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Lessons from Electricity Markets: Using Price Signals to Value O&M Performance

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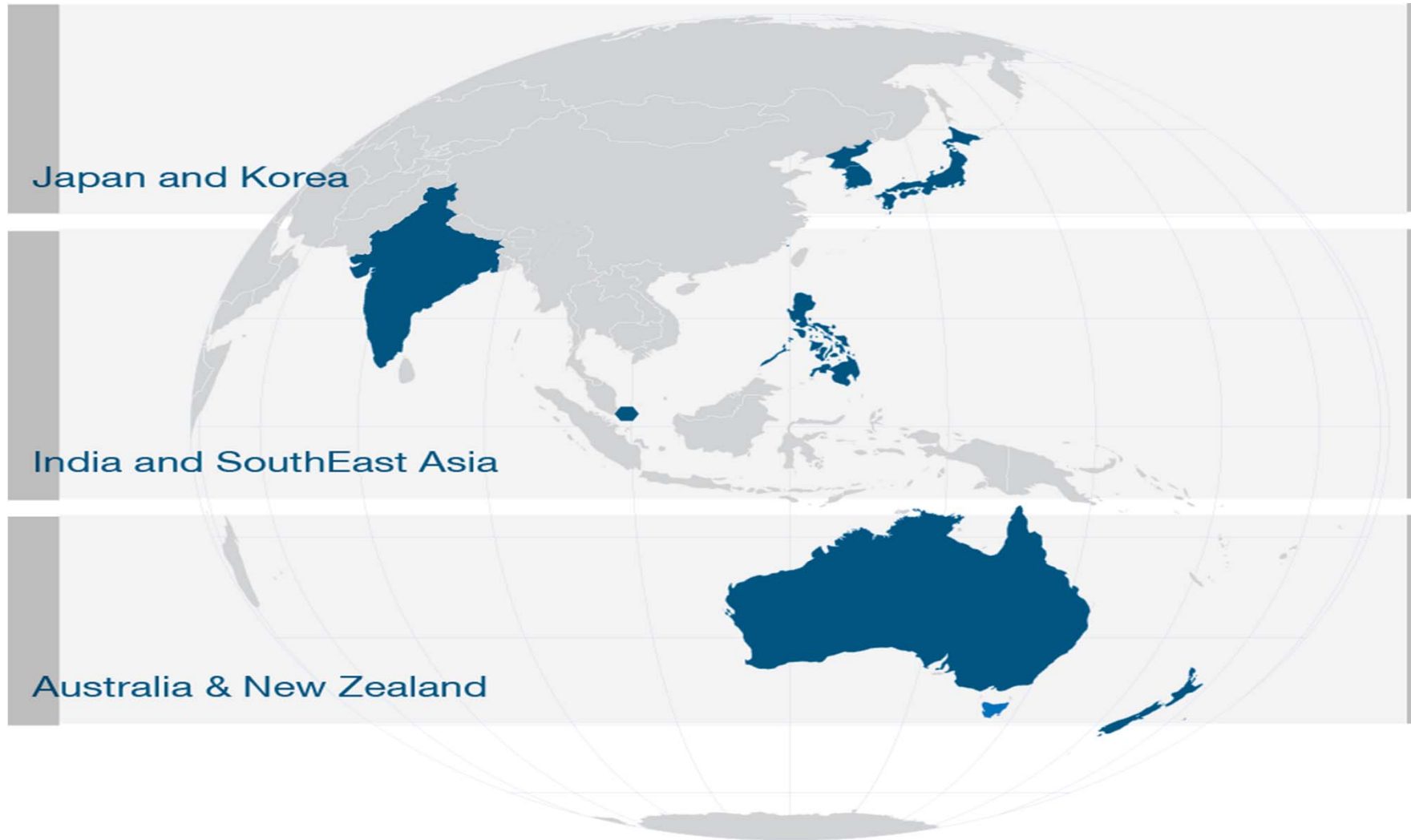
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My talk today

- Analyzing energy and capacity pricing in electricity markets
 - Characterization of Asia/Pacific electricity markets
 - Patterns of energy prices in different markets
 - Capital recovery and risk allocation
- Case studies in valuing O&M performance improvement
 - Life extension (Korea)
 - Cycling (Philippines)
 - Outage reduction (Singapore)
- Identifying price signals in the absence of actual electricity markets

Asia/Pacific is a patchwork quilt of electricity markets



Electricity market structures differ on a number of key attributes

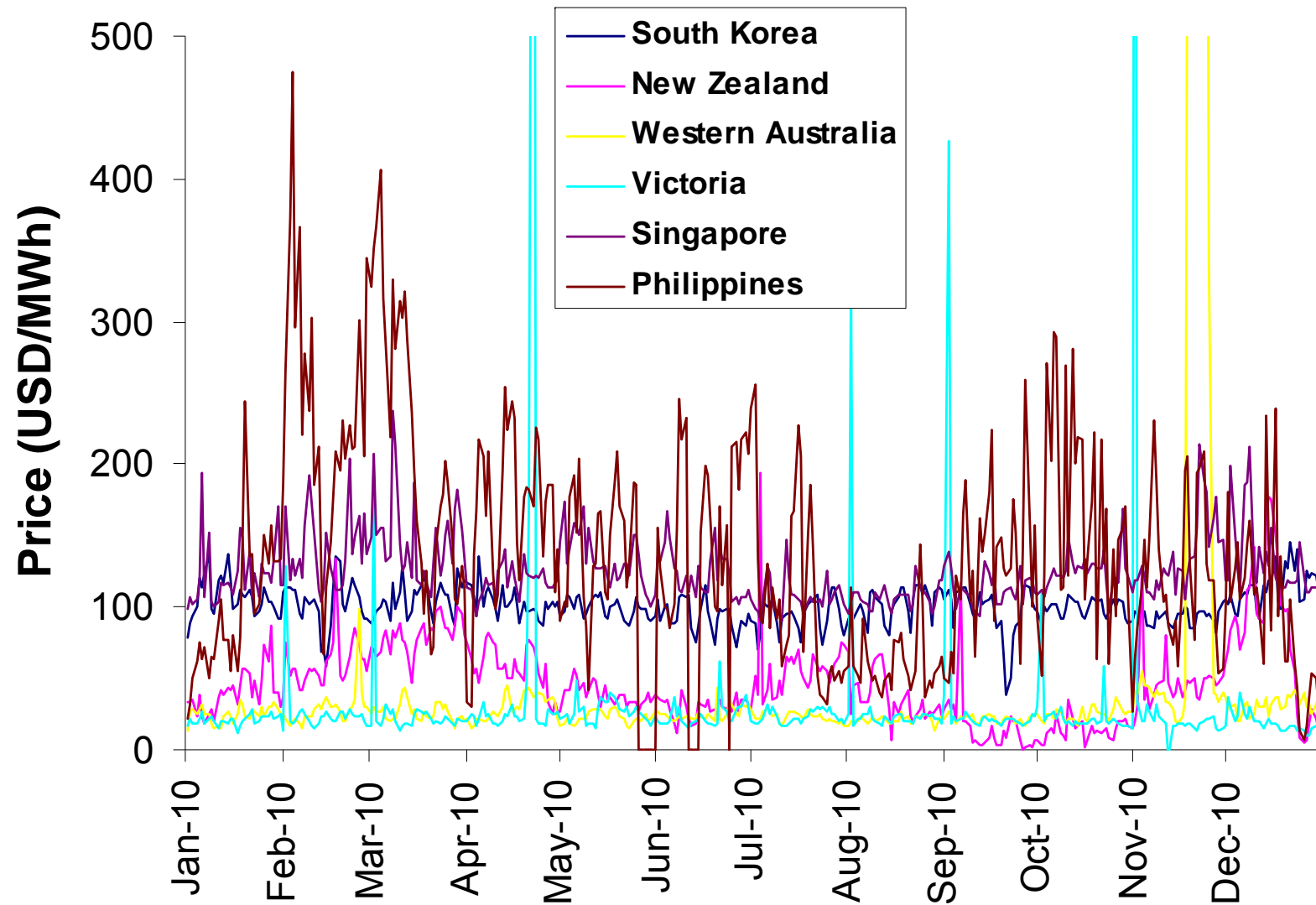
- Product
 - Energy-only
 - Energy and capacity
- Scope
 - Gross pool (all energy traded through market)
 - Net pool (bilateral contracts outside market)
- Location
 - Nodal
 - Zonal (or even regional)
- Bidding
 - Market-based
 - Cost-based
- Timing
 - Day-ahead
 - Real-time

Asia/Pacific markets exhibit considerable structural variation

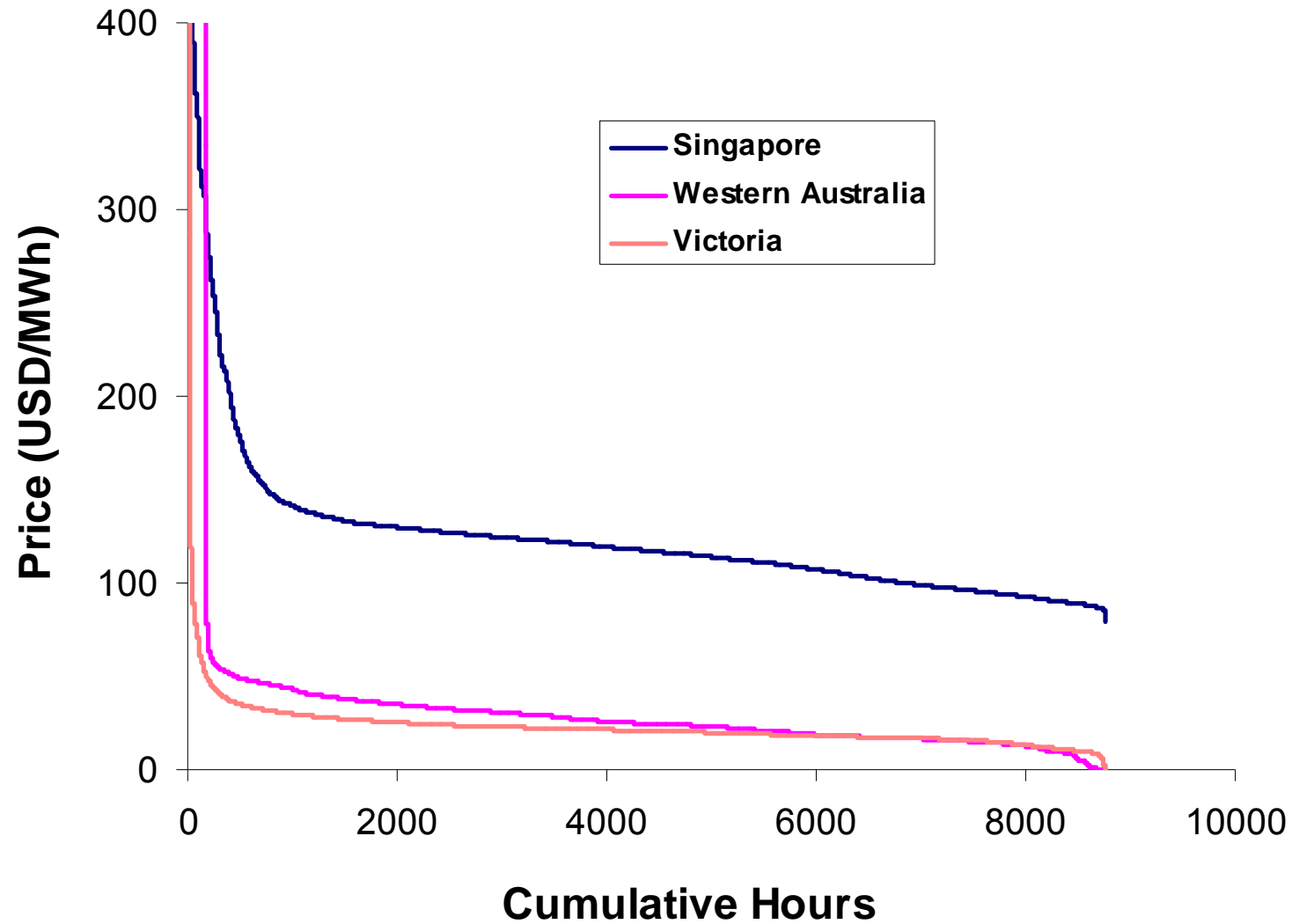
| Attribute | NEM (Australia) | NZEM (New Zealand) | NEMS (Singapore) | WESM (Philippines) | KPX (South Korea) | WEM (Western Australia) | JPEX (Japan) | IEX / PXIL (India) |
|------------------|---------------------------|------------------------------|----------------------------|------------------------------|-----------------------------|-----------------------------------|------------------------|------------------------------|
| Product | Energy-only | Energy-only | Energy-only | Energy-only | Energy and capacity | Energy and capacity | Energy-only | Energy-only |
| Scope | Gross pool | Gross pool | Gross pool | Gross pool | Gross pool | Net pool | Net pool | Net pool |
| Location | Zonal | Nodal | Nodal | Nodal | Regional | Regional | Zonal | Zonal |
| Bidding | Market-based | Market-based | Market-based | Market-based | Cost-based | Cost-Based | Market-based | Market-based |
| Timing | Real-time | Real-time | Real-time | Day-ahead, Real-time | Day-ahead | Day-ahead | Day-ahead | Day-ahead |

The four markets on the left – NEM, NZEM, NEMS, and WESM – are well-functioning and generally competitive electricity markets

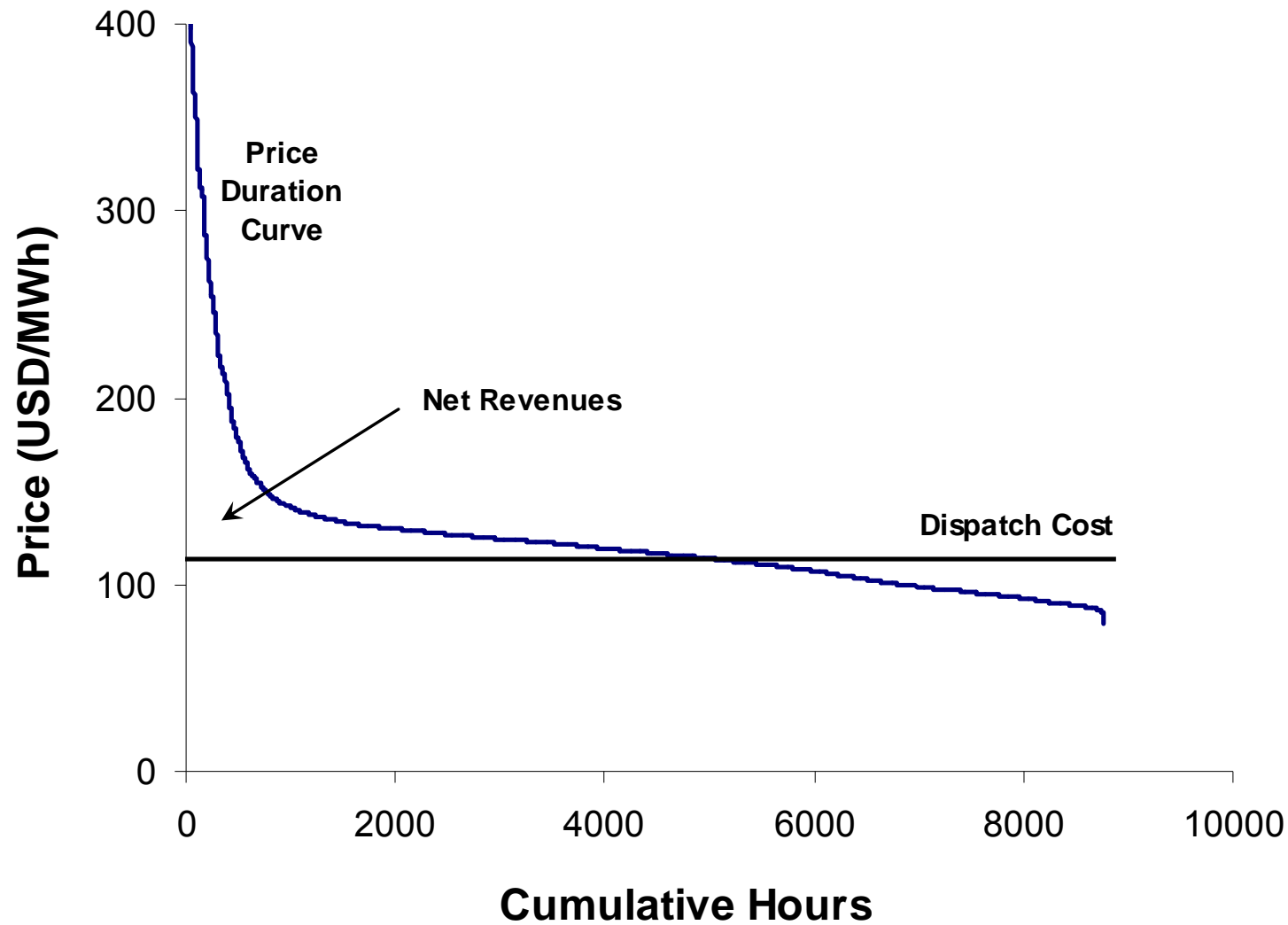
Character of market prices differs dramatically as well



Price duration curve ranks hours by price



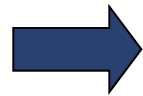
Net revenues represent the energy contribution to operating profit



Capital recovery

Single Buyer / PPA

Energy Payment



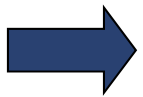
Fuel Cost, VOM

Capacity Payment



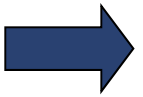
Capital, FOM

Operating Risk



Developer

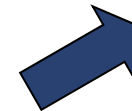
Financial Risk



Single Buyer

Merchant Generation

Energy Payment



Fuel Cost, VOM



Capital, FOM

Operating Risk



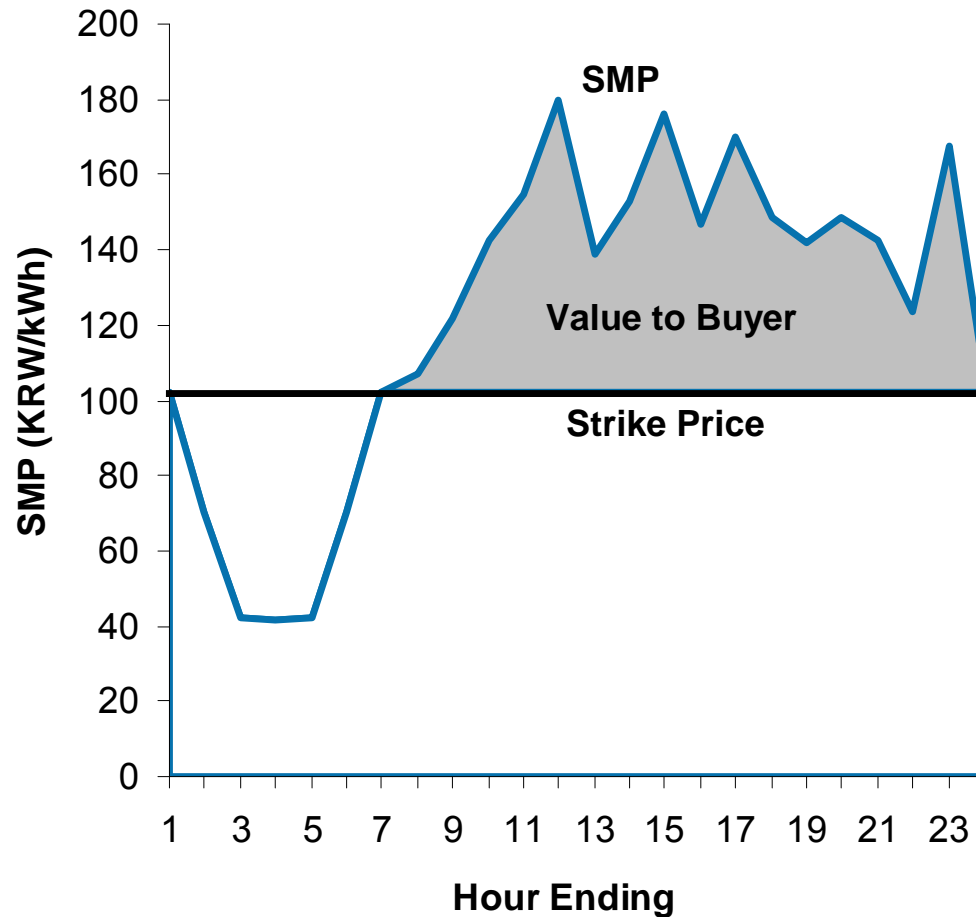
Developer

Financial Risk



Developer

One-way contracts enable risk shifting

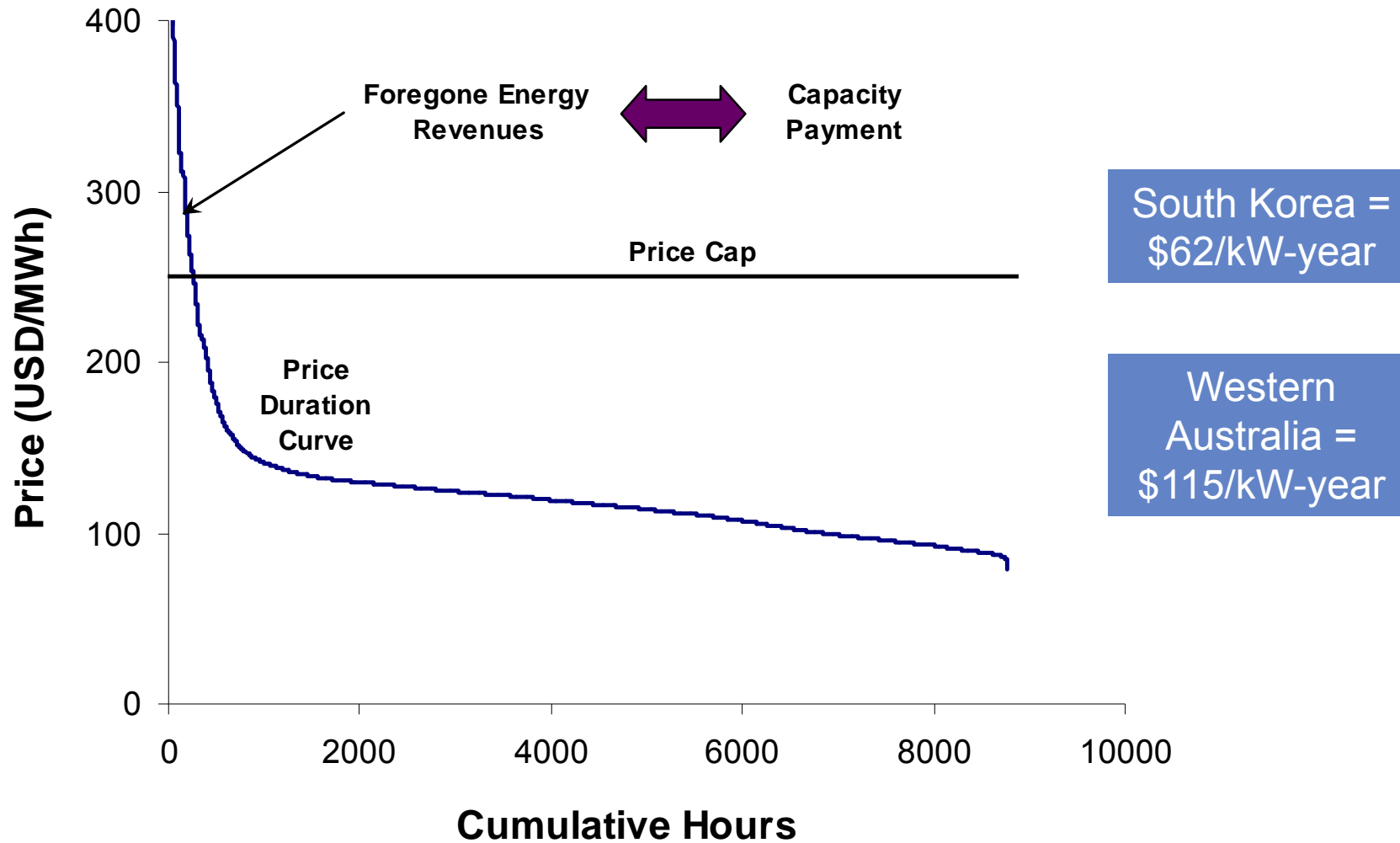


Key terms:

- Contract price (KRW/kW-year)
- Strike price (KRW/kWh)
- Contract quantity (kW)
- Contract duration (years)

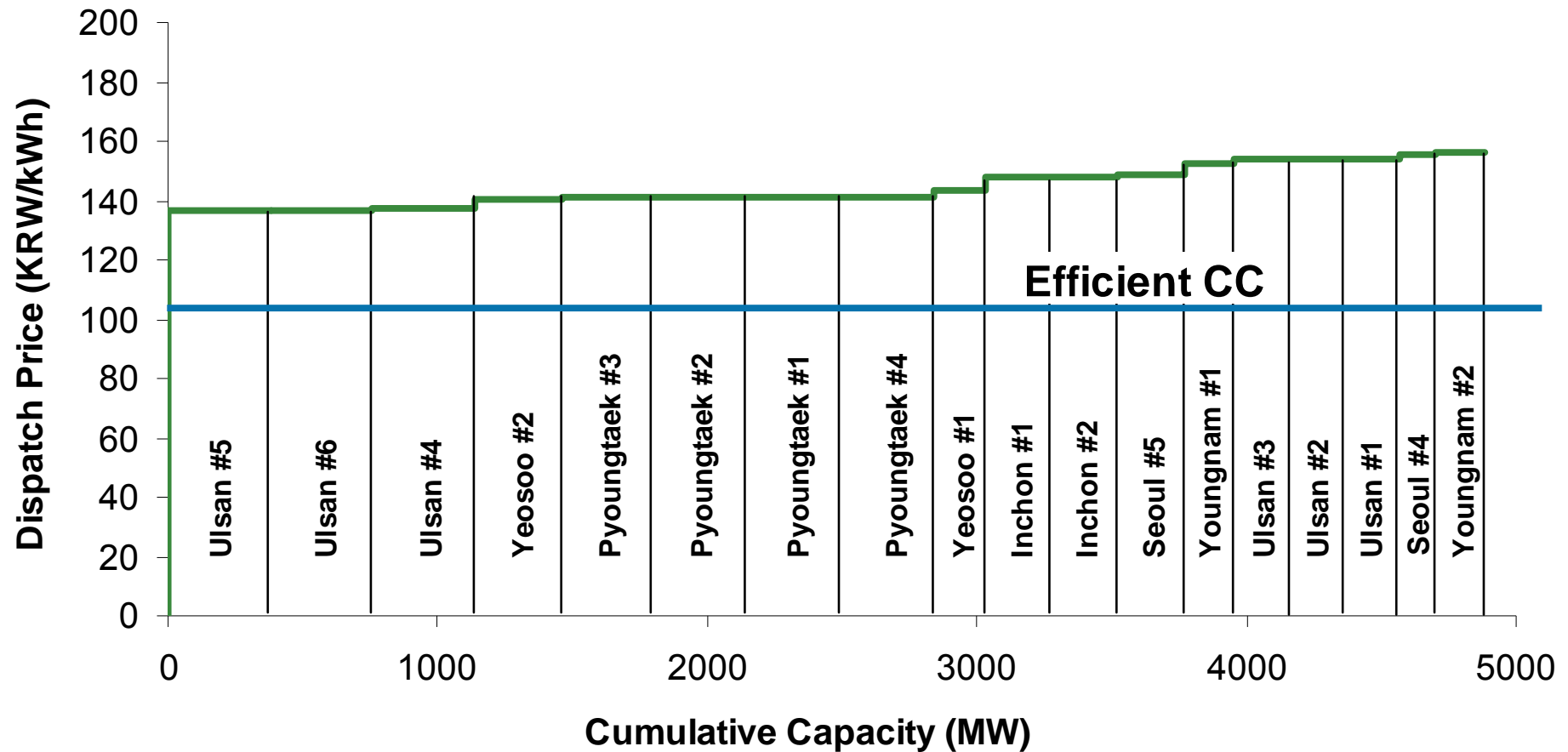
Buyer pays a contract price for the right to receive cash if SMP exceeds the strike price

Market-based capacity payment is a form of one-way option



Application: Life extension (Korea)

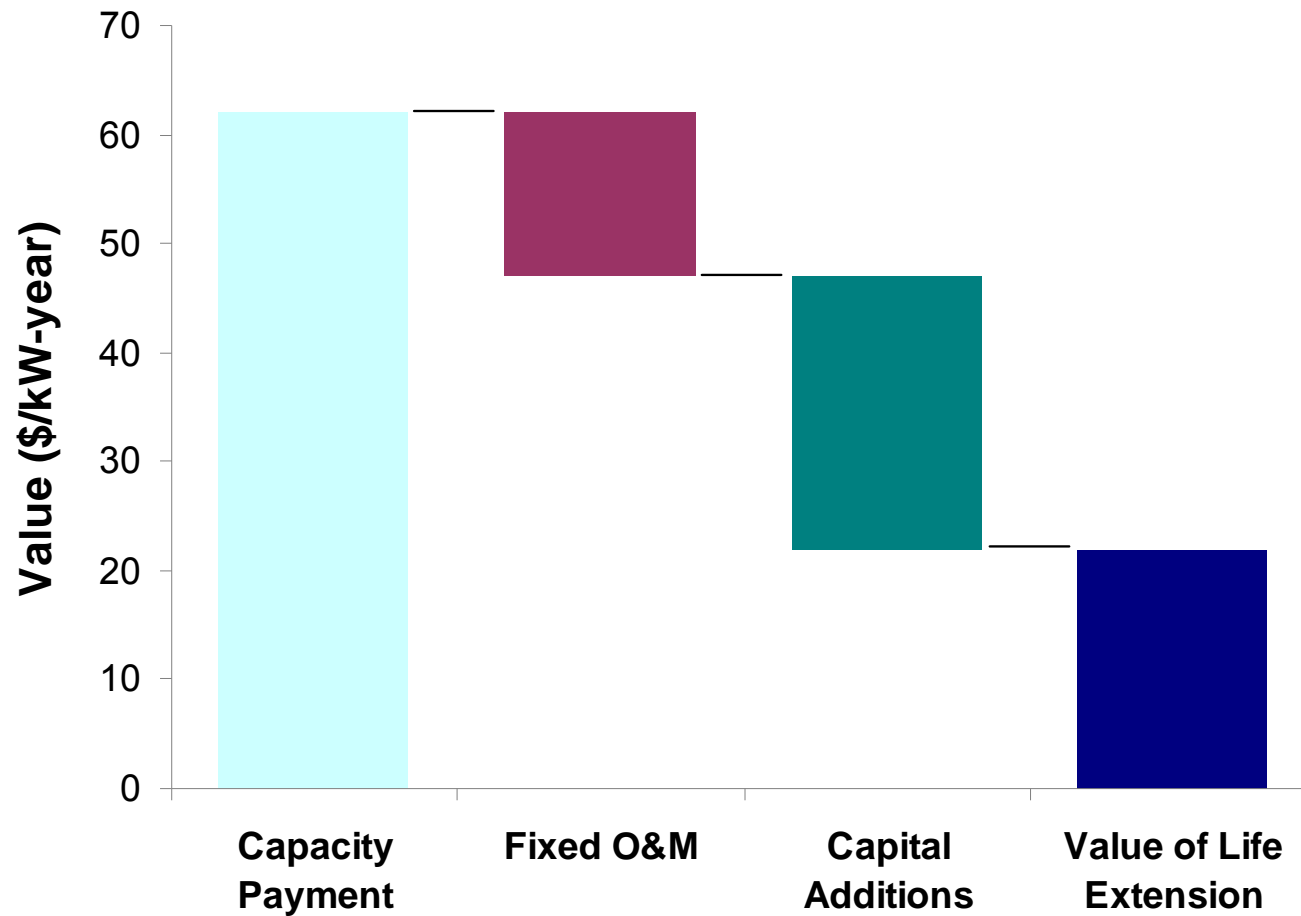
- South Korea has almost 5000 MW of aging, inefficient plant



Application: Life extension (Korea)

- Should they life extend these units?
 - Very high heat rates
 - Extremely low (or zero) capacity factors
 - High fixed O&M costs
 - Capital outlays required

Application: Life extension (Korea)



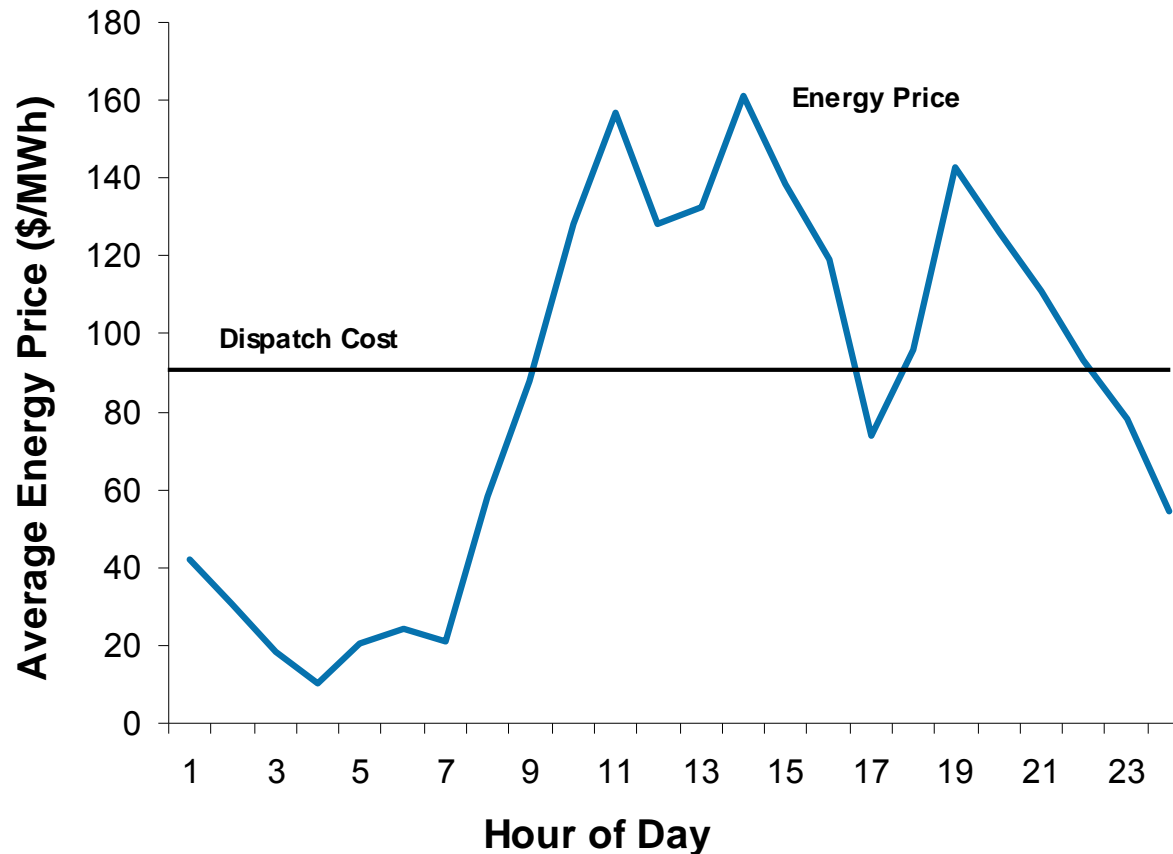
The existence of the capacity payment makes life extension economic in most cases

Application: Cycling (Philippines)

- Inflexible coal unit
 - Slow ramp times
 - High start-up costs
 - Minimum generation constraints
- Should operator cycle this unit?
 - Require some minor investment
 - Shorten economic life
 - Potentially increase O&M costs

Application: Cycling (Philippines)

- WESM prices exhibit strong daily profiles that yield losses in the absence of cycling



Cycling the unit gave it the possibility of making economic profit

Application: Outage reduction (Singapore)

- Highly efficient CCGT
 - Heat rate competitive with other CCGTs
 - High capacity factor
 - Potential for outage reduction via maintenance re-optimization
- Should operator invest to reduce outage times?
 - Require relatively minor investment
 - No heat rate penalties or associated risks

Application: Outage reduction (Singapore)

2011-2012 – Gas-constrained

- PNG supplies limited
- Generators collectively have sufficient CCGT capacity to utilize available PNG
- At the margin – based on opportunity cost – PNG competing even with HSFO
- Incremental availability has little value

>2012 – LNG and excess capacity

- LNG terminal coming online in 2013
- 4000 MW of new CCGT capacity coming online between 2010-2014
- Supply curve will flatten and net revenues for CCGTs shrink
- Incremental availability has little value

Incremental reductions in outage duration are not economic

Single buyers face a cost minimization problem

- Min Fuel + VOM + FOM + Capital
 - Operating constraints
 - Transmission constraints
 - Generation \geq Load
 - Capacity \geq Peak load + Planning reserve

Shadow prices on constraints yield “prices”

- $\text{Generation} \geq \text{Load}$



Energy
Price

- $\text{Capacity} \geq \text{Peak load} + \text{Planning reserve}$

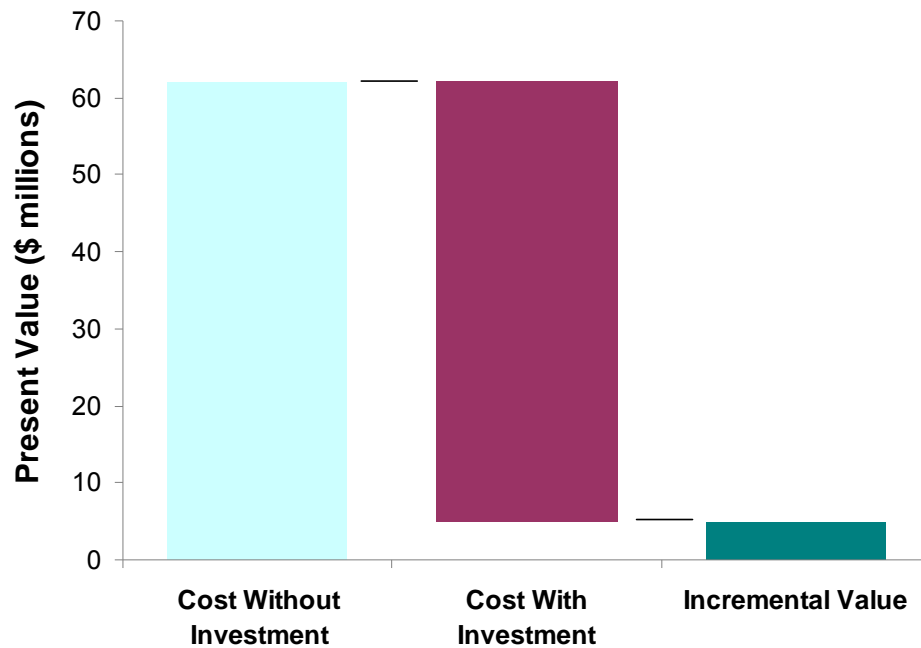


Capacity
Price

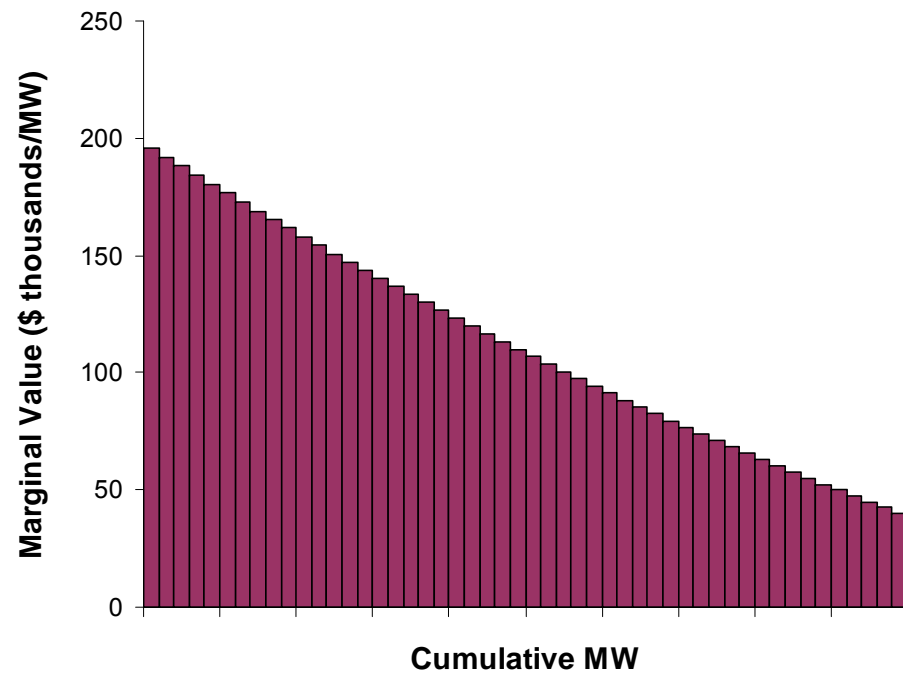
These “prices” can be used to determine the marginal value of O&M investments

Marginal value analysis is equivalent to incremental analysis

Incremental analysis



Marginal value analysis



The total area in the marginal value analysis equals the incremental value

Conclusions

- Energy and capacity prices in electricity markets provide visible measures of value
- These prices represent the appropriate benchmarks for consideration of O&M investments
- Equivalent “prices” can be inferred from the Single Buyer’s dispatch and capacity expansion cost minimization problems.

Thank you

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The Lantau Group (TLG) experts advise energy stakeholders in Asia

Economic Consulting

- Regulatory strategy
- Market development & improvement
- Competition policy
- Economic evidence for disputes
- Policy effectiveness
- Cost/benefit analysis

Strategy & Business Consulting

- Commercial due diligence
- Market analysis & opportunity assessment
- Asset valuation
- Electricity market modelling / fundamental analysis
- Business strategy

Examples



Our team delivers authoritative expertise with local accessibility