HSBC Global Research

Disruptive Technology

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Disruption Bytes

Building SMRs, space race launches, and quantum progress

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- **SMRs:** Powering data centres and more…are SMR projects "too expensive, too slow and too risky"?
- **LEOs:** Have we just witnessed a gamechanger in the LEOs sector? What can we expect next in the race for space?
- **Quantum:** Prioritising quality over quantity, the path to universal fault tolerant QCs and new partnerships

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In this update, we look at some recent developments within HSBC's Disruptive Technology theme and any potential implications investors should note.

SMRs: A new report has questioned the feasibility of small modular reactors, suggesting they are "too expensive, too slow and too risky". It cites numerous examples around the world for which project costs have spiralled and timelines have been pushed back. Despite this, SMR companies plan to roll out hundreds of SMRs around the world and more governments are signing up to bring them to their countries. We explore whether SMRs are feasible and could be part of powering data centres.

LEOs: A new rocket has entered the space race as it completed its first successful sea landing having spent 65 minutes navigating the Earth's atmosphere. It has taken a little over a year to go from exploding four minutes into launch to a successful soft landing. And there are plans to carry human payloads as soon as 2026, which would take place only after hundreds more test flights. To achieve this rate of testing over the next two years, vast manufacturing facilities are opening to accommodate mass manufacturing of the new rocket. We also look at how LEO connectivity is now portable.

Quantum: A major US tech company has partnered with the Japanese National Institute of Advanced Industrial Science and Technology to build a 10,000 qubit quantum computer (QC) by 2029. This comes after the tech company decided to take a quality over quantity approach to QC building by focusing on error corrections and gate operations over the number of qubits. Meanwhile a new 56 qubit trapped-ion QC has entered the market and has already achieved a 100x improvement on the infamous 2019 Google claims of quantum supremacy. And a quantum partnership has yielded results in developing logical qubits using physical qubits with big impacts on circuit error rates.

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Building SMRs

Are SMRs a way to meet data centre power demand?

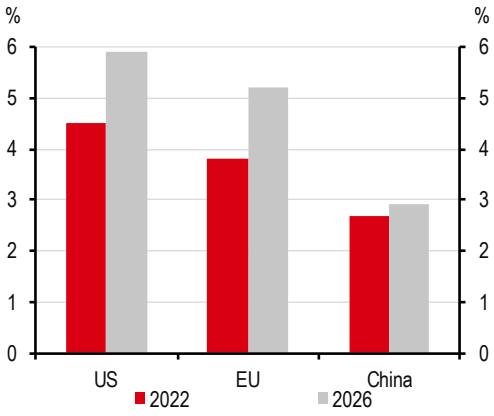
Data centres could account for 6% of all US electricity demand by 2026

As we highlighted in our 30 April 2024 Disruption Bytes report, data centres in the US accounted for c4.5% of total US electricity demand, which could grow to 5.9% by 2026, according to the IEA (International Energy Agency). Data centres in the EU account for 3.8% of total EU electricity demand, which could rise to over 5% by 2026, according to the IEA.

Smaller economies could see up to a third of their electricity go to data centres

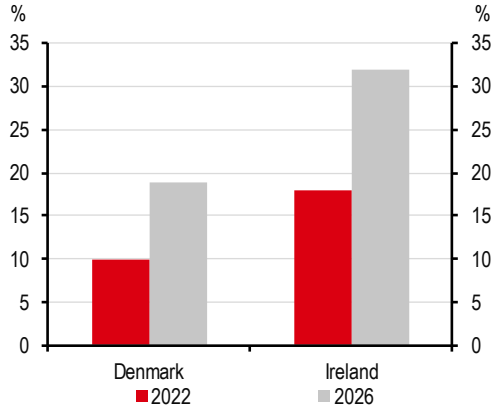
The potential rise in data centres' share of total electricity demand in Denmark and Ireland is even more stark. For instance, data centres in Ireland currently make up 18% of Ireland's total electricity demand (up from just 5% in 2015 and 11% in 2020), which could rise to 32% by 2026, according to the IEA. Meanwhile, in Denmark data centres could consume just shy of 20% of total electricity demand by 2026 (up from c.10% in 2022), according to the IEA. One might question how nations could plug the gap.

Data centre share of total electricity demand in major economies…



Source: IEA

…the uptick in demand heightened more in economies like Denmark and Ireland



Source: IEA

How feasible are SMRs?

SMR projects have a habit of cost and timeline overruns

In May 2024, the IEEFA (Institute for Energy Economics and Financial Analysis) released a report assessing the feasibility of SMRs to meet growing energy demands. The report looks at currently operating small modular reactors (SMRs) in China and Russia, claiming that both cost significantly more than initially projected and that additional SMRs under construction in both countries are years behind schedule. We highlighted previously that the SMR project the Utah Associated Municipal Power Systems in the US was working on was cancelled following soaring costs and insufficient interest in purchasing electricity from the facility. The report concluded that SMRs will be "too expensive, too slow and too risky" to help in the transition away from fossil fuels[1].

However, these SMRs are first-of-a-kind projects and volume can help reduce costs

However, it should be remembered that these contemporary SMRs are first of a kind-type projects and that according to Nuclear Engineering International, Russia is now building several SMRs in an almost series production, having made upgrades from its previous experience. China also intends on making its designs the basis for a significant exports sector. Despite cost overruns and delays to projects around the world, SMR companies remain confident that they can build SMRs within 3–4 years and have them online ahead of 2030[2].

Hundreds of GW of nuclear will be required by 2050 – good news for SMRs?

Moreover, the US government has committed to tripling its nuclear capacity by 2050 which translates to an additional c200GW[3] and the US Energy Secretary has said that "whether it happens through SMRs, or AP1000s (Westinghouse's nuclear power plant design), or maybe another design worthy of consideration, we want to see nuclear built"[4].

> **"The challenge lies not in the technical feasibility of the design, but in designing for factory production and providing a robust quality management system that generates trust and confidence among the supply chain, regulatory authorities, and the general public.**
>
> **Royal Society of Open Science, Patterson and Taylor**

SMRs can power data centres directly but could also supply electricity to the wider grid

As discussed in one of our recent expert events, SMRs could help to power data centres directly and add power to the grid more broadly. Both will be important because not all data centres will opt to be directly powered via SMRs and will still run off the grid, which will require an increased level of demand for electricity, which SMRs can help to plug. For instance, SMR company signed an agreement in March 2023 with Tennessee Valley Authority, Ontario Power Generation, and Synthos Green Energy to deploy some of their SMRs around the world including in Canada, the US, and Poland to supply clean energy to the grid and bolster energy security.

Experts believe SMRs could play a sizeable role in tech for energy transition

A recent Bloomberg[5] article highlighted a report by Liverpool University professors that reviewed the impact of building SMR/MMR (Micro Modular Reactors) factories in the UK that would manufacture, operate, remove, and recycle the reactors. According to the report, one such factory could replace 33% of current fossil fuel electricity generation over 15 years and four factories could enable a fossil fuel-free electricity system within 12 years[6]. However, it is also important to remember that the Hinkley Point C reactor plant is over ten years delayed and is likely to end up costing over GBP34bn, in large part because of the over 7,000 design changes the UK regulators required[7]. The UK government's Energy Security Strategy plans for 24GW of additional nuclear power by 2050 (i.e. c25% of projected UK electricity demand).

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[1] Small Modular Reactors: Still too expensive, too slow and too risky, IEEFA, 28 May 2024
[2] IEEFA report critiques feasibility of small modular reactors, Nuclear Engineering International, 4 June 2024
[3] Remarks as Delivered by Secretary Jennifer M. Granholm on Startup of Vogtle Unit 4 and Growth of U.S. Nuclear Industry, Energy.Gov, 31 May 2024
[4] As nuclear power flails in the U.S., White House bets big on a revival, The Washington Post, 5 June 2024
[5] Can Small Nukes Power a Greener UK Future?, Bloomberg, 12 June 2024
[6] The commoditization of civil nuclear power, Royal Society Open Science, 22 May 2024
[7] Can Small Nukes Power a Greener UK Future?, Bloomberg, 12 June 2024

What are the regulatory and political obstacles?

International regulators are harmonising standards to accelerate approval

According to The Financial Times[8] (April 2024), a major SMR company expects the UK regulatory process for SMR design approval to take 4.5 years and longer in other countries. The International Atomic Energy Agency (IAEA) has made strides into harmonising standards, having launched the Nuclear Harmonisation and Standardisation Initiative in 2022 to facilitate the deployment of SMRs[9].

> **For this business model to succeed, we need regulatory approaches to adapt to a new circumstance. We cannot afford the luxury of these regulatory marathons lasting five, six, seven years**
>
> **Rafael Grossi, Director-General of the IAEA**

Dozens of countries have committed to help triple nuclear energy by 2050 – another positive for SMRs…?

As background, it's interesting to note that the IEA forecasts that nuclear power capacity will need to more than double by 2050 to meet net zero targets, and at COP28 in 2023, 24 countries signed a declaration with the goal of tripling global nuclear capacity by 2050 including France, Japan, UK, and US[10]. In March 2024, it was announced that the Canadian, UK, and US nuclear regulators were expanding cooperation on technical reviews of advanced and small modular reactor technologies[11]. Moreover, in June 2022 it was announced that the EDF NUWARD SMR was being used as a case study for a joint European regulatory review led by the French nuclear regulator alongside the Czech and Finnish authorities[12].

Starship to change space

Return to Earth

SpaceX hit its fourth Starship launch and has reached return-to-earth status

In June 2024, the SpaceX Starship rocket returned to Earth for the first time having completed its fourth launch. This was a "soft" landing at sea, after 65 minutes, with the Super Heavy booster landing in the Gulf of Mexico and the Starship rocket landing in the Indian Ocean. Could this be a boon for LEOs, as a leapfrog connectivity for unconnected parts of the world? The Starship's increased payload capacity will allow SpaceX to carry up to 400 satellites per launch compared with around 60 that the Falcon 9 rocket can carry today[13], according to SpaceX's President and COO[14].

What's next for Starship?

SpaceX is building a new facility dedicated to manufacturing Starship

SpaceX is building a new manufacturing facility – Starfactory – in Texas, and the company has a goal of producing one Starship rocket every day. According to SpaceX's Manufacturing Engineering Manager, SpaceX already has a number of Super Heavy boosters and Starship rockets undergoing launch testing ready for future launches and more coming off the production line. SpaceX is adding several hundred thousand square feet of extra space to its production capacity which will be ready in summer 2024. The latest Starship model has been designed specifically to make it easier to mass manufacture[15].

At the fifth launch of Starship, SpaceX will unveil its Super Heavy "catching" tech

At the fifth Starship launch, SpaceX will look to debut its "catch" strategy to recover the Super Heavy booster after detachment from the Starship rocket; this is done using robotic arms built into the launch tower. The company is aiming to conduct this experimental technology at the next launch in late July 2024. The launch tower began construction in 2021 in Texas and is

[8] Next-generation nuclear developers battle with 'regulatory marathons', Financial Times, 25 April 2024
[9] IAEA Advances Efforts to Standardize SMR Deployment, Devdiscourse, 12 June 2024
[10] COP28 agreement recognises nuclear's role, WNN, 13 December 2023
[11] U.S., Canadian and U.K. Nuclear Regulators to Expand Cooperation on Technical Reviews of Advanced and Small Modular Reactor Technologies, NRC, 13 March 2024
[12] NUWARD and EDF are proud to start the second phase of the Joint Early Review of the NUWARD SMR design with an extended group of European nuclear safety authorities, EDF, 19 December 2023
[13] SpaceX: Both Falcon 9 and Starship Will Deploy Second-Gen Starlink Satellites, PC Magazine, 22 August 2022
[14] SpaceX adding capabilities to Starlink internet satellites, plans to launch them with Starship, CNBC, 19 August 2021
[15] SpaceX wants to build 1 Starship megarocket a day with new Starfactory, Space.com, 8 June 2024

480ft high, making it the tallest launch tower globally. Once the Super Heavy disengages in-flight, it will reignite its engines to slow down and the tower's arms will "catch" it and re-stack it ahead of the next flight[16].

Satellites require a good ground game

Starlink has launched its new antenna – the Starlink Mini which is about the size of a laptop and is designed to be portable

In June 2024 SpaceX revealed its latest Starlink satellite internet antenna – the Starlink Mini – which provides internet service via a portable kit that can fit in a backpack. The Starlink Mini weighs 1.1kg, include a built-in Wi-Fi router, and is about 12x10x1.5 inches (i.e. the size of a laptop), offering users download rates of between 50-100 Mbps, which is a slightly lower from the 150-250Mbps of the standard Starlink antenna[17]. This will initially provide connectivity anywhere in the US, making the most of SpaceX's >6,000 satellite constellation which now provides connectivity to over three million customers in over 100 countries[18].

Quantum advances

Could 10,000 qubits be achieved by 2029?

IBM is partnering to build a 10,000 qubit quantum computer by 2029

In June 2024, IBM announced it is partnering with the Japanese National Institute of Advanced Industrial Science and Technology (AIST) with the aim of developing a 10,000 qubit quantum computer (QC) by 2029. The partnership will also cover the development of the semiconductors and superconducting integrating circuits required to build QCs[19]. The aim is to have the QC running without a traditional supercomputer supporting it; today's QCs often have supercomputers running as backup to check the work of error prone QCs[20].

Is IBM able to reach that and prioritise error correction and gate operations?

In December 2023, IBM released a 1,121 qubit chip (called Condor). However, IBM has said it will now focus on QC error-resistance rather than qubit count. Turning attention to the Heron chip with 133 qubits but a record-low error rate 3x lower than any of IBM's previous quantum processors[21]. In December 2023, IBM also adjusted its Quantum Roadmap extending it to 2033 and beyond with a target of a 2,000 qubit commercial system by 2033, which makes the 10,000 qubit announcement with AIST particularly notable as it is about 75x more qubits than the current IBM 133 qubit machines[22]. IBM made this change to its roadmap in order to prioritise improvements in gate operations and error-correction[23].

Quantinuum making strides on the road to a universal fault tolerant QC

Quantinuum improves on Google's 2019 quantum supremacy claims

In June 2024, Quantinuum announced it had achieved a 100x improvement over Google's 2019 results when Google had claimed to have achieved quantum supremacy. Quantinuum did this using its H2-1 with 56 trapped ion qubits[24]. Adding to its achievements in April 2024 when Quantinuum and Microsoft revealed they had demonstrated reliable logical qubits that reduced circuit error rates by 800x by using 30 physical qubits to create four logical qubits[25].

At the beginning of the year, Quantinuum received funding from JP Morgan Chase, Mitsui & Co, and Amgen to accelerate the development of a universal fault-tolerant QC which could drastically accelerate and improve the results of complex financial workloads[26].

[16] SpaceX will attempt to 'catch' Starship rocket at next launch, The Independent, 17 June 2024
[17] SpaceX Sells Starlink Mini Dish For $200, But Only In Latin America, PCMag, 21 June 2024
[18] SpaceX unveils new Starlink Mini antenna for internet users on the go, Space.com, 26 June 2024
[19] IBM partners with Japanese research institution to deliver 10,000 qubit quantum computers, Data Centre Dyanmics, 17 June 2024
[20] IBM and AIST collaborate on 10,000-qubit quantum computer — 75x more qubits than rivals, Tom's Hardware, 17 June 2024
[21] IBM Releases First-Ever 1,000-Qubit Quantum Chip, Scientific America, 5 December 2023
[22] IBM Debuts Next-Generation Quantum Processor & IBM Quantum System Two, Extends Roadmap to Advance Era of Quantum Utility, IBM, 4 December 2023
[23] IBM unveils Heron quantum processor and new modular quantum computer, Network World, 4 December 2023
[24] Quantinuum inches closer to fault-tolerant quantum with a 56 qubit machine, The Register, 6 June 2024
[25] Quantinuum and Microsoft achieve breakthrough that unlocks a new era of reliable quantum computing, Quantinuum, 3 April 2042
[26] JPMorgan latest to pile into quantum upstart with $5B valuation, The Register, 16 January 2024

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