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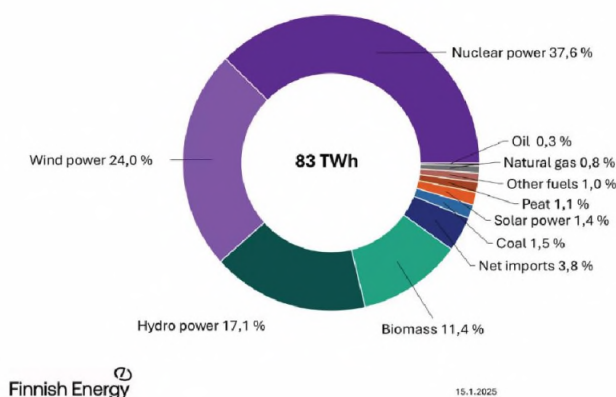
THE FINNISH MODEL FOR AMERICA'S ENERGY FUTURE

The debates surrounding America's energy policy have reignited, with a focus on traditional energy sources and their viability within the broader energy landscape. Central to these discussions is the question of whether profitable, low-carbon alternatives can coexist and thrive alongside conventional energy strategies.

For answers, look to Finland, a country that would rank fifth among U.S. states based on geographic size, right between Montana and New Mexico. Finland has quietly built a mix of wind, solar, hydropower and nuclear energy, along with battery research and production, that is both sustainable and affordable. This mix is not just generated in the country but is all part of a supply chain humming along, offering U.S.-based companies a place to 'friend-shore' manufacturing away from more risky locales like China.

With 95% of its electricity coming from carbon-neutral sources, Finland has achieved what many nations only aspire to: stable, low-cost energy powered by renewables and a smart, flexible grid rather than energy produced by oil, coal or gas. For U.S. cities, states and businesses grappling with rising energy demands and climate targets, Finland offers a compelling model for balancing economic growth with environmental stewardship. Moreover, potential R&D and business collaborations between U.S. and Finnish companies could unlock new opportunities for innovation in clean energy technologies. These collaborations could generate mutually beneficial ventures in the U.S. and other countries, leveraging Finland's renewable energy expertise, sustainable manufacturing and the U.S. market's scale to advance the global transition to low-carbon alternatives.

Electricity by energy source and net imports 2024



CREDIT: Finnish Energy

Fast Facts

- **95% of Finland's electricity is generated from carbon-neutral sources—wind, nuclear, solar and hydropower and the country has a goal of being carbon neutral by 2035.**
- **Wind energy provides over 18% of Finland's electricity, with plans for over 130,000 MW in new capacity.**
- **Finnish initiatives like the WISE ecosystem and partnerships with Wärtsilä are developing zero-emissions technologies, including hydrogen-ready engines and scalable clean energy systems.**
- **The VTT Technical Research Centre of Finland is pioneering small modular nuclear reactors for district heating and electricity.**
- **Finland is the only European Union country with all key battery materials in country.**

Finland's Clean, Low-Cost Energy Leadership

Without any domestic fossil fuel reserves within its borders, Finland has had to rely on importing costly and dirty fuel to power the nation. Today, Finland has made clean energy production the focus of its electricity policy with a 2035 goal of being a carbon-neutral country.

Leveraging its unique geography of extensive coastlines and over 220,000 islands, Finland has become a leader in wind energy, with 6,900 megawatts (MW) in operations, 2,400 MW under construction and over 130,000 MW in planning stages. Over the course of a decade, wind power has grown from less than 1% of the nation's electricity share to more than 25% in 2024. Another milestone was reached in October 2024 when Finland generated 50% of its electricity from wind during a peak wind generation.

Finland is increasingly using solar energy. Despite its northern location and dark winters, Finland gets a similar amount of sunlight to Germany and Denmark, and in the summer, the long days compensate for the darkness of the winter. Because of extended daylight, solar power makes a small, but mighty share of electrical generation with 1,000 MW across the country.

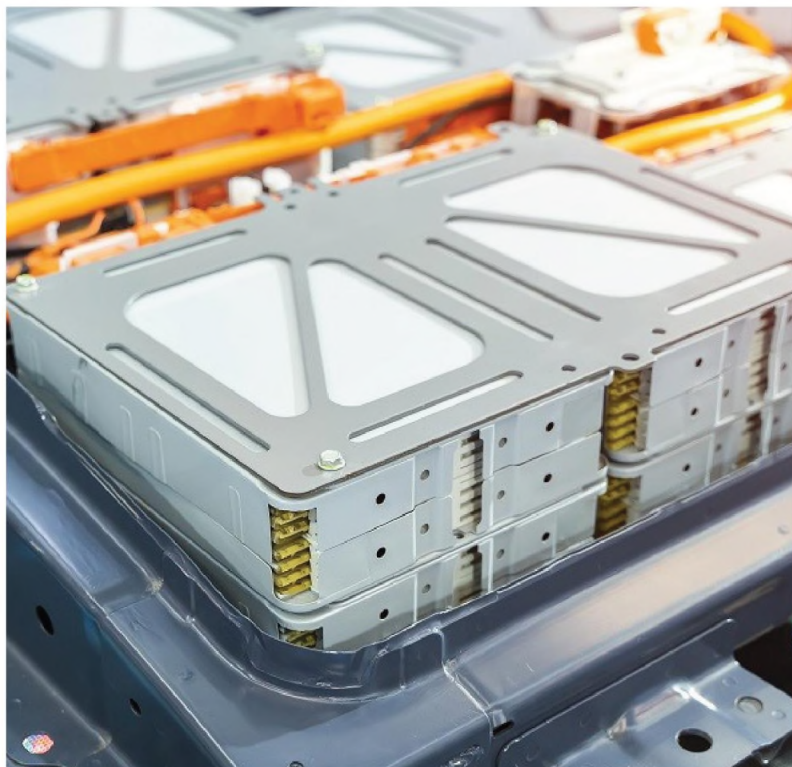
The majority of Finland's energy comes from nuclear power. With the recent commissioning of the Olkiluoto 3, [the third most powerful nuclear power unit](#) in the world, approximately 30% of Finland's electricity comes from one island, where the entire lifecycle of nuclear power is managed.

Its groundbreaking Onkalo [repository](#), a deep geological storage facility for nuclear waste, sets a global benchmark for safely managing the byproducts of nuclear power, ensuring long-term environmental safety. When completed, it will be the world's first long-term disposal facility for spent nuclear fuel.

Finland ingenuity is also at play for portable nuclear energy. The [VTT Technical Research Centre of Finland](#) is actively researching the potential of small modular reactors (SMRs) to be used for both district heating and electricity generation, with a particular focus on developing SMRs specifically designed for district heating applications in Finnish cities. Unlike other SMR projects that focus on energy for high-temperature industrial processes, VTT's research could enable the use of simplified and more economic solutions across the country. The country's excellence in nuclear power led the US Department of Energy to [sign a Memorandum of Understanding](#) with the Finnish Ministry of Economic Affairs in 2023 to strengthen the cooperation between the two countries, as the US is looking to start investing in new nuclear builds.

Finland's commitment to renewable energy extends beyond generation to the efficient transmission, distribution and consumption of electricity. The country has invested heavily in smart grid technologies, creating a sophisticated and flexible network that optimizes energy flow, enhances reliability and facilitates the integration of renewable energy sources. This flexibility is key to a decarbonized system.

Finland has also teamed up with Wärtsilä, a leading technology company, to work on the [Wide & Intelligent Sustainable Energy](#) (WISE) ecosystem, which will build scalable ecosystems and introduce secure and autonomous zero emissions-balancing energy production. The goal of the five-year program is to strengthen the Finnish energy sector to become the leading energy innovation ecosystem in the world and position Finnish companies as forerunners in systemic energy solutions with tangible case studies. In 2024, WISE reached significant milestones, such as the launch of the iHAPC Argon Power Cycle project, the establishment of a hydrogen-ready engine power plant and the Energy Data Platform for co-creation of new energy solutions.



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Fast Facts Continued

- **The Keliber project near the Gulf of Bothnia is expected to become Europe's first integrated lithium hydroxide production facility with an estimated annual production of approximately 15,000 tons of battery-grade lithium hydroxide monohydrate.**
- **Finnish company Fortum has developed a process to recover over 80% of materials in lithium-ion batteries, promoting sustainable recycling and reducing reliance on raw materials.**
- **Finland's real-time spot electricity pricing encourages consumers to adjust usage based on hourly rates, leading to instances where electricity prices fell to \$0 or even negative for 11% of 2024.**
- **Since 2009, Google has operated a data center in Hamina, 90 miles east of Helsinki, that uses innovative seawater cooling to achieve energy efficiency unmatched by traditional data centers and operates with 97% carbon free energy.**
- **Microsoft is currently building its own datacenter region in Southern Finland that will be powered by 100% renewable energy with waste heat diverted to the local district heating system and will be the largest in the world once complete.**

The Future of the Battery Supply Chain

Batteries play a crucial role in the clean energy transition and Finland is a potential major player with massive critical mineral reserves, a history of environmentally friendly mining and a [National Battery Strategy](#). In fact, Finland is the only European Union country with all key battery materials in country. This positions Finland as a safer, Western-friendly alternative to China.

Finland's lithium reserves, which are among the most significant in all of Europe, are centered in the Keliber project near the Gulf of Bothnia. Operated by Keliber Oy, and majority-owned by the global metals giant Sibanye-Stillwater, the project is expected to become Europe's [first integrated lithium hydroxide production](#) facility capable of feeding the demand for EV batteries across the U.S. and E.U. The estimated annual production from this project is approximately 15,000 tons of battery-grade lithium hydroxide monohydrate – enough to supply the growing international lithium battery market for at least 16 years.

In its November 2024 report highlighting the need for more recycling of critical minerals, [the International Energy Agency](#) noted that a successful scale up can lower the need for new mining by 25-40% by 2050. Here Finland has taken the lead as well, addressing the growing challenge of electronic waste from electric vehicles and portable electronics.

At the forefront is clean energy producer Fortum, which has developed a [hydrometallurgical process](#) to recover over 80% of the materials in lithium-ion batteries, including critical metals like cobalt, nickel and lithium. These materials are then reused in battery manufacturing, creating a circular economy that reduces reliance on virgin raw materials and minimizes environmental harm.



CREDIT: Business Finland

Finland's Sustainable Industrial Revolution

Finland's sustainable industrial revolution stands as a powerful example of how nations can align economic progress with environmental stewardship. Building on its history of innovation and resource management, Finland has embraced a transformative approach to industries by prioritizing sustainability and technological advancement with a focus on digitalization and artificial intelligence.

The shift focuses on sectors like renewable energy, bio-based materials and circular economy practices, driven by robust government policies and public-private collaborations. Initiatives such as the Sustainable Manufacturing Finland program and partnerships with research organizations like VTT have helped companies integrate green technologies and modernize value chains.

[Solar Foods](#), a standout example of this industrial renewal, has gained international recognition for its revolutionary protein, Solein®. Produced using air, water and electricity, Solein leverages cutting-edge technology to transform waste CO₂ and hydrogen into a sustainable food source. By winning NASA's Deep Space Food Challenge, Solar Foods demonstrated how Solein could sustain astronauts on long missions, highlighting Finland's ability to blend innovation with sustainability.



CREDIT:
courtesy
Solar Foods



CREDIT: courtesy Stora Enso

Finland's industries are also increasingly embracing circular economy principles, creating sustainable innovations, such as [Neste's sustainable aviation fuel](#). Compared to traditional jet fuel, Neste's product reduces greenhouse gas emissions 80% over the course of the fuel's life cycle.

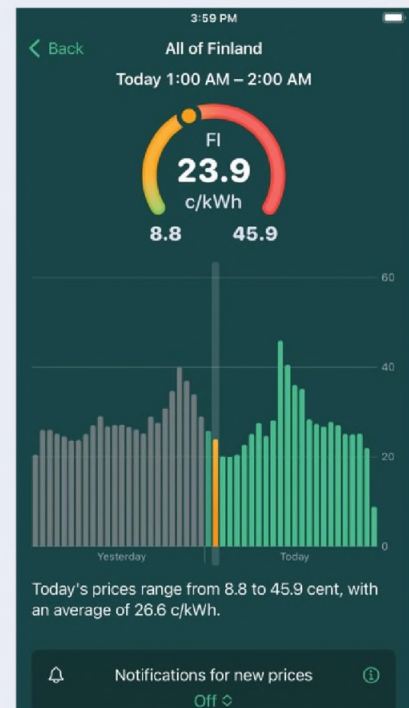
Similarly, [Stora Enso](#), a global leader in renewable materials, has redefined traditional forestry operations by developing bio-based packaging, wooden construction materials and textiles made from renewable fibers. Stora Enso's products, which are designed to be recyclable and biodegradable, embody Finland's vision of a circular economy, further cementing its role as a global pioneer in sustainable industrial practices.

Finland's Infrastructure is Critical to Energy Security

As the Ukraine war began, Finland divested from Russian energy supply chains and doubled down on safeguarding critical energy infrastructure, with advanced solutions that ensure energy system resilience and reliability. With a 100% grid reliability record, Finland's smart grid technologies demonstrate exceptional efficiency and robustness. These systems incorporate state-of-the-art cybersecurity measures to protect against evolving digital threats, ensuring stable and secure energy delivery even under challenging conditions.

In addition to its grid reliability, Finland has developed solutions that empower individuals and communities to actively engage in energy markets:

- 1. Spot Pricing:** Finland utilizes real-time electricity pricing through the Nord Pool power exchange, allowing consumers to adjust their usage based on hourly rates by tracking prices on their phone, just like we would do for the stock market. Starting on June 12, 2025, consumers will be quoted for 15-minute periods. This system encourages energy consumption when prices are low, reducing costs when possible and promoting grid stability. Last year, electricity prices fell to \$0 or even negative—meaning consumers were paid to use electricity—11% of the year.
- 2. Grid Feed-In Models:** The country supports decentralized energy production by enabling consumers to feed surplus electricity from renewable sources like solar and wind back into the grid, without compromising grid stability.
- 3. Energy Communities:** Finland promotes collaborative energy-sharing networks where groups of private individuals, such as housing cooperatives, jointly invest in renewable energy installations, typically wind power plants. These communities share the generated electricity, fostering local sustainability and reducing individual costs.



CREDIT: AppAdvice

Finland's proactive approach to energy security and consumer empowerment highlights its role as a global leader in creating resilient, sustainable and inclusive energy systems. The country's emphasis on innovation, collaboration and sustainability serves as a model for nations seeking to enhance their energy resilience while reducing their carbon footprint.



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CREDIT: Connie Zhou/Google



CREDIT: Connie Zhou/Google

A Model for U.S. Tech Giants, From U.S. Tech Giants

For U.S. industries seeking low-cost energy solutions, Finland's strategy proves that profitability and sustainability can coexist. Take Microsoft and Google. Years before the A.I boom and its energy needs began, the tech giants invested heavily in Finland's energy ecosystem citing its reliable, low-emission grid as a key reason.

Since 2009, Google has operated a [data center](#) in Hamina, 90 miles east of Helsinki. It uses innovative seawater cooling to achieve energy efficiency unmatched by traditional data centers. Last year, Google announced a billion-dollar expansion of the data center. The company will now be recovering heat from its operations, which operates today with 97% carbon free energy, and re-routing it into the town to warm homes, schools and businesses. It will represent 80% of the annual heat demand of the local district heating network, according to Haminan Energia.

Microsoft is currently building its own datacenter region in Southern Finland that will be powered by 100% renewable energy. Its waste heat will be [captured by Fortum](#) and diverted into the district heating system that will be the largest in the world once complete. The heat will be used to warm approximately 250,000 users in the cities of Espoo, Kauniainen and the municipality of Kirkkonummi, reducing emissions by 400,000 tons annually.

Why Finland's Example Matters Now

As new U.S. energy policies revive debates over drilling and fossil fuels, Finland offers a counter-narrative. The future of energy isn't just "Drill, Baby, Drill." Instead, the Nordic country offers American businesses, cities and states a market and environmentally friendly alternative that welcomes the U.S. with open arms.

The U.S. and Finland already have a strong business relationship, with Finland exporting more than \$5.5 billion per year to the U.S. and importing more than \$2.7 billion from the U.S. With Finland's ascension into NATO, the relationship is poised to get stronger, with the recent [Icebreaker Pact](#) serving as a prime example of the two nations' joining together.

Despite its small size, Finland has become a global leader in clean energy and sustainability. Regardless of the energy goals of the new administration, companies in the US can work towards their own clean energy goals by emulating and leveraging their trusted Finnish partner.

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