Making the most of renewable energy

Knowing your destination is half the journey.

Anon

A top 10 UK solar installation company
Contents for the next 20 minutes

1. Introduction to Caplor
2. Quick Update on Renewable Energy
3. Renewable Generation – Update and 2 examples
Who are We?

**Values** - Inspired, Sustainable, Improvement

**Approach** - Triple Bottom line

[www.caplor.co.uk](http://www.caplor.co.uk)  [www.caplorhorizons.org](http://www.caplorhorizons.org)
Some of our accreditations, awards and partnerships

Mkt share – 20+% residential 35+% commercial
Simon Sineck
World invested more in Renewable power than fossil fuels in 2017 ($280bn Vs 100bn)

Renewable – Global Update

Summary

- EU: +21 GW (86%)
- United States: +16 GW (61%)
- China: +64 GW (52%)
- India: +13 GW (44%)

Worldwide capacity added: 150 GW

*Data not yet available for Canada or globally.
Source: Wind Europe; U.S. Energy Information Administration; China Electricity Council; Government of India, Ministry of Power, Central Electricity Authority

Philippines makes a plan to produce 100% renewable energy within 10 years

1 million = number of Australian households now powered by the sun

Do good, have fun and then win the world

Mercedes-Benz, IKEA, TATA, BMW, Microsoft, Apple, Google, Walmart, Amazon, and others support renewable energy.
European Commission issues ‘final warning’ over air pollution breaches

Electric vehicle purchases rise by one-fifth in UK

UK Support 85% for Renewable (April 2018)

Notes: 2050 target allows for emissions from international aviation and shipping, not currently in carbon budgets

Approx. 29+% of Electric 2017
Policy context.

Important recent Government publications

**Industrial Strategy**
- Sets out *five foundations of productivity*
- Commits to investment in business-led innovation
- Aims to maximise the advantages for UK industry from the global shift to clean growth
- Commits to Local Industrial Strategies that build on local strengths and deliver on economic opportunities

**Clean Growth Strategy**
- Sets out a strategy to meet the UK’s Carbon budgets
- Since 1990 emissions have been cut by 42%
- UK has committed to an 80% reduction on 1990 levels by 2050
- The document sets out domestic policies to keep the UK on track to meet these targets

BREXIT – Appears to be slowing anything other than
Renewable sources of Energy

Anaerobic Digestion

Hydro

Thermal

Bio-fuel

Solar - water

Heat Pumps / exchanger

Bio mass

Wind
Deployment of all solar photovoltaic capacity in the United Kingdom.

<table>
<thead>
<tr>
<th>Tariff Band</th>
<th>Applications</th>
<th>% of total</th>
<th>Accreditations</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td></td>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>Air source heat pump</td>
<td>33,656</td>
<td>51%</td>
<td>30,942</td>
<td>51%</td>
</tr>
<tr>
<td>Ground source heat pump</td>
<td>9,575</td>
<td>14%</td>
<td>8,973</td>
<td>15%</td>
</tr>
<tr>
<td>Biomass systems</td>
<td>13,088</td>
<td>20%</td>
<td>12,557</td>
<td>21%</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>9,766</td>
<td>15%</td>
<td>8,642</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>66,085</strong></td>
<td><strong>100%</strong></td>
<td><strong>61,114</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Number of Non Domestic applications and total capacity by technology type, Great Britain, November 2011 to February 2018

<table>
<thead>
<tr>
<th>Tariff Band¹</th>
<th>Number</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Solid Biomass Boiler (&lt; 200 kW)⁴</td>
<td>12,938</td>
<td>67%</td>
</tr>
<tr>
<td>Medium Solid Biomass Boiler (200-1000 kW)</td>
<td>3,659</td>
<td>19%</td>
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<tr>
<td>Large Solid Biomass Boiler (&gt; 1000 kW)</td>
<td>80</td>
<td>0%</td>
</tr>
<tr>
<td>Small Solar Thermal (&lt; 200 kW)⁴</td>
<td>314</td>
<td>2%</td>
</tr>
<tr>
<td>Small Water or Ground Source Heat Pumps (&lt; 100 kW)⁴</td>
<td>789</td>
<td>4%</td>
</tr>
<tr>
<td>Large Water or Ground Source Heat Pumps (&gt;100 kW)⁴</td>
<td>193</td>
<td>1%</td>
</tr>
<tr>
<td>Biomethane⁵,⁷</td>
<td>91</td>
<td>0%</td>
</tr>
<tr>
<td>Biogas⁷</td>
<td>756</td>
<td>4%</td>
</tr>
<tr>
<td>Air Source Heat Pumps⁴</td>
<td>467</td>
<td>2%</td>
</tr>
<tr>
<td>CHP</td>
<td>69</td>
<td>0%</td>
</tr>
<tr>
<td>Deep Geothermal</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total⁶</strong></td>
<td><strong>19,356</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
The Opportunities

1. Compliance
2. Savings / earning
3. Responsibility / Reputation
2 Priced Case Studies – Surprise Surprise Solar PV and ????
Very standard 50Kw system with 90% electric use including FIT

<table>
<thead>
<tr>
<th>Quotation Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of system (excl VAT)</td>
</tr>
<tr>
<td>VAT @20%</td>
</tr>
<tr>
<td>Total Price of System</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Performance Indicators</th>
<th>SAP 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>System size (Installed Power)</td>
<td>49.92 kWp</td>
</tr>
<tr>
<td>Expected annual generation(^1)</td>
<td>44,928.00 kWh</td>
</tr>
<tr>
<td>Expected annual CO(_2) savings(^2)</td>
<td>25.52 tCO(_2)e</td>
</tr>
<tr>
<td>Estimated Generation Tariff (FIT)(^3)</td>
<td>£1,676 /yr</td>
</tr>
<tr>
<td>Estimated Export Tariff(^4)</td>
<td>£226 /yr</td>
</tr>
<tr>
<td>Estimated savings in electricity purchases(^5)</td>
<td>£4,889 /yr</td>
</tr>
<tr>
<td>Estimated effective Annual Revenue Year 1</td>
<td>£6,790 /yr</td>
</tr>
<tr>
<td>Initial Rate of Return Year 1</td>
<td>15.07%</td>
</tr>
<tr>
<td>Nominal payback at point of purchase Year 1(^1)</td>
<td>6.6 yrs</td>
</tr>
<tr>
<td>Average Annual Revenue Over 20 Year FiT Period</td>
<td>£10,903 /yr</td>
</tr>
<tr>
<td>Revenue generated over 20 Year FiT period</td>
<td>£218,058</td>
</tr>
<tr>
<td>Average Rate of Return Over 20 Year FiT Period</td>
<td>24.19 %</td>
</tr>
<tr>
<td><strong>Quotation Summary</strong></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Price of system (excl VAT)</td>
<td>£45,073</td>
</tr>
<tr>
<td>VAT @20%</td>
<td>£9,015</td>
</tr>
<tr>
<td>Total Price of System</td>
<td>£54,087</td>
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</table>

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</tr>
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<td>Estimated Generation Tariff (FIT)$^3$</td>
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</tr>
<tr>
<td>Estimated savings in electricity purchases$^5$</td>
<td>£4,889 /yr</td>
</tr>
<tr>
<td>Estimated effective Annual Revenue Year 1</td>
<td>£5,115 /yr</td>
</tr>
<tr>
<td>Initial Rate of Return Year 1</td>
<td>11.35 %</td>
</tr>
<tr>
<td>Nominal payback at point of purchase Year 1$^1$</td>
<td>8.8 yrs</td>
</tr>
<tr>
<td>Average Annual Revenue Over 20 Year FiT Period</td>
<td>£8,851 /yr</td>
</tr>
<tr>
<td>Revenue generated over 20 Year FiT period</td>
<td>£177,012</td>
</tr>
<tr>
<td>Average Rate of Return Over 20 Year FiT Period</td>
<td>19.64 %</td>
</tr>
</tbody>
</table>
Study 2 - Will Batteries be part of our future?

BATTERIES: GREAT FOR STORING ENERGY FOR SHORT TIME PERIODS AND VERY FAST RESPONSE – LOW SPACE
Constant stream of Battery news

GTM: Global energy storage market could reach 8.6GW / 21.6GWh by 2022

'Secondary Power Plants'.
Another interesting plan to use batteries to avoid a grid upgrade.
The utility covering Lebanon, a small New Hampshire town

SA Water plans 152MW of solar and 35MWh of energy storage

WorleyParsons: Oregon battery EPC deal kicks off wave of distributed energy projects

Masdar partners with Costa Rica utility on solar, storage and smart cities

IEA-PVPS: Integration of solar requires improved forecasts, flexibility resources, more storage

Spain vehicle charging. Utility Iberdrola said it would install 25,000 chargers, mostly in homes, by 2021.

Batteries and grid reliability.
The world’s largest battery, in South Australia, has proved its value in its first months of operation.

Varta Storage Top 3 in European Home Energy Storage Systems

BP to trial battery storage alongside Tesla at US wind farm

UK Now Has 3.2 GW Of Energy Storage, With Much More On The Way

65MW / 130MWh South Korea solar-plus-storage contracts

RWE plans 100MW battery at Tilbury UK

WorleyParsons: Oregon battery EPC deal kicks off wave of distributed energy projects

UK top-3 global markets for storage deployment

US: ESA lays path for 35 GW of energy storage by 2025

BP to trial battery storage alongside Tesla at US wind farm

65MW / 130MWh South Korea solar-plus-storage contracts

RWE plans 100MW battery at Tilbury UK
Already a huge amount available in the market

<table>
<thead>
<tr>
<th>Residential (&lt;20 kW)</th>
<th>Commercial (20 kW to &lt; 100 kW)</th>
<th>Utility (100 kW+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schneider</td>
<td>Goode</td>
<td>IDEAL POWER</td>
</tr>
<tr>
<td>Pika INERTIA</td>
<td>Su-Kam</td>
<td>Schneider</td>
</tr>
<tr>
<td>SolarWax</td>
<td>SolarEdge</td>
<td>IDEAL POWER</td>
</tr>
<tr>
<td>Omron</td>
<td>ABB</td>
<td>Schneider</td>
</tr>
<tr>
<td>ABB</td>
<td>Microtek</td>
<td>IDEAL POWER</td>
</tr>
<tr>
<td>EATON</td>
<td>DARFON</td>
<td>IDEAL POWER</td>
</tr>
<tr>
<td>Steca</td>
<td>Flin Energy</td>
<td>IDEAL POWER</td>
</tr>
<tr>
<td>Delta</td>
<td>Dell</td>
<td>IDEAL POWER</td>
</tr>
</tbody>
</table>

[Graph showing logos of companies across different categories]
Actual Activity in the UK March 2018

Project status (MW)

Battery storage planning applications

UK Battery Storage Project Database Report - March 2018

marketresearch@solarmedia.co.uk
How do they Pay ???

Power Profile with/without

- Ancillary services
- Charging before Red periods
- Load shifting & Peak shaving
Maximising self consumption from PV

‘Time-shifting’ PV energy from daytime surplus to meet evening demand
## Typical Financial Analysis – without renewable

<table>
<thead>
<tr>
<th>Item</th>
<th>105 kW 169 kWh</th>
<th>522kW 845 kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual DUoS+TUoS Cost Saving</td>
<td>£8,450</td>
<td>£24,900</td>
</tr>
<tr>
<td>Annual Capacity Market Revenue</td>
<td>£1,050</td>
<td>£6,150</td>
</tr>
<tr>
<td>Annual FFR/EFR Revenue</td>
<td>£7,700</td>
<td>£33,300</td>
</tr>
<tr>
<td>Annual O&amp;M Cost</td>
<td>-£1,000</td>
<td>-£1,500</td>
</tr>
<tr>
<td>Annual Income (Revenue Less O&amp;M Costs)</td>
<td>£16,200</td>
<td>£62,850</td>
</tr>
<tr>
<td>Capital Cost (Supply and Installation)</td>
<td>£125,000</td>
<td>£433,600</td>
</tr>
<tr>
<td>Payback Period</td>
<td>7.5 years</td>
<td>6.9y</td>
</tr>
</tbody>
</table>

Smaller – 12/13%
Larger – 14/15%

There are various grants, tax advantages
A sneaky 3rd - Electric Cars?

- 46,522 new electric and plug-in hybrid cars were bought in the UK in 2017
- Estimated - 60,000 low-emissions models to be registered in 2018
Thank you –

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caplor.co.uk/caplor-news/
Programme

9:15   Registration and networking

10:00  Welcome and introduction

10:10  The Marches Energy Strategy (Richard Vaughan, Herefordshire Council)

10:40  Clean growth case studies (Peni Brudenell-Pryke/Kenny Gallagher, Greengineering)

11:10  Networking break

11:45  Making the most of renewable energy (Gareth Williams, Caplor Energy)

12:05  Introduction to the Centre for Research into Environmental Science & Technology (CREST) (Jonathan Britten, University Centre Shrewsbury)

12:25  The Business Energy Efficiency Programme (BEEP) (Chris Atkinson, Worcestershire County Council)

12:45  Closing comments and networking lunch

14:00  Close
Some of our Clients

Mkt share - 25% residential 35%+ commercial

[Logos of various clients]
**System-performance imperatives**

- Security and access
- Environmental sustainability
- Economic development and growth

**Transition-readiness enabling dimensions**

- Energy-system structure
- Capital and investment
- Regulation and political commitment
- Human capital and consumer participation
- Infrastructure and innovative business environment
- Institutions and governance

Source: Fostering Effective Energy Transition, World Economic Forum

Almost $180bn was spent in developing economies, principally China, India and Brazil.

Worldwide, solar contributed up almost 60% of total spending. Almost 100 gigawatts of PV were installed, increasing global capacity by about one third.

Coal and gas saw capital investment of about $100m, or less than 40% of renewables investment.

According to the latest statistics from the International Renewable Energy Agency (IRENA), global renewable energy (RE) generation capacity hit 2,179 GW last year.

Leading the charge were renewable hydro, onshore wind and solar PV.
Countries with the largest lithium reserves worldwide as of 2017 (in metric tons)

- Chile: 7,500,000 metric tons
- China: 3,200,000 metric tons
- Australia: 2,700,000 metric tons
- Argentina: 2,000,000 metric tons
- Portugal: 60,000 metric tons
- Brazil: 48,000 metric tons
- United States: 35,000 metric tons
- Zimbabwe: 23,000 metric tons

Source: US Geological Survey
© Statista 2018

Additional Information:
Worldwide
What makes up your energy bill?

Dual fuel bill:
- Wholesale costs (37.9%)
- Network costs (26%)
- Environmental/social obligation costs (14.8%)
- Other direct costs (1.2%)
- Operating costs (17.2%)
- Supplier pre-tax margin (4.8%)

Gas bill:
- Wholesale costs (39.4%)
- Network costs (24.5%)
- Environmental/social obligation costs (1.6%)
- Other direct costs (1.2%)
- Operating costs (17.9%)
- VAT (4.6%)
- Supplier pre-tax margin (10.6%)

Electricity bill:
- Wholesale costs (36.3%)
- Network costs (27.6%)
- Environmental/social obligation costs (14.8%)
- Other direct costs (1.2%)
- Operating costs (16.5%)
- VAT (4.8%)
- Supplier pre-tax margin (-1.1%)

Data based on realised costs, as reported by the six larger energy companies in their annual consolidated segmental statements 2016 (£1,123 for dual fuel bill, £568 for gas only; and £554 for electricity).
How do UK prices compare with Europe?

- **UK ranks BELOW AVERAGE on gas prices**
- **AROUND AVERAGE on electricity prices**

**Average domestic gas price (medium user)**

- Average UK domestic gas price (incl. taxes) for medium user customer for period January to June 2017 is equal to the median EU price.*

**Average domestic electricity price (medium user)**

- Average UK domestic electricity price (incl. taxes) for medium user customer for period January to June 2017 is above the median EU price.*

*Source: Department for Business, Energy & Industrial Strategy*
Chart 1.4 Final energy consumption by user (Table 1.3a)
1. Electricity generation in 2017 fell by 1.0 per cent, from 339.4 TWh a year earlier to \textbf{335.9 TWh}, with falls in generation from coal and gas offset by an increase from renewables, primarily wind generation. UK electricity demand fell -1.8 per cent in 2017, from 357 TWh in 2016 to \textbf{350 TWh}.

2. Of electricity generated in 2017, \textbf{gas} accounted for \textbf{39.7 per cent} (down 2.5 percentage points compared to 2016) and \textbf{coal 6.7 per cent} (a fall of 2.3 percentage points on 2016). \textbf{Nuclear’s} share decreased by 0.2 percentage points on 2016 to \textbf{20.9 per cent}.

3. \textbf{Renewable electricity generation} was \textbf{98.9 TWh} in 2017, a record high, an \textbf{increase} of \textbf{18.8 per cent} on the 83.2 TWh in 2016, due to increased capacity and higher wind speeds. \textbf{Renewables’ share} of electricity generation increased by 4.9 percentage points on 2016 to \textbf{29.4 per cent}. \textbf{Renewable electricity capacity was 40.5 GW} at the end of 2017, a 13.3 per cent increase (4.8 GW) on a year earlier.

4. \textbf{Low carbon electricity’s share of generation} increased from 45.7 per cent in 2016 to a record high of \textbf{50.4 per cent in 2017}, driven by increased renewable capacity and more favourable weather conditions.
Firm Frequency Response (FFR)

- Small providers can work with the National Grid via an aggregator and take part in **FFR**
- **Revenue is based on the hours during which the ESS is available** for FFR
- Bidding process – this will be done by the aggregator
- Battery is used to either **absorb energy or feed** energy back into the network
- **Enhanced Frequency Response** (EFR) is also possible (response time reduced to <1 sec)
Capacity Market

• Introduced in 2014 to ensure sufficient reliable capacity is available

• **Payments offered to power generators for being available to generate** at certain times, and to demand response providers for being able to reduce electricity demand

• The market takes the form of an annual auction

• Battery systems taking part in FFR services qualify for participation in the Capacity Market
Reducing DUoS Charges

• Meet all or a significant part of consumption during red tariff rate periods from the battery
• Significant savings from avoidance of DUoS (Distribution Network Use of System) charges
• Battery losses need to be taken into account
Reducing TUoS Charges

• TUoS (Transmission network Use of System) charges are calculated based on the three half-hour periods per winter **with the highest demand** (TRIADS)
• They are not known in advance, but can be predicted by experts and typically fall into red rate periods
• Calculated based on location-specific £/kW charge multiplied by the average demand during triad periods
• Significant savings due to reduced TUoS charges
Short Term Operating Reserve (STOR)

• STOR is a service for the provision of additional active power from generation and/or demand reduction.

• **Short Term Operating Reserve** is needed because at certain times of the day National Grid needs actual reserve power in the form of other generation or demand reduction to be able to deal with actual demand being greater than forecast demand and/or plant unavailability

• Battery can be used for **either** STOR or FFR, but cannot be available for both at the same time. FFR gives higher yields
1. Currently, the largest battery projects in the UK stand at 50MW with Statera’s Pelham Storage project, thought to have been completed in December, and EDF’s West Burton battery which is due to begin delivering Enhanced Frequency Response (EFR) to National Grid this summer.

2. Closely followed by Centrica’s 49MW Roosecote battery, which has yet to be confirmed as completed but saw construction begin over a year ago.

3. RWE’s battery would be double this size and comes as a number of similarly sized projects have begun to emerge in both the UK and Ireland.

4. Lumcloon Energy in Ireland has partnered with Hanwha Energy Corporation and LSIS to invest €150 million (US$183.34 million) in the development of two 100MW battery energy storage projects as part of sustainable energy projects at Lumcloon and Shannonbridge, in Co Offaly.

5. This followed a planning application submitted by Centrica to Kilkenny County Council earlier this year that could see a 100MW battery built in Ireland.

6. Drax confirmed last year that it was planning to add a 200MW battery storage project to its coal-fired power station in North Yorkshire in an effort to add value through greater flexibility and extend its operation.