Next Generation Policy Instruments for Electricity Generation from Renewable Sources (RES-E-NEXT)

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Agenda

- General introduction to IEA-RETD

- Next generation policy instruments for renewable electricity (RES-E-NEXT)

The mission of IEA-RETD is to accelerate the large-scale deployment of renewable energies

RETD stands for "Renewable Energy Technology Deployment"

IEA-RETD provides a **policy-focused, technology cross-cutting platform** ("Implementing Agreement") under the legal framework of the International Energy Agency

- Created in 2005, currently **8 member countries**: Canada, Denmark, France, Germany, Ireland, Japan, Norway, UK
- IEA-RETD commissions annually **5-7 studies** bringing together the experience of some of the world's leading countries in RE with the expertise of renowned consulting firms and academia
- Reports and handbooks are freely available at www.iea-retd.org
- IEA-RETD organizes **workshops** and presents at international events

Key challenges for an accelerated RE deployment and IEA-RETD Themes

Key Challenges	IEA-RETD Themes

- Economic / societal justification for RE support
  - Jobs & economy
  - Externalities & co-benefits
  - Innovation
- Financing renewable energy deployment
  - business case
  - cost of capital and policy instrument design
- Communication / public acceptance
- System integration

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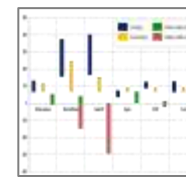
Key challenges for an accelerated RE deployment and IEA-RETD Project Examples

Key Challenges

- Economic / societal justification for RE
  - Jobs & economy
  - Externalities & co-benefits
  - Innovation
- Financing RE deployment
  - Business cases
  - Costs and policy instrument design
- Communication / public acceptance
  - Lack of understanding
  - Misleading information
- System integration
  - High variable RES-E shares
  - Market design

IEA-RETD Project Examples

Employment and Innovation through Renewable Energies (EMPLOY, 2009-12)



Cost and Business Case Comparisons of RE vs. non-RE Technologies (RE-COST, 2013)

Communication of best practices for RE (RE-COMMUNICATE, 2013)

Next generation RES-E policy instruments (RES-E-NEXT, 2013)

Economic / Societal Justification - Project Examples

Employment and Innovation through Renewable Energies (EMPLOY, 2009-12)

Renewable energy is seen as a great opportunity to create new jobs. Transparency on the overall impact of RE on employment and innovation is needed.

Outcome

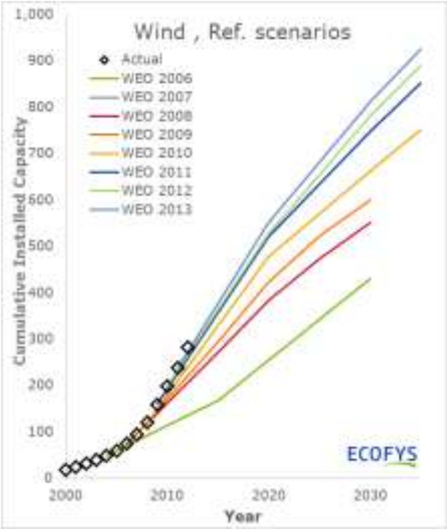
Methodology and indicators for sustained data collection and monitoring the impact of RE on employment and innovation.

Discussing assumptions in energy scenarios (RE-ASSUME, 2013) (blog)

How should energy scenarios be read?

Outcome

- Many energy scenarios currently being used seem not to incorporate rapid energy market changes adequately
- Policy makers should critically consider assumptions and methodological issues of energy scenarios that before deriving conclusions



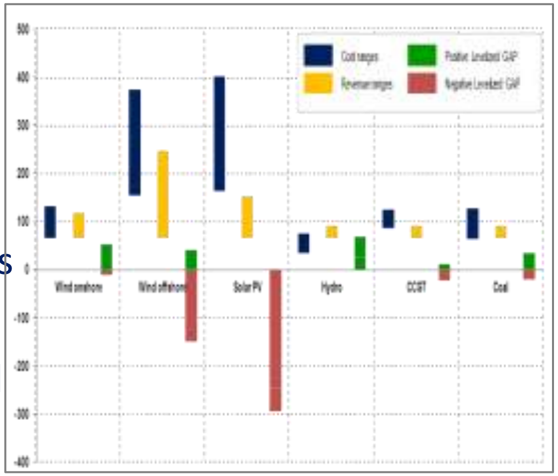
Financing Renewable Energy – Key challenges for large-scale deployment (FINANCE-RE 2011-12)

- Large-scale deployment of RE projects requires much higher levels of funding than invested to date

Outcome

- RE should be part of a robust economic development strategy
- Proven mechanisms should not be abandoned, but new policies have to reduce the risk-to-reward ratio to enhance private sector investor confidence

Cost and Business Comparisons of Renewable vs. Non-renewable Technologies (RE-COST, 2013)



- Are RET really less competitive than non-RET?

Outcome

- Generation costs of new RET are gradually approaching the costs of thermal generation
- Business cases are different for each region/technology pair and highly depend on market and policy conditions

Non-Technical and Non-Economic Barriers
(RENBAR, 2013)

Various so-called non-technical and non-economic barriers impede the deployment of renewables in many countries

Outcome

Knowledge sharing through examples and a toolbox to facilitate good policy measures.

Communication of best practices for RE
(RE-COMMUNICATE, 2013)

An identified barrier to a widespread use of RE are the (mis-) perceptions in the public, at a political level and within the industry sector.

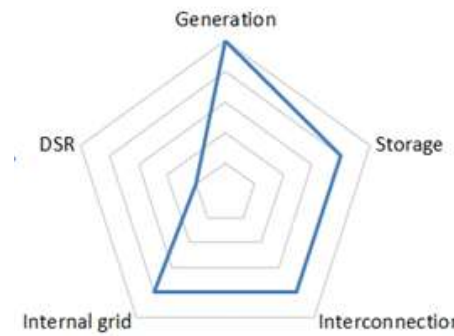
Objective

- Provide ideas and techniques on how the benefits of RE can be better communicated to and by policy and decision makers in order to accelerate the deployment of RE.
- Evaluate case studies from various communication campaigns.

Integration of variable renewable electricity sources in electricity systems (RE-INTEGRATION, 2014, ongoing)

Objectives

- What are typical sets of country specific factors that determine the choice of flexibility options?
- What does a – case study based – assessment conclude on the applicability and the effectiveness of the options?
- What general lessons might be drawn by countries with similar underlying conditions?

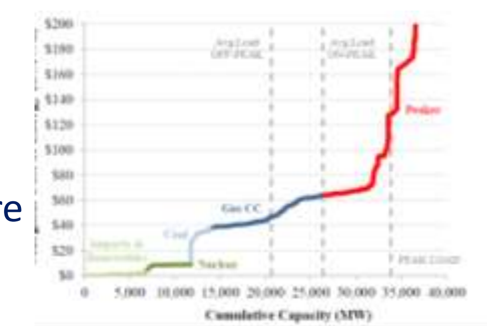


Market designs for high shares of RE (RES-E-MARKETS, in preparation, 2014-2015)

Energy market where renewables dominate may not work with marginal prices anymore.

Objectives

- Define how an "optimal" energy market design would look like where renewables are the leading energy source
- The study may use a green field approach and provide a "polar star option" where existing markets could be developed towards



Next generation of RES-E policy instruments
(RES-E-NEXT, 2013)

With substantial shares of RES-E the electricity markets will be affected. System regulation and RE policy instruments have to be changed in order to reflect the system impact.

Outcome

An overview of potential future market price mechanisms and next generation policy instruments that aim to improve the electricity system costs in the support schemes.

Agenda

- General introduction to IEA-RETD
- Next generation policy instruments for renewable electricity (RES-E-NEXT)

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- Introduction and Objectives

1. Securing RES-E Generation
2. Securing Grid Infrastructure
3. Enhancing System Flexibility
4. Securing Generation Adequacy

- Synthesis and Discussion
- Concluding Remarks

Next Generation RES-E Policy Instruments

Project Steering Group:	Michael Paunescu (CA, chair), Kjell Sand (NO), Simon Müller (IEA RED), Georgina Grenon (FR), Henriette Schweizerhof (DE).
Implementing Body:	NREL (USA), Ecar (Ireland), DIW Berlin (Germany) 3
Execution:	September 2012 – July 2013
Objective:	To provide an overview and analysis of next generation RES-E policy instruments in the light of changing electricity systems and markets with high shares of RES-E
Status:	Completed, downloadable at RES-E-NEXT, 2013

RES-E = Electricity from Renewable Energy Sources

Project Objectives

- Evaluate potential changes to policy tools currently used to support RES-E deployment (e.g., feed-in tariffs, quotas, etc.)
- Explore the changes that will be necessary under substantial shares of RES-E generation, especially in:
  - Electricity market design and function
  - Electricity system operation
  - Regulation of the electricity system, and
  - Design of RES-E policy instruments
- Explore interactions between different domains of RES-E policy, for example:
  - How system operational rules (e.g., curtailment) may impact investment (e.g. remuneration mechanisms)
  - How system flexibility strategies (e.g., demand response) may interact with existing market mechanisms (e.g., energy price caps)

Characteristics of next generation RES-E policy

With increasing penetration, variable RES-E integration increasingly affects power system planning and operation.

As a consequence:

- System-wide impacts will grow, requiring more complex system-wide analysis
- Expert and stakeholder communities are growing more diverse, increasing disagreement on best pathways
- Magic bullet solutions are less and less likely
- Solution-sets are increasingly likely to vary by jurisdiction
- Across jurisdictions, strong policy leadership required and policy coordination is key

Active, sustained, and coordinated evolution is central to next-generation RES-E policy.

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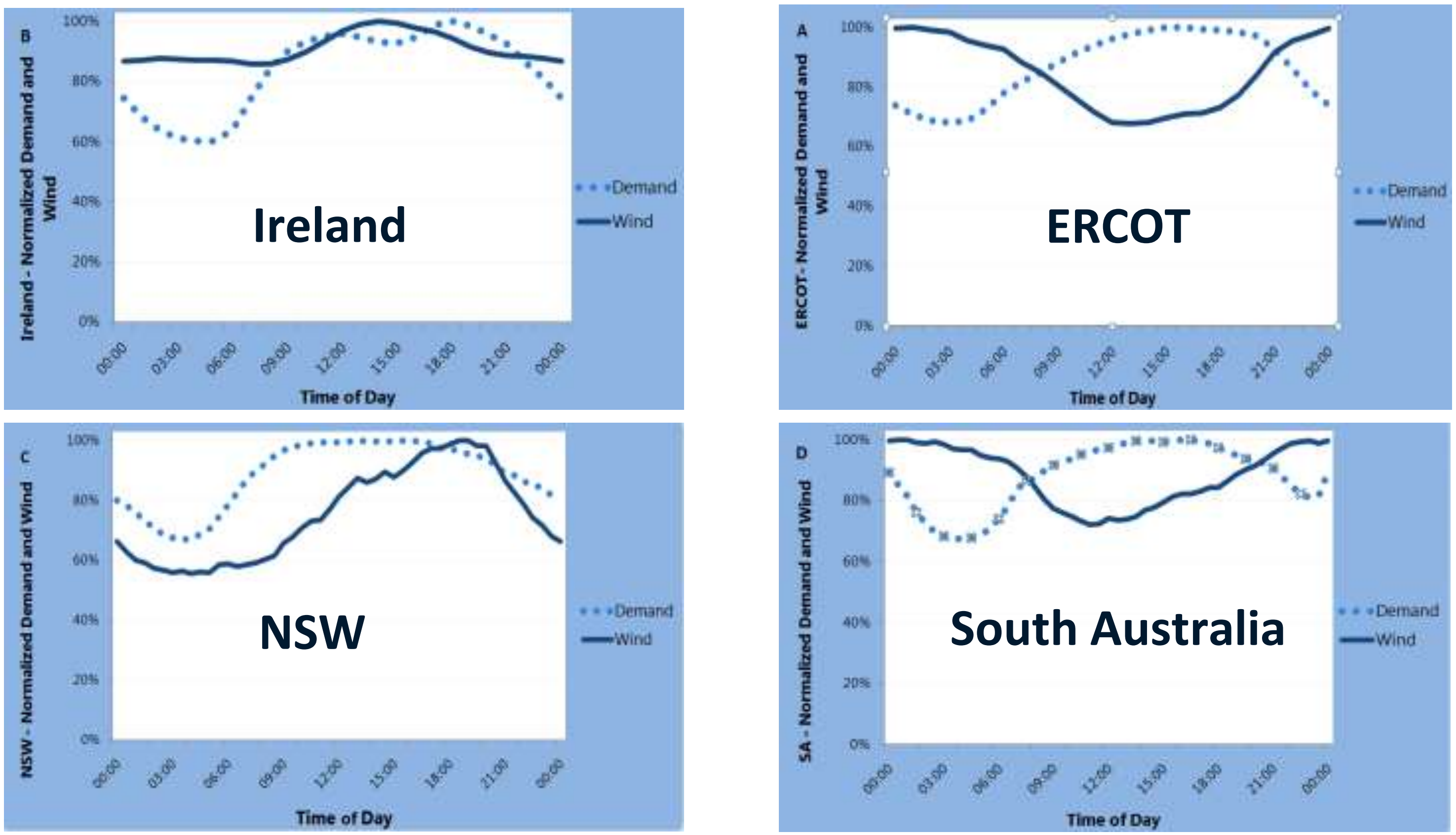
Every system is substantially different and faces unique challenges



As one basic example, wind availability and demand vary widely by system, impacting flexibility requirements, integration strategies, and policy choices.

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High penetrations of RES-E may present financial and technical concerns

Key strategic questions include:

- How can RES-E deployment continue to grow while managing the costs of incentives?
- How can higher RES-E penetrations be achieved while minimizing grid impacts?
- How might operational changes at higher penetrations impact RES-E generators' (utilities') revenue streams?

In light of these questions, what challenges need to be addressed through next generation policies?

Challenges include ensuring predictable revenue streams and stable grids—policies can address both

- **Grid-Related Challenges**
  - Non-dispatchable RES-E adds supply-side variability, increasing balancing needs
  - RES-E generators may need to increasingly provide grid support services
  - Congestion on transmission lines from wind, distribution feeders from distributed PV
- **Revenue-Related Challenges**
  Operational requirements could reduce revenues, especially via:
  - Prevalence of energy imbalance penalties
  - Requirements for RES-E to provide increased grid services
  - Greater curtailment of RES-E resources

Next Generation Policies can meet these challenges by being "cost, market and grid aware"

1. Maintain investment certainty for RES-E and minimise the cost of incentives ("cost aware")
   - e.g. FiTs with flexible adjustment
2. Encourage positive interplay with markets ("market aware")
   - e.g. proactive consideration of revenue impacts of curtailment practices and energy imbalance penalties
3. Respond proactively to changing grid needs ("grid aware")
   - e.g. linking price supports to requirements for RES-E to provide grid support services

Summary of Illustrative Policy Options

"Cost Aware"	"Market Aware"	"Grid Aware"
▪ Support new generation with cost containment ▪ FiTs with Flexible Adjustment ▪ Tenders for Long-Term Contracts ▪ Promote Innovation in Competitiveness and Market Entry ▪ Financing mechanisms – loan guarantees, preferential loans, securitisation, ▪ New business models – leasing, crowdfunding, etc.	▪ Improve Revenue Certainty in Wholesale Power Markets ▪ FiTs linked to wholesale energy prices ▪ Capacity payments linked to RES-E capacity credit ▪ Transparent and stable curtailment policies ▪ Transparent and stable energy imbalance rules	▪ Minimize Grid Impacts ▪ Incentives linked to grid support capabilities (voltage support, frequency response, etc.) ▪ Incentives linked to location of RES-E ▪ Incentives linked to distribution impacts ▪ Minimize Operational Impacts ▪ Incentives linked to dispatchability ▪ Incentives to improve forecasting data ▪ Incentives requiring integration into dispatch optimisation

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Overview of RES-E grid infrastructure issues

Development of grid is necessary

- Connecting generation to load
- Energy and price arbitrage
- Facilitates competition and reduces gaming
- Provides security and reliability
- Reduces aggregate variability and uncertainty of variable renewables
- Enables access to flexibility

But is also problematic

- High-quality RES-E can be far away from main load centres
- Planning conundrum: what first, grid or generation?
- Lumpy expansion
- Public acceptance

Solutions to Address the Challenges of Grid Development

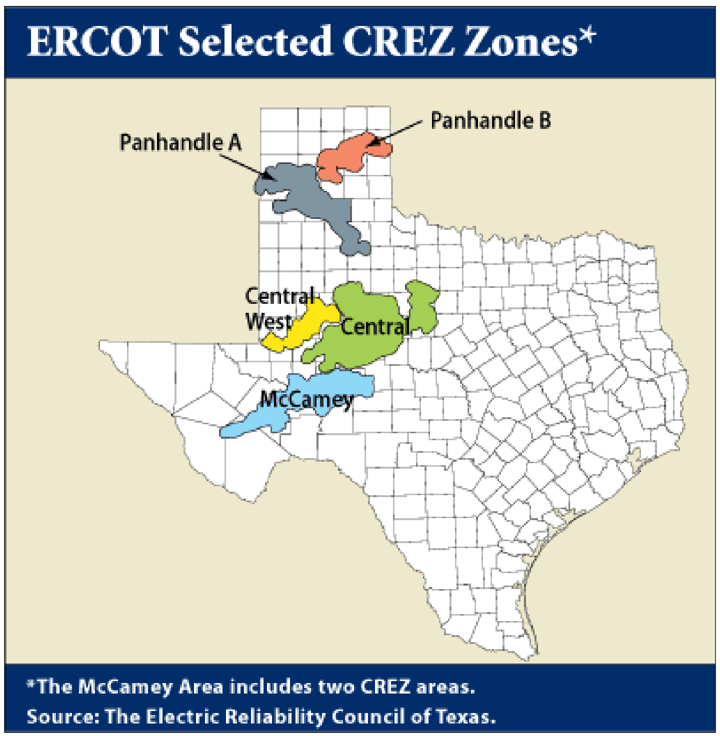
- Centralised planning
- Addressing public acceptance issues
  - Active stakeholder management and public consultation
  - Undergrounding or partial undergrounding
  - Submarine HVDC cables ("bootstrapping")
- Technological solutions
  - e.g. Dynamic Line Rating (DLR)
- Congestion management
  - e.g. Locational Marginal Pricing (LMP)

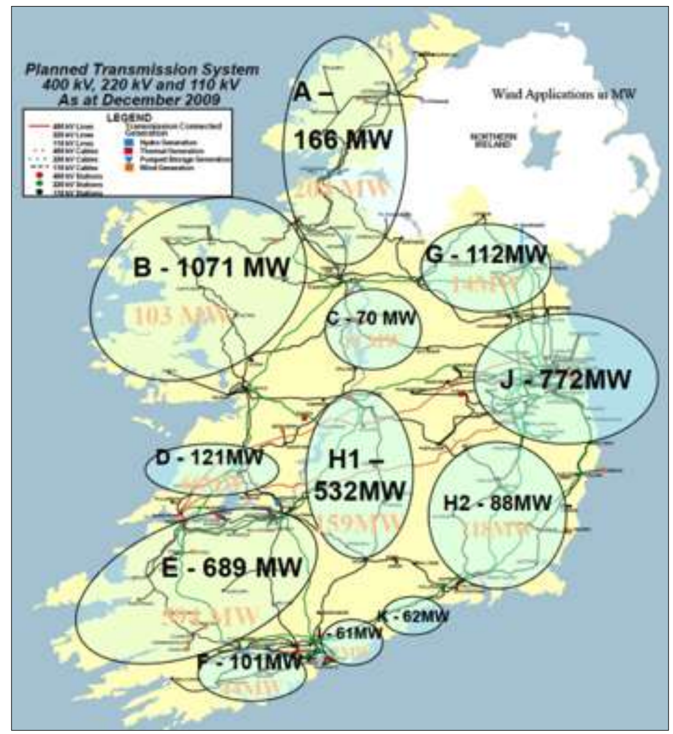
Dynamic Line Rating instrumentation, ERCOT West Texas

Centralised planning approaches have been effective mechanisms for transmission network development

Competitive Renewable Energy Zones (CREZ) in Texas have seen grid for 18.5 GW of wind built in 4 years

Group Processing in Ireland sets out rules for development of grid to support tranches of RES-E projects





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Addressing public acceptance issues is critical

Public acceptance issues have the potential to significantly delay transmission development project but there are mitigation options:

- Active stakeholder management and public consultation
- Undergrounding or partial undergrounding (subject to technical limitations)
- Overlaid HVDC (“bootstrapping”)

Technological solutions have a role

Effective technology solutions can avoid or defer investment in additional network capacity.

They should be promoted as policy as appropriate.

- Dynamic Line Rating (DLR)
  - Use of real time measurements can result in 25-30% increases in line capacity 90% of the time
- Special Protection Schemes (SPS)
  - Use of automatic corrective actions can avoid and/or delay infrastructure investment
- Active Network Management
  - Integrated systems can result in greater use of network capacity in low and medium voltage networks
  - They use real time measurements and control to manage a variety of resources against multiple constraints

Dynamic Line Rating instrumentation, ERCOT West Texas

Congestion management provides import benefits

Leading options for efficiency congestion management include:

Net Transfer Capabilities (NTC)

- Primarily used to manage cross border flows
- Computed periodically based on total transfer capacities (TTCs)
- Bilateral: problem of loop flows
- Systems are exposed to re-dispatch costs when actual conditions differ significantly from those assumed during calculation of NTCs.
- Unexpected increases in wind power production can result in high re-dispatch costs in other regions
  - See for example, Poland considering installing phase-shifting transformers

Locational Marginal Pricing (LMP)

- LMPs are the shadow nodal prices in Optimal Power Flow problem
- Wholesale prices include a congestion component, and differ between location.
- Used successfully in North America (PJM, NYISO, CAISO, ISO-NE MISO, and ERCOT)
- Requires centralised coordination
- With LMPs, causes, impacts and costs of congestion are more transparent
- Forces tighter coordination of real time system operation
- Strong resistance to the concept in Europe, likely due to exposure of sources of congestion

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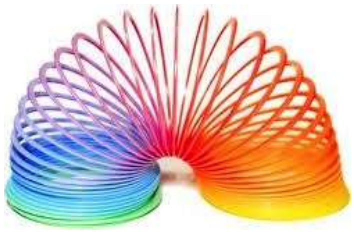
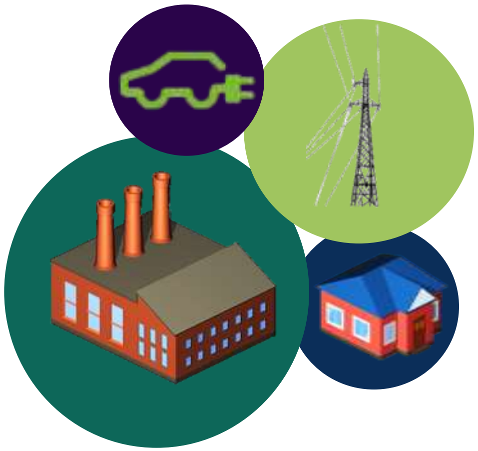
What is flexibility?

- More variable generation on a system increases the variability of the ‘net load’
- ‘Net load’ is the remaining system demand not served by variable generation
- Flexibility is considered as the ability of a system to deploy its resources to respond to changes in net load.
- High flexibility implies the system can respond quickly to changes in net load.



Where can flexibility come from?

- Sophisticated system operation techniques
- Market arrangements
- Demand Side Management
- Flexible Conventional Units
- Additional Reserve Capacity
- Interconnection
- Storage



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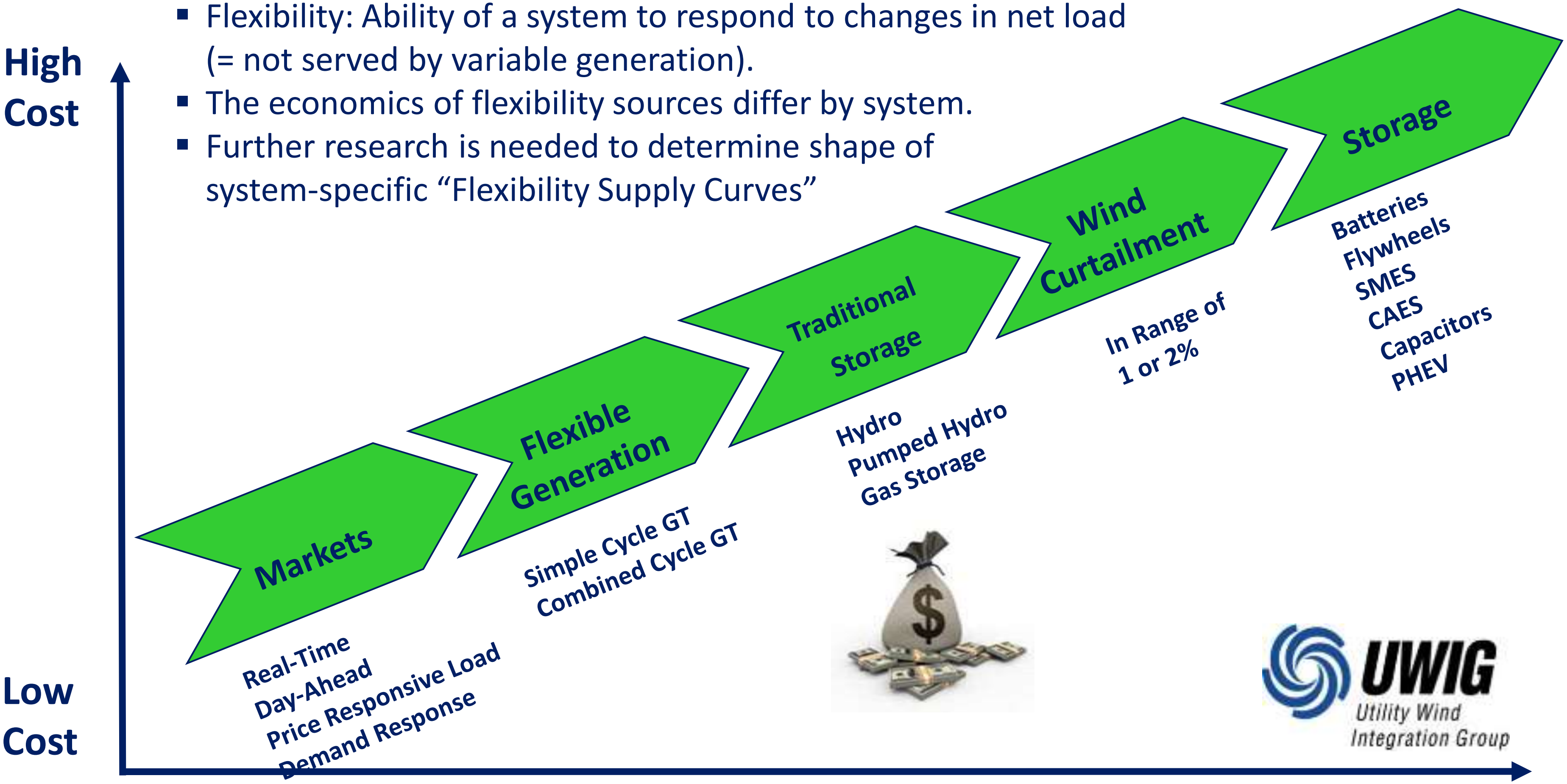
Flexibility options vary in cost

- Flexibility: Ability of a system to respond to changes in net load (= not served by variable generation).
- The economics of flexibility sources differ by system.
- Further research is needed to determine shape of system-specific "Flexibility Supply Curves"



UWIG
Utility Wind Integration Group

Metrics: How much flexibility is needed on a system?

Accurately estimating how much flexibility is required under a given RES-E penetration is central to effective policy planning. Thus flexibility metrics is an active research area, e.g.:

- NERC Flexibility Intensity Metric (2010)
- IEA GIVAR FAST method (2012)
- IRRE: Insufficient Ramping Resource Expectation (2012)

- No single accepted flexibility metric exists
- All metrics so far are highly data intensive, since accurate estimates require sub-hourly precision
- Metrics can signal how much flexibility is needed but do not address how to achieve/incentivise this flexibility

How to incentivize and reward flexibility

- There are contrasting perspectives on the best path towards incentivization of flexibility
  - Some observers suggest that “capability-based” mechanisms are likely to be a key part of evolution towards high RES-E futures.
  - Another perspective is that continued evolution in market design, e.g. very fast energy-only markets, widespread nodal pricing, and demand-side bidding, will be sufficient to reward flexibility
  - Some systems are in the process of designing and implementing specific flexibility incentivisation products (e.g. California Independent System Operator)
- The optimal path will vary by context, but the need to incentivize capability will be increasingly acute in high variable RES-E futures.

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High RES-E may amplify existing concerns about securing resource adequacy

- Resource adequacy is defined as a sufficient level of generating capacity to meet demand at some future date.
- In competitive energy markets, there are various pre-existing challenges in ensuring adequate generation capacity procurement
- Increase in zero / low marginal cost RES-E will alter operation of conventional units on the system & thereby revenues and investment incentives, and may further complicate the procurement of capacity

Aggregate revenue impacts of high RES-E are complex and unclear

The net impact on revenues (positive + /negative −) depends on type of unit & market structure.

- Impact on conventional unit utilization factors − / +
- Impact on energy prices −
- Impact on flexible capacity requirements & grid support +
- Impact on emissions costs − / +

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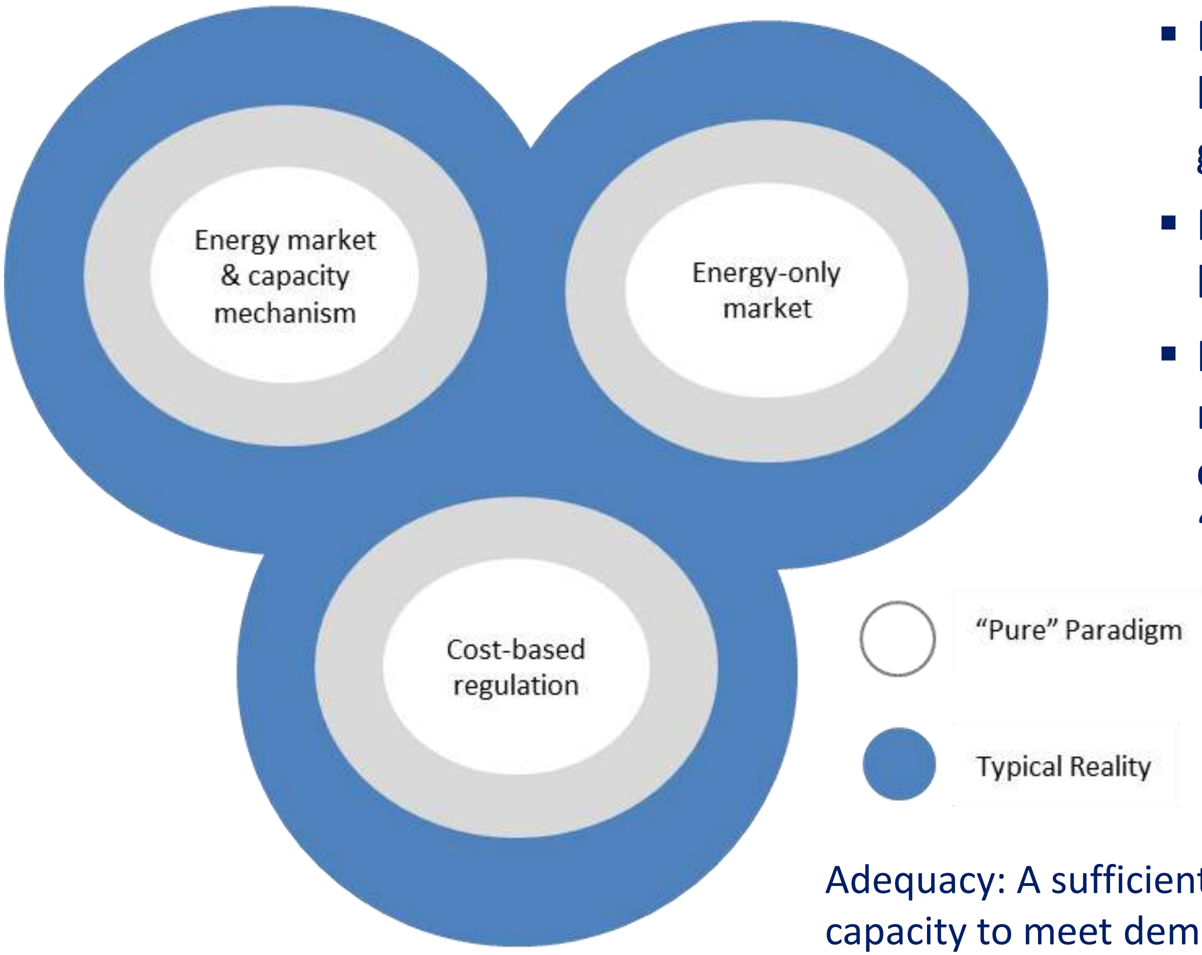
Capacity adequacy is addressed differently under the three dominant power market paradigms

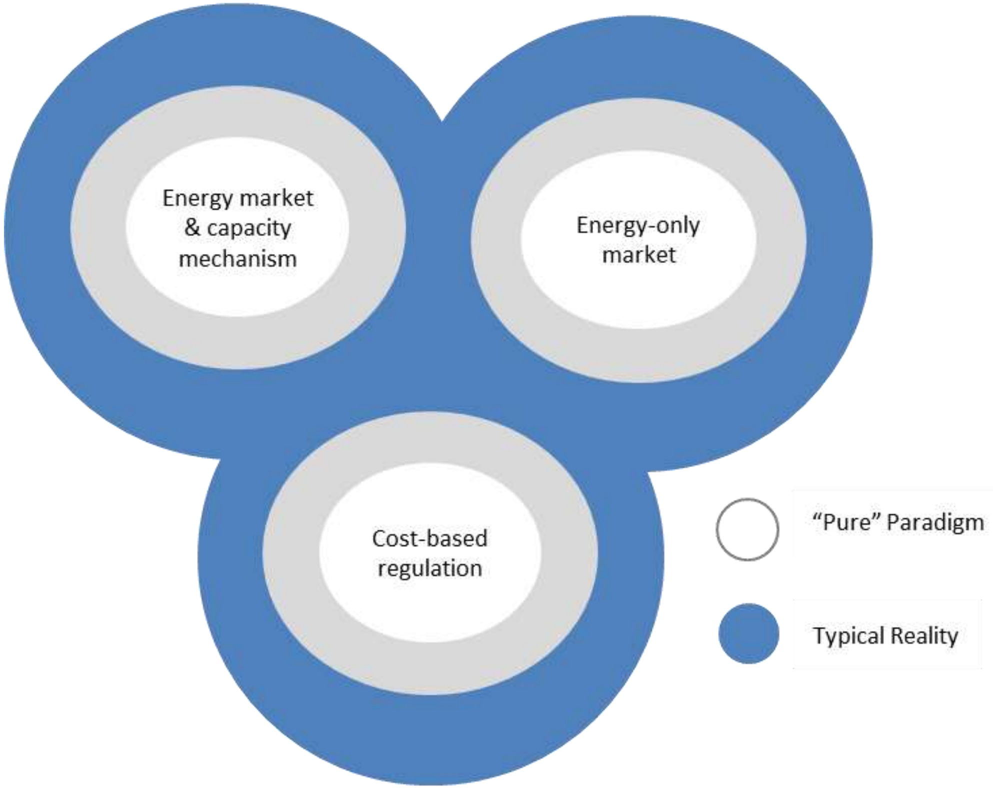


- Electricity prices are key to conventional generator revenues
- Rules vary significantly by market structure.
- Real-world power markets rarely conform to ideal or “pure” paradigms.

Adequacy: A sufficient level of generating capacity to meet demand at some future date

Capacity adequacy is addressed differently under the three dominant power market paradigms

- Energy-only markets tend to have more volatile prices
- Capacity mechanisms are more administratively managed market structures but act like an 'insurance premium' against capacity shortfalls
- Cost-plus regulated markets allow prices to be set by regulators



Can generation assets recover fixed costs in energy- only markets?

The answer depends on:

- Regulatory credibility – will regulator avoid intervening during times of high prices?
- Demand participation – how great is DSM potential?
- Uncertainty – will banks and developers consider scarcity revenues as sufficiently bankable for new investment?

All three have been issues prior to high variable RES-E penetrations, but may be exacerbated by:

- Increased volatility from high variable RES-E
- Uncertainty surrounding capacity value for variable RES-E

Several options exist to securing generation adequacy in high RES-E futures

- **Capacity Payments**

  In Ireland, the cost of peaking generation units is offered on a fixed basis to all generation that provides power during peak periods.

- **Capacity Markets**

  Some entities are made responsible to contract sufficient (equivalent) firm capacity to meet peak demand. Capacity resources typically include new or existing generation, imports, or demand response.

- **Strategic Reserves**.

  - TSO or other entity contracts on behalf of regulator for peaking capacity or demand resources. Resources only are entered into market above a predefined strike price —difficult to finance in energy markets.

- **Measures to Strengthen Energy-Only Markets.**

  - Example: Support for longer-term energy contracting to level annual variation of energy revenue . Contracts in Europe are 1-3 years ahead of power sale.

Securing generation adequacy in high RES-E futures requires coordination

Each of these leading options implies:

- Some level of administrative intervention into energy markets
- Medium or high risk to power plant investors
- Complex implications for demand-side resources and inter-regional trade.

All above imply that administrative coordination of energy markets is likely to increase into the future

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The path to power system transformation will not require policy or technology revolutions, but…

… an active, sustained, and coordinated evolution is central to next-generation RES-E policy.

Five principles that can guide this evolution are:

Harmonising Policy, Market, and Technical Operation

- RES-E remuneration schemes should be designed to minimise operational impact and market distortion
  - At high penetrations priority dispatch must give way to system stability
- RES-E remuneration schemes should create flexibility for future changes to market and system-operation rules, e.g.
  - Congestion management
  - Energy imbalances
  - Gate closure; dispatch rules
- Network protocols should maximise utilisation of existing resources
  - Greater grid-support participation from RES-E technologies required at high penetrations – e.g. reactive current injections during faults.
- Rigorous performance standards are required to unlock demand response potential as a RES-E balancing resource.

Rediscovering Coordination

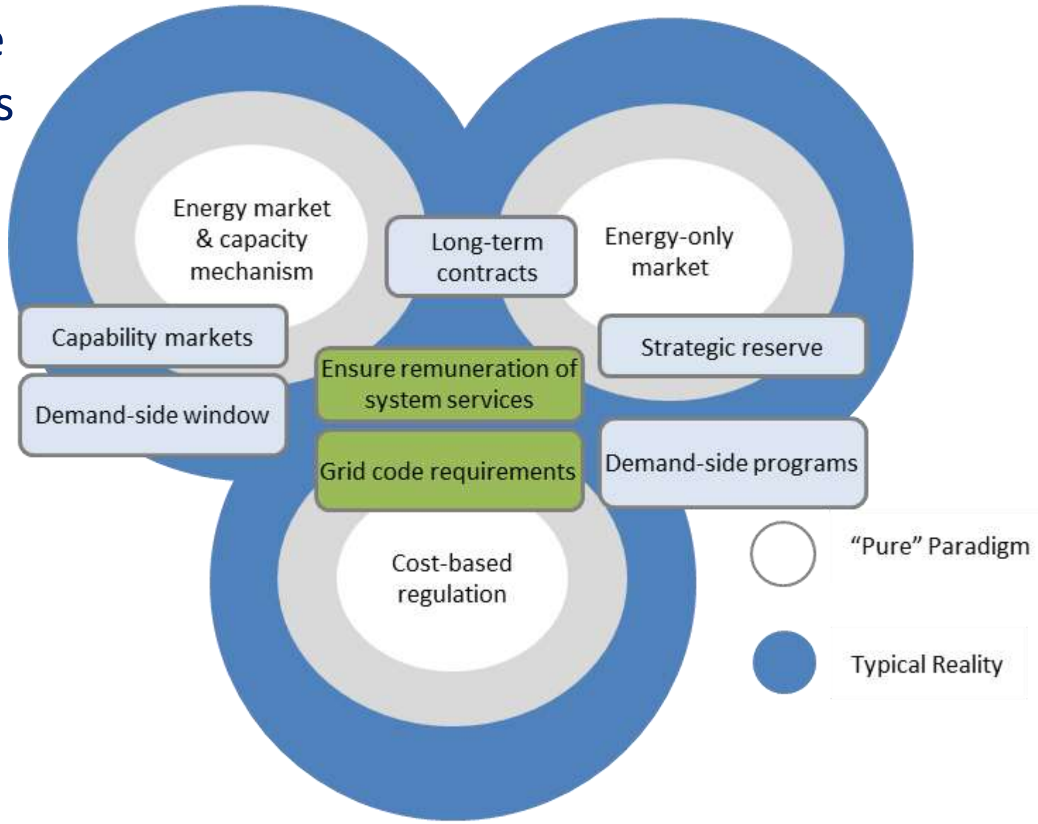
Across the RES-E policy landscape, there are various examples of the need for greater coordination:

- Optimising the geographic deployment of distributed and large-scale RES-E generation to maximise the capacity of existing networks
- Coordinating and sequencing large-scale transmission investments to access remote RES-E generation resources
- Identifying and incentivising the flexibility options which span generation, grid, advanced system operation, demand-side resources, and storage

Bolstering Confidence in the Regulatory Paradigm

Confidence in the stability of the market and regulatory structures is necessary for a positive investment environment.

- A range of regulatory changes may be required to accommodate high RES-E.
- Allow market and regulatory evolution without undermining confidence in the basic paradigms.



Illustrative paradigm-specific approaches to key RES-E challenges.

Sustaining Public Support

Across jurisdictions, public support will be necessary to continue the transition to high RES-E futures.

Key policy questions to be addressed to sustain public support:

- "Who Pays"— Who absorbs the costs of different policies (e.g., incentives for new generation, reinforcement costs for the distribution network, congestion costs). This will impact public support.
- "Winners and Losers" — Policies can anticipate and help soften the impact of new policy instruments
- "Stability versus Evolution" — Policymakers must strike a balance between providing policy stability to encourage investment and deployment of RES-E, and responding to changing market conditions, costs, and rules governing power-system operations.

Guiding Innovation

Innovation in the realms of technology, business models, market design, and project development likely will be vital to the transition to high RES-E systems, and reducing associated costs.

Examples include:

- Large-scale residential and small commercial demand response aggregation
- Viable business models for DSOs under high-RES-E futures
- Private investment in merchant transmission projects
- Viable storage and energy services business models
- Novel financing structures for RES-E generation projects

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Technical and policy options can make it work

- **Securing RES-E generation**
  - Incentives can be designed to encourage positive interplay with markets and systems operations
  - Incentives can be designed to be responsive to changing market conditions
- **Securing grid infrastructure**
  - Centralized coordination has a role in transmission-network development
  - Various policy and technology approaches help reduce public acceptance risk
  - Improved congestion-management practices (e.g. locational pricing) are important complements to grid extension
  - Deferral of grid investment creates value (e.g. through dynamic line rating technology)

Technical and policy options can make it work

- **Enhancing flexibility**
  - Flexibility requirements and solutions are highly dependent on system characteristics
  - Further progress in market design could unlock flexibility (e.g. locational pricing, demand side bidding)
  - Mechanisms rewarding flexible capabilities will be a key part of enhancing flexibility
  - Methods of quantifying flexibility needs require further development
- **Securing generation adequacy**
  - Administrative intervention to achieve adequacy in energy markets is unlikely to diminish in the near term
  - Adequacy solutions will have complex and significant impacts on various power stakeholders

Strategy sets reflect penetration levels, and grow more interdependent at high penetrations

Example policy evolution through stages of RES-E penetration.

	Securing RES-E Generation	Securing Grid Infrastructure	Short-Term Security of Supply: *Flexibility*	Long-Term Security of Supply: *Adequacy*
Low Variable RES-E	Establish basic RES-E support mechanisms (e.g., Feed-in tariffs, targets, tenders)	Evaluate grid infrastructure needs in light of RES-E resources	Evaluate system flexibility levels; determine binding flexibility constraints	Evaluate functioning of adequacy mechanisms
Moderate Variable RES-E	Integrate RES-E into dispatch optimisation	Establish RES-E grid codes and designated transmission zones	Improve forecasting Broaden balancing-area footprints	Initiate capacity-adequacy studies
High Variable RES-E	Influence location of RES-E on grid to lessen distribution or bulk grid impacts Encourage RES-E production ⇔	Employ low-visibility transmission technologies Employ active network management ⇔	Employ advanced system operation (e.g., advanced unit comfvise storage and/or additional flexible generation) ⇔	Improve adequacy mechanism in accordance with predominant paradigm

Integration of RES-E policies in energy market policies

- At relatively **low levels of generation, few operational issues** arise due to RES-E.
- In high-RES-E systems around the world, next-generation RES-E policies increasingly **are shaped by broader systemic considerations.**
- It is evident that RES-E will **impact all parts of power-system policy**.
- **RES-E considerations are becoming a fundamental component** of next-generation "power-system policy."

Evolution vs. Revolution

No technical or policy revolutions are necessary to achieve high-RES-E futures, but…

- … anticipating and **managing policy interactions** and policy debates will be key
- … as RES-E graduates into more central role in power-system operation, **policy harmonisation** will help maintain RES-E growth in an evolving power systems.
- **… coordinated evolution** is crucial, guided by **sustained, active leadership** to establish transition pathways**.**

Contact

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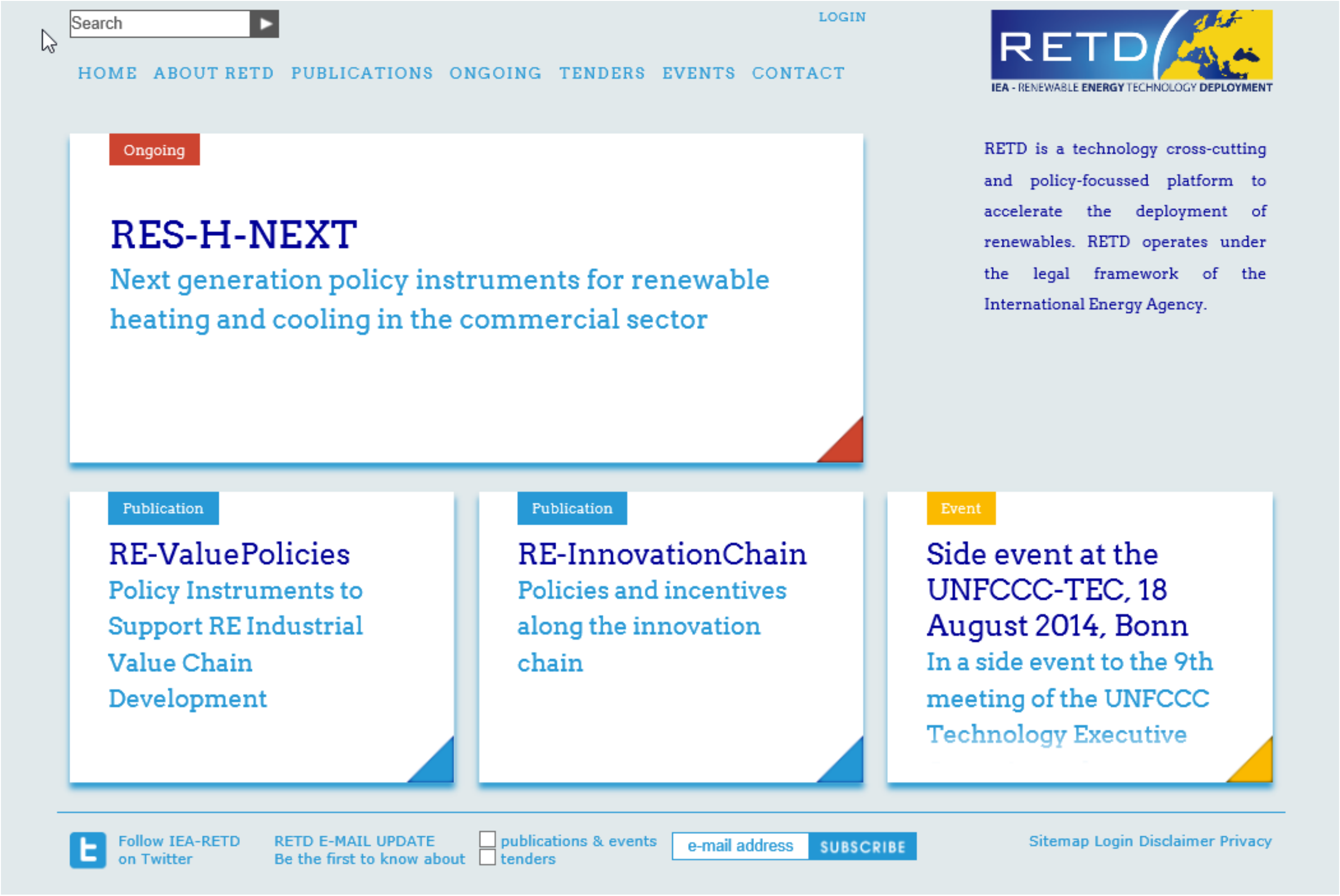

THANK YOU!

For additional information on RETD

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