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Important Dynamics and Considerations

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Important Dynamics and Considerations

While the roadmap lays out a clear path for Pennsylvania to strengthen its competitiveness in energy, data centers, and AI, there is also a set of complex and interconnected issues that can accelerate progress, slow it down, or reshape outcomes entirely. These are the "important dynamics and considerations." For many stakeholders, these issues are the ones that most directly shape their decisions and priorities.

They include permitting reform, the role of PJM, financing structures, energy sources, talent gaps, community buy-in, manufacturing supply chains, water and land use, and the tax implications of large-scale infrastructure investment. Each of these topics could stand on its own as a major policy paper, and many are already the focus of work by organizations across Pennsylvania and nationally.

In the context of this roadmap, these dynamics and considerations act as critical dependencies to the core strategies and actions, elevating the complexity of the moment and opportunity. At times they may provide opportunities to accelerate progress; at other times they may present barriers that must be addressed before forward movement is possible.

What follows is a set of concise write-ups for each consideration. They are not exhaustive but serve to recognize the issues, reflect stakeholder input, and outline the implications for Pennsylvania's ability to execute on the core roadmap. For readers who are most concerned with one of these areas, the details provide a clear entry point into how it connects to the larger strategy.

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Data Center Economic Impacts

Despite the recent surge in proposed data centers in Pennsylvania, broader economic impacts and tax implications particularly at a local level remain largely undefined. While property tax revenues may arise from land and buildings, the equipment housed within data centers is exempt from local property taxes, reducing the full potential fiscal impact for host communities. Still, for some communities, re-investment in older sites, or investment in new sites may provide a needed and sizable boost if the local industrial market is relatively stagnant. Sales and use tax effects at the state level are also uncertain, as are the total capital investments and employment numbers, which vary significantly by site. Rather than expecting each municipality to model these complex factors on their own, Pennsylvania would benefit from independent regional or statewide economic analyses that offer consistent, transparent projections. These analyses are especially important in the short term, as new projects continue to emerge and communities seek clarity on the true value of hosting this infrastructure.

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Demand-Supply Alignment

Balancing energy supply with evolving demand from data centers and AI infrastructure is one of Pennsylvania's most pressing challenges. This roadmap emphasizes the need to avoid building infrastructure simply for the sake of building. Instead, new generation, transmission, and data center assets must be strategically aligned with demonstrated and growing demand.

Market forces already limit the potential for overbuilding, since excess energy can often be sold into PJM and data center operators are typically contractually obligated for infrastructure costs. In this sense, developers are already positioned to internalize much of the risk, and state policy should continue to ensure that large-scale users bear responsibility for the infrastructure they require.

The greater risk to Pennsylvania lies not in overcapacity but in ensuring the right amount of strategic investment. PJM is experiencing a widening gap between projected peak demand and available supply due to rising AI loads, electrification, and retirements of existing generation. Addressing this risk requires timely additions of new generation capacity, modernization of the grid, and more accurate and transparent load forecasting. Improvements may include a return to integrated resource planning, stronger state-level oversight, and collateral commitments from developers to minimize uncertainty.

To guide these efforts, Pennsylvania should prioritize modular data center design, encourage the repurposing of existing infrastructure, and create mechanisms for coordinated oversight. A statewide coordination office or ombudsman, with expertise on the rapidly evolving technology and efficiencies, could play a vital role in aligning capacity expansion with actual demand. By pursuing this approach, the commonwealth can ensure reliability, affordability, and competitiveness while seizing the opportunities created by AI and data center growth.

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Infrastructure, Water, and Land Use

"Shovel-ready" means more than just available land. Competitive sites require reliable water and wastewater capacity, robust broadband and fiber connections, and firm, affordable power with clear interconnection options. Electricity and water remain immediate bottlenecks, while broadband and fiber expansion can extend benefits beyond a single project. Pennsylvania should map where water, power, and fiber converge and target upgrades that unlock multiple projects and broad benefits.

Data centers, in particular, demand large parcels of land and significant water for cooling, which can create conflicts with agriculture, residential development, and climate resilience. Careful siting and planning are essential to balance cooling technologies, hydrology, seasonal demand, and stormwater management, while coordinating permits across agencies. Brownfield and industrial sites can reduce conflicts and costs and pairing buildout with broadband extensions can close digital gaps in surrounding areas.

Parallel strategies such as substation upgrades, on-site or adjacent generation, and grid investments can ease long interconnection queues and transformer backlogs. Communities that host projects should see clear benefits, whether through infrastructure improvements, broadband access, or conservation set-asides. Impact fees or community benefit agreements can support water and wastewater upgrades, while transparent engagement with municipalities on resource sharing builds trust. Thoughtful planning across infrastructure, water, and land use will reduce opposition, accelerate approvals, and ensure growth that strengthens rather than strains communities.

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Large Tech Companies Focused on Immediate-Term Gains

Hyperscale developers today are prioritizing speed and short-term siting needs to meet their own goals and targets. Pennsylvania must ensure that these immediate projects also contribute to long-term public value. Clear expectations should be set at the outset: developers seeking expedited approvals should also invest in local talent pipelines, infrastructure that benefits communities, and community benefit agreements. Risk-sharing strategies can make this work more attractive for investment and collaboration. For example, flexible demand programs allow energy-intensive users to shift usage during peak hours, reducing costs for both businesses and utilities. Public-private cost-sharing can accelerate needed grid updates. Similarly, creative pilots that capture and reuse heat from data centers can lower operating costs. These types of partnerships align private investment with public benefit, making growth more efficient and broadly supported. Pennsylvania should learn from states where hyperscaler concentration has led to grid strain and community opposition and incorporate lessons learned.

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Local Land Planning/Local Dynamics

Local governments will determine where and how data centers and energy projects move forward in Pennsylvania. Many municipal zoning codes and comprehensive plans were not designed for facilities of this scale, which creates delays and uncertainty for investment. Pennsylvania can help communities that want to host these projects by providing model ordinances, zoning templates, and coordinated timelines that align state and local reviews. A state "no-wrong-door" function and a regulatory toolkit for local governments would simplify processes and reduce duplication. Communities need to understand trade-offs, benefits, and site realities such as land size, utility and other infrastructure demands. Accelerating brownfield or already-entitled sites may demonstrate benefits more quickly and clearly, and lower risk. Done well, local planning can become an accelerator, not a barrier, by aligning community priorities with statewide strategy and reducing the perception that projects are being imposed.

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Manufacturing Supply Chain

Pennsylvania has a unique opportunity to capture more of the value chain that underpins advanced energy systems and data centers. Localizing production of critical components such as transformers, switchgear, specialized cables, cooling systems, and backup generation equipment both plays to Pennsylvania's manufacturing strengths and drives broader economic impact. Western Pennsylvania already hosts firms like Mitsubishi, Hitachi, GE Vernova, and CorePower Magnetics, with strong capabilities in transformers and electrical equipment, offering a base to build upon. Addressing supply chain delays, particularly the national transformer backlog, should be an early focus, supported by procurement preferences, pooled purchasing, and in-state staging facilities.

Beyond hardware, Pennsylvania can lead by embedding artificial intelligence into manufacturing itself. More than 95 percent of the state's manufacturers are small or mid-sized enterprises (SMEs), and many face barriers in adopting advanced technologies. Team Pennsylvania's proposed AI Manufacturing Scaling Initiative aims to bridge this gap by connecting SMEs to the expertise and resources of tech companies investing in Pennsylvania data centers. Through partnerships, tools, and knowledge sharing, SMEs can adopt AI incrementally to improve efficiency, quality control, and supply chain resilience. This approach will help smaller firms grow into suppliers for data center infrastructure while enhancing their competitiveness in global markets.

Together, these efforts can strengthen Pennsylvania's role as both a supplier and an innovator. By pairing targeted investments in manufacturing capacity with programs that accelerate AI adoption among SMEs, the commonwealth can expand local supply chains, reduce project delays, and generate multiplier effects that reach well beyond the data center industry.

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Measuring Leadership in AI Commercialization

To lead in AI commercialization, Pennsylvania must pair strategic action with measurable results. Leadership will be defined both by the number of patents, licenses, and spinouts, and by how effectively ideas are moved from lab to market, scaled by businesses, and embedded in communities. To accelerate real-world impact, Pennsylvania must prioritize use-inspired research, that is, projects driven by practical problems and industry needs. Strengthening partnerships between businesses and higher education institutions will ensure that research is not only cutting-edge, but also immediately applicable, accelerating the cycle from discovery to deployment. Metrics should reflect the full commercialization lifecycle from early-stage innovation to product deployment, and include start-ups launched, jobs created, industry partnerships, investment attracted, and infrastructure leveraged.

Equally important is the ability to tell a story of broad-based growth. Pennsylvania's strength lies in the breadth of its ecosystem: world-class universities, a resilient manufacturing base, and growing public-private momentum. A strong commercialization scorecard should track outputs alongside ecosystem health, gauging how universities, talent systems, tech accelerators, and community partners are aligning to bring research to life. This balanced approach will help Pennsylvania demonstrate not just progress, but staying power, as it becomes a national hub for applied AI innovation.

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Nuclear as the Cornerstone of "All-of-the-Above" Energy Approach

Nuclear power stands out as one of Pennsylvania's strongest assets for supporting the growth of data centers and AI-driven infrastructure. It offers clean, firm electricity that can run continuously regardless of weather, making it an essential complement to intermittent renewable sources. With the second-largest nuclear generation fleet in the nation, Pennsylvania already has the expertise, supply chain, and industrial base to build on this advantage.

Nuclear's role is increasingly tied to the needs of hyperscale data centers. Operators such as Amazon, Google, and Microsoft are seeking carbon-free, reliable baseload power, and nuclear energy can meet that demand. Opportunities extend from large reactors and grid-connected facilities to emerging technologies such as small modular reactors (SMRs) and microreactors like Westinghouse's eVinci™, which could provide scalable, on-site power for both large and medium-sized data centers. These modular technologies, once commercialized, would allow Pennsylvania to deploy nuclear solutions more flexibly and at lower cost than traditional large-scale plants.

Three Mile Island Legacy

While the Three Mile Island Unit 2 closure remains a cautionary note, discussions about restarting Unit 1 or repurposing the site highlight Pennsylvania's potential to repower legacy assets.

Talent and Supply Chain

Pennsylvania's nuclear workforce, engineering programs, and supplier networks form a ready-made base to expand into advanced reactors and next-generation nuclear technology.

Local suppliers across fabrication, machining, instrumentation, and maintenance further anchor the nuclear supply chain.

Challenges remain. Nuclear projects require high upfront capital investment, long permitting timelines, and continued attention on safe waste management. Advanced reactors may not be commercially available until the 2030s, meaning they are unlikely to power the first wave of data center buildouts. However, over the long term, nuclear power can deliver durable economic benefits: stable electricity prices, well-paying jobs, and reduced land footprint compared to other clean energy options.

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Positioning nuclear power as a cornerstone of Pennsylvania's "all-of-the-above" energy strategy will enhance energy security, promote resilience, and strengthen the state's leadership in advanced manufacturing.

Pennsylvania's Existing Nuclear Industry

Pennsylvania operates nine nuclear reactors at four plants, providing more than 30% of the state's electricity

Westinghouse Electric Corporation | Cranberry Township
A global leader in nuclear design, SMRs, and advanced fuels

Curtiss-Wright | Cheswick
Supplies control rod drive mechanisms, pumps, and valves for nuclear reactors

BWX Technologies | Mt. Vernon
Manufactures nuclear components and fuels

Framatome | Cranberry Township
Provides nuclear services and fuel technology

**Non-exhaustive*

Pennsylvania Tax Structure and Local/State Taxes Broadly

States across the nation are evaluating tax policy to influence where data centers and supporting industries choose to locate. Since 2022, Pennsylvania has offered a Computer Data Center Equipment Exemption Program, which exempts sales and use tax by certified data center owners, operators or tenants. Pennsylvania should evaluate additional tax tools tied to designated regional AI-activation corridors where performance-based abatements or credits could be available to projects generating verifiable community and statewide benefits. At a local level, revenue-sharing or revenue recycling approaches, such as impact fees or credits tied to performance, payment-in-lieu-of-taxes agreements or funding for local infrastructure, could fund notable economic development needs ranging from site preparation, utility upgrades, or training grants in host communities.

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Permitting Complexities and Streamlining

Permitting is one of the most complex and critical steps in developing data centers or energy infrastructure in Pennsylvania. These projects often require a broad range of approvals from local, state, and federal entities, and the process can vary significantly by location, project type, and site conditions.

At a minimum, developers or project owners typically need land use and zoning approvals from local governments to ensure the site is suitable for industrial use. Building permits, demolition permits (for redevelopment sites), and stormwater or erosion control approvals may also be required. If the project involves energy generation, transmission, or heavy electrical load, additional permits from the Pennsylvania Public Utility Commission (PUC), Department of Environmental Protection (DEP), and possibly PJM come into play. These permits might include air quality, water discharge approvals, wetland or stream encroachment, and interconnection studies or agreements for tapping into the electric grid.

The complexity arises not only from the number of permits but from how they interact. Different agencies have different timelines, data requirements, and stakeholder review processes. Local ordinances can add layers of variance or conditional use hearings. For greenfield sites, infrastructure like roads, water, and sewer may need to be expanded, triggering additional review.

Because permitting touches so many systems such as land, energy, water, and environmental impacts, it is often cited as a top barrier to investment. Streamlining, sequencing, and coordinating these reviews is essential to keeping Pennsylvania competitive while ensuring that development is responsible and community-aligned.

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PJM Dependencies

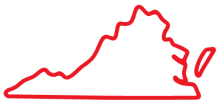
PJM remains one of Pennsylvania's most important assets, providing a large and well-regarded regional transmission organization that attracts investment to the commonwealth. At the same time, the pace of PJM's planning and interconnection processes does not always align with the urgency of data center and AI-related demand growth. Stakeholders widely recognize the need for more timely decisions and greater certainty for investors and utilities.

Pennsylvania should focus on using its position as a major energy exporter within PJM to advocate for reforms that improve planning and interconnection timelines. Recent updates to PJM's rules, including expedited review for shovel-ready projects, mark progress. Additional opportunities include commissioning joint studies with PJM, the U.S. Department of Energy, and the Pennsylvania Public Utility Commission (PUC) to identify priority transmission corridors and better align regional and state-level planning. Utilities also have tools available, including the ability to pursue supplemental transmission projects outside PJM's formal process. While this approach can be complex, it highlights the flexibility already within the system.

Transmission upgrades will be critical, and Pennsylvania should highlight the potential of strengthening existing infrastructure. Utilities such as PPL have shown leadership in this area, offering models that could be replicated more broadly. At the same time, data centers themselves can contribute to grid stability by offering flexible demand services or onsite generation, reducing pressure on the system.

By coupling strong advocacy within PJM with state-led planning, strategic transmission upgrades, and innovative partnerships with data centers, Pennsylvania can ensure that PJM continues to be a driver of reliability and competitiveness as the energy landscape evolves.

Lessons from Other States



Virginia leveraged its role in PJM to attract large-scale data center development, but slow interconnection timelines and grid strain have forced policymakers to revisit incentive and planning frameworks.

Illinois and New Jersey have pursued reforms that allow utilities to accelerate specific transmission projects outside of PJM's formal process, highlighting alternative ways to build to build critical infrastructure more quickly.

Maryland has increased coordination between its state energy office and PJM to better align state policy priorities with regional planning, ensuring that renewable and distributed resources integrate into the grid effectively.

Renewables and Other Energy Technologies

Renewable energy is often cited as a necessary component of Pennsylvania's long-term energy mix, yet significant challenges remain before it can play a major role in powering data centers and advanced manufacturing. Solar and wind resources require large land footprints, face permitting hurdles, and often encounter local opposition. Hydropower potential exists but is underutilized, and geothermal deployment remains limited. Critically, renewables are intermittent and require large-scale batteries or other storage technologies to provide firm, reliable baseload power. At present, these storage systems are expensive, land-intensive, and not yet widely available at commercial scale.

In addition to these resources, other energy technologies such as biofuels, hydrogen, and long-duration storage are emerging as potential options for data centers and industrial users seeking lower-carbon alternatives. Biofuels may be particularly relevant where on-site generation or backup systems are needed, while hydrogen and storage technologies could help meet firm power needs in the longer term. Each faces its own challenges, cost, scalability, and supply chain readiness, that must be addressed before widespread adoption.

Stakeholders and advocates for renewable energy will need to accelerate technology improvements and cost reductions for renewables and other clean energy options such as biofuels, hydrogen, and long-duration storage to be a more viable near-term option for Pennsylvania's industrial and digital infrastructure. That means making solar, wind, and storage more efficient, more cost-competitive, and more easily integrated into the grid. Until then, renewables remain a supplemental rather than primary solution.

Corporate buyers continue to signal demand for renewables to meet sustainability pledges and will be critical to anchoring early off-take agreements that de-risk development, unlock financing, and catalyze the build-out of next-generation clean energy infrastructure. These projects will only make a material difference for Pennsylvania's competitiveness if they can scale in ways that complement firm power from natural gas and, longer term, nuclear power.

For now, Pennsylvania should treat renewables and other emerging energy technologies such as biofuels, hydrogen, and long-duration storage as one piece of an all-of-the-above strategy. Natural gas provides the most practical firm power option within the next decade, while renewables can play a role in diversification if paired with advances in storage, cost reduction, and smarter siting.

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Social License/Community Buy-In

Securing community support will be essential to Pennsylvania's long-term success in attracting data centers and aligning them with broader economic development goals. Community Benefit Agreements (CBAs) provide one pathway, but they must be designed carefully to balance consistency with local flexibility. Standardization can help establish baseline expectations, yet each community has unique needs that should be addressed through negotiation and dialogue.

Fundamental elements of effective CBAs include commitments to talent strategy, particularly creating pathways to the middle class through apprenticeships, training centers, and partnerships with community colleges or trade schools. Agreements should also address broader issues such as energy cost containment, local infrastructure improvements, and the use of new tax revenues to fund community priorities. Lessons from other sectors, such as Pennsylvania's landfill impact fee model, show that it is possible to combine a standardized framework with room for municipalities to negotiate additional or alternative benefits.

At the same time, CBAs should not be the only tool. Local governments will need to revisit comprehensive plans and zoning ordinances to determine where data centers fit within their long-term vision. Communication between municipal officials and developers will remain critical at every step. Community buy-in will depend on whether residents and businesses can see real, lasting benefits from having high-performance computing infrastructure in their region. Data centers on their own may not create many direct jobs, but they can serve as anchors for broader innovation ecosystems from powering advances in sectors like energy, agriculture, life sciences, and manufacturing to supporting research and enabling local startups. An opportunity lies in intentionally connecting what happens inside these facilities to the surrounding economy, even through indirect or downstream activity. By linking data center development to tangible local outcomes and creating clear but flexible frameworks for community benefit, Pennsylvania can strengthen trust, minimize opposition, and ensure projects deliver shared prosperity.

Resources for Community Benefit Agreements:

https://www.wri.org/insights/community-benefits-agreements-us-clean-energy

https://climate.law.columbia.edu/content/community-benefits-agreements-database

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Workforce/Talent Pipeline Gaps

Pennsylvania's challenge is both skills and scale. The state must train more people for construction trades, high-voltage work, controls engineering, and data center operations, while also attracting specialists in AI and advanced computing. To date, both Google and Amazon have announced broad workforce development initiatives as part of their commitments to investment in the commonwealth, opportunities that should be fully maximized. Pennsylvania should consider a statewide talent council, regional readiness assessments, and shared metrics that track completions, placements, and wage growth. Expanded apprenticeships, micro-credentials, and co-ops should connect students to in-demand roles. Community colleges, universities, and unions can co-design training programs using existing facilities and labs.

Just as important, Pennsylvania must embed AI literacy and technical exposure across the entire talent pipeline, starting in K–12 and continuing through higher education and adult learning. Preparing for an AI-enabled economy is no longer optional. It is foundational to long-term workforce competitiveness.