Beyond subsidy: How the next levy control framework can cut carbon at least cost

Annex 1

Overview of our Levy Control Framework modelling

Green Alliance's Levy Control Framework (LCF) 2 model is designed to calculate the level of additional funding necessary, post 2020, to achieve the UK carbon emissions target in the power sector. Based on the Committee on Climate Change's (CCC's) view of electricity demand, we estimate, to achieve 100g carbon target in 2025-26, the power sector will need to generate 90TWh of low carbon generation in 2025-26.

The model enables us to identify the cost of policy decisions which affect both the wholesale electricity price and mix of low carbon technologies available to support achievement of the target.

Coverage

The model includes ten of the most significant low carbon technologies for the 2020 period: nuclear, carbon capture and storage, offshore wind, onshore wind, tidal lagoon, tidal stream, wave, biomass conversion, large scale photovoltaics and energy efficiency (or negawatts).

Other low carbon technologies, rooftop solar and various biomass technologies were excluded from the modelling because there was insufficient long term data about their likely costs in the 2020s, they were too many and variable to include and, particularly in the case of rooftop solar, because there is little expectation in long run forecasts that there will be funding for a new distributed generation feed-in tariff post 2016.

The model covers the 15 year period from 2015-16 to 2030-31, but the analysis focuses on the first five years of the next LCF period, 2021-22 to 2025-26, referred to as LCF2. Any Renewables Obligation (RO) certificates, Final Investment Decision Enabling for Renewables (FIDER) and other Contracts for Difference (CfD) awarded before 2021-22 in LCF1, will still form part of total LCF cost but will decrease over time and become a smaller component of the levy as contracts end. In the early 2020s, LCF1 will still be a significant component of the total level but, unfortunately, there was insufficient information in the public domain for it to be included in our modelling.

The model

Our model simulates the annual negotiation and auction process by which low carbon technologies will be awarded CfDs.

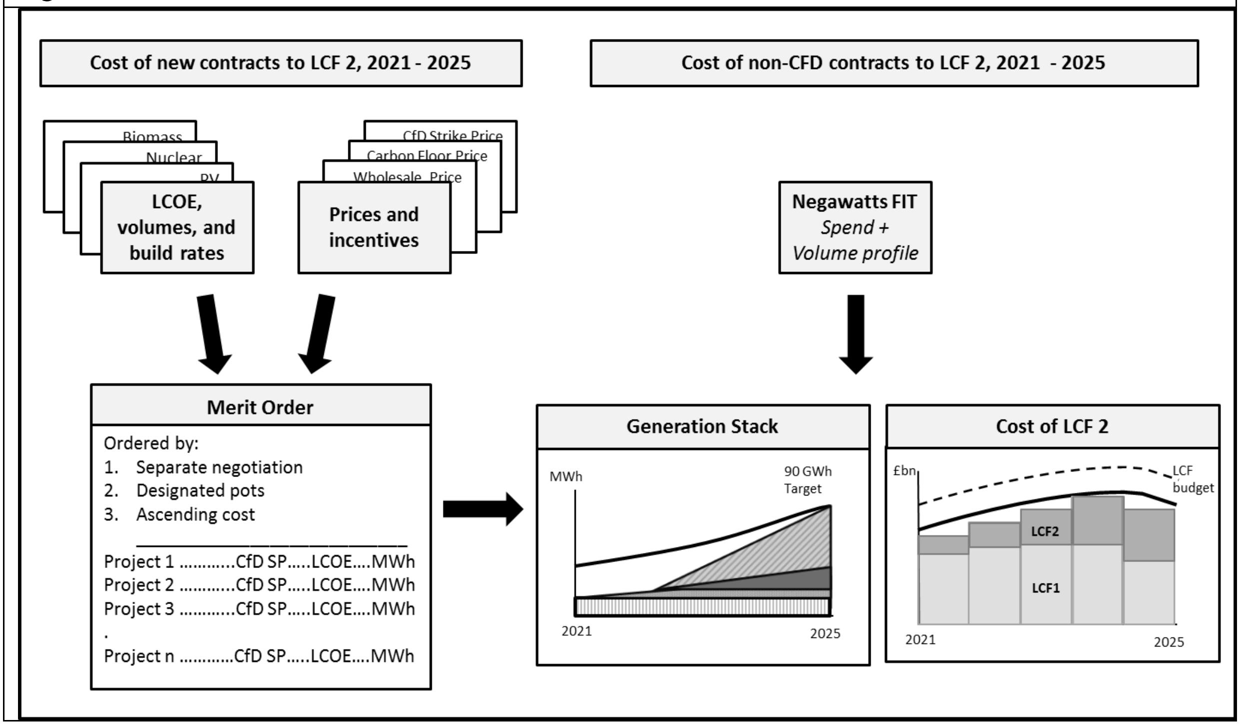
The model uses technology specific forecasts about the range of the levelised cost of energy (LCOE), maximum achievable deployment rates, rate of technological and supply chain improvements which will reduce cost and increase load factors. Together with simplified assumptions about the likely size of deployment units and distribution of projects across the cost range, reflecting differing site and engineering costs, a set of over 2,500 proxy projects are used to populate the model.

The model contracts and deploys these low carbon projects up to the limit of the budget each year. To simplify, projects are assumed deploy in the year they are contracted where in fact the auction or negotiation may happen in advance of generation. The budget is allocated in the following preference order: first, to technologies with separately negotiated contracts and not subject auction; second, to emerging technologies; and, third, to mature technologies. Within those preferences, projects with the lowest CfD strike price are deployed first.

Projects are only deployed where they are available and up to the point that LCOE is equal to the CfD strike price. The LCOE, CfD strike prices and wholesale electricity price are exogenous to the model. However, the scenarios modelled have been reviewed to ensure they are consistent with the source data, ie we have reviewed offshore wind deployment levels to ensure they could deliver the learning and technology savings implied in the LCOE reduction forecast.

The model is constructed around a base case which represents our best estimate of policy in the 2020s based on current government announcements. The model allows us, by changing those assumptions, to test alternative scenarios by say, including onshore wind, currently effectively excluded through the planning process, or examining the effect of a continued carbon price floor (CPF) freeze on the cost of the LCF.

Fig 1. Overview of the Green Alliance LCF2 Model



Base case and scenarios

The business as usual scenario, scenario one, is our base case and the assumptions of current policy are: carbon capture and storage, onshore wind or solar are not available or eligible to be included in the CfD auction; there is no feed-in tariff for negawatts; that separate auctions for mature and emerging technologies continue and that contracts for nuclear are separately negotiated; and the carbon price floor is unfrozen in 2020 and returns to its original trajectory of £78 per tonne by 2030.

The slow delivery scenario, scenario two, reduces the deployment of offshore wind to 1GW per year. Since the model does not have an automatic link between deployment levels and LCOE reductions achieved this scenario makes a manual adjustment to reduce technology savings achieved and, therefore, CfD strike prices likely to result.

The meeting carbon budgets at least cost scenario, scenario three, increases the number of technologies that are available and eligible for a CfD in the 2020s, including onshore wind and negawatts. A scenario that also includes large scale PV could lower cost further after 2023 but was not felt to be deliverable in the current planning environment. Onshore wind is included via a subsidy-free CfD, set to provide a market stabilisation mechanism, not a subsidy, and to take account of the cost of variable generation that this technology imposes on the system.

Data sources

Data for the model has been sourced from the most recent authoritative sources available. Although it is not always possible to identify all source assumptions, our review found few major differences forecasts of technology costs and build rates although wholesale prices forecasts have consistently moved downwards. Where there have been differences in underlying technological assumptions, we have used what we consider to be the most up to date central or mainstream view.

Levelised costs of energy are used throughout which compare annual cost rather than lifetime cost. Therefore, this analysis does not take into account the increased overall cost of technologies, like nuclear, which is awarded 35 year rather than the standard 15 year contracts. New capacity deployable is less than total capacity because it focuses on capacity that is available to come on stream in the 2020s.

All financial values in the model and our results are expressed in 2012 prices.

A summary of the core data assumptions used in the model are set out below. A more detailed list of sources is available in the Bibliography.

Table 1. Core data assumptions

Technologies	LCOE (£/MWh)	CfD Strike Price	New capacity deployable	Load factor	Sources
Nuclear	£79-102 in 2020-21 falling to £75-£101 in	£101 in 2020-21 falling to £93 in	0GW in 2020-21 rising to 2.9 GW by	80% in 2020-21 rising to 90% in	DECC (2013), CCC (2015), Carbon Connect (2014) with

	2025-26	2025-26	2025-26	2025-26	earliest deployment dates modified in line with latest industry analysis
Carbon capture and storage (gas and coal)	£120-160 in 2016-17 falling to £100 in 2025-26	£167 in 2021-22 falling to £108 in 2025-26	0.6GW in 2020-21 rising to 7GW by 2030-31	63% in 2020-21 rising to 77% in 2025-26	CCC(2014 and 2015)
Offshore wind	£71-103 in 2020-21 falling to £70-97 in 2025-26	£120 in 2017-18 falling to £95 in 2030-31	1.9GW in 2020-21 rising to 21GW in 2030-31	42% in 2020-21 rising to 49% in 2025-26	DECC(2013), Statkraft (2015),CCC (2014), Crown Estate(2015), BVG (2015)
Onshore wind	£67-£102 in 2020-21 falling to £66-100 in 2025-26	Subsidy-free CfD	0.7GW in 2020-21 rising to 8GW in 2030-31	26% in 2014-15 rising to 30% in 2030-31	DECC (2010,2013,2015), CCC(2015), National Grid (2015)
Tidal lagoon	£150 project in 2021-22 and £90 project in 2025-26	£168 in 2021-22 and £92 in 2025-26	495GWh project 1 and 6000GWh from project 2	n/a	Poyry (2014)
Tidal stream	£200 - £300 in 2014-15 falling to £70-100 in 2030-31	No strike price forecast available, modelling based on £305 reference price	0.07GW in 2020-21 rising to 0.1GW in 2025 and 3.7GW in 2030-31	31% in 2021/22 and remaining at 31% in 2025-26	CCC (2015), ETI (2015), modified in line with industry estimates of build rates
Wave	£350-400 in 2014/15 falling to £120 in 2030-31	No strike price forecast available, modelling based on £305 reference price	0.006GW in 2020-21 rising to 1GW in 2030-31	31% in 2021-22 and remaining at 31% in 2025-26	CCC (2015), modified in line with industry estimates of build rates
Biomass Conversion	£106-127 in 2020-21 remaining at £106-127 in 2025-26	No strike price forecast available, modelling based on	4GW in 2020-21, if not already deployed, falling to	65% in 2021-22 remaining at 65% in 2025-26	DECC (2013), ARUP (2011), CCC (2013), Poyry (2013), Frontier Economics

		£105 reference price	3.8GW as converted plant reaches end of life		(2014)
Large scale photovoltaics	£84-96 in 2020-21 falling to £73-82 in 2025-26	Subsidy-free CfD	1.5GW in 2021-22 rising to 15GW by 2030-31	11% in 2021/22 and remaining at 11% in 2025-26	CCC (2015), CEBR (2014), DECC (2012,2013,2014)
Energy efficiency / negawatt feed in Tariff	£32 in 2021-22 and remaining at £32 in 2025-26	n/a	2,760GWh in 2021-22 rising to 13,800 GWh in 2025/26	n/a	Green Alliance (2012,2014)
Wholesale prices					
Carbon price floor effect	Wholesale electricity prices modelled with DECC consistent policy CFP, £59/MWh in 2021-22 rising to £73/MWh in 2025-26 and with market carbon price, £58/MWh in 2021-22 rising to £67 in 2025-26.				CCC (2015)
Wholesale electricity price	£54/MWh rising to £67 in 2025-26				DECC (2015)
New generation	Gas with a target consistent carbon price at £85/MWh in 2020-21 rising to £95/MWh in 2025/26				CCC (2015)
Subsidy free CfD					
Subsidy free CfD	£80/MWh in 2021/22 remaining at £80/MWh in 2025/26. This price comprises two components: the new generation + carbon price less the system cost, which will rise with higher penetration of renewables. New generation costs are set out above and systems costs are £5/MWh in 2021/22 rising to £15/MWh in 2025/26 based on Nera/Imperial analysis, modified in line with other industry and expert estimates.				Nera/ Imperial College (2016)