Bitcoin Policy
UNITED KINGDOM

Briefing Paper

UK Power Grid Demand Balance using Bitcoin Mining as a Demand-Side Flexible Response

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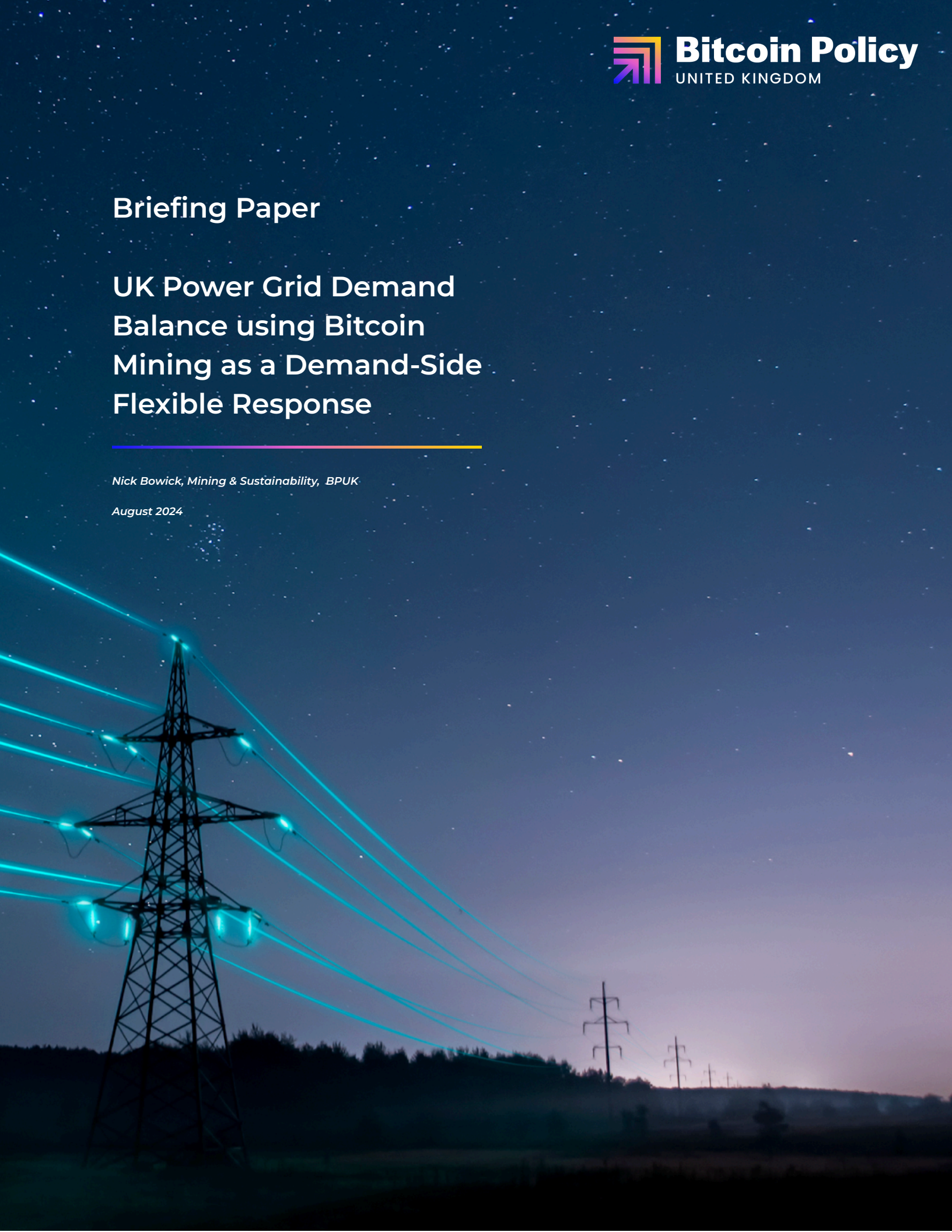


THE UK'S RENEWABLE ENERGY CHALLENGE

The UK Government released the British Energy Security Strategy in April 2022[1], detailing ambitious targets to deliver up to:

- 50 Gigawatts (GW) of offshore wind by 2030
- 70GW of solar energy by 2035
- 24GW of nuclear by 2050

The new Labour government have committed to expand and accelerate these plans as part of a wider ambition to transform the UK into a "clean energy superpower"[2].

As the UK seeks to decarbonise, National Grid and the newly launched GB Energy will need to adapt to an increasingly complex role in our nation's energy needs. The grid will not just need to distribute energy, but will need to **actively moderate changes in supply and demand**. The grid is facing:

- Increased gross electricity demand as fossil-intensive sectors like transport and domestic heating are electrified
- Increased intermittency in supply caused by a greater proportion of renewable power generation
- Integration of smart and dynamic incentive and control technologies

This briefing paper explores the challenges that the UK energy grid faces as we move to an energy mix more reliant on renewable energy. **And we see two clear problems, and one perfect solution that resolves both.**

PROBLEM #1 - HOW TO INCENTIVISE OVERBUILD

The first problem facing the delivery of the UK Energy Security Strategy is that the current model of privatised development clashes with the price cannibalisation that comes with the "overbuild" of renewables necessary to hit our ambitious targets.

To achieve a high net level of renewable power generation, the UK is building a capacity with a peak generation that will often exceed demand. We must "overbuild" renewables so that average generation approximately matches average demand. Early renewable projects could be assured of nearly 100% utilisation for their power generation as the fossil fuels would be throttled back as renewable supply rose. But this incentive model breaks down before we reach net zero. During days where renewable supply peaks above 100% of consumer demand, the market can no longer provide a buyer, and suppliers are left with stranded and therefore wasted energy. **As renewable generation rises, diminishing returns manifest.**

At a certain point, the green energy transition becomes a victim of its own success. Recent instances of failed wind farm licence auctions in the UK show that uncertainty in utilisation and revenue leads to a lack of confidence in renewable projects. Renewable energy producers understandably want assurance of a return upon their investment.

The "contract for difference" model allows the government to underwrite renewable projects with a guaranteed price for all energy (even paying them to stop generating during times of oversupply). As the supply of cheap renewables increases, so will payments under this scheme, which will paradoxically increase costs and diminish the financial advantage of renewables.

The UK has hit a roadblock. The next wave of renewable and nuclear energy is going to create a projected **72 Terawatt Hours (TWh) of annual oversupply by 2030**; there is a 50GW hole in the demand-side[3] which threatens the commercial viability of our energy strategy.

The private sector cannot organically meet our renewable energy targets; state intervention will be needed.

[1] HM Government - British Energy Security Strategy - April 2022
[2] Labour Party - Make Britain A Clean Energy Superpower - March 2024
[3] LCP.com - "British Energy Security Strategy: Homegrown clean power, but at what cost?" - R. Gogna & E Smith, 20 Apr 2022

PROBLEM #2 - HOW TO COPE WITH SUPPLY INTERMITTENCY

The second problem facing the UK Energy Security Strategy is the shift away from a supply-control grid where fossil-based generation could be throttled back and forth according to demand, to a supply-fluctuating grid where **uncontrollable and intermittent renewable energy does not mirror the demand**. How should we deal with large national fluctuations in supply, without power cuts or unprecedented price volatility? With less control for the supply-side inputs of the system, the strategy moves to how we can control elements of the demand-side through **demand side response**.

Demand side response (DSR) is a method of intelligently shifting demand for energy to better match supply. Methods currently being developed in the UK are:

1. **Industrial & Commercial DSR**
   Industrial and commercial DSR models offer financial incentives for large industrial and commercial consumers to move their demand away from peaks, or to remove it altogether. These consumers operate energy-intensive equipment like furnaces or cold storage facilities, and already have dynamic consumption metering and control equipment.
2. **Domestic DSR & Aggregators**
   Domestic DSR models are an emerging form of incentivised flexibility targeted at individual households and “aggregators”, which coordinate numerous small consumers. This will require many consumers to change the way they have historically consumed energy, and will often involve incentive payments.

Domestic DSR is technologically immature. Whilst promising pilot projects are underway, large-scale Domestic DSR requires a great deal of domestic infrastructure development, public engagement, participation and incentivisation.

Both DSR models have obvious merit in moving consumption of energy to times that better suit the National Grid’s supply. But they are inherently costly and are a weak lever of control for NG Electricity System Operator (ESO) , as **they can only influence consumer habits**, rather than directly setting demand.
Both Commercial and Domestic DSR face significant practical limitations and it is unclear whether they can provide the full 50GW of reliable flexibility required to meet our targets.

Instead, we propose a commercial DSR partner which solves both of the issues identified above, one which is mature, scaleable and **already in large-scale commercial use** in the USA and Scandinavia[4][5].

BITCOIN MINING AS THE SOLUTION

Contrary to early alarmist headlines, Bitcoin mining can reduce energy costs and accelerate the green energy transition when paired with renewables and used as an alternative DSR capability. This system-of-systems offers the following unique attributes[6]:

- **Unlimited demand** - they can be sized according to renewable supply to offer a buyer for all stranded energy, even in the most remote areas of the UK;
- **Flexible demand** - they can be dynamically throttled to match fluctuating supply;
- **Unlimited duration** - they will not saturate or run out like a battery.

Bitcoin mining operates with natural DSR-like behaviour because:

- **It is only viable to mine with the cheapest energy** - it will operate as a “buyer of last resort” and consume all cheap, waste energy when available, but will decline to compete with primary demand, and;
- **It operates like an inverse peaker plant**, halting its consumption of oversupply when primary demand appears[7];

[4] KPMG - Bitcoin’s role in the ESG imperative - B. Consolvo & KP Caron, Sept 2023
[5] S&P Global - “Bitcoin miners flocking to Texas want to stabilize ERCOT’s volatile renewables” - B. Mulder, 23 Feb 2023
[6] Social Science Research Network (SSRN) - Leveraging Bitcoin Miners as Flexible Load Resources for Power System Stability and Efficiency - Nic Carter et al. Nov 2023
[7] Bitcoin Policy Institute - How Bitcoin Mining’s Flexibility Reduces Carbon Emissions - M Paez, T Cross, 1 Aug 2024

- **It is interruptible** - the computers operate with millisecond response to DSR commands;
- Zero Scope 1 **greenhouse gas** (GHG) emissions;
- Zero UK Scope 2 GHG emissions;
- **It offers a sustainable funding model** - mining facilities can pay for themselves;

Bitcoin mining can contribute to UK GDP by converting up to 72TWh of wasted and stranded energy into a productive economic output with multiple revenue streams by:

- **Paying renewable generators** for the energy it consumes, increasing their margins;
- **Requiring zero government subsidies** - because it generates its own revenue through the mining of Bitcoin
- Increasing domestic economic activity at the local level via job creation - because bitcoin mining facilities can be sited specifically in support of the Strategic Spatial Energy Plan[8]

[8] HM Government - Strategy and policy statement for energy policy in Great Britain - 1 May 2024

ILLUSTRATION - MONETISING OVERBUILD

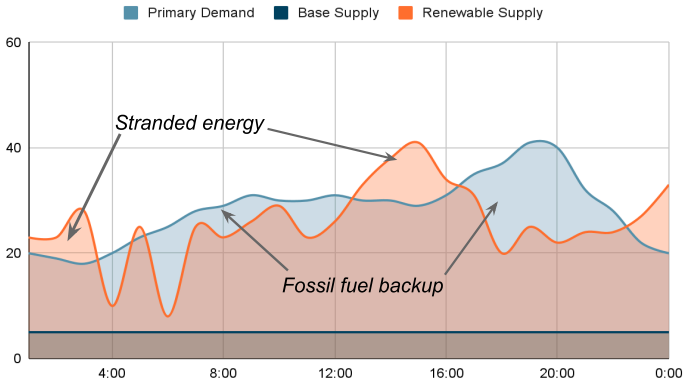


Figure 1: Supply & Demand - Status Quo

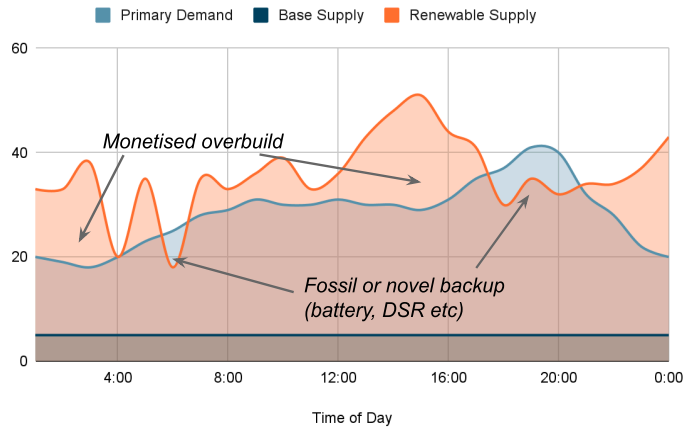


Figure 2: Supply & Demand - Monetised Overbuild

Figure 1 above shows an illustrative example of 24 hours of energy supply and demand. Note the periods of significant shortfall in renewable supply, for which carbon-intensive fossil fuels usually fill the gap. Note also the peaks of generation which are wasted, and deter further investment in renewables due to diminishing returns - **as more renewables are built, these periods of stranded energy will increase**.

Figure 2 shows an illustrative example of a successful "overbuild" of renewables, enabled by the monetisation of spare power generation. The significant amounts of spare energy **no longer result in lost revenue or taxpayer cost**. Note the shortfalls in generation, which will still exist, but are small enough to often be mitigated by novel low-carbon technologies like large-scale battery storage or emerging DSR strategies.

Bitcoin mining is the only technology which provides a **completely elastic demand** for spare renewable energy, setting a "floor" price and monetising supply that would otherwise be wasted or even curtailed at cost. Bitcoin mining solves the problem of the commercial viability of the UK's Energy Security Strategy targets, as renewable energy providers can be assured there is a buyer for all the energy they produce, and their projects will not suffer from lack of use. The unique attributes of domestic Bitcoin mining paired with the UK's renewable energy ambitions means it is the **only mature, scalable technology that can solve Problems #1 and #2 identified above**.

Bitcoin mining is the perfect technology to solve the issues we face in the viability of our energy ambitions, and it currently has zero large-scale penetration in the UK market. This is a **golden opportunity to monetise our renewable resources** and enable our green energy ambitions.

OWNERSHIP STRUCTURE

There are three ownership models for Bitcoin miners as a keystone to grid balancing:

1. **Private mining facilities** can be built via free market enterprise. The government can shape these facilities through passive regulation, with for example, grid access licensing rounds in conjunction with the energy auction rounds or rewarding local communities for hosting facilities through profit-share arrangements.
2. **National Grid owned mining facilities** - which would allow for the ESO to have in-house DSR capability at its fingertips, and would draw revenue (rather than costs) from its grid-balancing operations.
3. The creation of **GB Energy** could provide the opportunity for direct state investment in mining facilities, allowing it to set the floor price of energy and make anticipatory investments to enable renewables projects.

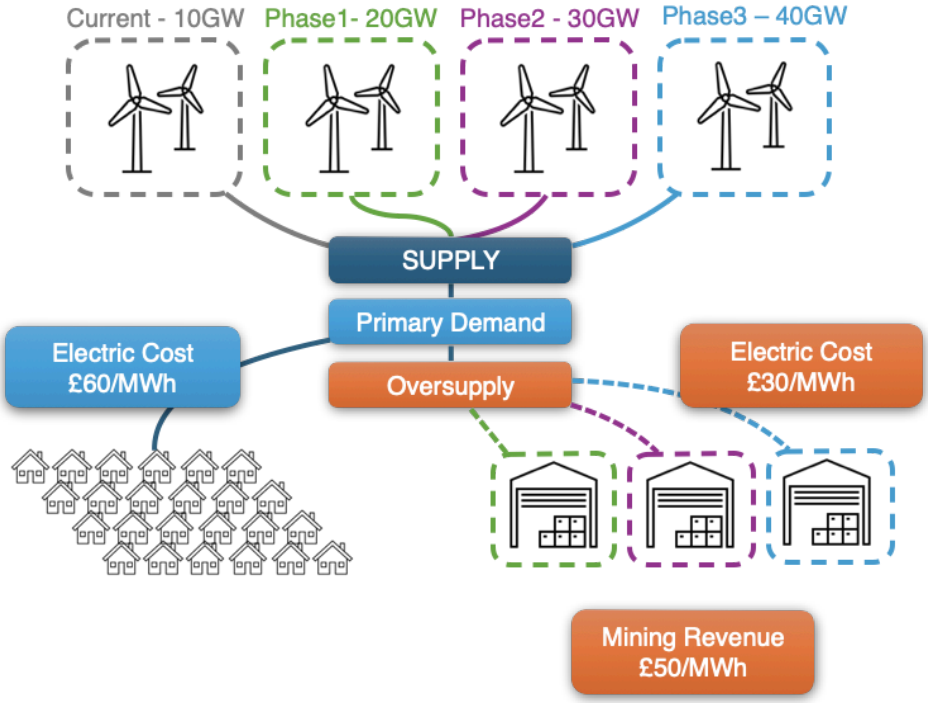
THE PATH TO CLEAN ENERGY

1

Stronger Business Cases
Integration of Bitcoin mining facilities with renewables projects will provide a “floor” price for their energy, strengthening the appeal of the next generation of licencing auctions.

2

Assured Revenues
Any oversupply can be consumed by Bitcoin mining facilities, 24/7, at a fixed or variable price. The UK’s Energy Strategy no longer suffers from diminishing returns.



3

Grid Resilience
Floor pricing creates an automatic DSR behaviour in miners, who will relinquish energy to core users as soon as demand appears. Full Commercial DSR capability can be provided to NG ESO

4

More Green Energy
Increased monetisation of renewable energy improves viability and commercial appeal of renewable projects. The UK’s electricity supply becomes greener and more affordable.

CONSUMER BENEFITS

The ultimate beneficiaries of this proposal would be **consumers**, through direct and indirect means:

- By unlocking the commercial feasibility of the “overbuild” of renewables, Bitcoin mining will be the catalyst for **more cheap, green energy** in the UK.
- Monetising stranded energy reduces the net unit cost of renewable energy, resulting in **lower household bills**, improved profitability for suppliers and increased competitiveness versus fossil fuels.
- The ambitious targets of the UK government’s energy strategy can be enabled via free market incentives with **no taxpayer subsidies** necessary.
- The revenue from mining itself could **generate up to ~£2bn** per annum.