Review of Electricity Market Arrangements consultation

Response from UCL Institute for Sustainable Resources

10th October 2022

Contributors: Paul Drummond, Michael Grubb, James Price, Serguey Maximov Gajardo
With support from: Kathy Page

The UCL Institute for Sustainable Resources delivers world-leading research, teaching and enterprise in the sustainable use of global resources.

We would be delighted to discuss this consultation, or any of our other work. Please contact Katherine.page@ucl.ac.uk

Chapter 1. Context, vision, and objectives for electricity market design

1. Do you agree with the vision for the electricity system we have presented?

Yes

The consultation documentation covers an impressive array of issues organised in a logical way, pinpointing many of the issues relevant to electricity decarbonisation *per se.*

The BEIS team clearly have a good grasp of these issues. As befits REMA the focus is upon issues related to market-oriented mechanisms, but as a vision for the electricity system overall, some other dimensions are also important:

The centrality of transmission capabilities appropriate to a low carbon future. Inadequate transmission is potentially a major obstacle to the vision articulated, and the "vision" refers to optimising 'assets operating at local, regional, and national levels', but not directly to optimising the transmission assets themselves. This is presumably omitted from REMA on the grounds that transmission is primarily a regulated asset, incentivised under RIIO price regulation – but it should still be mentioned as a key part of wider landscape. If transmission adequacy *per se* is assumed to be addressed primarily through non-market mechanisms, this should be stated explicitly. If not, the relationship between wholesale market locational signals and transmission investment requires much more articulation.

It could perhaps lay more stress on the economic fundamentals of the transition, from a system organised around commodity pricing to a system that will rest on assets of very low operating cost. Also, a possible missing element concerns issues raised by the energy crisis and the routes and processes of transition, which inevitably will be affected by the crisis. More details of our analysis of the crisis can be found in a recent paper in our *Navigating the Energy-Climate Crises* series.[1]

2. Do you agree with our objectives for electricity market reform (decarbonisation, security of supply, and cost-effectiveness)?

Yes

We agree with the objectives, but there are further considerations.

[1] https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett_sustainable/files/ucl_isr_necc_wp3_with_cover_final_070922.pdf

Cost-effectiveness is a deceptively simple term, but it needs unpicking / clarifying – it is generally assumed to be a term of the aggregate, rather than the distribution of costs and benefits. The energy crisis has illustrated serious drawbacks to market models based purely on short-run-marginal-cost-on-all pricing. There is a distinct element when thinking about vulnerable energy users – both households, and internationally exposed industries. It may not be for BEIS to decide on whether distributional assistance is justified but there should be an acknowledgement of the potential options, not least because the measures currently being taken by government have potential to undermine aspects of electricity market operation. For example, the current approach of an overall consumer price cap financed by government creates obvious problems for efficient market operation, including that forward contract offers have no incentive to offer a good deal since the buyer price will be covered by the government. Revenue caps also inevitably have adverse consequences.

There are obvious challenges with addressing distributional concerns within market reforms, but they should be noted, and the question raised whether options to help tackle them through market reform could in some ways be better than the alternatives. The term "cost-effectiveness" does not adequately convey these various dimensions.

Also in this context, one could already flag here the tension between investment security / low cost of capital, and related innovation/learning-by-doing – most easily secured through government – and market principles. BEIS could consider either a fourth Objective, or clarifying, "cost-effectiveness in the context of distributional concerns, innovation and the structural transition".

Chapter 2. The case for change

3. Do you agree with the future challenges for the electricity system we have identified? Are there further challenges we should consider? Please provide evidence for additional challenges.

No

The text covers several important challenges – but largely overlooks those highlighted by the energy crisis and the scale of cost inversion now evident in the system and does not mention transmission investment. We agree with the first four challenges. Whether the fifth 'managing price volatility' is in itself a major challenge is perhaps worth discussing and clarifying whether it refers to short-run volatility due to variable output, or long-run volatility / price cycles due to imbalance of investment relative to demand. Short-run volatility may be an appropriate characteristic of a renewables-intensive future, conveying important information. Consider a trivial example: if expansion of wind energy halves energy prices for half the time – implying greater volatility – is that a problem, or a desirable outcome?

We acknowledge the UKERC REMA submission on this point, and in relation to transmission: nowhere in the REMA challenges does it seem to be explicitly acknowledged that to some degree, achieving all the other stated objectives hinge upon development of a transmission system that is fit for the future rather than designed for the past.

The BEIS list of challenges does not pin down a key challenge around relationship of short-run market signals to efficient investment incentives, or offer any options in relation to the fundamental distributional challenges highlighted by the energy crisis and government responses.

There are some further considerations for a future system. A recent paper in our *Navigating the Energy-Climate Crises* series[1] suggests five "challenges and implications" for reform that seeks to align strategic goals with response to the energy crisis. These have some overlaps with the BEIS 'future challenges' of course, but may merit some consideration:

- Structural reform that recognises the underlying transition from a commodity-driven system/market to the asset-based nature of most non-fossil sources. This involves fundamental questions about the relationship between short-run wholesale market signals and efficient investment

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

- Separating marginal from average cost of system. The government is resorting to emergency measures which threaten to seriously distort the system and may even impede the transition: structural solutions are required that reflect the large divergence between marginal and average / inframarginal costs
- Targeting vulnerable groups. Whilst a decision on whether and how to target support to vulnerable groups is ultimately for government to decide, we think BEIS should lay out options that could facilitate direct consumer access to cheap renewables, with the option for governments to target such access if they choose to do so, which is practically impossible to do with the current market structure.
- Need for renewables to share balancing and backup costs, which we regard as an element in relation to system flexibility and cost-efficient operation. Efficient locational signals, as flagged by BEIS, will be valuable but the challenge is also whether and how these can translate into efficient investment.
- Engage consumers. We consider this is a wider challenge beyond a narrow focus on "increasing system flexibility". Consumer flexibility is important but not a panacea and research flagged in the UKERC submission underlines its apparent limitations at present. It will need to evolve, perhaps over extended periods, with both support and incentives alongside e.g. the rollout of EVs. Also the scale of electricity demand increase implied by most decarbonisation scenarios could stretch the capacity of renewables and the transmission system, underlining the strategic value of efficient electricity use. Almost all appraisals underline that demand-side measures reduce system costs.

Our subsequent report suggests ways in which market reform could encompass improved incentives for energy efficiency.[2]

4. Do you agree with our assessment of current market arrangements/that current market arrangements are not fit for purpose for delivering our 2035 objectives?

Yes

We agree they are not fit for purpose.

Chapter 3: Our Approach

5. Are least cost, deliverability, investor confidence, whole-system flexibility and adaptability the right criteria against which to assess options?

Yes

We would however suggest BEIS clarify the first and consider their relationship with the five 'challenges and implications' set out in our published paper.**Error! Bookmark not defined.**
The first BEIS criteria, 'least cost', contains an important phrase of 'least cost to consumers and sub-groups of consumers', which points to distributional dimensions often neglected in 'least cost' objectives (see our response to Q3); and the criteria seem to omit any specific reference to decarbonisation.
We suggest including, after 'least cost', a specific criterion relating to consistency with declared governmental social and environmental objectives, including the timescales for decarbonising electricity to meet the government's 2035 target, and meeting the legislated carbon budgets.
We suggest the last item, 'adaptability', could also be clarified and expanded, to include 'evolution and adaptability'. This would identify reforms which can be implemented relatively quickly but which could help to pave the way for the more fundamental shift toward future visions of a decarbonised electricity system.

6. Do you agree with our organisation of the options for reform?

Yes

[2] Forthcoming report in our *Navigating the energy-climate crises* working paper series, which will be hosted on this webpage https://www.ucl.ac.uk/bartlett/sustainable/research-projects/2022/sep/reforming-electricity-markets-low-cost-and-low-carbon-power The authors have provided a draft of this paper to the BEIS REMA team.

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

We think that Figure 7 sets out the options in a clear and accessible way.

Chapter 4: Cross-cutting questions

8. Have we identified the key cross-cutting questions and issues which would arise when considering options for electricity market reform?

No

We offer comments on this from a 'three domains' perspective, which recognises distinct though related theoretical fields and evidence on decision-making relating to (i) behavioural and organisational characteristics, (ii) neoclassical, least-cost optimising behaviour assuming rational foresight, particularly concerning broadly marginal changes within a given system context, and (iii) innovation, evolutionary and institutional theories which reflect insights concerning structural and non-marginal change, deeper innovation, and dynamic processes in context of deep uncertainty and transition. In addition to our previous published research in this area, stemming from the book *Planetary Economics*, we have also recently completed a condensed paper focused squarely upon the implications for policy packages including the role of markets.[3]

The first item in this part of the REMA consultation - 'the role of the market' - is framed around a classical 'Second Domain' perspective of identifying market failures. It may be useful to refer to the Three Domains framing, to extend this to first-domain behavioural characteristics of consumers (especially), and the underlying third-domain dynamics of innovation and transition processes. These cannot be adequately captured in terms of traditional 'barriers' which are largely referenced to a theoretical characterisation of decision-making which doesn't adequately reflect the other decision-making domains.

Specifically, first-domain economics is fundamental to understanding what can and cannot be expected of consumer engagement, including 'energy demand reduction' (the last cross-cutting element in the consultation document) but also beyond this.

Third-domain economics is central to the question of minimising financing costs (which is also in the consultation document's list) and supporting the full chain of innovation, along with related infrastructure (which are not evident in the consultation document's list); the associated theories of transition could also illuminate issues in 'delivering objectives through the transition'.

One clear example is that this multi-domain perspective would highlight the need to consider more systematically the co-evolution of locational signals with consumer capabilities on the one hand (first domain) and transmission capacity on the other (third domain).

This might therefore offer a way to help present (and expand) cross-cutting issues within a more consistent and theoretically-grounded logical structure. A "three domains" lens could also help pinpoint the nature of challenges in the relationship between wholesale market and investment – and how that may vary according to the scale: in general, the larger the scale and timescale of investment (and consequently, the bigger the risks for investors and the deeper the uncertainties and interdependencies of different decision-makers), the harder it is for short-run market signals alone to guide efficient investment.

Chapter 4 of the consultation document does not quite pinpoint the structural disjuncture: CfDs have demonstrated huge economic gains from long-run contracts backed by governments, due to capital efficiency

[3] *Planetary Economics: Energy, Climate Change and the Three Domains of Sustainable Development* (2014), winner of 2021 Marcel Boiteux prize for "outstanding book contributing to energy economics and its literature" by *International Association for Energy Economics*. Now available for free download @ https://climatestrategies.org/publication/planetary-economics/. Two journal papers are published, summarising (i) the broad framework and (ii) focusing on innovation theories and processes; a third, 'Different Therefore Equal', draft prepared for a special issue of the *Oxford Review of Economic Policy*, focuses upon the complementary role of different policy instruments and is available from the authors on request.

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

for investment supported by support for coordination and industrial collaboration; but are disconnected from any market-based signals for efficient investment, location, or operation. That is evidence of the implicit dysfunction in the current 'market arrangements' and bridging that disjuncture between second and third domain incentives – to an extent, trying to foster greater connection between chapters 5 (wholesale markets) and 6 (low carbon investment) of the REMA consultation, is perhaps the most fundamental cross-cutting challenge.

Finally, additional thought could be given to whether the list of cross-cutting issues should include:

- Distributional Issues, as indicated
- The underlying economics, tensions and boundaries between 'postage stamp', zonal, and locational marginal pricing

10. What is the most effective way of delivering locational signals, to drive efficient investment and dispatch decisions of generators, demand users, and storage? Please provide evidence to support your response.

The question seems to assume that locational signals can equally drive efficient investment and dispatch.

This is not likely to be correct. We recommend the UKERC REMA submission, which has covered this point in more detail.

12. How do you think electricity demand reduction should be rewarded in existing or future electricity markets?

One tentative, derivative suggestion from our work on long-term contract markets is that that cheap long-term contracts through a Green Power Pool could be struck with landlords, who could pass the costs through to tenants in terms of attractive electricity rates. Landlords would also have information and an incentive to improve the structural energy efficiency of the property so as to make rental terms more attractive.
By aligning long-term asset-based energy finance with properties, whilst energy contracts for tenants carry short-term pricing signals reflecting system balancing costs, this could offer a new way to help overcome the tenant-landlord divide which has long impeded household energy efficiency, whilst still incentivizing more 'smart' and flexible electricity use. This is a tentative idea that could merit further exploration.

Chapter 5: A net zero wholesale market

13. Are we considering all the credible options for reform in the wholesale market chapter?

Yes

Mostly yes – but not quite. First, we think it useful to draw a distinction between 'splitting the market' (which is covered well), and 'dual market' proposals of the nature we have proposed and developed in our latest research. This links a long-term demand-side contracts structure, appropriate to the capital structure of renewables, to the wholesale market for strategic balancing (in the sense of complementing the variability of renewable energy output). See also responses in rest of this section.

Some combinations of options at different levels could be interesting, e.g. local generation and distribution in specific areas.

14. Do you agree that we should continue to consider a split wholesale market?

Yes

There is a good discussion of the 'split markets' proposal.

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

'Dual markets' could be more fully represented. Our detailed design suggestions, which are being developed in an upcoming report,[2] would indeed deliver separation of marginal from average costs, whilst preserving marginal cost incentives of purchases 'at the margin' from the wholesale market.

Note also, there are some more decentralised variants, in which some of the roles ascribed to the System Operator (or other Green Power Pool operator) could be decentralised to energy suppliers.

15. How might the design issues raised above be overcome for: a) the split markets model, and b) the green power pool? Please consider the role flexible assets should play in a split market or green power pool - which markets should they participate in? - and how system costs could be passed on to green power pool participants.

In the attached annex and forthcoming report[2] we summarise points from our study into the potential design and implementation structures of a Green Power Pool, and also possibilities for open long term contract markets. These include detailed design options for how marginal cost incentives could be passed through to consumers, 'at the margin' of their consumption choices. These do add complexity, and we aim to outline simpler starting points for evolving a Green Power Pool approach. This starts with CfD-derived electricity and simpler consumer contract design, and develops towards more complex and fully marginal-cost-reflective structures over time.

16. Do you agree that we should continue to consider both nodal and zonal market designs?

Yes

We think keeping both options on the table makes sense. Renewables integration will likely benefit from more spatially diverse deployment. Locational pricing could help incentivise that, and as a result better: i) optimise system operation (e.g., by minimising/avoiding redispatch costs), ii) inform network investments as congestion can be easily identified and iii) signal locational choices for generation investments and storage to lower system cost. On iii), this particularly concerns investment in variable renewable energy, as spatially granular pricing will avoid over-concentration in the sites with best resources and will support investment in 2nd or 3rd best sites if they reduce total system costs, because of this diversity.

It remains unclear which level of granularity, and how it may be specifically applied, would be best. However, we believe that zonal pricing could deliver many of the benefits of a locational pricing approach, with greater simplicity than nodal pricing. A zonal approach may also be easier to dovetail directly with a dual markets structure, allowing demand-side contracts to differentiate by zones in ways which may be more complex with locational marginal pricing (LMP).

Finally, it is possible that a zonal approach may fit better with ideas for devolving greater responsibility for system operation, as for example with the proposals for DSOs and Distributed Service Providers, noted elsewhere in the REMA consultation. However, such issues have not been a focus of our own research and we do not claim to have fully resolved these issues.

17. How might the challenges and design issues we have identified with nodal and zonal market designs be overcome?

As above, we believe some form of incentive to ensure spatially diverse deployment of variable renewable energy (and the transmission investment to support it) would likely lower overall system costs. This would minimise redispatch and avoid gluts of production when it is windy in one area and famines when it is not. Transmission investment is relatively cheap and gets prioritised over storage by electricity system models that seek to plot cost-optimal pathways to decarbonisation (although storage is also often essential).

The question remains as to whether locational pricing is the most appropriate route to incentivise this. On this point, and to understand potential regulatory changes to overcome the challenges mentioned in the document, we think more work is needed to: i) gather evidence from countries/regions that use zonal/nodal pricing to help understand how other systems meet these challenges (e.g. PJM in the US for nodal pricing,

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

where some evidence suggests liquidity is not a problem, for instance), and ii) perform GB specific modelling and analysis to better speak to the challenges identified.

21. Do you agree that we should continue to consider reforms that move away from marginal pricing?

Yes

Marginal cost pricing has obvious economic merits but serious attention is required to ways of gaining the benefits where most obviously appropriate – in terms of short-run operational efficiency – and clarifying areas where benefits are less obvious and/or involve important trade-offs.

Specifically, we agree that reforms that move away from the current 'short-run-marginal-cost-on-all' pricing on all generators merit attention. Doing so could substantially reduce the cost to consumers and reduce the currently very high level of inframarginal rent received most obviously (but not only) by low-marginal cost generators, notably renewables supported by the Renewable Obligation mechanism.

Consideration of marginal costs and pricing remains valuable – indeed essential for efficient operation. In a dual-market design, short-run marginal pricing for the wholesale market focused on fossil-based generators would remain beneficial. The differential between generators – and thus the scale of inframarginal rent - would be much reduced, whilst the most efficient plant would still be incentivised to run at any given time. For a Green Power Pool, the long-run marginal cost of new plant to meet growing demand should be minimised (with a focus on capital rather than operational costs – correspondingly, its long-run marginal cost). For example, this could be achieved through a competitive auction mechanism for the procurement of new capacity at fixed prices based on long-run costs. Our detailed analysis of Green Power Pool design starts with consideration of a CfD-derived pool for this reason.

Chapter 6: Mass low carbon power

24. Are we considering all the credible options for reform in the mass low carbon power chapter?

No

On the CfD side, the most relevant credible options are covered in the document. It would be worth exploring alternative contract allocation rules that may be based on total system cost rather than only strike prices, as a higher bid from a generator that has a more convenient location (from a system efficiency perspective), or other technical advantages (such as embedded storage) could present higher value to the system and therefore be preferred. However, it is evident that calculating this extra value is not trivial and it is dependent on specific assumptions.

An option that appears to have been given insufficient attention as a means to incentivise mass low carbon power would be to explore whether and how government could help convene and coordinate PPAs structures, by helping to overcome coordination and counterparty problems in the PPA market as it exists today. Although their contribution to clean investment remains limited, they could be a credible option to keep capital costs low by guaranteeing the generator a long-term price. The main reasons for limited adoption (and higher costs) are the high transaction costs (there is considerable technical and legal knowledge required to favorably negotiate a PPA) and their relatively short duration (varied but often around 5 years or less) which does not provide sufficient risk hedging to the generators.

The government (or a governmental backed agency) could work directly with the associated business groups to structure standardized forms of long-term PPA contracts, providing the role of coordination and decreasing the transaction costs for the parties. It also could act as an aggregator of energy buyers and/or generators. Standardized PPA contracts embody a generalizable commitment to deliver low-carbon electricity at a fixed price for a given duration. Economically this would be analogous to bonds, but yield value in terms of electricity at a fixed price rather than interest payments on loans. Such 'clean electricity bonds' would

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

therefore acquire a tradeable value, substantially reducing transaction costs, counterparty risks and encouraging longer term contracts. This approach could operate alongside a targeted Green Power Pool derived from government backed CfDs, interacting much in the way that a private bond market exists alongside government bonds. This concept is outlined in our forthcoming paper, section 5.[2]

This would not offer possibility for direct targeting, or offer large-scale capital investment efficiency to the degree offered by CfDs. Due to the greater level of market engagement, the greater scope it could give for smaller scale renewable generators, and potential for fostering innovation, however, we believe it merits further consideration as a complementary approach.

26. Do you agree that we should continue to consider supplier obligations?

No

Suppliers have a crucial role, and this could be enhanced roles, but the risk exposure and relatively short time horizons of most suppliers could make them inadequate counterparties at least for major renewables investments. Supplier involvement in smaller scale renewables could be strengthened if PPA markets can be improved, as indicated, and the role of suppliers in low carbon investment could potentially be subsumed in this.

29. Do you agree that we should continue to consider central contracts with payments based on output?

Yes

Central contracts with payments based on outputs, like the current CfDs, have been key to de-risking investments in wind energy in the last few years. They should continue to be considered as they help to drive down capital cost and reduce the overall cost of to achieving the decarbonization of the electricity generation sector.[4]

30. Are the benefits of increased market exposure under central contracts with payment based on output likely to outweigh the potential increase in financing cost?

Different studies have shown that CfDs are the most economically efficient policy for increasing the deployment of renewables (wind in particular) in the long term.[5]

However, the lack of market exposure under the current CfD scheme does not provide incentives for supporting system flexibility.

The effect on the cost of capital of different market exposure variants of CfDs depends on the characteristics of the future electricity system, as these affect wholesale market prices and wind capture prices.[4]
An alternative way to account for the contribution of the generator to the system's flexibility is by modifying the contract allocation rules to be based on the total cost (or benefit) to the system, rather than solely on the bid strike price.[6]
In general, and in relation to the following questions relating to REMA Chapter 6, we refer to the evidence submitted by UKERC on this topic. We note that all options would be compatible with a CfD-derived Green Power Pool approach to utilising the electricity generated under such contracts.

---

[4] UKERC report, Risk and Investment in Zero-Carbon Electricity Markets
https://d2e1qxpsswcpgz.cloudfront.net/uploads/2021/11/UKERC_Risk-and-Investment-in-Zero-Carbon-Electricity-Markets.pdf

[5] https://d2e1qxpsswcpgz.cloudfront.net/uploads/2021/11/UKERC_Risk-and-Investment-in-Zero-Carbon-Electricity-Markets.pdf;
https://www.diw.de/documents/publikationen/73/diw_01.c.852061.de/dwr-22-35-1.pdf;
https://www.sciencedirect.com/science/article/pii/S0928765522000471?via%3Dihub

[6] Ostrovnaya et al (2020), 'The high cost of electricity price uncertainty',
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3588288

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

Chapter 8: Capacity Adequacy

45. Are we considering all the credible options for reform in the capacity adequacy chapter?

Don't know

We have not had time to focus on this chapter. The capacity market is a valuable insurance instrument for the present but remains structurally limited in its ability to integrate the demand side.
In the long run, a Green Power Pool could have backup capability and smart demand-side contracts built in. This may enable us to move beyond the capacity market.

Chapter 10: Options across multiple market elements

73. Do you agree that we should continue to consider an Equivalent Firm Power auction?

No

This option has glaring inefficiencies since balancing and backup for renewables should be a shared property – it is the system, not individual generators, which need backup. The proposal is also poorly specified (should backup be required for peak output, average output, average peak in winter, or another metric?). It is also discriminatory if applied to renewables since no plant has 100% reliability.

Do you have any other comments that might aid the consultation process as a whole?

We have provided additional information in the form of an annex attached below, which we would refer you to.

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

Annex to Consultation Submission

Over the next five years, non-fossil energy in total is projected to reach 75% of UK generation, including rapidly rising variable input from wind and solar. Emerging from the energy crisis in sustainable ways hinges upon implementing electricity market reforms which align with the resulting opportunities and challenges. Our recent report[i] examined and critiqued some of the fundamental issues in electricity market design, which are largely common across Europe, explaining why the current design is simply not fit for this future. We suggested five guiding principles for assessing market reform options for electricity transition in the context of the energy crisis, as summarised in Box 1.

Box 1: Five guiding principles for assessing market reform *(source: see endnote 1)*

1. The growing prevalence of lower-cost renewables, mostly on long-term contracts, is not an aberration in electricity markets but a fundamental feature which offers opportunities that could be seized by substantial changes in electricity market design.
2. Structural solutions are required to separate the average price of electricity from the short-run marginal-gas cost and risk-based premium pricing of current wholesale markets.
3. Governments need to consider whether vulnerable groups – in both households and business – can or should be priority beneficiaries of the revolution in cheap clean electricity.
4. Seizing the opportunity of low-cost renewables ultimately requires market structures which apportion backup and balancing costs appropriately and proportionately.
5. Along with supporting infrastructure, pursuing the energy transition will require new policy approaches and institutional structures to engage consumers across all energy uses, to enhance investment in energy efficiency, innovation, and electrification with flexibility.

We believe the establishment of a Green Power Pool (GPP), alongside supporting the development of a private Power Purchase Agreement (PPA) market, could contribute to addressing of these guiding principles for aligning long term and shorter term responses (alongside those articulated by the REMA consultation). In the following, we outline how:

1. The growing prevalence of lower-cost renewables, mostly on long-term contracts, is not an aberration in electricity markets but a fundamental feature which offers opportunities that could be seized by substantial changes in electricity market design.

Some key Governmental support mechanisms for renewable energy already reflect the first of these guiding principles, with tailored policies that have driven rapid renewable expansion and cost reductions. Contracts-for-difference (CfD) have also started to decouple the average electricity cost from the short-run marginal price (the second guiding principle): as the rising wholesale price now far exceeds the falling strike-price of recent CfDs, these contracts are now paying back the excess revenues they make by selling electricity.

This valuable progress has, however, been achieved largely by separating financial terms for investment from the actual electricity market, rather than reforming the market. If projected forward, this carries a striking implication: under current plans and proposals in Great Britain, within five years, half of all electricity generation would depend upon government-designed and underwritten contracts. Whilst consistent with principles of competition through competitive auctions, there are reasonable concerns about such an outcome, even when acknowledging that on paper it would seem the cheapest way to drive (and to decarbonise) our electricity system. Moreover, current CfD design, with currently high earnings followed by repayments against a fixed strike price, is complex and does not address the other three guiding principles indicated for reforms.

Alongside government-backed contracts that have largely brought renewables to their current level, the private sector has been making an increasing contribution, through both ‘green tariffs’, and bilateral renewable energy Power Purchase Agreements (PPAs). **The legitimacy and effectiveness of ‘green tariffs’ is challenged by the current market design, which – as indicated by their costs still generally**

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

rising in line with wholesale prices – makes it almost impossible to disentangle their economics from the marginal price-based spot market. Despite vibrant innovation in PPAs, their contribution to clean investment remains limited by the gulf between their typical contract duration (a few years) and those needed for efficient financing of large-scale renewables (a decade or more), as well as by transaction costs and the need to complement the variable output of individual renewable generators.

In effect, electricity generation has already moved away from a single homogenous market – the dominant wholesale market is accompanied by fixed-price, government-backed generation contract for renewables, and private PPAs. Feasible reforms should build on these foundations. The most promising option to do so, in Great Britain, would be for the UK government to:

(1) **Draw upon the existing CfDs, under which generators provide power at fixed strike price (ultimately), to establish a Green Power Pool**, to which (an initially targeted, but growing proportions of) consumers may be given direct access at prices reflecting average costs of renewable generation (embodied by agreed strike prices). The Pool could purchase 'balancing' services from the traditional (fossil-based) wholesale market, with associated costs charged to holders of GPP consumer contracts for the proportion of 'balancing' energy only.
(2) **Work directly with the associated business groups to structure standardised forms of long-term private PPA contracts, providing role of coordination and elements of contract standardization** which are currently lacking. Such purely private-sector contracts would represent a managed evolution from current PPAs, facilitated by government to overcome failures of coordination, aggregation, time horizons, and counterparty risks, which currently prevent PPAs from realising their theoretical potential to support efficient low carbon investment. This approach could lead to a private sector 'electricity bond market', based on standardised and tradeable PPAs for low carbon power, which could operate alongside a targeted Green Power Pool.

2. Structural solutions are required to separate the average price of electricity from the short-run marginal-gas cost and risk-based premium pricing of current wholesale markets.

CfD contracts themselves currently, and are likely to continue to, return surplus revenues to consumers (albeit in indirect ways), but do not facilitate direct access to cheaper and more long-term stable electricity prices for consumers. Establishing a CfD-derived Green Power Pool (hereafter, CfD-GPP) need involve no significant change to the main financial dimensions of the CfD regime that has so successfully supported the growth of large-scale renewables. Such a pool would likely involve all generation with existing CfD contracts – increasingly dominated by offshore wind, but with some waste- and biomass-based generation, and expanding in a few years to nuclear as and when the Hinkley Point C reactor comes online. A directly government-backed and targeted Green Power Pool could legitimately prioritise those domestic generators, which mostly would generate 'as available'.

The step of targeting CfD-derived electricity at the most vulnerable is bound to add complexities. However, it could offer a way for reform to encompass the third guiding principle suggested, of targeting support, through prioritizing access to publicly-backed cheap renewables. Without this, the UK Treasury either has to use fiscal targeting, or will remain exposed to continuing large, and highly uncertain, expenditure implications of its current 'price cap' approach. Ring-fencing would be crucial to prevent on-selling of the much cheaper power the CfD-derived GPP contracts would offer, particularly if electricity prices derived from marginal cost approaches remain at historically high levels.
A private PPA-based long-term contracts market would not require the same institutional structure, as it would be open to all wiling market participants. The initial price for such contracts, if it were 'kicked-started' by a negotiated shift in renewable generators supported by the Renewable Obligation to long-term, fixed-price contracts, would be set by those negotiations. Thereafter its attraction would reside in terms that appealed to consumers wanting to buy green power and willing to sign up to long-term contracts, to reduce exposure to the fossil-fuel based and volatile wholesale market. Such a market would give easier and quicker access for smaller-scale renewables, and future prices would reflect the ease of such new build. Electricity

from interconnections with other countries would most obviously flow through either private PPAs or the wholesale market.
If included directly in a CfD-derived Green Power Pool, the additional electricity available would easily match the demands associated with a range of additional consumer groups, including those already on 'green tariffs', and consumers who use electricity which displaces other fossil fuel uses and offers flexibility, as with electricity vehicles and heat pumps.

On either route, the volume available would make it feasible to open such a Green Power Pool / long-term contracts market to all interested consumers. Investors in new renewable (and potentially storage) capacity would be free to choose which route to market (wholesale market, GPP or private long-term contracts) best suits their economic characteristics. With or without government underwriting, a structure of contracts based on average long-term costs would begin to delink the average cost of electricity generation from the marginal wholesale price.

3. Governments need to consider whether vulnerable groups – in both households and business – can or should be priority beneficiaries of the revolution in cheap clean electricity.

A CfD-derived Green Power Pool offers a route through which consumers most sensitive to high electricity prices could be given prioritised access to electricity from cheap renewables, should the government so choose. Some such targeting would be necessary should a GPP be launched purely on the basis of existing CfDs whilst other renewables continue to sell purely into the wholesale market. Specifically, CfD-derived electricity could be offered to two particular groups of high political and welfare concerns:

- Industrial consumers whose international competitiveness is directly threatened by the differential between GB electricity prices and countries where electricity prices are directly regulated: in GB, one definition of such industries could be those already eligible for compensation for the GB's Carbon Price Floor;

- Special-purpose windows for suppliers to market power to fuel poor domestic consumers – groups already targeted for previous government supports, or otherwise defined for this purpose.

In both cases, the price to these consumers would necessarily be regulated to reflect the generation plus applicable network charges and other taxes and levies, not linked to the wholesale market. The volumes of electricity available from existing CfDs match or exceed the demand of these groups, and will be expanding rapidly.

4. Seizing the opportunity of low-cost renewables ultimately requires market structures which apportion backup and balancing costs appropriately and proportionately.

To provide firm power, electricity supply contracts based on wind and solar most obviously require backup and balancing from the rest of the system for when there is insufficient wind or solar to meet demand – though in reality, that is required for almost any bilateral (e.g. PPA) contract, since no equipment can operate with 100% reliability. This has implications for the design and accounting of such contracts, including emissions accounting.
A key principle is that efficient backup and balancing is ultimately a property of the system, not individual sources, but as a group, renewables require more backup and balancing than other sources. These costs should be allocated appropriately and proportionately to the renewables sector, however, this carries several implications. Under a Green Power Pool, this implies two-tier contract structures which separate the average (renewables cost) from the marginal cost of meeting electricity demand above the low carbon output at any given time.[ii] A reverse logic could apply when the available low-carbon generation exceeds the demand in the pool, with the surplus sold into the wholesale market. The procedures for balancing a more private sector PPA-based long-term contracts market could draw upon these same principles, as well as the experience already embodied in the growing PPA-renewables market.

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

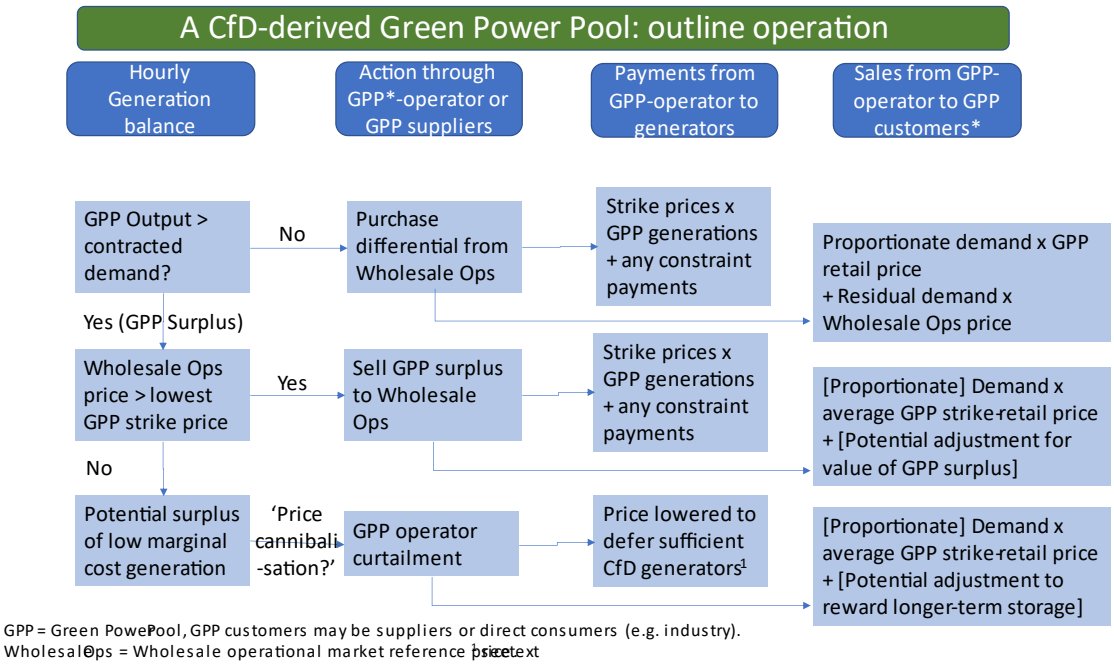
T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

The Green Power Pool and long-term contract markets can be designed to give transparency to the balancing and backup costs required to deliver reliable power to consumers. Under most conditions, passing these costs through to consumer contracts will best create the incentives to manage variability efficiently; the extent to which this can be done in practice will depend upon the capacity of consumers and their suppliers to respond to time-varying prices and the separation of average from marginal costs, and can evolve over time. In conditions of overall excess generation from renewables and inflexible generators, renewable generators could be exposed to these signals in ways which directly reflect debates about possible adjustments to CfD contracts for conditions of high renewables output. The figures below outline how physical balancing and associated economic incentives and flows could operate.

Increasing renewables output relative to demand

Physical state	Physical flows	Economic flows (full-incentive model)*
Insufficient pool generation to meet pool demand	Pool imports from wholesale market	Additional costs passed through to consumers, applied to demand exceeding their 'proportionate' share of renewables generation
Sufficient pool generation to meet pool demand, so some surplus	Pool exports to wholesale market	If price of sales exceeds the pool (output-weighted) average strike price, pool is in financial surplus, savings passed through to consumers (higher marginal price, but appearing as a saving applied to demand below 'proportionate' share of renewables)
		If price of sales is below the pool (output-weighted) average strike price, pool is in financial deficit, cost differential passed through to consumers: in this case, consumers see a marginal price below the average cost of the renewables
Renewable and 'must run' generation in country exceeds national demand + exports	Pool exports to wholesale market at a 'floor price' and may constrain off some generation	Alongside above structure for consumers, generators would normally receive fixed price contract structures derived directly from existing CfD strike prices. To preserve the original financial terms and prevent a negative floor price, in such extreme conditions government underwriting could pay any renewables constrained off as 'deemed generation' .

**** This model would require sophisticated infrastructure for consumers to respond to a variety of pricing structures, and more complete attention to generation incentives under different conditions.***



GPP = Green Power Pool, GPP customers may be suppliers or direct consumers (e.g. industry).
Wholesale Ops = Wholesale operational market reference price.

[1] see text

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/

5. Along with supporting infrastructure, pursuing the energy transition will require new policy approaches and institutional structures to engage consumers across all energy uses, so as to enhance investment in energy efficiency, innovation, and electrification with flexibility.

Institutionally, a Green Power Pool would require either a government-backed body to design and implement demand-side contracts, or amending the operational terms of CfD-contract generators so that they were required to sell their electricity to designated special-purpose supplier windows indicated above, with regulation to ring-fence the electricity for the vulnerable groups identified.

Prioritised access to a Green Power Pool of CfD-derived cheap renewables could legitimately and sensibly include both support and potentially obligations with regard to end-use investments to improve efficiency and enhance flexibility. Thus we conclude that creating 'dual markets', which reflect the fundamentally different characteristics of renewables vs fossil fuels, is not only possible, but can be done in ways which could offer new possibilities for helping particularly sensitive consumers in business and households, with contract structures which preserve or enhance economic efficiency through transmission of balancing costs, and thereby may open new routes for responding to the energy crisis in ways which can accelerate the transition towards cleaner and secure electricity systems. The government or GPP implementing agency would have legitimate reason to engage directly, for example to enhance energy efficiency. Potentially, the government could help disadvantaged customers invest in improved efficiency, and/or capacity to respond flexibly to the incentive of facing the marginal prices when their consumption exceeds the output of renewables available.

Similarly, private PPAs would clearly place value on the flexibility of consumer demand, potentially offering them implied or actual discounts on contracts with customers who, for example, include end-use storage with the equipment to utilise it actively.

These would not be incidental gains: as widely noted, the future energy system will need efficiency and flexibility as electrification proceeds. It is thus entirely appropriate that market reforms adopted in the context of the energy crisis, but with an eye to the longer term, should both encourage and support consumer engagement – and thereby form the basis for transition that is demonstrably required, as we move from a system based on international commodity markets to more domestic – and now much cheaper – renewable energy assets.

---

[i] M. Grubb (2022a), 'Navigating the crises in European energy: Price Inflation, Marginal Cost Pricing, and principles for electricity market redesign in an era of low-carbon transition' - co-published as *INET Working Paper 191 (ineteconomics.org),* and *Working Paper #3 in UCL-ISR Series Navigating the Energy-Climate Crises,* at https://www.ucl.ac.uk/bartlett/sustainable/research-projects/2022/sep/reforming-electricity-markets-low-cost-and-low-carbon-power

[ii] This has some analogy to contract structures being developed in the EU for managing gas consumption, by allowing high (marginal) prices to be fed through only for gas demand exceeding threshold values.

UCL Institute for Sustainable Resources
Central House
14 Upper Woburn Place London WC1H 0NN

T+44 (0)20 7679 2000
https://www.ucl.ac.uk/bartlett/sustainable/