Sujet traité : Mégatendances favorables au nucléaire / Nuclear-Friendly Megatrends

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Special Report

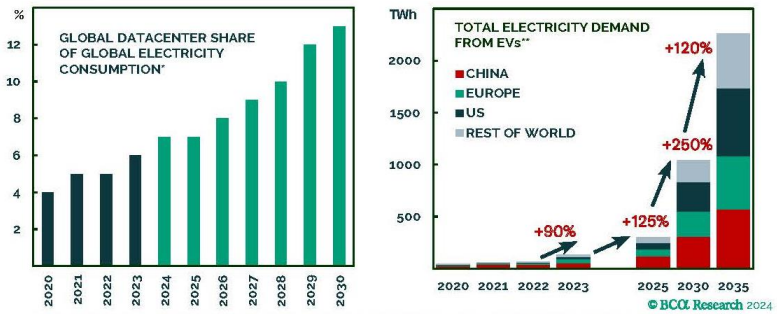
Nuclear-Friendly Megatrends

In this Issue

Executive Summary

- Three megatrends stand out for their growing energy needs: AI, EVs, and reshoring.
- AI model training and inference are hugely energy intensive, so too is the hardware that powers them and the datacenters that house AI-related hardware.
- EVs' rising growth goes beyond sales of passenger cars in China, Europe, or the US. The impressive growth in the rest of the world and in non-passenger car sales will spur on additional electricity consumption.
- Reshoring and the clean tech manufacturing boom will reignite industrial activity in developed markets, which will lead to a significant rise in the demand for clean energy sources.
- Nuclear energy can sufficiently help meet the energy demands of all three megatrends, which require uninterrupted baseload, carbon-free energy.

Watt's Up?



* SOURCE: HUAWEI TECHNOLOGIES, ON GLOBAL ELECTRICITY USAGE OF COMMUNICATION TECHNOLOGY: TRENDS TO 2023.
**INCLUDES PASSENGER CARS, BUSES, LIGHT COMMERCIAL VEHICLES, AND HEAVY-DUTY TRUCKS. SOURCE: GLOBAL EV DATA EXPLORER, IEA.

Bottom Line: AI, EVs, and reshoring will lead to a massive surge in demand for electricity. Carbon-free, cheap, baseload nuclear energy stands to greatly benefit from these megatrends going forward. Utility companies exposed to nuclear energy, in particular, have much upside from the upcoming bull market in electricity. Near term, the utility sector also makes a good overweight candidate within equity portfolios. The defensive nature of utility equities will come in handy as markets become more jittery, and they are currently cheap and oversold.

Nuclear-Friendly Megatrends

Megatrends can drastically shape markets and economies alike. In the current decade, three stand out. Although they are still mostly in the early innings of development, artificial intelligence (AI), electric vehicles (EVs), and reshoring all have growing energy needs.

As it stands, the International Energy Agency (IEA) expects global growth in electricity generation to increase by more than 25% by the end of the decade and to almost double by 2050 (**Chart 1**). However, these projections are likely to be challenged by the massive electricity demand coming from these megatrends.

AI, especially in its generative form, has captivated markets and will usher in a new era for the global economy. But AI is highly energy intensive, and demand for AI in general grows so too will its electricity needs.

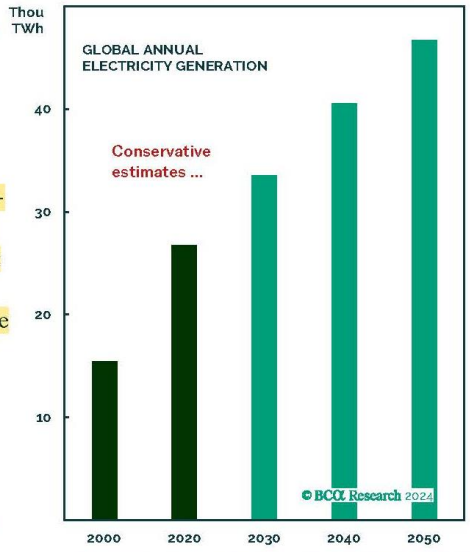
Second is the EV revolution. Adoption of passenger and commercial EVs continues to tick higher, meaning a sufficient and dependable source of electricity to power EVs will need to grow too, and quickly.

Reshoring is third, but this is more of a DM trend, predominantly in the US for now. There is a strong push to reclaim ownership of industrial activity and expand existing industries. The return of manufacturing will spur on higher electricity consumption in the US and Europe.

These megatrends have more than just high energy needs in common. They are all also bound by decarbonization. Tech companies powering the global AI wave like Google, Meta, and Microsoft, among others, have committed to net zero emissions in coming years. EVs are much the same. Government subsidies are geared toward incentivizing less carbon emissions. Most developed countries have penned 2030-2040 as a deadline for no longer selling gasoline powered vehicles.

The cherry on top is reshoring, which adds further impetus to energy demand for industrial activity in the developed economies de-risking their supply chains.

CHART 1
Global Electricity Generation Set To Skyrocket



SOURCE: INTERNATIONAL ENERGY AGENCY (IEA) WORLD ENERGY OUTLOOK 2021 STATED POLICIES.

All together, these megatrends will increasingly need to seek out carbon-free, baseload energy. While several energy sources are carbon-free, just one can provide cheap, baseload power at any time of the day, all day: Nuclear energy.

For this reason, nuclear energy stands to greatly benefit from these megatrends going forward.

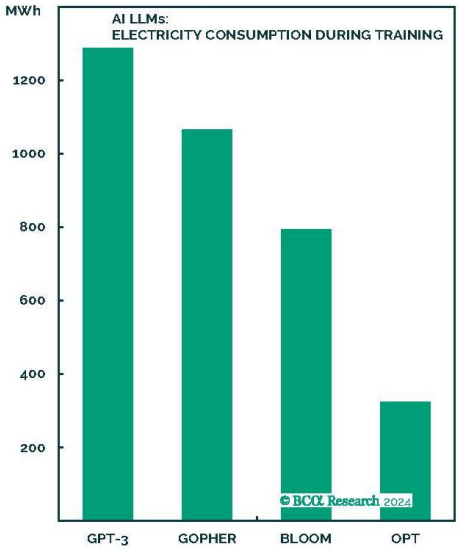
AI: Electrifyingly Energy Intensive

AI-derived large language models (LLMs) are power hungry, both in their training and inference phases. Computing power used to train LLMs and others has gone exponential in the past decade. In training, models like Open AI's GPT-3 consumed almost 1,300 MWh of electricity (**Chart 2**). This is roughly equal to that used by 1,400 average US households in a month.

LLM inference is even more energy intensive. Estimates suggest that ChatGPT responds to approximately two million daily requests, consuming more than 17,000 times the daily energy of the average US household. Tasks also matter. Image generation is more intensive than text given it is more complex to compute (**Table 1**). As interest in more complex AI tasks rises, alongside growing AI development and demand, so too will its energy needs.

Computing competition is another consideration. AI model developers and service providers like Google, Meta, Microsoft, and OpenAI, are in a rat race to achieve the most "complete" models. And while energy

CHART 2
AI Model Training Consumes A Lot Of Energy



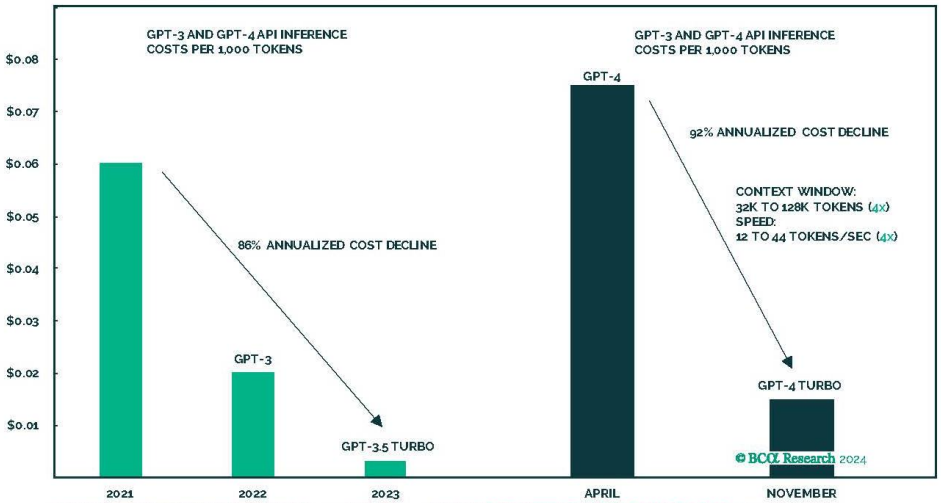
SOURCE: SEMIANALYSIS.COM.

TABLE 1
AI Energy Use By Inference Task

TASK	INFERENCE ENERGY (KWh) MEAN	STD
Text Classification	0.002	0.001
Extractive Qa	0.003	0.001
Masked Language Modeling	0.003	0.001
Token Classification	0.004	0.002
Image Classification	0.007	0.001
Object Detection	0.038	0.02
Text Generation	0.047	0.03
Summarization	0.049	0.01
Image Captioning	0.063	0.02
Image Generation	2.907	3.31

SOURCE: LUCCIONI, A, JERNITE, Y AND STRUBELL, E. 2023. POWER HUNGRY PROCESSINGS: WATTS DRIVING THE COST OF AI DEVELOPMENT?. SEE HERE FOR MORE: https://arxiv.org/pdf/2311.16863

CHART 3
AI Model Inference Costs Are Also Falling Fast



SOURCE: ARK INVESTMENT MANAGEMENT LLC, 2024, BIG IDEAS 2024 REPORT, HTTPS://WWW.ARK-INVEST.COM/BIG-IDEAS-2024
NOTE: THIS ARK ANALYSIS IS BASED ON A RANGE OF DATA SOURCES, INCLUDING PATEL AND KOSTOVIC 2023, AND ARK INVESTMENT MANAGEMENT LLC 2023, WHICH ARE AVAILABLE UPON REQUEST.

demand remains high, hardware and dataset prices used for training and inference have fallen too (**Chart 3**), spurring on a virtuous cycle of more competition, complexity, and ... energy consumption.

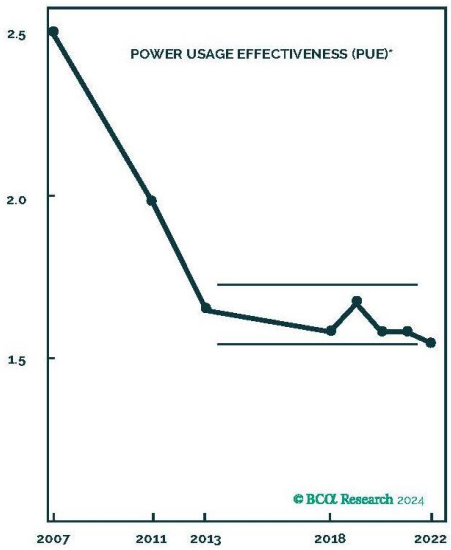
Datacenters Account For Most Energy Demand

Datacenters account for most energy demand. They primarily consume electricity for computing power and subsequent cooling of GPUs. Datacenters require baseload energy because they are always "on."

LLM models' hardware is an energy cruncher too. Graphics processing units (GPUs) which power LLMs have high cooling requirements, which again translates into more electricity usage in datacenters. Since traditional cooling systems are not designed to keep GPUs cool, larger systems require significantly more electricity to do the job. Already, cooling GPUs account for 30%-to-50% of datacenter power consumption globally. Underestimation of GPU cooling can add an additional 10%-to-100% of the total amount of electricity needed.

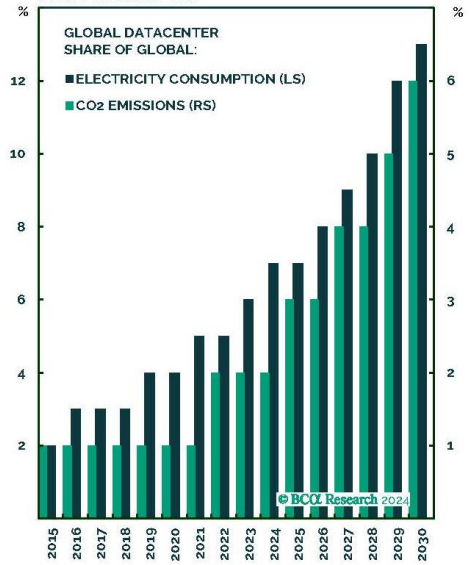
As the global AI rollout takes shape, demand for datacenters has skyrocketed. Today, a shortage of power is already delaying new datacenters by two-to-six years, according to commercial real estate firm CBRE Group. In the US, which leads the world in datacenter market share, existing datacenters are already struggling to meet demand. Centers in Northern Virginia the country's "datacenter capital", with installed capacity of 3,400 MW, are running with just 0.2% spare capacity.

CHART 4
Energy Efficiency In Datacenters Has Stalled



* A MEASURE THAT SHOWS THE AMOUNT OF POWER USED BY THE COMPUTING EQUIPMENT IN A DATACENTER RELATIVE TO ITS TOTAL ENERGY CONSUMPTION. THE CLOSER PUE IS TO 1, THE MORE EFFICIENT A DATA CENTER'S POWER USAGE IS.
SOURCE: UPTIME INSTITUTE INTELLIGENCE AND MCKINSEY & COMPANY

CHART 5
Datacenters Are Power Hungry, And Polluters Too



SOURCE: HUAWEI TECHNOLOGIES, ON GLOBAL ELECTRICITY USAGE OF COMMUNICATION TECHNOLOGY: TRENDS TO 2023.

In the US, datacenters consumed 4% of the country's energy supply in 2022, and are expected to consume 6% by 2026, and nearly 10% by 2030, according to the IEA.

The US Department of Energy also cites that datacenters consume 10-to-50 times the energy per floor space of a typical office building in the US. It is worrying that gains in power usage effectiveness – the amount of power computing equipment in a datacenter uses relative to its total energy consumption – have been stagnant for more than a decade (**Chart 4**).

Globally, datacenter electricity demand and carbon emissions are set to rise rapidly, just like with AI model training and inference (**Chart 5**). Electricity demand is projected to account for 13% of annual global electricity consumption by 2030, an amount close to what Japan currently consumes annually. Meanwhile, datacenter emissions are expected to account for 6% of the world's carbon footprint by 2030.

Okay, so everything AI has tremendous energy needs. Who will be able to meet them going forward?

Utility companies will benefit from higher demand but would still need to expand capacity to meet AI's future needs. They alone simply cannot afford to fund future AI energy demand. In the US, utilities generally have high levels of debt and weak cash flow relative to Big Tech companies – which are

flush with cash and are showing a growing interest in funding energy projects (**Chart 6**).

Big Tech companies will expand their interest in energy projects. No more funding energy projects issues, other than satisfying pledges made by Big Tech themselves: To reach net zero carbon emissions in their operations, some sooner than later.

This means that additional power sourced for Big Tech's AI ambitions will increasingly come from low-carbon, renewable energy sources. But the buck does not stop there. AI models, hardware, and datacenters all have a singular requirement, the need for baseload power. Renewables like wind and solar are unable to provide baseload power because they generate electricity intermittently. Natural gas is an option for net exporter countries like the US but is still considered "dirty" to some extent. If the Big Tech stick to net zero, they will need to chase energy from sources like nuclear. Among carbon-free energy sources, nuclear has the highest capacity factor to meet baseload requirements for AI (**Chart 7**, top panel) and cannot be beaten by other clean energy sources on adding extra power capacity (**Chart 7**, bottom panel).

CHART 6
Utilities Are Both Cash And Debt Constrained Vs Big Tech

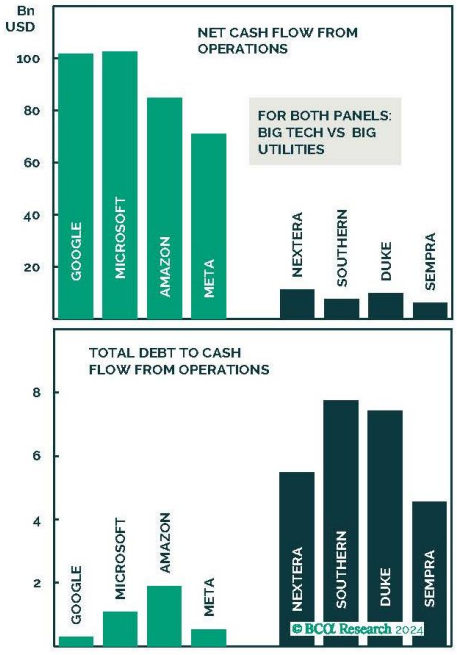
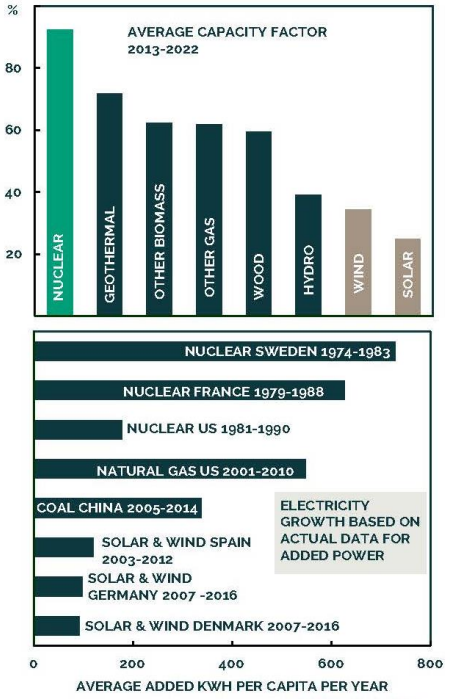


CHART 7
Nuclear Can Meet All Of AI's Energy Needs



SOURCE: US ENERGY INFORMATION ADMINISTRATION (EIA).
NOTE: CAPACITY FACTOR BASED ON HISTORICAL RECORD FOR BEST 10-YEAR PERIOD.

It is no wonder that Big Tech's interest in nuclear is on the rise. Three of the world's largest energy buyers, Nucor Corporation and US tech giants Google and Microsoft, are working together to develop new business models and aggregate their demand for advanced clean electricity technologies, including advanced nuclear.

Microsoft has signed two agreements on nuclear energy, one of which in 2023, agreeing to buy nuclear power from Constellation Energy to power part of its datacenter network.

Amazon is also getting in on nuclear. In March of this year, the world's largest retailer purchased a 100% powered nuclear datacenter from Talen Energy. Amazon reaffirmed its decision by stating it will continue to explore investing in other sources of clean, carbon-free energy outside of its wind and solar energy supply.

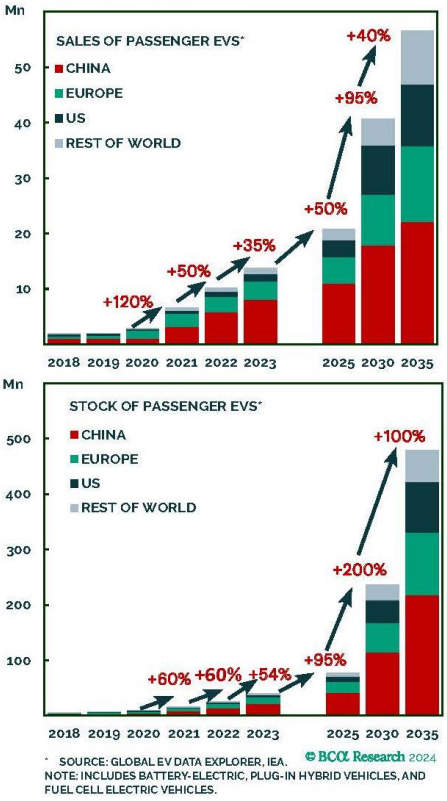
EV Revolution: Don't Miss The Forest For The Trees

Some say the EV craze is already dying out. They view slower growth in new sales of passenger EVs, falling lithium prices, and the 20% year-to-date correction in Tesla's stock price as signs that the EV market could already be maturing.

However, reducing EVs to what is happening in a handful of markets or to Tesla would be a big mistake. The EV revolution is a global phenomenon, an energy-hungry one at that.

Although the annual growth in global sales of passenger EVs has materially slowed compared to 2021 and 2022, the IEA forecasts that global sales will grow by 25% per annum until 2035 (**Chart 8**, top panel). By then, the global fleet of passenger EVs is expected to reach 480 million units, more than ten times today's global EV stock and a 30% stock share of total automobiles by 2035 (**Chart 8**, bottom panel).

CHART 8
R(EV)olution Is Intact



* SOURCE: GLOBAL EV DATA EXPLORER, IEA. © BCA Research 2024
NOTE: INCLUDES BATTERY-ELECTRIC, PLUG-IN HYBRID VEHICLES, AND FUEL CELL ELECTRIC VEHICLES.

Among other things, improvements in price competitivity, range per charge, charging time, and access to charging points are expected to bolster the EV transition in two of the largest markets, Europe and the US.

The rising competition among US and European car manufacturers and the challenge from smaller, cheaper Chinese EV makers has already started putting downward pressure on the average retail price of EVs available in the two regions (**Chart 9**). This is particularly obvious in Europe, where domestic car manufacturers such as Stellantis and Volkswagen are rising to the challenge from Chinese EV makers.

Consumers now have a much wider array of options to choose from compared to just five years ago, with the number of unique models offering 300+ miles per charge growing fast. Optionality and generally higher EV range is particularly important for the US market. A large part of EV reluctance is due to the short range per charge (**Chart 10**, top panel). The other good news

CHART 9
Global EV Prices Will Come Down

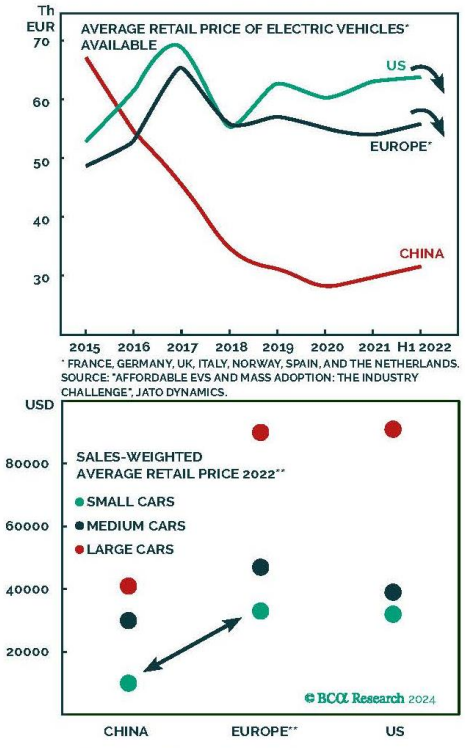
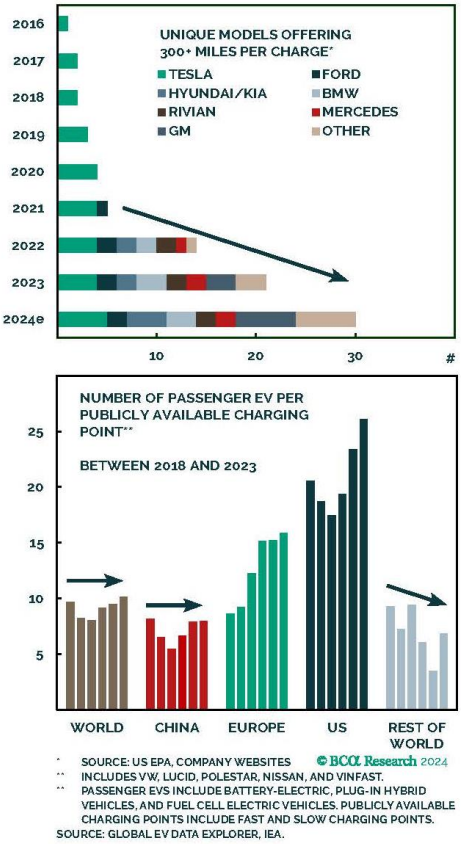


CHART 10
Lower EV Reluctance



about longer-range batteries is that they are typically made with materials better suited to fast charging. In the meantime, publicly available charging points have generally managed to keep up with the rising stock of passenger EVs (**Chart 10**, bottom panel). There are now four million public charging points available globally – which means there is one per 10 passenger EVs.

When musing about the future of EVs, an important aspect is often ignored: The EM (ex. China) and non-passenger car EV segments are shifting gears fast. Many EM countries have started supporting the transition to EVs, leading to stunning annual growth rates in sales (**Chart 11**, top panel).

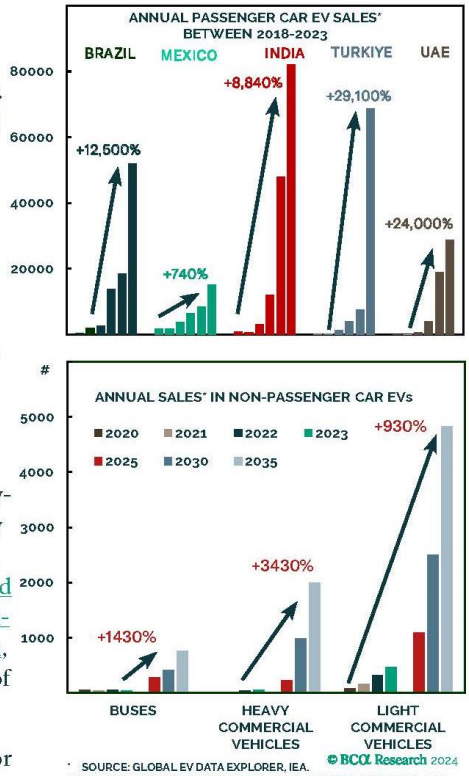
Non-passenger car EVs, which consist of light commercial vehicles, buses, and heavy-duty trucks are also joining the electric fray (**Chart 11**, bottom panel). Sales more than doubled from 2021 to 2023 and are expected to closely follow in the tire tracks of passenger car EVs when it comes to future growth, especially when you consider the long list of government pledges around the world.

So, what do these growth numbers mean for future electricity demand?

In 2023, global electricity demand from EVs of any type amounted to more than 120 TWh worldwide, or 0.5% of global electricity demand (**Chart 12**). By 2035, the IEA pencils in 2 100 TWh needed to power a global EV fleet representing one third of all vehicles. This is 17 times more than in 2023 and represents half of what the US consumes annually today.

Considering road transportation accounts for about 15% of global energy-related emissions, the transition to EV is of central importance to decarbonizing. As with AI, it also represents an opportunity for nuclear energy, since EVs are only as clean as the source of energy used to charge them. The US Department of Energy provides estimates for emissions depending on the carbon intensity of the electric grid by state (**Chart 13**). These estimates show a wide range of emissions for all EVs depending on the state energy mix.

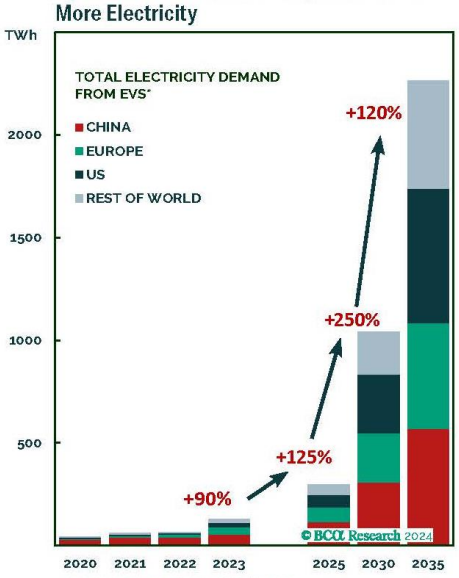
CHART 11
EV Growth Segments



* SOURCE: GLOBAL EV DATA EXPLORER, IEA.
NOTE: INCLUDES BATTERY-ELECTRIC, PLUG-IN HYBRID VEHICLES, AND FUEL CELL ELECTRIC VEHICLES.

CHART 12

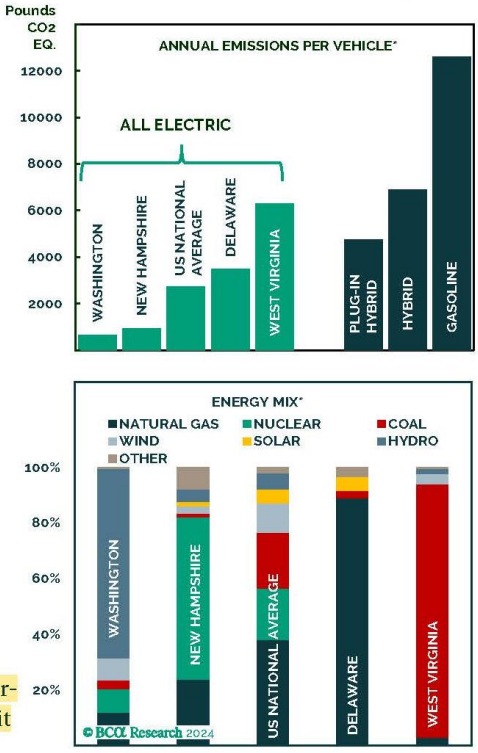
By 2035, Global EVs Will Require 17 Times More Electricity



* SOURCE: GLOBAL EV DATA EXPLORER, IEA.
NOTE: INCLUDES PASSENGER CARS, BUSES, LIGHT COMMERCIAL VEHICLES, AND HEAVY DUTY TRUCKS

CHART 13

EVs Are Only As Green As Their Energy Grids

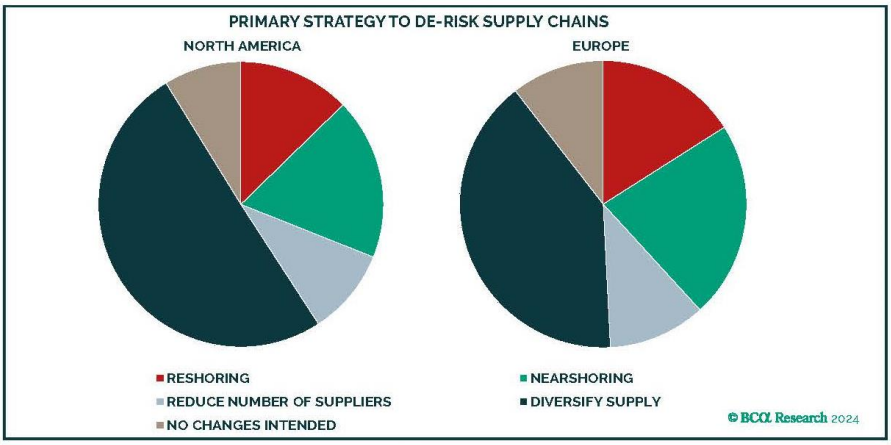


* BASED ON ASSUMPTIONS WITH 2022 DATA FROM EIA.
SOURCE: US DEPARTMENT OF ENERGY

For example, an EV charged in hydropower-heavy Washington State is expected to emit 19 times less carbon than gasoline cars and seven times less carbon than a plug-in hybrid. In coal-heavy West Virginia, EVs still manage to emit less carbon emissions than gasoline cars, but only by a factor of two. In New Hampshire, where 58% of electricity is generated by nuclear power (the highest share among US States), EV emissions are close to those in Washington State, despite 24% of New Hampshire's electricity sourced from natural gas. As decarbonizing becomes more pressing, these differences will become more relevant, eventually favoring nuclear energy over natural gas.

EV charge demand patterns also favor nuclear energy – the ultimate baseload power source. Demand from charging stations tends to peak in the morning and in the evening. For example, most EV charging takes place overnight. This is when renewable energies like solar and wind have low capacity factors. Future charging options like flash and in-road charging also call for clean, baseload energy.

CHART 14
Reshoring Will Continue To Accelerate As Geopolitical Turmoil Rises



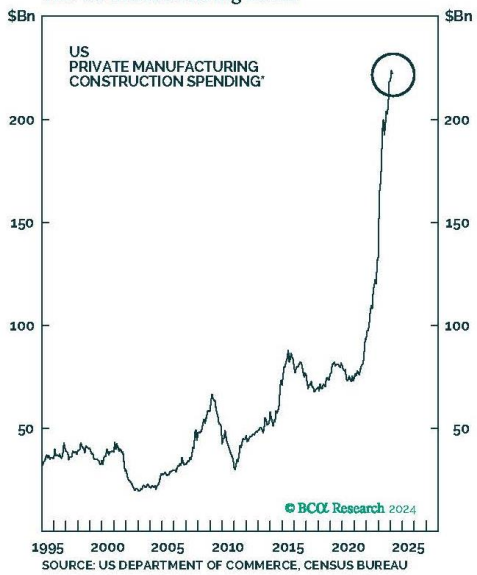
SOURCE: ECONOMIST IMPAC TRADE IN TRANSITION SURVEY (SEP-NOV 2022).

Reshoring And The Clean Tech Manufacturing Boom

The supply chain disruptions experienced during the Covid-pandemic forced developed economies to rethink their overall supply chains. Meanwhile, the Ukraine-Russia war and its implications on energy and commodity markets accelerated the reshoring trend to de-risk supply chains from countries such as Russia or China. By the end of 2022, 13% and 16% of North American and European companies considered reshoring as a primary corporate objective, respectively (**Chart 14**).

When it comes to critical industries such as EVs, batteries or semiconductors, however, the US and Europe are positioning themselves to do more than just de-risk their supply chains from China. The Inflation Reduction Act in the US and the NGEU/Net Zero Industry Act in the European Union (EU) are leading to a manufacturing boom. The boom has been pronounced in the US (**Chart 15**).

CHART 15
The US Manufacturing Boom

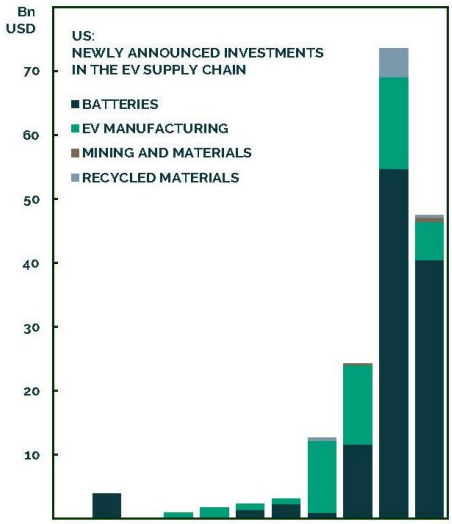


SOURCE: US DEPARTMENT OF COMMERCE, CENSUS BUREAU

In the battery sector alone, more than a $100 billion worth of investment has been announced in 2022 and 2023, of which 80% is for battery manufacturing and 20% for EV manufacturing (**Chart 16**). On the other side of the Atlantic, trade tensions are rising between the EU and China. The EU is expected to impose additional tariffs on Chinese EVs, as cheap Chinese EVs have been flooding the European market and are suspected of being kept artificially low via large subsidies from Beijing.

Government incentives are also a key factor when it comes to semiconductors (**Table 2**). China has been leading the push with a $150 billion envelope from 2021-2025, but is now followed closely by the US, South Korea, and the EU with support programs

CHART 16
Reshoring The EV Supply Chain



SOURCE: JAMES MORTON TURNER. © BCA Research 2024

TABLE 2
The World Is Fighting Over Another Industry: Semiconductors

	KEY GOVERNMENT INCENTIVES FOR SEMICONDUCTOR INDUSTRY					
	TAIWAN	SOUTH KOREA	JAPAN	CHINA	US	EU
GLOBAL SHARE SEMICONDUCTOR MANUFACTURING CAPACITY	20%	19%	17%	16%	13%	8%
PROGRAM	STATUTE FOR INDUSTRIAL INNOVATION	K-CHIPS ACT	NATIONAL SEMIS PROJECT	14th FIVE-YEAR PLAN	CHIPS AND SCIENCE ACT	EU CHIPS ACT
TIME FRAME	2023-2039	2022-2031	2022-2025	2021-2025	2022-2026	2022-2030
AMOUNT ($Bn)	15-20	55-65	10	150	74	49

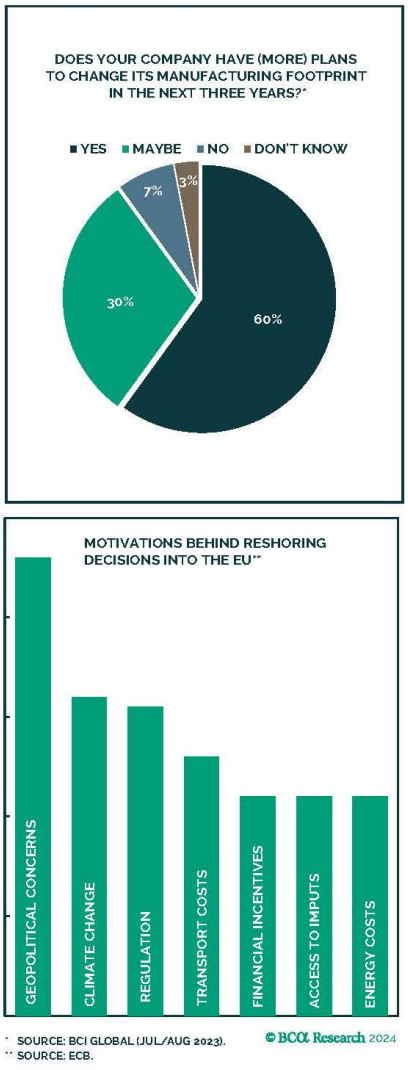
SOURCE: RBC, BCG, AND SEMICONDUCTOR INDUSTRY ASSOCIATION.

spanning until 2030. Despite delays, Taiwan Semiconductor Manufacturing's $40 billion chip manufacturing complex in Arizona is making progress, and so is Intel Corp's facility in Ohio. These two companies are also working on joint projects in Europe which will show promise going forward.

Whether it is producing the batteries powering EVs or the GPUs powering data-centers, this wave of more industrial activity is going to need a significant amount of electricity. By 2030, manufacturing EV batteries on US soil will require about 30 TWh of electricity per year – the equivalent of 2% of total US industrial electricity used in 2022.

Again, this is where nuclear energy can shine. This is not simply a manufacturing boom, but a clean tech manufacturing boom. According to a BCI Global survey, most companies intend to change their manufacturing footprint by 2030 (**Chart 17**, top panel). In the Eurozone, climate change is the second most important factor for moving production back into the EU (**Chart 17**, bottom panel).

CHART 17
Reshoring & Decarbonizing



* SOURCE: BCI GLOBAL (JUL/AUG 2023).
** SOURCE: ECB.

Investment Implications

A bull market for electricity is in the making, energized by the aforementioned megatrends. The need for decarbonizing and the positive momentum nuclear energy currently enjoys imply that our Nuclear Theme equally weighted equity portfolio, constructed using the most common constituents in nuclear energy-related ETFs, will continue to outperform the broad market for years to come (**Chart 18**).

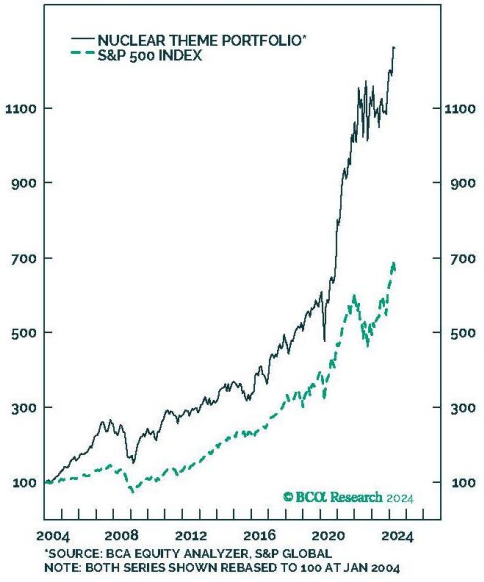
When discussing How To Invest In The Nuclear Renaissance, we noted that utility companies running nuclear power plants would benefit from the Nuclear Renaissance despite not being involved in the nuclear fuel cycle per se. As a matter of fact, 36 of the 48 constituents of our Nuclear Theme basket are utility companies.

More generally, the utility sector makes an excellent overweight candidate within equity portfolios, both on a tactical and a structural time horizon. US utilities are also highly ranked at #3 in BCA's MacroQuant's Sector Selector (**Chart 19**).

Due to its defensive nature, the utility sector has upside given BCA Research's expectations of a recession penned for the end of 2024 or in early 2025. Historically, utilities tend to outperform the broader market when government bond yields fall (**Chart 20**). Moreover, valuations are cheap and utilities appear to be oversold (**Chart 21**).

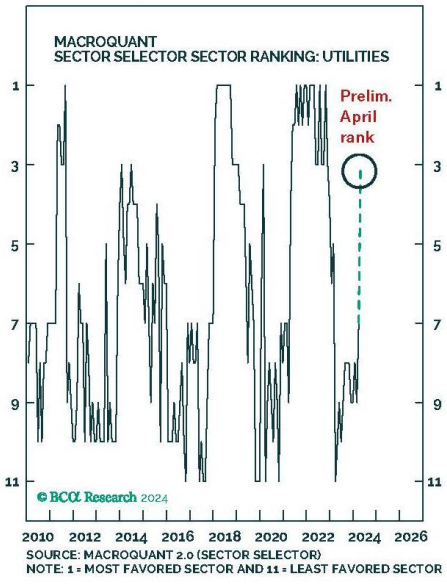
Within the utility sector, we recommend investors favor companies exposed to the nuclear theme. Since 2000, the utility companies in our Nuclear Theme portfolio

CHART 18
Nuclear- And Investor-Friendly Megatrends



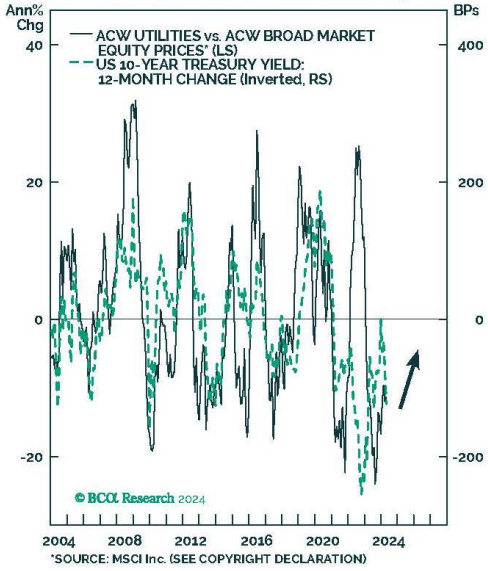
*SOURCE: BCA EQUITY ANALYZER, S&P GLOBAL
NOTE: BOTH SERIES SHOWN REBASED TO 100 AT JAN 2004

CHART 19
BCA MacroQuant Favors Utilities



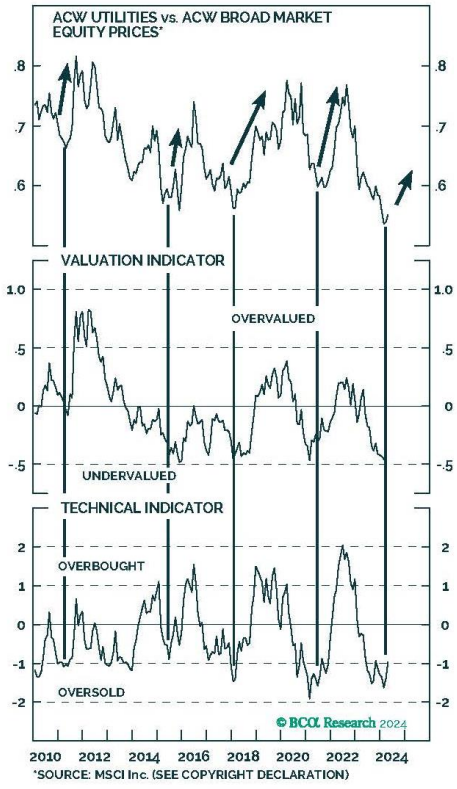
SOURCE: MACROQUANT 2.0 (SECTOR SELECTOR)
NOTE: 1 = MOST FAVORED SECTOR AND 11 = LEAST FAVORED SECTOR

CHART 20
Once Bond Yields Fall, Utilities Will Outperform



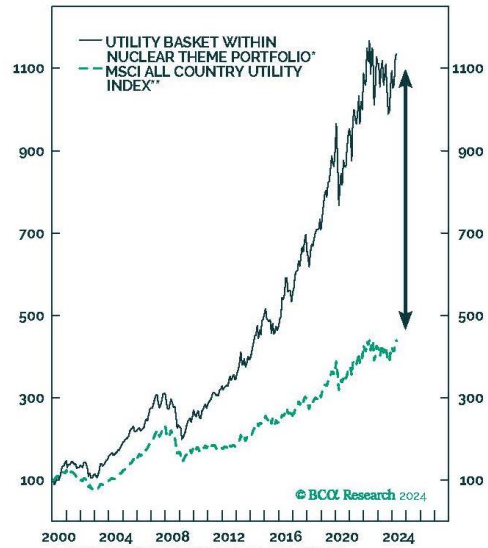
*SOURCE: MSCI Inc. (SEE COPYRIGHT DECLARATION)

CHART 21
Cheap And Oversold



*SOURCE: MSCI Inc. (SEE COPYRIGHT DECLARATION)

CHART 22
Energizing A Trade On Nuclear Power



* SOURCE: BCA EQUITY ANALYZER, S&P GLOBAL
**SOURCE: MSCI Inc. (SEE COPYRIGHT DECLARATION)
NOTE: BOTH SERIES SHOWN REBASED TO 100 AT JAN 2010

have outperformed the global utility sector by 600% (**Chart 22**).

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