Regulatory and Policy Frameworks of AI Data Centers in EU and in the US

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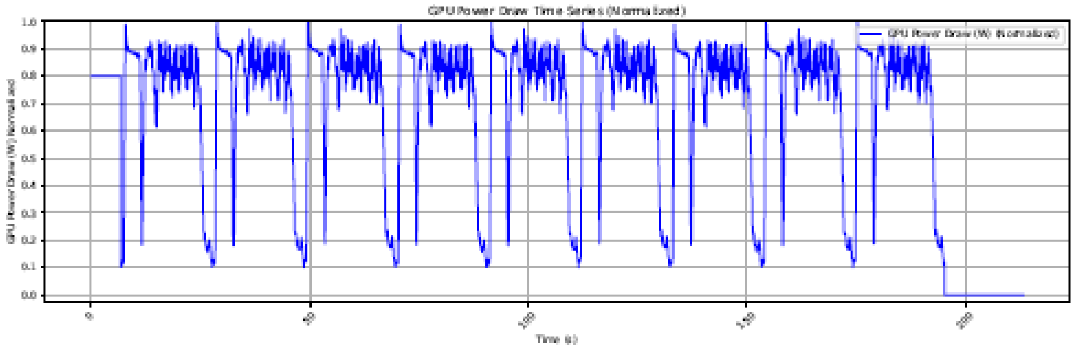
AI training DCs: Grid Stability Challenge

- ***NERC White Paper***: ***AI training facilities*** *create novel challenges with* ***ramping rates*** *up to 1.9 p.u./sec*



- *Source of disturbances and* ***risk of incidents*** *for their size and their resonance frequency*
- ***AI training workloads*** *show extreme power variability: Computation phases (~90% TDP*) vs Communication phases (~10% TDP), synchronized across 100,000+ GPUs (OpenAI/MS/NVIDIA* ***technical paper*** *August 2025)*
- *Large energy consumers requiring* ***generator-like requirements***
- ***NERC recommendations*** *- likely new FERC standards in next future*

(*) TDP: Thermal Design Power

Different types of Data Centers

Three Distinct Categories with Different Grid Impacts

1. *Traditional Data Centers*

- *Stable, predictable load profiles*
- *70-80% average capacity utilization*
- *Smooth ramping characteristics*
- *Example: Cloud storage, enterprise applications*

2. AI Training Facilities

- *Synchronized workloads across 100,000+ GPUs*
- *Computation phases (~90% TDP) vs Communication phases (~10% TDP)*
- *Extreme variability: 10% → 90% TDP in seconds*
- *Grid impact: Similar to losing a large generator*

3. AI Inference Data Centers *(Operations/Production)*

- *More stable than training, less than traditional*
- *Workload depends on user demand patterns*
- *Still significant but manageable variability*

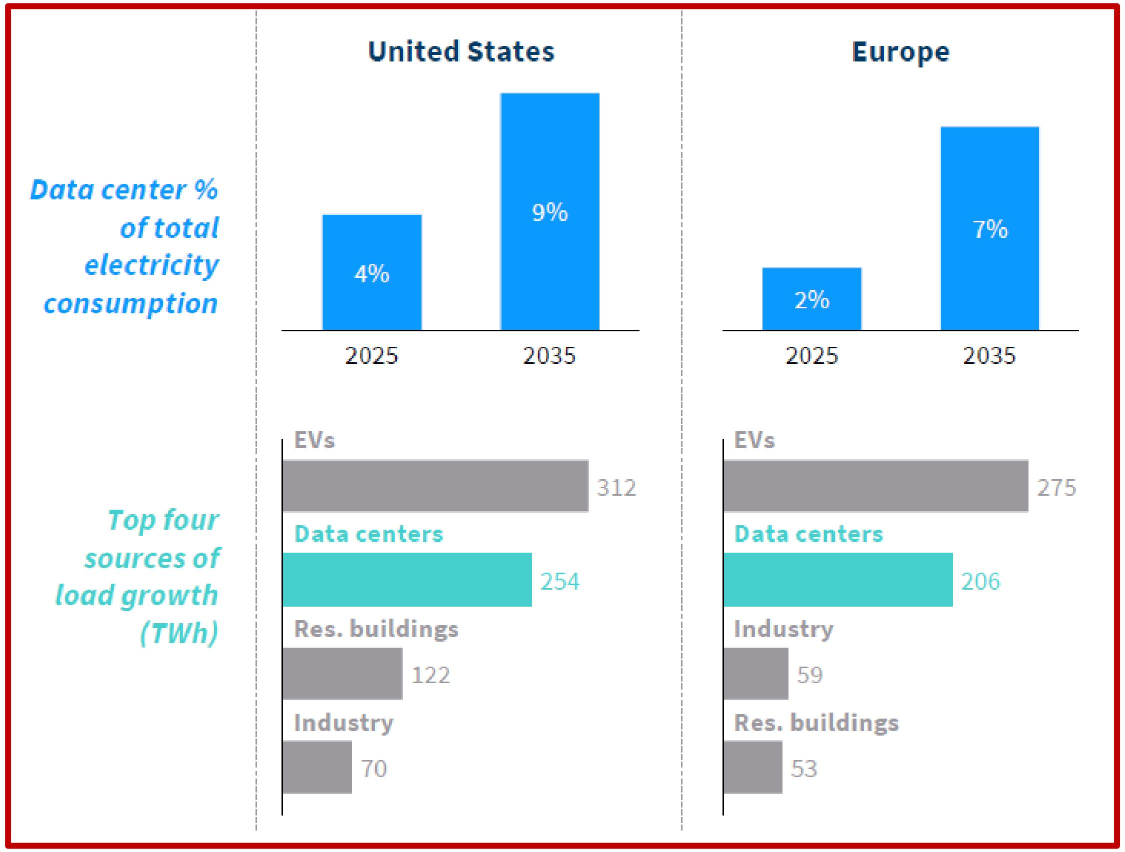
The Energy Appetite: AI in Perspective

- *Avg **AI prompt** requires **10x** more electricity **than Google query***
  - *Training GPT-4 class model ≈ 50 GWh (estimated)*
  - *Large AI training cluster: 500-1,000 MW continuous load*
  - *Equivalent to a **medium-sized city***
- ***Growth Trajectory for Data Centers (DCs)**:*
  - *Global DCs electricity: **460 TWh (2022)** → potentially **1,000+ TWh (2026)***
  - ***AI portion growing** from ~10% to 40%+ of DCs consumption*
- ***Grid Operator Concerns:***
  - *Frequency stability: **sudden 1,500 MW load loss** documented (NERC review)*
  - *Planning reserves: traditional demand **forecasting models inadequate***
  - ***Connection queue**: years of backlog in key regions*

The AI-Climate Dilemma

(2024, Floridi et alii, Yale)

- ***In Europe,*** *DC demand is expected to triple, even though expected EV demand is higher (picture drawn from* ***RMI recent study****)*
- ***Climate impact****: utilities extend* ***fossil fuel generation units*** *to meet data center demand (sometimes* ***nuclear*** *as well, where available)*
- *Country examples (DC demand % of total electricity):*
  IE: 21% *(projected 30% by 2032)*
  NL: 5.2% *DE: 3% FR, IT: 2.2-2%*



EU/1: Why Ireland

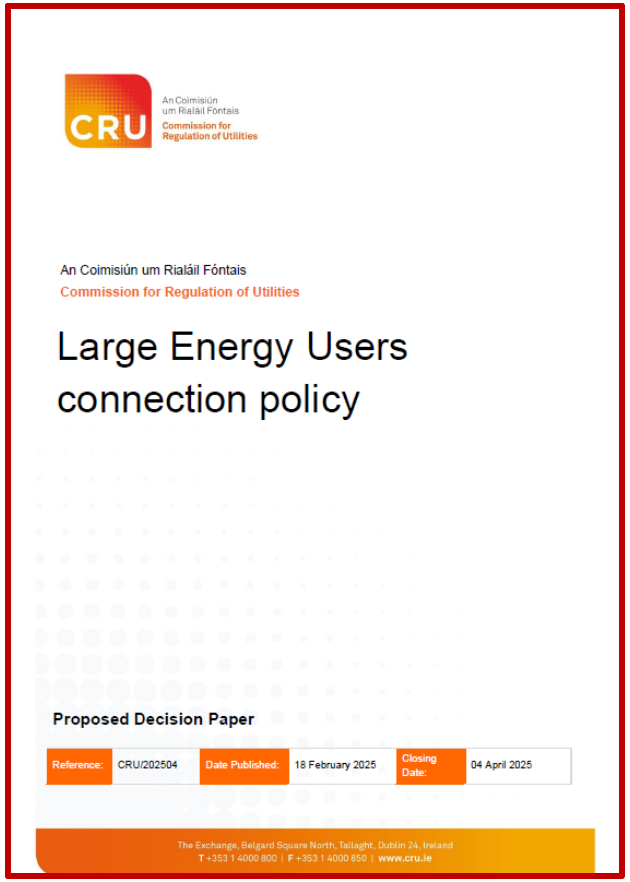
- ***2015: 5% DCs*** *of national electricity;* ***2023: 21%; 2032 30%*** *projection*
  - ***Dublin area*** *alone:* ***48%*** *of electricity serves data centers*
- *Highest concentration globally:* ***reasons***
  - ✓***Tax regime***
  - ✓***Cool climate*** *(natural cooling advantage)*
  - ✓*Strategic* ***location (EU-US*** *connectivity)*
  - ✓*High-quality* ***digital infrastructure***
  - ✓***But****: Grid investment didn't keep pace*
- *The first regulatory Response:* ***CRU moratorium (2021 in Dublin area*** *due to grid capacity exhausted)*

  The moratorium is having real-world consequences. In September 2024, Amazon Web Services' [AWS] country lead for Ireland, Neil Morris, announced that Amazon would not embark on further DC investment in the country until its offshore wind strategy and energy policies were resolved – despite having announced more than €30bn of investment in other European locations, including Spain, Germany, France and the UK (source: KPMG)

EU/1: Irish Regulator's Comprehensive Proposal

CRU Consultation Paper *(Febr-25)- 4 pillars*

- ***Energy self-sufficiency****: New data centers must have* ***dispatchable*** *generation equal to maximum capacity (technology neutral)*
- ***Future-proofing****: Equipment must be hydrogen/biofuel compatible, if thermal, or use renewable coupled with storage*
- ***Intelligent localization****: Grid operators must publish* ***capacity maps****; connections can be refused in saturated zones*
- ***Operational flexibility****: Data centers shall provide demand response services during grid stress periods*



CRU

An Coimisiún um Rialáil Fóntais

Commission for Regulation of Utilities

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Commission for Regulation of Utilities

Large Energy Users connection policy

Proposed Decision Paper

Reference:	CRU/202504	Date Published:	18 February 2025	Closing Date:	04 April 2025

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EU/1: Irish Industry Reaction

*from **Addleshaw Goddard analysis***

⚠ ***Generation Adequacy***

- *Industry demand **far outstrips** power supply*
- *CRU's 2021 Direction: strict criteria for grid connections*
- *New Large Energy Users Policy awaited: will set parameters for future development*

⚠ ***Network Planning Process**: slow-moving, prone to objections & judicial review*

- *Hope: **New Planning Act** will introduce mandatory timelines + "sufficient interest" test: should speed process and reduce frivolous objections*

EU/2: Spanish *«Concurso de domanda»*

[*Decreto 14863 11 July 25*]

- ***Legal innovation***: *abandoning «First Come, First Served»*
- ***GHG emissions*** *avoided as a merit index*
- *Further criteria: projects promoting* ***electrification*** *of industrial processes and* ***green energy vectors***
- *DC expected evolution: from 200 MW to 730 MW (2026)*

BOLETÍN OFICIAL DEL ESTADO

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III. OTRAS DISPOSICIONES

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

14863 *Resolución de 11 de julio de 2025, de la Secretaría de Estado de Energía, por la que se convocan los concursos de capacidad de acceso de demanda en determinados nudos de la red de transporte.*

El Real Decreto-ley 8/2023, de 27 de diciembre, por el que se adoptan medidas para afrontar las consecuencias económicas y sociales derivadas de los conflictos en Ucrania y Oriente Próximo, así como para paliar los efectos de la sequía, ha introducido importantes modificaciones en el marco regulador del acceso a las redes de transporte y distribución de energía eléctrica.

Tal y como se mencionaba en aquella norma, en los últimos tiempos se ha venido observando un fuerte aumento de las peticiones de acceso a las redes para conectar nuevas instalaciones de demanda. De forma análoga a lo que ocurrió con los permisos de acceso y conexión a las redes de las instalaciones de producción de energía eléctrica en los años previos a la aprobación del Real Decreto-ley 23/2020, de 23 de junio, por el que se aprueban medidas en materia de energía y en otros ámbitos para la reactivación económica, estas peticiones se producían aprovechando los escasos requisitos que se les exigía a los promotores de estas instalaciones, lo que en última instancia podía alimentar el comportamiento especulativo de los agentes, caracterizado por un acaparamiento de la red que en algunos casos no venía justificado por el interés real o la madurez de las inversiones previstas. Teniendo en cuenta la naturaleza de la red de transporte como recurso escaso, se justificaba la necesidad de abordar una reforma normativa que articulase un medio eficaz y ordenado de otorgamiento de la capacidad de acceso a las redes de transporte a los interesados en su uso y aprovechamiento.

US Approach: case by case
FERC Rejection vs ERCOT Flexibility

- ***FERC***: *Amazon-Susquehanna Case*
  - *Rejected: 300→480 MW **co-location** agreement (existing nuclear unit, «BTM»)*
  - ***Reasoning**: Unfair cost-shifting to consumers (alleged $140M annually)*
  - *Split decision: 2 favor vs 1 against (President Phillips **dissenting** in written)*
  - *Phillips: Step backward for national AI leadership, affordability can be solved*

- ***ERCOT***: *Texas Model*
  - *Threshold: **75 MW** for "large loads"*
  - ***Flexibility**: Controllable Load Resource program*
  - *Innovation: Data centers as **active grid participants***
  - *Market integration: **Load reduction compensation***

Analysis of DC energy regulation cases in EU (using Harvard Taxonomy for AI regulation)

TABLE 1A: EU REGULATORY METHODS BY COUNTRY

Country	Prohibition	Process	Input-based	Output-based
Ireland	Conditional connection refusal in saturated zones	Capacity mapping, gradual ramping mechanisms, flexibility services	Localization criteria (capacity availability vs congested areas)	Emissions transparency, annual reporting, national consumption monitoring
Spain	-	Abandonment of "first come, first served"; structured qualitative assessment	Electrification criteria, green energy vectors prioritization	Competitive scoring system based on GHG emissions avoided
Germany	Administrative sanctions for non-compliance	Mandatory energy management systems, public reporting	-	Technical PUE thresholds (<1.5 by 2027, <1.2 for new), 100% renewables by 2027, waste heat recovery 10%→20%

Source for Taxonomy: [Harv. L. Rev. 138/6, n.1562 (April 2025)]

Two Different Models

TABLE 2: EU VS USA: REGULATORY PHILOSOPHY COMPARISON

Jurisdiction	European Union	United States
Timing	Ex ante regulation	Ex post adjudication
Approach	Comprehensive integrated frameworks	Sectoral coordination with federal oversight
Enforcement	Binding obligations with penalties (up to 1-200 M€ annually per country)	Market-driven with case-by-case quasi-judicial review
Coordination	Integrated policy coordination	Federal-state coordination
Dominant Method (Harvard Taxonomy)	Mixed methods (all 4 categories)	Hybrid approaches with process regulation dominant, significant input-based and output-based elements
Regulatory Certainty	High predictability, substantial upfront compliance costs	Lower direct costs, greater uncertainty in outcomes
Key Examples	CRU proposal for self-sufficiency dispatchable generation requirements; German PUE progressive mandates; Spanish competitive allocation procedure	NERC technical frameworks; FERC Amazon-Susquehanna rejection; ERCOT 75MW thresholds

Policy Recommendations

- ***Evolution of non-discrimination***: *Traditional "first come, first served" principles must yield to* ***environmental considerations***
- ***Bridge the gap*** *between AI regulation and energy policy – avoid sectoral silos*
- ***Only technology and good rules together can save the system****: combine flexibility, requirements and standards with cross-stack tech solutions: software smoothing, GPU controls, and rack-level storage*

- *The AI-energy nexus requires* ***fundamental evolution of energy law principles:*** *from sectoral regulation to integrated frameworks that address technological, environmental, and economic interdependencies.*

THANK YOU
FOR YOUR ATTENTION!

If you're interested I suggest you to download the full ERRA paper:

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https://erranet.org/regulatory-and-policy-frameworks-for-ai-data-centers-in-eu-and-us/