Beyond the Compute–Energy Nexus: Integrating Regional Water Availability into the Infrastructure Equation

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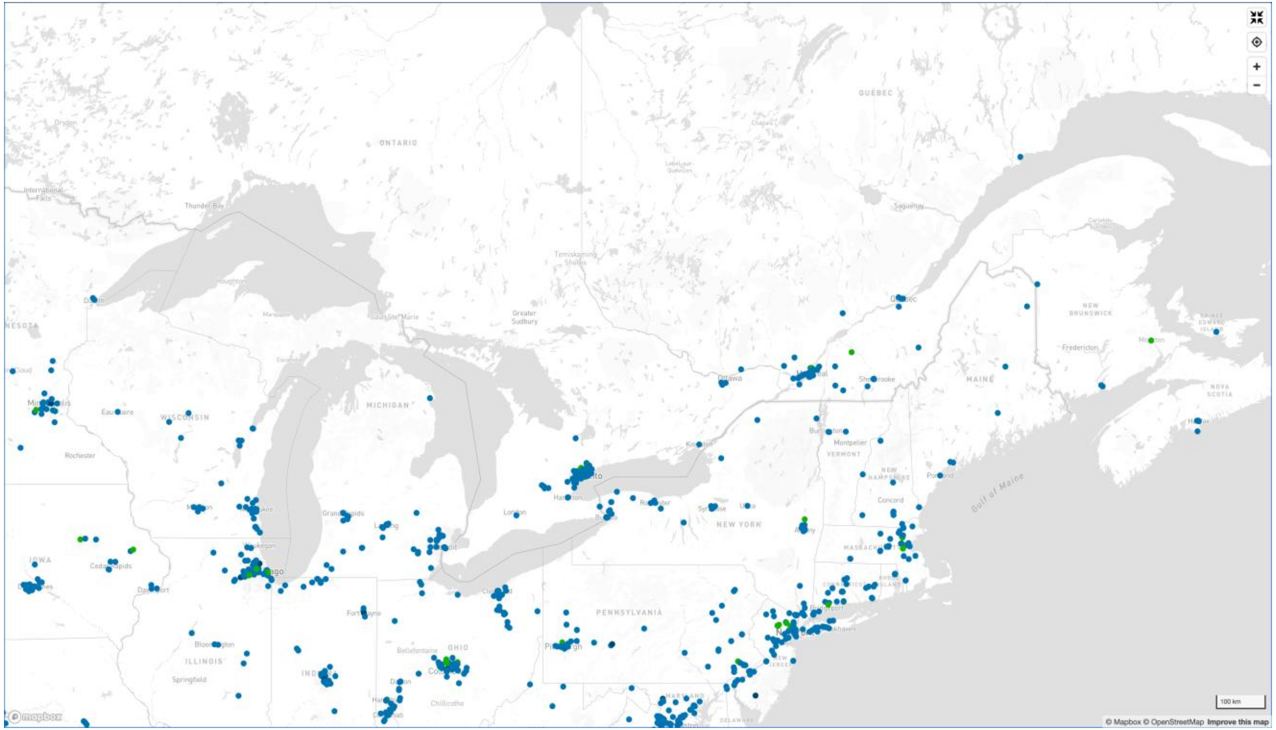
EMERGING DIGITAL TECHNOLOGY DEMAND

Interconnected Systems



Data Centers – Current and Planned

Critical Water-Energy Metrics

300k–5M gal/day Direct cooling per DC

17.4B gal US DCs consumed (2023)

2x by 2028 Projected growth

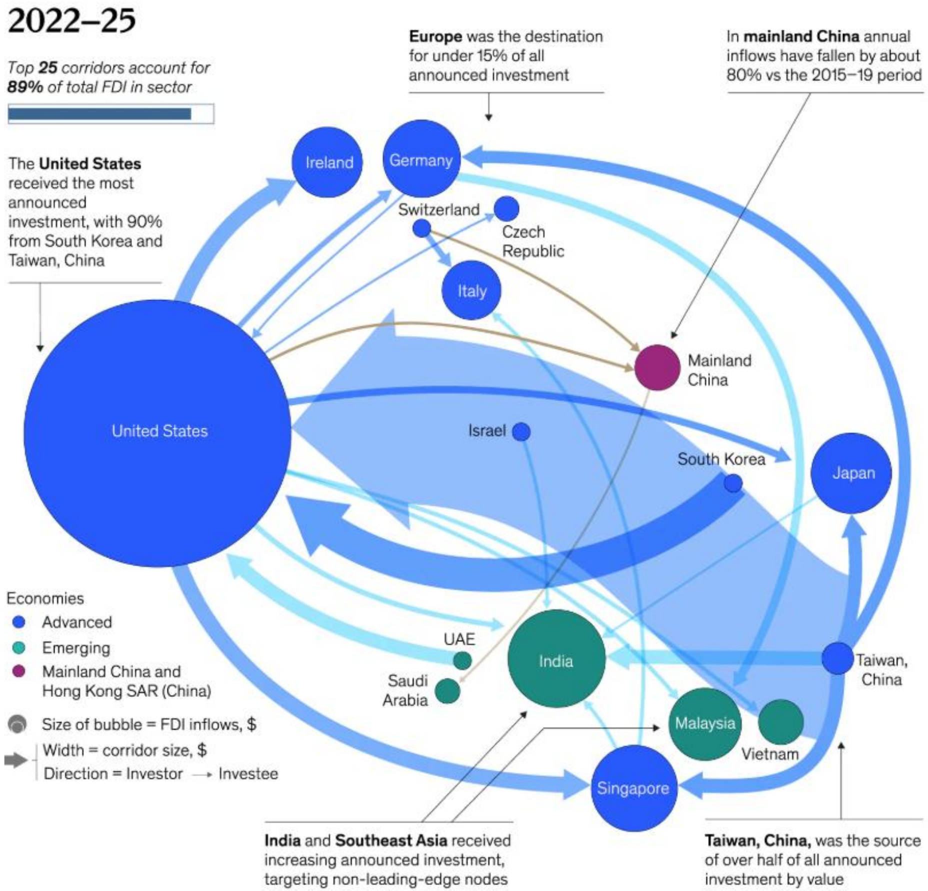
Thermoelectric Plants
70% of Great Lakes withdrawals

Power Sector
.47 gal/kWh consumptive use

PUE•WUE Coupling
Critical holistic metrics needed

Foreign direct investment in semiconductors reconfigured sharply toward the United States.

Semiconductors: Top 25 corridors by announced greenfield foreign direct investment (FDI), $ billion



Note: Adjusted for inflation based on World Bank's US consumer price index, indexed at 2024.
Source: fDi Markets; McKinsey Global Institute analysis

McKinsey & Company

November 2025

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THE DIGITAL TRANSFORMATION CHALLENGE

Explosive Growth

AI Market Explosion

$189B
2023

→

$4.8T
2033

25x Growth in 10 Years

Data Center Market

$242.7B
2023

→

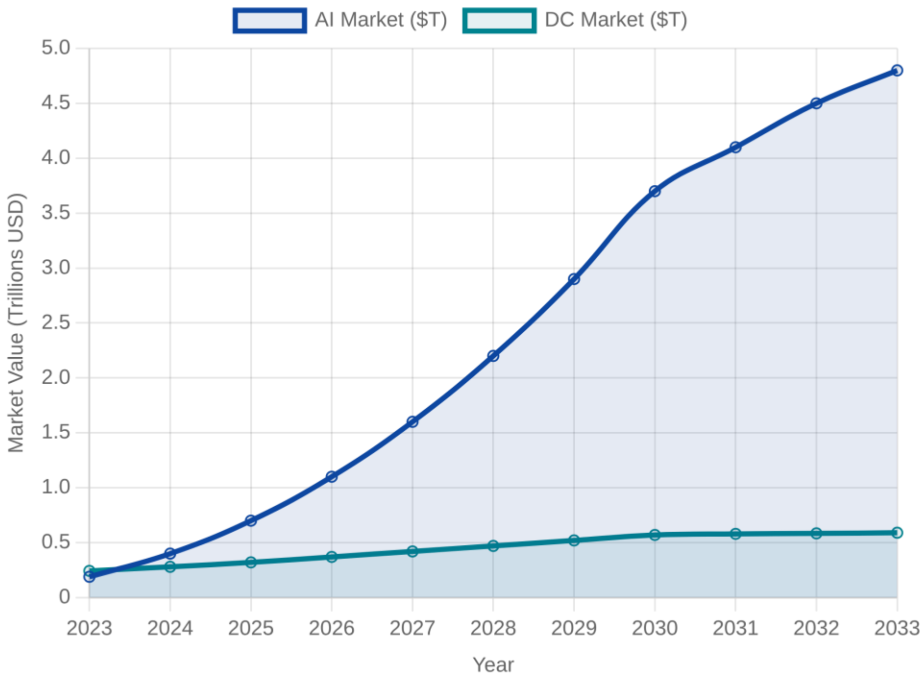
$584B+
2032

2.4x Growth Expected

Critical Metrics

Hyperscale DC Count	Doubling every 5 years
New DC Capacity (2025)	≈10 GW breaking ground
Global Electricity Use	1–1.5% already

Market Growth Trajectory



DATA CENTER RESOURCE DEMANDS

1-1.5% Global Energy Use
Current consumption
Growing rapidly

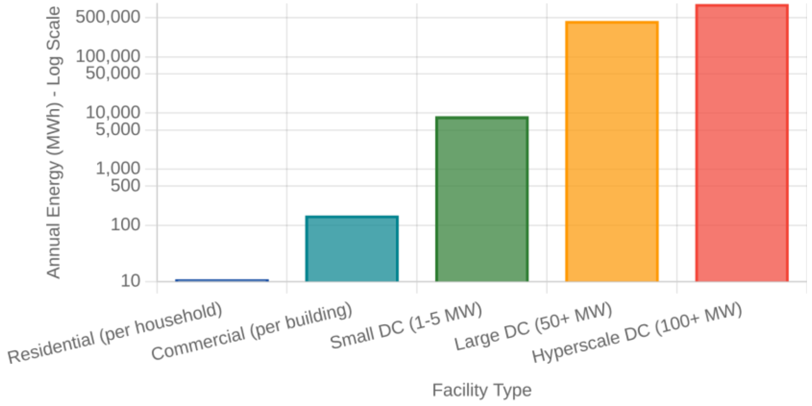
≈10 GW New Capacity
Breaking ground 2025
Unprecedented scale

2x Growth Every 5 Years
Hyperscale facilities
Exponential trend

Modern Data Center Infrastructure


High-density server deployment

Energy Intensity Comparison



GREAT LAKES BASIN: A PRECIOUS RESOURCE

20% Global Freshwater

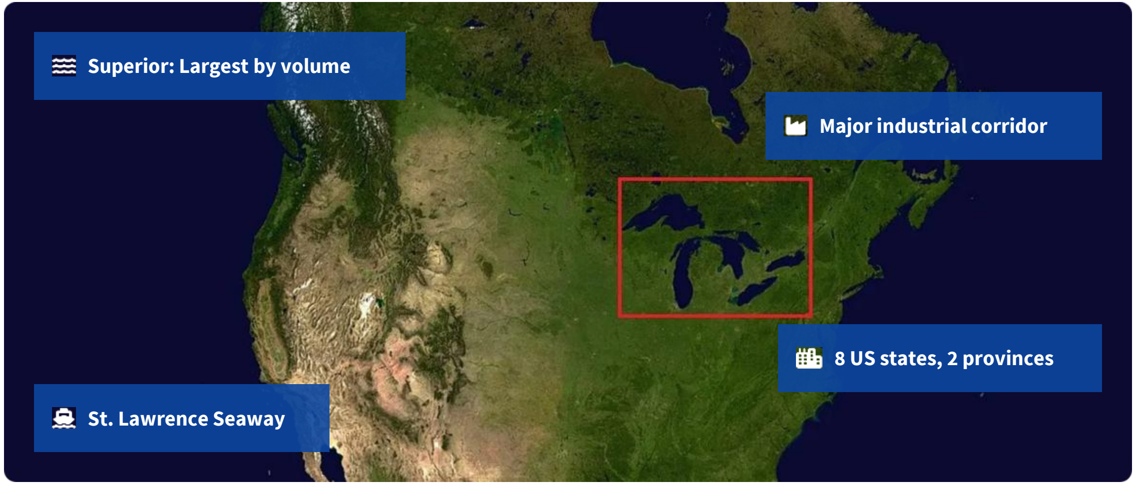
≈6 Quadrillion Gallons
20% of global surface freshwater

40M+ People
Served by the basin

$6T Regional Economy
Annual economic activity

~1% Annual Renewal
Slow natural replenishment

Great Lakes Basin



Ecological Hotspot

3,500+
Species

250+
Fish Species

Critical Habitat:
Supports migratory birds, endemic species, and complex food webs

Climate Sensitivity:
Vulnerable to temperature and water level changes

REGIONAL DATA CENTER GROWTH

Great Lakes Hotspots

25% of US Data Centers
≈847 facilities in Great Lakes states

2.7+ GW Capacity
Major announced projects

Ohio Growth
0.6 → 5 GW (2024-30)

Major Data Center Projects

Amazon New Carlisle, IN — 2,250 MW
Massive campus development with multiple phases
Seeking aquifer withdrawals

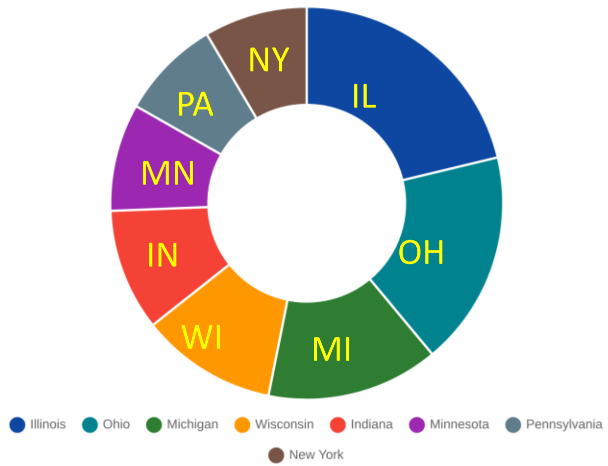
Microsoft Mount Pleasant, WI — 450 MW
Phase 1 with closed-loop cooling design
100% renewable energy commitment

Central Ohio Region — 5 GW Target
Utility forecast: 0.6 → 5 GW by 2030
Grid infrastructure challenges

Water Sourcing Trends

Kankakee aquifer: 24 MGD permits sought • Lake Michigan direct withdrawals
Municipal supply partnerships • Groundwater exploration increasing

Data Center Distribution by State



Concentration in industrial corridor

CASE STUDY: MICROSOFT MOUNT PLEASANT

Sustainable Design Leadership

450 MW
Phase 1 Capacity

Electrical Capacity
Expandable multi-phase development

Near-Zero
WUE Target

Water Efficiency
Closed-loop liquid cooling design

100%
Renewables

Clean Energy
Committed renewable energy sourcing

Technical Innovation

Closed-Loop Liquid Cooling
- Targets near-zero Water Usage Effectiveness (WUE)
- Minimal evaporative losses
- Advanced heat rejection systems
- Seasonal optimization protocols

Auxiliary Cooling
- ≤350k gallons/day (May-September)
- Peak summer demand only
- Municipal water supply partnership
- Backup systems for reliability

Energy Optimization
- AI-driven cooling optimization
- Variable speed drive systems
- Heat recovery opportunities
- Grid-responsive load management

Sustainability Impact

Industry Leadership in Water Efficiency

≤0.1
Target WUE (L/kWh)

≤1.2
Target PUE

90%+
Water Savings vs Traditional

Zero
Net Carbon (Goal)

Regional Benefits
- Minimal impact on local water resources
- Partnership with municipal utilities
- Economic development catalyst
- Technology demonstration for region

Lessons Learned
- Closed-loop systems are viable at scale
- Municipal partnerships enable sustainability
- Upfront investment pays long-term dividends
- Transparency builds community trust

INDIRECT WATER FOOTPRINT: POWER GENERATION

Hidden Water Costs

70%
Great Lakes Withdrawals
From thermoelectric plants

0.47
gal/kWh
Average power sector consumption

100x
Variation
Between cooling technologies

Water Intensity by Generation Type

Nuclear Once-Through

Withdrawal: 20-50 gal/kWh **Consumption:** 0.4 gal/kWh

Coal Once-Through

Withdrawal: 20-60 gal/kWh **Consumption:** 0.69 gal/MWh

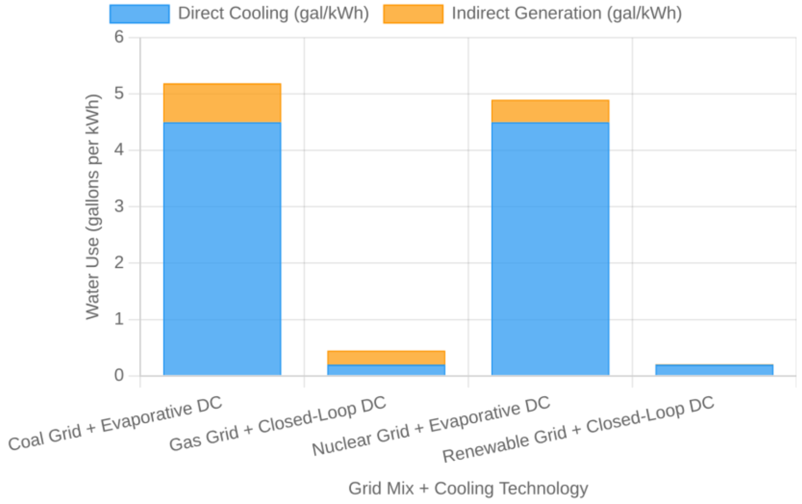
Natural Gas CCGT Recirculating

Withdrawal: ≈2.8 gal/MWh **Consumption:** 0.25 gal/kWh

Wind & Solar

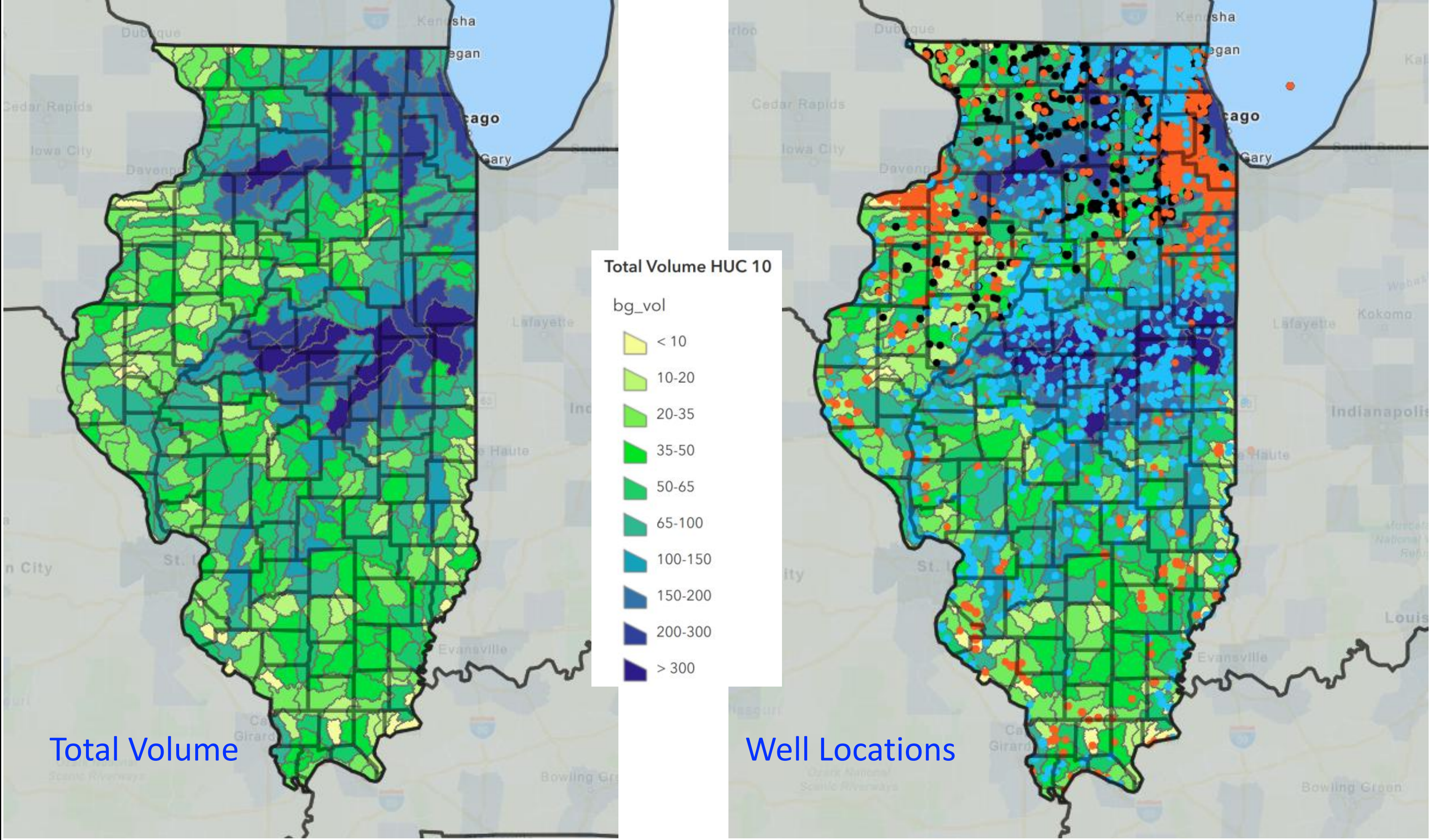
Withdrawal: Minimal **Consumption:** Near Zero

Data Center Total Water Footprint



Key Insight

A data center's total water footprint includes both direct cooling water and indirect water from electricity generation



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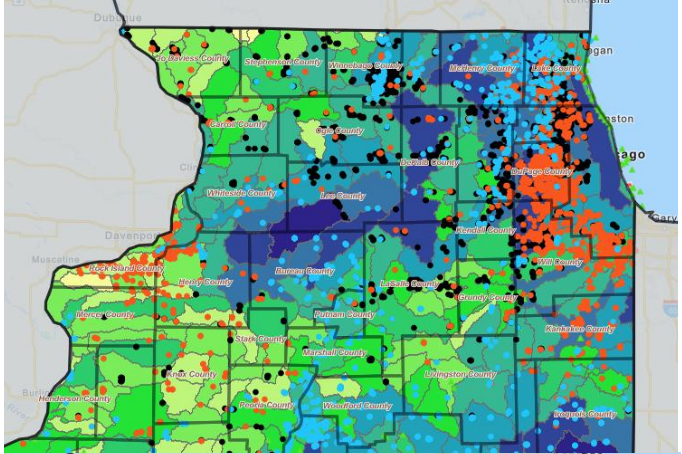
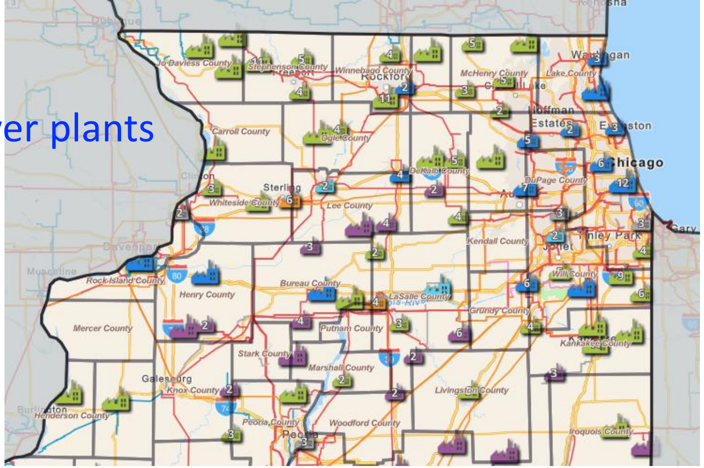
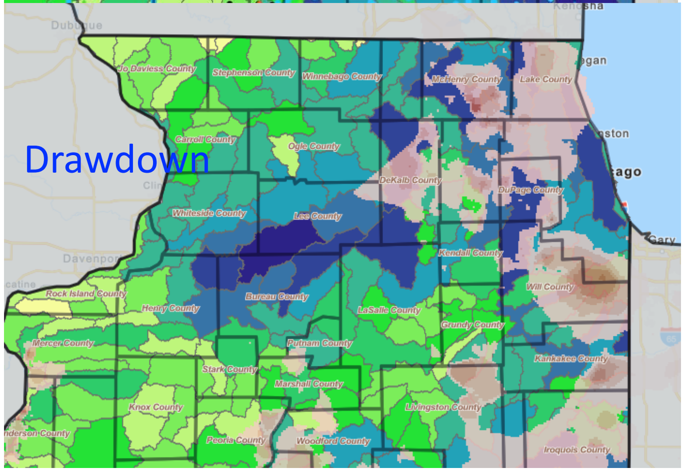


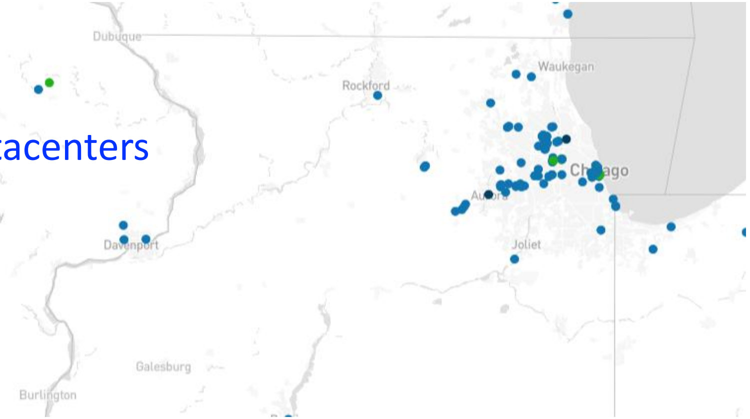
Power plants



Drawdown



Datacenters



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SUSTAINABILITY TARGETS & BEST PRACTICES

Actionable Benchmarks

≤0.2
L/kWh

WUE Target
Water Usage Effectiveness

Leading Edge

≤1.2
Ratio

PUE Target
Power Usage Effectiveness

Industry Best

100%
Hourly

Clean Energy
Hourly-matched renewables

Carbon Free

Zero
Net Loss

Consumptive Use
Closed-loop or DLWC

Basin Priority

Technical Best Practices

Advanced Cooling
- Closed-loop liquid cooling systems
- Direct-to-chip cooling for high-density racks
- Deep-lake water cooling where feasible
- AI-optimized HVAC controls

Real-time Monitoring
- Continuous WUE and PUE monitoring
- Public sustainability dashboards
- Automated efficiency optimization
- Predictive maintenance systems

Heat Recovery
- Mandatory waste heat reuse where feasible
- District heating partnerships
- Industrial process heat applications
- Greenhouse and aquaculture integration

Policy & Implementation

Regulatory Framework
- Tie permits to verified sustainability plans
- Mandatory efficiency reporting
- Cumulative impact assessments
- Cross-jurisdictional coordination

Incentive Alignment
- Performance-based tax incentives
- Renewable energy procurement support
- Water efficiency rebates
- Innovation demonstration funding

Stakeholder Engagement
- Community benefit agreements
- Transparent environmental reporting
- Local workforce development
- Environmental justice considerations

SUMMARY: ROADMAP FOR A SUSTAINABLE DIGITAL FUTURE

Coordinated Action

Great Lakes Region as a Case Study

Digital expansion and freshwater preservation can co-exist through integrated water-energy planning, transparency, and coordinated stewardship across the Great Lakes–St. Lawrence region.

Utilities

Align grid upgrades with renewable build-outs

Coordinate transmission planning with clean energy deployment

Develop demand response programs

Enable data centers to provide grid flexibility services

Implement time-of-use pricing

Incentivize load shifting to renewable energy availability

Regulators

Tie permits to verified clean-energy plans

Link water withdrawals to renewable energy commitments

Require cumulative impact modeling

Assess basin-wide effects of clustered development

Enhance cross-border coordination

Strengthen IJC and Compact Council collaboration

Developers

Publish real-time sustainability dashboards

Transparent reporting of water and energy metrics

Implement closed-loop cooling systems

Minimize consumptive water use through advanced technology

Establish community benefit programs

Share economic and environmental benefits locally

Researchers

Improve basin-scale impact models

Develop tools for cumulative environmental assessment

Advance cooling technology research

Optimize water-energy efficiency trade-offs

Monitor ecosystem responses

Track long-term environmental indicators

Implementation Timeline

2025
Policy Framework

2026-27
Technology Deployment

2028-30
Regional Integration

2030+
Global Model