



The evolution of data center energy use: *U.S. data center reports to Congress*

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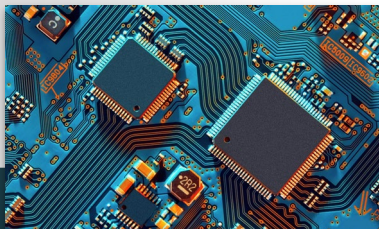


ENERGY TECHNOLOGIES AREA
BERKELEY LAB

Berkeley Lab's Basic to Applied R&D and Capabilities on Energy Efficient Computing Systems

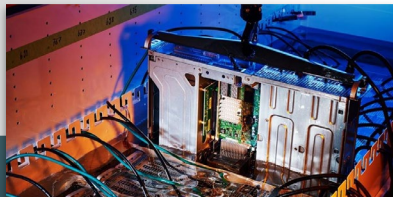
Beyond CMOS Microelectronics

Exploring new physics leading to higher energy efficiency in computing



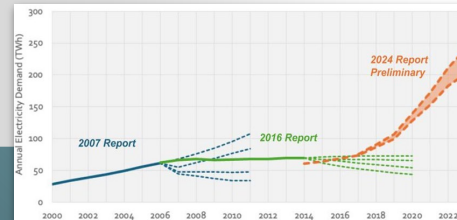
Thermal Management & Optimized DC Systems

New materials and thermal management systems with integrated optimized energy use



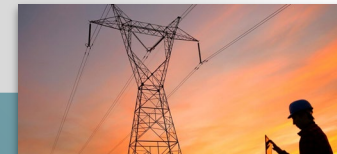
National and Local Energy Use Modeling

Empirically-sound characterization of data center energy and water use and opportunities for data center optimization



Tech Assistance, Markets and Policy

Identifying emerging best practices for industry. Support load forecasting, regulatory actions and program to mitigate load and rate impacts



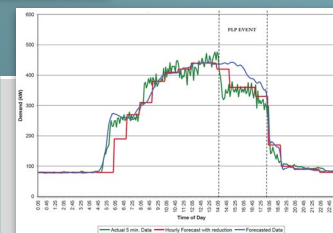
Architectural Specialization

More productive hardware development languages and advanced packaging technologies for cost-effective incorporation of specializations into mainstream platforms



Optimization Testbeds

Virtual and physical testbeds to benchmark and maximize the computing per Joule to understand and predict relationship between applications and power/energy use and algorithm efficiency



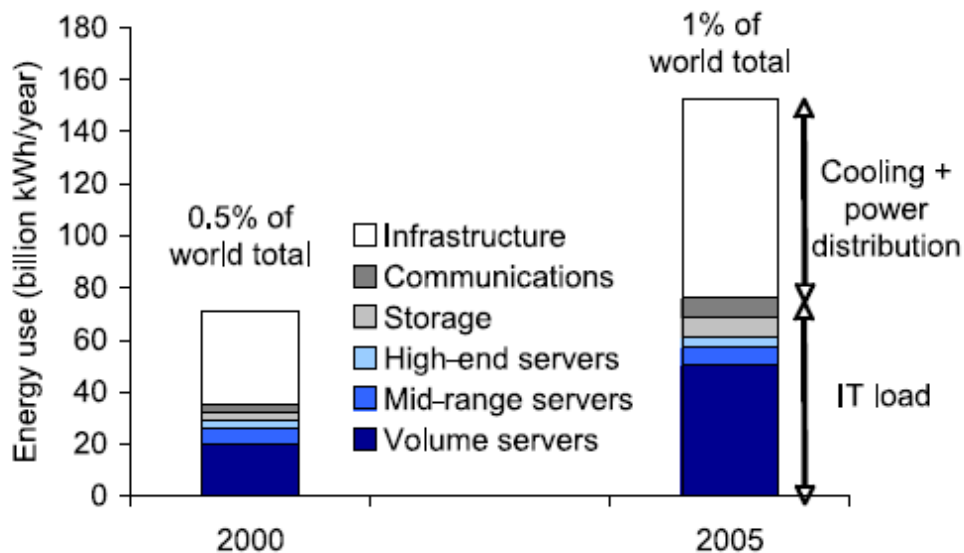
Load Flexibility, Storage and Waste Heat Reuse

Evaluating electric load flexibility and storage integration, CFE control to meet growing electricity demand and use waste heat in co-located systems

Berkeley Lab data center energy estimates in the 2000's

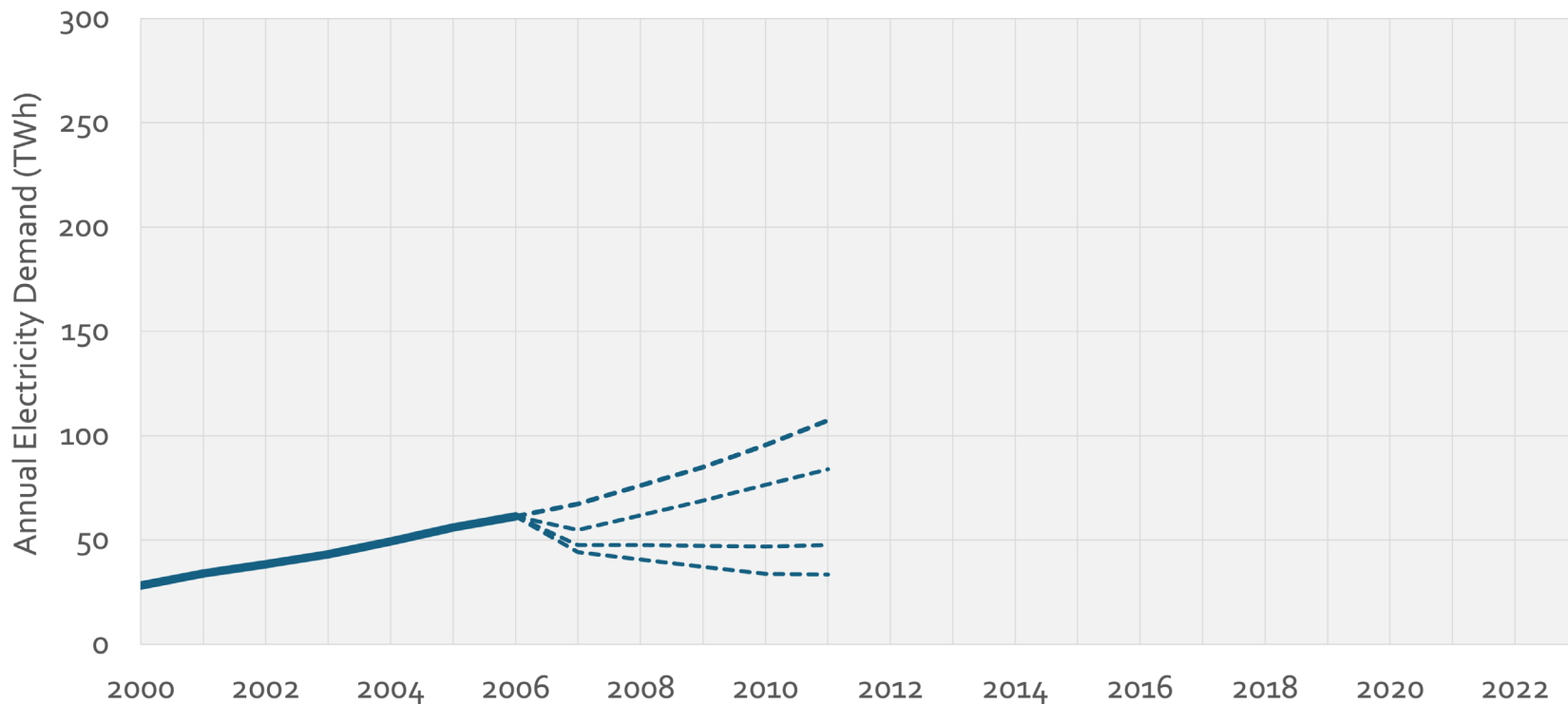


Data center electricity use doubled from 2000 to 2005

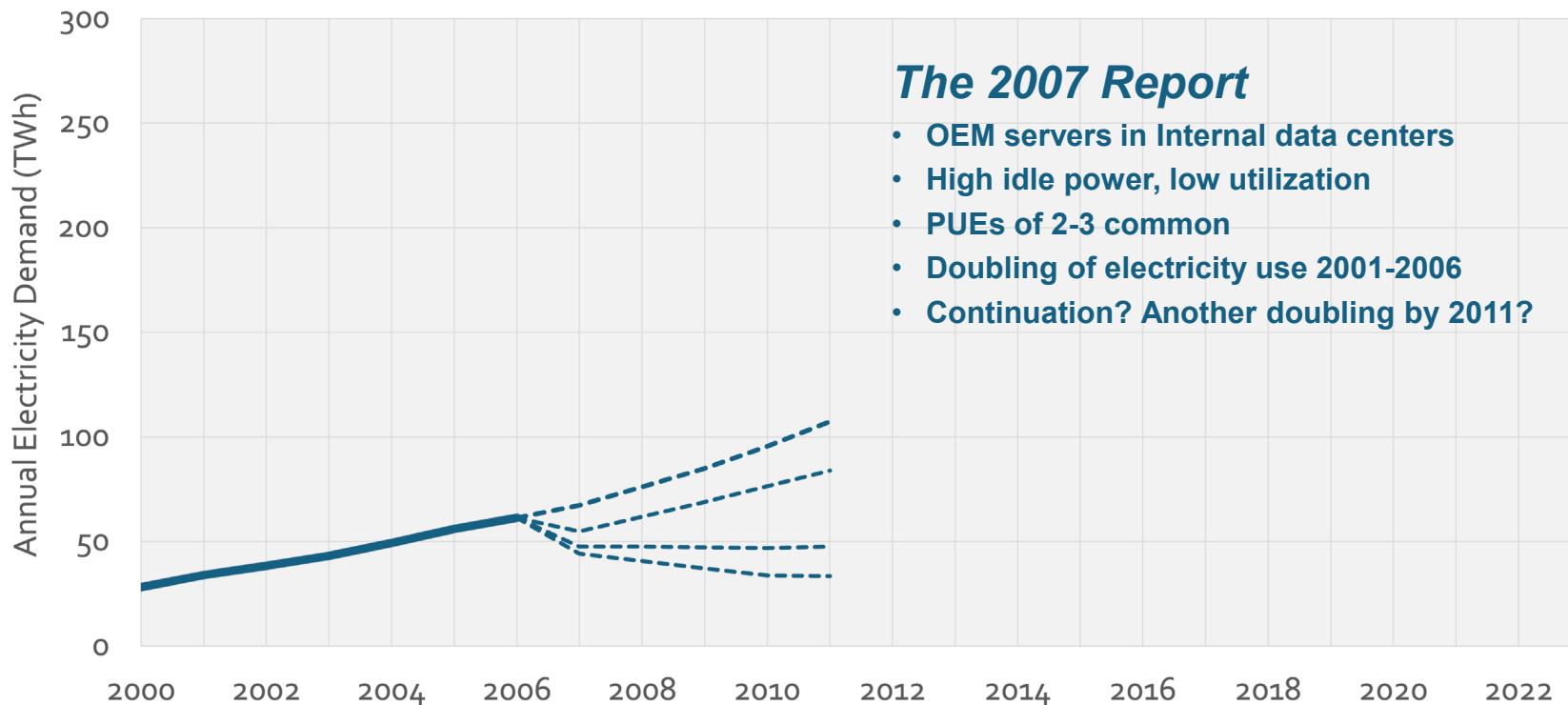


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US Data Center Reports



US Data Center Reports

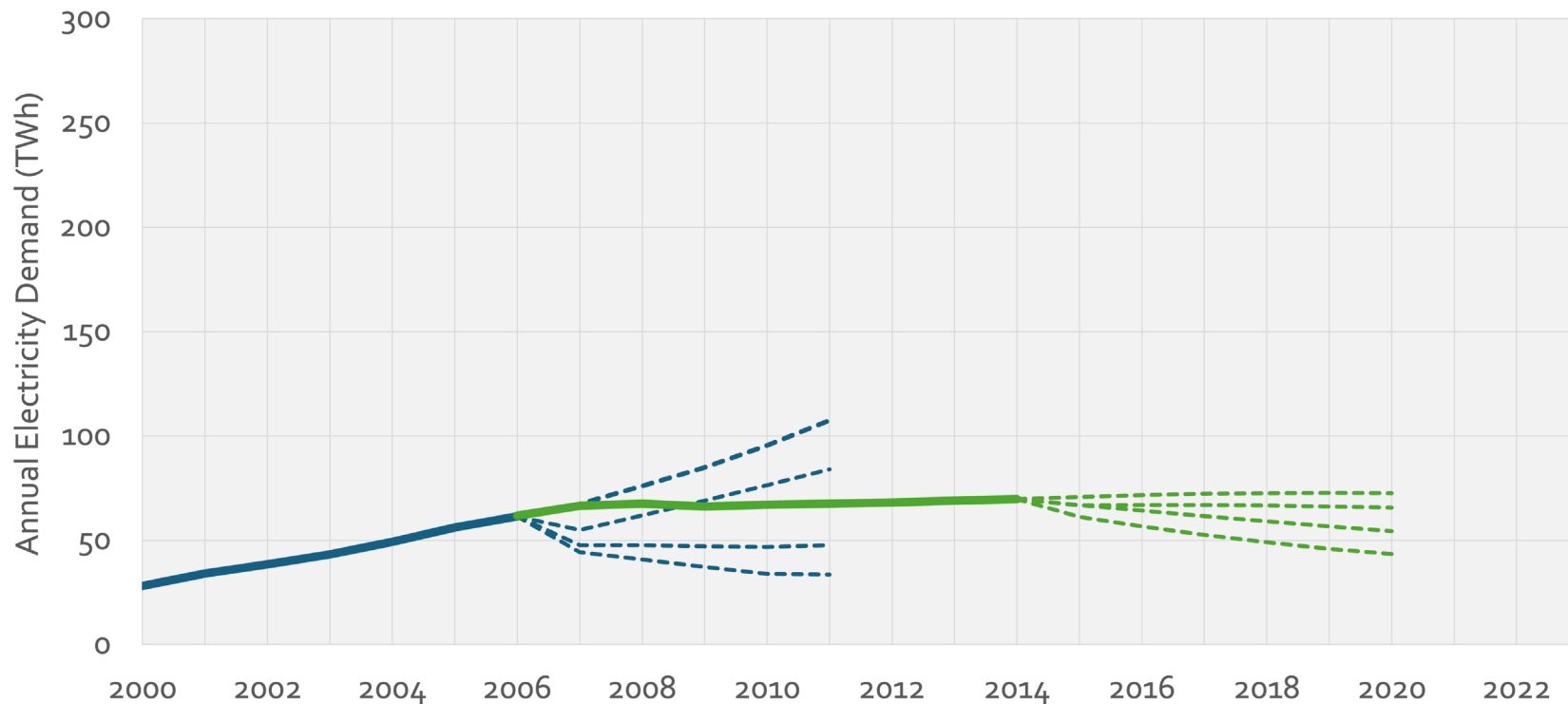


The 2007 Report

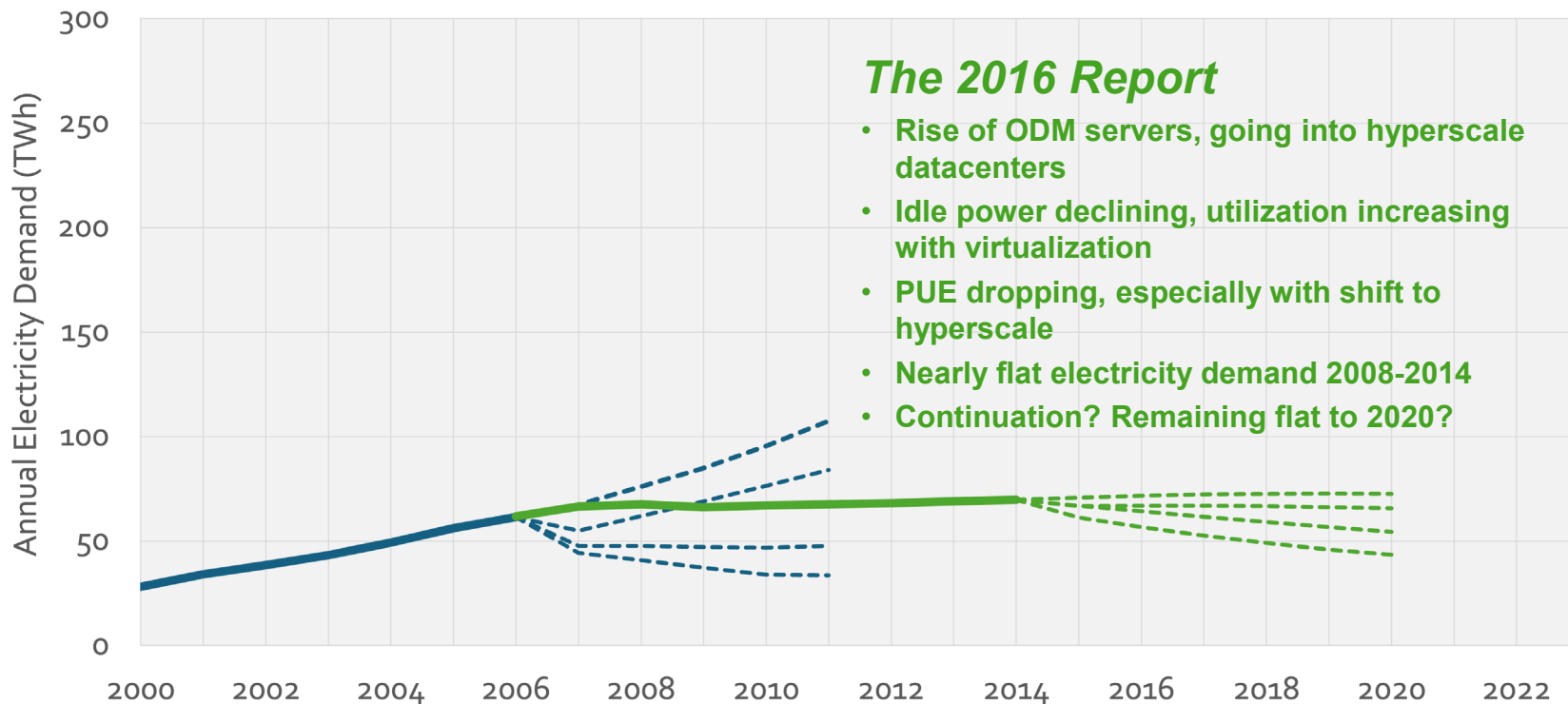
- OEM servers in Internal data centers
- High idle power, low utilization
- PUEs of 2-3 common
- Doubling of electricity use 2001-2006
- Continuation? Another doubling by 2011?



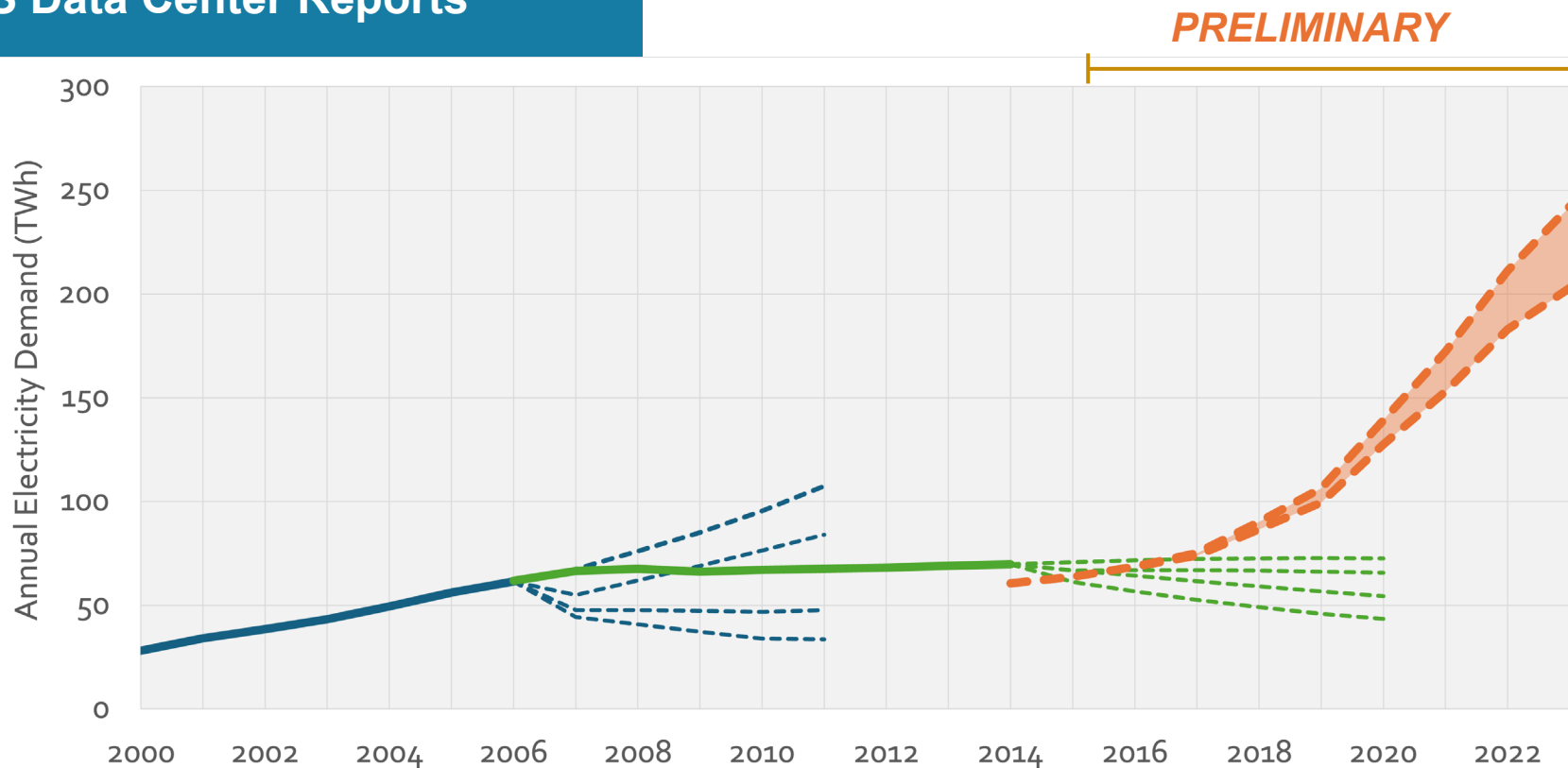
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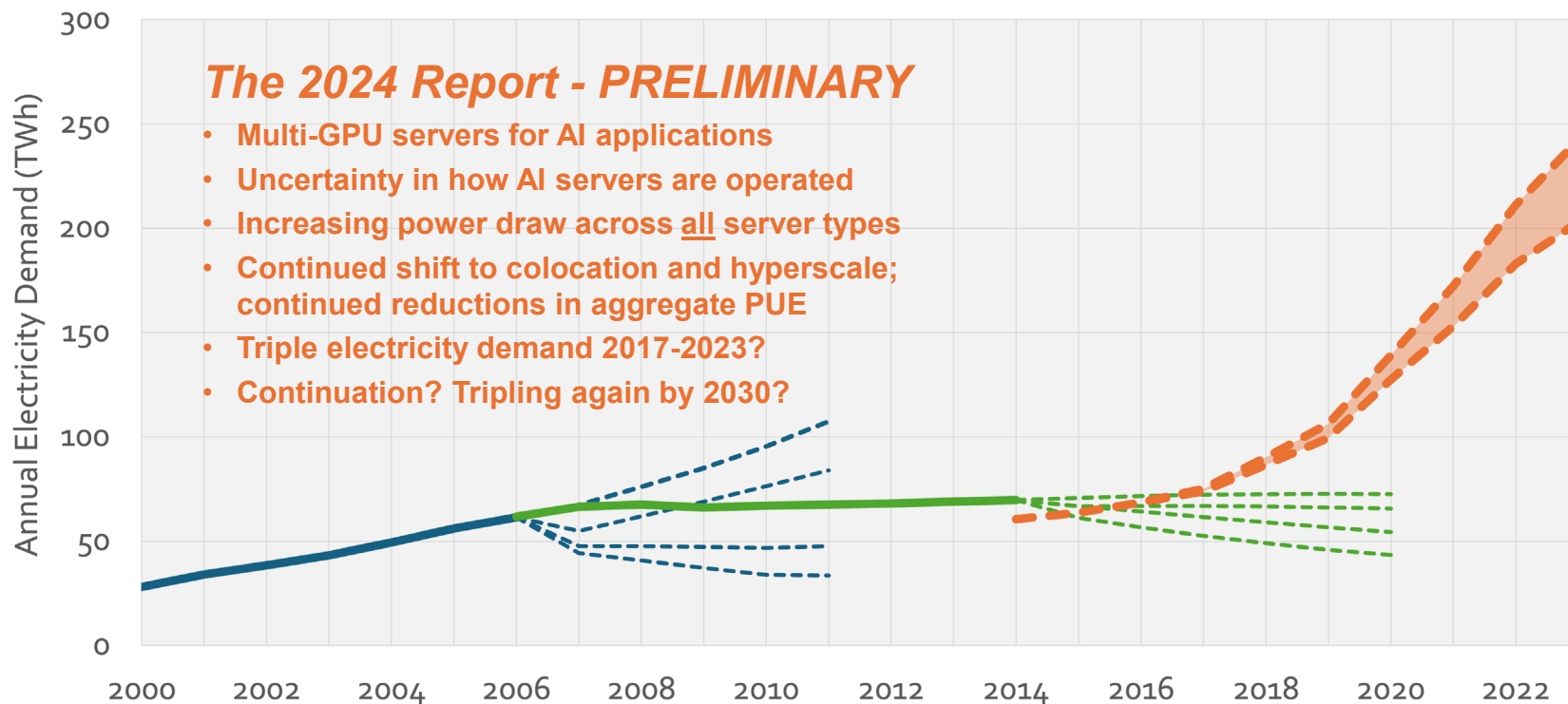
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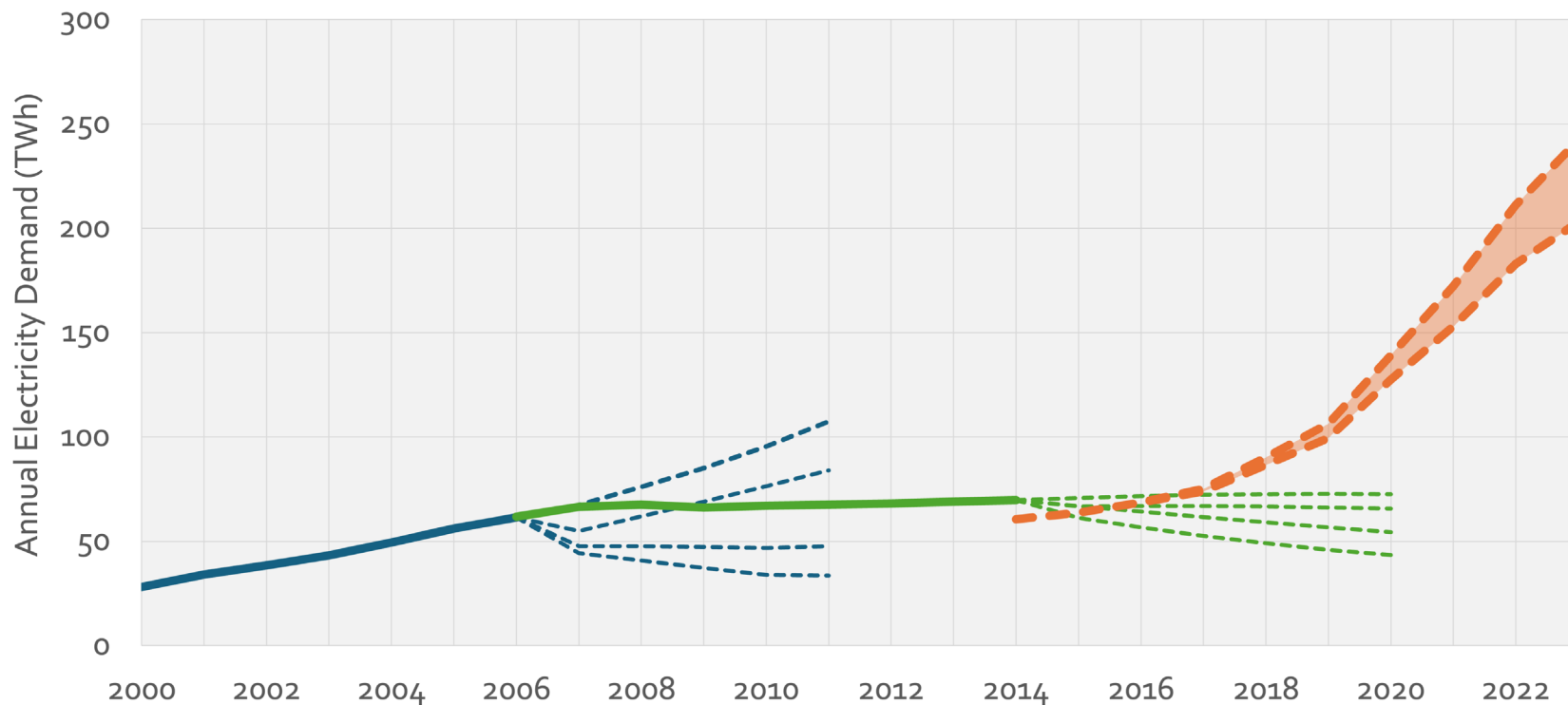
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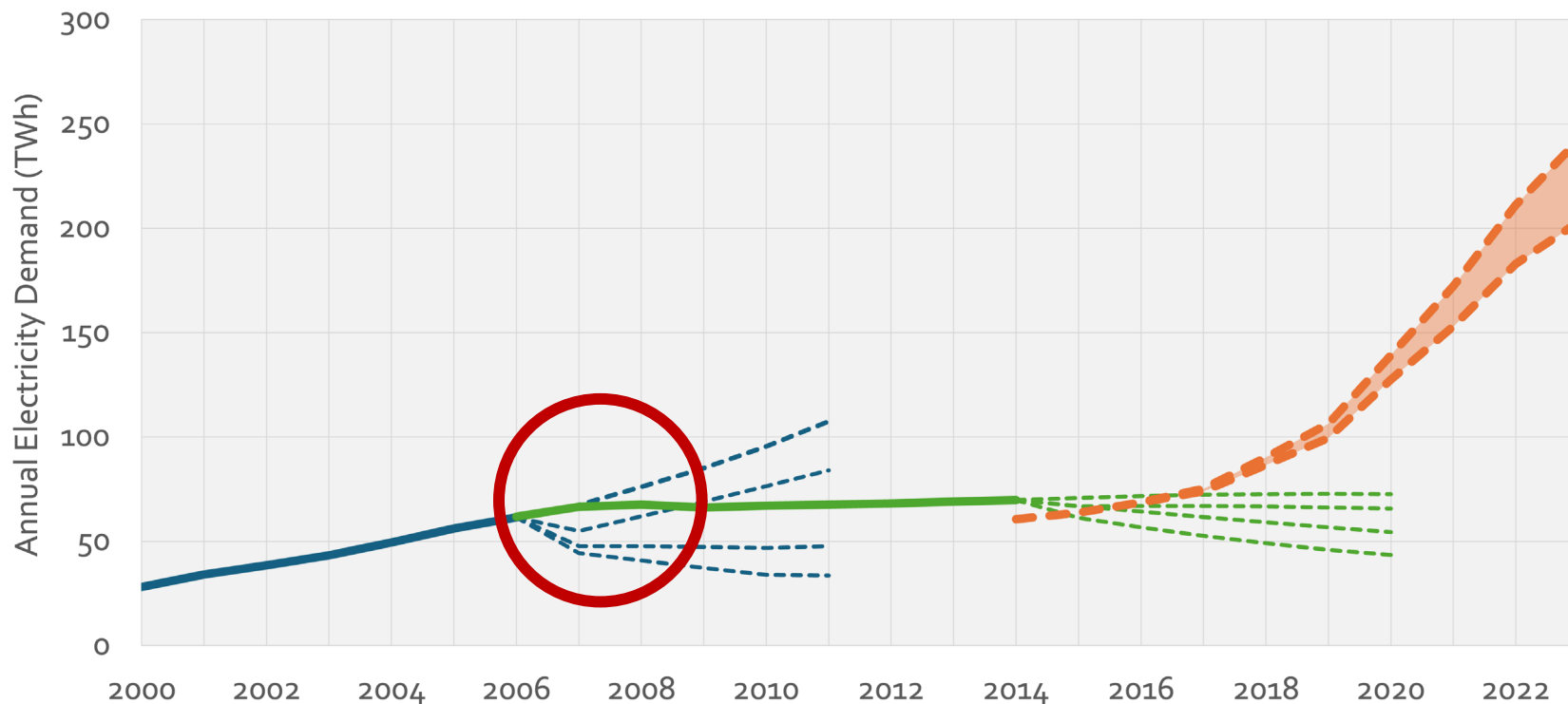
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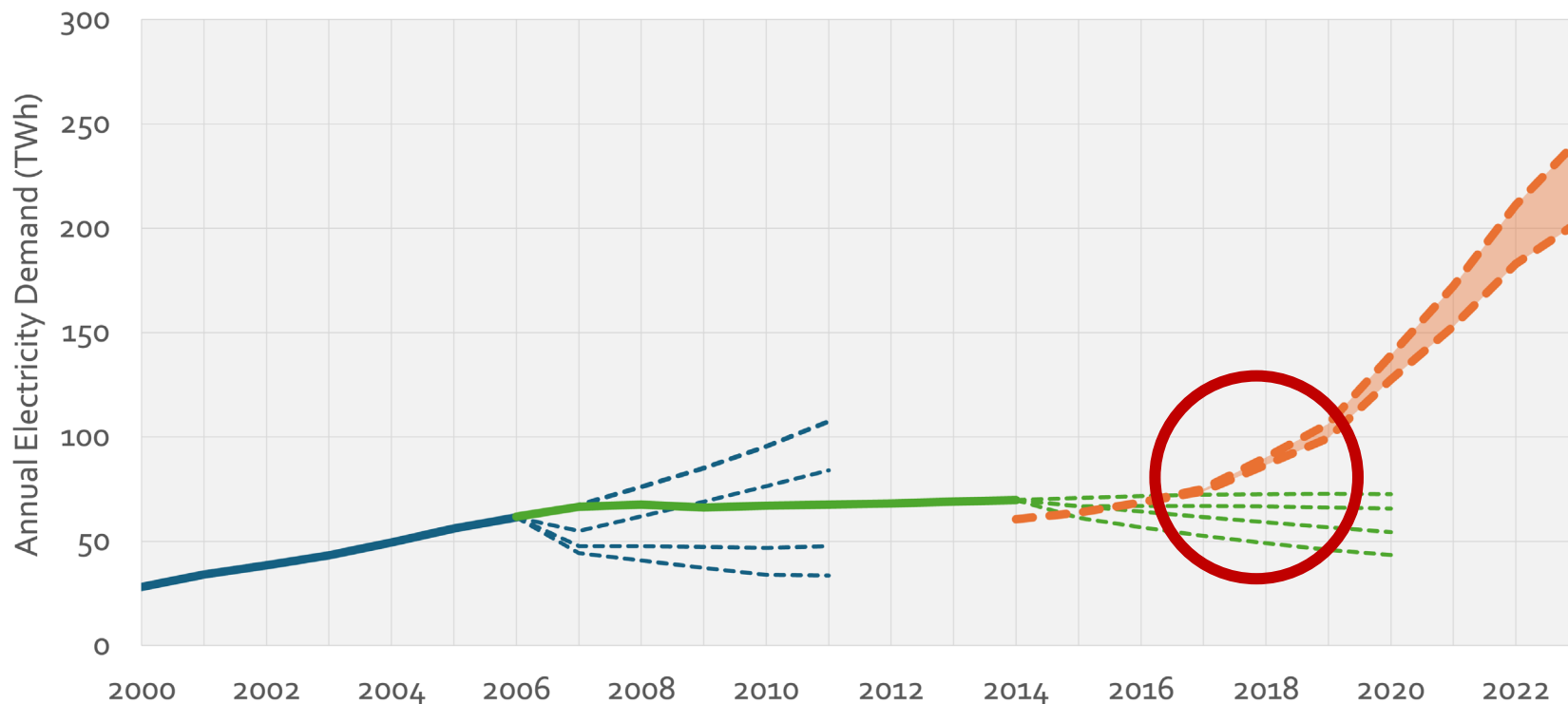
Turning points



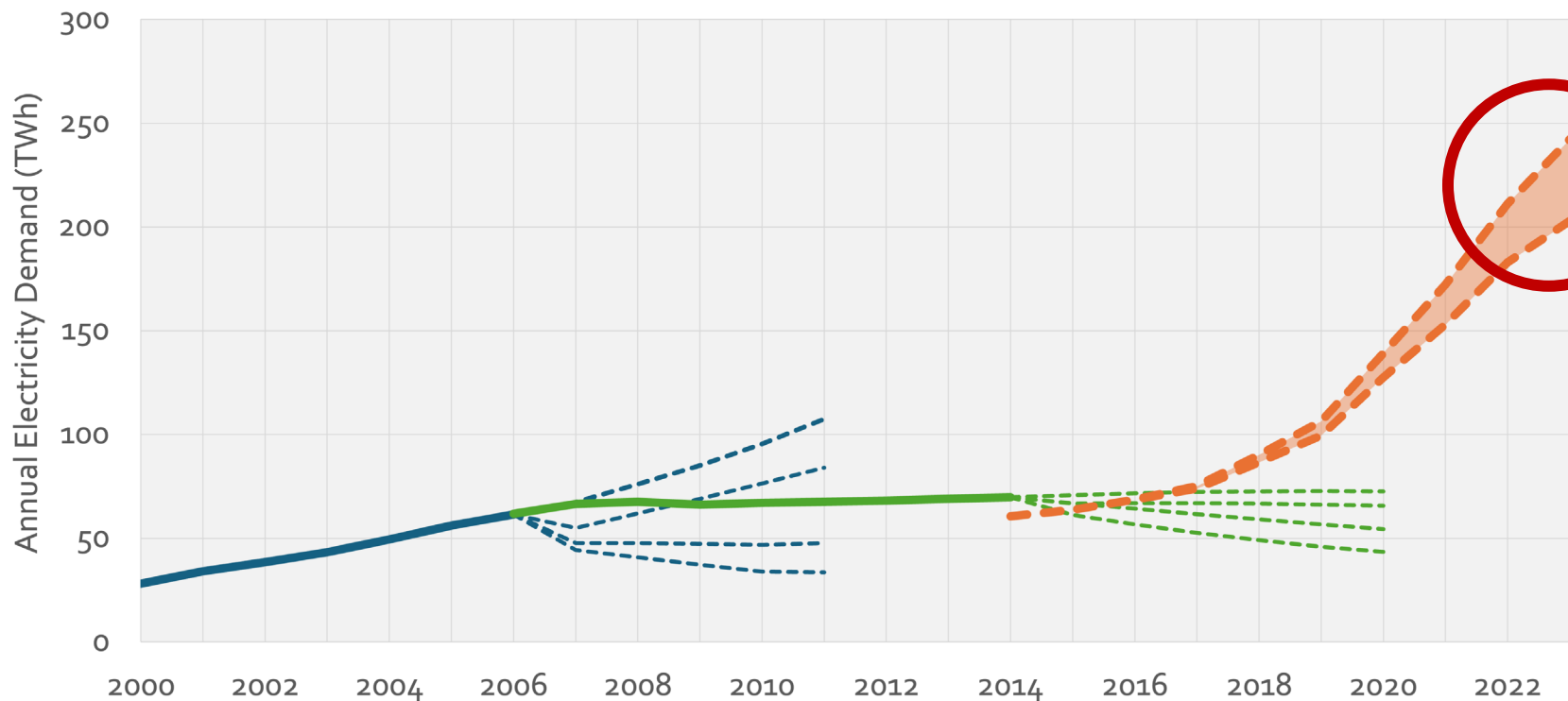
Turning points



Turning points



The current moment



The road ahead

