

WHITEPAPER



CRITICAL ISSUE:
**DRIVING U.S. ENERGY POLICY
AND REDUCING FOREIGN
DEPENDENCE ON
CAPACITOR FILMS FOR
ENERGY OPTIMIZATION**



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EXECUTIVE SUMMARY

UP TO **2-4x**
ENERGY STORAGE

UP TO **2x**
BETTER THERMALS

UP TO **50%**
SMALLER CAPACITORS

According to the U.S. Energy Information Administration, demand for the electric power grid in the United States will likely face a 27 percent increase by 2050. Significant improvements to the grid infrastructure are needed to meet this demand and maintain safe reliability, in conjunction with new technologies that will make energy flow more efficient, affordable, and reliable. The Federal government is driving several initiatives related to renewable energy, power grid enhancements, electric vehicles, and the development of fusion energy. These plans all rely on upgrading aging infrastructure and developing new technologies through domestic suppliers that reduce dependence on China and other nations.

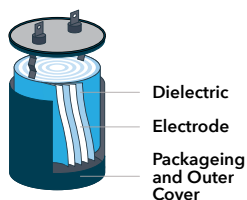
New policies and provisions include:

- Inflation Reduction Act
- CHIPS and Science Act
- Executive Order on Catalyzing Clean Energy Industries
- GOA Report on Fusion Energy
- Paris Agreement

Capacitor films will play a critical role in meeting future demand and reliability. Yet, the United States remains nearly 100 percent dependent on foreign supply. This includes approximately 80 percent from China, 10 percent from India, and about 10 percent from Europe.

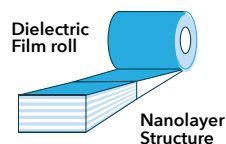
Capacitor films today are based on a material known as BOPP (Biaxially Oriented Polypropylene). The industry has reached the technological limits of this material, and users are seeking next generation solutions to meet growing demand.

Conventional Film Capacitor



Low Energy Density
Low Temperature Use

Peak NanoPlex Dielectric Film



High Energy Density
Exceptional Breakdown Strength

Plastic Film Capacitors	Dielectric Constant	Max Temp.
BOPP	2.2	85° C
PET	3.1	105° C
Others (PPS, PEN, PTFE)	1-3	150° C
Peak NanoPlex Film	4-6	150° C



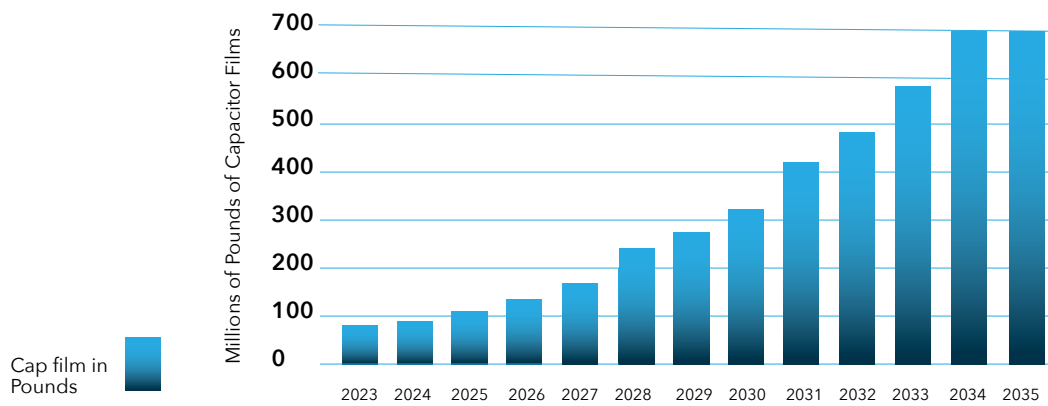
NANOPLEX™

**PEAK NANO
HAS DEVELOPED
A BREAKTHROUGH
CAPACITOR FILM
TECHNOLOGY
CALLED
NANOPLEX™**

In 2024, the United States will order 80 million lbs. of capacitor films, according to Grand View Research, with projected growth between 10 to 25 percent annually through 2035. Emerging energy sources, such as fusion, could accelerate this growth significantly.

Peak Nano has developed a breakthrough capacitor film technology called NanoPlex™. This technology significantly outperforms existing BOPP capacitors and is designed and manufactured entirely in the United States. This paper details how this new generation of capacitor films can help meet growing demand for power and satisfy emerging energy policies, while reducing foreign dependence on supply.

U.S. CAPACITOR FILM DEMAND



Source: Grand View Research 2022 Report





STRATEGIC SOLUTIONS FOR U.S. ELECTRIC POWER NEEDS

The U.S. government is driving several initiatives related to renewable energy, carbon emissions, power grid enhancements, EVs, and the development of fusion energy. These plans are based on upgrading an aging power grid and developing new technologies through domestic suppliers that reduce dependence on China.

According to the U.S. Energy Information Administration, advanced technologies, working in conjunction with power-grid improvements, must meet a 27 percent increase in demand by 2050. Emerging technologies like NanoPlex™ film capacitors will be essential in growing power demands. Driving these changes are provisions included in the following legislation, executive orders, and international accords:

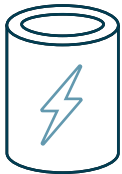
EMERGING TECHNOLOGIES LIKE **NANOPLEX FILM CAPACITORS** WILL BE ESSENTIAL IN GROWING POWER DEMANDS.

- **The Inflation Reduction Act (IRA)** - The Inflation Reduction Act of 2022, which provides significant incentives for investing in renewable energy and clean technologies, also spurs interest in power and utilities, according to EY. The law extends tax credits with incentives for wind, solar, carbon sequestration, pure hydrogen, nuclear, and other technologies. The act targets a \$369 billion investment in energy and climate over the next decade. It is expected to drive a cumulative capital investment of more than \$4.1 trillion in the U.S. energy supply infrastructure.
- **CHIPS and Science Act** - This is one of the leading drivers of critical reshoring efforts and will drive domestic energy demand. The CHIPS and Science Act will boost American semiconductor research, development, and production. America invented semiconductors, but today produces about 10 percent of the world's supply – and none of the most advanced chips. Instead, the nation relies on Asia for 75 percent of global production. The CHIPS and Science Act will unlock billions of dollars in private-sector semiconductor investment, including production essential to national defense and other critical sectors.
- **Executive Order on Catalyzing Clean Energy Industries** - Contains several policy statements focused on creating a sustainable domestic energy program. This requires U.S.-based supply chains to protect our national security. In section 101, the White House states it is the policy of my Administration for the Federal Government to lead by example to achieve a carbon pollution-free electricity sector by 2035 and





5200
TERAWATT
HOURS
BY 2050

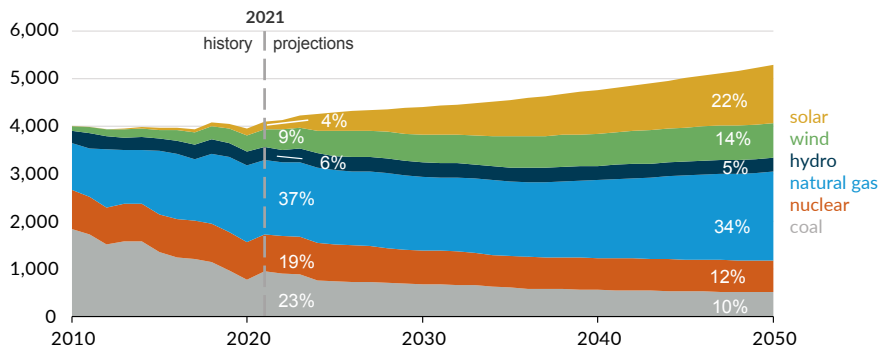


U.S. POWER CONSUMPTION

According to the US Energy Information Administration, electricity demand in the United States stood at roughly 4,000 terawatt hours in 2022. The market is projected to rise and reach 5,200 terawatt hours by 2050 – an increase of approximately 27 percent. Our aging power grid and increased demand create a crisis-level reliability risk, as demonstrated recently in Texas.

U.S. Electricity Generation from Selected Fuels AEO2022 Reference Case

Billion Kilowatthours



STRATEGIC RISKS TO POLICY EXECUTION

Six Strategic Risks for U.S. Energy Policy

The U.S. power grid is large, complex and aging. As we move forward with significant energy policies, from renewable energy to the promise of fusion technology, new solutions will be required to sustain and upgrade the national power grids.

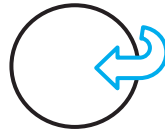
The gap between policy and execution will require us to rethink our power grid technology, ensure a sustainable U.S.-based supply chain, and address seamless integrations.



SIX

STRATEGIC

RISKS



1 | 90% reliant on China supply chain
Critical materials and components are primarily sourced from China.



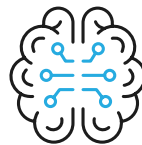
2 | Expanding policy portfolio requirements
The myriad of new policies create compliance risk to upgrade and sustain grids.



3 | Geopolitical Risks
China and Russia represent high-risk parts and critical materials, including lithium.



4 | Power grid age and fragility
Most of our current power grid is over 25 years old and needs to be upgraded.



5 | Expanded power demand and growth
Power demands continue to grow with populations, reshoring, EVs, and AI.



6 | Power grid integration from renewable sources
Power generated from different sources requires proactive conditioning to be seamlessly integrated into the grid.



ADDRESSING THE RISKS IN U.S. ENERGY POLICY

We are fortunate that many steps to mitigate or eliminate the above mentioned risks are underway. When we consider the significant policy demands mentioned previously, U.S.-based companies need to address five major technology areas to enable an entirely domestic energy program:

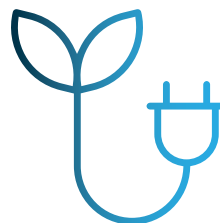
ENABLE AN
**ENTIRELY
DOMESTIC**
ENERGY
PROGRAM.

Here is a quick summary of how this mitigation can be achieved:

- 1. Eliminate our dependence on China** - Today, a U.S.-based technology and supply can replace our reliance on storage capacitors produced predominantly in China. NanoPlex™ technology uses a new power-storage medium of film capacitors. It has proven to be the only solution that meets the current demands of the power grid, can help power condition renewable energy, and address future demand for fusion energy based on research from Sandia National Labs.
- 2. Integrate Multi-Source Power Generation** - In the data provided by the Energy Information Administration, significant growth predictions for renewable energy are predicted. Seamlessly integrating these sources into the U.S. power grid requires next-generation power conditioning capabilities being developed today. With proper funding, mass production will support growth to achieve national policy plans.
- 3. Mitigate Geopolitical Risks** - Reshoring supplies required to sustain and evolve power grid technologies based on next-generation solutions like NanoPlex will reduce dependence on foreign supply-chain risk from China.
- 4. Enhance and Stabilize Current Power Grids** - Eaton Corporation and other companies have developed mobile power enhancement solutions using high-powered, capacitor-based, enabling power providers such as ERCOT to deliver more stable power grids. This technology is early in the deployment phase and if appropriately scaled, could create a method to provide power on demand anywhere needed. NanoPlex films' ability to store higher energy in a smaller package will yield size and weight reductions necessary for viable and widespread grid mobility solutions.
- 5. Fusion Readiness** - Today, Sandia, Oak Ridge, and other national labs, in partnership with firms such as General Atomics and SARA, are developing groundbreaking fusion energy solutions but are constrained by the limitations of current film technologies. Technology such as NanoPlex-based capacitors will enable 2-3X power efficiency gains, critical to helping clean U.S.-based power production.



IMPROVING THE GRID, OPTIMIZING GREEN ENERGY AND PREPARING FOR FUSION



ENHANCING U.S.-BASED ENERGY PRODUCTION TODAY AND TOMORROW

NanoPlex capacitors are one of the new technologies required for our nation to have a U.S.-based energy supplychain. This technology will sustain our current power grid, integrate renewable energy sources, and accelerate the development of fusion energy. NanoPlex-based solutions can enhance, optimize, and expand critical aspects of the U.S. power grid related to power management, distribution, and efficiency:



Power Grid Enhancement

- Mobile Capacitor Boosters
- Optimize Distribution Efficiency

Today's limited power grid has been in service for decades, while demand has significantly exceeded its original capacity. Companies like Eaton Corporation have created mobile power management solutions that supplement



Renewable Integration

- Integrate Renewable Sources
- Optimize Power Conditioning

Each type of energy generation can contribute to the overall power grid capacity, but each power source generates power with different attributes and consistency. The ability to integrate these various sources into a predictable and consistent power service is one of the critical areas that NanoPlex solutions can help scale and optimize the grid. or increased demand.



Fusion Power Optimization

- Nano Powered Lasers
- Optimize Power Generation

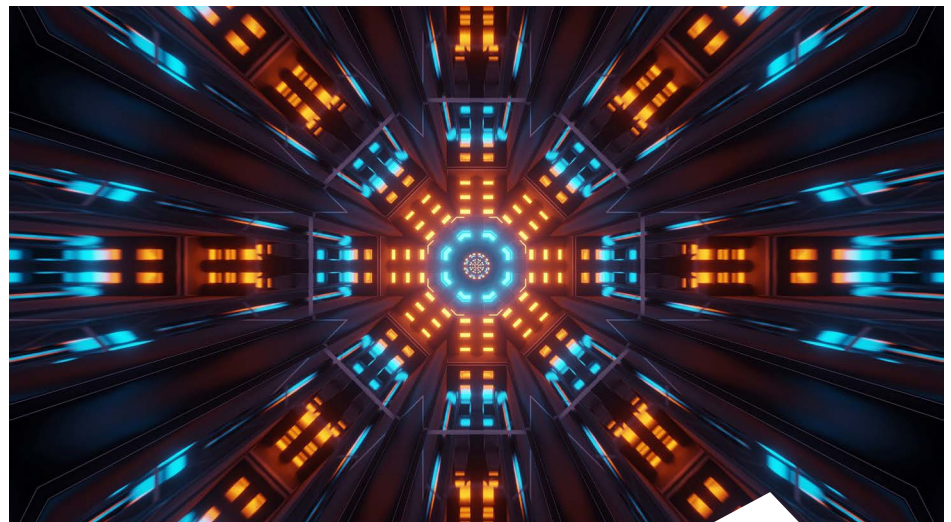
The first significant step in fusion power generation is using lasers to create a reaction. NanoPlex-based capacitors enable higher-intensity laser pulses, increasing the efficiency output of fusion reactors by two to four times of conventional solutions - BOPP (Biaxially-Oriented Polypropylene), China produces 90% of global supply. or increased demand.



NANOPLEX IS FUSION READY - INVEST NOW

EACH FUSION
REACTOR
REQUIRES
**HUNDREDS
OF THOUSANDS
OF POUNDS**
OF NANOPLEX
CAPACITOR
TECHNOLOGY.

Our U.S. energy policy rightfully looks toward fusion power solutions. This technology requires a secure U.S.-based supply chain. Leading scientists at national labs and companies such as General Atomics are developing capacitor solutions that can utilize NanoPlex technology. Each Fusion reactor requires hundreds of thousands of pounds of NanoPlex capacitor technology. The government and private-sector companies need rapid action and investment to secure a significant investment. Manufacturing equipment lead times for producing tens of millions of pounds of capacitor film annually requires investments of \$300 to \$500 million and development times spanning three to four years. Without a paradigm shift in prioritizing domestic capacitor film manufacturing soon, there remains a growing risk for capacitor film supply disruptions and shortfalls in the power grid, clean energy (wind, solar, fusion) generation, EVs, and military pulsepower applications.





THE STRATEGIC IMPERATIVE - ELIMINATE CHINA FROM U.S. POWER GRID

The United States energy storage sector has a 100 percent dependence on foreign supply of thin polymer (BOPP) films for capacitor devices. The lack of U.S. domestic production poses a significant threat to continued infrastructure operations and advancing White House initiatives in transportation, electrical grid infrastructure, and defense markets. U.S. import levels of capacitor films are approaching 25% of the global manufacturing capability and are solely dependent on supplies from China and other Asian manufacturers.

Making the strategic move to NanoPlex solutions can transition our power grid to a US-based supply chain. NanoPlex has emerged as the next-generation replacement for BOPP for three core reasons:



1. US-Based Design and Manufacturing - NanoPlex is patented, designed, and manufactured in the U.S. and will provide the power grid with a protected and scalable supply chain.



2. Next-Gen Power Capabilities - NanoPlex-based capacitors exceed BOPP-based solutions in every dimension.

- a. **More Power:** 2 to 4 times more power storage
- b. **Smaller Footprint:** 50 percent size reduction to optimize deployment.



3. Cost Benefits - The next-gen power capabilities enable designers to optimize cost by managing power solutions with half the capacitors or twice the power capabilities within the same footprint. Either way, the value and benefits derived from using NanoPlex technology exceed current BOPP-based options.





THE STRATEGIC GAP IN U.S.-BASED CAPACITORS TO MEET ENERGY POLICY

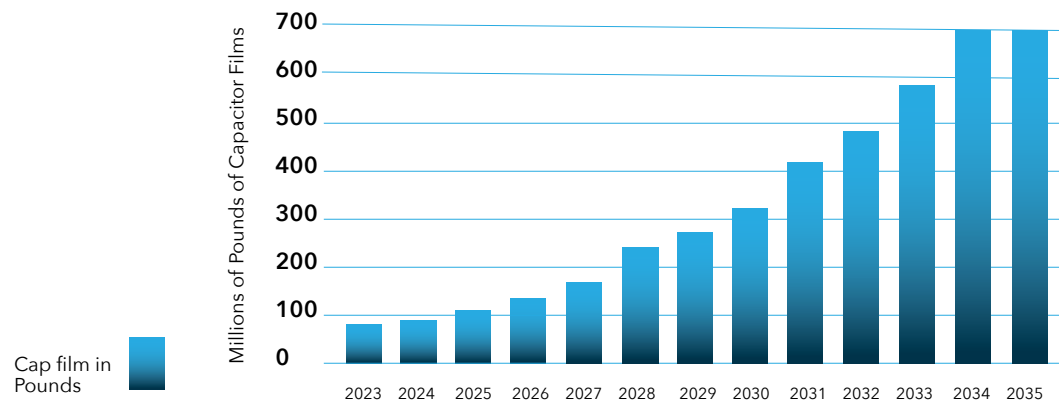
700
MILLION
POUNDS
BY 2035

The United States consumed more than 80 million pounds of thin polymer capacitor films imported this year to meet market demand and is expected to grow to over 700 million pounds by 2035. Increasing demand for electrical energy and electricity-powered devices poses a more significant challenge for the U.S. The market for capacitor film demand is being driven by the following:

- 27% growth in overall power for consumers and industry
- 35% annual growth in EVs and charging stations
- Development of Fusion Energy

The US strategically needs a domestic capacitor polymer film manufacturing capacity to eliminate reliance on China and India for capacitor film.

U.S. CAPACITOR FILM DEMAND



Source: Grand View Research 2022 Report



RESHORING FILM CAPACITORS FOR U.S. ENERGY POLICY

WE MUST RESHORE CAPACITOR FILM PRODUCTION

During the past few years, global supply chains in virtually every technology field have been vulnerable and subject to geopolitical risks. We must reshore capacitor film production to address U.S. energy policies, similar to chip technology.

The infrastructure to produce capacitor film at volume is highly specialized and possesses multi-year lead times. For example, manufacturing lines capable of approximately three million pounds per year of capacitor film requires a production space roughly equal to the size of a football field.

It requires investments approaching \$50 million per line and a current lead time from suppliers of 36 to 48 months. The projected increasing demands across the domestic energy, transportation, and government markets result in critical need and speed for domestic investment and the development of multiple capacitor film manufacturing lines.

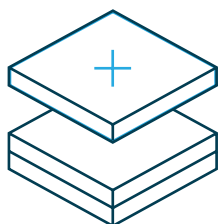
As Peak continues to rely on its own in-house fundraising, product lead times are dependent on the rate of the company's fundraising efforts. In some cases, delays in fundraising could substantially extend lead times based on market conditions. Government support could help ensure effective and reliable timelines and many in cases accelerate them.





ENABLING A U.S.-BASED CAPACITOR FILM SUPPLY CHAIN WITH NANOPLEX

PEAK HAS DEMONSTRATED SIGNIFICANT CAPABILITIES TO RELIABLY MASS PRODUCE ULTRA-THIN CAPACITOR FILMS BELOW 6



Peak was founded to commercialize high-performance polymer film technology to support the domestic warfighter and critical infrastructure targeted applications. With early roots in Defense Advanced Research Projects Agency and Department of Defense-based technology development programs leveraging its patented thin nanolayered polymer film technology, Peak has raised more than \$80 million of private equity funds. The capital has enabled a high-performance polymer material manufacturing foundry and developed an initial production capacity of up to 1,000,000 pounds per year of high-performance capacitor polymer film for use in selected military and high energy density capacitor applications.

The Peak Capacitor Film Production Facility is the only known manufacturer of dielectric film for capacitors in the U.S. It is currently producing thin polymer capacitor films that are undergoing qualification with integrators of capacitor devices in various markets, including defense/pulsed power, transportation, electrical grid, and medical sectors.

Peak has demonstrated significant capabilities to reliably mass produce ultra-thin capacitor films below 6 microns. This includes new Nanoflex materials and traditional plastic capacitor films.

Peak has begun a business growth plan to expand its capacitor film production facility and dedicate capital to broaden its capability to recapture state-of-the-art biaxially-oriented film manufacturing to support the conventional electric grid, electric vehicles, and renewable energy generation farms for domestic growth.

This will also reduce 100 percent dependence on foreign polymer film supply chains, reduce the environmental impact of delivering energy through more efficient polymer films, reduce energy transportation costs of using foreign-made films, and enable growth in green energy generation farm installations through more efficient supply chains.

However, the annual 80 million pounds per year U.S. requirement of polymer capacitor films outpaces Peak's current resources and growth plans without significant assistance from government prioritization and partnerships with domestic capacitor converting companies.



INVESTMENT STRATEGY FOR U.S.-BASED CAPACITOR FILM INDEPENDENCE

PEAK AIMS TO INCREASE CAPABILITY FOR 15 MILLION POUNDS PER YEAR IN CAPACITOR FILM CAPACITY

Leveraging its manufacturing foundries and polymer materials in Cleveland, Ohio, along with a workforce of nearly 100 engineers and highly skilled manufacturing personnel, Peak Nano has put forth a domestic infrastructure initiative to the U.S. Department of Energy.

This initiative, presented under Title XII and loan programs, aims to accelerate the domestic scale-up of polymer film manufacturing to meet the demands of existing electric vehicles, renewable energy, and high-pulsed power electric grid and fusion generation capacitors.

Peak aims to increase capability for 15 million pounds per year in capacitor film capacity targeted toward:

- 9 million pounds per year of dielectric film for grid and renewable applications
- 5 million pounds per year of oriented capacitor film for grid and EV applications
- 1 million pounds per year targeted toward pulsed power and fusion-generated systems
- Supporting quality assurance systems & equipment
- The continued growth and support of domestic materials and electrically focused human resources for manufacturing and developing capacitor filmmaterials, products, and integrated systems.

The critical size for an effort that could ensure a supply of only 10 to 20 percent of the current U.S. capacitor film annual demand will require an overall capacitor investment approaching \$500 million and a timeframe of four to five years to realize the domestic supply of capacitor film to market. It is imperative action be taken by the federal government to remedy the existing 100 percent foreign reliance on capacitor films to maintain a living and continually advancing energystorage chains.

CONCLUSION

Peak Nano is working to address the demands related to our power grid, EVs, and fusion energy, which requires government and private industry investments in several areas. Peak continues to develop and invest in NanoPlex film technology and production. Still, it will require government and private equity funding to build and validate the solutions needed for NanoPlex to address one critical technology related to capacitor film independence. This reshoring project will also create new high-skill, high-paying U.S. jobs. We seek to partner with the government and private companies such as General Atomics. We can create a brighter future for an independent U.S. energy policy and execution.

CREATE A **BRIGHTER FUTURE** FOR
INDEPENDENT U.S. ENERGY.



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