The Role of Standards & AI in enabling integrated UK Smart Energy Systems

Smart Energy: A Digital Transformation for policymakers

Figure 1. Source: AI Microsoft Copilot

Introduction

Digital technologies are fuelling the transition from fossil fuels to more sustainable forms of energy. This paper considers the application of digital technologies and data analytics to optimise energy use, production, and management in the UK. It highlights how the Internet of Things (IoT) sensors, standardised communication protocols, and artificial intelligence (AI) are being used to create intelligent energy ecosystems. The potential benefits for consumers are greater control over their energy usage leading to cost savings and a greener future.

Underpinning this transformation are a class of inventions called Standard Essential Patents. (SEPs) The paper considers how fair and free access to these technology building blocks is vital to keep innovation in the sector flourishing.

Smart Energy in the UK

In 2021 the UK Government produced an ambitious plan for the period to 2050 entitled "Digitising our energy system for Net Zero[1]". This incorporated a Smart Systems and Flexibility plan. This plan laid out in detail the policy initiatives necessary to achieve the goal.

[1] https://www.gov.uk/government/publications/digitalising-our-energy-system-for-net-zero-strategy-and-action-plan

Production of the plan featured close cooperation between 4 government departments: Department for Energy Security and Net Zero[2], Ofgem[3], Innovate UK[4] and Department for Science, Innovation and Technology[5](DSIT). A key component of the plan is the adoption of new technologies and the incorporation of data analytics in the governance of next gen systems.

This extract from the plan demonstrates how Smart Energy Technology appliances play an important role in supporting the planned Net Zero by 2050 goals. *"We will take powers, when parliamentary time allows, to regulate energy smart appliances, to set requirements underpinned by the principles of interoperability, data privacy, grid stability and cyber security. We will ensure that our approach is compatible with wider government regulation of consumer connected products"*[6].

This year an update was issued.[7] The UK registered the one millionth electric vehicle, heat pump applications increased by 50% and the share of electricity coming from renewables has risen from 7% in 2010 to almost 50 %. Following on from the election of a new Labour Government, DSIT issued a press release noting that it was expanding in scope and size. "*..bringing experts in data, digital and AI from the Government Digital Service (GDS), the Central Digital and Data Office (CDDO) and the Incubator for AI (i.AI) to unite efforts in the digital transformation of public services under one department."* [8]

Government policy to date has supported growth in the Smart Energy Sector. The UK Solar Power Market[9] size in terms of installed base is expected to grow from 18.53 gigawatt in 2024 to 53.12 gigawatt by 2029, at a CAGR of 23.53% during the forecast period (2024-2029).

The energy companies are responding to the growth challenge. In the UK Octopus Energy[10] , a renewable energy group specialising in sustainable energy, has introduced Agile tariffs for EV, solar panel and battery owners. This provides householders with cheap renewable energy from 00:30 to 05:30am.

To complement the innovations taking place at the household, a revolution is taking place in the overall structure of electricity networks. These networks are having to adjust from their traditional monitoring and control approaches to a sensing, control and data collection structure using AI. The figure below from UK Power Networks[11] shows the, old world versus new world, structural transition underway in UK energy distribution and consumption.

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[2] https://www.gov.uk/government/organisations/department-for-energy-security-and-net-zero
[3] https://www.ofgem.gov.uk
[4] https://www.ukri.org/councils/innovate-uk/
[5] https://www.gov.uk/government/organisations/department-for-science-innovation-and-technology
[6] https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021
[7] https://www.gov.uk/government/news/energy-secretary-takes-action-to-reinforce-uk-energy-supply
[8] https://www.gov.uk/government/news/dsit-bolstered-to-better-serve-the-british-public-through-science-and-technology
[9] https://www.mordorintelligence.com/industry-reports/united-kingdom-solar-power-market-industry
[10] https://octopus.energy/smart/agile/
[11] https://dso.ukpowernetworks.co.uk/smart-grid-index

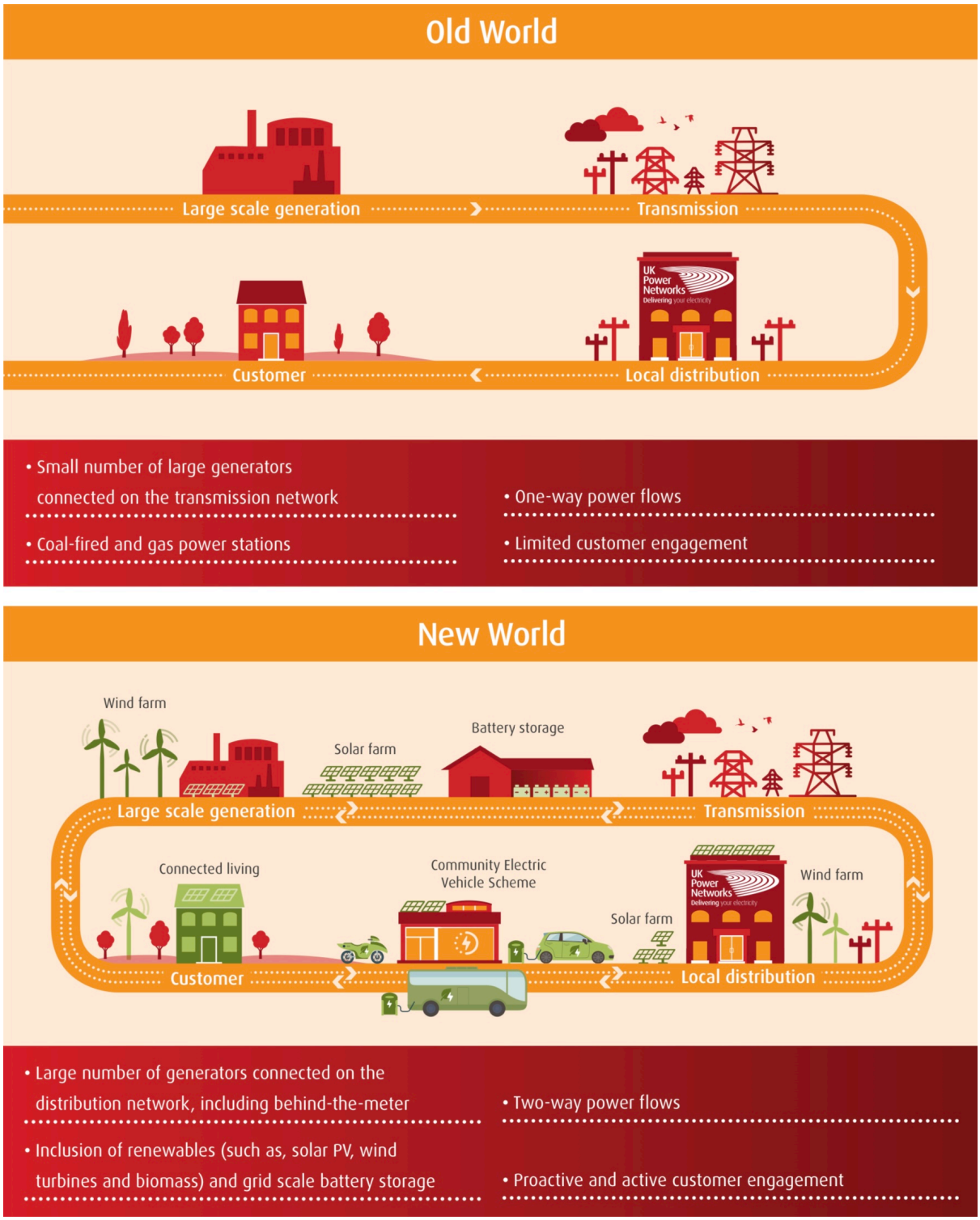

Figure 2. Source: UK Power Networks

The Role of AI in Smart Energy

AI is increasingly playing a role in developing the sector. Increased processing power combined with the growth of smart IoT sensors, that have the ability to monitor energy usage, generation and distribution, is providing businesses in the UK with new ways to reduce their energy consumption. The company Invisible Systems[12] worked with the popular UK bakery chain Greggs to serve up a 5% saving to their annual energy costs. They use sensors to provide a wealth of data which is fed into AI based data analytics systems. The insights gained help their customers make better informed decisions, driving energy efficiency improvements.

Likewise, in the power distribution sector AI based energy applications use machine learning, harvest data from IoT network nodes, all with the goal of increasing the efficiency, stability and resilience of the distribution networks.

One example of how this works in practise is the ongoing work[13] to reduce lost electricity (network transmission losses) which were estimated to be in the UK in 2022, to be 25 Terawatt Hours, 8 percent of the total electricity supplied. (that's enough power to heat 10 million UK homes for a year). These savings are being enacted by analysing data gathered from new nodes inserted into the network. These nodes transmit data to the cloud, this data is analysed by AI machines and provide real time monitoring information to the network controllers. This information can then be used to create self-healing grids.

By analysing real-time grid data, AI can identify and automatically reroute power around disruptions, minimising the impact of outages on consumers. Overall, AI has the potential to significantly improve the efficiency, reliability, and resilience of the UK's energy grid.

Predictive maintenance is another area where AI can be beneficial. By analysing sensor data from transformers, power lines, and other grid components, AI can predict potential equipment failures. This enables proactive maintenance, preventing outages and improving grid reliability.

In essence, by analysing vast amounts of data from smart meters, sensors, and weather monitoring instruments, AI can intelligently control energy generation, storage, and distribution. This allows for optimised grid efficiency and minimised power loss. This helps reduce stress on the grid and potentially lowers electricity costs for consumers.

[12] https://www.invisible-systems.com/monitoring-sensors-blog/the-future-of-energy
[13] https://www.verdict.co.uk/lost-in-transmission-how-cloud-is-combatting-high-line-loss-and-poor-reliability-in-power/

8 Power-Innovation in Smart Energy

As noted previously, one the areas of rapid growth in this sector is the use of connected IoT sensors to provide real time monitoring of electrical and mechanical equipment. One company innovating in this space is 8Power, based in Cambridge in the UK. They make a range of wireless low power IoT sensors.

Innovations like these 8Power sensors (*Figure 6*) are revolutionising predictive maintenance in critical infrastructure. These tiny devices harness vibrations from machinery to generate their own power, enabling real-time monitoring for up to a decade without battery changes. AI analysis of the transmitted sensor data can result insignificant cost savings and improved reliability for operators of electrical and mechanical equipment

This type of innovation is being used in the water industry where the water pumps are driven by electrical motors. As the motors age, they start to consume more electrical energy due to mechanical wear and tear. The smart vibration sensors continually monitor the operation of the motors. This data is then transmitted to the cloud for analysis. The sensors use a variety of communication standards. A variant of the Bluetooth standard, Bluetooth 5[14] uses a long range low power mode called Coded Phy. Reducing bandwidth down to 125kbps increases range to over 1km. Additionally 4G and NFC standards are incorporated in the modules.

NFC[15] works with an app and is designed to make installation at the remote location easier. AI systems analyse the transmitted data and send the resulting parsed information back to the operational centre. The information highlights locations of concern. This real-time data allows for preventive maintenance, reducing energy consumption and ensuring a reliable water supply for consumers.

Figure 3. Source: 8Power Energy Harvesting Sensor

In the UK, a typical large water company can have up to 1200 clean water sites ranging from

[14] https://www.nordicsemi.com/Products/Wireless/Bluetooth-Low-Energy/Bluetooth-5
[15] http://nearfieldcommunication.org/technology.html

simple two pump installations up to large multimillion pound reservoir treatment works. The clean water sites can total 30,000 machinery assets that are mechanical and may fail at any point in time. Failure in can be catastrophic, resulting in sewage polluting waterways with the ensuing damage to the environment. The results that 8Power have seen at small scale in their water treatment plants have been encouraging. In one recent example their IoT sensors/AI system picked up a problem in a major pumping station which allowed them to quickly perform preventative maintenance.

If the fault had been allowed to fester for another few days it would have suffered failure with the resulting environmental damage and a repair bill in excess of £250K. Having sensors in place saved money and priceless reputational damage.

Figure 4. Source:8Power Hydroelectric Pump.

By combining new sensor technology, wireless communication, and AI-based maintenance,

the industry can achieve significant reductions in operational costs, prevent costly emergencies, and guarantee a more stable and reliable utility supply.

Consumer Benefits derived from Smart Energy

The integration of these components together with new digital applications will herald a new age of energy supply. This new age places the consumer at the centre of the network and makes available a number of benefits designed to reduce costs and simplify day to day living.

The integration of solar, battery and EV at the household level opens up the possibility of new business models, e.g. buying excess energy from your neighbour, selling your energy back to your Distribution System Operator (DSO). For this to happen will require new regulation and for the implementation new, interoperable, technical standards.

A number of smart energy systems are already being installed in UK households, the most common being Nest[16] and Hive[17] . A large number of small companies are responding to the growth for solar and battery installations taking advantage of the government incentives on offer. Smart systems can be programmed to learn household preferences and adjust settings for heating, cooling and lighting, optimising comfort and efficiency.

Beyond convenience, smart energy can also save money. Dynamic pricing plans, such as those from Octopus previously mentioned, allow households to take advantage of lower electricity rates during off-peak hours. Peer-to-peer energy trading systems of the future will allow consumers to buy excess solar energy from neighbours or sell energy back to the grid. Smart appliances can also automatically adjust energy use based on a variety of parameters. E.g. off-peak usage, household occupation, hours of daylight, forecasted weather, making smart choices, lowering electricity bills.

Overall, smart energy innovations have the potential to empower consumers with greater control and transparency over their energy use. This can translate to potential cost savings, a more sustainable future, and a more comfortable and convenient home environment.

Innovation, Politics, Standards and Regulation-a cause for concern?

Smart Energy is a policy area that lends itself to political innovation. The bright, bold new future of smart energy is causing a number of stars to align in the political and regulatory firmament. In 2019 the UK became the first major economy to pass into law a domestic requirement for net zero greenhouse gas emissions by 2050. To oversee this transition the Climate Change Committee[18] was set up as an independent, statutory body established under the Climate Change Act 2008.

Many of these changes are underpinned by the application of innovative new technologies protected by patents. Patents are a type of intellectual property right that protects technical inventions. In other words, it gives the inventor or owner exclusive rights to the invention for a certain amount of time. This encourages people to invest in research and development because they know they will be able to profit from their creations.

[16] https://nest.com/energy-solutions/
[17] https://www.hiveenergy.co.uk
[18] https://www.theccc.org.uk/what-is-climate-change/a-legal-duty-to-act/

The role of Standards in Smart Energy

The flow of data from the IoT energy sensors in the AI processing engines in the Cloud requires wireless communication. For these technology solutions to be deployed in different territories and across multiple use cases, ranging from the smart home to the electricity grid, interoperable wireless and video standards are required. These standards are built using special class of Patents called Standard Essential Patents (SEPs). In the UK, the Intellectual Property Office[19] (IPO) is the body responsible for intellectual property (IP) rights including the governance of the patents that form the building blocks to Smart Energy Technologies.

It's not just the fast expanding area of smart homes that is using SEPs. More tradition sectors of the electricity supply industry, such as the National Grid, are open to new ideas and new SEP based inventions. A study the Iplytics Group[20] highlights how the number of patents mentioning smart grid has been steadily rising over the years.

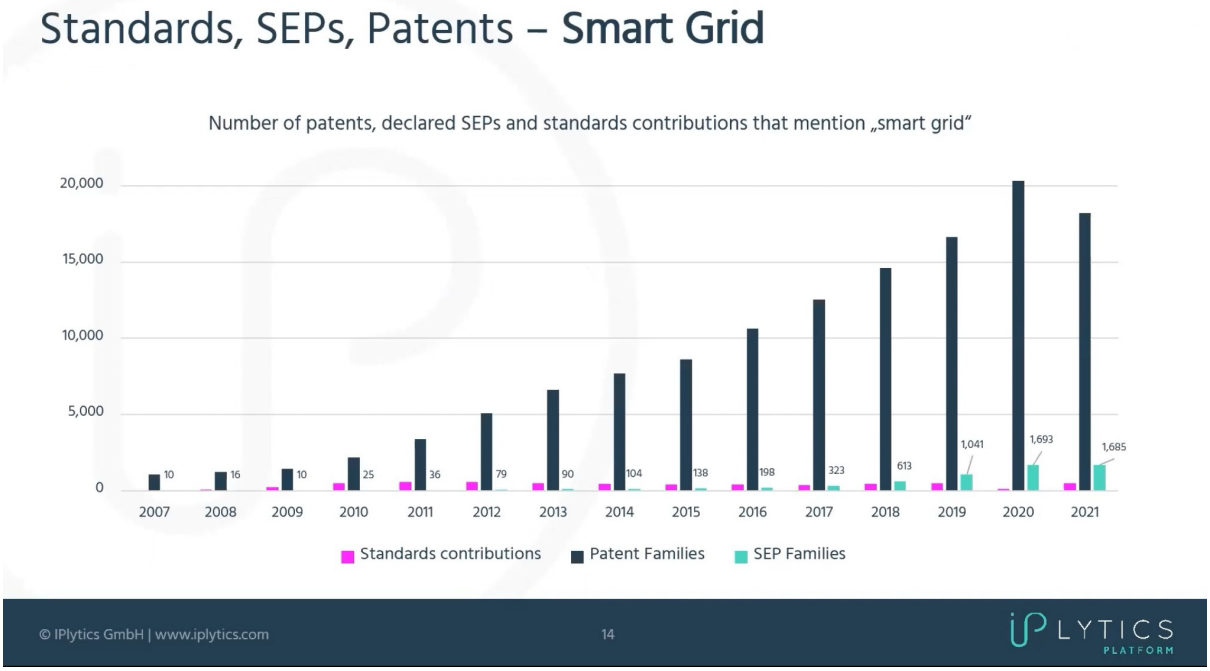

Figure 5. Source: iPlytics Gmbh

As noted above SEPs are patents that are necessary for a certain technology to work in an interoperable manner. For example, many of the patents used in mobile phone networks are SEPs.
Many basic technologies used in cell phone networks (like 2G, 3G, 4G, and 5G) are protected by patents. In the past, only large tech companies used SEPs. But now, smaller companies in many industries, like energy, manufacturing, health and farming, are also using these technologies. This means it's important to make sure SEP licensing is fair for these growing industries in Europe.
While big companies still license SEPs to each other, there are more companies now that only make SEP-based products (without owning the patents) or only own SEPs to license (without making products).
The problem is that innovators, small and medium sized businesses (SMEs) and start-ups in the smart energy sector lack awareness of the patents behind the IoT technologies they are

[19] https://www.gov.uk/government/organisations/intellectual-property-office
[20] https://www.lexisnexisip.com/solutions/ip-analytics-and-intelligence/iplytics/

using. In most cases, they are unaware that they are using technologies that are patented and the patent owner has the right to charge a royalty fee on top of the cost of the component they are using.
The Diagram below graphically displays the nub of the issue, SEP usage comes with baggage. that baggage is in the form of potential litigation.

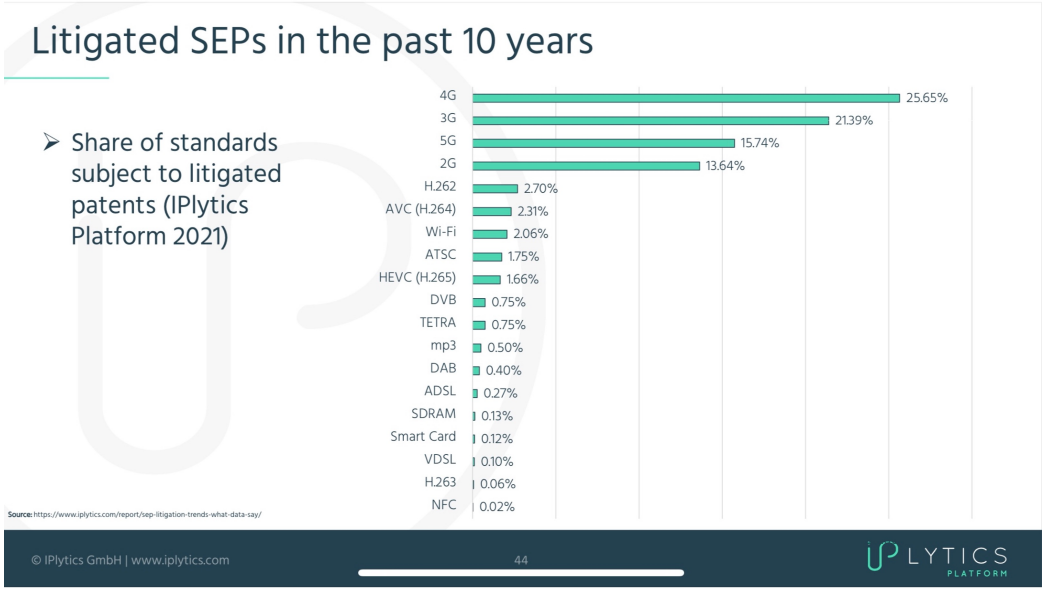

Figure 6. Source: iPlytics Gmbh

SEPs underpin Open Standards, the Open Standard making process is inclusive, collaborative, consensus driven, vendor-neutral and most importantly transparent. The SEP licensing system on the other hand is opaque.

This lack of transparency is one of the factors that has led to the UK IPO to take action to improve the situation.

The balance between the interests of those who hold the patents and those who want to use them is broken. The fair, reasonable and non-discriminatory (FRAND) terms have become unfair, unreasonable and discriminatory against the companies that want to use the patents. Small and medium sized businesses and start-ups struggle to afford legal and technical advice and so suffer from the high costs and legal uncertainty caused by this situation.

A few abusive SEP holders are intent on extracting supra-FRAND terms. This posturing is being reinforced with the threat of expensive litigation and ultimately the application of injunctions.

UK Courts and SEPs

An increased number lawsuits are occuring around the world over SEPs. Courts in many countries are taking on these cases, and the UK courts are becoming especially good at handling them. Because of this expertise, the UK court system is a valuable source of legal rulings (case law) on SEPs.

Recent UK Court cases involving SEP litigation are throwing a spotlight on issues impacting SMEs and companies licensing smaller volumes of patents. In the recent Interdigital[21] versus Lenovo[2223] case Mr. Justice Mellor called out for more transparency from SEP holders.

He stated in paragraph:200 of his judgement:

"the SEP universe would be able to converge on and agree FRAND terms very much more quickly if the basics of each SEP licence were made public (by 'basics' I mean the number of units covered, the royalty rates or total sum paid/payable and which standards are involved)."

In paragraph:499 he took up the topic of volume discounts which Interdigital applied to large customers and highlighted the plight of smaller licensees.

"most importantly of all, the sizes of the volume discounts said to be used by InterDigital plainly discriminate against smaller licensees, which is exactly what FRAND is supposed to avoid."

The UK Court also decided to reject InterDigital's request for an injunction against Lenovo. This decision is worthy of note because it sends a clear message that hawkish SEP holders cannot use the threat of injunctions to extract excessive licensing fees.

UK Regulation-current status.

The UK Intellectual Property Office (IPO) is actively addressing the rise in SEP disputes and their potential impact on UK innovation, particularly for smaller businesses. Following a public consultation in 2023, the IPO issued a forward-looking plan[24] to improve the SEP licensing landscape. The key components of this plan are to enhance transparency, support the SME community and improve dispute resolution.

While the IPO has so far opted against legislative changes, specifically regarding injunctions by SEP holders, they remain committed to policy development based on stakeholder feedback.

[21] https://www.interdigital.com
[22] https://www.lenovo.com/gb/en/
[23] Interdigital vs Lenovo [[2023] EWHC 1578 (Pat)
[24] https://www.gov.uk/government/publications/standard-essential-patents-2024-forward-look

Conclusion

The analysis of the market potential for Smart Energy in the UK paints a promising picture of substantial growth in the coming years. 2024 was National Election year in the UK and manifesto pledges concerning energy transition played a central role in the debate [25] .The election resulted in a win for the Labour party and at the time of writing they are moving to enact their policy pledges including the formation of GB Energy[26]. A policy statement on onshore wind[27] was released, this commits to doubling onshore wind energy by 2030. The Energy Secretary, Ed Milliband , set out his priorities in this statement[28].

The National Grid/ Electricity System Operator (ESO) has produced a beyond 2030 report[29] and is calling for investment into a proposed a £58bn network upgrade plan.

What is clear is that the application of Smart Energy Technologies using AI will play a crucial role in supporting these initiatives.

At the core of this transition lies the power of data collected from Internet of Things (IoT) devices in homes, buildings and across the electricity network. This data is transmitted via a digital network to the cloud for processing and analysis, generating valuable insights that can be relayed back to DSOs to optimise operations. The standardised technologies underpinning these broadband and narrowband data pipelines are the result of contributions from numerous companies around the globe.

The Government/IPO have a significant role to play in ensuring a legal and regulatory framework that supports the continued growth of Smart Energy. A key aspect of this is ensuring that the technology bricks and mortar that the systems are built upon are legally fit for purpose.

Policymakers must take action to curb excessive, gatekeeping, licensing practices by a small number of bad actors when it comes to SEPs. Properly regulated SEPs are essential to

[25] https://www.nortonrosefulbright.com/en-gb/knowledge/publications/88cda3a0/party-manifestos-energy-transition-to-play-a-central-role-in-uk-election
[26] https://labour.org.uk/change/make-britain-a-clean-energy-superpower/
[27] https://www.gov.uk/government/publications/policy-statement-on-onshore-wind/policy-statement-on-onshore-wind
[28] https://www.gov.uk/government/news/energy-secretary-ed-miliband-sets-out-his-priorities-for-the-department
[29] https://www.nationalgrideso.com/

unlocking the full potential of UK Smart Energy by providing SMEs with unfettered access to the essential technological building blocks at a fair price.

Figure 7. Source : AI Microsoft Copilot

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