

A photograph of several wind turbines on a mountain peak, viewed through vertical blue bars. The background shows a hazy mountain range under a cloudy sky.

Macro Meets Micro:

DECIPHERING RENEWABLE
ENERGY TRENDS IN 2024



THE GROUNDWIRE GROUP

Fresh, relevant, and actionable strategy

From the energy transition to the economy, we are in the midst of a global paradigm shift that will continue to play out in unexpected ways. Our proven techniques are rooted in the emerging discipline of systems thinking. This offers a framework for understanding why complex systems produce existing outcomes. Using a facilitative approach, Groundwire can help your organization solve its most difficult problems by identifying opportunities to shift the system and change the outcome.



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A systems-thinking approach to our energy future

What is systems thinking?

Our first annual renewable energy trends report puts a new spin on typical trend forecasting. By applying systems thinking to the dynamic landscape where renewable energy unfolds, readers unearth new insights that can guide their work throughout the year.

In a world where complexity grows exponentially, and the connections between economies, people, and cultures are ever more entwined, systems thinking offers a way of grappling with that complexity. Visualizing all the various elements in a system and mapping their interactions can help us understand the connections that form our modern world.

Today's fast-paced business environment drives a task-oriented mindset that leaves little room for the bigger picture. Context is treated as a distraction and organizational bias seeks simple solutions. This report will instead explore many layers of context to tease out the trends that really matter, empowering renewable energy leaders to drive a more successful clean energy transition.



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In the rearview: major events of 2023

- Implementation of historic U.S. energy policies in the Inflation Reduction Act
- Rising interest rates and supply chain costs stall projects
- Hottest year in NOAA's 174-year climate record, by a mile
- The most billion-dollar disasters recorded in the U.S. in a single year¹
- The most solar capacity installed globally, and in the U.S., in a single year^{2,3}

These events don't happen in isolation. They are deeply connected to a broader system driven by human actions. How we react and how we interact with what is happening around us, allows us to shape our shared energy future.

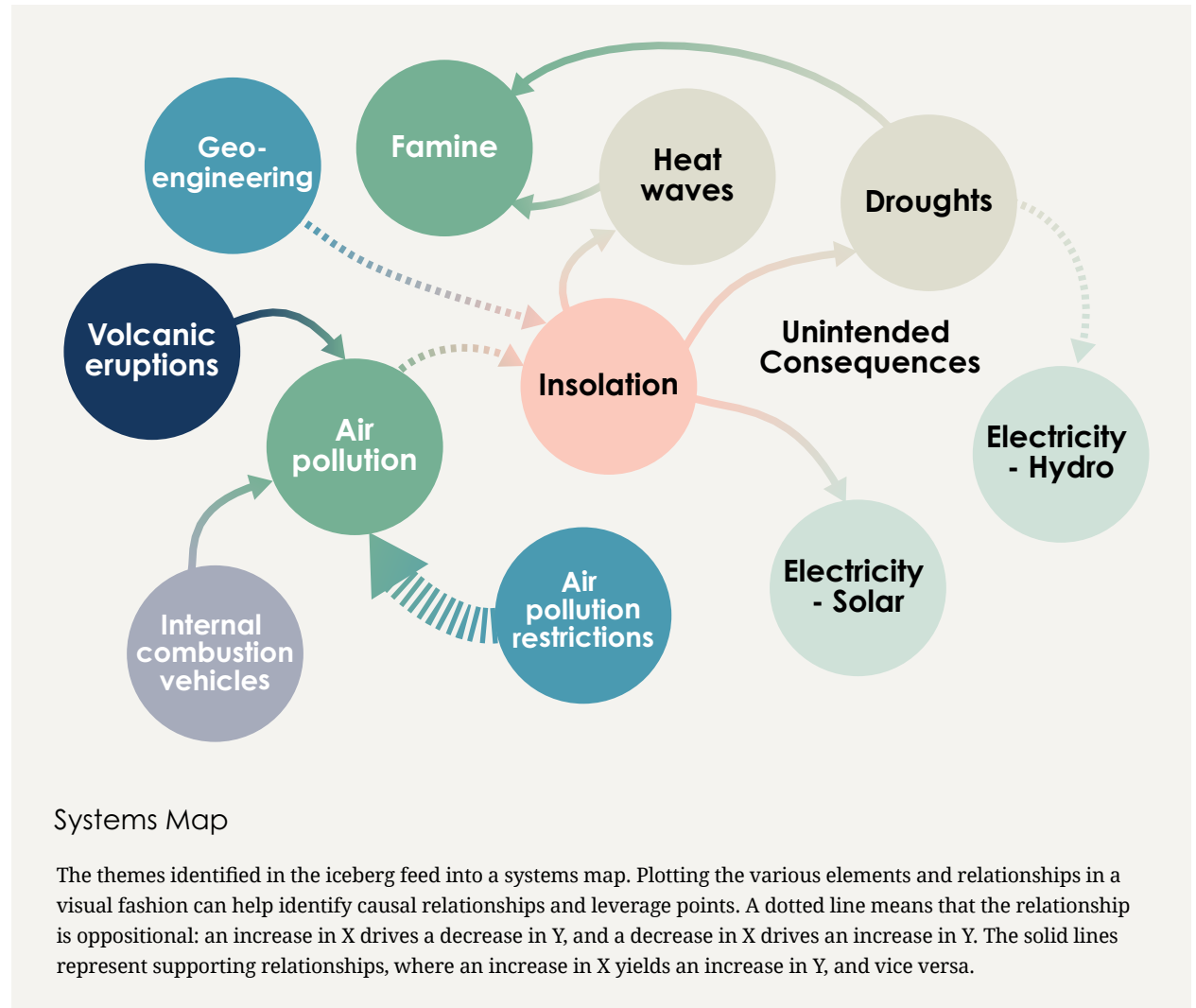
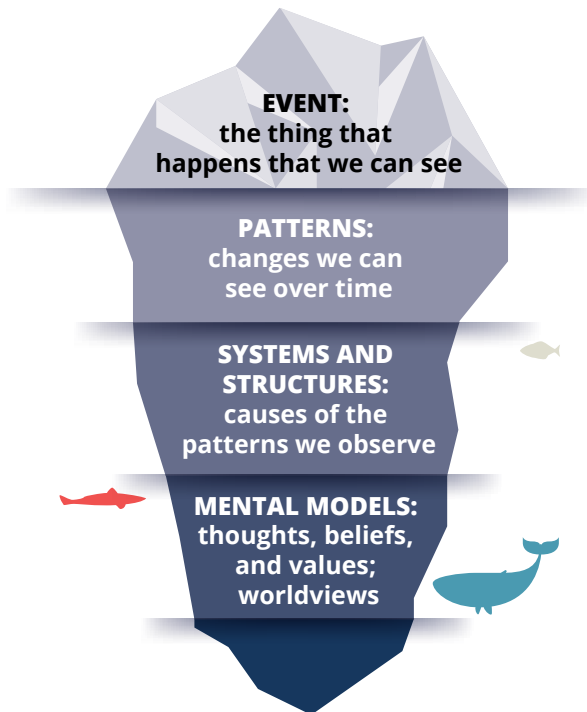


Decoding Systems

The strength of systems thinking is the ability to visualize complex systems and interactions.

Iceberg Model

An iceberg model is an effective way to begin understanding a complex system. An event, the thing that is easily observed, is at the tip of the iceberg. The layer underneath is used to identify patterns or changes we can see over time contributing to the event. The next layer is dedicated to the systems and structures that are causing the patterns. The bottom layer identifies mental models – the thoughts, beliefs, values, and worldviews underpinning systems and structures. All these layers are interacting to produce the observable event



2024 Themes in Focus

Water and Commerce



Growing risks to insurance markets and global trade

From drought restrictions in the Panama Canal to natural disaster claims, water is everywhere except where it's needed most. Renewable energy technologies will be affected on multiple fronts.

Interest Rates and Unemployment



Where economy meets development

Developers are eager to see interest rates begin to drop from their 20-year highs. This will not happen quickly, and structural factors keeping unemployment low will pose additional challenges.

Trust and Verification



The new paradigm for information

Deepfakes and a fractured information landscape are feeding cynicism and disbelief. New tools and strategies are needed to build public trust and support for the clean energy transition.

Water and Commerce

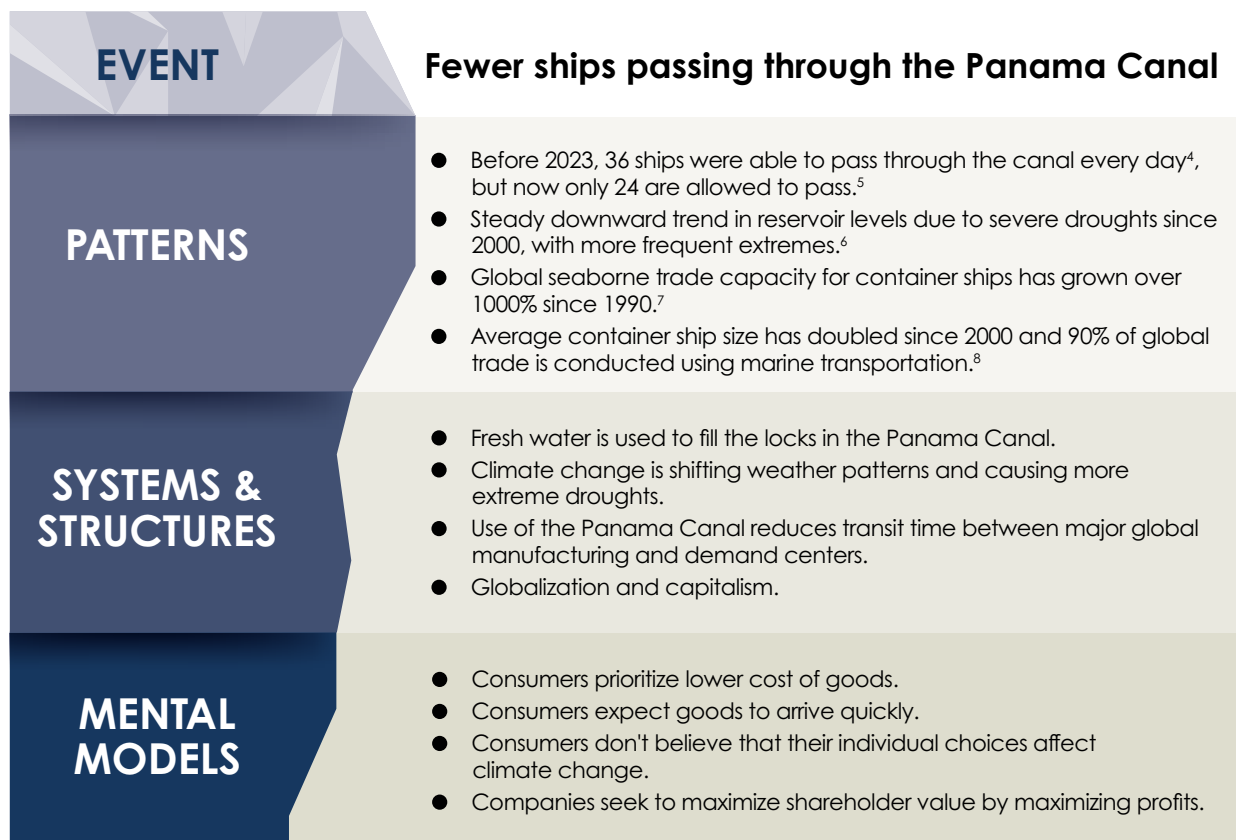
Water can't flow uphill and that's a problem for the Panama Canal. The sea level on the Pacific side of the canal is higher than on the Atlantic side, and the geography of the Panama isthmus humps toward the middle, where Gatun Lake sits. During their eight-to-ten-hour transit across Panama, vessels must be lifted twenty-six meters above sea level through a series of locks.⁹

Five percent of global seaborne trade and 46% of container traffic between the U.S. East and Gulf Coasts and Northeast Asia navigate this passage. Using the same source that provides more than half of Panama's drinking water, fifty million gallons of fresh water floods these locks to complete each ship's maneuver.¹⁰

El Niño conditions have driven record droughts in Panama, which recently experienced its lowest October precipitation on record.¹¹ In addition to the reduction in ship passages, vessels are being forced to reduce their total cargo weight by up to 40% to reduce draft.¹²

U.S exports of grain and petroleum products to Asia are being impacted by the reduction in trade capacity, driving up global commodity prices. In response, some trade is being re-routed, with vessels detouring through the Suez Canal or around the Cape of Good Hope.¹³

Meanwhile, ongoing tensions in the Middle East are limiting the viability of the Suez Canal alternative – traffic is down 42% in the Suez Canal since November 2023.¹⁴



50 million gallons

Capacity of fresh water needed to flood the canal locks to complete each ship's maneuver

Water and Commerce Analysis

Groundwire maintains a database related to the trends identified in this report. Issues related to water are incredibly broad: too much water, not enough water, water appearing in the wrong place or at the wrong time, conflict over groundwater rights, groundwater withdrawals to grow perfect potatoes, the hubris of human interventions meant to bend water to our will, the list goes on.

At its most macro scale, many of these micro trends will have spillover effects on the broader global economy. Global trade disruptions and droughts increase the risk of famine, destabilizing regions and creating climate refugees. Meanwhile the climate impact of shipping diversions can itself lead to a vicious cycle. Longer travel distances and delivery delays incentivize higher vessel speeds and burn more fuel, contributing to an increase in emissions, which drives more climate change.

The shipping slowdown in the Panama Canal illustrates many of the same interrelated dynamics on display in these other stories. However, there are some very tangible direct impacts to renewable energy development which can be seen through this lens. Half the volume of goods by weight that transit the Canal are fossil fuel products.¹⁵

The added cost to ship products via longer routes will inevitably drive up the price of these globally traded commodities, which could benefit renewable energy

alternatives in the long run. The tensions further restricting global trade via the Suez Canal, on the other hand, may introduce new challenges. According to S&P Global, more than half of solar panels and batteries are shipped via the Suez Canal.¹⁶ An increase in global shipping costs will ultimately have an impact on all forms of cargo, including essential components for building renewable energy projects.

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Availability of fresh water is a growing issue that will affect renewable energy in other ways. Electrolytic hydrogen production typically requires fresh water and water access will become a key constraint dictating where clean hydrogen production facilities can be built in the U.S. Hydropower generation capacity has been at risk across broad regions of the U.S. as drought cycles have become more dramatic. While major precipitation events in the Western U.S. helped replenish reservoirs in 2022 and 2023, annual production capacity has fluctuated by as much as 50 million megawatt hours in recent years.¹⁷

Most other forms of renewable energy do not require water, a key selling point relative to many other forms of electricity generation, but solar panel efficiency can take a major hit if the panels are not cleaned regularly with fresh water. This is an area of active research, including one potential breakthrough by MIT researchers who demonstrated that panels can be effectively cleaned using electrostatic technology.¹⁸

Water trends associated with flooding and the built environment will also play a role in the future of renewables. Insurance companies are staggering under the weight of increasingly frequent and costly natural disasters, many of which are being fueled by climate change. An October 2023 report from re-insurer Gallagher Re estimated that global insured losses would exceed \$100 billion in 2023, the sixth year since 2017 to surpass that threshold.¹⁹ These broader property losses have created a precarious situation for renewable energy developers, who must contend with higher premiums and a lack of insurance capacity at a time when project development is growing exponentially – along with its risks.

KEY TAKEAWAYS

Renewable energy developer costs are likely to rise with another slowdown in global shipping. Stresses to the availability and affordability of insurance premiums will add further challenges to the business case. Developers must plan for the possibility of higher costs and delays in component shipments.

These challenges could threaten the availability of clean energy to meet decarbonization goals. Policymakers should consider strategies for offsetting supply chain cost increases and how to backstop insurance markets that could limit project development.

50 million ^{mwh}

Fluctuation of annual U.S. hydroelectric production

Interest Rates and Unemployment

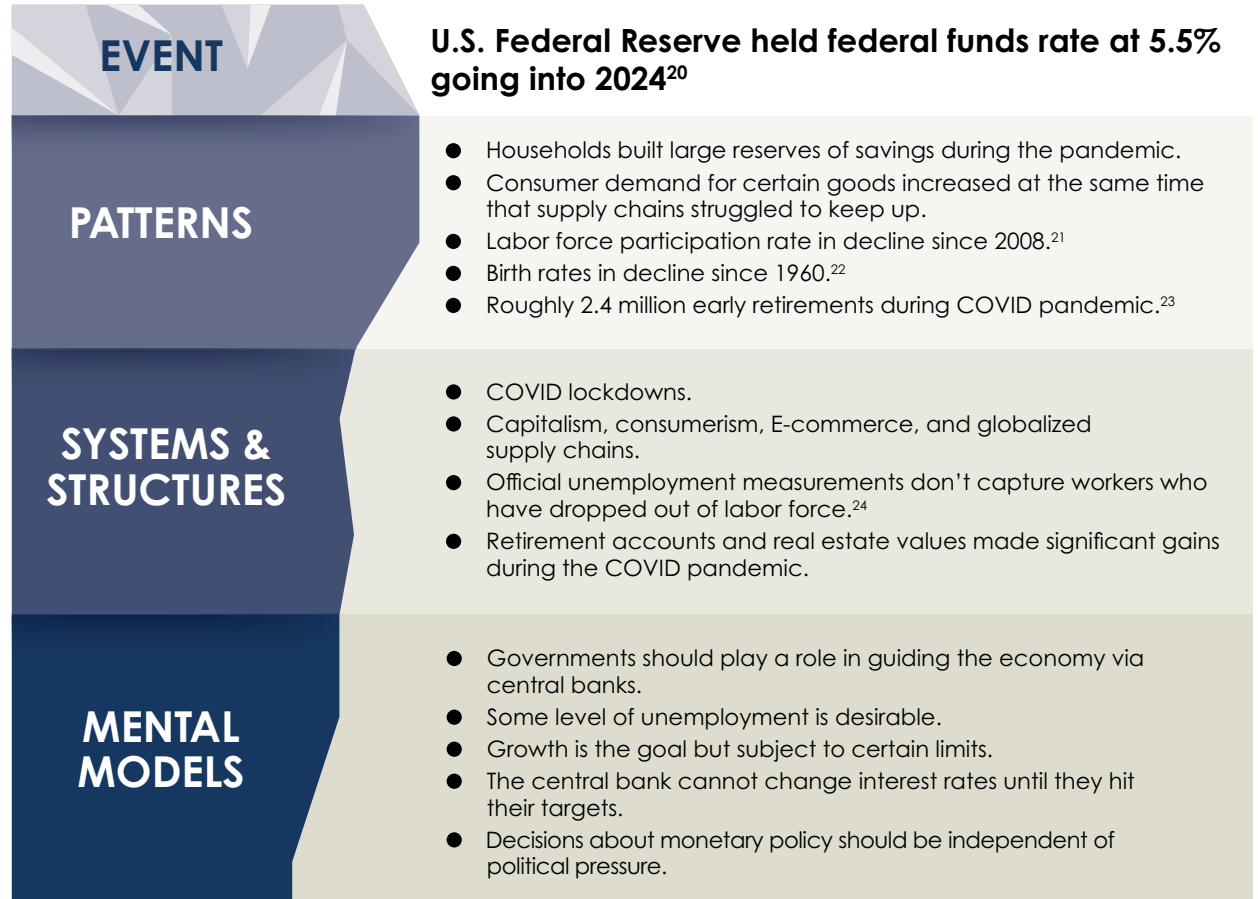
One way central banks manage the rate of inflation within an economy is through raising or lowering the interest rates on federal funds, which banks use as a benchmark for setting commercial interest rates.

The U.S. Federal Reserve (Fed) has a difficult needle to thread – inflation is bad, but deflation is also bad. In an overheated economy where inflation is high, prices rise dramatically. This reduces the value of cash holdings and household savings, and wages typically can't keep up with the rising price of essentials.

Economists fear deflation because it is often a signal of weak demand in the economy or a lack of available credit. In its December 2023 meeting, the Fed re-iterated its mission as it announced the intent to maintain interest rates at 5.25-5.5%: “The Committee seeks to achieve maximum employment and inflation at the rate of 2% over the longer run.”²⁵

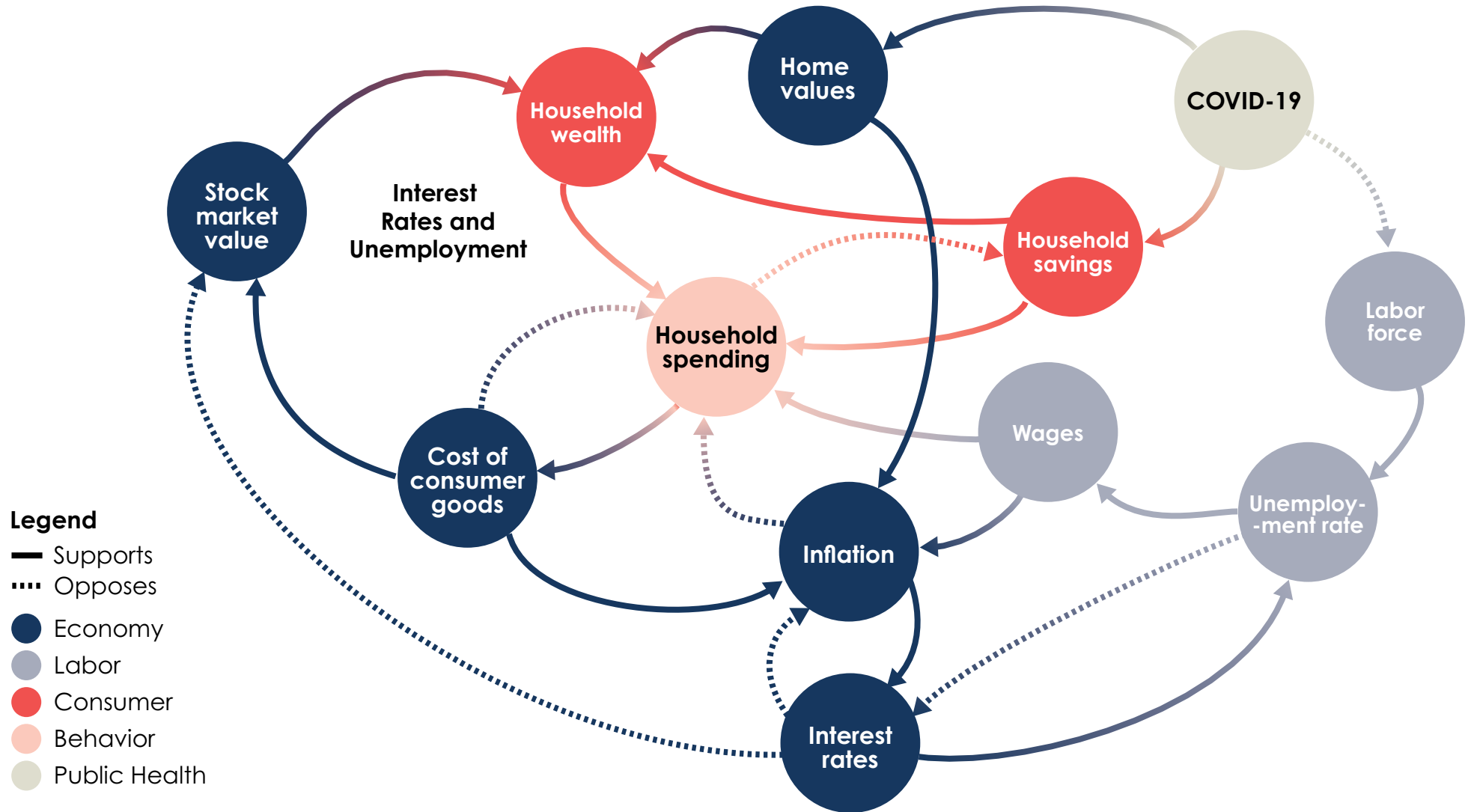
In this case, maximum employment does not mean 0% unemployment. Many central banking economists, including the head of the Federal Reserve Bank of Philadelphia, consider 4% to be an ideal level of unemployment.²⁶

Unemployment lower than 4% can drive wages higher and continue to feed inflation, known as a “tight labor market”. The issue the Fed must now contend with is that unemployment has generally remained below 4% since 2018.



Interest rates are now at 20-year highs. Inflation began to skyrocket in 2021 and reached highs not seen since 1981. Current rates, combined with a tight labor market have significant implications for the clean energy economy.

Interest Rates and Unemployment System Map



Interest Rates and Unemployment Analysis

Economists are beginning to question the strength of these relationships. Household spending has remained strong despite inflation. Stock market values have rebounded even while interest rates remain high. If some of these traditional feedback loops no longer function, the Fed faces a unique challenge – they must consider how to change course without losing credibility.

This challenge comes at a time when political rhetoric and consumer sentiment about the economy is especially heated, with a Presidential election on the horizon. Meanwhile, the ongoing wave of retirements among Baby Boomers will put downward pressure on the true size of the labor market for years to come.

Low unemployment will carry knock-on effects for developers of renewable energy projects. Wages inevitably increase in a tight labor market, adding more stress to development budgets already under pressure from materials price increases and higher lending costs. Moreover, labor shortages could drive delays to project timelines.

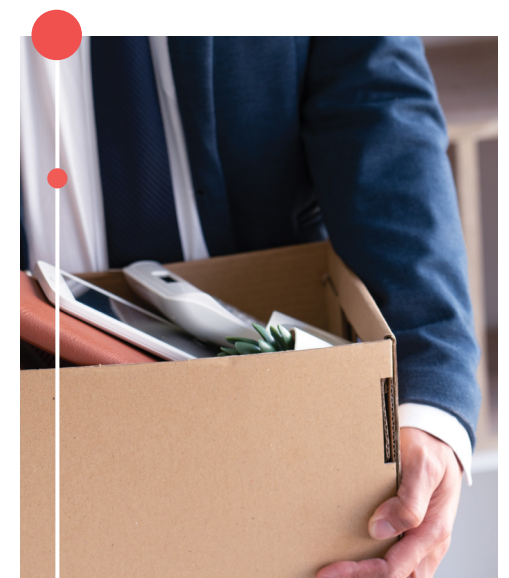
Renewable energy projects are being hit especially hard by high interest rates, which had been held below 2.5% for 14 years prior to COVID. Unlike fossil fuel generation, where the up-front costs tend to be lower while the operational costs include expensive fuel inputs, renewables trade off their low operational costs (OPEX) for a higher up-front capital expenditure (CAPEX) that is

typically funded using project finance. An analysis from BloombergNEF in August 2023 evaluated recent cost increases for U.S. offshore wind projects. They found that high interest rates have added 35% to the cost of energy relative to 2021 levels, while increases to project CAPEX and OPEX were responsible for an additional 22% increase. Bonus tax credits may help to offset 16% of the total increase, but qualifying for

Wages inevitably increase in a tight labor market, adding more stress to development budgets already under pressure from materials price increases and higher lending costs



Photo: Unsplash/Joshua Woroniecki





these credits requires the use of domestic supply chains, many of which have not yet been built.²⁷ Absent a major recession, it seems unlikely that interest rates will fall to pre-pandemic levels in the foreseeable future.

Consumer sentiment and cost of living affordability will also have a significant impact on renewable energy policies. High interest rates are eating into household budgets by driving up the cost of automobile purchases and other household debt, including new mortgages. Meanwhile, inflation has driven up the cost of essential household goods. The prices of frequently purchased

goods like groceries have remained stubbornly high, and consumers will be very sensitive to the suggestion that clean energy policies will raise their utility bills.

+35%

Recent cost increase due to interest rates (relative to 2021) for U.S. offshore wind projects, according to BloombergNEF

KEY TAKEAWAYS

Renewable energy developers and policymakers committed to climate action must consider how a business model built on cheap development capital can continue to thrive in this new environment.

They should also think carefully about how to address consumer price sensitivity if they wish to maintain public support for renewable energy policies, which are often discussed in terms of how much these projects might add to a consumer's monthly bill.

Trust and Verification

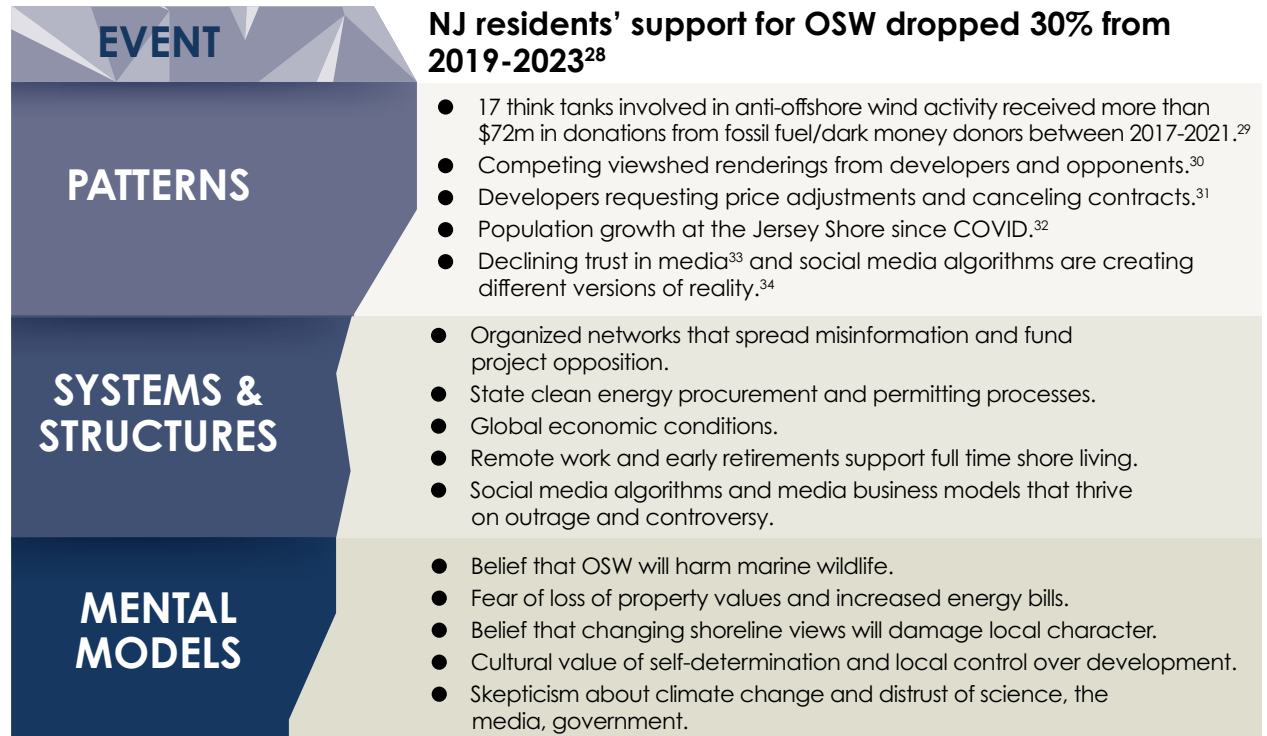
There's a lot of debate about what happened in New Jersey. How could public opinion on offshore wind shift so dramatically in such a short time? New Jersey has now become practically synonymous with offshore wind opposition, though state leaders continue to forge ahead.

A simple explanation could be that the earliest proposed projects are moving through their development process and are becoming more real. A change in state law to supersede local authority over certain siting decisions, which was exercised in early 2022 to overrule objections from local authorities in Ocean City, also didn't sit well.³⁵

Meanwhile, a spate of whale deaths along the Jersey Shore in early 2022 appeared to stimulate a surge of concern from locals who linked these deaths to offshore wind activities. There is no scientific evidence to support this claim, and the deaths are part of a broader trend being monitored by scientists since 2017, long before offshore wind survey activities began.³⁶ Brown University researchers recently identified a vast network of misinformation groups, funded by fossil fuel interests, who have falsely linked whale deaths to offshore wind.³⁷

Deteriorating economic conditions in 2023 laid the groundwork for further discontent.

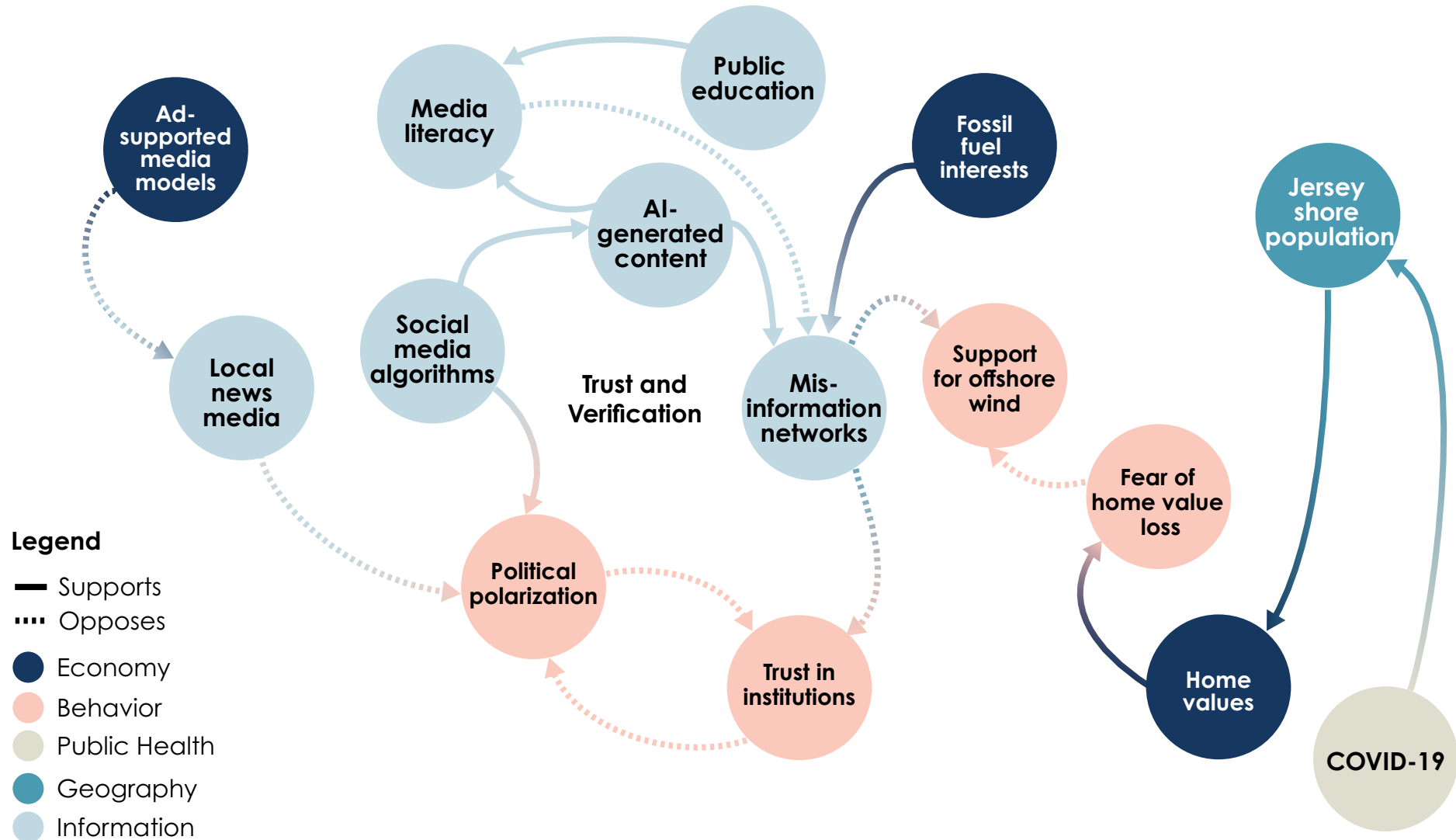
At a time when household budgets were experiencing the shock of inflation not seen since the 1980s, offshore wind developers across the East Coast requested increased



prices and larger tax breaks to sustain the viability of their developments. One New Jersey developer was granted a larger tax benefit in 2023, prior to the September date of this survey, only to cease development of the project in November.³⁸

Members of the public may feel disempowered by public processes without access to reliable information from unbiased sources.

Trust and Verification System Map



Trust and Verification Analysis

More than half the world's population will have the opportunity to participate in elections in 2024, a historic record.³⁹ While some of these elections will occur in countries with very weak democratic influence, a new threat may undermine electoral results in even the most mature democracies: staggeringly sophisticated artificial intelligence tools.

Large language models, image generation, and video manipulation technologies have become broadly available to the masses since early 2023 and their sophistication grows by the day. These tools are already being weaponized in the U.S., with a fake robocall mimicking President Biden sent out to New Hampshire voters telling them not to show up at the primary polls.⁴⁰

There is a growing sense of unreality. If anything can be fake, how do people decide what's real? We're on the cusp of a crisis of trust, with new tools desperately needed to help certify reality.

Renewable energy and climate issues have their own challenges with trust and verification. While misinformation threatens public support for climate action, there is also a real need for verification tools within the systems meant to monitor and ensure compliance with decarbonization policies.

Hydrogen tax credits are a hot topic in the U.S. as we enter 2024, with major decisions expected on how the

carbon intensity of hydrogen will be measured for the purposes of receiving lucrative federal incentives.

Fierce lobbying from a wide spectrum of interests are advocating for differing levels of granularity in how to measure hydrogen's electricity inputs. All sides generally agree that the most granular, and therefore most accurate measures of carbon intensity would require systems for tracking electricity production and use that are not broadly available today.⁴¹

Voluntary carbon markets and carbon offset schemes are contending with similar issues. In 2023, the New

We're on the cusp of a crisis of trust, with new tools desperately needed to help certify reality

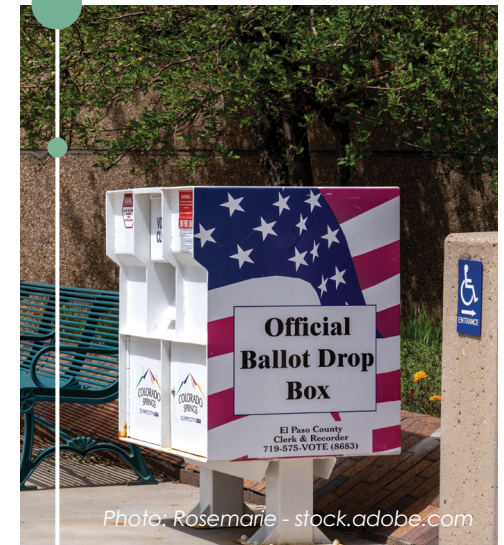


Photo: Rosemarie - stock.adobe.com



KEY TAKEAWAYS

It is imperative that policymakers drive transparency and accountability in how tax dollars are used to fund the energy transition

Yorker broke open a major scandal involving the world's largest carbon credit provider.⁴² Universal standards for carbon accounting don't yet exist. The Commodity Futures Trading Commission issued proposed guidance for the listing of voluntary carbon credit derivatives in late 2023.⁴³ With the European Union's Carbon Border Adjustment Mechanism (CBAM) tariff transition period now underway,⁴⁴ carbon accounting will take on new significance in 2024.

Developers must do the hard work of building relationships with the communities in which they operate. This means proactively engaging with stakeholders and reflecting their concerns in their development plans.

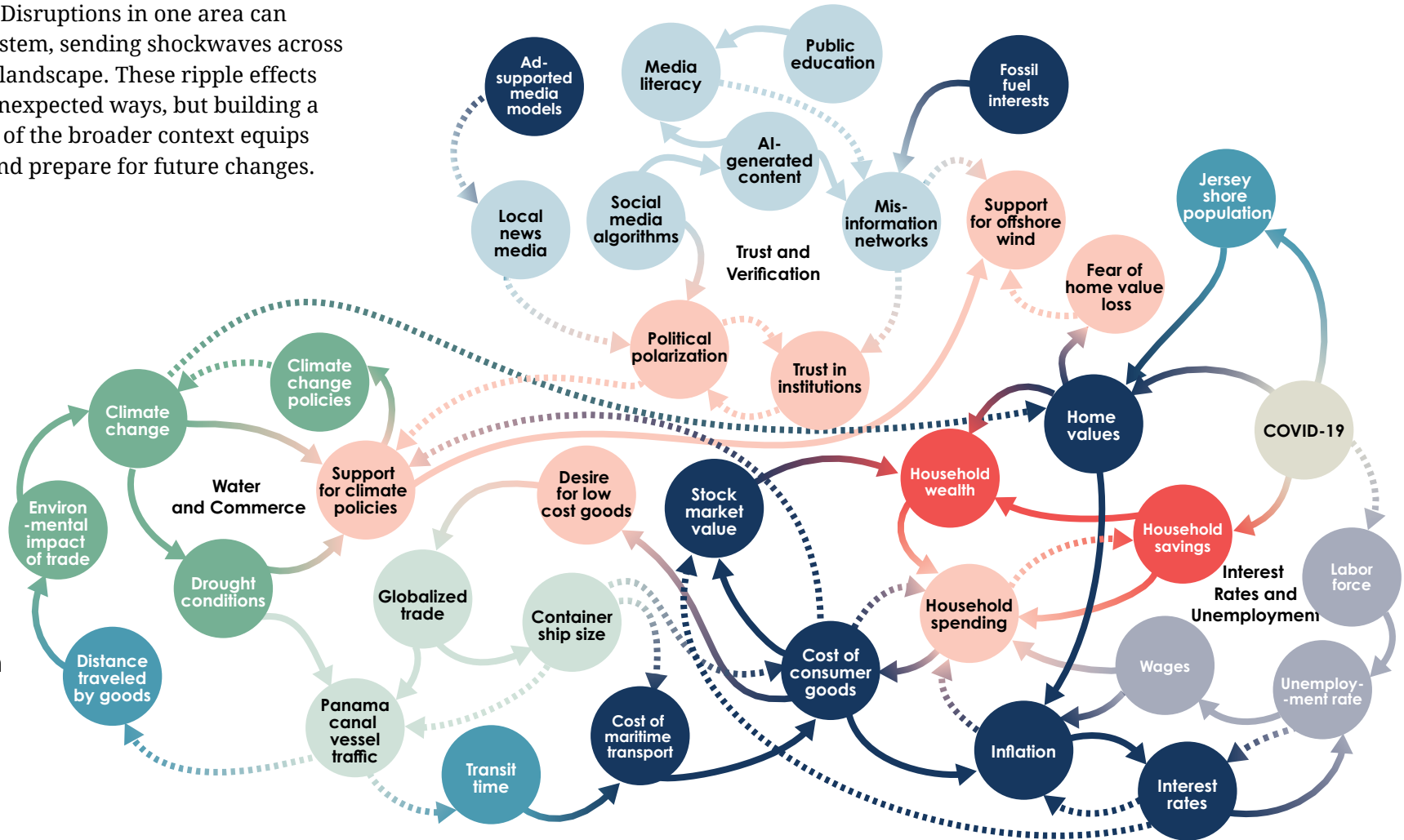
It is imperative that policymakers drive transparency and accountability in how tax dollars are used to fund the energy transition, with straightforward and accurate accounting of emissions impacts.

In the end, it's all connected

When we zoom out, each of these system maps share common connections. Disruptions in one area can influence the entire system, sending shockwaves across the renewable energy landscape. These ripple effects change the future in unexpected ways, but building a deeper understanding of the broader context equips leaders to anticipate and prepare for future changes.

Legend

- Supports
- ⋯ Opposes
- Economy
- Labor
- Consumer
- Behavior
- Public Health
- Environment
- Trade
- Geography
- Information



Understanding the signals

The Federal Reserve, droughts in Panama, election interference. At a glance, these topics might not seem like such obvious signals to watch when developing renewable energy projects in 2024. This report demonstrates how macro trends influence the micro trends driving the energy transition.

Understanding why is the secret to building a successful strategy. As the year unfolds, Groundwire will be monitoring these trends as we advise our clients on how to turn observation into action.



About the author

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A renewable energy veteran with nearly 20 years of industry experience, Abby has worked in nearly every aspect of renewables – from rooftop solar to offshore wind, with roles spanning project development to government affairs and new market strategy.

In founding Groundwire, Abby's ambition is to lead the energy transition by helping businesses and organizations solve their most challenging problems. Groundwire's practice combines cross-sectional experience in the energy transition, insights into the larger context, and creative ideation techniques to help clients build a new vision of the future. She graduated first in her class with an Executive MBA from Villanova University, graduated Summa Cum Laude from Penn State University with a BA in Energy and Sustainability Policy, and studied geology and environmental science at Bryn Mawr College.

Get in Touch

Groundwire can help you make sense of complexity and zero in on what matters. Contact us today to learn more about our strategic advisory services.



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With special thanks to Raquel Pichardo, Chief Communications Strategist. Her narrative and editorial support were essential to the process of building this report.

Designed by Rachel Steele www.steeleydesign.com

Resources

1	https://www.noaa.gov/news/us-struck-with-historic-number-of-billion-dollar-disasters-in-2023	16	https://www.spglobal.com/marketintelligence/en/mi/research-analysis/supply-chain-red-sea-shipping-disruption-impact.html	31	https://www.canarymedia.com/articles/wind/the-us-of-fshore-wind-industry-faces-a-moment-of-reckoning
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4	https://www.eia.gov/todayinenergy/detail.php?id=60842#	19	https://www.ajg.com/gallagher/-/media/files/gallagher/gallagher/natural-catastrophe-report-q3-2023.pdf	34	https://www.princeton.edu/news/2021/12/09/political-polarization-and-its-echo-chambers-surprising-new-cross-disciplinary
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