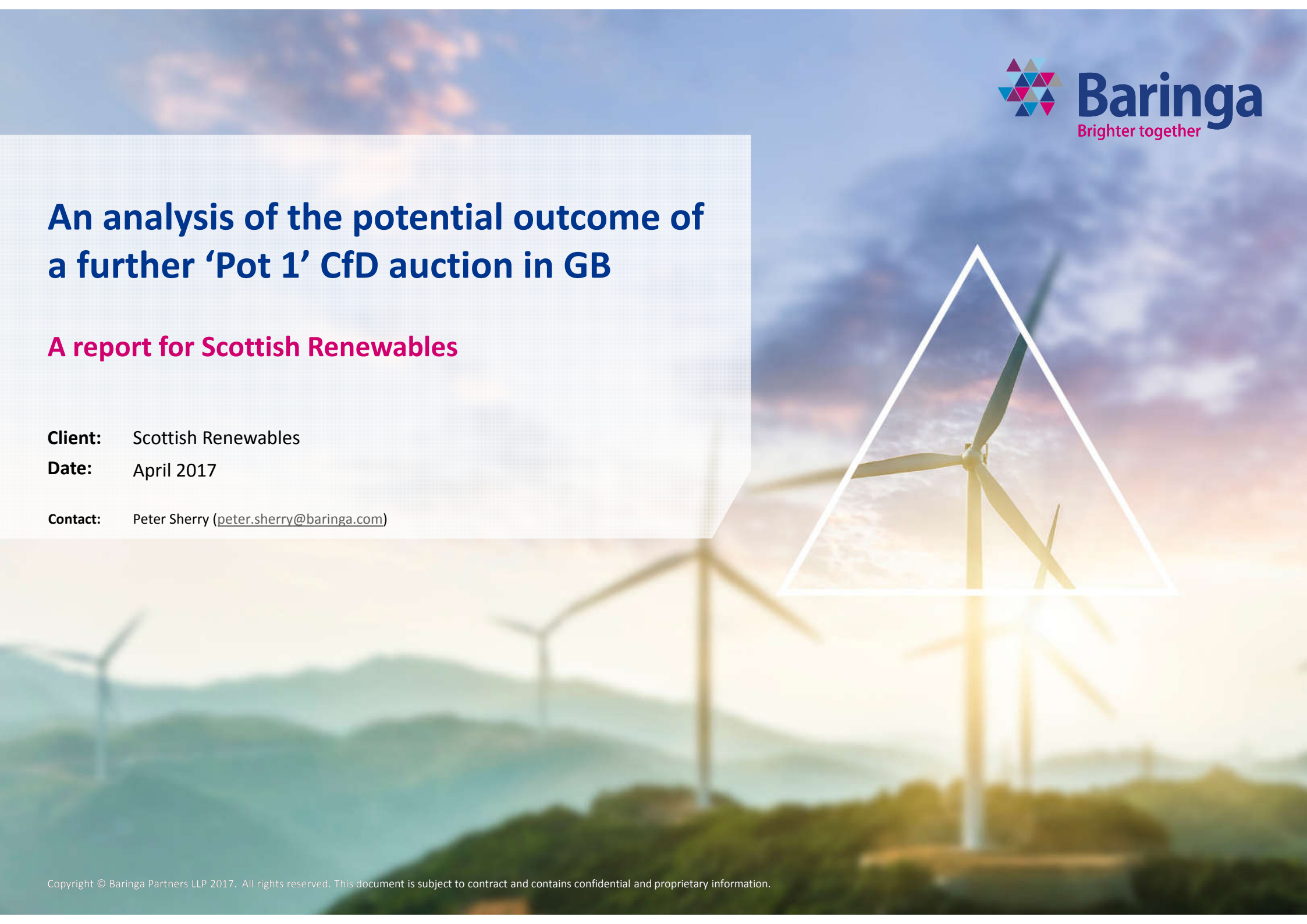

An analysis of the potential outcome of a further 'Pot 1' CfD auction in GB

A report for Scottish Renewables

Client: Scottish Renewables

Date: April 2017

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Executive Summary

We estimate that an additional 1 GW of onshore wind could come forward under the CfD regime, without the need for subsidy

Introduction

- Scottish Renewables has asked for an assessment of the costs of deploying an additional 1 GW of 'Pot 1' renewable capacity through an auction for Contracts for Difference (CfDs) in Great Britain. Under current CfD allocation rules, Pot 1 includes **onshore wind** and **ground-mounted solar PV** (>5MW).
- An Excel-based tool was developed to simulate a hypothetical auction for Pot 1 capacity, with a target of procuring 1 GW of capacity
- The auction is assumed to take place in 2018/19, with the **capacity coming online in the period between 2021 and 2023**. The commissioned capacity would be contracted under the CfD for the first 15 years after their commissioning, with an assumed economic life of 25 years.
- We have used an internal pipeline of consented projects, and the overall eligible volumes were validated against the total consented volumes in the BEIS Renewable Energy Planning Database (REPD)
- The Levelised Cost of Energy ('LCOE') of all the projects in the list was calculated using the most recent data available for capital costs, operating costs and hurdle rates of renewables projects in the UK, and then a merit order was created to reflect underlying project differentials

Key results

- Based on our modelling, onshore wind is relatively more competitive than solar PV in the Pot 1 merit order
- We estimate that **the 1 GW** of successful onshore wind capacity in the auction could come forward without subsidy – **consumers would receive a net payback in NPV terms** relative to our projected wholesale price of electricity
- The clearing price for the auction is projected to be **£49.4/MWh** in real 2017 terms (£46.1/MWh in real 2012 terms)*
- Based on Baringa's reference case electricity price projections and capture discounts, the Low Carbon Contracts Company (LCCC) would need to top-up the revenues of the 1 GW of capacity cleared in the auction by around **£8m** per annum for the first five years. Thereafter, the budget commitment from the LCCC will be negative (i.e. the generator pays back on average each year), due to expected wholesale price rises. The total budget payback by the generators over the remaining twelve years of the CfDs would be £86m on an undiscounted basis (average payback **£7m** per annum).
- On a present value basis, the LCCC would **receive a net payback of £18m** over the period in real 2017 terms
- The renewables cleared in the auction would mitigate over **8 million tonnes of carbon dioxide** in the 25 years of their operation

** Using the CfD auction framework, only the most competitive projects would succeed, therefore the projected clearing price is indicative of the cost of those particular projects, and should not be read as an average of costs for the sector as a whole.*

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Assumptions – project list

Volume of eligible capacity and key data acquired from our the project list

- We assume that a further Pot 1 CfD auction takes place in 2018/19, for delivery of projects between 2021 and 2023 (i.e. post the current LCF period)
- We have used an internal database of consented GB onshore wind and solar PV projects (post-ROC)
- We have cross-checked aggregate volumes by technology from our database with the latest REPD released by BEIS in January 2017. The total volumes are broadly consistent across the two sources, with some variation due to additional project-level research undertaken by Baringa.
- Total project volumes entering the auction are **just under 5 GW** across onshore wind and solar PV
- Just over 70% of the onshore wind projects in the database is located in Scotland, with the remainder located in England and Wales. Conversely, close to 95% of consented solar PV projects are located in England and Wales.
- Every project in the Baringa database contains information on:
  - Technology used (Onshore wind, Solar PV)
  - Developer type (classified as either Vertically Integrated Utilities, or 'VIUs', or 'Portfolio Developers')
  - Project capacity
  - Location (and TNUoS zone if transmission-connected)
  - Load factor
  - Connection type (Transmission or Distribution)
- Levelised costs of energy (LCOE) have then been estimated on a project specific basis, using these project-level inputs along with Baringa's internal cost assumptions (see next slide)

Assumptions – project costs

Key cost assumptions

- Our current cost assumptions take into account the latest market intel from auctions around the world, which suggests a significant reduction in cost since 2015-16 (see more details in Annex). We have then included GB-specific cost items (such as grid connection costs, BOP, FOM).
- We include differentiation at a project level – by location, developer type, project size and grid connection
- Below, we show the project cost projections (real 2017) for a plant **reaching a Final Investment Decision (FID) in 2020**, averaged for each technology:

Technology	WACC (pre-tax real)	Capex -total (£/kW)	Fixed Opex (£/kW/year)	Variable Opex (£/MWh)	PPA discount (£/MWh)
Wind Onshore	5.3%	1,040	40	2	4
Solar Photovoltaics	5.0%	660	20	0	4

- Load factors vary by location: onshore wind load factors average 31% (range of 19-46%), and solar load factors average 10% (range of 9-12%).
- Pre-tax real WACC rates assume a cost of debt of around 4%, equity hurdle rates of 10-14% and a gearing ratio of 60-80% (varying by developer type). This reflects the availability of the CfD as a relatively low risk route to market, and we would assume a higher WACC if the CfD route was not available.
- Capex consists of two categories:
  - A) turbine/panel costs, which are driven by international cost benchmarks, as these are imported (using a long-term exchange rate of 1.2 EUR/GBP)
  - B) other capital costs, which are specific to GB, such as connection costs and use of system charges
- PPA costs are paid to the off-taker to manage the sale of the physical output into the market and any associated imbalance costs. They are assumed to be 8% of the average captured price for wind, and 7% for solar PV.
- For all transmission connected projects we have added:
  - A) TNUoS charges based on the relevant TNUoS zone, and taking Baringa's long-term projection for TNUoS charges
  - B) Locational pricing for transmission losses based on National Grid's P350 modification
- For all distribution-connected projects we have added embedded benefits of £4/MWh on average (for avoided BSUoS, losses and AAHEDC)
- We stress that these cost input assumptions could vary by at least +/- 10% on a project-specific basis (before accounting for load factor)
- Overall, while there is a range of uncertainty, auction results from around the world (especially from Latin America) as well as recent statements from major European utilities suggest that there is scope to attain the cost levels assumed in this report.[1]

[1] *For example:* *http://analysis.windenergyupdate.com/construction/eon-eyes-wind-costs-below-30-eurosmwh-through-closer-ties-suppliers*.

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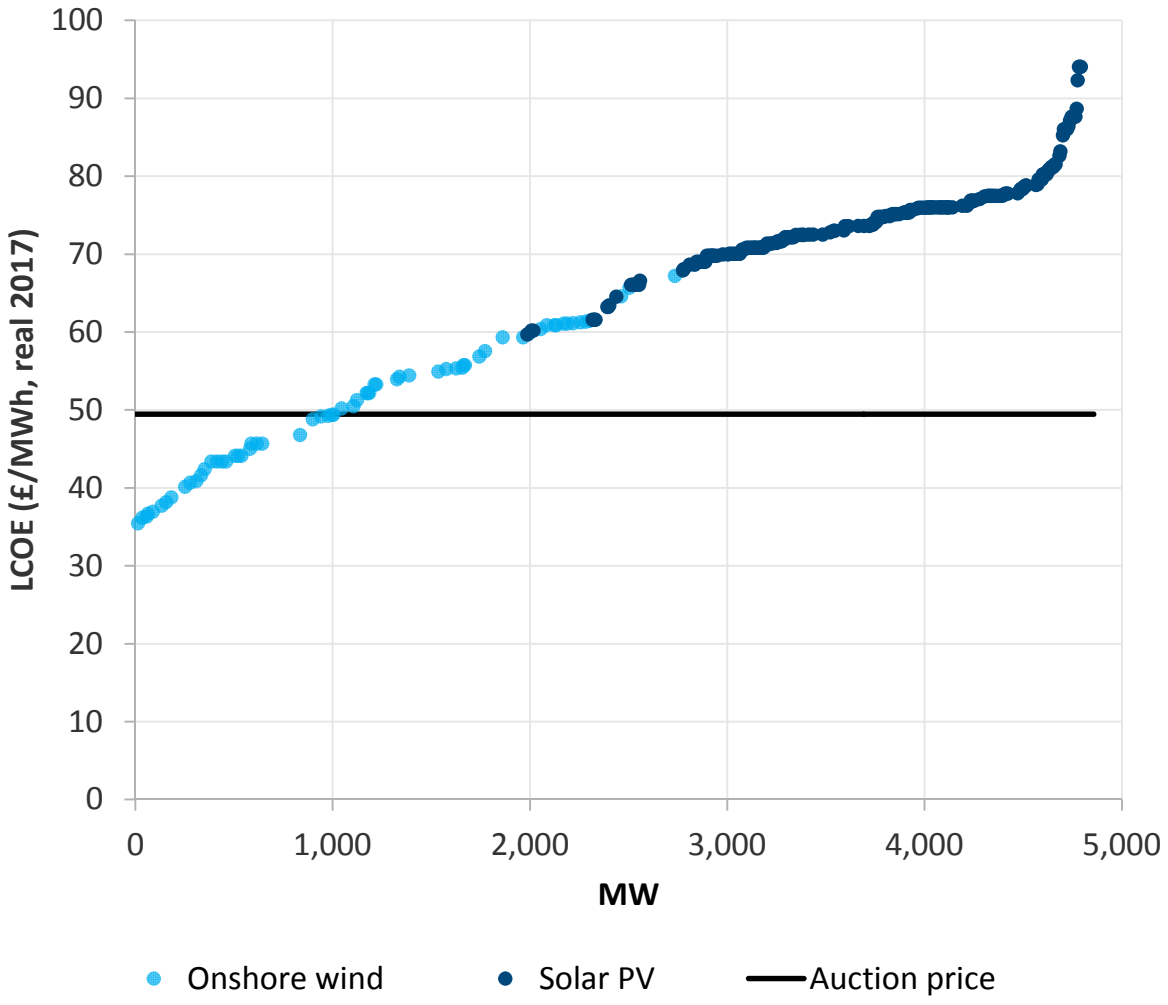
Auction merit order

Based on our database of consented projects, we estimate that an auction for 1 GW of capacity would clear at a price of around £49/MWh, with onshore wind dominating

- Assuming that developers bid their LCOE into the auction, the auction price for 1 GW capacity would be estimated at £49.4/MWh (real 2017 terms)
- This result is broadly in line with recent observed results for onshore wind from around the world, which are in the range USD$40-60/MWh (~£30-50/MWh), but much lower than the previous UK CfD auction from early 2015, which cleared at just over £80/MWh.
- An increase of the capacity target to 2 GW would result in a clearing price of ~£60.2/MWh, which again is much lower than the first round CfD auction
- In general, the LCOEs of wind projects are lower than solar PV, given resource availability in GB, and hence the auction of 1 GW would clear entirely on onshore wind in the absence of any other constraints
- We estimate that the cheapest solar project would clear just below £60/MWh (again, significantly lower than that achieved in the 2015 CfD auction)

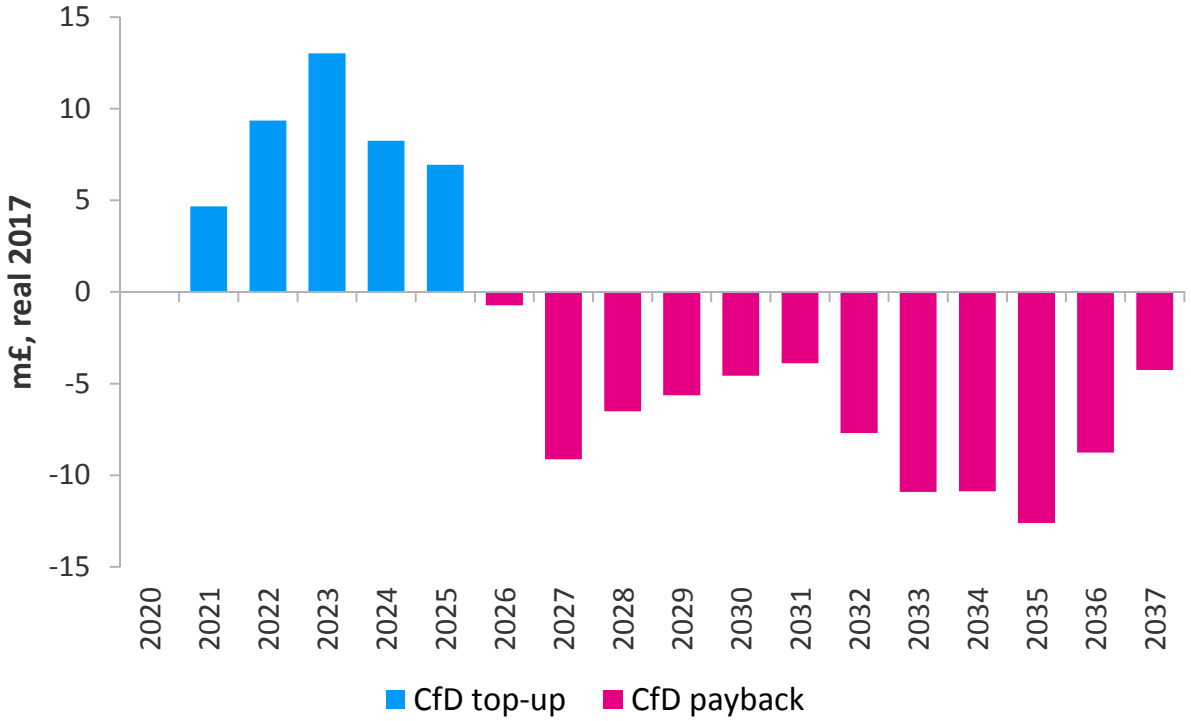


Budget draw for a 1 GW auction

The LCCC would have to provide top-up for the first five years after commissioning, then it would actually gain revenues as wholesale prices are projected to rise above the auction clearing price

- Under the CfD regime, projects are paid the difference between the auction clearing price and the day-ahead hourly wholesale price at the time of generation (known as the 'capture price')
- Baringa projects hourly wholesale power prices for the GB market out to 2040, updated quarterly and provided to our clients on a subscription basis:
  - In our Reference Case, we project the wholesale price to increase from its current level of ~£50/MWh, mainly due to commodity price increases*
  - We estimate that the capture price for onshore wind will be around 10-20% lower due to 'cannibalisation' caused by highly correlated wind output across GB (with this discount highest in overnight periods)
  - Captured prices for solar are expected to follow the baseload wholesale price closely (with discounts < 5%), due to the general coincidence of maximum solar output at periods of relatively high within-day demand

- The captured price for onshore wind is lower than the auction price for the first 5 years, then higher than the auction price for the remaining 12 years (nb. projects commission across the three years 2021-23).
- For the first 5 years, the LCCC would need to provide a total net payment of £42m undiscounted to support these projects under the CfD regime (representing an average payment of £8m pa).
- For the remaining 12 years, the LCCC would receive a total net payback of about £85m undiscounted, as captured wholesale prices are estimated to rise above the CfD strike price for most of these projects (average payback of £7m pa).
- Over the horizon, the LCCC would receive a net payback of £43m undiscounted (in real 2017 terms).
- **On a present value basis, using a public sector WACC discount rate of 3.5%, the LCCC would receive a payback of £18m (in real 2017 terms).**

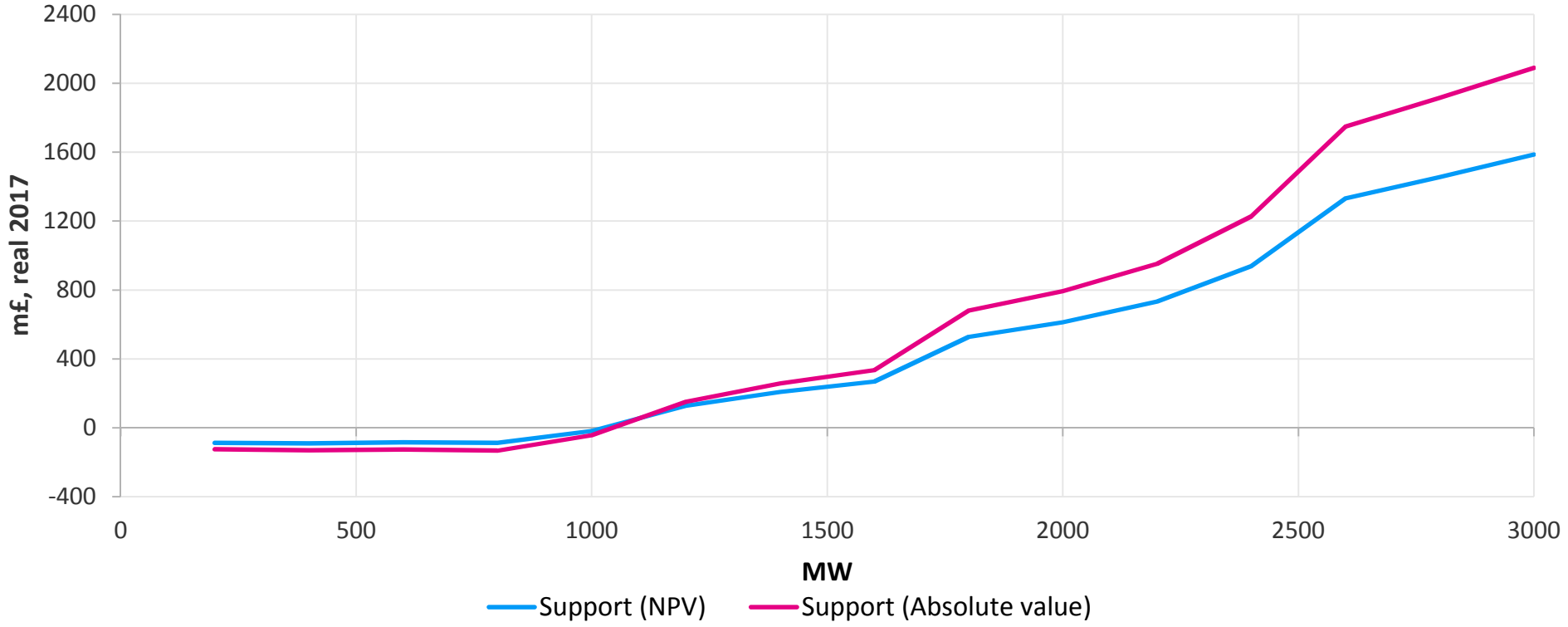


** In this study, we have used prices at NBP basis: including BSUoS charges and transmission losses*

Sensitivity on auction volume

Budget draw for different auction capacity target assumptions

- For a capacity target of 1 GW, the clearing price is lower than the average captured price and therefore the LCCC receives a net payback on the CfDs
- The break-even point to ensure net zero support from LCCC is just above 1 GW in NPV terms
- An increase in capacity accepted in the auction increases the clearing price, which in turn increases the total cost for the LCCC



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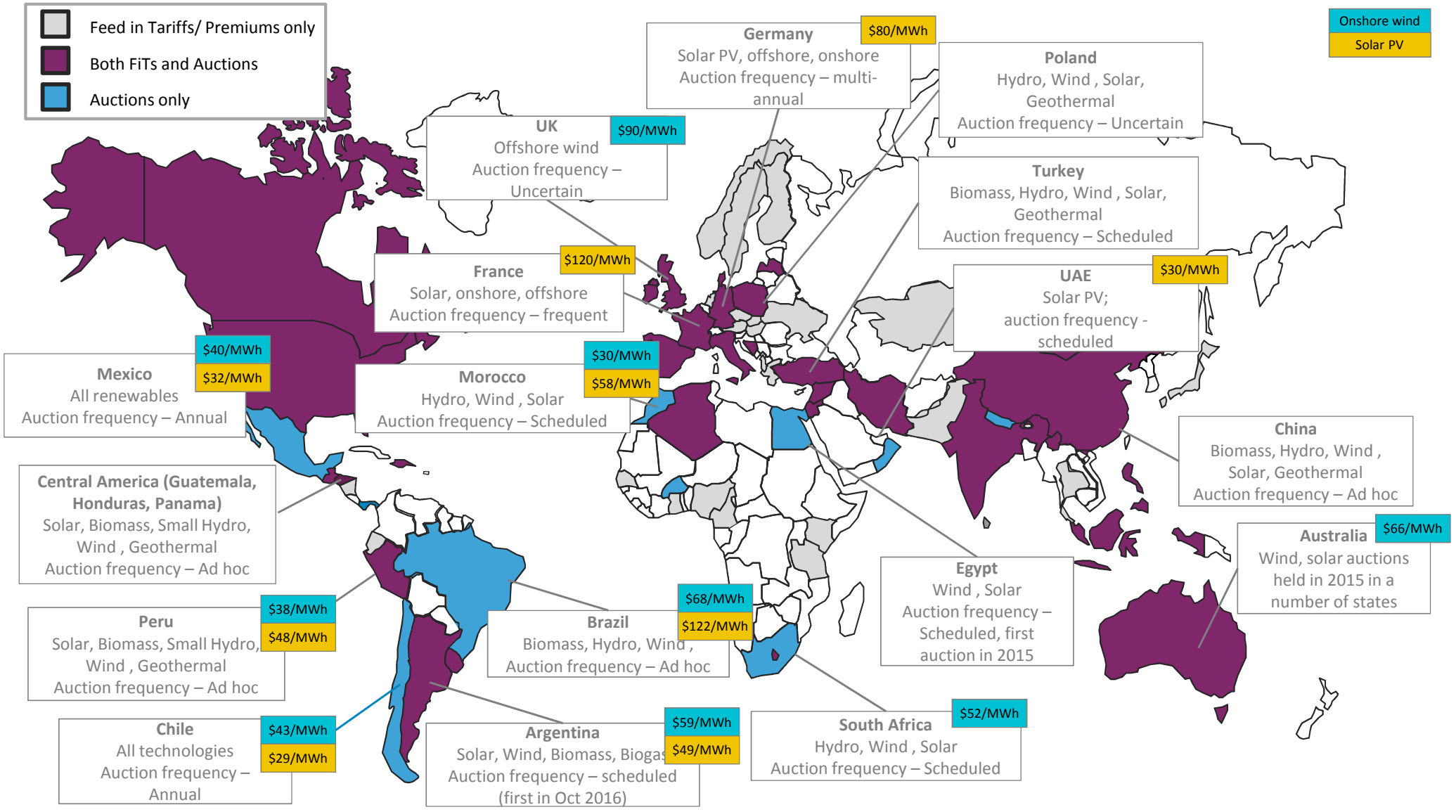
A selection of recent global auction results

Renewable auction prices are reducing globally, and these inform our cost input assumptions



Source: Baringa analysis; IRENA (https://www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_energy_auctions_in_developing_countries.pdf); all prices are stated in USD

LCOE calculations

Levelised Cost of Energy (LCOE) and Present Value calculations

- The Levelised Cost of Energy (LCOE) of these projects includes all the costs to generate electricity, annualised for the period that the project will be active:
  - $LCOE\left[\frac{£}{MWh}\right] = \frac{Annualised(Capex[£])}{\sum_{Year} Generation[MWh]} + \frac{FixedAnnualOpex[£]}{\sum_{Year} Generation[MWh]} + VariableOpex\left[\frac{£}{MWh}\right] + PPA\ costs\left[\frac{£}{MWh}\right]$
  - We assume that all the auction participants will bid their LCOE into the auction, but in reality they may bid higher or lower depending on the competitive dynamic and strategic considerations, as well as to take into account the post-CfD 'merchant' period.
- The Present Value of money is used to discount future flows of money due to their lower value compared to present money:
  - $PresentValue[£] = \sum_{All\ years} \frac{CashFlow_N}{(1+WACC)^{YearN}}$
- Therefore the main levers of the auction price are:
  - Costs (capex and opex)
  - Generation (load factor and lifetime of the project)
  - WACC

Glossary

Abbreviation	Explanation
BEIS	Department for Business, Energy and Industrial Strategy
BOP	Balance Of Plant
CfD	Contract-For-Difference
DEVEX	Development Expenditure
FOM	Fixed Operating and Maintenance (costs)
GBP	Great Britain Pound (assume real 2017 unless otherwise stated)
LCCC	Low Carbon Contracts Company
LCOE	Levelised Cost of Energy
NPV / PV	Net Present Value / Present Value
PPA	Power-Purchase Agreement
REPD	Renewable Energy Planning Database
TNUoS	Transmission Network Use of System Charges
USD	United States Dollar
VIUs	Vertical-Integrated Utilities
WACC	Weighted Average Cost of Capital