UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Market design for a high-renewables European electricity system

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Overview of this talk

① EU climate targets: Implications for electricity

② Market impacts of RES-E to date

③ Principles for a “2^{nd} generation” market design

④ Key elements of market design

⑤ Summary of policy recommendations

EU climate targets: Implications for electricity

Electricity will bear large fraction of EU 2030 climate targets

- — Key role for intermittent renewable generation
  - — Resistance to nuclear, limited hydro expansion, environmentally-undesirable coal
- — Dominant 50%+ RES-E share needed in many MSs

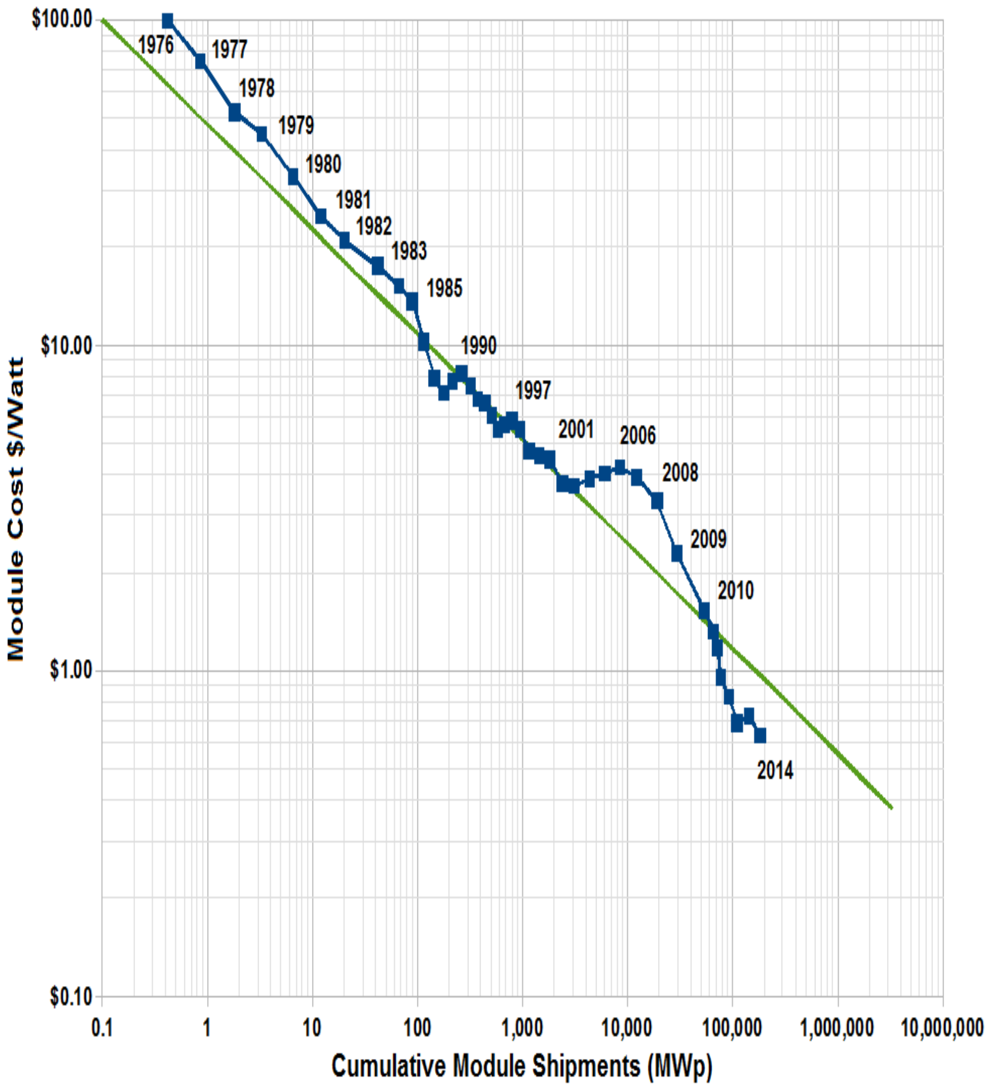
Large challenge without new electricity market design

- — Current generation investment driven by governments: RES support & capacity mechanisms
- — Future opportunities from RES cost reductions, battery technologies, further interconnection etc.

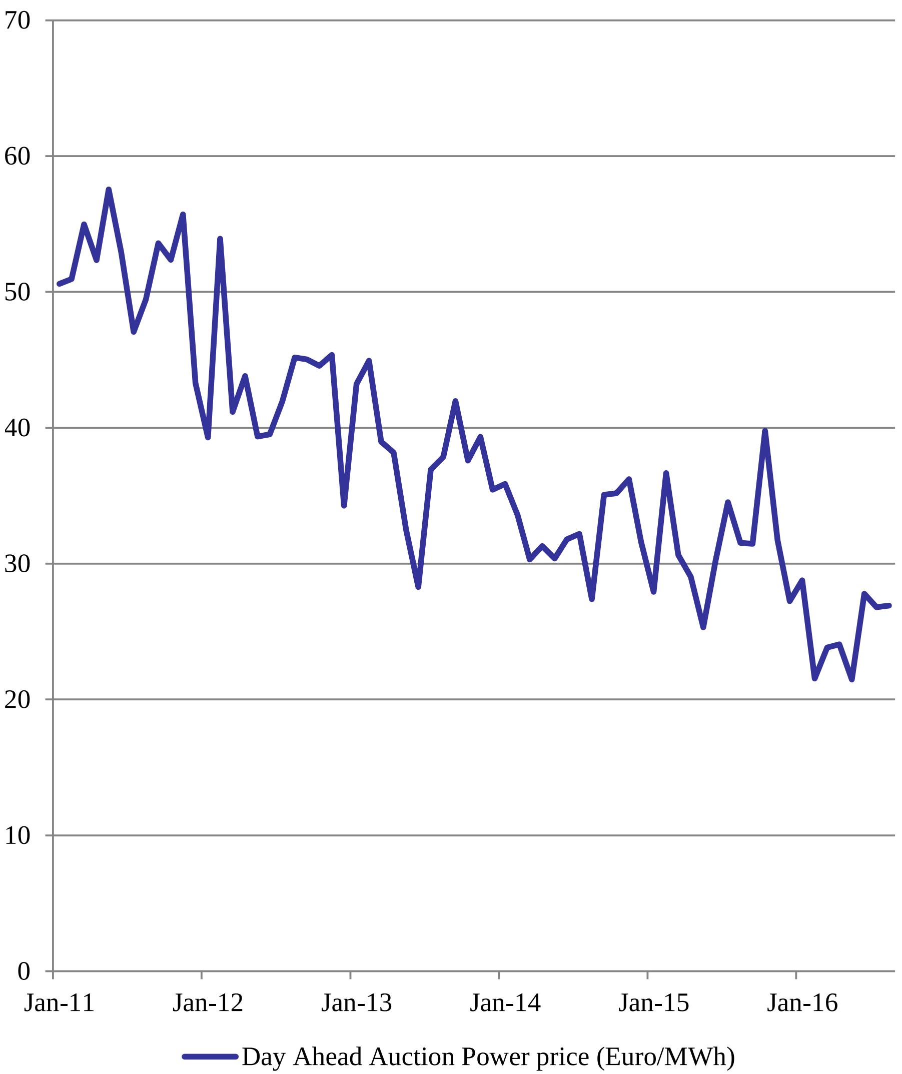
Today: Ideas for “2nd generation” market design

Swanson's law & German electricity prices

Solar PV cost ⬇20% as capacity x2



Wholesale price ⬇50% in 5 years



Key market impacts of RES to date

1. **Cost reductions**
   — Learning rates: Solar PV 17-22% & wind 7-9%

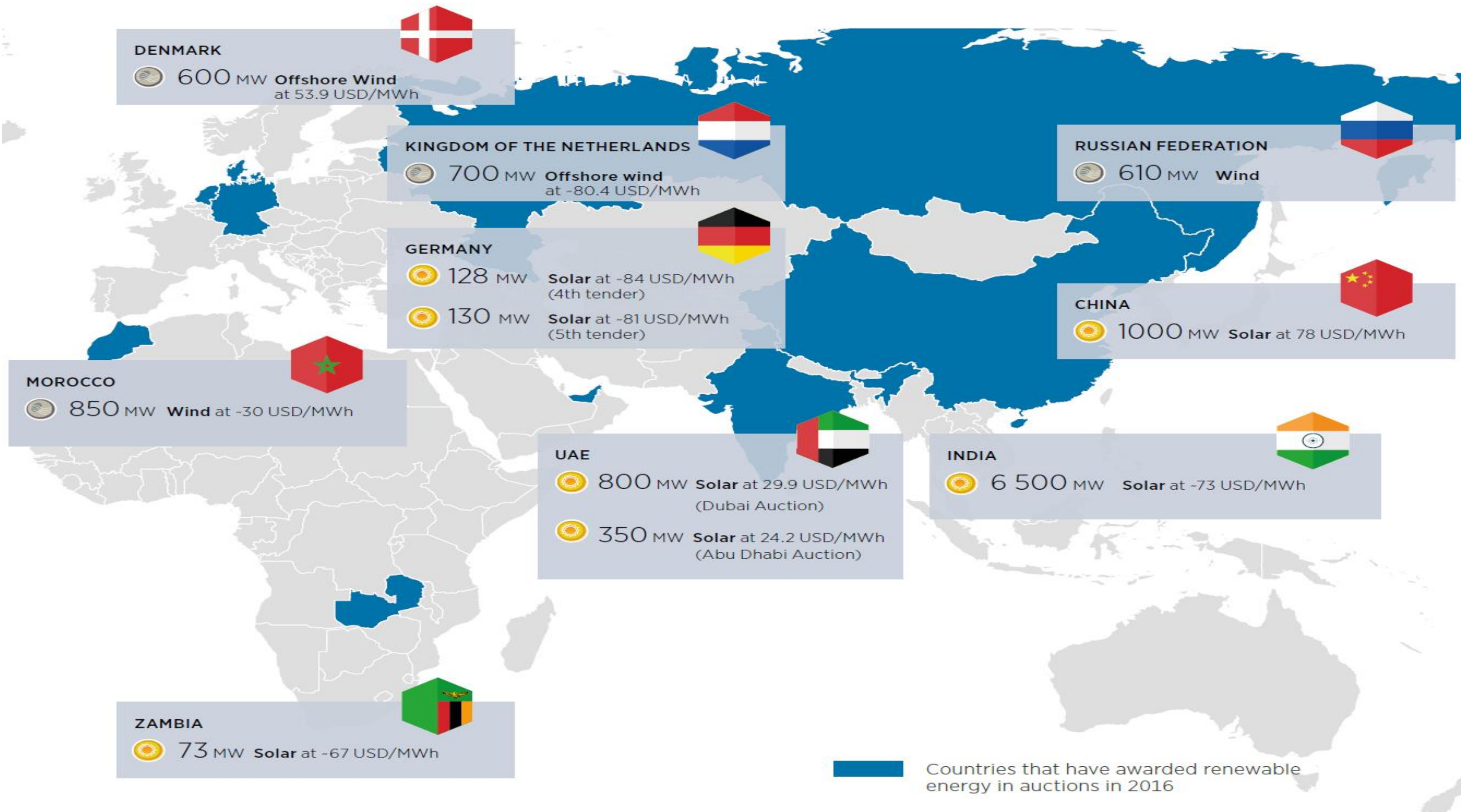
2. **Merit-order effect**
   — ***Short run***: Lower prices, sometimes negative…
      — Germany: ≈40% of 2011-16 price decline due to RES

   — ***Longer run***: Exacerbates "missing money" problem & reduces forward market liquidity
      — Italy: More wholesale market power in evening hours

3. **System issues**
   — Higher transmission costs due to locational distortions
   — Fewer conventional plant to provide ancillary services

Plus: Many impacts were not anticipated by policy & firms…

Recent auction results for renewables



Note: a) GWh: gigawatt-hour.
Source: Countries that have implemented auctions to date based on REN21, 2010, 2011, 2012, 2013, 2014 and 2015; and recent bids from IRENA, 2017a

Source: IRENA (2017)

Principles for “2nd generation” market design

① Correct **market failures** close to source

② Allow cross-country variation, **not one-size-fits-all**

③ Let prices reflect **value & cost of all electricity services**

④ Collect revenue shortfalls with **least distortion**

⑤ **De-risk financing** of low-carbon investment

⑥ Retain **flexibility** to respond to new information

Further interconnection & market integration

Intermittent RES raises the value of interconnection

1. Reduces supply variability
2. Dampens price volatility

Table 1: Potential short-run gains from EU-wide market integration

	EU-28 estimate	
	€ million	Shares
Day-ahead coupling	1,010	26%
Intraday coupling	37	1%
Balancing	1,343	35%
Unscheduled flows	1,360	35%
Curtailment	130	3%
Total gains	3,880	100%

Large overall EU-wide gains from more market integration

- Remunerate properly all interconnector services
- Connect more to hydro reserves in Nordic market

Challenge: Uneven distribution of benefits across MSs

Realism on electric energy storage

Do batteries "solve" intermittent RES? Not any time soon…

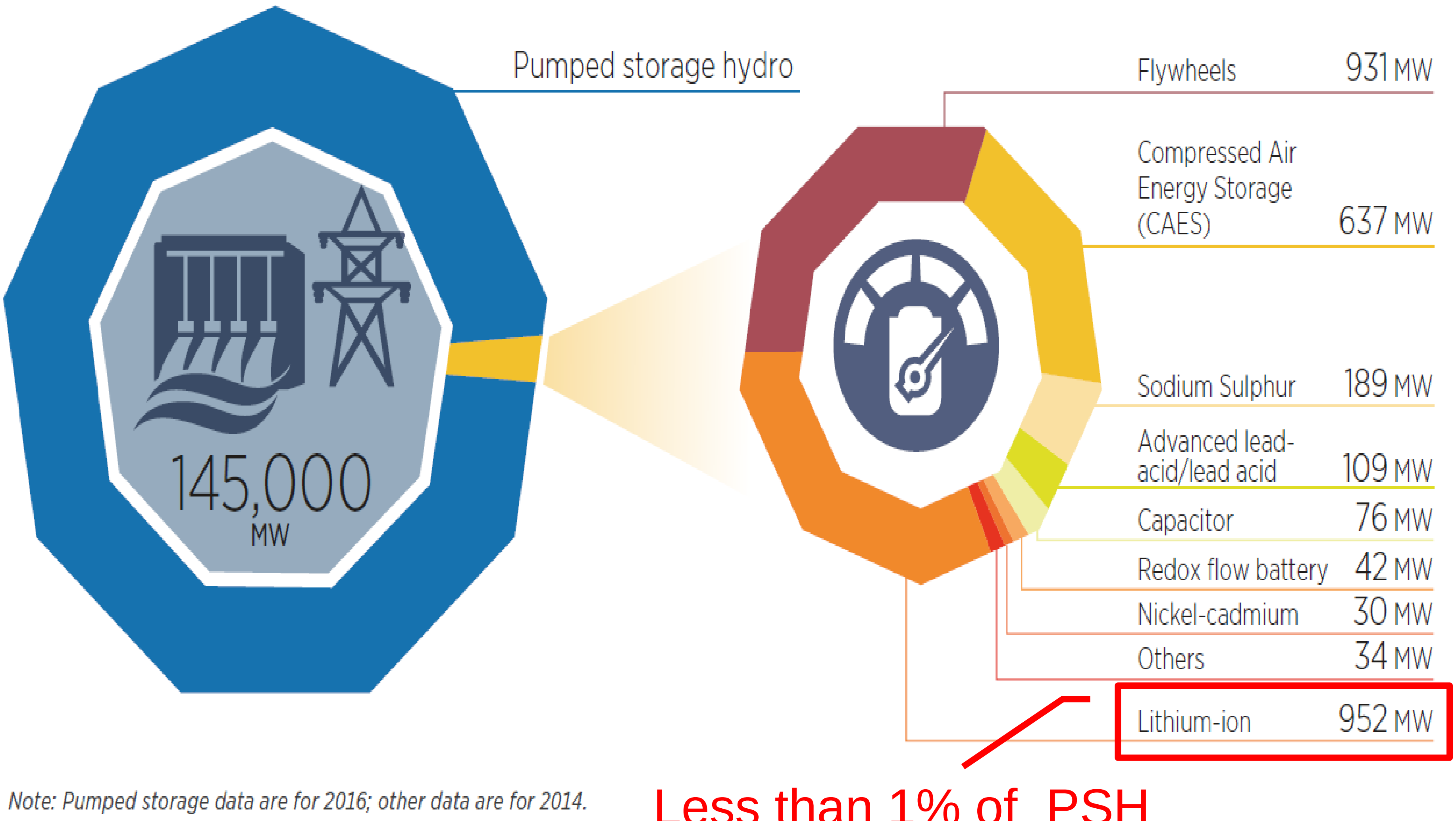
1. Volumes remain tiny vs other types of storage
2. Optimistic forecasts still imply high running costs
   — Moore's Law does not apply to electrical storage
3. Challenges around incentives & business models

$\Rightarrow$ **Other flexibility mechanisms cheaper & more important**
(e.g., interconnectors, flexible gas-fired plant, DSR)

High-value uses for battery storage:

1. Provide very fast frequency response…
   (*remuneration?*)
2. Shave peak use & defer network upgrades…
   (*incentives?*)

Electric storage vs pumped storage hydro



Note: Pumped storage data are for 2016; other data are for 2014.
Source: IRENA, 2015h; pumped storage data from IHA, 2016

Source: IRENA (2017)

Efficient RES support mechanisms

EU's current preferred policy instrument: Premium FiTs

— 2013: 58% FITs, 26% green certificates, 16% PFiTs

Why support RES? To correct market failures…

1. ***Innovation spillovers***
   — Cost reductions driven by volume of installed *capacity*
2. ***Financing constraints***
   — High-RES-E system more sensitive to cost of capital
3. ***Carbon underpricing***

⇒ **Use <u>auction-determined</u> support for <u>capacity</u>** (not output)

— Targets *directly* innovation market failure

— Auctions play two roles:

1. Minimize overall procurement costs
2. Reveal cost information across technologies

Auction design to support RES capacity

Pay for a fixed number of MWh/MW capacity:

- FiT of €*X* per MWh for the first *Y* full-load hours of output
  - €*X* determined at auction
  - *Y* set by government (by technology & location)
    - *e.g.* *Y*=30,000 hrs & 34% capacity factor → 10 year PPA
- Thereafter RES receives wholesale market price (only)

⇒ **Capital subsidy: lifetime support is independent of output at any given hour**

1. Creates predictable post-auction payment stream
2. Reduces locational distortions for new investment
   - Reduces transmission costs
3. Avoids incentive to bid negative prices to earn subsidy

Similar design has been used for onshore wind in China

More granular electricity pricing

Current short-run pricing does not properly value flexibility

1. ***Demand***: Intermittent RES-E raises need for granular prices
2. ***Supply***: Costs of sending differentiated price signals is falling

Benefits of nodal pricing

- Better locational incentives for new generation investment
  - Complement to support for RES *capacity*
- Better network use, interconnector arbitrage & storage use

How granular prices?

- ***Nodal***: more efficient dispatch (✓ if very congested)
- ***Zonal***: more liquidity (✓ if less congested)

Transition management?

- Hedging more volatile prices (e.g. TCCs in US)
- Grandfathering of FTRs?

Long-term contracts & risk management

Volatile climate policy creates new policy/regulatory risks

— RES subsidies; EU ETS reforms; carbon price floor

— Plethora of policies favours private sector “policy arbitrage”

⇒ **Overarching goal: Simplify & stabilize policy environment**

— Better remuneration of flexibility services

— Less reliance on politically-backed projects

Capacity mechanisms can correct “missing markets”

— Reliability Options (ROs) allow scarcity prices & signal efficient use of interconnector capacity

Risk management for market-driven RES

1. Balancing risk
2. Wholesale price risk
3. Output risk

Hedging (e.g., via large utility)

Summary of policy recommendations

① Use **capacity-based auctions** for RES support

② Ensure **proper remuneration of interconnectors**

③ Shift to **more granular pricing** of electricity

④ Support **market-based long-term contracting**

⑤ Be realistic about medium-run **potential of battery storage**

⑥ Create more **cost-reflective DG network charges**

Plus: Shift from RES deployment support to early-stage R&D