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SCOTTISH RENEWABLE ENERGY FESTIVAL
SEPT 16 - OCT 1

Claire Mack

Chief Executive

Scottish Renewables

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Scotland’s solar industry: the state of play

Tweet @ScotRenew

#SRSOLAR19

Morag Watson

Director of Policy

Scottish Renewables

Tweet @ScotRenew

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The Energy White Paper

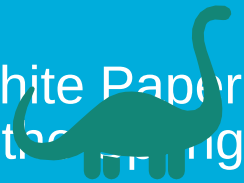
Just in case you were too afraid to ask…**White Papers** are policy documents produced by the Government that set out their proposals for future legislation.

15 Nov 2018

Greg Clark ‘Trilemma’ Speech

I am going to set out more details through a policy paper in the next few weeks, before publishing a detailed White Paper to follow in the new year.

White Paper in the Spring



White Paper in

BEIS/Ofgem Consultation Blizzard

?

Significant Code Reviews

1) TARGETED CHARGING REVIEW (TCR)

- Principles-based assessment of options based on: **fairness**, **reducing distortion** and **practicality and proportionality**.
- consider **reform of residual charging arrangements** for both **generation and demand**, to ensure it meets the interests of current and future consumers;
- keep the other **'embedded benefits'** that may distort investment or dispatch decisions **under review**.

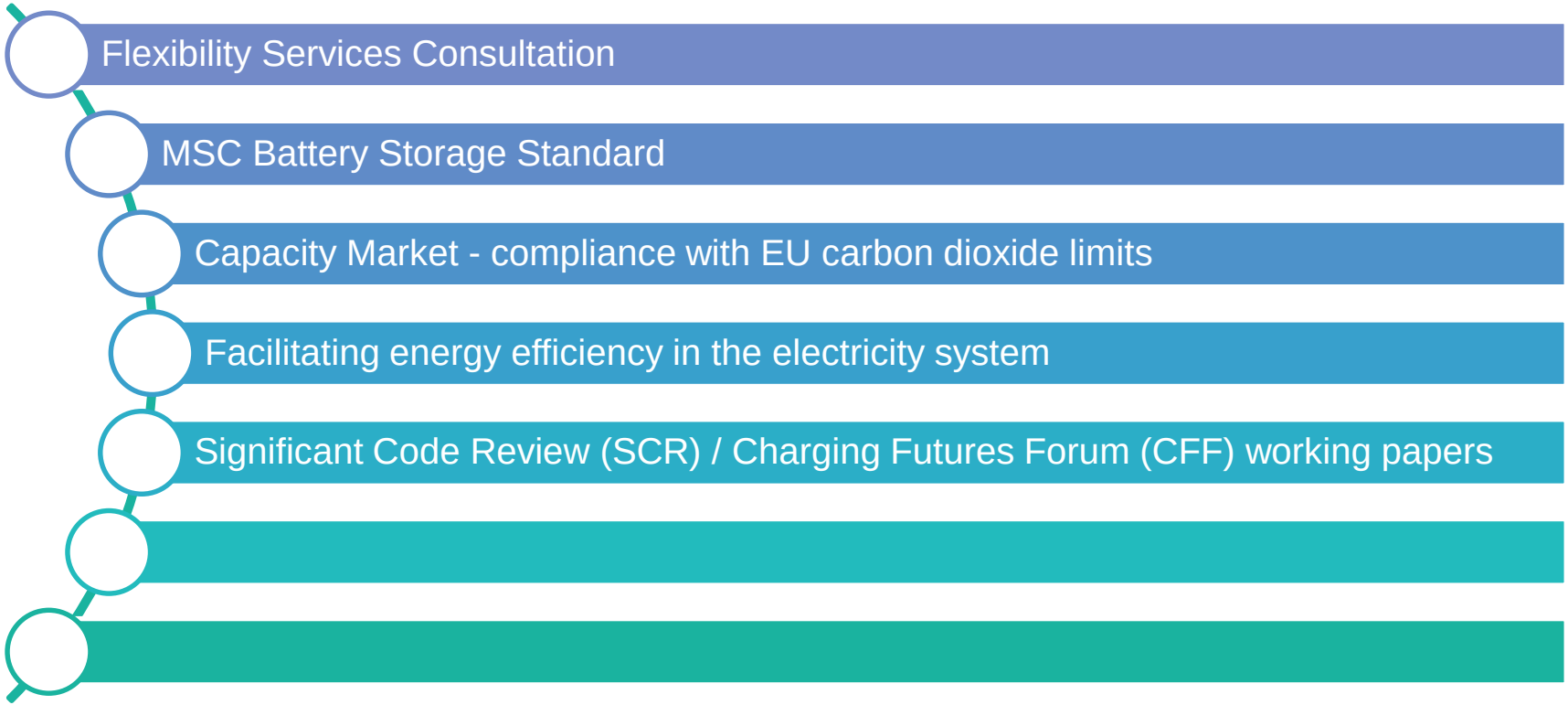
2) ELECTRICITY NETWORKS ACCESS PROJECT (ENAP)

- Objective: to ensure electricity networks are **used efficiently and flexibly**, reflecting **users' needs** and allowing **consumers to benefit from new technologies and services** while **avoiding unnecessary costs** on energy bills in general.

BEIS/Ofgem Consultation Blizzard…

- Reforming the energy industry codes
- Carbon capture, usage and storage (CCUS): business models
- Flexible and responsive energy retail markets
- Application Interactivity and Connection Queue Management
- Regulated Asset Base (RAB) model for nuclear
- Open Letter Consultation on the RIIO-ED2 Price Control
- Position Paper on DSO: our approach and regulatory priorities

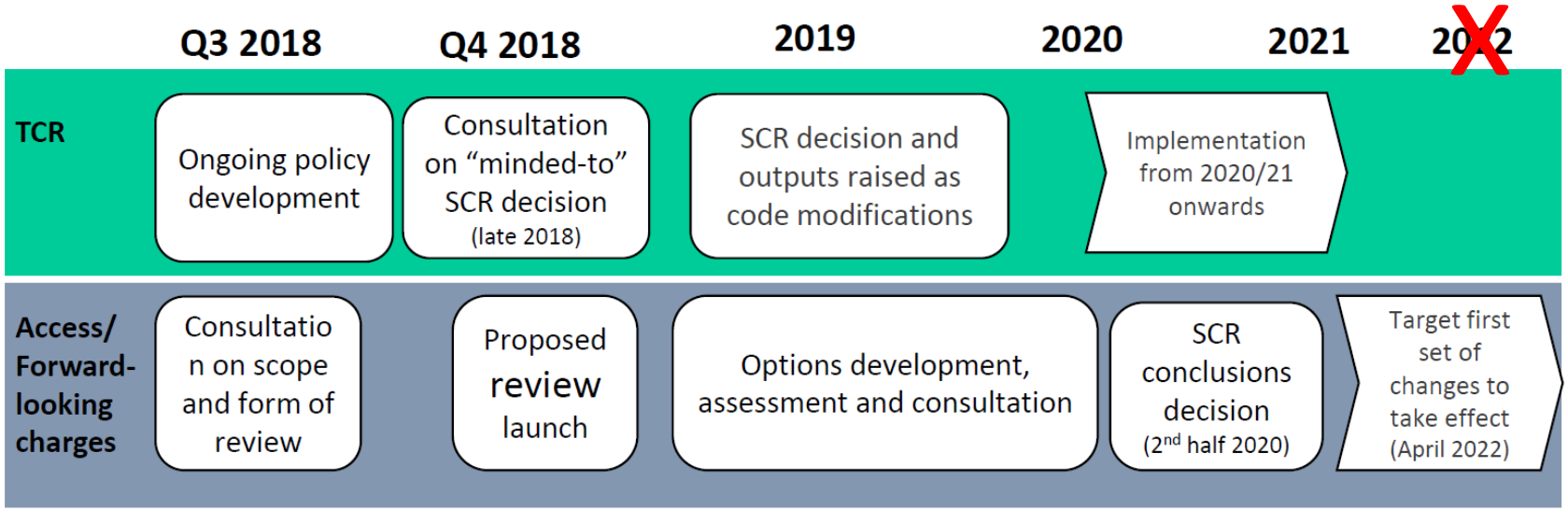
…BEIS/Ofgem Consultation Blizzard



This will last for years – and now a kick into the long grass

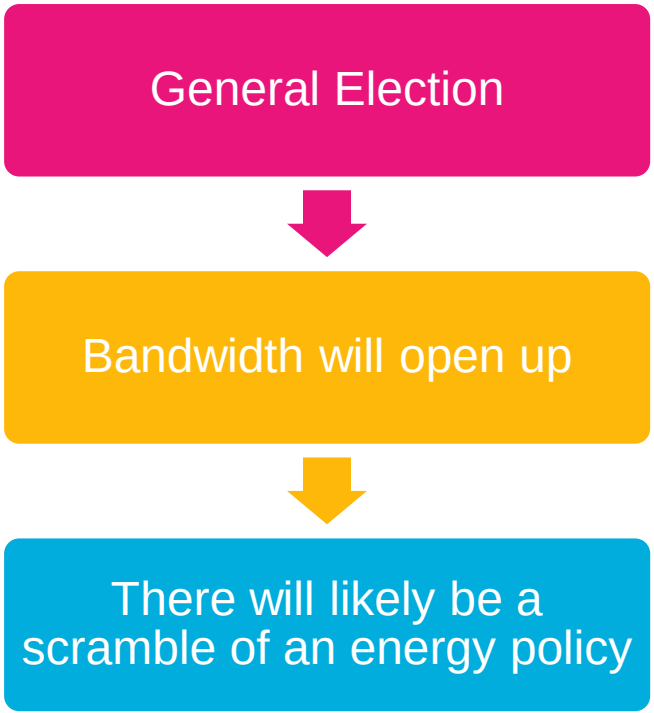
ofgem Making a positive difference for energy consumers

Key timings and how to engage



Meeting with Lord Duncan

A General Election and COP26



The COP (Conference of Parties), is the decision-making body responsible for monitoring and reviewing the implementation of the United Nations Framework Convention on Climate Change.

It brings together the 197 nations and territories – called Parties – that have signed the Convention.

COP26 will be held at the end of 2020 in Glasgow. 30,000 people per day are expected to attend and the eyes of the world will be on this event.

What does a COP look like?

John Moore

General Manager

Locogen

#SRSOLAR19

Scottish Renewables Solar Conference 2019

Sunshine on Leith

The Solar Opportunity

The UK now has 13GW of installed PV but of this under 3% is in Scotland

The UK is targeting 54GW of Solar to meet its net zero Carbon goal – where can Scotland contribute?

- → Roof mount residential
- → Roof and local ground mount commercial
- → Utility scale

On a pro rata basis we should be aiming for over 5 GW of new capacity across these three areas

This is 15x what we have already installed

Why are we not getting our share of PV in Scotland?

- → The sun never shines?
- → There's no payback?
- → Other barriers?

Others will be looking at the residential and utility scale sectors – I will focus on the commercial rooftop opportunity

In Scotland, commercial made up only 17% of installed capacity and much of this can be attributed to Farm based systems

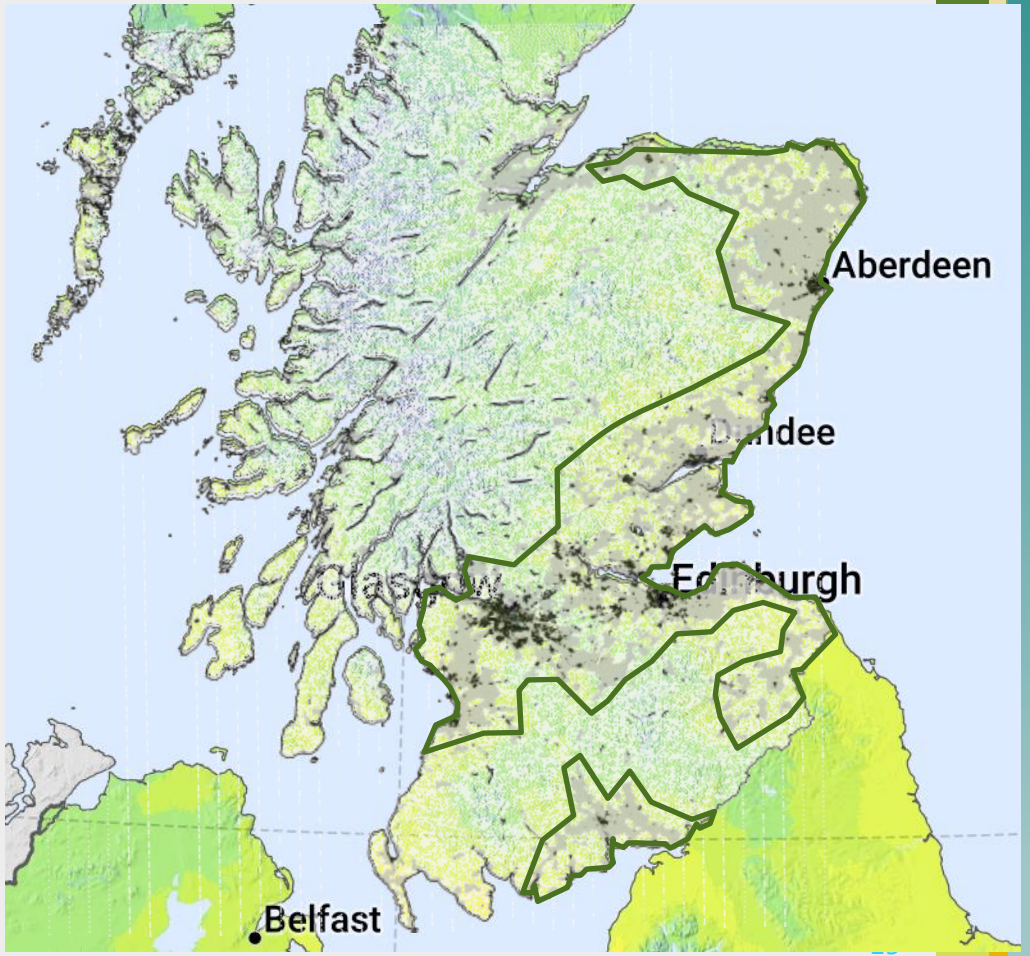
- → Why is it so hard to sell PV for commercial property?

Sunshine on Leith?

The sun never shines?

Resource vs Population

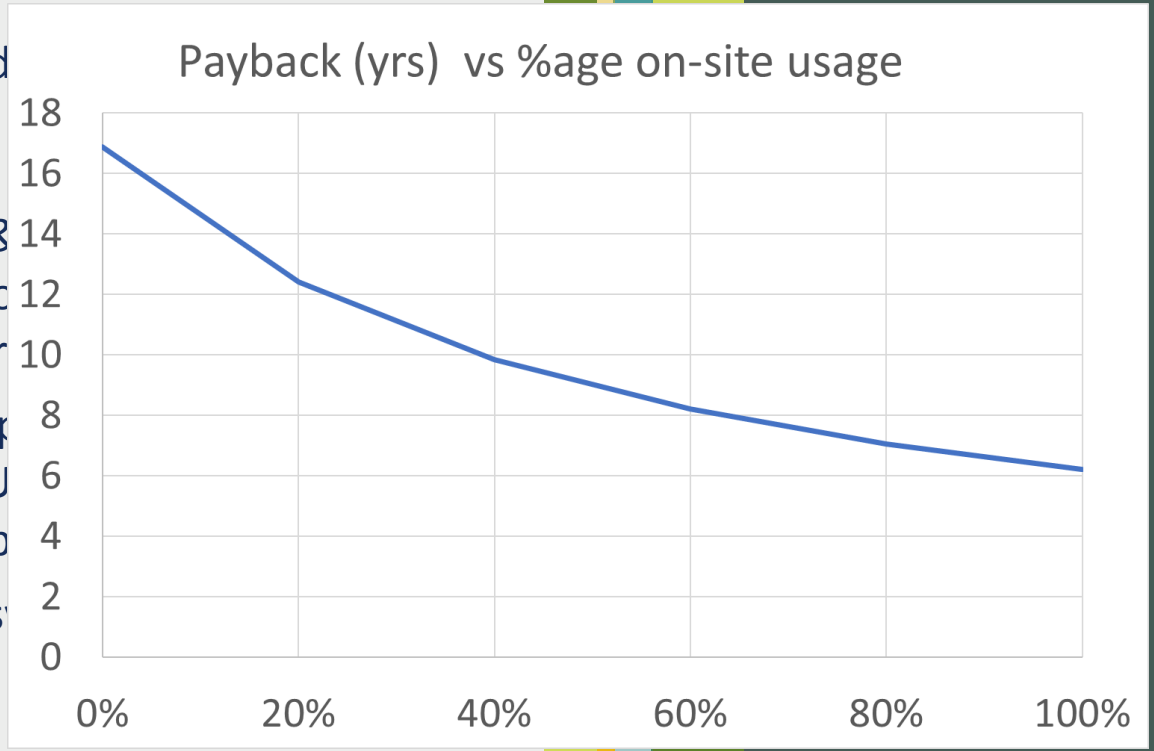
- East coast insolation levels are viable (and getting better!)
- Main population lives in the good insolation areas
- This means a high proportion of potential sites are viable



Source: SolarGIS.com

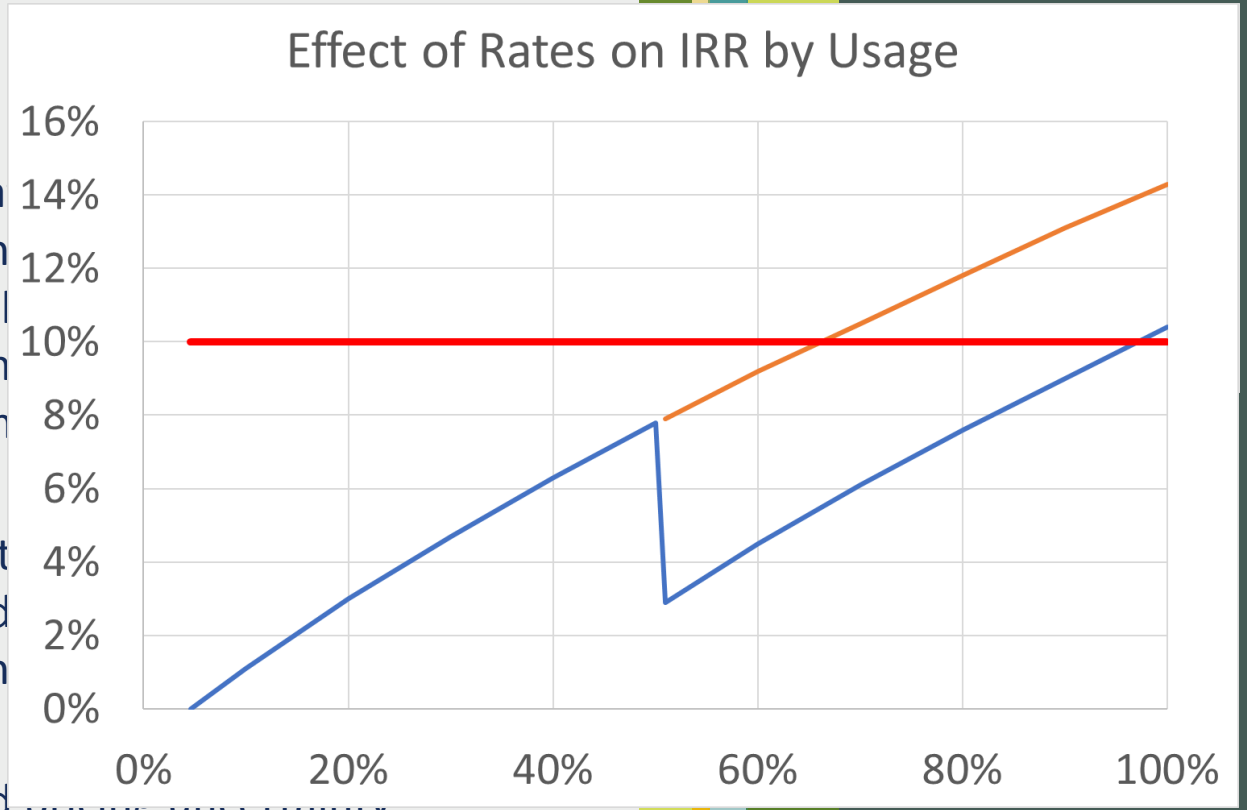
There's no payback?

- Best value of PV is where it d
  purchase:
  - Domestic
  - Commercial btm (roof &
  - Grid connected (if Use c
    allocation resolved – vir
- Scotland saw only 35% of cap
  compared with 46% across U
  of UK total when it makes up
- But for a 50kW roof mount s
  acceptable



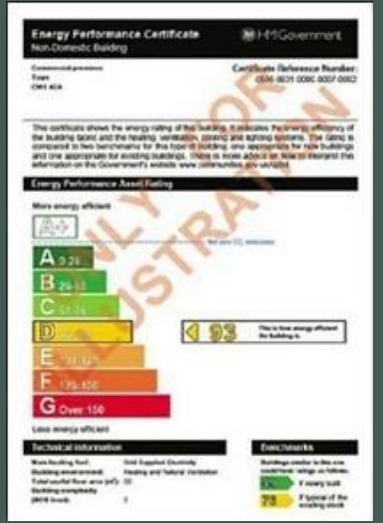
Other barriers?

- Business rates
  - Over 50kW, onsite
    current rates valua
  - Why is the Scottish
    discouraging install
    – It is preventing in
    even generating an
- Planning
  - Scottish PD ends at
    to 1MW in England
  - Why is the Scottish
    barrier to roof top
- Others include SEG, grid



What would help unlock this?

- Remove the 50kW “cap”
- Where there are regulatory measures, installations are going ahead
  - Local Authorities and Carbon targets
  - Housing Associations & EPC requirements
- Commercial property should be encouraged to meet EPC requirements and this can be stick and carrot
- New build property – especially commercial – should be designed for PV – clear roofs with correct orientation and safe access



Conclusions

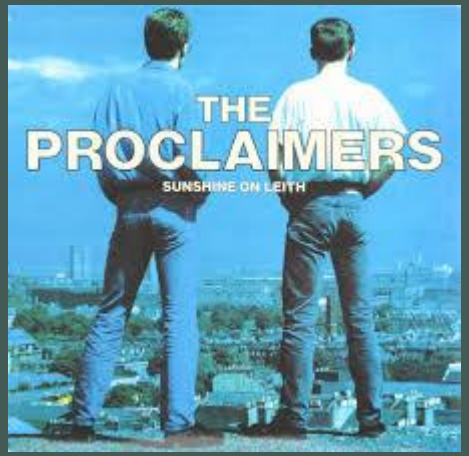
Yes – the sun does shine on Leith – we just need to capture it:

- → Remove the business rates disincentive where energy is used on-site
- → Regulate so that commercial property owners invest in PV and other efficiency measures

It won't take much but it needs both a bit of stick **and** a bit of carrot to shift habits

All the measures needed are directly in control of the Scottish Government – so no excuses…

Thank you



Donald Speirs

Business Development Manager

Dulas

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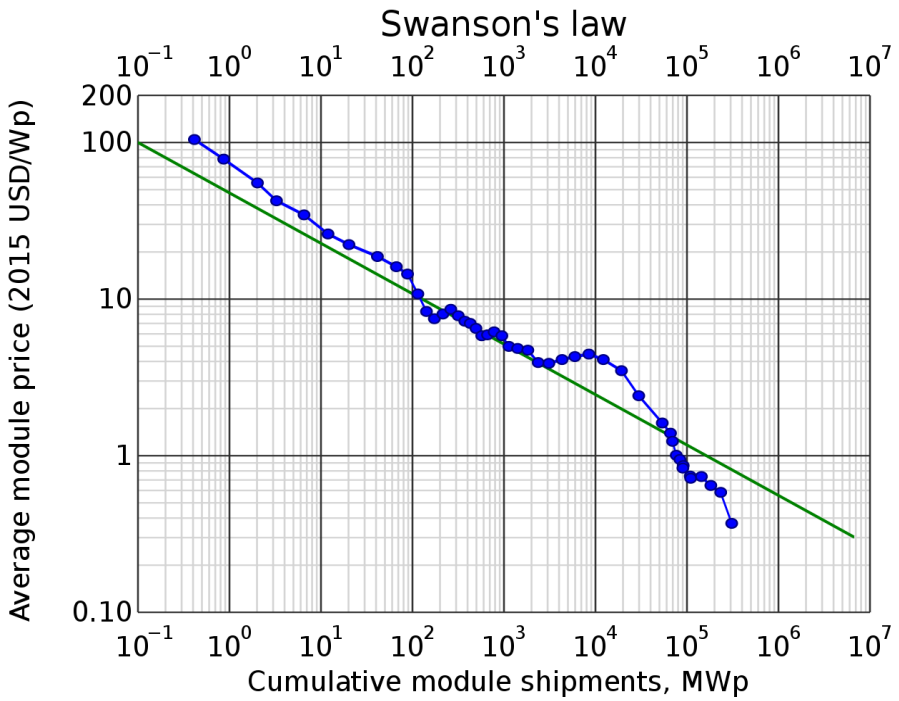
Comments on Recent Developments in the Far East Solar PV Market

Donald Speirs
Business Development Manager
DULAS LTD

The New Lands Of the Rising Sun

- 1980's, 1990's – Solar PV technology was dominated by the Americans. ITC offered as state support
- 1990's, early 2000's – Japan was the world technology leader, due to cyclical public opinion shifts away from nuclear and environmental factors (Kobe). Continuing same debates today
- Mid 2000's – mid 2010's – Germany dominated the production & installation, due to generous Feed in Tariffs. Growth continued after tariff removal.
- 2015 onwards – Chinese five year economic plan 2015-2020 subsidised huge growth in capacity
- Improving Chinese quality and cost of labour drive down prices, make them the world leader for panel production
    - Technology transfer from Germany to China
    - 60% of world solar panels now manufactured in China
- Now moving into era of **Grid Parity pricing**



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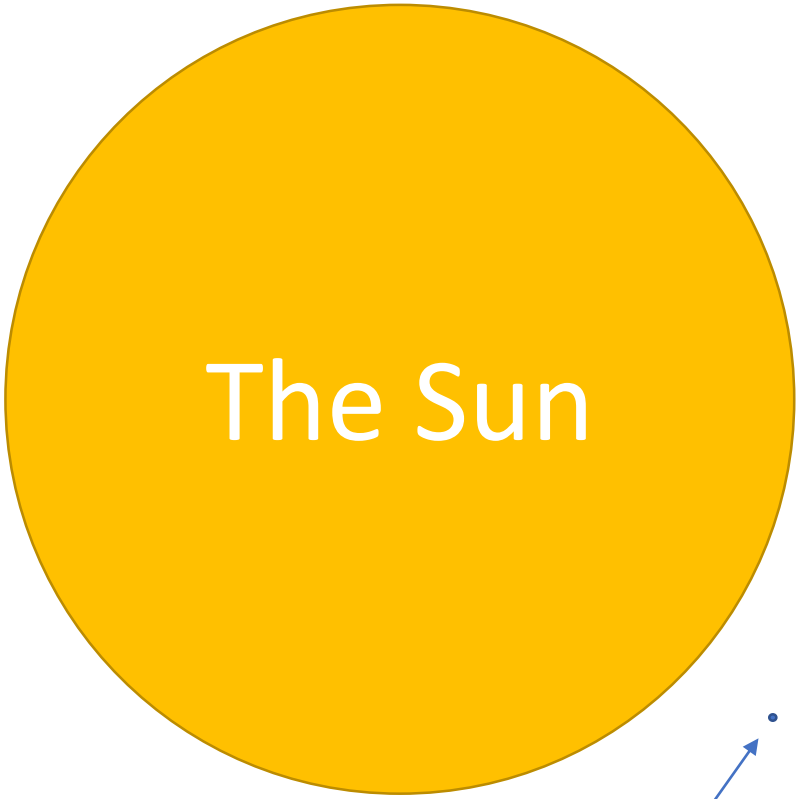

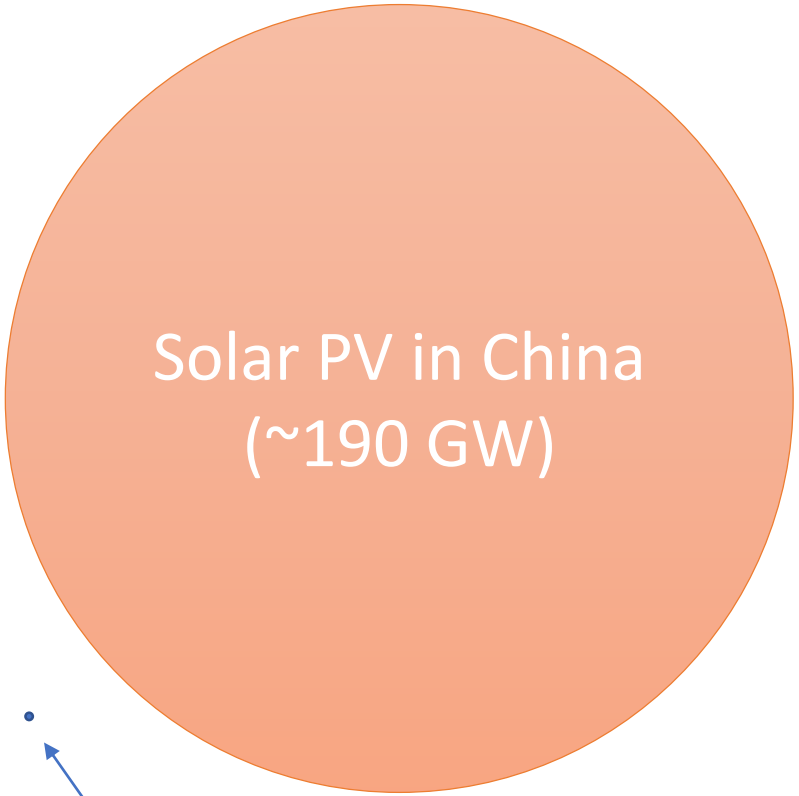

The Earth

Solar PV in Scotland

Scale Drawing

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Dominant Chinese Supply Chain

2018 RANK	COMPANY	HEADQUARTERS	2018 SHIPMENTS (GW)
1	JinkoSolar	China	6.7
2	LONGi	China	5.7
3	Canadian Solar	Canada	5.7
4	JA Solar	China	5.2
5	Trina Solar	China	4.8
6	Tongwei	China	4.8
7	UREC	Taiwan	4.1
8	Hanwha/Qcell	Korea	3.9
9	Suntech	China	3.3
10	Aiko	China	3.3

Source: NREL Q4 2018 global market update

- Gross operating margins in the range 10-15%
- Canadian Solar has large scale Chinese manufacturing plant
- Chinese manufacturing footprint extends across SE Asia for worldwide shipments

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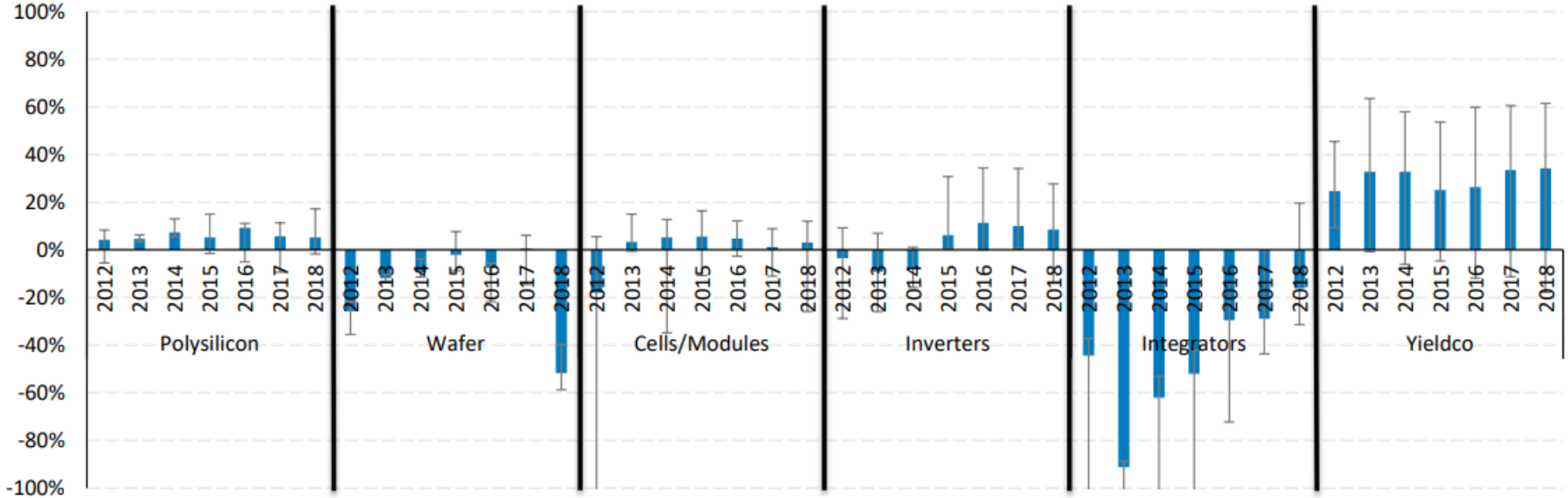
Profitability Across the Supply Chain



Source: NREL Q4 2018 global market update

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Opportunity & Risks of Chinese Supply

- Low product cost, driven down by volume manufacture (Swansons Law)
- Excellent product quality, focus on customer service and delivery
- Vast manufacturing capability, scalable orders possible
- Rapid technology development – bullish about introduction of new technology
- Long-term financial status of product suppliers
- Warranty claims & long-term customer service
- Product development focused on needs of primary customer base (i.e. not Scotland)
- Environmental/Human capital concerns in the supply chain

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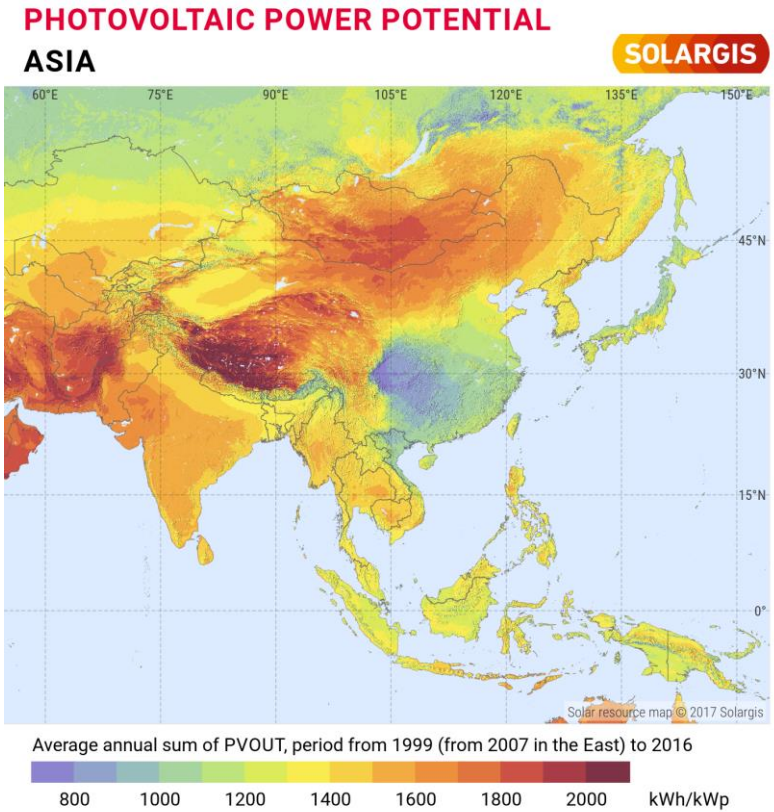
Regional Market

- Asian market size approaches 4 Billion people (0.75 B in Europe)
- Rapidly seeing price and product homogeneity across the Asian region
- Most projects now being built at grid parity (without storage)
- Chinese EPC Companies working abroad and backed by
- Export Credit finance & other financial products that are available
- Low cost manufacturing options (Vietnam)



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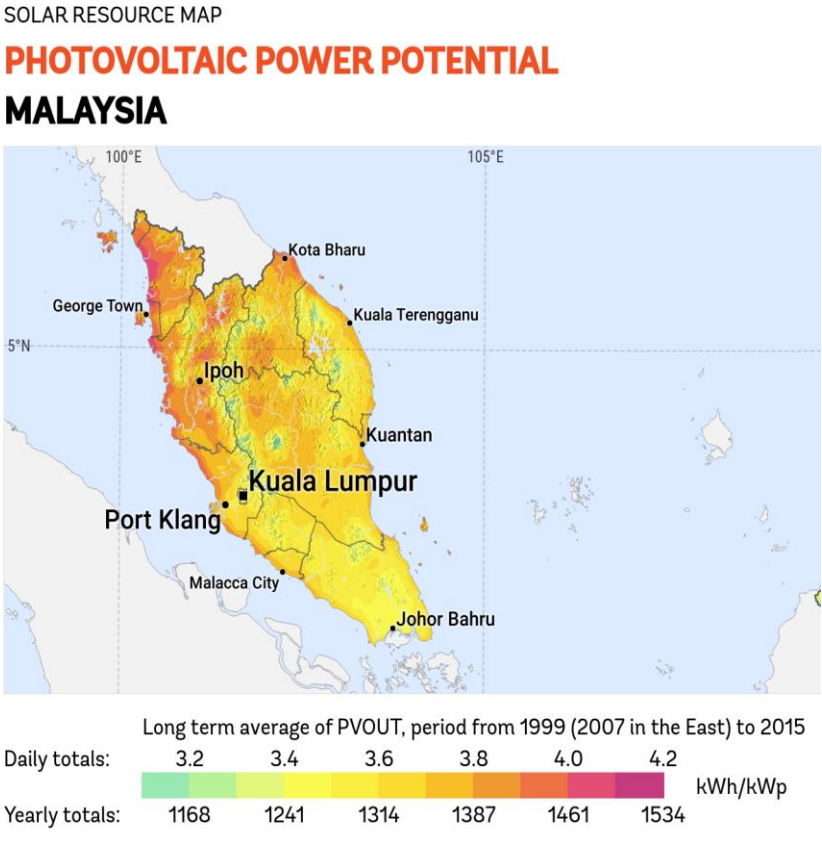
Malaysia Solar Market

- Tropical latitude, constant temperature, humidity and solar irradiance year round
- Very little requirement for panel tilt. Many cases a flat panel is as good as tilted, especially in the south
- Vertically integrated utility (TNB) offering limited scale net metering against a retail price of electricity is 9-12 cUS/kWh
- 2017 build price for solar bids was c. 8cUS/kWh (grid parity or below)
- 800 companies bought bid documents in 2019 for an estimated 5-10 projects of 500MW
- 6.7GW Capacity was bid, with lowest price of 4.2cUS/kWh, compared to 2017



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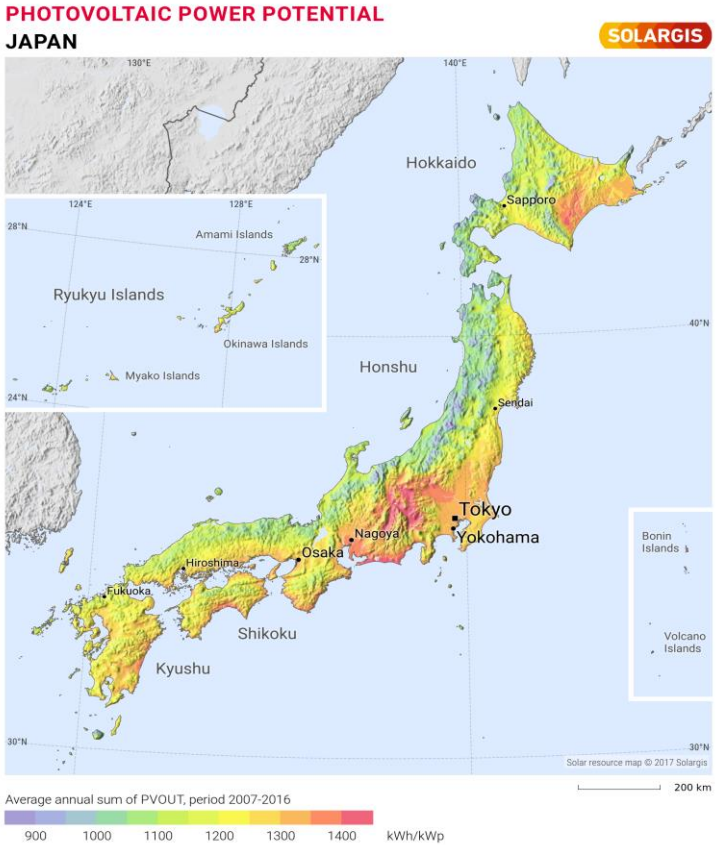
Japanese Solar Market

- Sub-tropical and northern latitude
- Very specific energy constraints in Japan
  - Nuclear considered very difficult politically
  - Lack of indigenous gas resources or pipelines – LNG major importer at premium price compared to piped gas
  - Offshore wind is very limited due to water depth & earthquake risk – looking at floating options
  - Continued solar deployment, although onshore potential will be limited to due lack of available land and building space
- Considering importing liquid green fuels from other jurisdictions where low cost production is feasible (e.g. hydrogen, methanol)



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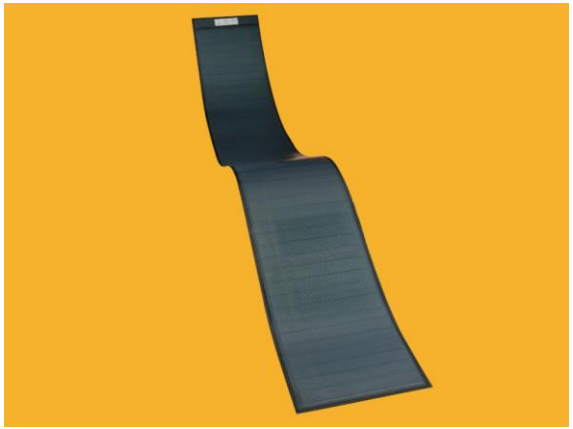
Coming Innovations

- Bifacial Modules
- Flexible Solar panels for building integration
- Offshore Floating Solar at Tropical Latitudes
- Continued Cell Chemistry Evolution



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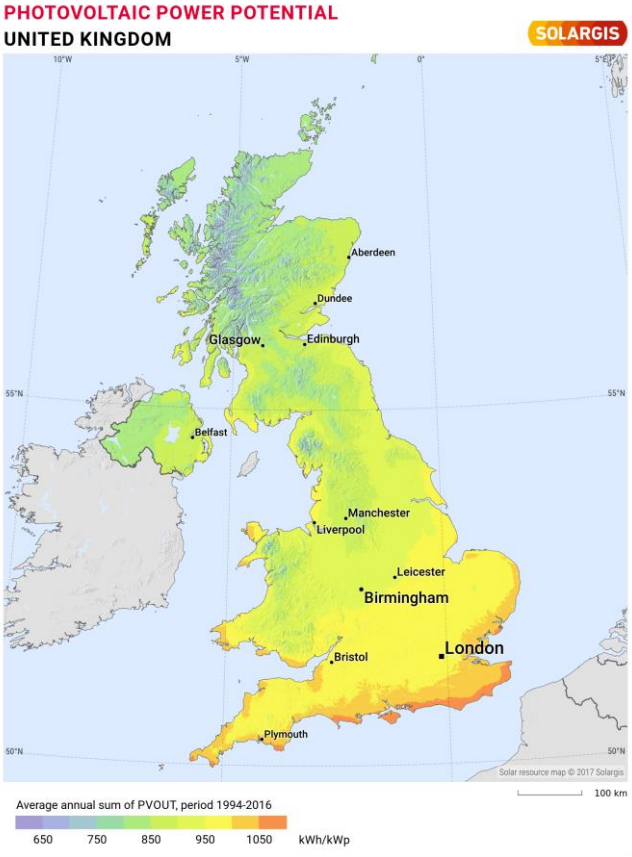
Scottish Context

- Benefit from the technology drive that is happening overseas
- Focus on mitigating the challenges of the Scottish Environment
- Develop supply chain relationships outside of Europe and America, particularly China
- Look to leverage Scottish know-how opportunistically (e.g. offshore tropical solar)
- Fiscal policy measures to support a steady and consistent industry growth



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Claire Mack
Chief Executive, Scottish Renewables

Morag Watson
Director of Policy, Scottish Renewables

John Moore
General Manager, Locogen

Donald Speirs
Business Development Manager, Dulas

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Revenue and risks

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Nick Sharpe

Director of Communications

Scottish Renewables

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Catherine Falconer

Commercial Manager

Scottish and Southern Energy Networks

#SRSOLAR19

Revenue and Risks
SR Solar Conference

Catherine Falconer - SSEN
September 2019

Scottish & Southern Electricity Networks

ENA ERA G99 - Background to the change

- Driven by the latest requirements for generators connecting to the GB distribution system as a consequence of the introduction of new European Network Codes
- The EU Network Codes aim to **harmonise the technical and market rules** to provide a sustainable, secure and competitive electricity market across Europe
- Various working group formed to facilitate the change including
- Any generating unit commissioned and connected on or after **27th April 2019** must comply with G99, as appropriate
- Requirements to comply with G99 will apply to new connections, increases in load or significant changes to connected generators
- **Current consultation on further changes**

Loss of Mains Protection: Real DSO

- Distributed Generation (DG) is required to be equipped with Loss of Mains (LoM) protection:
  - Commonly by Rate of Change of Frequency (RoCoF) or Vector Shift (VS) relays
  - Intended to prevent the formation of power islands.

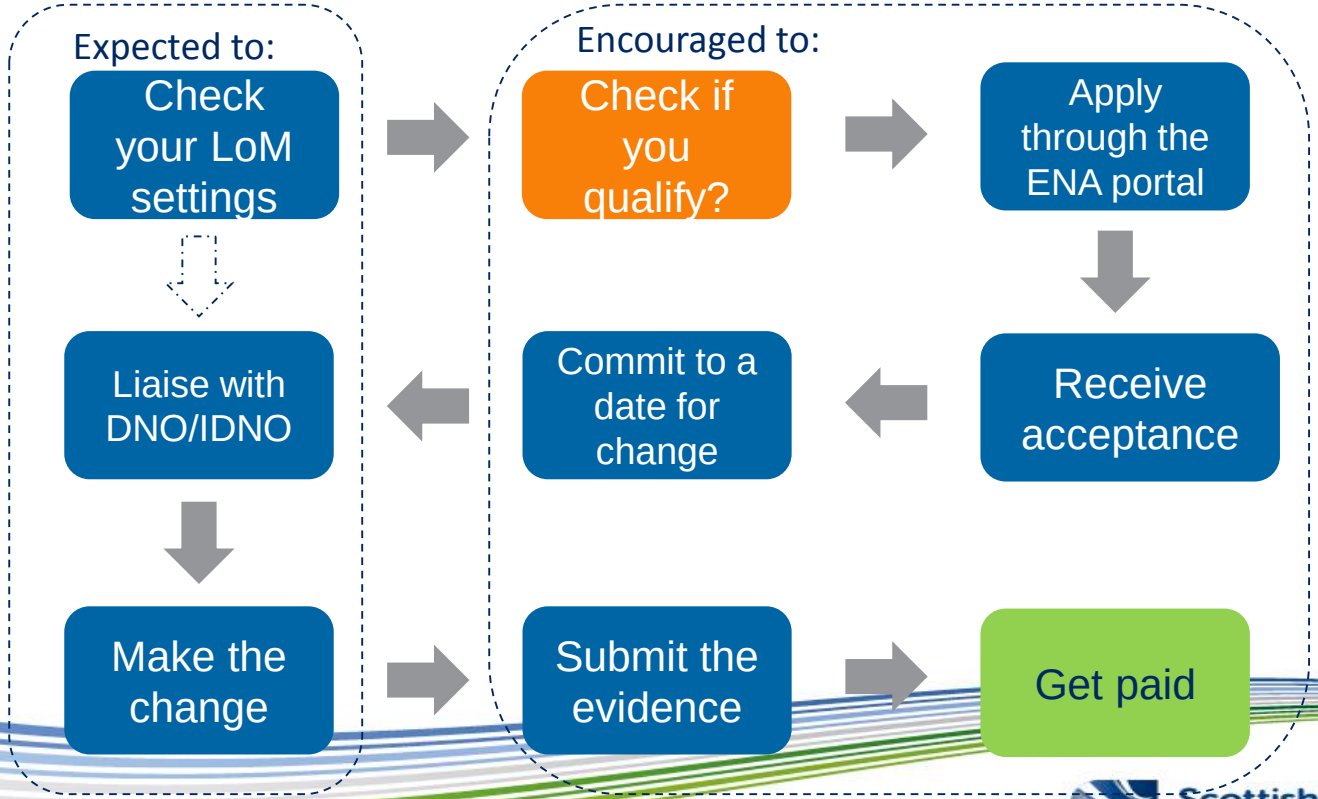
- LOM should only operate where a generator is running “islanded” – however
  - VS and over-sensitive RoCoF could trip for certain transmission faults
  - The risk from this is growing going forward

The Distribution Code Requirement: What Needs to Be Done

Means of LoM protection	Synchronous or Doubly Fed Induction Generator units	Other units
VS/RoCoF relay (Programmable)	Reprogram to use RoCoF with settings of 1Hzs^{-1} and time delay of 500ms	
VS/RoCoF relay (Not Programmable)	Replace with a RoCoF relay with settings of 1Hzs^{-1} and time delay of 500ms	Disable/disconnect LoM protection
Other	No action required	

Scottish & Southern Electricity Networks

Generators and Site Operators



Scottish & Southern Electricity Networks

The Accelerated Programme

- Run by National Grid ESO and Network Operators (DNOs/IDNOs)
- Aims to accelerate compliance with the new Distribution Code requirements (Ofgem approve August 2019)
- Commence in **Sept/Oct with a first short window aiming to be 12th November.**
- Will stop once the cost of accelerating any remaining changes outweighs the benefits achieved by these changes
- Funded by National Grid ESO through BSUoS
- Network Operators responsible for managing the direct relationship with the Generators

Open to all Generators connected before 1st Feb 2018 not yet compliant with the new requirements.

Scottish & Southern Electricity Networks

The Payment Sum (Provisional)

Payment depending on the scope of works:

- £4,000 for each protection device that require protection replacement works; plus
- Up to £4,000 that is made of
  - £1,500 for the first protection device that requires either protection function deactivation or protection settings change; plus
  - £500 per protection device for up to 5 additional protection devices that require either protection function deactivation or protection settings change;
- £500 for sites that are subject to post-event sample site visits.

Useful Links: http://www.energynetworks.org/electricity/engineering/loss-of-mains.html

Scottish & Southern Electricity Networks

Western Isles and Skye: CMZ

SSEN identified a Constraint Management Zone (CMZ) across the Western Isles and Skye and commenced a procurement exercise to secure services in these areas:

- **CMZ Prepare –** Required to support the network during planned maintenance work.
- **CMZ Respond** - Required to support the network during fault conditions as a result of maintenance work during planned outages**.**
- **CMZ Restore** - Needed to support the network during sustained network faults.

Scottish & Southern Electricity Networks

The CMZ: An Invitation to Register

SSEN invited any organisation which can export energy to the network, or reduce demand by 500kW or more to register their interest.

We are now:

- Reviewing all applications and those who qualify will progress to contract,
- Additionally all registered assets will be stored on SSEN's database for contact in the event of future opportunities.

More information at https://picloflex.com/dashboard

This will be an exercise repeated across SSENs networks.

Scottish & Southern Electricity Networks

Further Questions?

Register for SSEN Events and Newsletters at:

✓ https://www.ssen.co.uk/connections/subscribe/

More information on G99:

✓ http://www.energynetworks.org/electricity/engineering/distributed-generation/engineering-recommendation-g59.html

✓ http://www.dcode.org.uk/consultations/open-consultations/

More information on

✓ ALoM Programme: http://www.energynetworks.org/electricity/engineering/loss-of-mains.html

✓ WI and Skye CMZ: https://picloflex.com/dashboard

Scottish & Southern Electricity Networks

Andrew Renton

Principal

Castletown Law

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CASTLETOWN LAW

Solar Energy Generation Scotland

Transition to Subsidy Free Development at Volume and Challenges for PV and BESS

Who is Castletown Law?

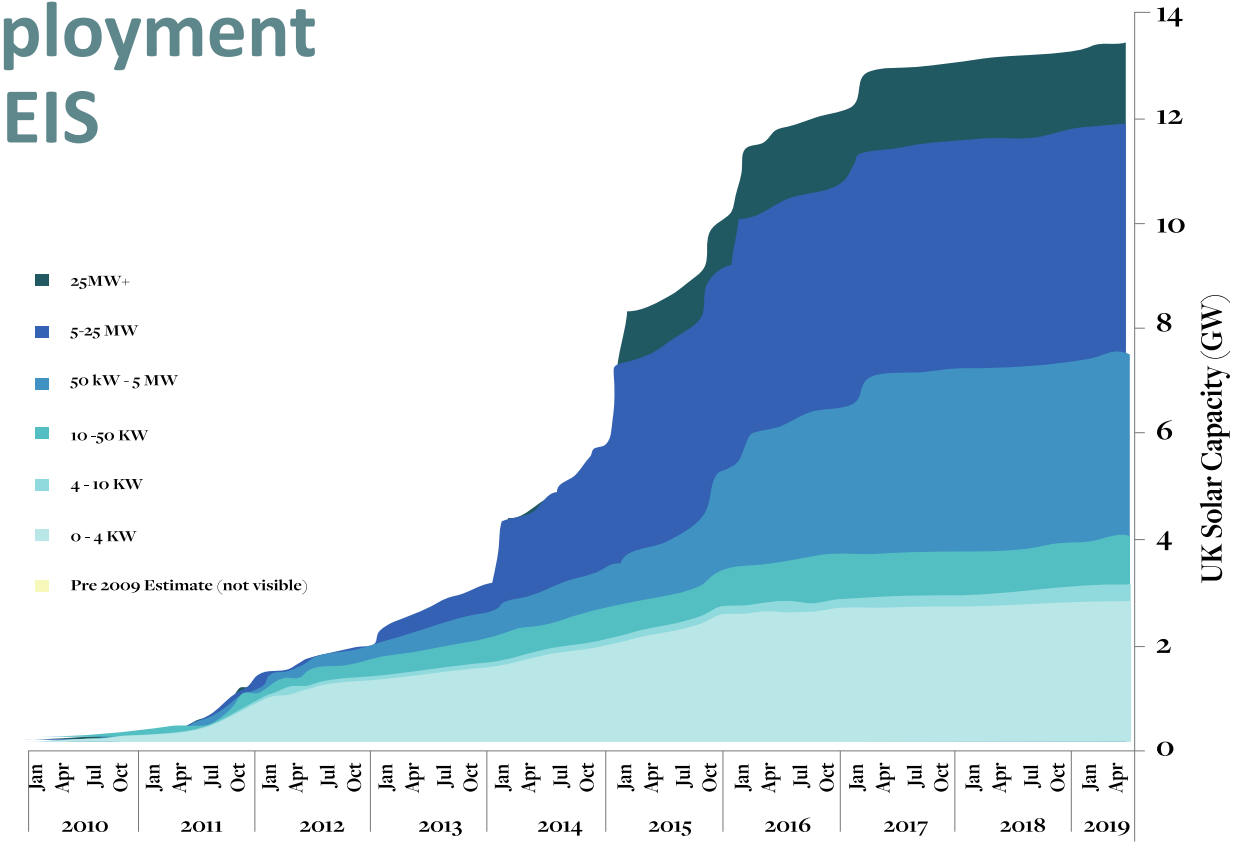
- Specialist Law firm
- Energy and Infrastructure experts
- Operating internationally
- Staffed by experts in their field
- Average qualification period of >20yrs
- ABS model delivering value to clients

PV Without Subsidy

- Removal of renewables obligation and Tariff payments.
- Across Europe and the UK from 2020 PV installations will lose their FiT payments.
- Justification for this lies in the reduction in cost of development of new PV and the LCOE.

Current PV Deployment according to BEIS

UK Solar Deployment:
By Capacity
(updated monthly)

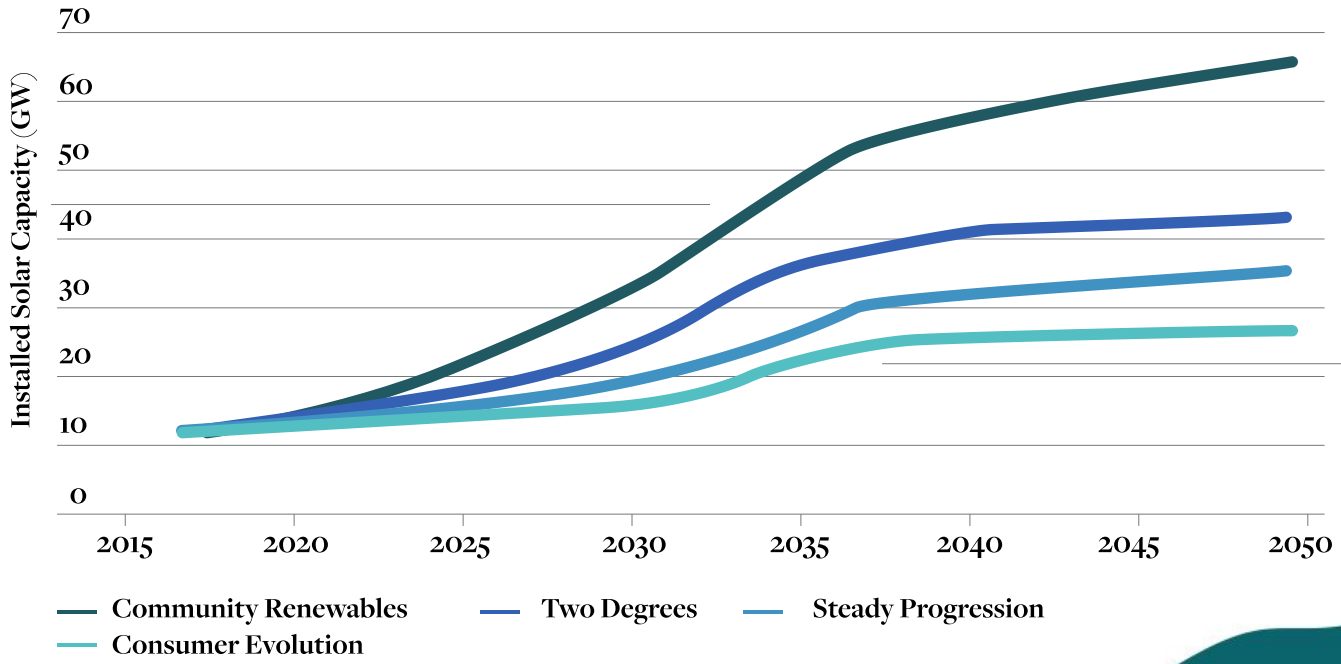


March 2018-2019 Solar PV Subsidies

FiTs (standalone)	580r	580r	582r	583r	584r	584r	584r	584r	584r	584r	584r	584	584	584
FITs (not standalone)	816,250r	817,979r	819,494r	821,168r	822,961r	824,555r	826,209r	828,159r	830,075r	832,068r	833,701r	835,960	837,900	839,069
RO (ground mounted)	755r	758r	758r	758r	758r	758r	758r	758r	758r	758r	758r	758	758	758
RO (not ground mounted)	22,333r	22,333r	22,333r	22,333r	22,333r	22,333r	22,333r	22,333r	22,333r	22,333r	22,333r	22,333	22,333	22,333
CfDs (ground-mounted)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Unaccredited	102,430r	103,836r	104,922r	106,205r	107,606r	108,780r	110,422r	112,003r	114,028r	116,774r	118,871r	120,374	123,837	137,726
TOTAL	**942,350r**	**945,488r**	**948,091r**	**951,049r**	**954,244r**	**957,012r**	**960,308r**	**963,839r**	**967,780r**	**972,519r**	**976,249r**	**980,011**	**985,414**	**1,000,472**

The Future - according to National Grid

Solar Capacity



Rapid growth in **Community Renewables** driven by domestic uptake of solar plus storage.

Cost parity achieved at different times in the scenarios according to business model, leading to further growth.

Modelling without Tariffs

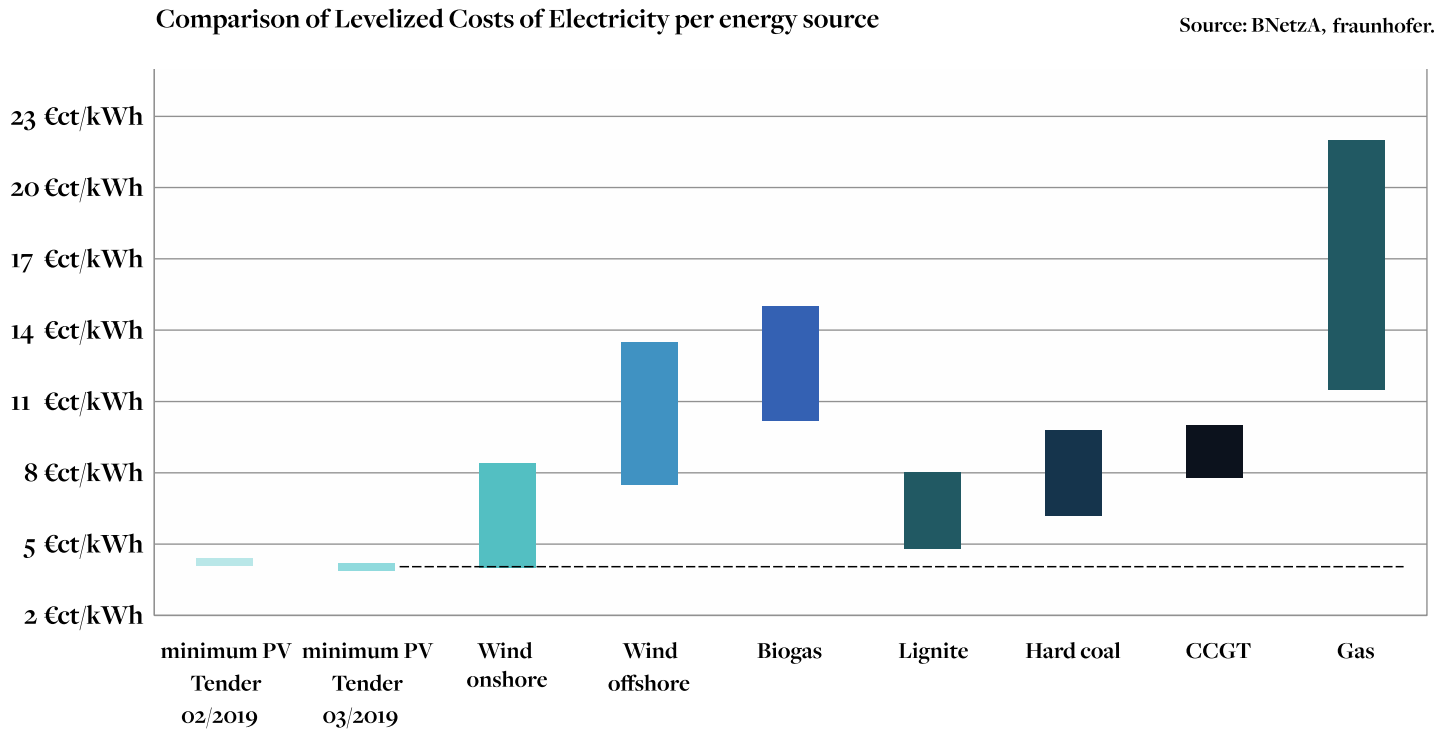
Electricity Wholesale v Retail Prices 2010 - 2019

The SEG Exception

If you are based in Scotland and haven’t yet installed a renewable electricity technology such as solar PV, you may be able to apply for the interest-free Home Energy Scotland loan to help with the initial costs. To be eligible for the loan you must not start work on your system until you have received a written loan offer.

Experience in Germany

LCOE after Subsidy in Germany



Subject Modelling

- Site specific costs
- Charitable intent
- On site consumption
- Corporate PPA
- Return on investment
- Participation in hybrid schemes
- Grid costs
- Revenue stacking options

Adapting to a Zero Subsidy World

- It is surprising that industry is surprised by the removal of subsidies. In other countries this has followed the time when Solar PV generation approached parity on LCOE and in some cases there was a sudden and dramatic turning off, leading to litigation and claims.
- In the UK it was trailed as pending review and then announced on the basis of a long lead times to allow industry to adapt.
- The purpose of subsidy was to support the introduction of new generation technology until it was sustainable on an economic model without subsidy.
- The key for industry and government is a planned transition.

The Energy Act 2011

- The Energy Efficiency (Private Rented Property) (England and Wales) (Amendment) Regulations 2019 make changes to Part Three of the 2015 Regulations
- From 1 April 2019, landlords of domestic properties with an EPC rating below E must carry out up to £3,500 (inc VAT) worth of works improving their energy efficiency if they cannot obtain third-party funding to meet the costs.
- This requirement applies before the property is let on a new tenancy, or by April 2020 if no new tenancy has been entered into.
- IN SCOTLAND- Energy efficiency standards regulations to be laid before Scottish Parliament following consultation- Autumn 2019.
- For domestic PRS properties there may be a slow and delayed uptake by Landlords in compliance- Resources for enforcement are limited in local Authorities.
- The opportunity to improve housing conditions for those who are just about managing in PRS will be missed!

Commercial & Industrial Incentives

- Government can encourage Energy efficient buildings by providing discounts on local rates or property tax.
- CO2 emissions ratings certificates of a certain level could be made mandatory for commercial buildings within a period of time.
- Changes in Building Regulations provide incentives to maintain commercial property PV developments.
- Competing for CfD's for greater proportions of generation from PV.
- Corporate PPA developments for LV installations.
- Better UoS charges approach for renewables generally and PV in particular.

Complex Interdependencies - Hybrid

- Technologies should be integrated to work in harmony.
- Wind, solar, bio-mass, tidal, nuclear and storage can work together and in a complimentary way.
- Seasonal differences, network stability, consumer trends, can be analysed to predict the likely future model for Solar PV demand.
- Working with storage at all scales of production is now the next horizon for electricity generation and management.
- The grid and network connection impediment - time!
- Most PV generation is not certain because of changes in atmospheric conditions so grids and networks need to become more adaptable.

Models for Post Subsidy

- Local leadership at a regional and national level needed for development at all levels in Scotland.
- Planning requirements for low carbon energy solutions. Modelling for producers (including domestic) to operate as suppliers.
- Look at the Stadwerke model in Germany - where Local authority land is provided for JV PV generation projects.
- Commercial and rooftop options for tenant consumption.
- Revisit a MUSCO (Multi Utility Service Company) option where heat, electricity, gas, water and waste water, broadband, telecomms and refuse are delivered on a community basis.

Solar – Storage Integration – Why?

- Back up to generation.
- Solar generation does not match peak demand profiles.
- Mitigating short term spikes impact on network.
- Grid connections more available with control mechanisms available in storage.
- Power quality management can be helped by storage.
- Peak load management is available without additional generation capacity in reserve.
- Multiple active power quality systems my impact negatively on the network.

Source: western power Distribution

Use Case Demonstrations

- Stored electricity sold at +ve margin.
- Matching generation and demand profiles.
- Peak load shifting/lopping.
- Low cost of charging at low demand prices.
- Management of reactive power requirements.
- Lower connection capacity needed.
- Predictable ramp mechanisms with reduced grid impact.
- Export constraint management.
- Digital management allows multiple storage and renewables systems to integrate.

Source Western Power Distribution and RES powerchange

PV + BESS

- PV cost is measured in £/MW- how much does it cost to build.
- Storage cost is more complex and depends on use case modelling and accessibility of ancillary services for revenue stacking.
- Identify the income generation most suited to the use case required in the local network/grid.
- Three examples:

    a) Time of Day PPA

    b) Capacity PPA

    c) Ancillary services (reserve/frequency/reactive/smoothing)
- PV + BESS is potentially more bankable.
- Reducing concerns on technology risk means integrated systems more likely.

What's Next?

- Government by good intention is trying to dictate the next steps through consulting on the appropriate approach.
- As we have seen in the nuclear sector a sense of realism is needed to allow industry to operate.
- If as we seem to be accepting Solar PV is approaching parity in the UK, then regulation is needed to ensure the required proportion of Solar PV is delivered.
- Regulators should encourage the integration of technologies to maximise the reduction in carbon based generation.
- Government targets are admirable but we may be able to do better with more flexible regulations. Industry is moving too quickly for government.
- Regulation should be split into enabling and delivering (cooperation) and policing and compliance (supervision).
- Government should set a high level framework and monitor the delivery which it should leave industry and regulators to deliver.

CASTLETOWN LAW

Thank you. Invite us in.

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Silvia Raineri

Solar PV Consultant

Natural Power

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Natural Power

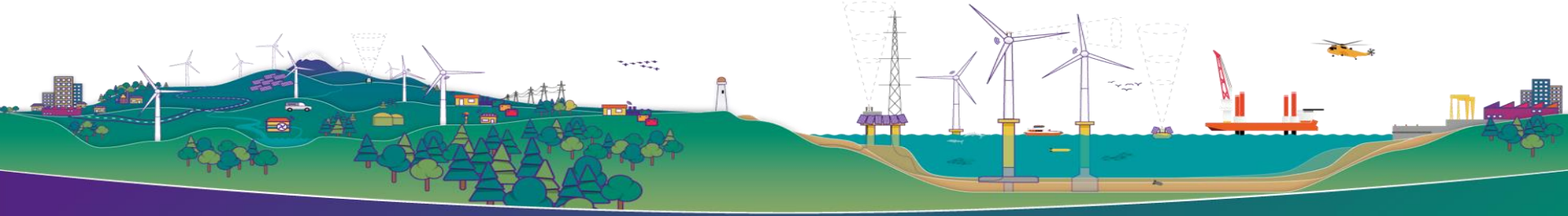
Solar PV Technology Drivers and LCOE trends enabling zero-subsidies projects

Scottish Renewables Solar Conference

Date: 26th September 2019

Produced By: Silvia Raineri - Solar PV Consultant

Natural Power



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Our services

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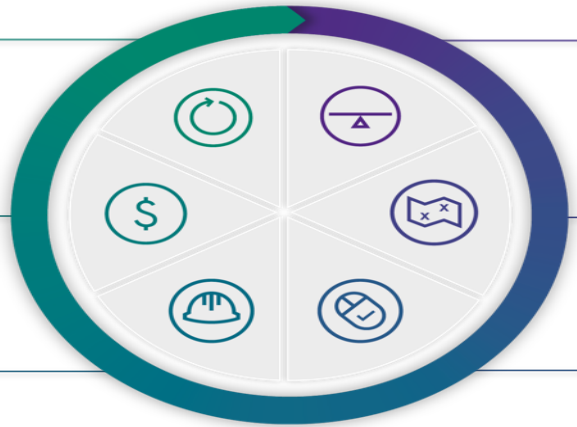
- Engineering
- Planning & Permitting
- Environmental
- Project Management

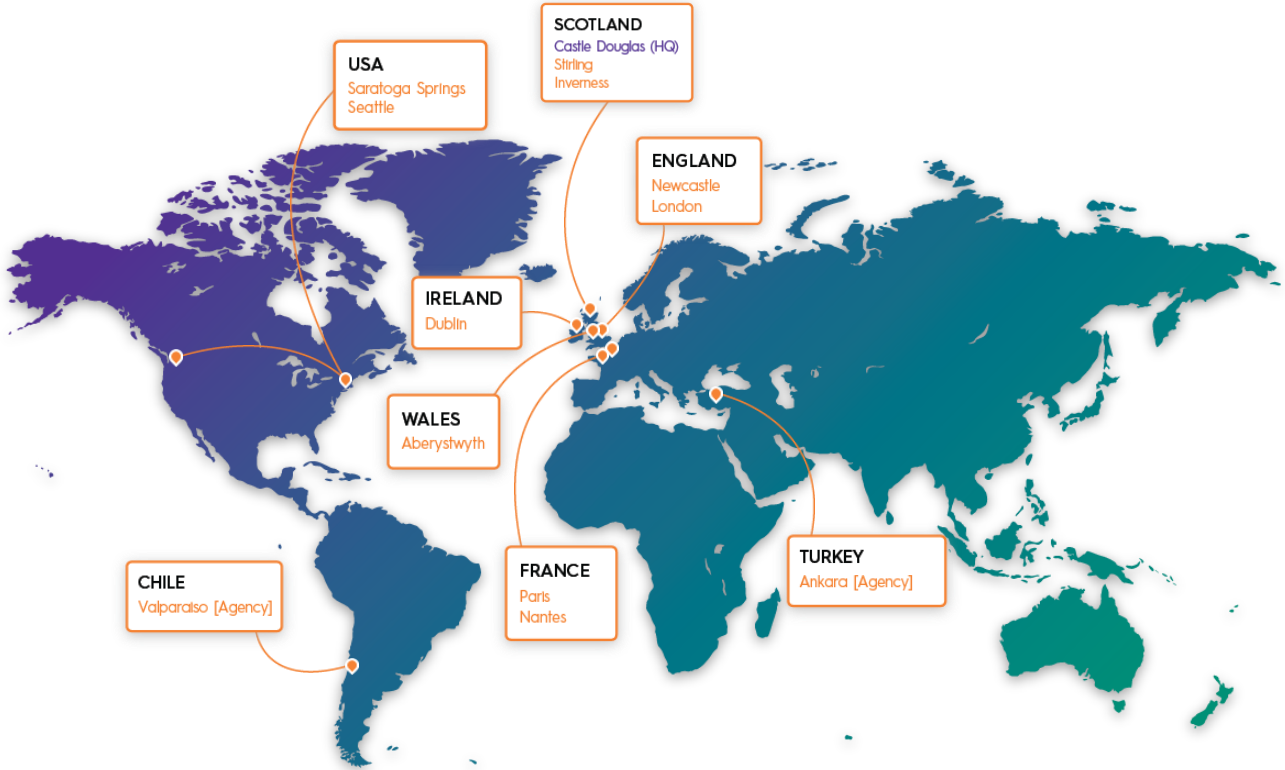
PROJECT PHASE



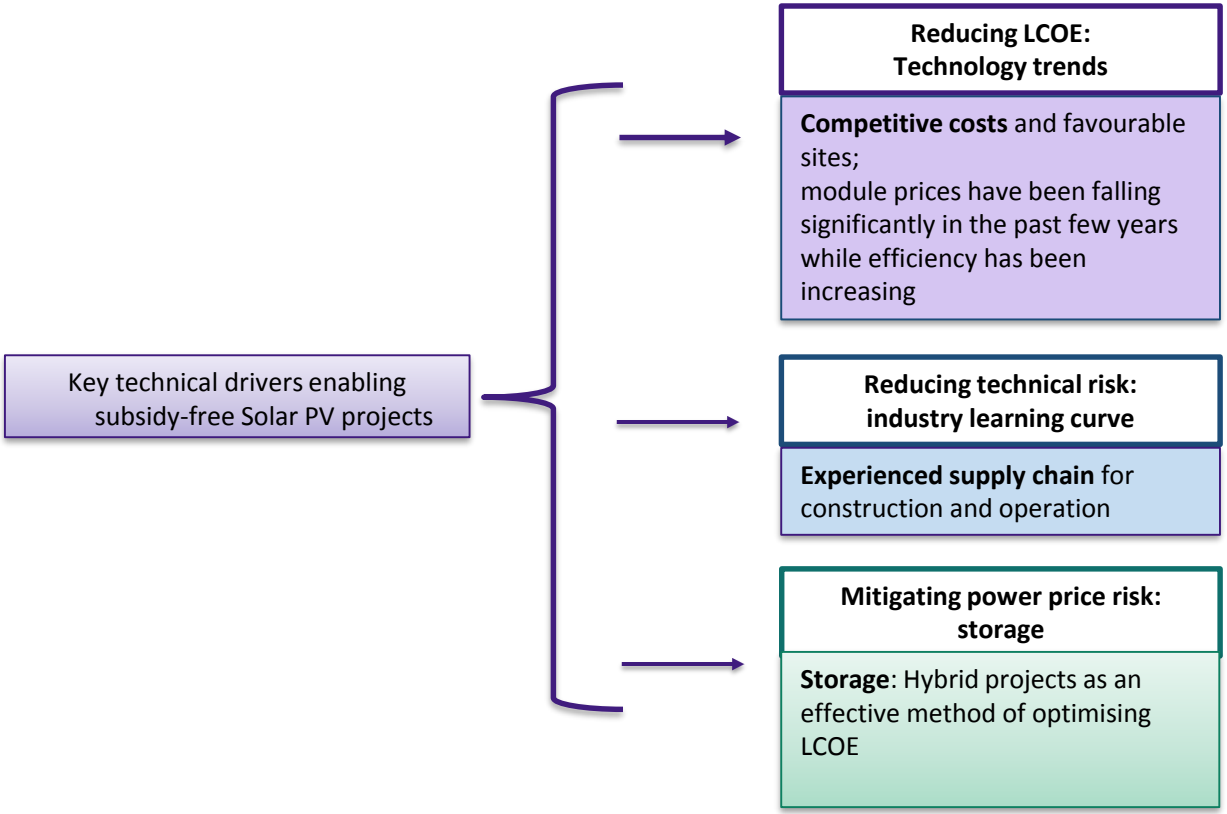
SECTOR

- Onshore Wind
- Offshore Renewables
- Solar
- Hydro
- Renewable Heat
- Grid & Infrastructure

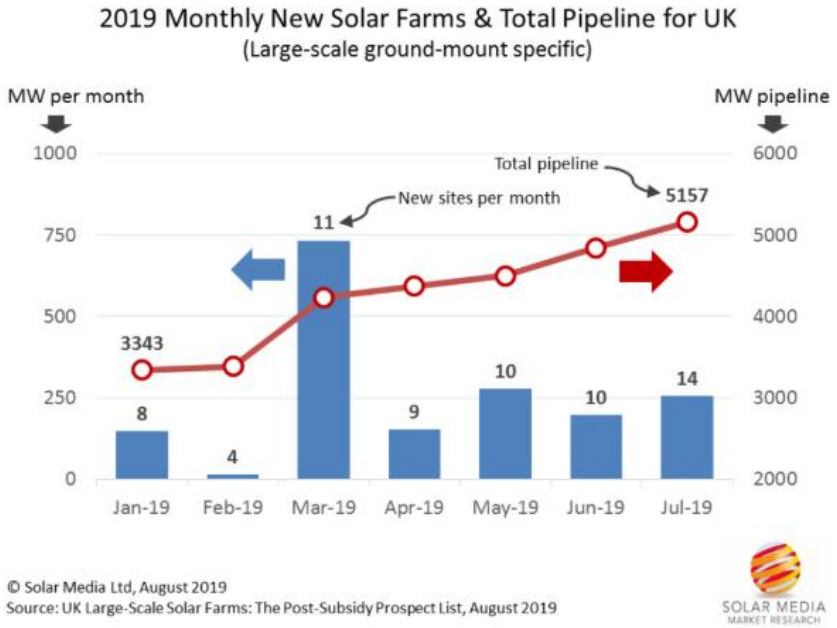
Worldwide offices



The zero-subsidy opportunity

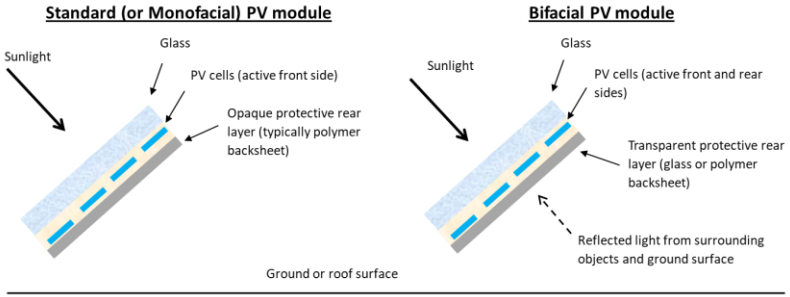


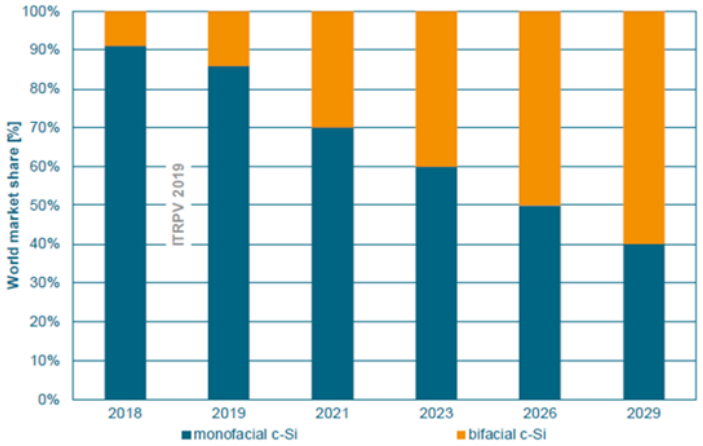
The UK pipeline of large-scale ground-mounted solar farms now stands at over 5 GW, with about 10 new sites being added to the database every month.



Solar Technology Trends: Bifacial PV Modules

- Bifacial modules increase power by generating from both the front and back side of the module
- Power gains depending on solar cell technology used, location and system design (typical Scottish site around 5-10%)
- So far, mainly viable in sunny climates and/or highly reflective surfaces
- Bifacial gain is difficult to model accurately

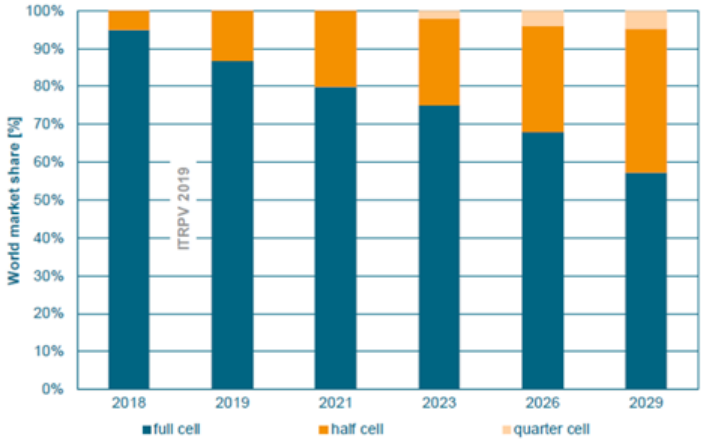




Source: 2019 International Technology Roadmap for Photovoltaic

Solar Technology Trends: Half-cut cells Modules

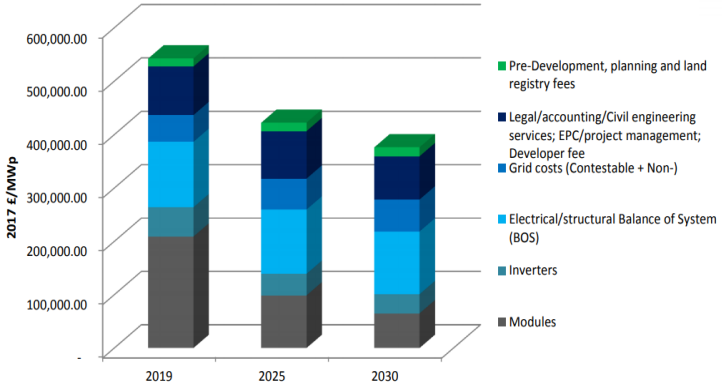
- Higher output and reliability due to smaller cell size
- Increasingly offered by most major module manufacturers
- Relevant for low irradiance climates like Scotland, if the modules are installed in portrait mode with shading conditions, can achieve up to 50% more energy



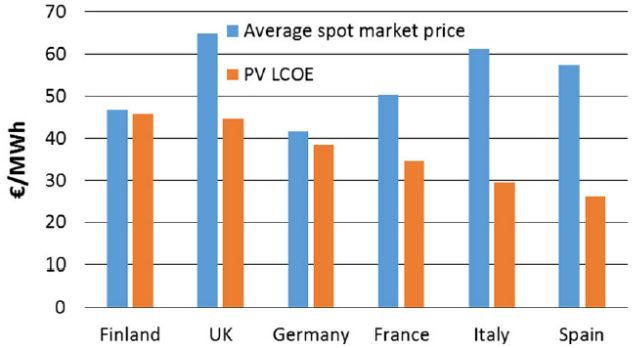
Source: 2019 International Technology Roadmap for Photovoltaic

Lower solar PV module prices and ongoing reductions in balance of system costs remain the main driver of reductions in the cost of electricity for Solar PV.

- Module prices have dropped ~95% in the last 12 years, and 40-50% in the last year alone (driven by Chinese oversupply).
- Further reductions are expected as cell efficiencies increase and production capacity grows.
- Projected Opex cost reductions are more moderate and improved through better monitoring and increased inverter lifetimes.



Source: UK *Solar Trade Association 2018*



Source: EU PVSEC PAPER- Impact of weighted average cost of capital, capital expenditure, and other parameters on future utility-scale PV levelised cost of electricity -wileyonlinelibrary.com/journal/pip

Reducing technical risk: industry learning curve

Equipment manufacturers, construction contractors and O&M providers have all benefited from growing experience through the wide deployment of Solar PV technologies.

- Optimisation of performance and lessons learned in design and manufacturing
- Greater understanding of weather impacts and dust on solar panels
- Greater understanding of permitting process
- Improved methodologies in yield assessment result in reduced uncertainties
- Focus on “design for operability” – the long-term life of the system

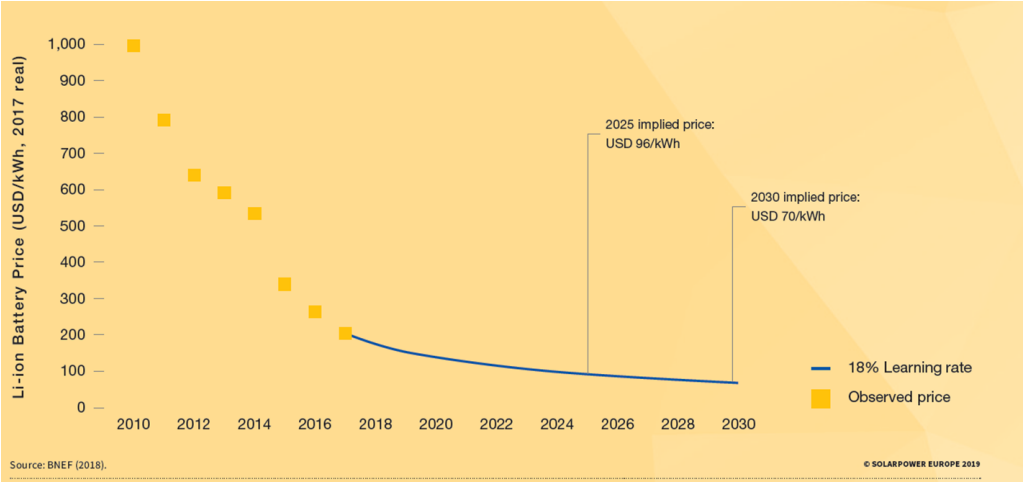
Aspect	Exacerbating factors	How to minimise losses and uncertainty?
Shading	• Tight row spacing • Uneven terrain • Nearby trees or buildings	• Sensible row spacing, module landscape orientation, setbacks • 3D terrain modelling • Site visit to confirm nearby shadings • Vegetation maintenance strategy

Aspect	Exacerbating factors	How to minimise losses and uncertainty?
Soiling losses	• Dry, dusty climate • High industrial/agricultural activity • Coastal site	• Site visit to confirm conditions • Module cleaning strategy

Aspect	Exacerbating factors	How to minimise losses and uncertainty?
Warranties	• Design exceeds inverter limits, high DC:AC ratio • Aggressive ground conditions, flood risk, extreme weather (structures)	• EYA based on detailed electrical design • Inverter manufacturer to confirm design is acceptable • Site-specific mounting structure warranty

Co-location of solar with battery storage is growing

- provides risk diversification and an effective method of optimising LCOE
- allows Capex/Opex reduction sharing infrastructure and grid costs
- enables generation capacity to be oversized with respect of grid export limit
- offers revenue stacking benefits (time and peak shifting and price arbitrage)



The costs of battery storage have decreased dramatically in the last decade. the potential for further cost reduction is substantial – by 2030, prices could fall by more than 60% compared to current levels

Source: SolarPower-Europe-Global-Market-Outlook-2019-2023

We are entering a new period of gradual transition which may lead to significant growth in the subsidy-free market opportunity in the UK.

As the renewables market continues to mature, developments such as further LCOE and risk reduction, operational optimisation may enable investors to engage with new business models.

The subsidy-free market is still in its infancy, but we see it moving further north and it's time to consider its potential opportunities.

Thank you

Silvia Raineri – Solar PV Consultant
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https://www.naturalpower.com/white-paper-co-location-of-wind-and-solar-pv/
https://www.naturalpower.com/modeling-bifacial-pv-systems/

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Building new business models

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Andrew Smith

Managing Director

Greenbackers Investment Capital

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Building new business models
How can we attract finance to subsidy free solar development? What business models will deliver solar deployment at scale? How can householders be incentivised to install PV?

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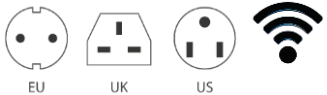

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How can we attract finance to subsidy free solar development?

Market

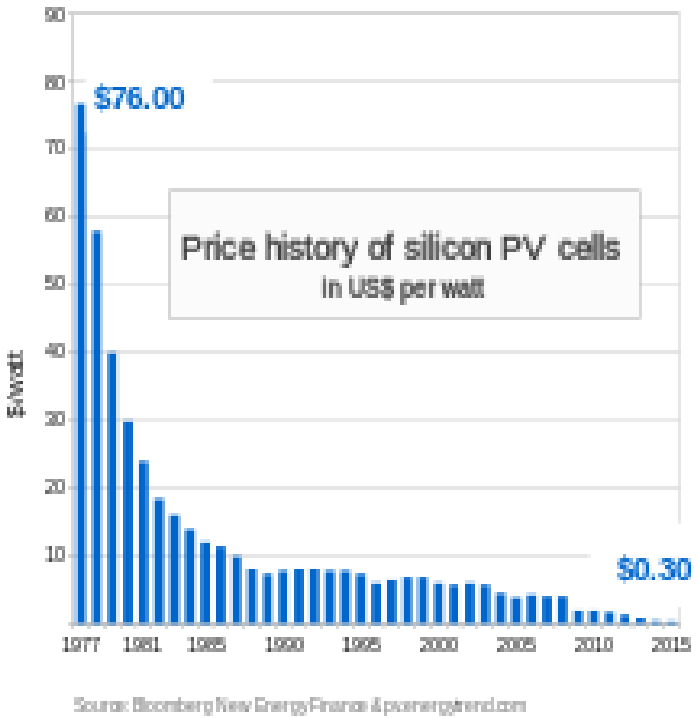
By 2050, Solar PV will dominate the renewable sector on a global basis and especially in southern hemisphere

Cost reduction vs volume has been dramatic. Further scale and automation to continue downward trend

Value-add

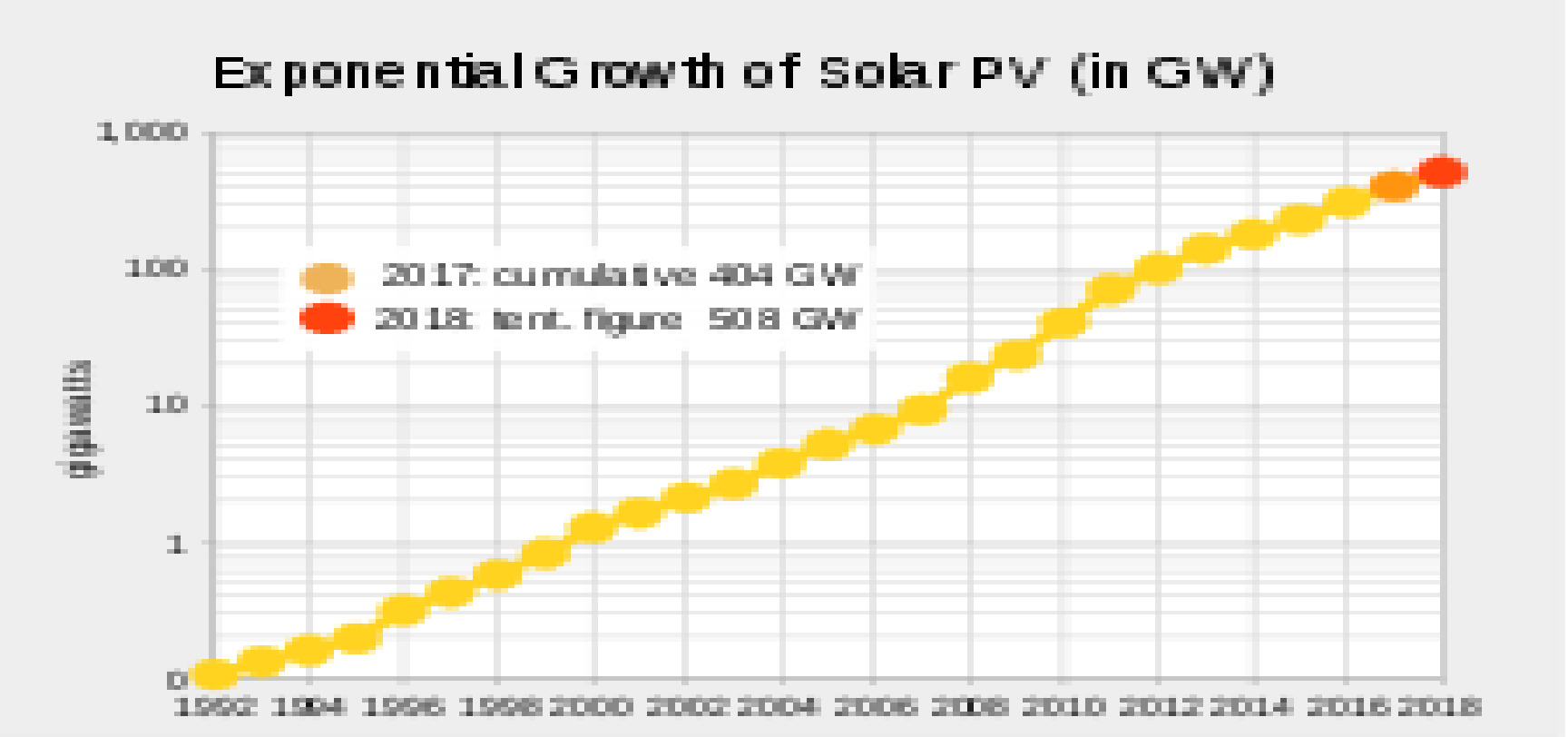
Energy storage to make more of existing and new capacity (eg ILI)

Price History



- Cost has reduced by 99% over 4 decades due to a combination of conversion efficiency, scale and policy (see below)
- Efficiency of solar conversion in crystalline silica (Si) is reaching a plateau encouraging new and potentially disruptive technology
- Lambda Stretch – extending useful light wavelengths – nanodot (+2% in conversion)
- Perovskites – cheaper, higher conversion efficiency (25%), still in commercialisation
- BIPV (Building Integrated PV) eg Solarmass (one installation rather than two for roof tiles and panels)
- Organic thin film PV – eg Heliatek, Poweroll

Growth of Solar PV (in GW)



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What business models will deliver solar deployment at scale?

- *Large scale solar parks could offer off-grid solar as a service*
- *Consolidation and integration across value chain from module manufacturers, operators, users, energy cos. to governments*
- *Smart grid offers opportunity to consolidate and extend distributed PV generation. We see lots of R&D in this area.*
- *Could utilities own and control distributed PV?*
- *Are PPA's viable – would reduce cost and risk*
- *Leasing?*

Potential Barriers?

- *Insufficient scale, regulatory structure*

How can householders be incentivised to install PV?

Community shared ownership
Point & Sandwick model
Measured benefits + conversations with Treasury
Helping the fuel poor
Housing associations

Recent Financing in Other Sectors?

- *Orbital Marine on Abundance* a 30 month secured Debenture to help build the first production model Orbital O2 2MW tidal turbine ….. the project had already secured more than £9 million in grants and equity funding
- *Nova Innovation on Seedrs* "We're launching a crowdfunding campaign to give people who care about sustainability, the environment and social value, an opportunity to invest in the next generation of clean energy.
- *Scottish Investment Bank with SME* SIB Director Kerry Sharp said: "SME has repeatedly proved its resourcefulness, culminating in the successful testing of its innovative PLAT-I platform and generation of first power. We've supported the company every step of the way since it relocated to Scotland in 2016 and have underlined our continued backing by contributing to its latest fund-raise."
- *Simec Atlantis – at the start*

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Finance

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Simon Peltenburg

Chief Projects Officer

Ripple Energy

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Simon Peltenburg, Chief Projects Officer

A Consumer-Driven Route to Market for Subsidy Free Renewables

- The Problem: Wholesale price and REGOs are insufficient
- Solutions: reduce capex and opex; increase yield; compete for CPPA; ask for other financial support, or ….
- Access the actual value that end consumers place on high quality energy

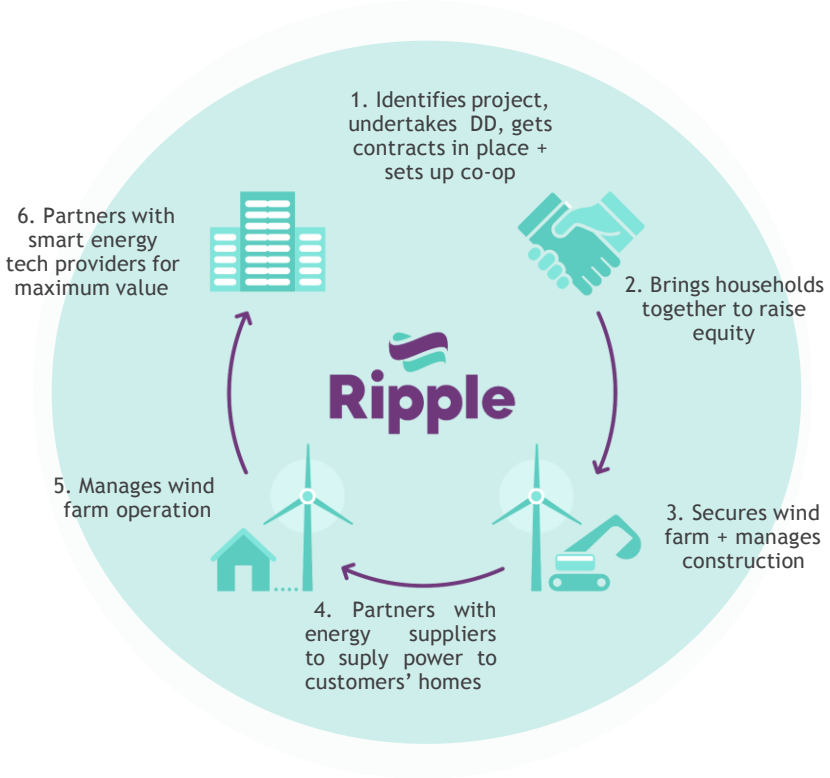
Consumer Power Engagement Challenges

- Net Zero energy needs consumer engagement
- Green tariffs still have price volatility despite stable opex
- Consumers want to have control of their own power
- Domestic generation isn’t an option for all
- 80% consumers still don't even switch …

Ripple's vision:

50% of UK homes owning their own source of clean power by 2050

The Ripple Model



- Avoids any need for consumer to be an expert
- Suitable for any subsidy-free renewable energy
- Gives access to UK's cheapest sources of power
- Creates additional generation
- Affordable - about £1,300 per home
- Available for all property types – renting and apartments
- Can move with the householder
- Allows consumers to switch supplier
- Stabilises bills and gives savings of £100 - £175 / yr

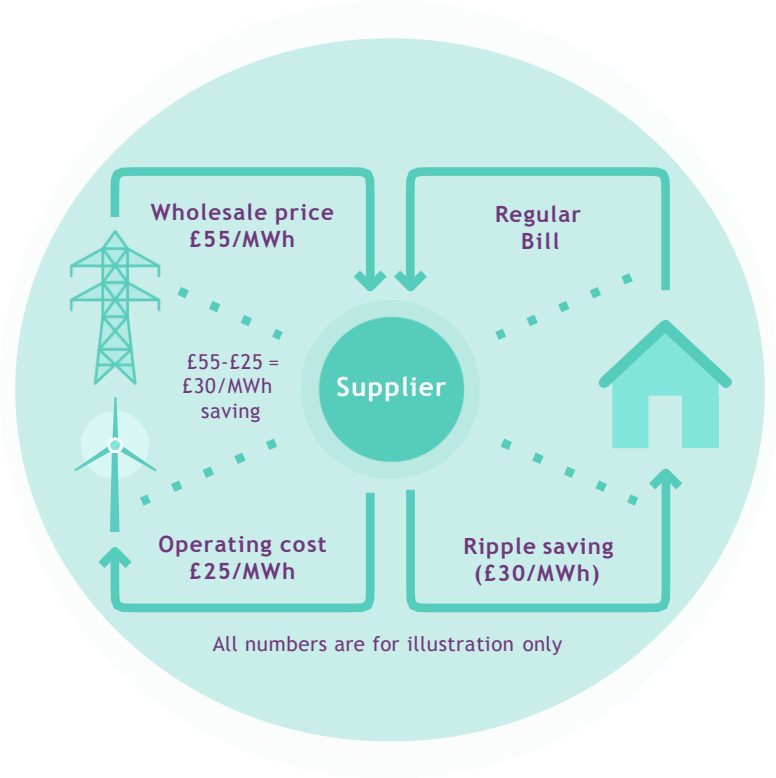
How customers reduce their bills

1. Customers pay the construction cost of the wind farm upfront

2. Once the wind farm is built the cost of its electricity is just the operating cost of the wind farm

3. PPA is at the OpEx of wind farm, stable for operating life

4. Saving = (wholesale – OpEx) x share of output

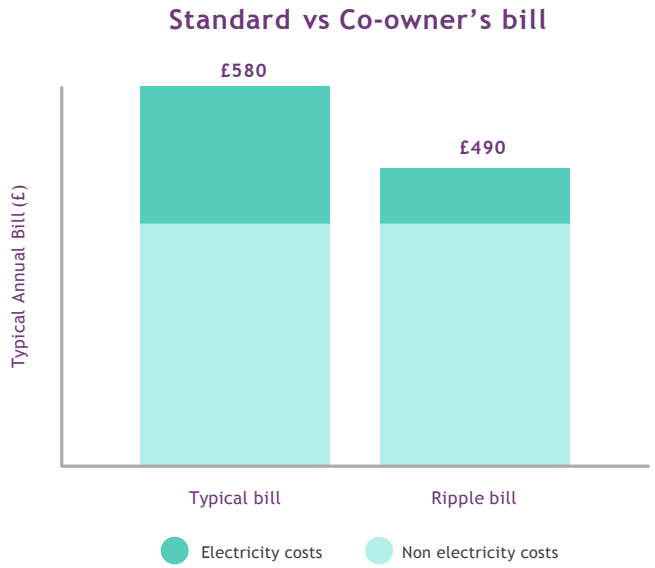


A typical customer bill

Customers save on the wholesale electricity part of their electricity bill.

Saving is difference between wholesale price and wind farm's operating costs.

All other elements including supplier margin remain the same as a regular bill



Ripple

1. Savings estimated against Ofgem's typical 3.1MWh bill of £577 as of January 2019
Non-electricity costs include grid, levies, taxes, supplier margin

Examples from Other Markets

Solar in the US

- California – SolarShares for customers of Sacramento Municipal Utility District
- Florida – Orlando Utilities Commission customers pay a higher rate locked in
- New York – rooftop solar communities

Wind in Netherlands

- Windcentrale
- Qurrent

EU Drive for Renewable Energy Communities

- *Clean Energy for All Europeans*

Backbone of a smart home energy system

Integrate home energy technologies

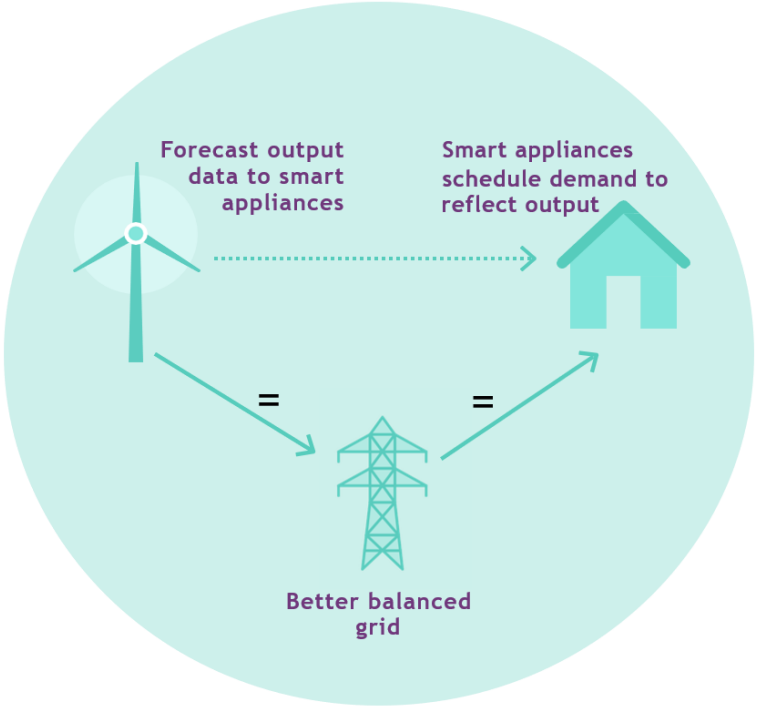
- Home batteries
- Heat storage
- Smart EV charging
- Smart appliances

Scope for micro demand side response

- Demand patterns could reflect own output
- Potential for additional value for owners

Give consumers confidence to go electric

- Stable prices could help EV / electric heating switch
- Power EV / heating with low priced green electricity



Thank You

Simon@RippleEnergy.com

Ripple

Morag Watson
Director of Policy, Scottish Renewables

Andrew Smith
Managing Director, Greenbackers Investment Capital

Simon Peltenburg
Chief Projects Officer, Ripple Energy

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Propelling new development: drafting the blueprint for growth

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Gina Hanrahan

Head of Policy

WWF Scotland

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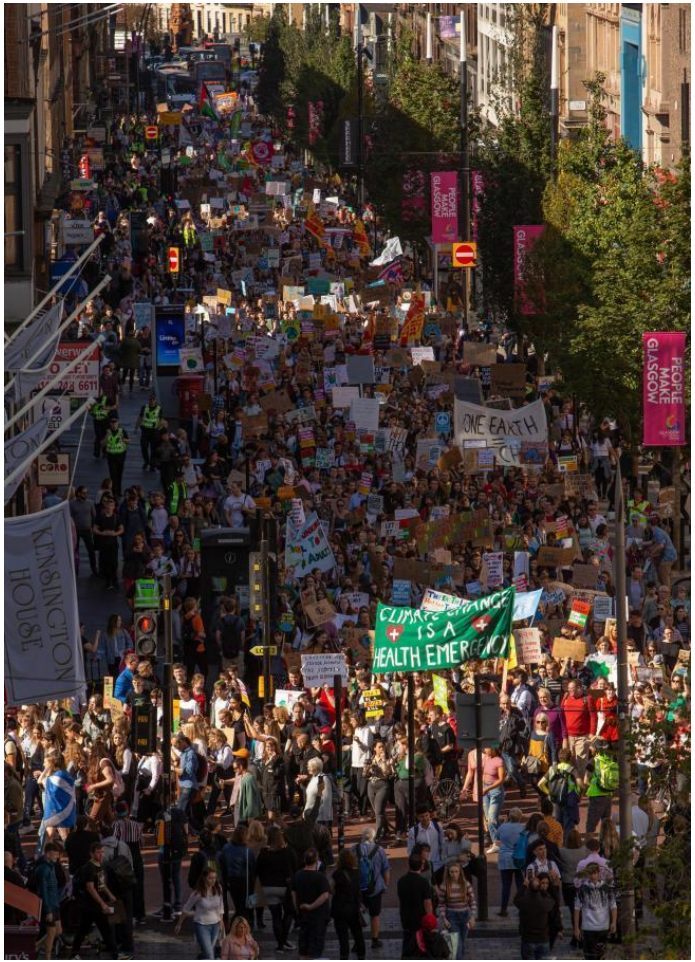
Responding to the Climate Emergency

Gina Hanrahan, Head of Policy,
WWF Scotland

Picture - Jeff J Mitchell/Getty Images. Guardian 2019

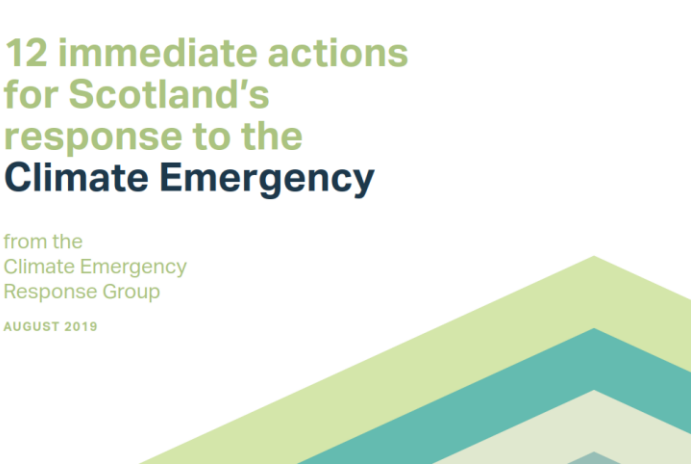
We’re in the middle of a climate and nature emergency

Picture - Mark McKenna / Zuma Press. LA Times 2018



Pictures – Top left: Neil Pooran/Edinburgh Live 2019, Bottom left: Metro 2019, Right:

The Climate Emergency Response Group

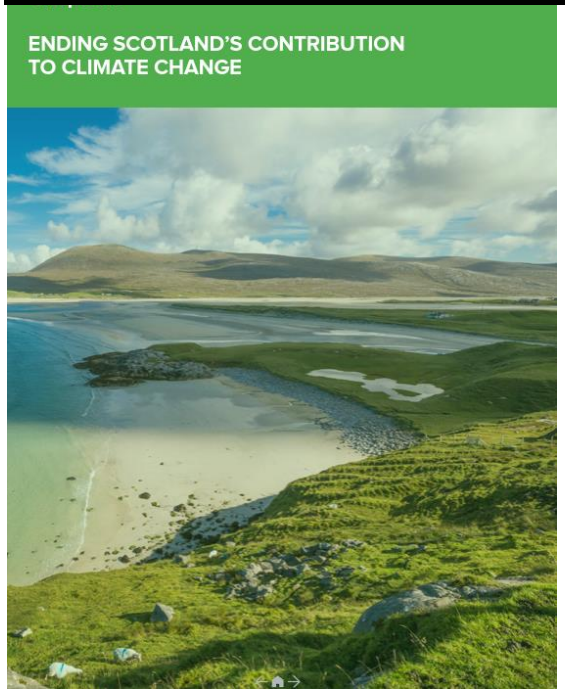


CHANGEWORKS · Climate-KIC · Confor · energy saving trust · Everwarm · JACOBS · Locogen · NHS National Services Scotland · scdi · Scottish Land&Estates · scottish renewables · Sunamp Heat Batteries · SSN Sustainable Scotland Network · STAR Renewable Energy · sustrans · vegware · The University of Edinburgh · WWF · 2050 Climate Group

The 12 Point Plan

1. Mobilise £11bn public procurement
2. 4 Green City Region Deals
3. Emission free City Centres by 2030
4. Public interest CCS company
5. Guidance on Climate Friendly Diets
6. £110m Agriculture Fund
7. Regional Land Use Plans
8. Zero Carbon Building Standards
9. Accelerate Energy Efficiency
10. Heat Pump Sector Deal
11. Net Zero Electricity Planning
12. Give SNIB a climate mission

Climate at the Heart of the Programme for Government – an ‘Embryonic Green New Deal’?



“Tackling climate change also creates opportunities. We can lead the way in showing how our society and economy can transition to net zero in a way that creates economic opportunity and provides the assurance of rewarding work for all.”

2020 – Climate Emergency Comes Home to Glasgow

Picture - UNFCCC/EURACTIV 2017


WWF
FOR YOUR WORLD

Neil Collar

Partner / Head of Planning Law

Brodies LLP

#SRSOLAR19

PROPELLING NEW DEVELOPMENT: LAND USE PLANNING

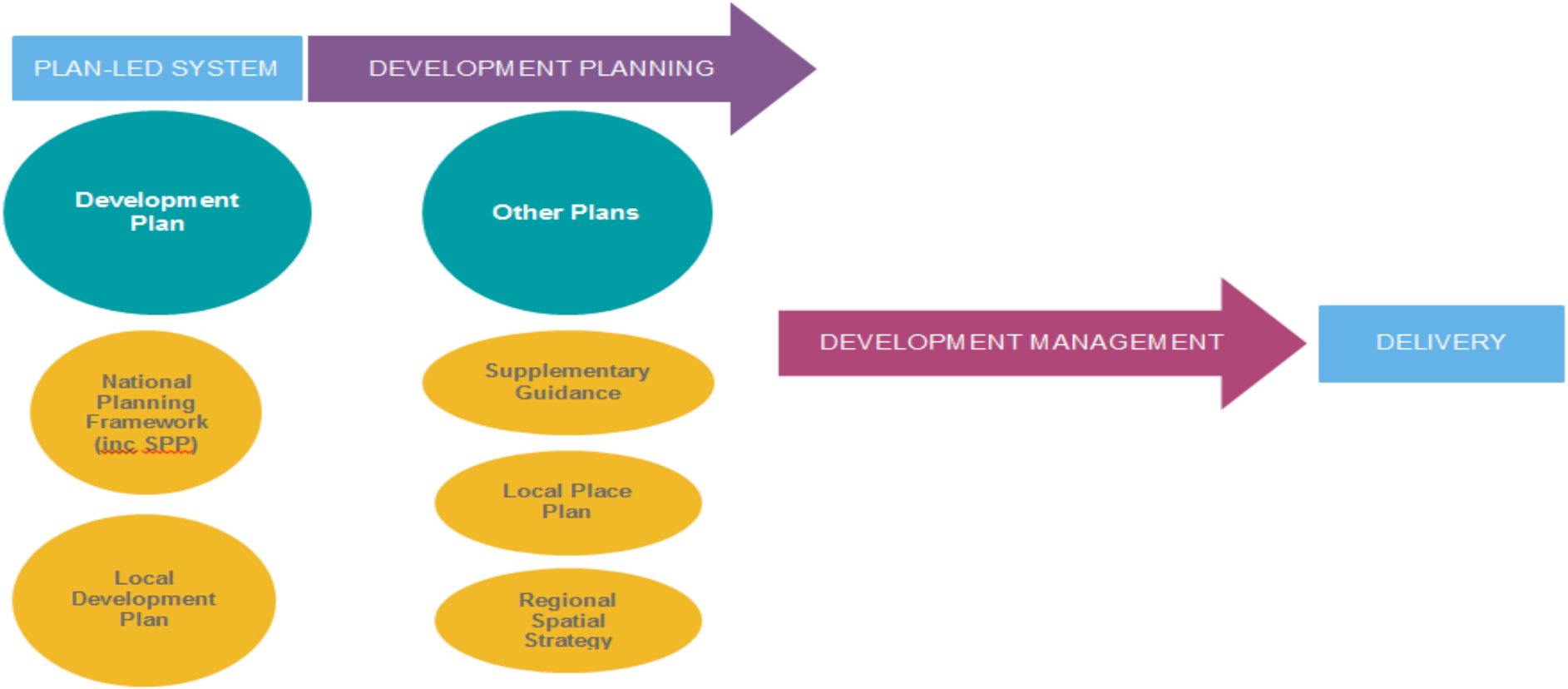
Neil Collar

BRODIES LLP

ENLIGHTENED THINKING

BRODIES LLP

PLANNING (SCOTLAND) ACT 2019



PLANNING REFORM

Known Known

- Review of National Planning Framework
- Scottish Planning Policy to move into NPF

Known Unknown

- Adoption date – 2021?
- Content and scope – lots of lobbying first

"Reform planning regulations in Scotland to at least match the situation in England, where up to 1MW of rooftop solar is 'permitted development', would be a good start (as opposed to just <50kW in Scotland). But why not go further? I would suggest there should be permitted development for all rooftop solar, regardless of size, instead of an arbitrary limit."

Andrew Lyle, Locogen

PLANNING REFORM

Known Known

- Review of Permitted Development Order

Known Unknown

- Timing
- Scope of future changes

Wendy Saigle

Principal Sustainability + Renewable Energy Engineer

AECOM

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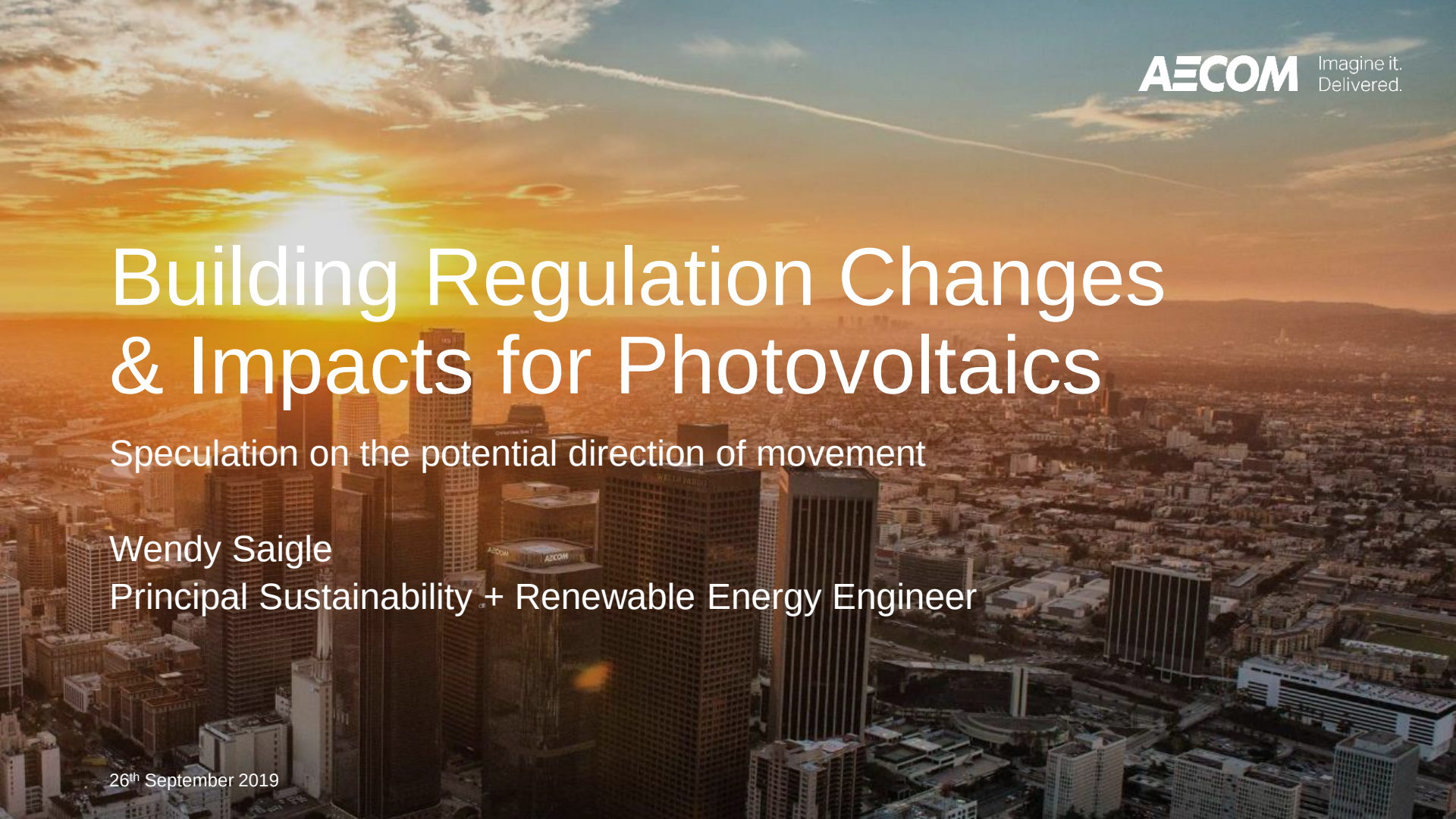


Building Regulation Changes & Impacts for Photovoltaics

Speculation on the potential direction of movement

Wendy Saigle
Principal Sustainability + Renewable Energy Engineer

26th September 2019

Building Regulations - UK

Scotland
Technical Handbooks

- Section 6 - Energy
- Section 7 - Sustainability
- Domestic
- Non-domestic

England
Building Regulation

- Conservation of Fuel and Power
  L1A: New Dwellings
- L1B: Existing Dwellings
- L2A: New Non-Domestic
  L2B: Existing Non-Domestic

Wales
Building Regulation

- Conservation of Fuel and Power
- L1A: New Dwellings
- L1B: Existing Dwellings
- L2A: New Non-Domestic
  L2B: Existing Non-Domestic

Northern Ireland
Technical Booklets

- Conservation of fuel and power
- F1: Dwellings
- F2: Buildings other than dwellings

Changes Upcoming Scottish Building Regulations

Review of Energy Standards

- **2015** Energy Standards review
  - How energy performance of buildings can be improved to reduce carbon emissions
  - First stage - Jun to Sep 2019 (now closed)
- **2021** Next set of energy standards programmed to be introduced

Published Responses

- Electricity grid has decarbonised. Carbon factors should be updated to reflect this
- Suggestion to incorporate updated carbon factors into building energy models in the National Calculation Methodology (NCM) before 2021 updated edition

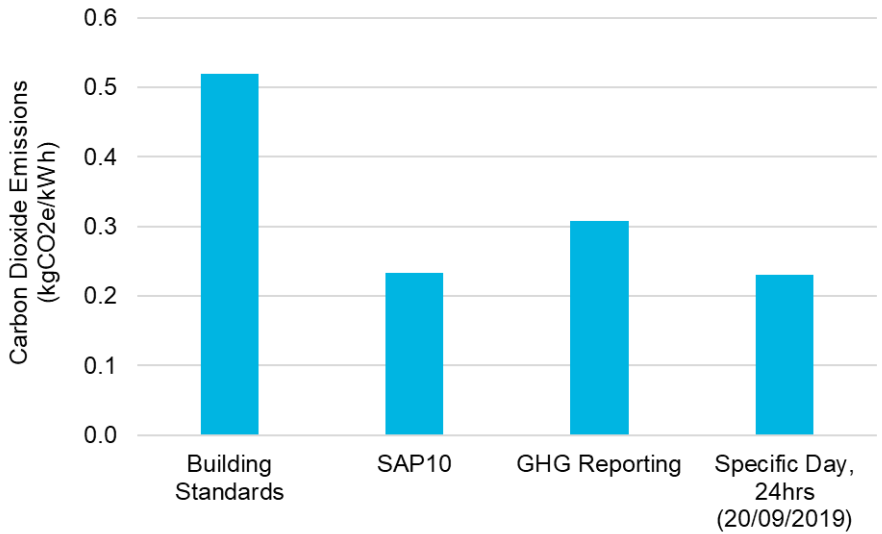
Drivers for Change

- Net Zero Carbon
  - UK commits to Reaching Net Zero Carbon emissions by 2050
  - Scotland commits to reaching it by 2045
- Falling renewable prices
- Rising Fossil fuel prices
- Energy Security

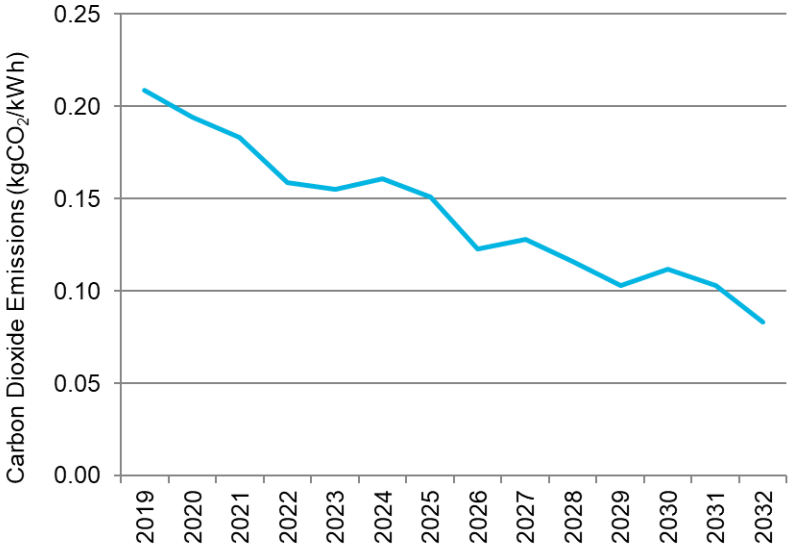
UK Electricity Carbon Factor

- Building regulation UK electricity carbon factor could potentially decrease
- Carbon factors are used in National Calculation Methodology (NCM) to meet building standards

UK Carbon Factors



UK Carbon Factor Projection (BEIS)



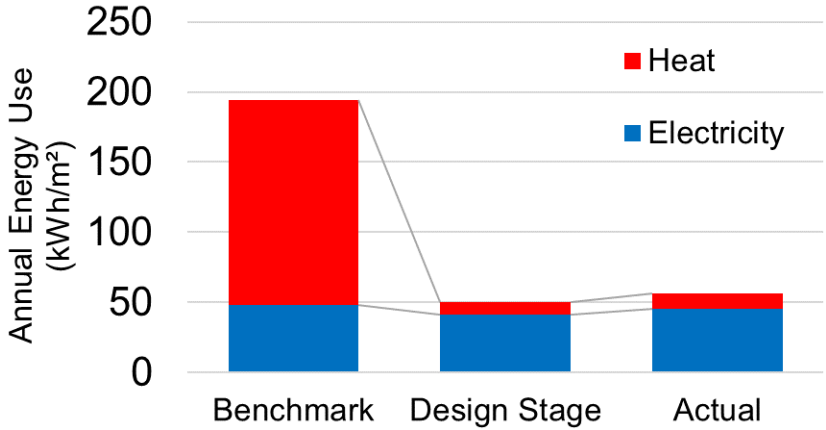
Case Study – Primary School

71% less energy
compared to typical
Scottish Energy Officers Benchmarking
Study of 2016-17 (2018)

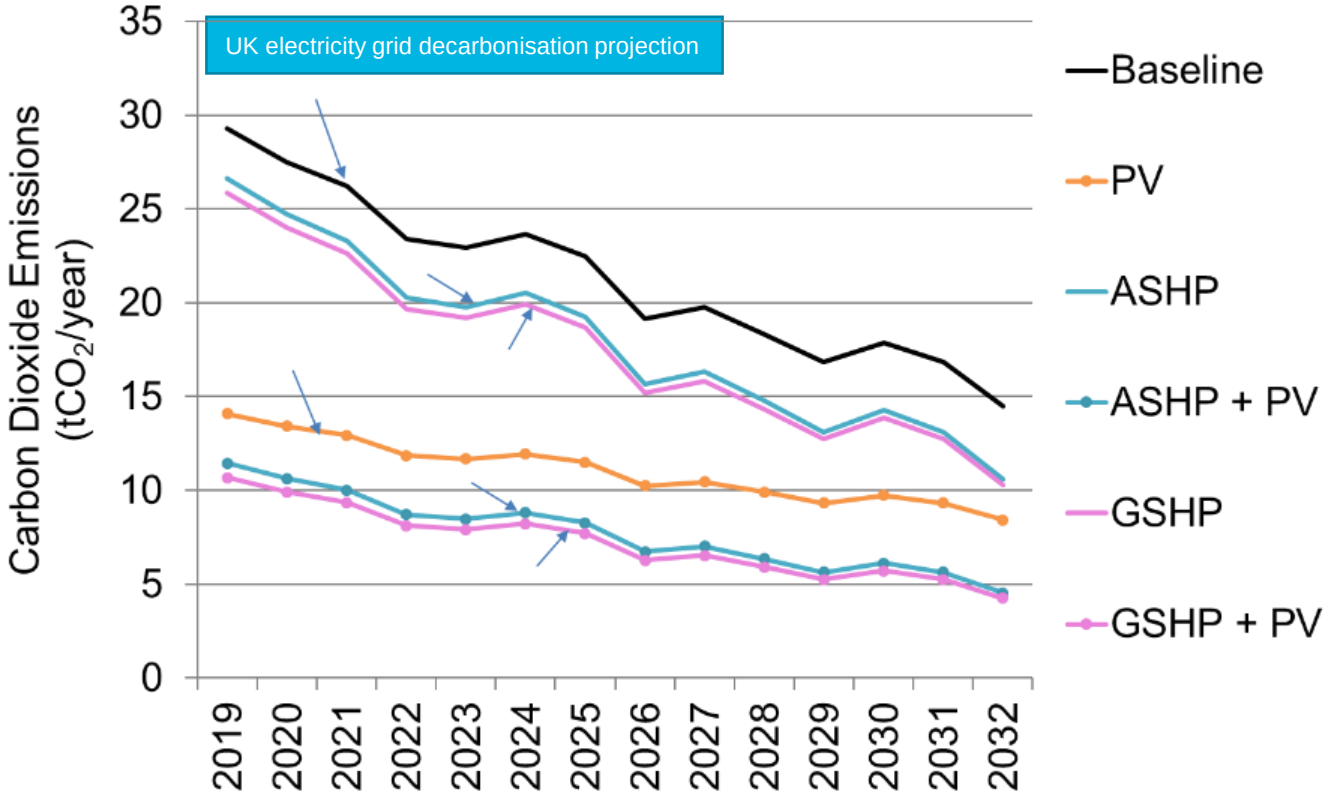
Context:
– Primary School is a two-storey school with a central circulation and hub space

Performance metrics:
- Energy Performance Certificate (A, 25)
- PassivHaus Certified
- Soft Landings applied

Low energy:
– High insulation
– High airtightness
– Mechanical Ventilation with Heat Recovery
– Seasonal commissioning



Nearly Net Zero Carbon – Scenarios on Case Study

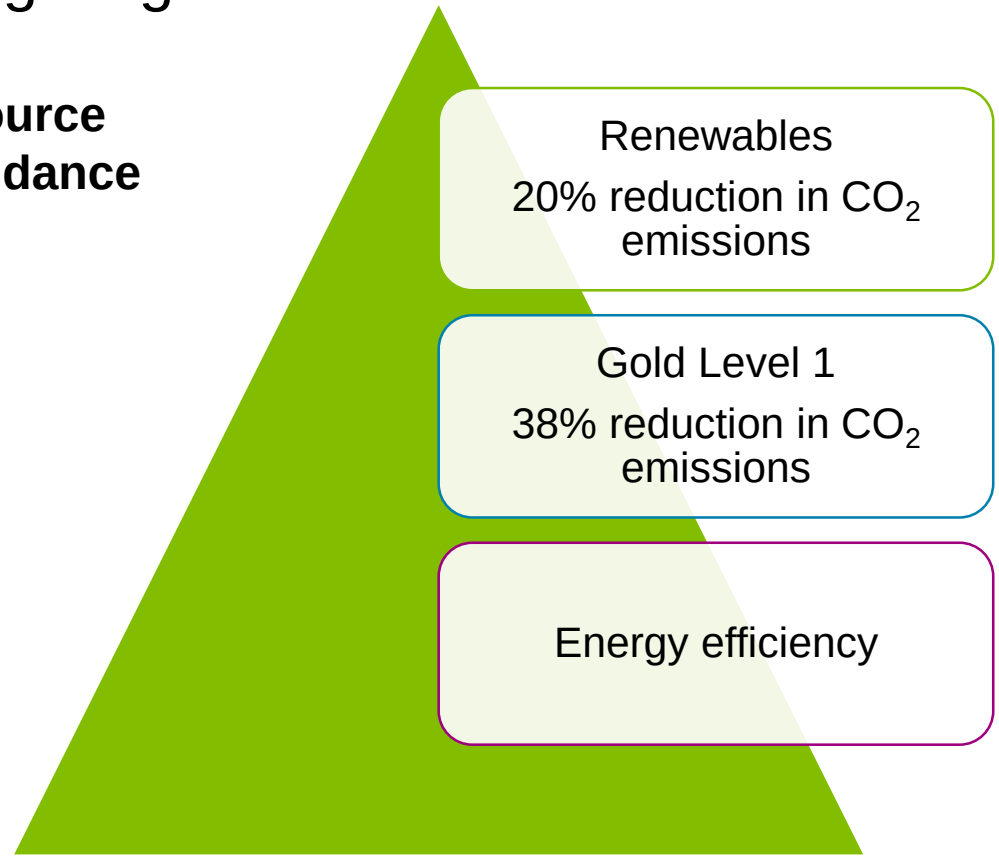


Details

- Primary school
- Low Energy
- Baseline:
  - UK Electricity grid decarbonising
  - Natural gas heating
- After technologies
  - Remaining CO_2 offset with payment

Scotland – Beyond Building Regulations

Glasgow City Council SG5: Resource Management Supplementary Guidance



England – Beyond Building Regulations

Draft London Plan


THE DRAFT LONDON PLAN

Net zero-carbon developments,

Extends to non-domestic

35% on-site CO_2 reduction

Remaining CO_2 offset with payment

Energy Statement Net zero carbon on-site emissions by 2050

Implications for PV

Nearly net zero carbon

- Variety of Low and Zero Carbon technologies
- PV likely to remain in demand

Declining grid CO_2 emission factors

- CO_2 savings of PV may decline relative to solar hot water heating
- Potential increase in interest in hybrid solar systems generating electricity and heat (PV-T)

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Head of Policy, WWF Scotland

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Partner / Head of Planning Law, Brodies LLP

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Tweet @ScotRenew
#SRSOLAR19

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