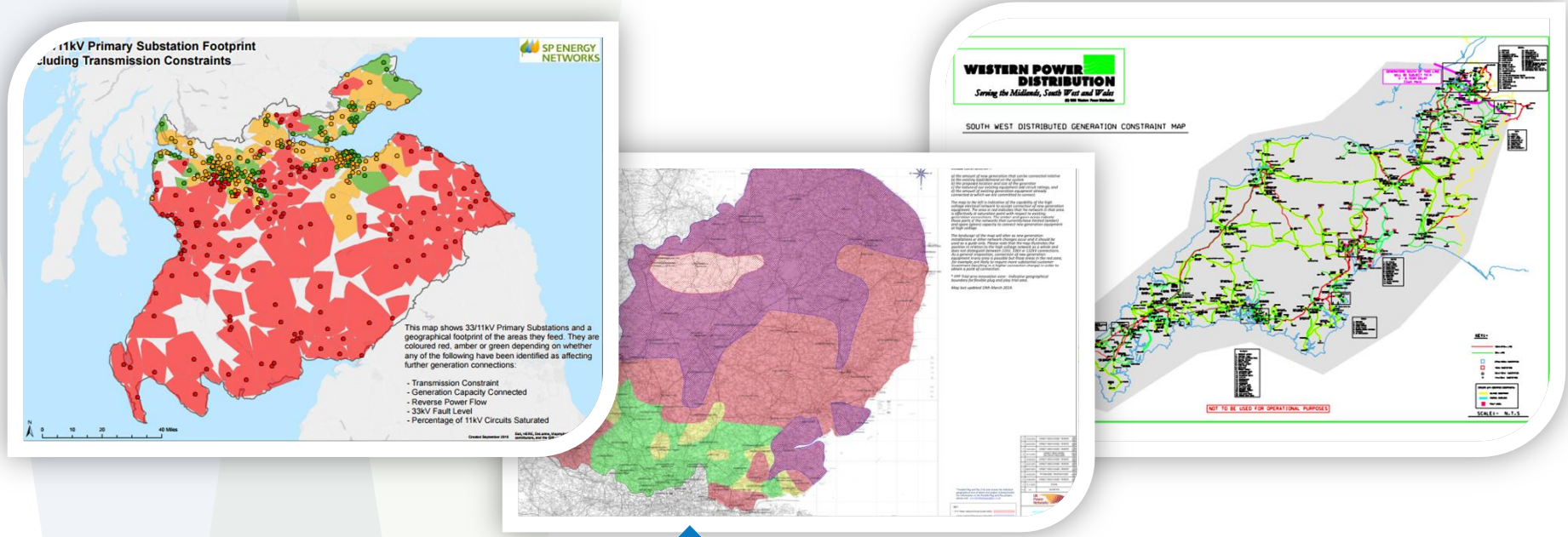
The changing nature of development

There used to be two major challenges to development of a renewable site: **consenting and grid**

Now there are added challenges of finding new revenue streams.

smarter grid solutions

Grid connections are difficult to obtain



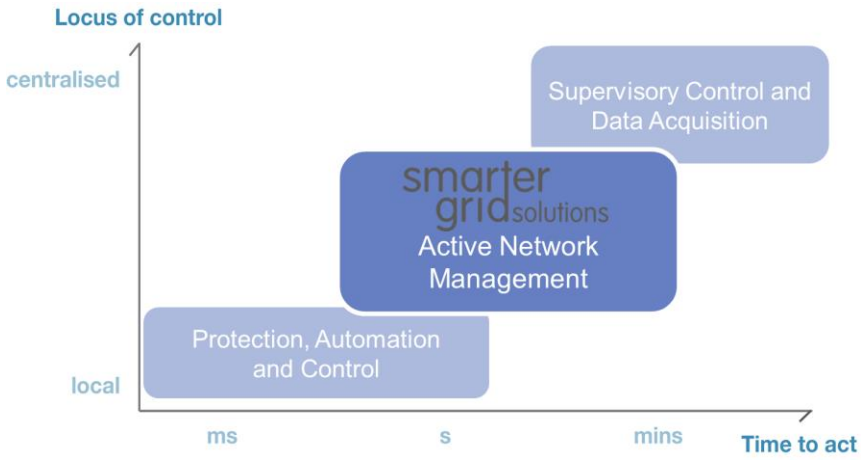
nationalgrid

ofgem

smarter grid solutions

Active Network Management (ANM)

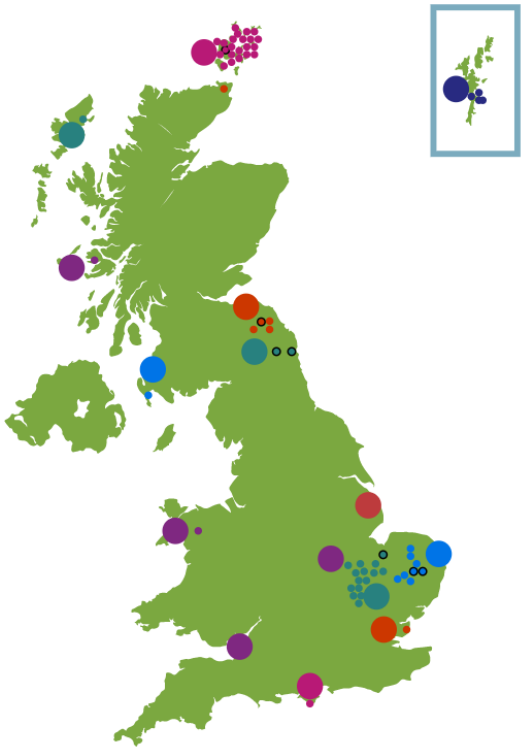
- Maximises (2-3x) grid hosting capacity by managing generator output in response to grid constraints in **real time**
- Layers between existing utility systems
- Aligns with RIIO principles as a Non-Wires Alternative (NWA) to traditional grid upgrades



smarter grid solutions

Active Network Management: BaU adoption

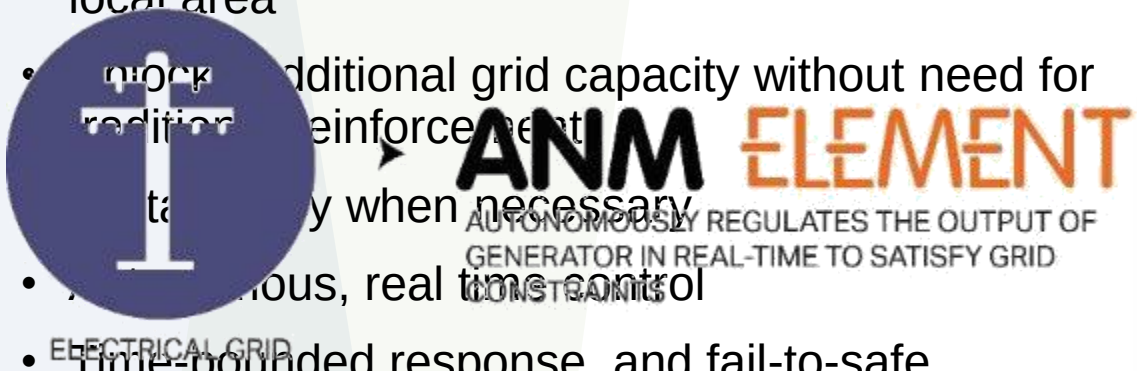
- 300 MW under management
  - Mixture of wind, PV and hydro
  - From 80kW to ~45-50MW
- 300 MW contracted for actively managed connections across 7 operational ANM systems:
  - Managing against thermal, voltage and stability network constraints

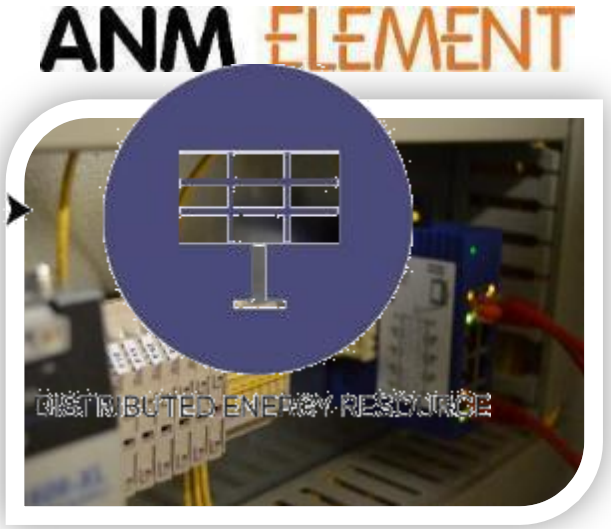


smarter grid solutions

ANM Element: what does it do?

- DER controller, manages interaction with grid and local area
- Unlock additional grid capacity without need for traditional reinforcement
- Intervenes only when necessary
- Autonomous, real time control
- Time-bounded response, and fail-to-safe
- Can operate as stand-alone, or as part of global ANM system





smarter grid solutions

ANM Element – Use Cases

- Flexible connections: can save you time and money
- Shared connections: stand-alone behind the meter solutions
  - Connect multiple generators to same *firm* grid capacity
- Scheduling connections:
  - Real time optimisation
  - Utilise energy storage
  - Demand side management
- Market participation:
  - Control through aggregators
  - Respond to signals from system operators

smarter grid solutions

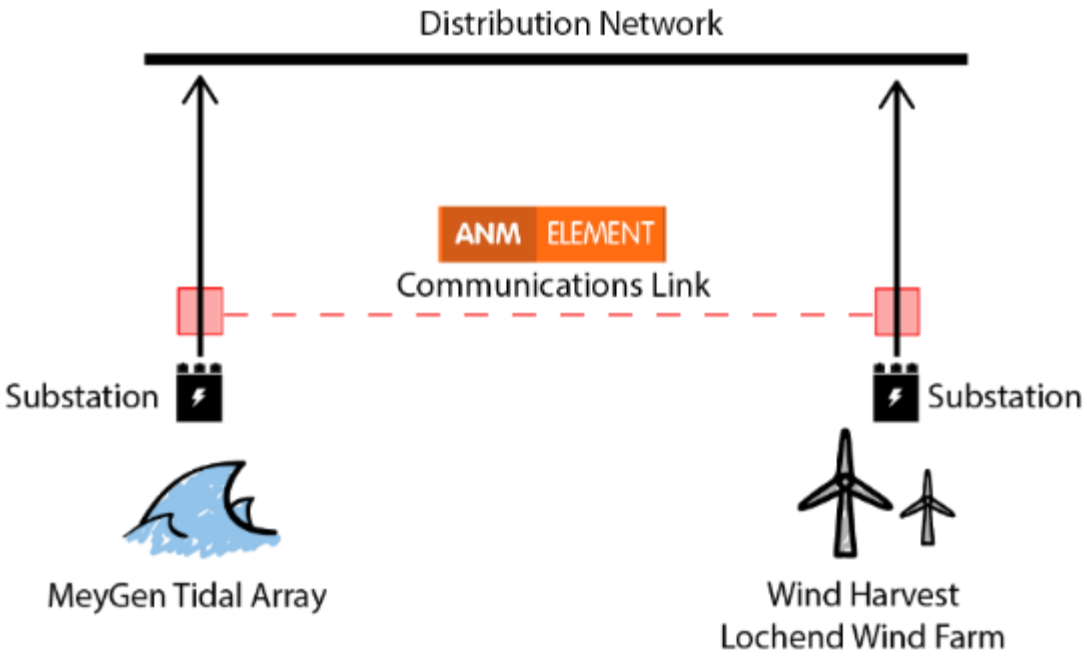
Coltishall Solar Farm

- 300 acre, £50 m solar energy farm
- 40 MW total capacity split across two points of connection
- Part of the Norwich ANM Scheme (UKPN)
- Limited capacity within the area but a high volume of applications from developers
- ANM scheme in Norwich has a total of 65 MW of PV connections to date.
- Flexible Connection meant that the site was built and connected to the network in **7 weeks**

smarter grid solutions

Behind-the-Meter ANM

- Behind-the-meter ANM system
- Two generators sharing the same connection grid capacity
  - Different sites and individual meters
- First of its kind in the UK
- Monitors export from tidal array and wind farm
- Controls wind farm to keep export levels within tidal array's firm export capacity
- Lochend Wind Farm connected 3 years ahead of schedule
- Solution is applicable to any generation mix




smarter
grid solutions
Thank you
lkane@smartergridsolutions.com
www.smartergridsolutions.com

Alan Mason

Sector Lead for Scotland

TNEI

tnei

A specialist energy consultancy

Solar PV and Power Quality

Alan Mason BEng MIET

6th September 2107

Contents

- What is Power Quality
- Lessons from the South West
- Power Flow
- Voltage
- Irradiance

What is Power Quality

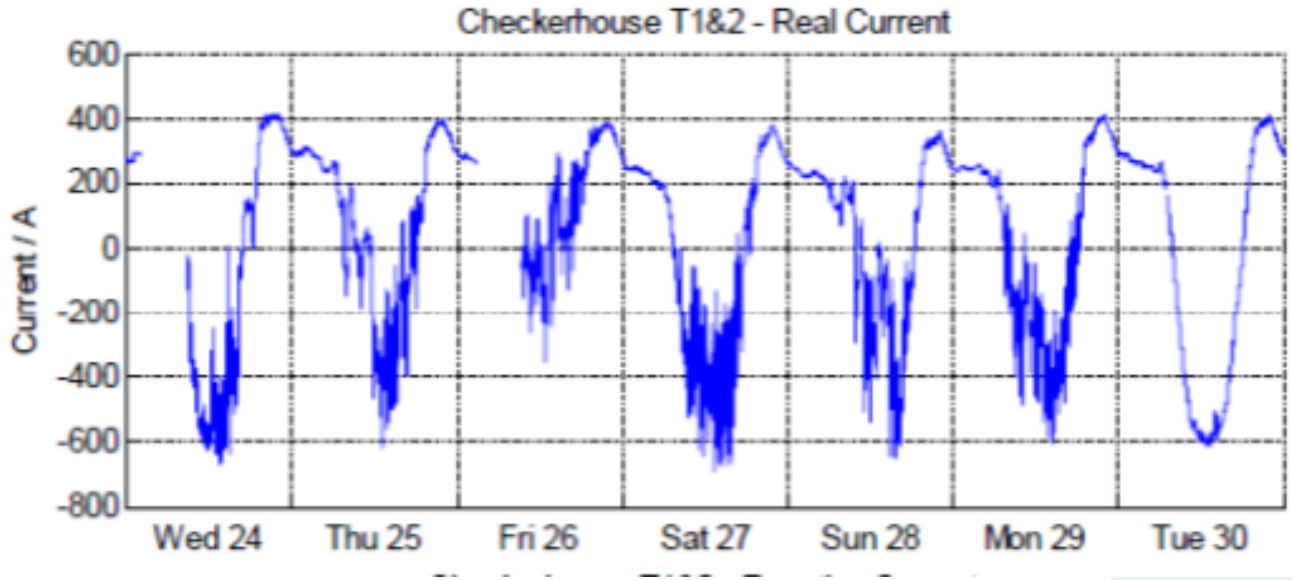
- Power Quality describes how the operation of the behaviour of any connected load or generation causes the voltage to deviate from being a pure 50Hz sine wave at nominal voltage.

Lessons from the South West

- WPD has over 1.5 GW of solar projects over 1 MW connected at 11 kV and above.
- Their experience can provide a “lessons learnt” on how to manage the connection of solar PV in Scotland.

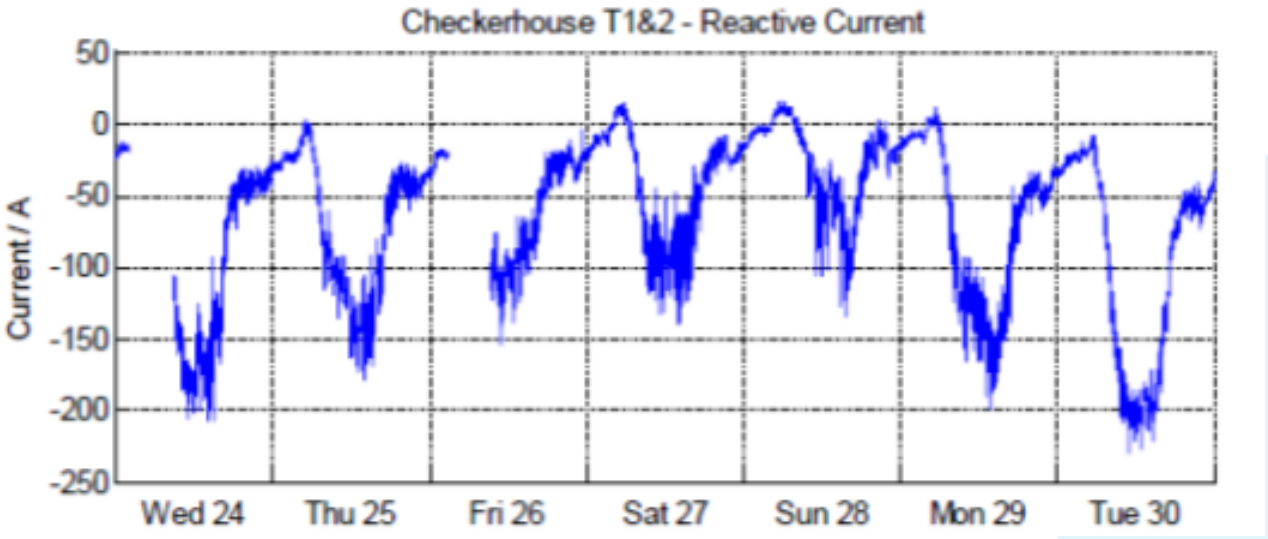
Power Flow

- Power Flow through the transformers reversed over the 24 hour period



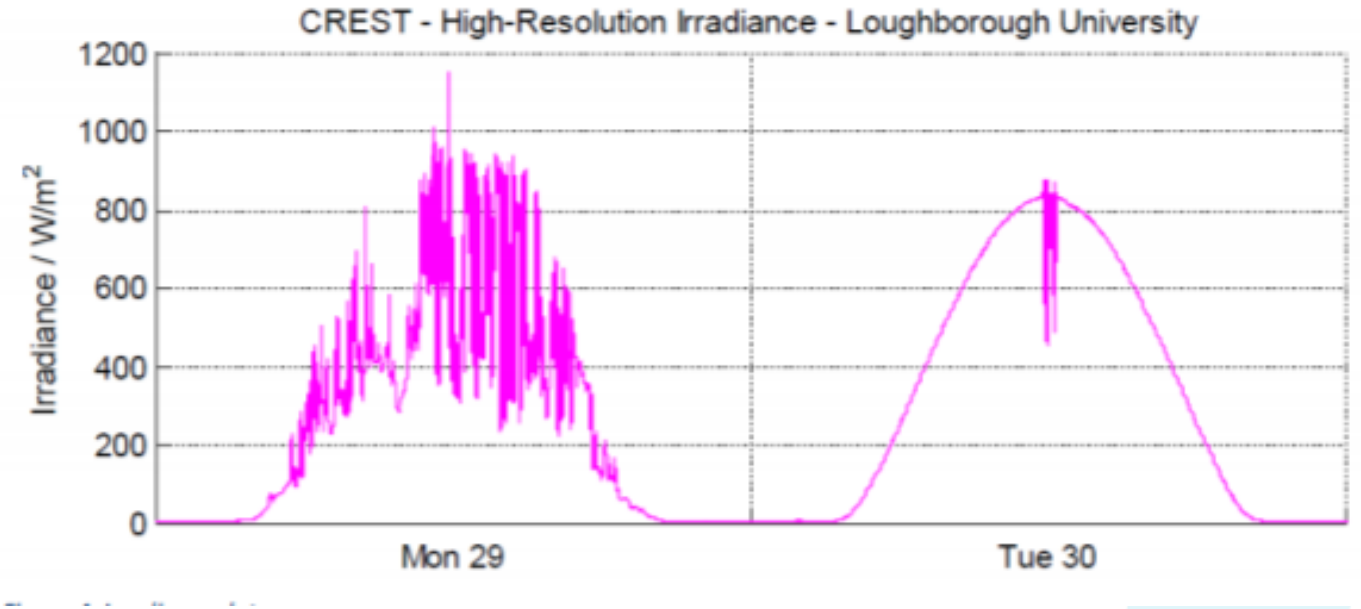
Reactive Current Flow

- Power Flow is linked to reactive power flow as the unit is operating in Power Factor Mode



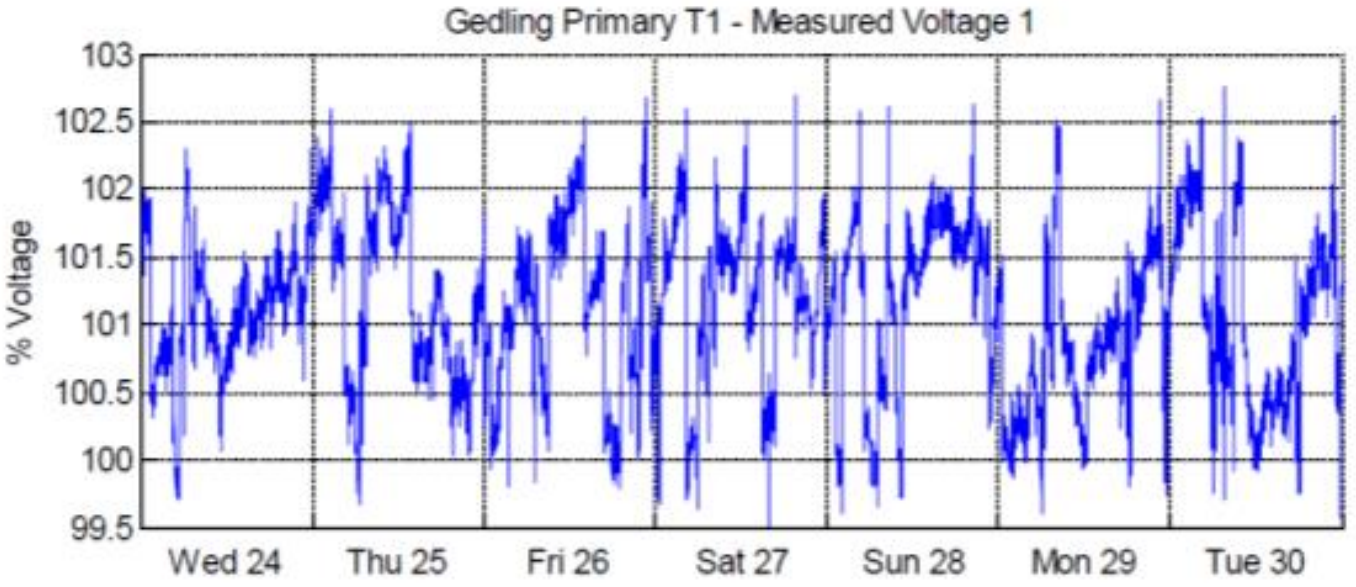
High Resolution Irradiance

- Solar Farm output can vary considerably if there is variable cloud cover.



Voltage Variation

- The plot below is considered as a well controlled voltage that will vary by as much as 0.03 p.u. a day.



Harmonics

- Solar Inverter can inject high order frequency harmonic distortion onto distribution connection which can cause unusual disruption to customers and can be hard to detect.

Mitigation

- **P**roper **P**lanning **P**revents **P**oor **P**erformance
- SPEN and SSEN can use clauses in the connection agreements to ensure a degree of protection against power quality issues.

Voltage Control

- Ensure that all solar generation operates in Voltage Control. This will work to maintain a constant voltage rather than varying with output power.
- This is straight forward to achieve using solar inverters.

Power Fluctuations

- Wind Power connected at 33 kV is required to ramp from standstill to full power.
- Solar inverter can control ramp up by adjusting the operating point.
- Engagement with inverter manufacturers would allow this capability to be understood and defined.
- Battery storage could to alleviate extreme problems.

Accessing the Network

Michael Rieley, Scottish Renewables
Gerard Boyd, SP Energy Networks
Chris Clark, Emtec Energy
Laura Kane, Smarter Grid Solutions
Alan Mason, TNEI

IN ASSOCIATION WITH

SISER

Scottish Institute for Solar Energy Research

scottish renewables

SOLAR CONFERENCE & EXHIBITION

6 SEPTEMBER 2017 **EDINBURGH**

Decarbonisation and Sustainable Communities

Gillian Wilson

Head of Development

Community Energy Scotland

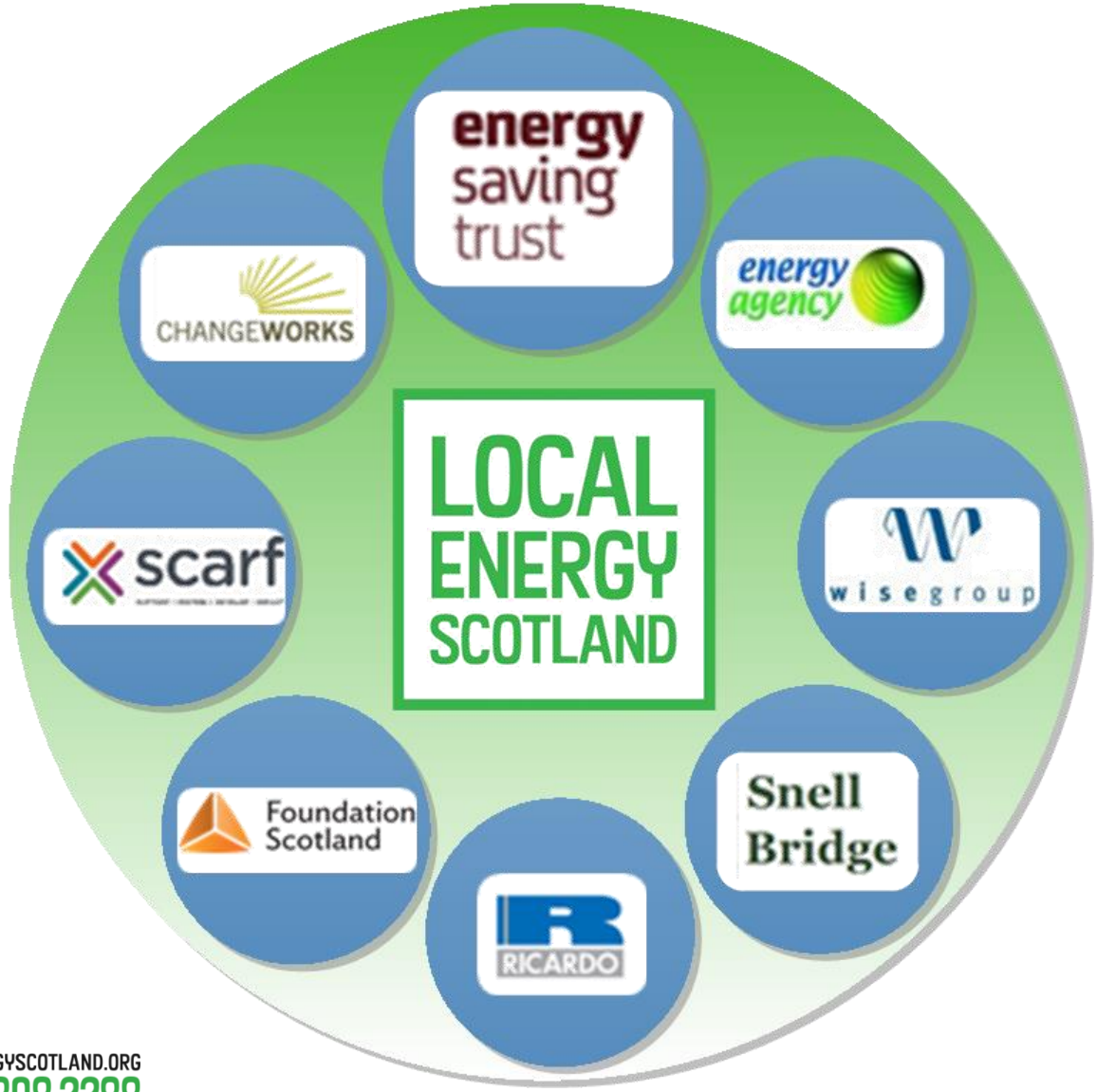
Laura Nicolson
Shared Ownership Development Manager
Local Energy Scotland

SCOTTISH RENEWABLES
SOLAR CONFERENCE

Laura Nicolson - Local Energy Scotland

Greener Scotland
Scottish Government

Who we are



Delivers the Scottish Government's

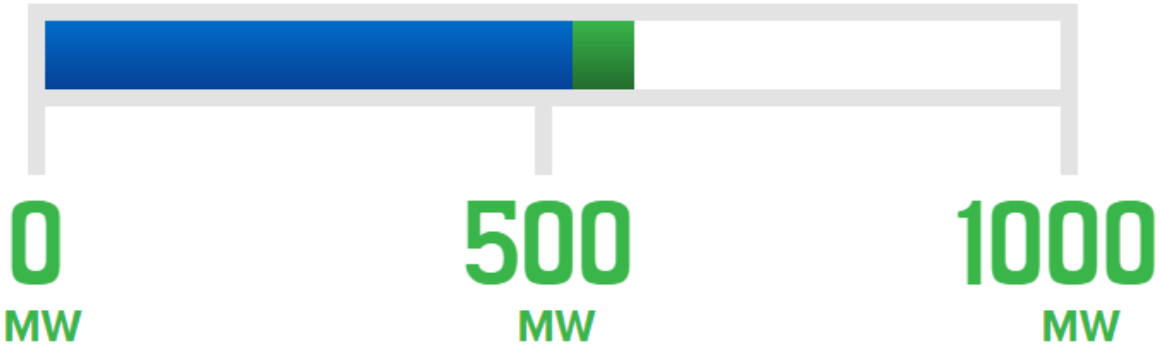
Community and Renewable Energy Scheme (CARES)

LOCALENERGYSCOTLAND.ORG
0808 808 2288
FUNDED BY THE SCOTTISH GOVERNMENT

Greener Scotland
Scottish Government

Community and Renewable Energy Scheme (CARES)

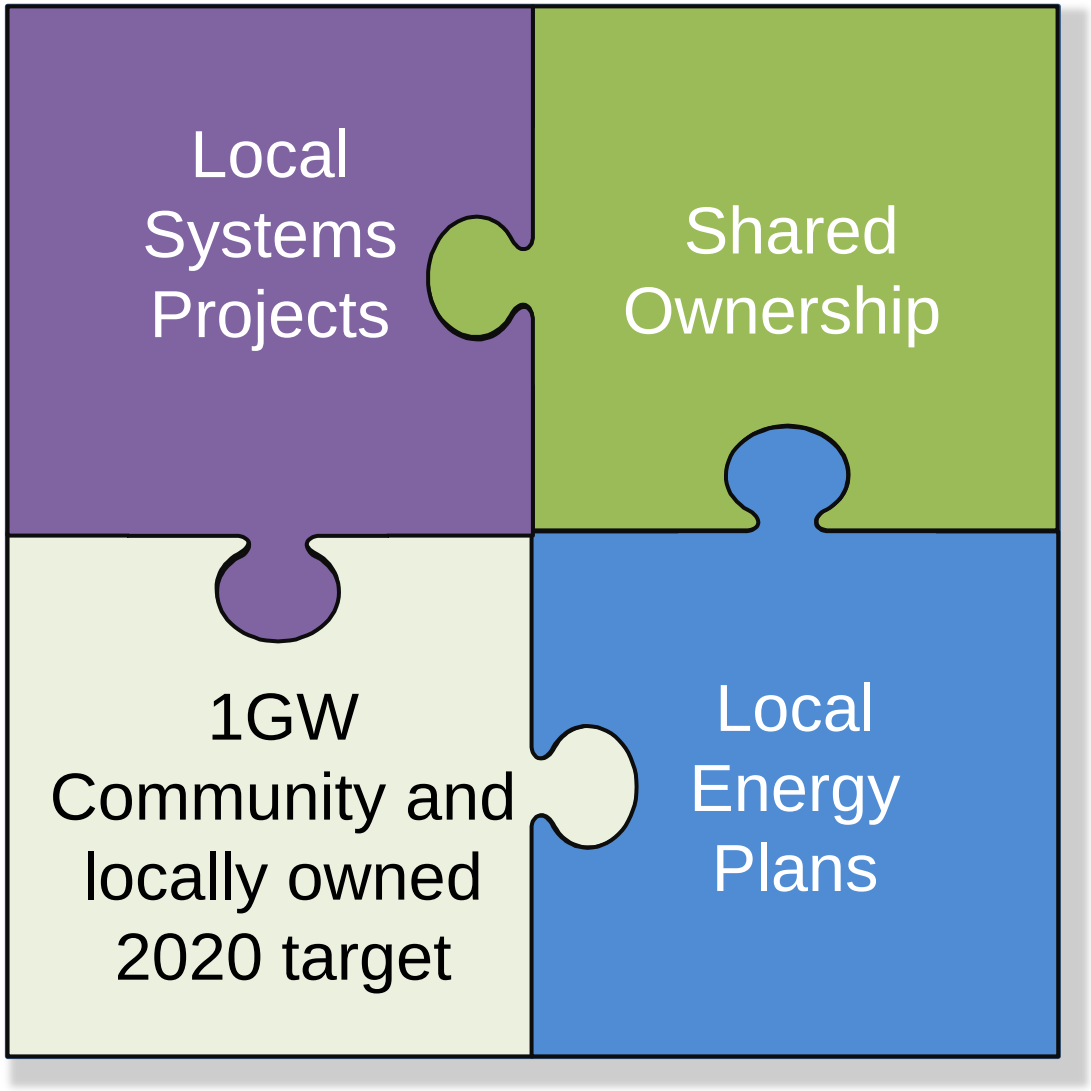
- SG target for 1GW community and locally owned energy by 2020 and 2GW by 2030



- 50% of newly consented renewable energy projects will have an element of shared ownership by 2020

- Development of local energy systems

Priorities


Local Systems Projects
Shared Ownership
1GW Community and locally owned 2020 target
Local Energy Plans

Models of Community Energy

CARES - Non-Financial Support

- CARES Online toolkit
  - Technology specific modules
  - Project Development modules
  - Finance Model – tool to assess financial viability

- Case studies

- Partnership portal

- Frameworks Contractors – mini competition template (legal, financial & project management)

- Local Energy Scotland staff

Project Support Team

LOCALENERGYSCOTLAND.ORG
0808 808 2288
FUNDED BY THE SCOTTISH GOVERNMENT

Greener Scotland
Scottish Government

Shared ownership is any structure which involves a community group as a meaningful financial partner in a renewable energy project.

Stewart Energy – 3.9MW Wind Project

- Completed August 2015
- 75% Owned by Stewart Energy
- 25% - Lesmahagow Development Trust
- Community benefit £10k /MW

- Annual six figure income for the next 20 years
- 4th Turbine – increase benefit by a further 25%

Shared Ownership Scottish Government Target

"We will ensure that by 2020, **at least half** of newly consented renewable energy projects will have an element of shared ownership."

Shared Ownership
Where are we now?

18MW of community ownership in operational Shared Ownership projects

5MW in construction

Up to 400MW consented but not built

Up to 60MW in planning

Up to 10MW in scoping

Shared Ownership
Where are we now?

Net Economic Benefits

Finance options

Business rates

Community engagement

Uncertainties for developers and communities

Shared Ownership
What about Solar?

Innovative finance for and with communities

Refinancing

Community share offers

Heat?

Contact us

www.localenergyscotland.org

Shared Ownership Manager: 07879 683719

laura@hi.localenergyscotland.org

Gordon Cowtan

Smart Fintry Project Director

Fintry Development Trust

Gordon Cowtan

Smart Fintry Project Director

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY
GET SWITCHED ON

Background

- FDT Background
  - Been in existence for over 10 years
  - Shared ownership at Earlsburn windfarm
  - Delivered projects in the local community
  - Long held aspiration to supply electricity

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY
GET SWITCHED ON

Shared Ownership

- Two residents looking at community renewable possibilities in the local area – 10+ years ago
- Windfarm developer arrived on the scene
- Let's not re-invent the wheel
- Additional, 15th turbine to be added to the development
- Community receives income from electricity generated

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY GET SWITCHED ON

Fintry Development Trust

- FDT set-up as the body to receive and use the income
  - Democratic organisation
  - Now has over 200 members
- Income generated used by FDT for other energy reduction and sustainability projects
- Goal – make a connection between big renewables and local energy use

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY GET SWITCHED ON

Projects Delivered

- Domestic energy survey and insulation
  - First project
  - 80% surveyed, 50% able to receive insulation
- Sports club
  - 150kW wood chip boiler replacing oil boiler
  - 50kW of PV on roof
- Micro-renewables scheme
  - Over 30% of households now have some form of micro-renewable (from only 3% 4 years ago)

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY
GET SWITCHED ON

Projects Delivered

- Fintry Energy Efficient Transport – rural car club
- Fintry Grant Scheme
  - Approx 120 grants of £500-£1000 to householders
- External insulation on hard-to-treat homes
- Primary School
  - Carbon Cutter Police
  - Woodland classroom
  - 5kW solar panels on nursery school
- 200kW biomass district heating scheme
  - Providing low-carbon heat for 25 park homes

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY GET SWITCHED ON


CARBON
CUTTER
POLICE
TURN OFF YOUR LIGHT
CCP

Current Project - Smart Fintry

- Match local electricity supply with demand to create a local energy economy
- Reduce electricity costs to end users by addressing UK market charges and mitigating peak demand
- Reduce the local carbon impact of the Fintry community
- Produce a blueprint and policy guidance for other similar community projects in the UK

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY
GET SWITCHED ON

SMART Fintry Structure

- Partners

2 year LECF funded project

Progress to Date

Year 1

- SMART Fintry Local Tariff has been launched
- Local generators have now joined the project and are supplying Fintry with 100% renewable electricity
- Each end user has a smart meter installed
- Network communications deployed to create a virtual link between producers and consumers enabling the transfer of generation and demand data

Progress to Date

Year 2

- Over 100 homes have now signed up
- Four innovation areas –
  - Community Capacity
  - Active Energy Customers
  - Regulatory Impact
  - Demand Side Response
- Create a report outlining policy guidance for future UK projects

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY GET SWITCHED ON

SMART FINTRY

GET SWITCHED ON

For more information

smartfintry.org.uk

FDT FINTRY DEVELOPMENT TRUST

SMART FINTRY

GET SWITCHED ON

Josh King
Operations Manager
AES Solar

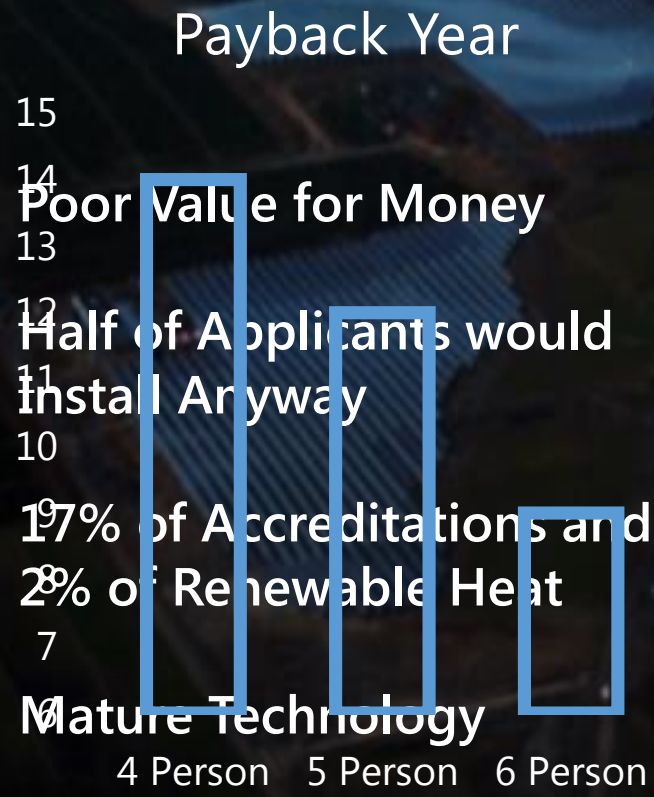
Rediscovering Solar Thermal

Josh King
Operations Manager
AES Solar

AES Solar
EST. 1979

Annual Solar Thermal Sales

RHI Under Threat



Poor Value for Money

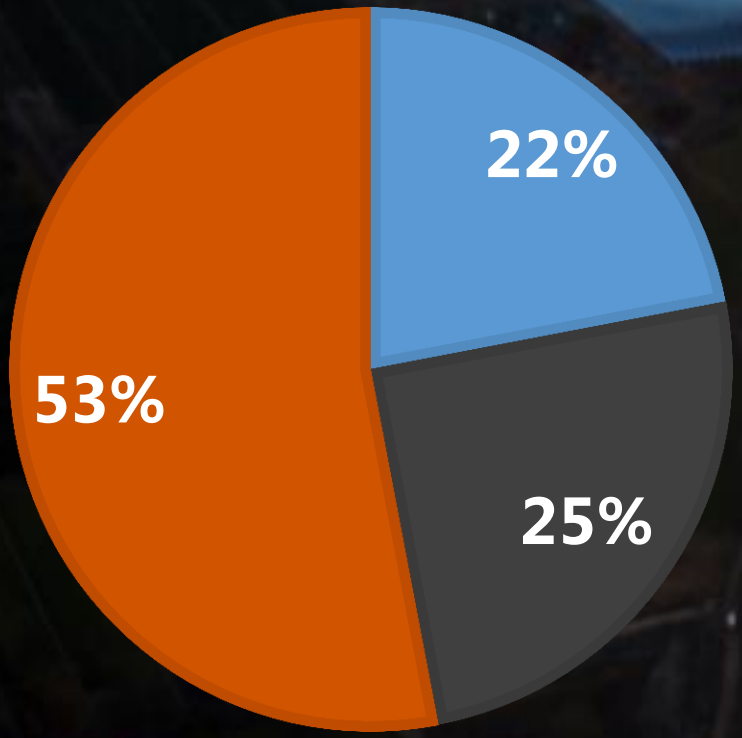
Half of Applicants would Install Anyway

17% of Accreditations and 2% of Renewable Heat Mature Technology

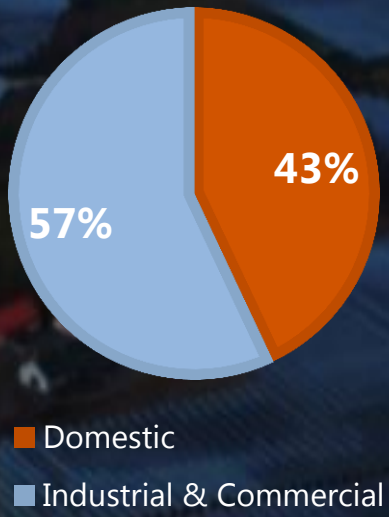
Rediscover Heat

AES Solar
EST. 1979

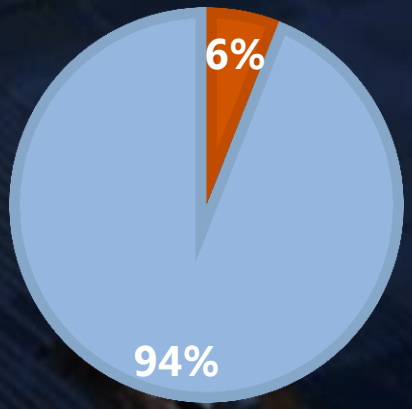
ENERGY DEMAND



HEAT DEMAND

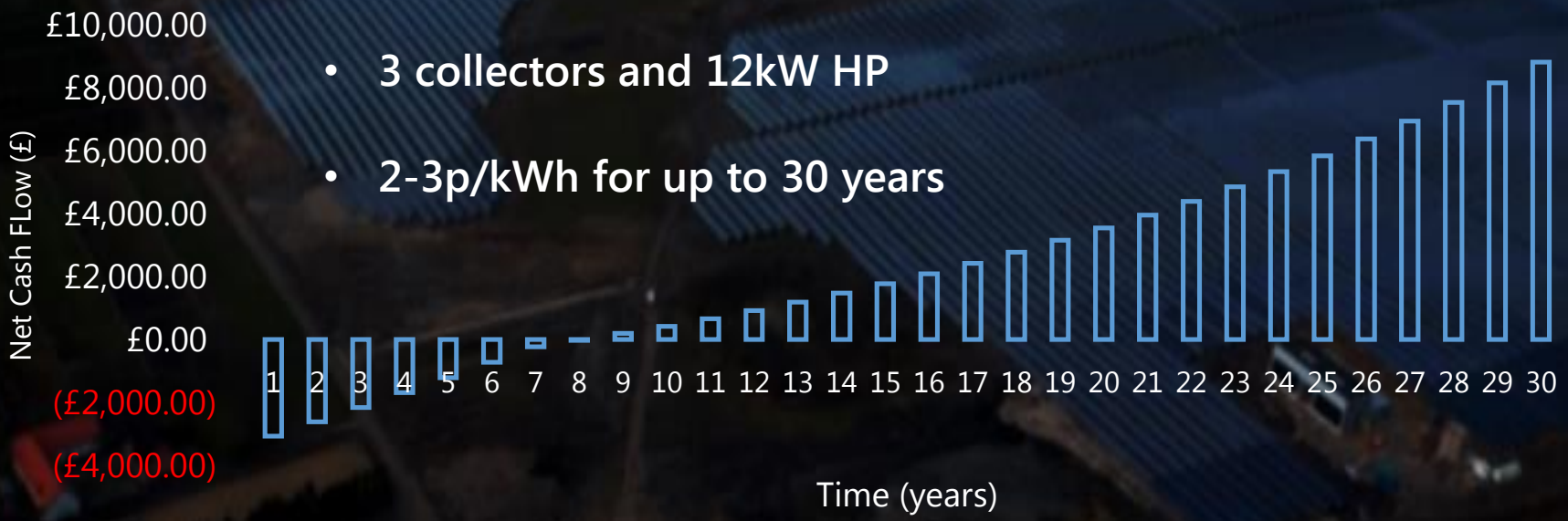


HEAT GENERATION



Heat Pump and Solar Thermal

- UK Annual SPF of 3
- ST Improves SPF in all Euro Climates
- Typical 3 bedroom in Edinburgh
- 3 collectors and 12kW HP
- 2-3p/kWh for up to 30 years



AES Solar
EST. 1979

Solar PV and Solar Thermal

Typical 16 Panel System in Glasgow

14 x PV Panels = 160kWh/m^2

2 x ST Panels = 498kWh/m^2

PV and Immersion

Storage and EV's

Sensible Design and Integration

www.aessolar.co.uk

AES Solar
EST. 1979

Rediscovering Solar Thermal...

Policy

Finance

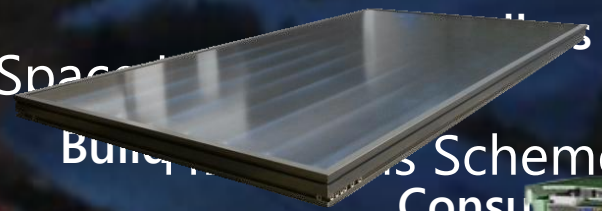
Awareness

Integration

Planners

Homeowners

Local Authorities



District Heating

- Vojens
- Collector area: 70,000 m^2
- Annual production: 28,000 MWh
- Annual demand covered: 49%
-
- Seasonal Storage Pit
- 200 Million Litres

AES Solar
EST. 1979

www.aessolar.co.uk

District Heating

- Silkeborg
- Collector area: 156,694 m^2
- Annual production: 80,000 MWh
- Annual demand covered: 20%
-
- Number of consumers: 90,000
- 508 kWh/m^2

AES Solar
EST. 1979

Thank You

www.aessolar.co.uk

Decarbonisation and Sustainable Communities

Gillian Wilson, Community Energy Scotland
Laura Nicolson, Local Energy Scotland
Gordon Cowtan, Fintry Development Trust
Josh King, AES Solar

IN ASSOCIATION WITH

SISER

Scottish Institute for Solar Energy Research

scottish renewables

SOLAR CONFERENCE & EXHIBITION

6 SEPTEMBER 2017 **EDINBURGH**