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CRYPTOCURRENCY

Three Ways Governments Are Co-opting Crypto

> To supersede notes and coins, they're rushing in where Bitcoin never ventured

BY EDD GENT

The rise of cryptocurrencies is rewriting long-standing ideas about how money should work. Eager not to get left behind, governments around the world are jumping on the bandwagon leading to an explosion of national experiments in crypto-friendly regulation and state-backed digital currencies.
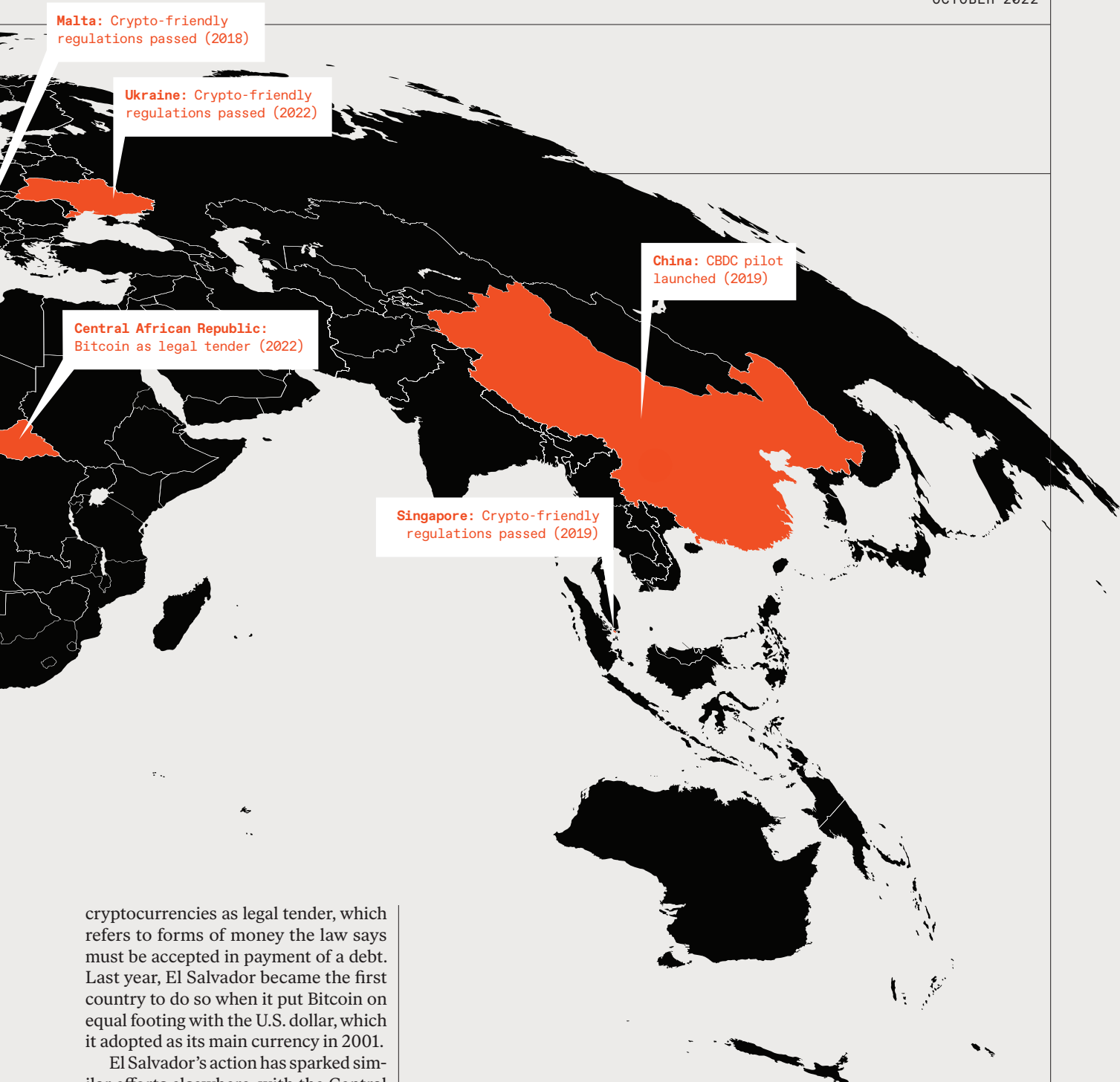
In most developed economies, the production and distribution of money has predominantly been the remit of central banks for at least a century. That was turned on its head in 2009 with the launch of Bitcoin, which uses blockchain technology to delegate the minting and governance of the digital currency to a decentralized network of volunteers.

Since then, a host of new cryptocurrencies have emerged, promising a fast, cheap, and secure way to transfer money directly between users without relying on banks or payment providers. Volatile prices and regulatory uncertainty have limited their adoption as a medium of payment, but the underlying technology has led to a major rethink of what money should look like in the digital age.

"They proved that there can be a new way to organize money and make payments, and that this can be widely adopted," says Andreas Veneris, a professor of computer engineering at the University of Toronto, who has advised the Bank of Canada on digital currencies.

How governments have reacted to these developments varies significantly. Some have taken the leap and embraced

Malta: Crypto-friendly regulations passed (2018)

Ukraine: Crypto-friendly regulations passed (2022)

China: CBDC pilot launched (2019)

Central African Republic: Bitcoin as legal tender (2022)

**Singapore:** Crypto-friendly regulations passed (2019)

cryptocurrencies as legal tender, which refers to forms of money the law says must be accepted in payment of a debt. Last year, El Salvador became the first country to do so when it put Bitcoin on equal footing with the U.S. dollar, which it adopted as its main currency in 2001.

El Salvador's action has sparked similar efforts elsewhere, with the Central African Republic becoming the second country to make Bitcoin legal tender in April. The Swiss city of Lugano also announced plans to make Bitcoin, Tether (a stablecoin pegged to the value of the U.S. dollar), and LVGA (a Swiss Franc–based stablecoin launched by the city in 2020) "de facto" legal tender by allowing people to make all payments to the authorities in them.

Pietro Poretti, director of Lugano's Economic Promotion Division, says the city wants the local economy to get a boost by pulling in crypto enthusiasts, giving the city a crucial head start in what could be an important technology in the future. "It certainly doesn't do any harm being equipped for what is coming, to be ahead of the curve rather than catching up," he says.

For now, though, cryptocurrencies don't make good legal tender due to their wildly fluctuating values, says Thomas Dimpfl, a professor of economics at the University of Hohenheim, in Stuttgart, Germany. That's proven a significant problem for El Salvador's government, whose Bitcoin holdings have lost roughly 60 percent of their value due to the recent crypto crash. "A good legal tender is
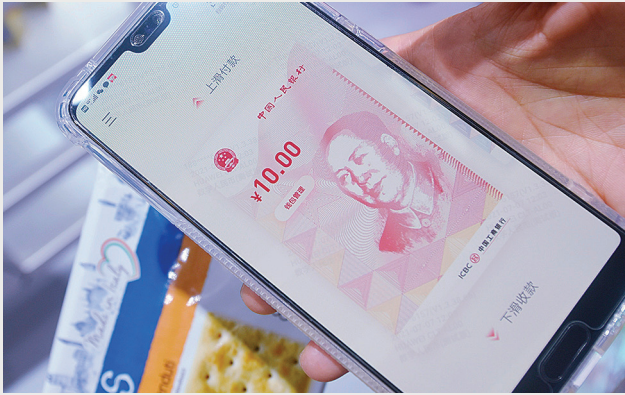
In China, users can pay with e-CNY, the digital currency issued by China's central bank.

something that is reliable," he says. "The biggest risk is that [Bitcoin] is just so volatile."

Other countries have taken a less extreme approach, adopting crypto-friendly regulations that support innovation while still keeping these new forms of money at arm's length. Sergiu Hamza, CEO of crypto analyst firm Coincub, in Dublin, which provides a ranking of crypto-friendly countries, says the pace of experimentation has accelerated dramatically in the last year. "It changes so fast," he says. "In [May], we have compiled a list of 150 news articles on different regulation changes, with at least 10 countries radically changing their positions."

While die-hard crypto-anarchists might bristle at government oversight, Hamza says many in the industry welcome the clarity that regulation brings for both users and service providers. Perhaps unsurprisingly, major financial centers like Singapore and Switzerland and tax havens like Malta and the Bahamas have been ahead of the pack when it comes to passing more sophisticated crypto regulation. "Countries that are used to financial innovation and countries that are at the forefront of technology—obviously it's easier for them to understand crypto and deal with it," says Hamza.

Malta was one of the first countries to regulate cryptocurrencies when it passed a trio of laws in 2018 that defined Virtual Financial Assets and set out rules for how they could be issued, traded, and exchanged. Singapore has also been proactive, running a regulatory sandbox for financial technology, or fintech, com-

panies since 2016 and introducing the Payment Services Act in 2019. The latter regulated how cryptocurrencies could be issued, and it established oversight mechanisms for exchanges and other crypto firms.

It's not only finance hubs getting involved though—the country that shared Coincub's top rankings for crypto-friendliness (alongside the United States) was Germany. The country charges no tax on gains from crypto held for longer than a year and a recently passed law allows investment funds called *spezialfonds*, which are not available to retail investors and therefore more lightly regulated, to invest up to 20 percent of their holdings in cryptocurrency.

Most countries setting crypto-friendly rules are trying to boost their domestic crypto industry, but there can be other reasons too. Ukraine has made headlines for using cryptocurrencies to raise funds for its defense against the Russian invasion. Max Semenchuk, a blockchain entrepreneur, reports that he's acting as an advisor to Ukraine's Ministry of Digital Transformation. He says that the country has long had a progressive attitude to cryptocurrencies and has topped adoption rankings for years, currently standing at about 12 percent of the population.

Shortly after the start of the war, a law passed that recognized cryptocurrencies as legal assets and introduced financial-monitoring measures. Semenchuk says it had been in the pipeline for years. The aim is primarily to support the use of the technology by individuals. "Cryptos work best at the places where more traditional instruments are not working," he says. "There's not so much trust for the

banks. We have got some history of banks folding, and [of] crisis and devaluation of currency."

Other countries are taking a different tack. Rather than easing the adoption of cryptocurrencies, they are developing digital currencies of their own. China launched pilots of its digital yuan, reportedly, in four cities in late 2019. By the end of last year, total transactions had crossed 87.6 billion digital yuan with 261 million electronic wallets opened, according to the People's Bank of China. The project has now expanded to 23 cities and use has accelerated in 2022 with a reported total transaction volume hitting at least 83 billion yuan.

It's not the only such project, though. In October 2020, the Bahamas' Sand Dollar became the first central bank digital currency (CBDC) to be rolled out nationwide, and since then, digital versions of the Eastern Caribbean Dollar, Nigeria's naira (the e-Naira), and the Jamaican dollar (the Jam-Dex) have all launched. An executive order from the Biden administration in March called for the U.S. Treasury Department to investigate the possibility of a digital dollar and according to the Atlantic Council, more than 50 countries are in advanced stages of exploring CBDCs.

One of the primary motivations is that, like cryptocurrencies, CBDCs could make it possible to instantly transfer money between people without relying on third parties, resulting in cheaper, faster payments. "Payment systems today are expensive; they are clumsy and slow," says the University of Toronto's Veneris, pointing out that much of the underlying technology is more than 40 years old.

Public-sector organizations don't have a great record when it comes to digital transformation, though, says Dante Disparte, chief strategy officer at Circle, the company behind the USD Coin, a cryptocurrency pegged to the U.S. dollar. Expecting them to make the right calls on the future of digital money seems unwise, he says, adding that government's role should be to set guardrails on private-sector innovation.

"The air gap between the central bank, the banking system, your wallet, and your money is a feature, not a bug," Disparte says. "[CBDCs] would be the equivalent of the aviation-safety authorities choosing to fly planes and build jet engines." ■

Billionaires Battle for Global Spectrum Domination › Their skirmish over the 12-GHz band could affect every Internet user

BY MICHAEL DUMIAK

Dish Network Corp., owner of this 5G cellular tower, is in a high-stakes skirmish with Elon Musk's SpaceX over the use of the 12-gigahertz spectrum band.

Billionaires, satellite links, and political chicanery: A present-day, oligopolistic game of jockeying for prime placement in the 12-gigahertz spectrum has at least a few of the ingredients of a thriller. Or—given the outsize personalities involved (including Elon Musk and Michael Dell), and the epic, six-year duration of the dispute to date—maybe more like a space opera.

At issue is a set of frequencies at which Musk's SpaceX transmits its Starlink Internet service, the company's well-publicized play for broadband beaming down from low-Earth orbit to satellite dishes in remote areas. Charlie Ergen's Dish Network Corp., which transmits TV on these frequencies and is one of the two big satellite viewing providers in the United States, has launched a 5G wireless service and wants to increase its signal volume in this set of wavelengths. Musk's side says Dish's move would create debilitating static that would impede his satellite transmissions; Ergen's engineers say that's nonsense. As for Dell (think Dell computers), his private investment firm holds rights to some of the airwaves in play. At the moment, his group is siding with Dish.

The current field, more precisely 12.2 to 12.7 GHz in the Ku microwave band, is a lot of bandwidth lightly used. At present, it is the go-to frequency range for assorted satellite broadcasts, live feeds, and ISS tracking. But the companies fighting over it recently cranked up their clashing. The sides are lobbying a shorthanded U.S. Federal Communications Commission, taking swipes at each other such as when Musk blasted his foes as "super shady and unethical." He took return fire from Dish for "flimsy" and "far-fetched" objections to opening bandwidth.

But what does it mean for those outside the immediate fray? For civilians going about their daily business? For people—possible satellite service subscribers—all around the world?

Only a handful of people who understand the nature of possible interference and related issues seem to be paying attention now. "Rights to use frequencies have not been sharply defined, and the overlapping permits generate controversy," says Thomas Hazlett, a Clemson University economist who writes about bandwidth battles (and once served as FCC chief economist). But the rulings—and market activities that result—stand to have real social impact wherever signals from satellite broadcasts or satellite Internet connections may one day fall. Which means pretty much everywhere.

The contretemps is understandable, given the economic value placed on frequency rights. More than 100 bandwidth auctions over the past 30 years had netted about US $230 billion for the U.S. Treasury as of the spring of 2022. But as with television, radio, and the railway before that, citizens aren't likely to tune in until more tangible developments happen. Industry players, however, are paying close attention, and the pressures are intense. In the United States, the intensifying jockeying over the fate of the 12-GHz spectrum band "is purely market driven," says Shahed Mazumder, global director of telecom solutions at Aerospike, a database firm.

"There's political pressure, the business pressure, and monetary pressure; there are legitimately major things going on here," says Mike Dano, who's been following the dispute as editorial director at Light Reading, a news website covering the global telecom sector. "Billions of dollars of value, potentially, [will] be created or destroyed depending on how an FCC engineer finally decides on it," he adds. Meanwhile the politically appointed commissioners at the FCC are down one member, leaving the board split 2-2 along party lines. Regular deadlocks make controversial calls like this one more difficult.

More techie influences may also affect the spectrum spat. In 2018, the United States became the first to approve a spectrum-sharing setup in the Citizens Broadband Radio Service band (3.5 GHz). It's an advanced concept allowing different sets of users to share spectrum—making more room. Dano says the FCC is under pressure to allocate 12 GHz in accordance with that bandwidth-sharing philosophy.

This notably did not happen with U.S. 5G network rollouts, which turned into a snarling issue earlier this year over fears of mutual interference in the C-band between high-speed cellular service towers and plane altimeters in low-visibility conditions on approach to airports.

Meanwhile Starlink wants to extend the reach of its satellite broadcasts to further-flung places; it has, for example, expressed a desire to open gateways in the United Kingdom. While its 12-GHz fight with Dish is centered in the United States, satellite spectrum allocation is...special. Space has international dimensions, points out Plum Consulting's Selçuk Kırtay, who has written about spectrum sharing and interference ever since he covered the topic in his 2001 doctoral thesis. Slicing up the Ku band has history—it even left its mark at a global astronautical confab in then-Czechoslovakia in Star Wars–era 1977.

Ofcom, the U.K. regulator, is monitoring developments with U.S. allocations in 12 GHz. This slice of the spectrum in the 12.2-to-12.7-GHz frequency range is sure to be a hot topic of conversation at the quadrennial ITU World Radiocommunication Conference to be held next year in the United Arab Emirates.

Stay tuned, say experts and satellite industry watchers. "How the conflicts are resolved in the U.S.A. will materially affect markets around the world," Clemson's Hazlett says. ■

Deutschland to England, on a Single Charge > Mercedes's solar-boosted EV shows off 1,200-km range

BY LAWRENCE ULRICH

The Mercedes-Benz Vision EQXX, and its showroom-bound tech, looks to banish EV range anxiety for good: In April, the sleek prototype sedan completed a 1,000-kilometer (621-mile) trek through the Alps from Mercedes's Sindelfingen facility to the Côte d'Azur in Cassis, France, with battery juice to spare. It built on that feat in late May, when the prototype traversed 1,202 km (747 miles) in a run from Germany to the Formula One circuit in Silverstone, England.

Despite modest power, a futuristic teardrop shape, and next-gen tech, the EQXX is, quintessentially, a small Mercedes luxury sedan. To underline the German automaker's real-world intent, Mercedes vows that the EQXX's power train will reach showrooms by 2024.

"The car is an R&D project, but we're feeding it into the development of our next compact-car platform," says Conrad Sagert, an engineer at Mercedes who is developing electric drive systems.

The engineering effort included specialists with the Mercedes-EQ Formula E team; it thus draws from their well of electric racing experience. Developed in just 18 months, the rear-drive Vision EQXX is powered by a single radial-flux electric motor—developed entirely in-house—fed by a battery pack with just under 100 kilowatt-hours of usable energy. One thing that won't reach production by 2024 is the EQXX's high-silicon battery anode, which Sagert says is closer to four years from showrooms. Such silicon-rich anodes, which can squeeze more range from batteries, are widely expected to be popularized over the next decade.

The car's 241-horsepower output delivers a reasonable 7-second acceleration from 0 to 100 kilometers per hour (0 to 60 miles per hour). But with a feathery (for an electric vehicle) 1,770-kilogram curb weight and wind-cheating aerodynamics, the carbon-fiber-bodied EQXX is designed for pure efficiency, not winning stoplight races. According to Sagert, the Benz sipped electrons at 14 kilometers per kilowatt-hour on its Riviera run, nearly double the roughly 7.2 km/kWh achieved by the Lucid Air (the current record holder for EV range). On the trip to the United Kingdom, he says, its efficiency squeaked just past 12 km/kWh. If that electric math still seems esoteric, the England-bound Benz delivered the equivalent of 111.3 kilometers per liter of fossil fuel (262 miles per gallon), nearly double the 58-km-per-liter energy efficiency of the industry-leading Tesla Model 3 Standard Range.

A roof panel with 117 solar cells lessens the burden by powering a conventional 12-volt system to run accessories, including lighting, an audio system, and dashboard display screens worthy of *Minority Report*. The Mercedes EV team found that on the cloudy April trip to southern France, with plenty of tunnel passages, the panels extended the EQXX's expected range by 13 km. On the sunnier May drive to the U.K., the solar boost provided an extra 43 km of range.

Aerodynamics naturally play an essential role, including a tiny frontal area and a dramatic Kamm tail whose active rear diffuser extends nearly 20 centimeters at speeds above 37 kilometers per hour. The sidewalls of the specially designed Bridgestone tires sit flush with

the body and 51-centimeter magnesium wheels, aiding a claimed drag coefficient of 0.17. This figure exceeds that of any current production car. Surprisingly for such a tech-forward design, the EQXX features traditional exterior mirrors. Mercedes says the camera-based "mirrors" used on many concept cars drew too much electricity to generate a tangible benefit.

Defying today's EV norms, the battery and motor are entirely air cooled. Replacing liquid-cooling circuits, pumps, and fluids with a smoothly shaped underbody that acts as a heat sink set off a spiral of savings in weight and packaging. Unlike solving the engineering challenge endemic to internal combustion engines and most EVs, which involves getting heat out of the system to keep the battery and motor from exceeding optimal operating temperatures, Mercedes solved the opposite problem: Active front shutters can close to limit the flow of cooling air as necessary.

"We had to insulate the electric motor. It's still about heat management, but the other way around," Sagert says.

Add it up, and the EQXX transfers a claimed 95 percent of electric energy into forward motion, up from 90 percent for Mercedes's current models such as the EQS. If that doesn't sound like much gain to nonengineers, Sagert puts it another way: The EQXX reduces typical EV energy losses by 50 percent.

"We're always hoping for this magical thing, but it's really the sum of the details," Sagert says.

That obsession with tiny details paid off. Based on computer and dynamometer simulations, engineers saw a 1,000-km trip on a single charge as a challenging but achievable target. With that goal in mind, they plotted the Mediterranean road trip to Cassis, France. Instead, the car blew away those conservative projections. Pulling into Cassis, the EQXX had 140 km of range remaining.

"We thought about waving and just driving on, but we weren't allowed," Sagert says, not least because Mercedes board member and chief technology officer Markus Schäfer was waiting to greet them. Mercedes then set its sights higher,

choosing Silverstone and its Formula One track for a subsequent team meetup.

The sleek sedan capped off the record-breaking trek with an energy-guzzling flourish: Despite some misgivings, the team handed their precious prototype to a Formula E team driver, Nyck de Vries. The type-A racer forgot all about efficiency and pushed the car to its limits on the Silverstone F1 circuit, watched by nervous engineers. Where long-distance drivers had relied almost exclusively on regenerative braking (with four adjustable levels) during their runs, de Vries got to test the car's novel aluminum rear-brake rotors. Those ultralight rotors are possible because the Benz so rarely needs to use its foot-operated mechanical brakes, as telemetry readings from the track showed.

For the average driver on public roadways, that difference will yield huge dividends—principally, how far you can go on a single charge.

"Range anxiety is not a problem anymore," Sagert says. "If your range isn't enough today, wait two years; the [next] step will be big." ■

Rafael Mariano Grossi, director general of the International Atomic Energy Agency [hand to hat], paid a visit to the Zaporizhzhia nuclear power plant on 1 September to see the state of the combat-scarred facility firsthand.

ENERGY

Is Embattled Ukraine at Risk of Another Nuclear Disaster?
> Russia's near-miss attacks just one part of the goings-on that could foreshadow catastrophe

BY PETER FAIRLEY

The March 2022 seizure of Ukraine's Zaporizhzhia power plant by Russian forces and more recent shelling of the plant have veered dangerously close to nuclear disaster. But a more opaque threat may also stalk Europe's largest nuclear power plant and Ukraine's three other nuclear power stations: a cloak-and-dagger struggle pitting activist nuclear professionals against alleged Russian agents at state nuclear energy firm Energoatom.

It's an unstable situation that increases the risk of accidents that could spread radiation across Europe and threatens Ukraine's ability to defend itself. Ukraine's 15 reactors generate over half of its electricity and, thanks to Ukraine's rapid postinvasion synchronization with Europe's power grid, electricity exports are helping the embattled nation finance its defense.

The murky internal battle for Ukraine's nuclear power popped into sight briefly in March, when a few Ukrainian news outlets and *IEEE Spectrum* reported that Ukrainian counterintelligence officers had detained and questioned Energoatom director of personnel Oleg Boyarintsev. That cast a shadow over officials across Energoatom whom Boyarintsev had appointed.

In June and July, the plot thickened, as moves by counterintelligence agents with the Security Service of Ukraine (SBU), deputies in Ukraine's parliament, and Energoatom officials heightened concerns about the security and safety of the firm's operations.

- SBU spy hunters said they had pierced an "extensive agent network" led by Boyarintsev's longtime political patron and business partner Andriy Derkach, whom the SBU and U.S. intelligence agencies say is a Russian agent;

- Ukraine's president, Volodymyr Zelenskyy, affirmed pervasive infiltration of Ukraine's state security service, which routinely places officials at Energoatom headquarters and its plants;

- Energoatom CEO Petro Kotin stunned a panel of deputies probing his firm's personnel issues by telling them Boyarintsev would not appear as requested because he had the day off; and

- Kotin gave contradictory explanations for dismissing the director of the Rivne Nuclear Power Plant, which sits less than 60 kilometers from Belarus. Kotin said Pavlo Pavlyshyn, the sacked former director, was both suspected of hiding safety violations and was needed for a critical mission: starting up a new facility to store spent fuel previously sent to Russia. Without ready access to a depository for storing spent fuel, Ukraine can't refuel its reactors.

Ukrainian news site Glavcom's take from the hearing was that Ukraine's nuclear plants were "in danger," and that a "hunt for collaborators" was on. The panel's deputy chairman concurred, posting, "Russian ears are sticking out now from all sides."

In August, Energoatom sent *Spectrum* a statement by Kotin insisting that allegations of Russian influence are "part of a broad information campaign of Russian propaganda." Kotin pointed to post-invasion moves to sever ties to Russia's nuclear industry, including "the complete rejection of Russian nuclear fuel, Russian services, components, and technologies."

But Kotin's critics are not backing down. Olga Kosharna, a former advisor to Ukraine's nuclear regulator, sued for defamation after Energoatom accused her of being under Russian influence. The suit will be heard in October according to her lawyer, who heads the energy-law committee for Ukraine's bar association.

Kosharna maintains her March 2022 claim that officials planted by Boyarintsev facilitated the Zaporizhzhia plant's capture, including a new plant director appointed eight days before the 24 February invasion. Kosharna says Boyarintsev is part of a larger group headed by Andriy Derkach, who the SBU says worked for Russian intelligence under the codename "Veteran."

Derkach is a long-serving Ukrainian deputy, a pro-Russia media commentator, and a former Energoatom CEO. His whereabouts since the invasion are unknown. He gained global notoriety delivering alleged kompromat—compromising material—on U.S. President Joe Biden in 2019. In spite of that, he is widely credited with driving Boyarintsev's inclusion in 2020 when Zelenskyy appointed Kotin and a new leadership team at Energoatom. Why else, ask people like Kosharna and other nuclear professionals, would someone with Boyarintsev's connections win a job so crucial to Ukraine's security?

Between the appointment of Kotin's team and Russia's February 2022 invasion, journalists, activists, and government watchdogs documented a series of suspicious activities including the dumping of electricity on the market, the illegal dismissal of Energoatom's independent anticorruption official, and embezzlement of funds for the long-delayed spent-fuel repository.

They also decried a slide back toward Russian influence at Ukraine's Russian-designed and mostly Russian-fueled nuclear plants. Ukrainian security analyst Pavel Kost had previously praised Energoatom as one of the "quiet heroes" of post-Yanukovich Ukraine. Last year he called out the growing influence of "pro-Russian circles" and "silent sabotage" of crucial projects such as the spent-fuel repository.

Over half of Ukraine's parliamentarians called last year for new leadership to improve Energoatom's operations and assure nuclear safety.

Jeff Merrifield, a former U.S. Nuclear Regulatory Commission member and international nuclear consultant, likened the situation facing Ukraine's nuclear plants to a "multilayer set of chess." While he declined to address the specific accusations against Energoatom leaders, Merrifield said they "were not entirely surprising" based on some of the "unsavory" activity he's observed in 20 years of work in both Ukraine and Russia.

Kosharna, meanwhile, is not the only Ukrainian professional challenging Energoatom's actions under Kotin. The loudest critical voice among engineers and scientists (at least in writing) is Georgiy Balakan, a former top Energoatom engineer who led collaborations with U.S. national labs, Westinghouse Electric, and European agencies to upgrade safety at Ukraine's plants. Since April, he has posted a series of risk assessments, warnings, and questions regarding management of Energoatom.

Balakan was among the nuclear safety experts who successfully pushed for Zaporizhzhia to stop generating electricity last month. Cooling its reactors—a move endorsed in August by the U.S. National Security Council—was expected to reduce the likelihood and severity of a potential accident. ■

Robot Bests Surgeon in Precision Task

High-precision autonomous surgical robots—which would be available 24 hours a day, never get tired, and never lose focus—are on the drawing board. In a paper published 10 May in *IEEE Transactions on Automation Science and Engineering*, a multinational team of researchers reported the results of a study where a robot was able to complete a common training task for robot-assisted surgery with the same accuracy as that achieved by an experienced surgeon, only faster.

Minho Hwang, an assistant professor at the Daegu Gyeongbuk Institute of Science and Technology, in South Korea, was involved in the study. He notes that many robotic surgery systems currently rely on automated control of cables, which are subject to friction, cable coupling, and stretch—all of which can make precision positioning of these robotic arms difficult.

"When humans control the robots, they can compensate through human visual feedback," explains Hwang. "But automation of robot-assisted surgery is very difficult due to [these] position errors."

In their study, Hwang and collaborators strategically placed 3D-printed markers on the robotic arm of a standard da Vinci robotic-surgery system. This allowed the team to track the arm's movements using a color and depth sensor. They then analyzed the movements using a machine-learning algorithm. Results suggest that the trained model can reduce the mean tracking error by 78 percent.

Next, the researchers put their system to the test against a human doctor who had performed more than 900 surgeries. The surgeon and the robot had to complete a peg-transfer task, a standardized test for trainees in robot-assisted surgery that involves moving six triangular blocks from one side of a pegboard to the other and then back again.

In the most difficult variation of the peg-transfer exercise, the robot achieved the same level of placement accuracy as the surgeon, but it completed the task 31.7 percent faster on average.

In future work, the team plans to extend its approach to surgical subtasks such as tissue suturing. — **Michelle Hampson**