Is the Electricity Spot Market Robust to Particular Prospective Change?

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Question

Does an increasing share of renewable generation imply

- difficulties for the operation of the spot market and/or
- insufficient investment for efficient generation capacity of the industry?

Where renewable generation has zero marginal cost and volatile fuel supplies

Agenda

- The Future
- The essence of a ”normal” wholesale market
- Role of storage, present and future technologies in providing discretion
- Discretion of electricity suppliers (offers) and demanders (bids) and the spot market
- Operation of the spot market and investment in capacity
- Capacity Market comment

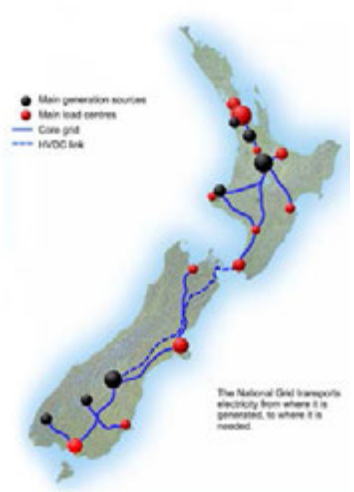
The Future

not forecasts but (and not all) possibilities

- A variety of sources of change
- Climate and renewables (variance higher?)
- Technological change – efficiency in energy use, instant communication/control, demand, etc., etc..
- Batteries store *electricity*
  - Act as reservoirs for electricity
  - managed as reservoirs
  - have frictions and costs to be determined

Wholesale Market

Spot and hedge markets sit on a national platform



Transacts electricity between demand and supply

Combines hedge (long term) and spot (very short term) transactions:

Spot enables demand = supply at each instant in time, for all market participants

Hedge provides long term prices (by contract or ownership)

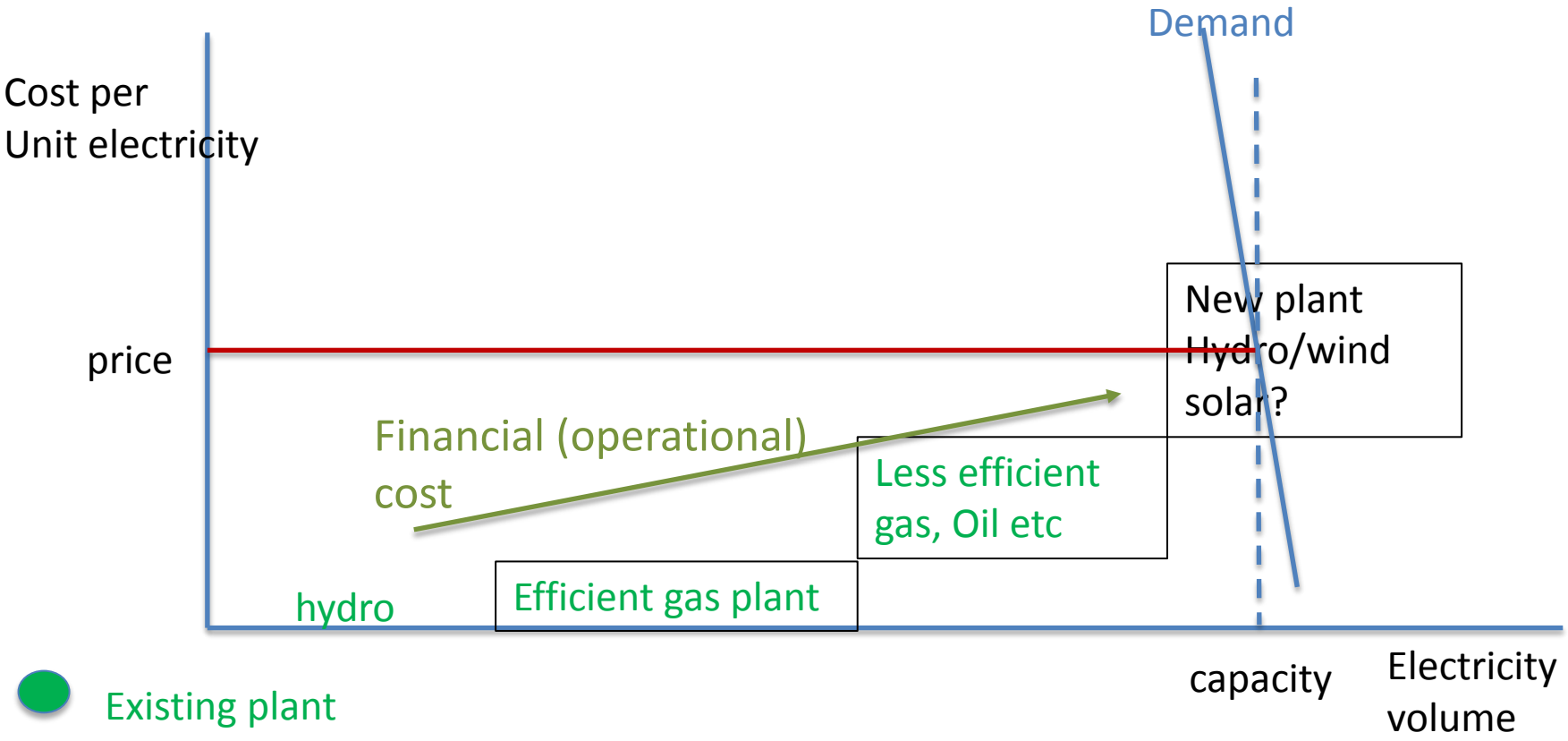
Spot Market Operation

- Spot market: all electricity exchanged across the platform must go through the spot market
- Operated by System Operator subject to rules
- Operation requires individual market participant have discretionary actions:
  - Participate or not
  - Some ability to vary demands/supplies,
  - Driven by a profit motive
- Operation provides electricity pool with certain qualities (security, voltage/cycles)

The Hedge (Capacity Investment) Market

Criterion for entry of generation plant is (in expectations)

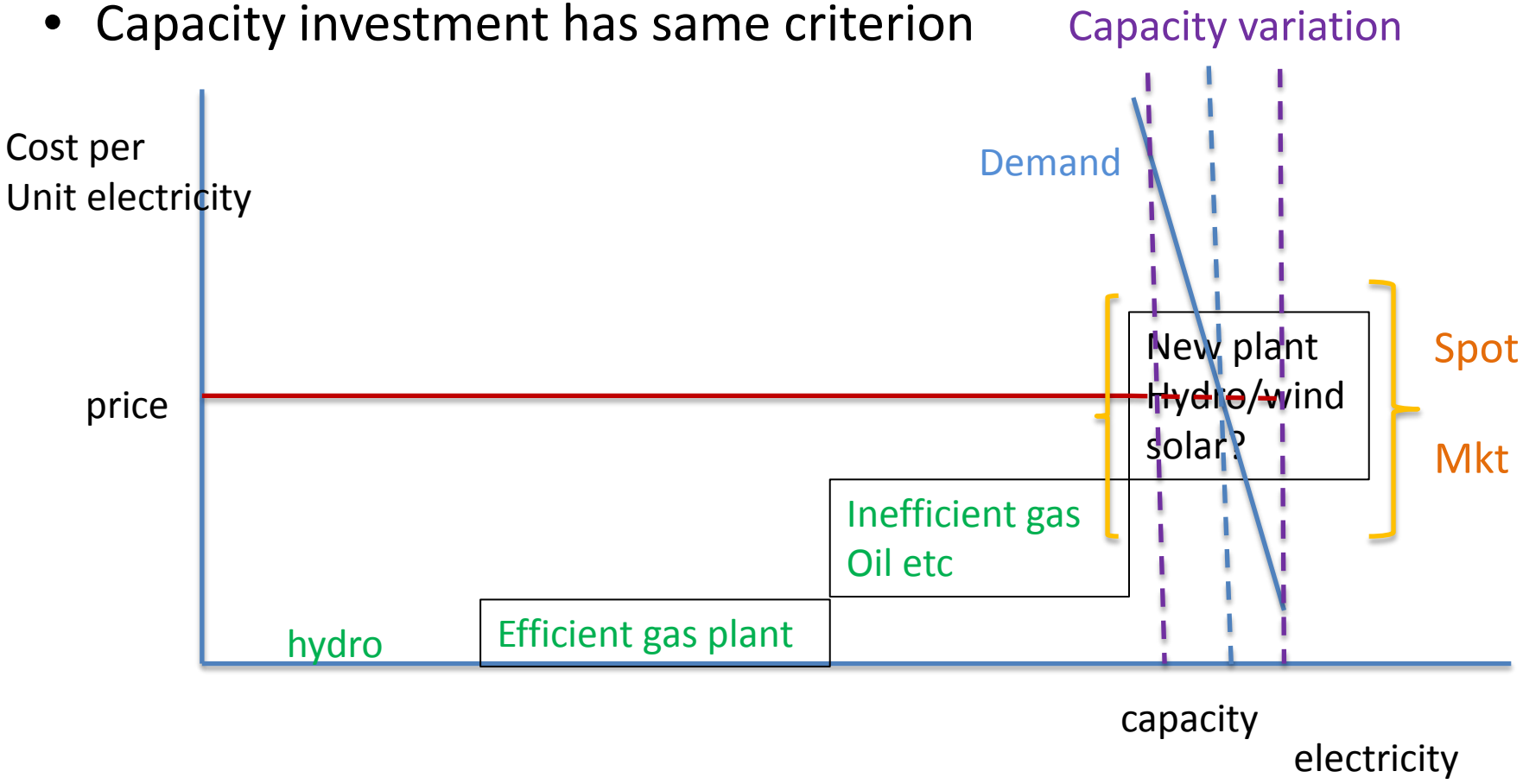
- *Hedges for the generator: PV of hedge earnings > PV of plant costs*
- *Efficiency in the hedge market requires that the prices of hedges are approximately equal to the unit cost of the least cost new plant*



Volatility and Spot Market

The wholesale market must have a spot market

- Supply=demand in real time
- ½ hour wholesale price 85% hedge 15% spot
- Volatility higher with renewables?
- Capacity investment has same criterion



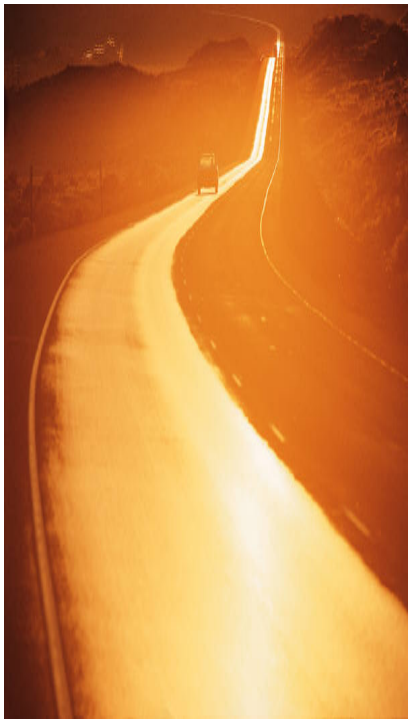
Generation in the wholesale market:

spot, hedge/forward and capacity: timing matters

Anticipated Spot price characteristics

Supply cost of generation plant/fuel, *Demand*, *Climate* and events

The Future



Capacity Investment

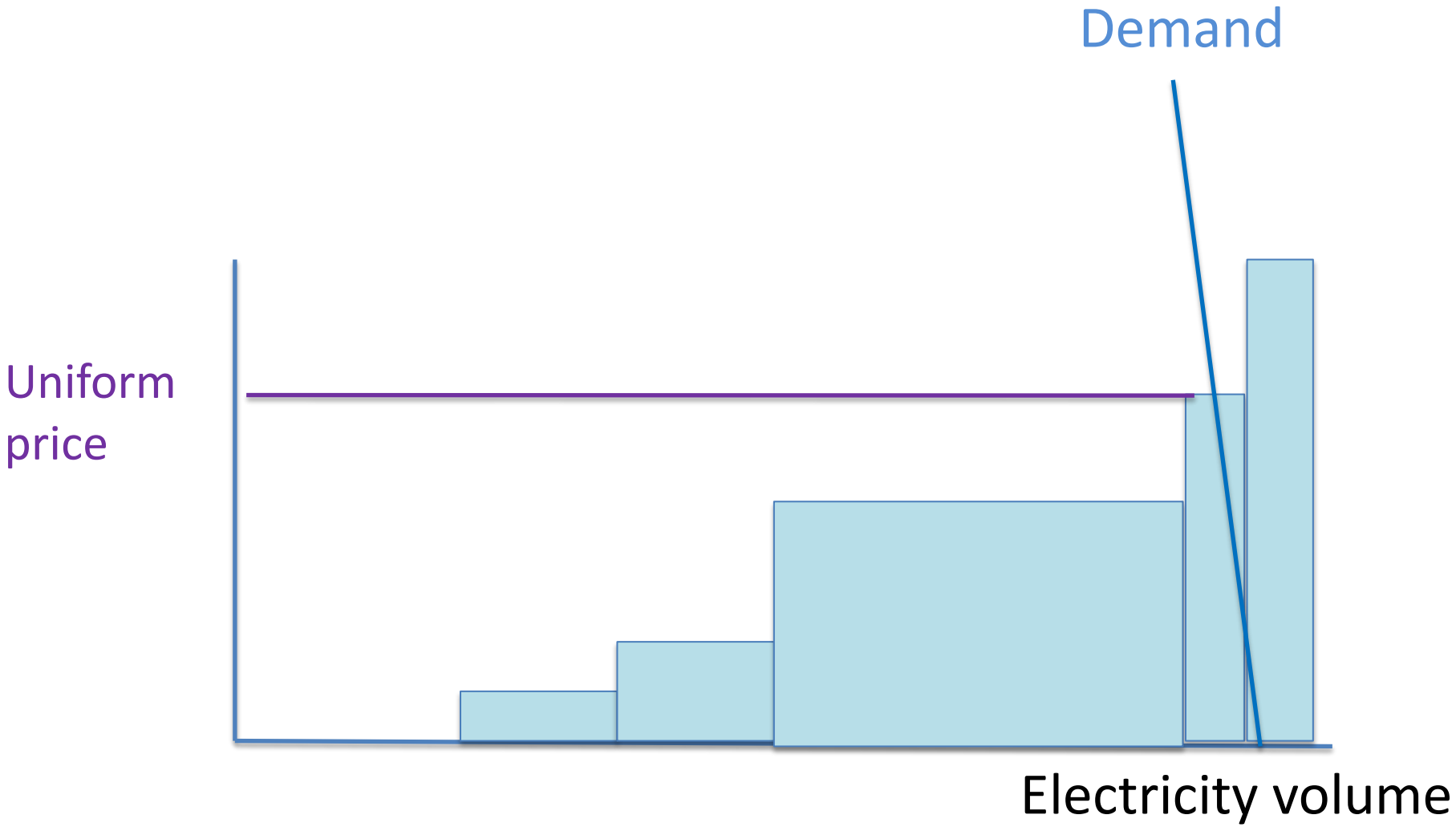
Forward/Hedge decisions
Prices & amount

- Short term demand
- Expected spot prices
- Existing hedges
- Inflows, Storage, plant capacity etc
- Supply and transmission events

The Present
-> Spot offers

Spot Market

In ½ hr trading period



Efficient Spot market

Induced by competition and a common price

Requires

a) demand equals supply at the market clearing spot price at each node; and

b) that offers to the market are based upon *opportunity cost* of the generation offered

In a ½ hour snapshot of time in which market rules and infrastructure are fixed: what is opportunity cost?

Opportunity Cost

(allocation across resources and time)

The cost of generating in a *trading period* is

- The financial (operational) cost of resources used : eg oil purchased

Plus

- The value of the option to delay generation to a future trading period

Delay Options I

(allocate resource use across time)

Rule with option to delay: generate now if and only if the price of electricity now exceeds the expected price in some future period

Requires: ability to store *fuel* and/or *electricity* for future use

- hydro water reservoirs
- gas pipeline/reservoirs
- batteries are reservoirs for electricity

Delay options generally economically efficient

Delay Options II

Storage provides generator *discretion* and valuable *options*

Hydro with reservoirs have zero operational marginal cost, but (almost) never offer in at zero price: rather offers in at the value of storing water.

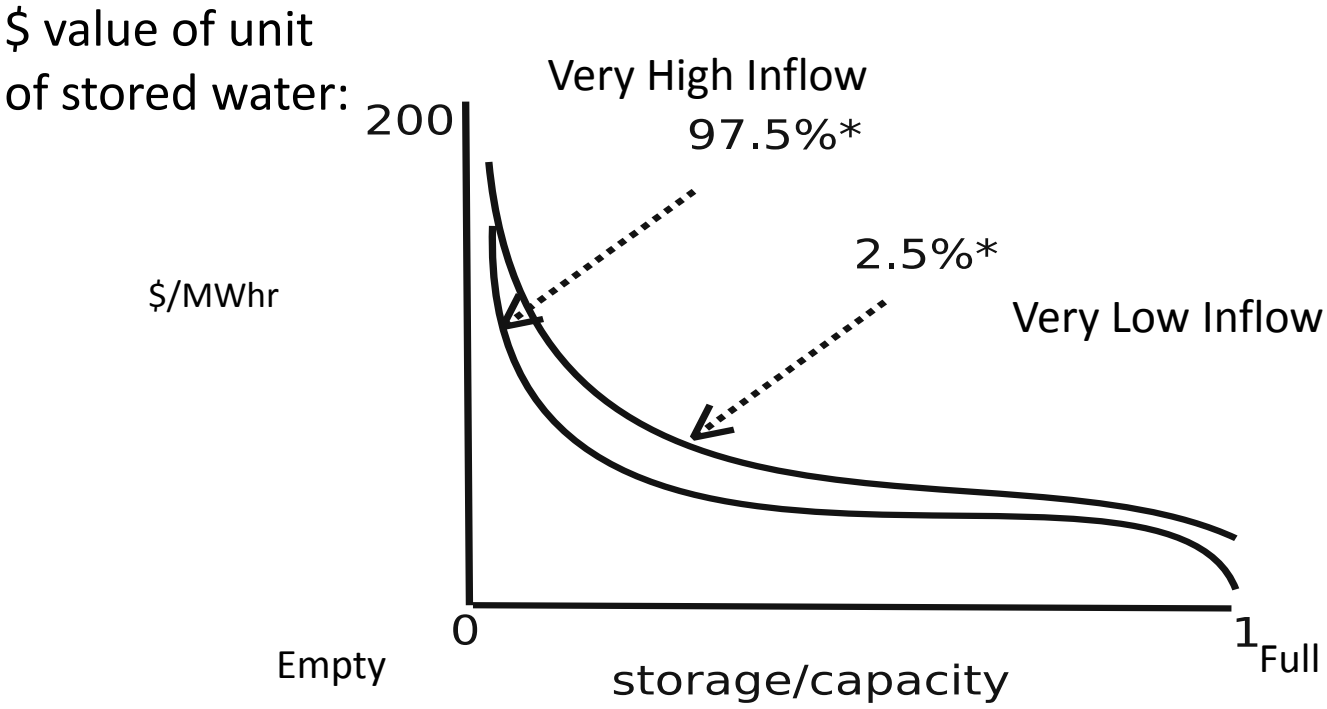
Hydro is typically marginal generation and (with zero operational marginal cost) the observed NZ spot price is the value of the option to delay use of water

Run of river and wind power generation have no delay options and negligible operational marginal cost so offer ”all” to the market at zero price

Delay Option Value of unit of water in a trading period

ie electricity price

Source a model calibrated to NZEM and simulated for trading periods for 200 years (Evans and Guthrie)



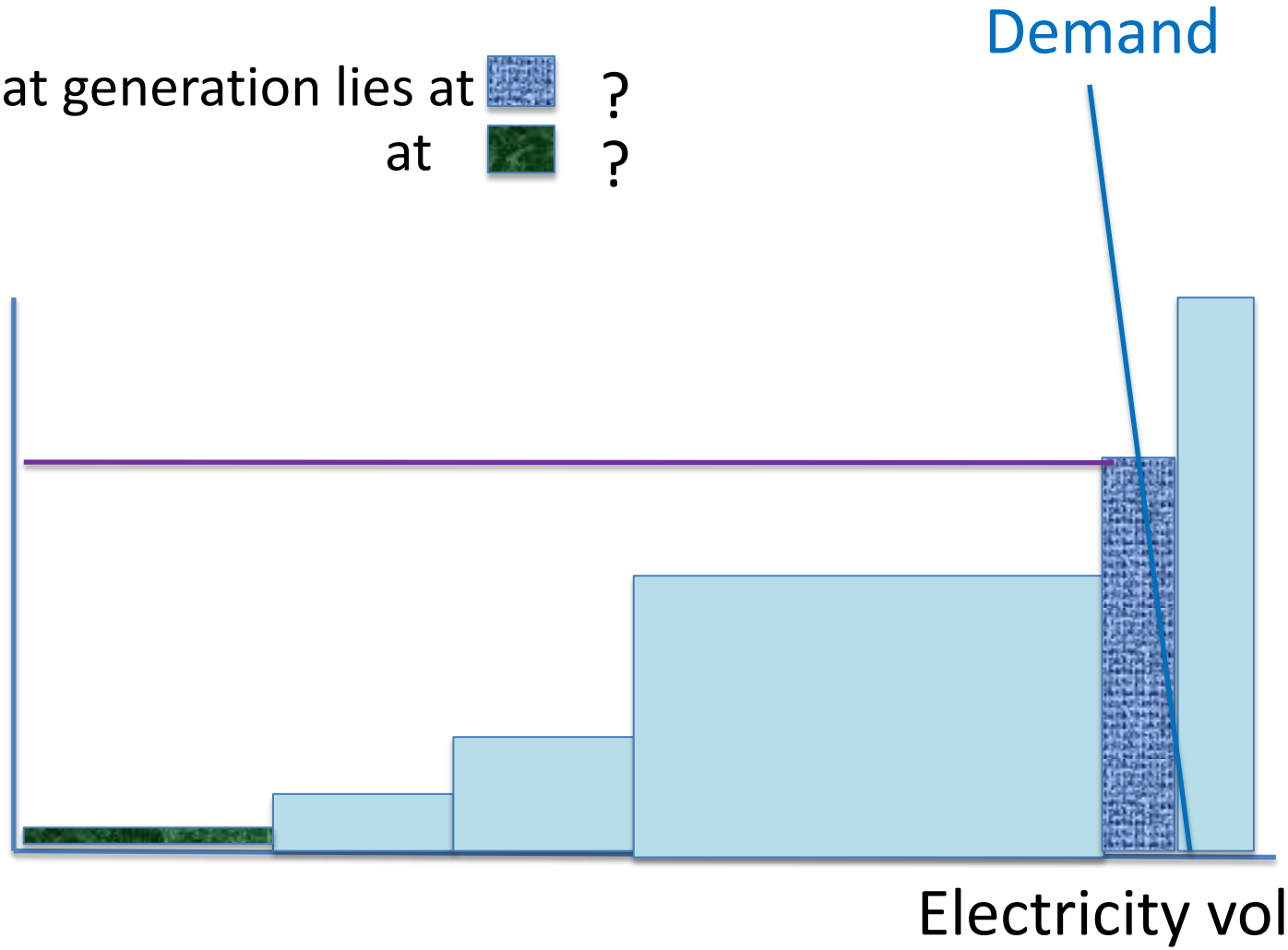
* Percentile of unconditional inflow distribution

Spot Market

Composition of generation

What generation lies at ▪ ?

at ▪ ?



▪ Offers to the spot market: sum is total variable cost of production

Delay Options III

Battery management has the same general principles as water/gas reservoirs

Batteries are reservoirs for electricity, and complement generation plant

Separate generation and supply: e.g. wind power *plus* batteries would provide delay options *that the market operator would see.* Batteries provide generator (demand) discretion regarding transactions with the spot market

Rule: Invest in storage (reservoirs) if the expected present value of delay options it provides exceeds its cost

Implications for the Wholesale Market of substituting zero-operational-marginal cost generation for fossil fuel

I Spot Market Operation

- Sufficient share of hydro generation enables operation with zero price offers.

- For markets of wholly renewables
  - batteries would be important: particularly with small share of hydro
  - Operation will reflect the wide holding of batteries
    - Participants will to an increased extent internalise/manage shocks to supply and demand, and
    - Render the market operator's task different as management of shocks will depend more on participant actions than formerly.

Implications for the Wholesale Market of substituting zero-operational-marginal cost generation for fossil fuel

II Hedge/Capacity investment

- The decision rule whether to build/buy hedges is the same whether or not operational marginal cost is zero and volatility is higher

- Increased market volatility would affect decisions taken.
    - Without batteries likely induce investment delays, ceteris paribus; BUT
    - Will also improve the economics of batteries
    - Net effect???????

Capacity Market

as well as spot and hedge markets?

- Capacity markets are additional to the spot market: entail capacity provision and funding separately
  - Capacity (additional) determined by central planner and
  - Provision of a level of capacity a condition of participation in the energy/spot market, or
  - provided by a procurement auction
- Capacity market performance has significant gaming and unstable rules: performance is at best chequered

- The *operation* of the spot/energy markets can be treated as if for the normal (energy only) market form

Capacity

- Capacity is influenced by a range of interventions:
  including in energy only markets

- Capacity markets polar case where marginal capacity is determined by a central planner but can happen in different ways (eg CA)/UK-Germany

- Is such intervention implied by increased renewables? no *prima facie* case

Some Sources

- Evans, Lewis, ”The electricity spot market: is it future proof*?”, The Electricity Journal*, 30 (2017) 25-29.

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- Evolving US Utilities Batteries Position: batteries instead of peakers (LA)
https://www.scientificamerican.com/article/world-s-largest-storage-battery-will-power-los-angeles/

Thank you for your attention