Grid Integration: The Regulatory Challenge

Session II: Grid Integration and Management

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#ERRAConference2025

The «Grid Risk»: The IEA Alert

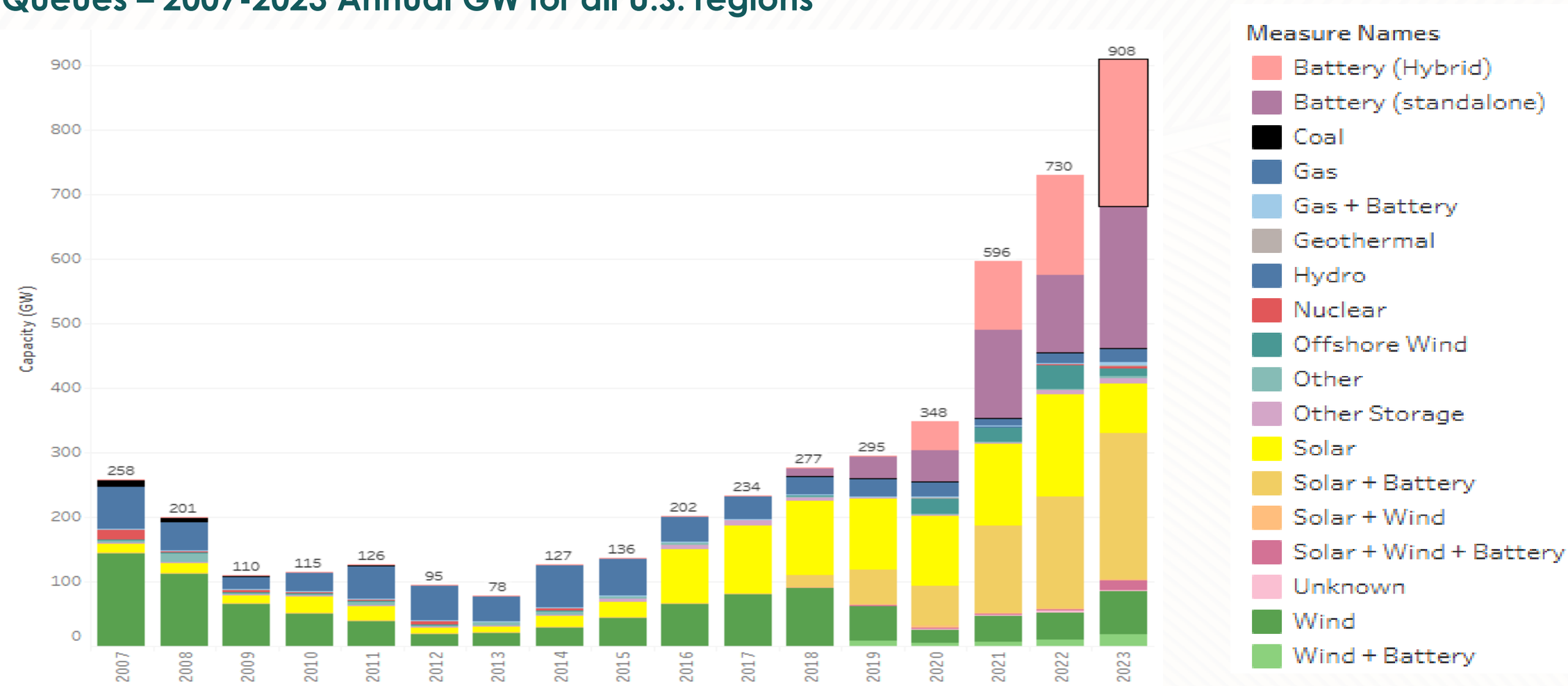
Electricity Grids and Secure Energy Transitions (IEA, 2023)

«GRIDS RISK BECOMING THE WEAK LINK OF CLEAN ENERGY TRANSITIONS»

- At least 3 000 GW of renewable power projects, of which **1 500 GW** are in advanced stages, are waiting in grid **connection queues** – equivalent to 5 times the amount of solar PV and wind capacity added in 2022.
- This shows grids are becoming a **bottleneck for transitions** to net zero emissions.
- The number of projects awaiting connection worldwide is likely to be even higher, as data on such queues is accessible for countries accounting for half of global wind and solar PV capacity.
- While investment in renewables has been increasing rapidly – nearly doubling since 2010 – **global investment in grids** has barely changed, remaining **static at around USD 300 billion per year**.

An Example: Connection Requests in US

Generation, Storage and Hybrid Capacity in Interconnection Queues – 2007-2023 Annual GW for all U.S. regions



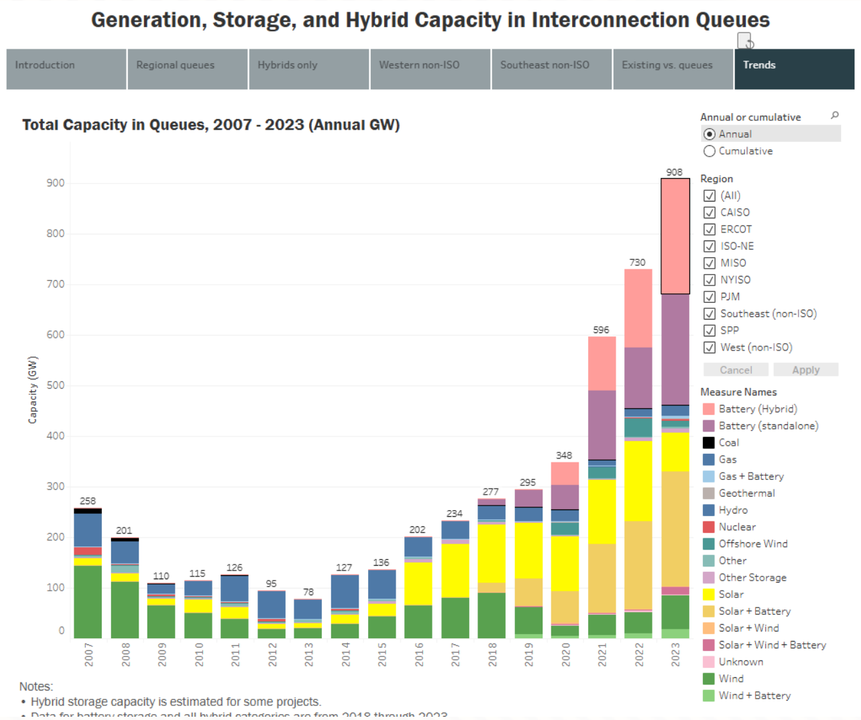
Source: Laurence Berkeley Lab, 2025

An Example: Connection Requests in US

Cumulative data:

*«nearly 2 600 GW of total generation and storage capacity now seeking connection to the grid (over **95% of which is for zero-carbon resources** like solar, wind, and battery storage). However, most projects that apply for interconnection are ultimately withdrawn.»*

*«Historically **only ~20% of projects (and only 14% of capacity)** requesting interconnection from 2000-2018 have reached commercial operations.»*

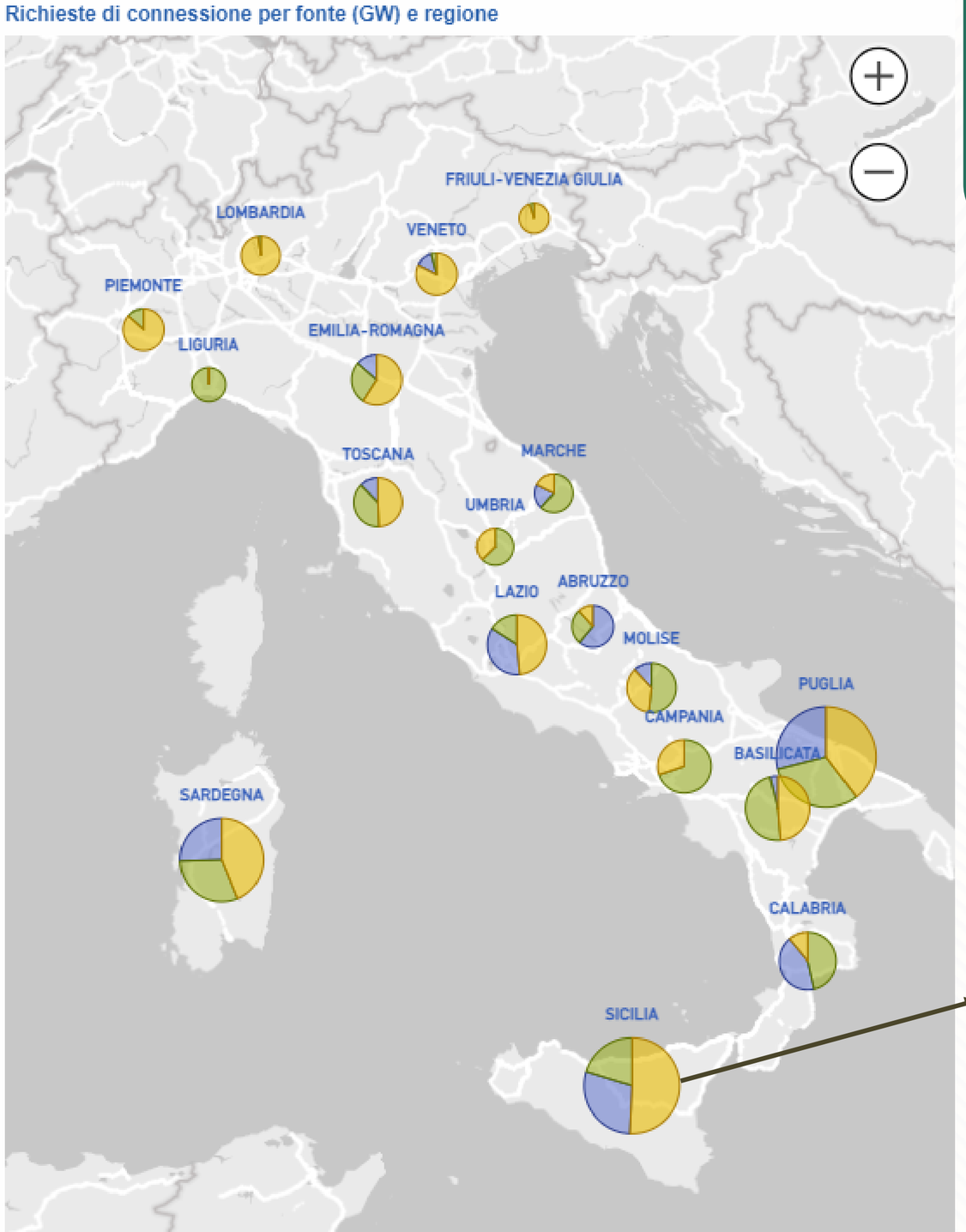


Source: Laurence Berkeley Lab, 2025

An Example: Connection Requests in Italy

Demand peak in Sicily:
3.5 GW (August)

Request for connection:
80+ GW (Solar and Wind)



LEGEND:

- Solar
- On-shore WIND
- Off-shore WIND

SICILIA

81.73 Potenza (GW)
1167 Pratiche

- **41.49** GW (50.77%) **822** Pratiche
- **16.58** GW (20.28%) **310** Pratiche
- **23.66** GW (28.95%) **35** Pratiche

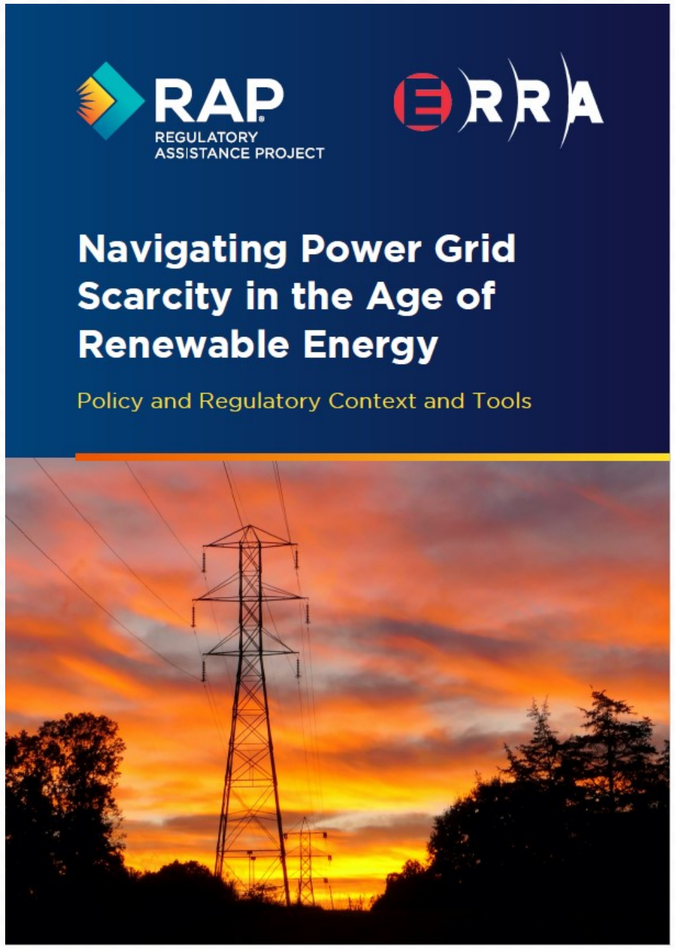
Source: Terna, 2024

ERRA-RAP Grid Scarcity Toolbox

RAP-ERRA Report 2024

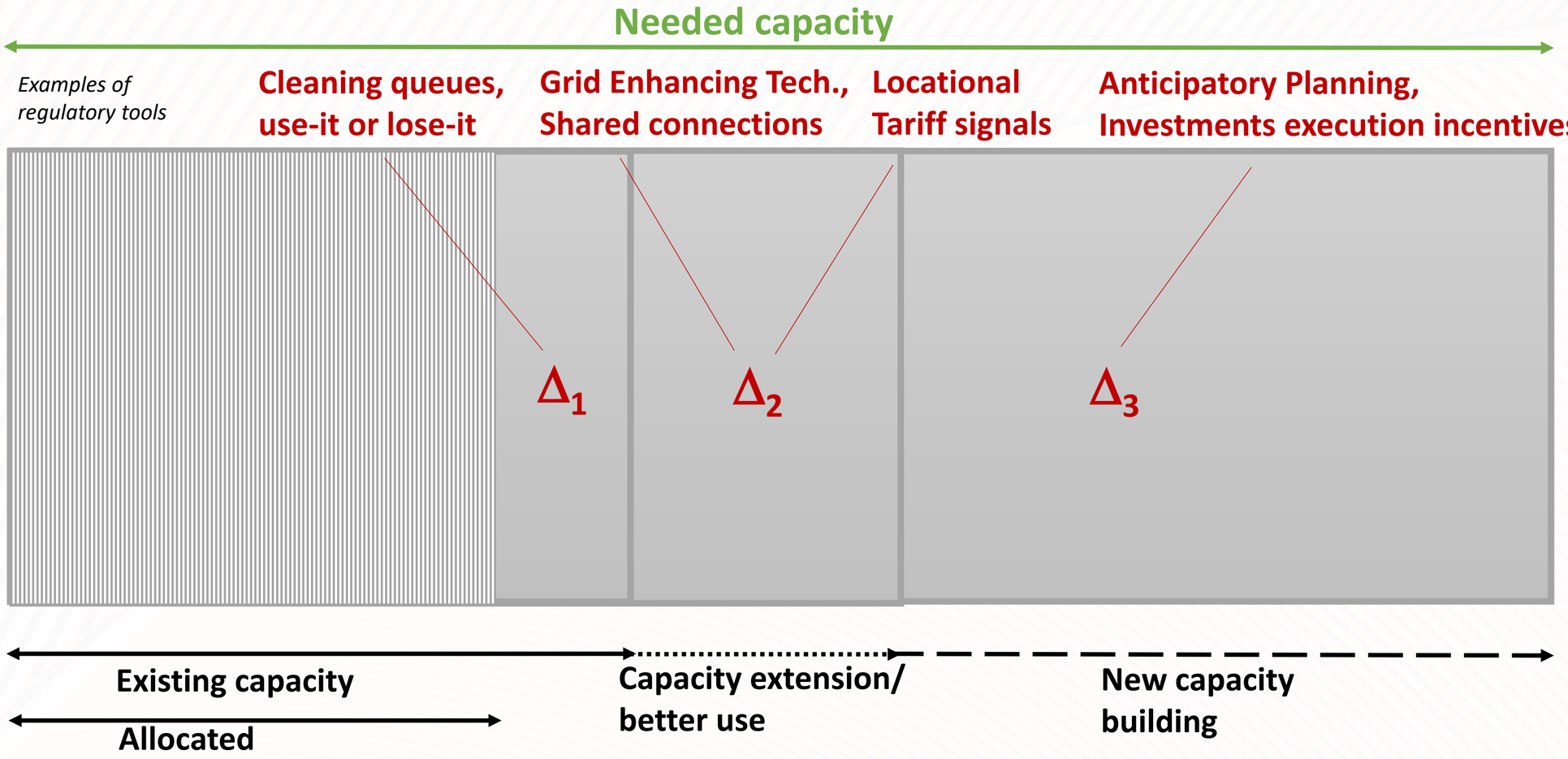
- As the issue becomes more apparent also among ERRA member countries, the Association issues the Study on how **grid scarcity** is perceived among ERRA regulators and how the issue can be tackled with an adequate **toolbox**
- ERRA survey results for 11 member countries

- **Case studies** on:
  - **cable pooling in Poland,**
  - **grid transparency in Belgium,**
  - **competitive renewable energy zones in Texas.**



No-Regret Option:
Make Better Use of Existing Grids

RAP-ERRA Report 2024



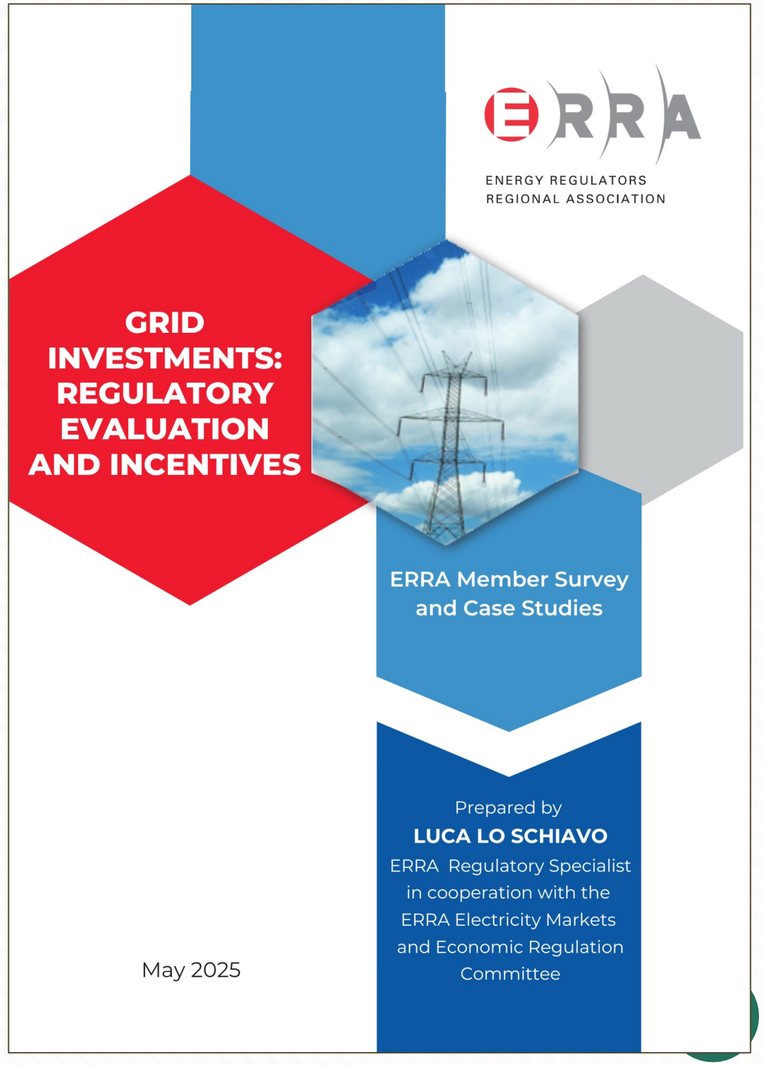
ERRA Report «Grid Investment»

ERRA 22ND ANNUAL CONFERENCE

هيئة تنظيم الخدمات العامة
Authority for Public Services Regulation

Forecoming 2025

- Focus on:
  - regulatory **assessment of grid plans** submitted by grid operators and how regulators evaluate proposed investments
  - regulatory **incentives for investments execution** (timeliness and efficiency).
- Survey of practices in 13 Erra Members
- **Case studies** on:
  - **Armenia: DSO long-term planning**
  - **France: incentives for execution (TSO)**
  - **Georgia: grid plan assessment**
  - **North Macedonia: tariff incentives**
  - **Rhode Island: tariff recognition & monitoring**



ERRA Survey: Findings

- **INTEGRATION CHALLENGE**: Electricity grids face simultaneous challenges of renewable integration, growing demand, and reliability requirements across both transmission and distribution levels.
- **GRID PLAN REGULATORY ASSESSMENT**: grid planning must address both conventional infrastructure needs and emerging technological solutions
- **CBA FRAMEWORKS**: the ERRA survey shows that cost-benefit analysis implementation still varies widely, from comprehensive frameworks to ad hoc analyses, with substantial differences in benefits considered and thresholds.
- **STAKEHOLDER CONSULTATION**: Although common practice, duration requirements vary (from 30 days to some months), with limited stakeholder participation frequently reported as a challenge especially on network users side.
- **REGULATORY INCENTIVES FOR INVESTMENT EXECUTION**: Advanced incentive frameworks for timeliness and efficiency remain limited, with notable examples including Oman's "Project Delivery Investment" scheme and French TSO mechanism.

ERRA Survey: Recommendations /1

Category	Recommendation
Grid Optimization	**Prioritize efficient use of existing infrastructure** through Grid Enhancing Technologies (GETs) and other measures before expanding networks
Standardized Assessment	**Implement structured templates for grid plans** with clear minimum requirements for both TSOs and DSOs
Cost-Benefit Analysis	Develop proportionate **CBA frameworks with appropriate thresholds and standardized methodologies** for multiple benefit categories
Scenario Planning	Enhance **long-term planning with multiple scenarios** to address fundamental uncertainty and cross-sectoral integration

ERRA Survey: Recommendations

Category	Recommendation
Stakeholder Engagement	**Strengthen consultation processes** with adequate duration (3-6 months) and multiple engagement methods
Investment Recognition	Design **tariff treatment** approaches that **balance risk allocation** while incentivizing timely implementation
Execution Incentives	Implement balanced mechanisms with **reasonable deadbands for timelines** and clear **reference costs for efficiency**
Monitoring Systems	Establish **comprehensive frameworks** with clear amendment thresholds and **regular reporting requirements**

Case Studies: 1/

Oman Project Deliver Incentive

- **THRESHOLD:** applicable to transmission investments > 20 million Omani Rials
- **MILESTONES:** two different stages, project awarding and project commissioning
- **PENALTIES**: calibrated penalties applies if milestones are not met; with 2% for awarding delays and up to 7% for commissioning delays. penalties are capped at the lowest between 10% of project cost and 3.5% of TSO business revenues.
- **DEADBANDS:** at both stage and for the overall project lifetime, to prevent penalties for minor delays while maintaining pressure for overall timely delivery
- **ANALYSIS OF DELAY REASONS:** penalties don't apply in case of force majeure events, supply chain disruptions, government decisions, and natural disasters.
- **EX-POST EFFICIENCY ASSESSMENT:** APSR undertakes ex-post CAPEX efficiency assessment and RAB reductions in case of inefficiencies during the price control review (for both transmission and distribution)

Case Studies: 2/

France Incentives for Transmission

- **CAPITAL EXPENDITURE:** rise from 2.1 billion € (2023) to 6.2 billion € (2028, expected) due to new connections, development of offshore wind, network renew and resilience
- **THRESHOLD**: from 1st August 2025, applicable to projects > 50 millions €
- **EFFICIENCY SHARING**: 20% of efficiency sharing (bilateral) above 105% if actual cost is >105% of expected cost (in this case sharing is a penalty), or below 95% if actual cost is <95% of expected cost (in this case sharing is a bonus).
- **UNIT COSTS**: for a list of assets, sharing of 20% of savings in terms of actual unit costs in respect of standard unit costs (scope: 450 M€/y CAPEX; 165 M€/y Opex)
- **MILESTONES WITH BONUS/PENALTY**: for a list of critical project, milestones have been set; a bonus of 0.5 M€ is set for each milestone timely reached, and a penalty variable with delay (progressively) if the milestone is not timely fulfilled
- **CAP FOR BONUS/PENALTY:** max +/- 10 M€ per year (milestone economic effect)

Case Studies: 3/

Rhode Island (US) ISR mechanism

- **REGULATORY LAG:** after a decade of rate freezes, the utility required a capital tracker mechanism to recover the cost of incremental investments made between rate cases
- **ISR MECHANIMS**: legislation created an annual framework, allowing utilities to propose and recover annually costs associated with infrastructure, safety, and reliability investments without regulatory lag, submitting an investment plan
- **REGULATORY ASSESSMENT**: the Commission reviews the plan to ensure that they are reasonably needed to maintain safe and reliable distribution service in both the short and long term
- **EFFICIENCY INCENTIVE**: this approach can encourage on-time and on-budget investments because the amount eligible for discretionary cost recovery is limited to the budgeted amount, and any over-budget costs face regulatory lag
- **RECENT REFORMS**: adjustments for limited / flexible extra-budget costs

Case Studies: 4/

Armenia DSO Long-Term Planning

- **DISTRIBUTION NETWORK AGEING:** due to decades of underinvestment, a significant portion of Armenia's distribution network exceeds its operational lifespan, increasing maintenance costs and reliability issues (degradation of critical network components) and losses in the distribution system
- **BARRIER TO RENEWABLE INTEGRATION**: the ageing distribution infrastructure lacks the necessary technological upgrades to handle fluctuations in renewable energy output, increasing curtailment risks and inefficiencies
- **REGULATORY MANDATE TO DSOs**: from 2015, PSRC has required DSOs to submit a detailed 10-year investment plan that includes technical and economic justifications.
- **RESULTS**: progressive improvement in level of network losses and reliability; strategic adjustments of service quality related investments in front of increase demand related (connections)

Case Studies: 5/

Romania Locational Tariff Signal

- **LOCATIONAL TARIFF FOR INJECTION:** From 2025, an injection charge is introduced for producers connected to distribution networks (110 kV, >5MW) where electricity generated is in excess and carried to other geographical zones to be consumed
- **RATIONALE:** losses due to the transit of electricity in HV distribution network (110 kV) because of the generation surplus in the zone (a study was conducted with participation of all DSOs and TSO; public consultation followed); before the intervention, losses were recovered only through withdrawal charges
- **IMMEDIATE EFFECT:** The injection charge covers only additional losses in HV distribution network due to electricity surplus generation to the local consumption and it is in one case 6% and in the other 17% of the withdrawal charge for the same voltage level
- **EXPECTED RESULT**: it's also expected a serious signal for new producers to locate in other geographical zones with demand surplus

ERRA next initiatives on Grid investments

Technical Workshop
Winter 2025-26

Avoiding the Risk of Gridlock

- How to mitigate the increase of network investments
- How to attract sufficient capital for investments
- How to provide the right tariff signals to both users and generators for optimal capacity utilization and correct location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