

# **THE DEVELOPMENT AND REVIEW OF THE METHODOLOGY AND DETERMINATION OF THE LEVELS OF OFFER PRICE CAP AND FLOOR, AND MARKET PRICE CAP AND FLOOR FOR ENERGY AND RESERVES**



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**Development Academy of the Philippines  
August 11, 2015**



# Power Wrangler Introduction

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## **Richard Penn, M.Sc.**

Richard has over 35 years of experience in regulated and deregulated electricity markets. In that time he directed the operation and dispatch of over 7,000 MW of hydro-electric generation. He was the Director of commercial operations for a 25,000 MW portfolio consisting of nuclear, hydro-electric and fossil-fired generation. He has been the Manager, Market Surveillance in both Ontario and Alberta, Canada with over 15 years in dealing with market issues. He has provided consulting services to major trading companies involved in the North American markets. Presently he is providing on-going consulting services to major loads in Alberta.

He is Principal at Power Wrangler which provides consulting and information technology services to Alberta market participants.



# Power Wrangler Introduction

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## **Derek E. H. Olmstead, Ph.D.**

Derek has over 10 years of experience in competition and public policy assessment. He has experience in the Alberta, Australian (NEM), and Ontario electricity markets. He has coordinated various electricity market assessment projects including: unilateral and coordinated market power; market rule assessment; efficiency estimation; impact of information on competition; environmental policy impact; and retail market performance.

He recently participated in the Australian government's review of a major generation merger (AGL and Macquarie Generation).



# Presentation outline

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- Terms of Reference
  - What we looked at
- Principles
- Practices in other Jurisdictions
- Current and recent practices in WESM regarding price mitigation
- Background
  - The market as we see it; review of data
- Demand vs. supply side caps
- Recommendations

## Terms of reference

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A Market Advisor was engaged to provide expert and independent advice and to raise recommendations regarding the development and review of the methodology and determination of the levels of offer and market price cap and floor for energy and reserves.

The offer price cap was established in June 2006 by the WESM Tripartite Committee, which is comprised of the Department of Energy (DOE), Energy Regulatory Commission (ERC), and Philippine Electricity Market Corporation (PEMC), to mitigate the occurrence of extremely high WESM prices. In addition, in May 2014 the ERC implemented the secondary price cap as an interim pre-emptive mitigation measure for sustained high prices in the WESM.

# What we were asked to look at

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	Market cap	Offer cap	Secondary market cap	Market floor	Offer floor
Energy	Yes	Yes	Yes	Yes	Yes

Market cap – Maximum price in the market for energy

Market floor – Minimum price in the market for energy

Offer cap – Maximum offer price in the market for energy

Offer floor – Minimum offer price in the market for energy

Secondary market cap – The maximum price in the market when a pre-defined cumulative market price exceeds a given level



# The purpose of setting price caps and floors

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- The key purposes of setting the price cap and floor are:
- Technical
  - In the event the market does not clear at any price because of supply scarcity and load is shed as a consequence, setting the price administratively to some capped value is useful
  - The market price floor would be set under the opposite supply demand characteristics
- Structural constraint
  - As a constraint on the exercise of market power
  - Most electricity markets the generation industry has a relatively small number of participants, it is typically an oligopoly
  - Price caps are about preventing the abuse of market power



## Too high, too low

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- Too high a price cap can in the short-term lead to the abuse of market power. In the longer term this may also lead to inefficient investment.
- Too low a price cap discourages investments in peaking generators and reliance on base-load facilities or aging plants that are costly to maintain, have slow response and will ultimately lead to reliability issues.
- The “correct” price cap encourages efficient investment, new generation and more market participants that in turn dilutes generation oligopoly.





# Principles for the cap and floor

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- Offer and market price caps must be greater than marginal cost
- Generation capacity should be available to meet peak demand
- Over time, prices must allow all generation costs to be recovered
- The price signal should provide meaningful information about the value of electricity
- Control of market power
- Market outcomes must be fair to consumers
- The price floor should be low enough to allow competition to occur

## The WESM structure

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- Energy-only market; no capacity auctions or payments
- No open market for reserves / energy is not presently co-optimised with reserves. But this is expected in the near future.
- Gross generation power pool: generators offer their output to the market, load potentially can
- The algorithm then minimizes the cost of meeting demand, nodal prices, transmission constraints accounted for to determine a load-weighted average price for Luzon and Visayas
- Contracts overseen by the ERC: contracts are physical in nature, we take this structure as given, but we like others have concerns over the nature of this style of contract in its interaction with the market.
- A FIT program has been introduced into the Philippines



## The WESM structure, continued

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- Measures of health of a market include such features:
  - As supply and continued growth in supply or replacement of inefficient generators
  - Success in meeting growing demand
  - Prices sufficiently high to compensate investors
  - Net revenue sufficiently high to cover fixed costs (continued new investment being a sign of that)
  - Prices converge towards long-run marginal cost, this is the lowest cost outcome for consumers over time
  - Principled, consistent market development

# Supply

## Combined Luzon and Visayas WESM Registered Capacity, 25 March 2015

Plant fuel type	Registered capacity	Capacity share
Coal	5,863	37.2
Natural gas	2,769	17.6
Hydro	2,440	15.5
Oil	2,375	15.1
Geothermal	1,771	11.2
Wind	373	2.4
Biofuel	98	0.6
Solar	81	0.5
Total	15,770	100.0

# Forthcoming supply

*Table 2: Power supply outlook to 2019, committed power projects<sup>1</sup>*

Year	Luzon			Visayas		
	Coal	NG	Renewable	Coal	NG / oil	Renewable
<b>2015</b>	517	100	115	0	19	87
<b>2016</b>	150	450	42	270	0	100
<b>2017</b>	570	0	0	0	0	8
<b>2018</b>	0	0	0	0	0	0
<b>2019</b>	460	0	2	0	0	0

*Table 3: Power supply outlook to 2020, indicative power projects<sup>2</sup>*

Year	Luzon			Visayas		
	Coal	NG	Renewable	Coal	NG / oil	Renewable
<b>2015</b>	0	0	0	0	0	49
<b>2016</b>	750	0	106	150	0	105
<b>2017</b>	1,950	2,065	170	300	0	61
<b>2018</b>	1,500	1,200	183	0	0	54
<b>2019</b>	1,500	1,350	78	0	0	6
<b>2020</b>	350	0	50	0	0	0

<sup>1</sup>“Power supply outlook until 2020,” Electric Power System Management Bureau, Department of Energy, 15 June 2015.

<sup>2</sup>Ibid.

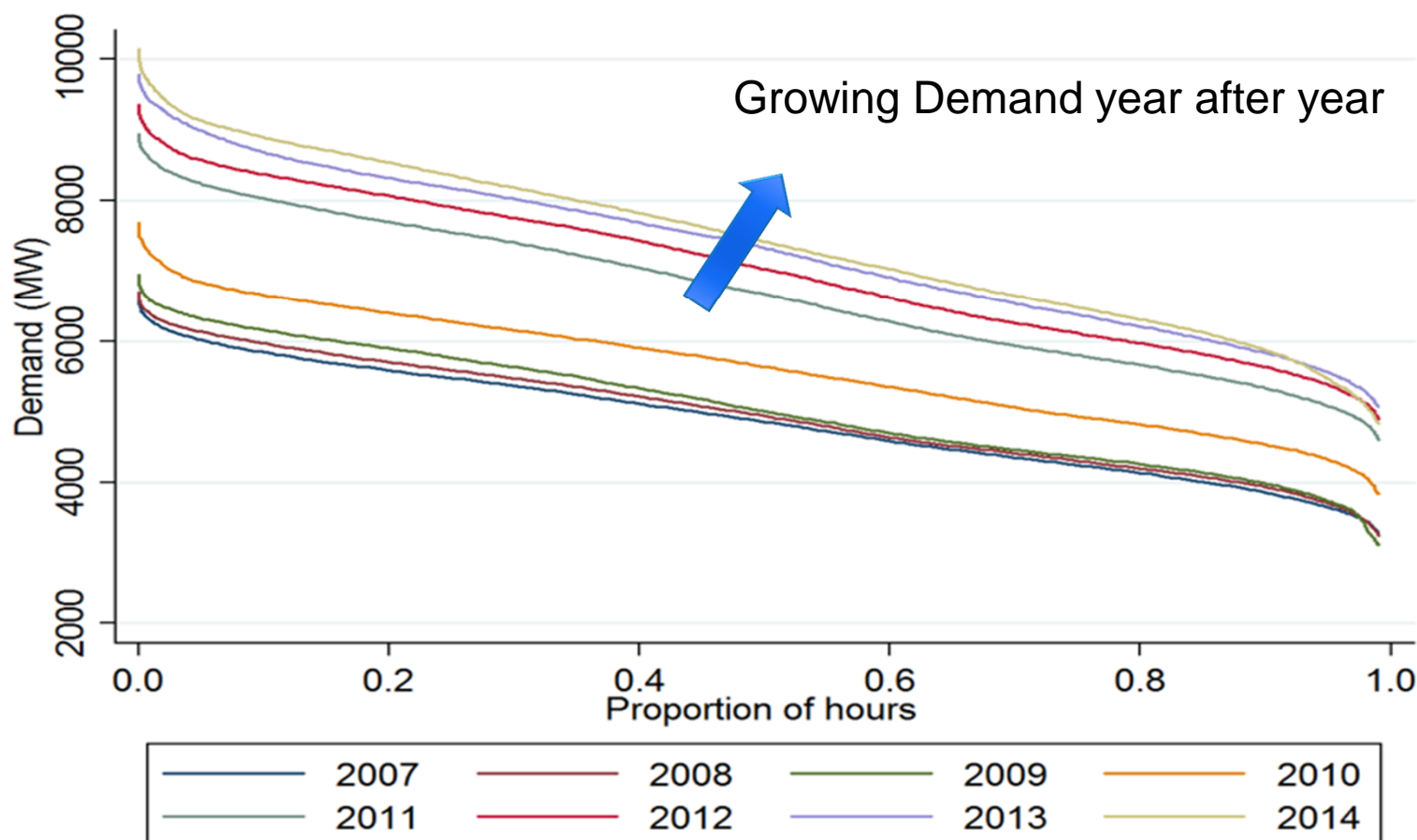


# Demand

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- Gradual growth through time
- Implies a continuing need for capacity installation
- Impact of Visayas' inclusion to the WESM on 26 December 2010: step change upward of demand

# WESM demand-duration curves, year-by-year



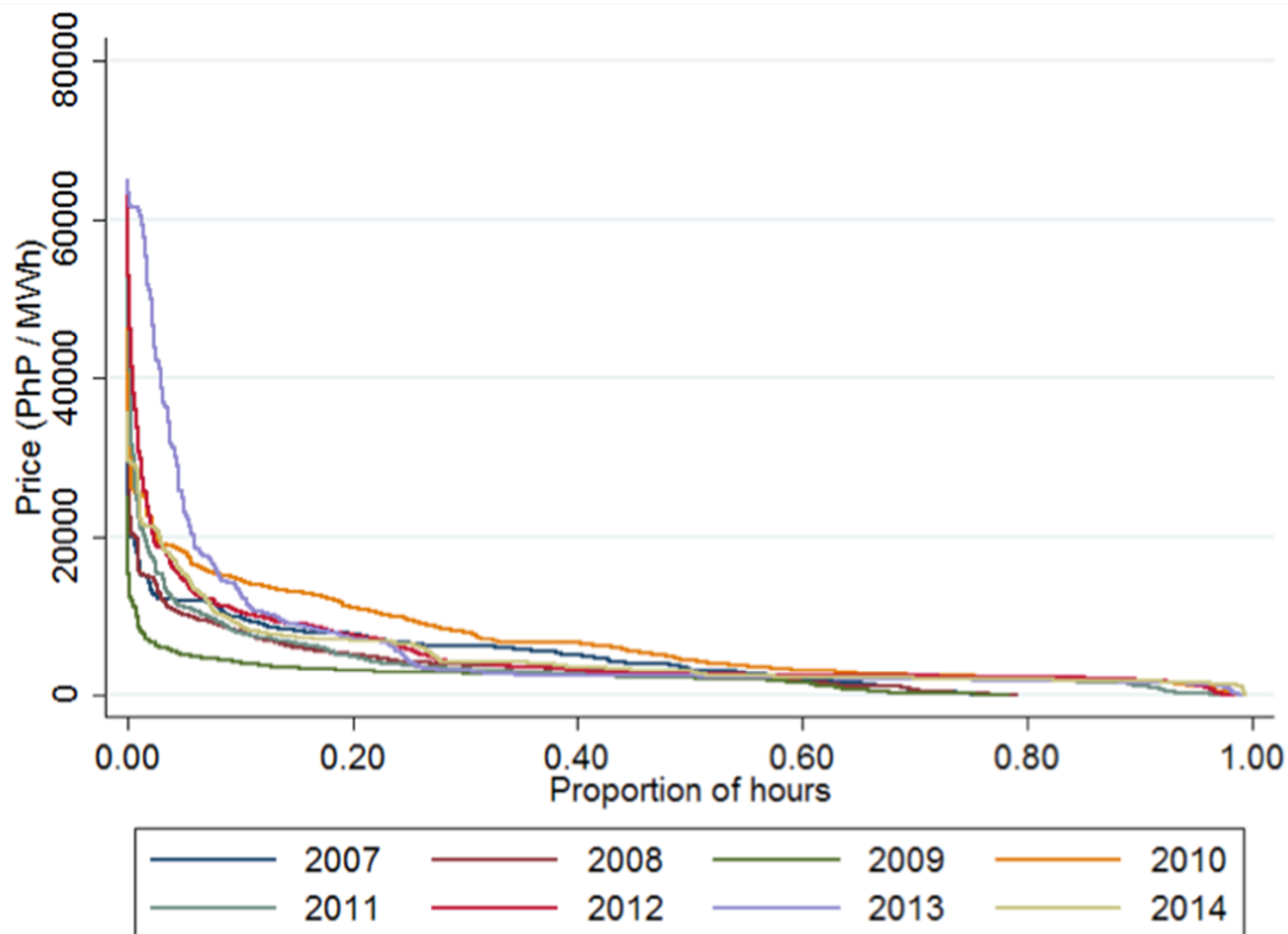
# Prices

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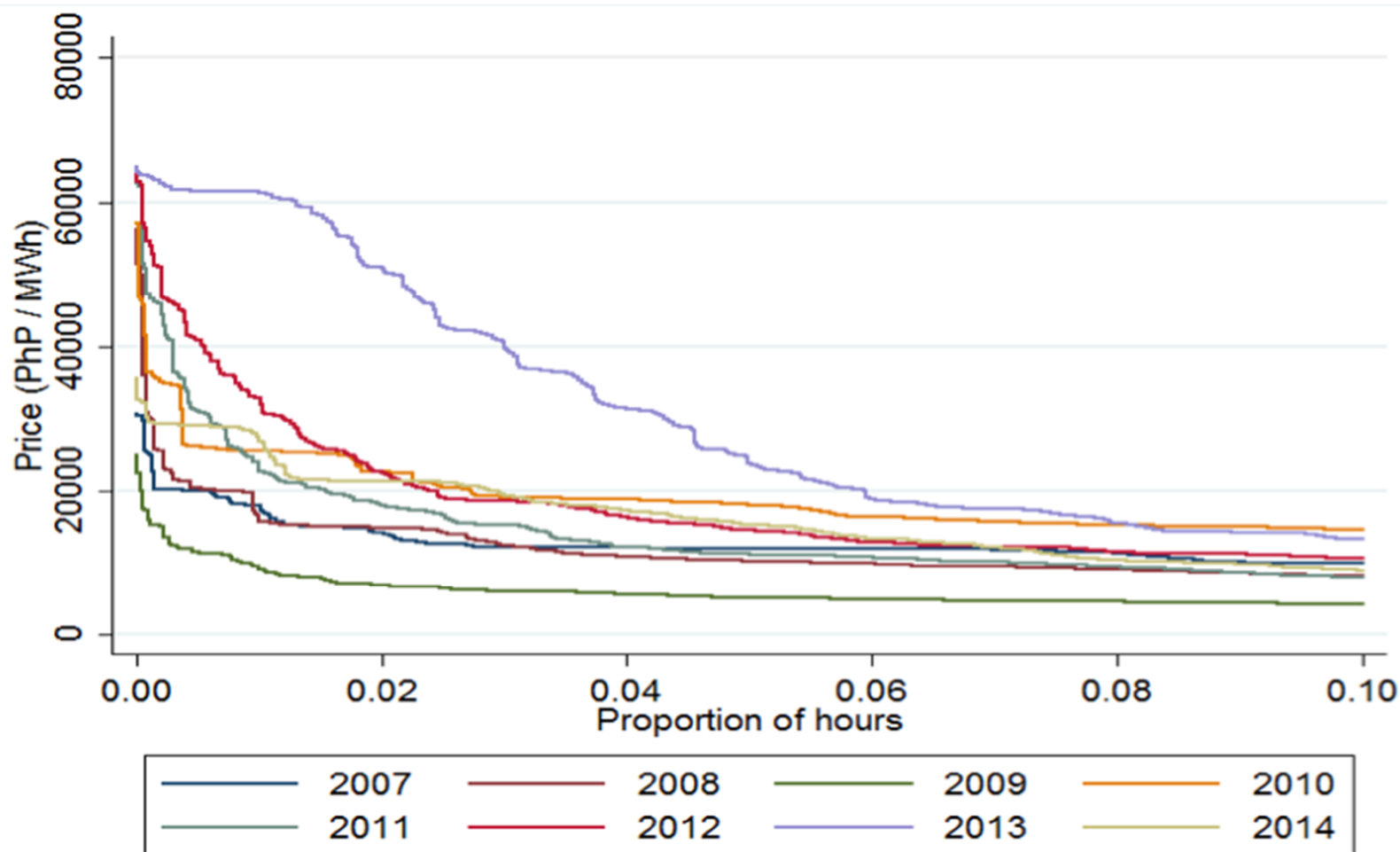
- The following figures illustrate duration curves of observed spot market prices in Luzon and Visayas respectively by year.
- They are portrayed as:
  - The complete annual record
  - The top 10% of hours where typically an area where the most expensive peaking generators tend to recover their fixed costs, in the Philippines these are presently oil and diesel generators
  - The bottom 2% of hours where prices may go negative



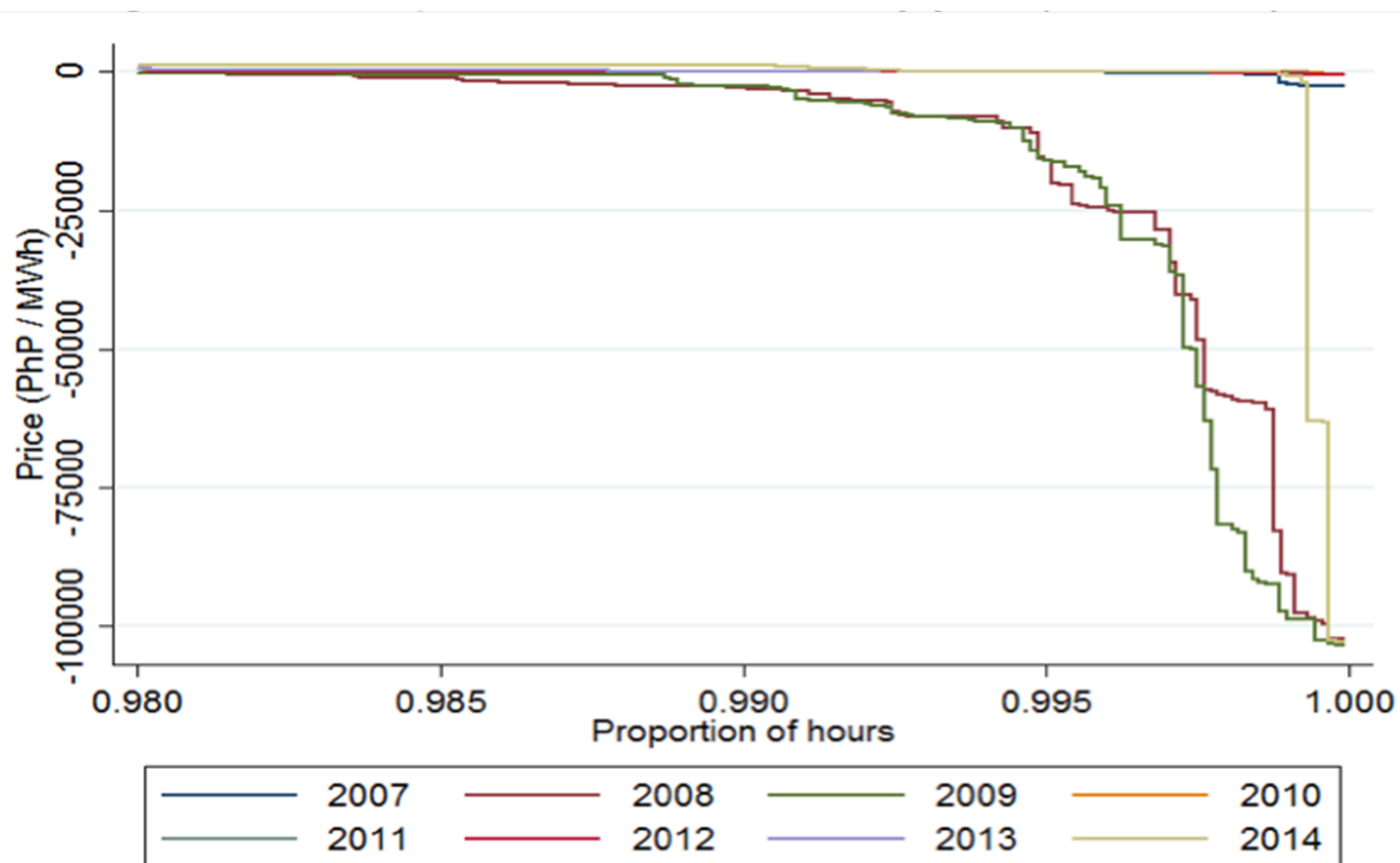
# Luzon price-duration curve (positive prices)



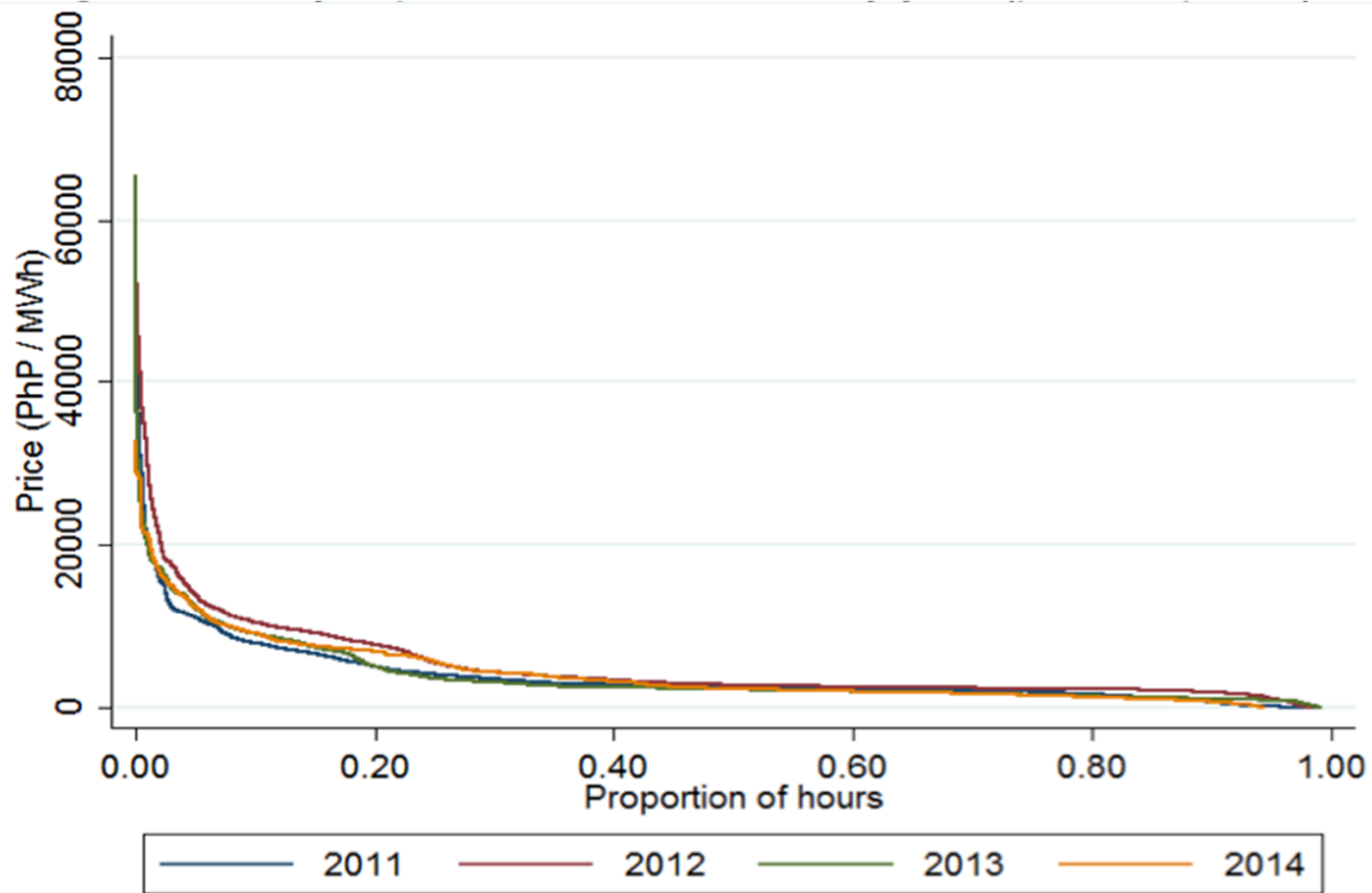
# Luzon price-duration curve (top 10%)



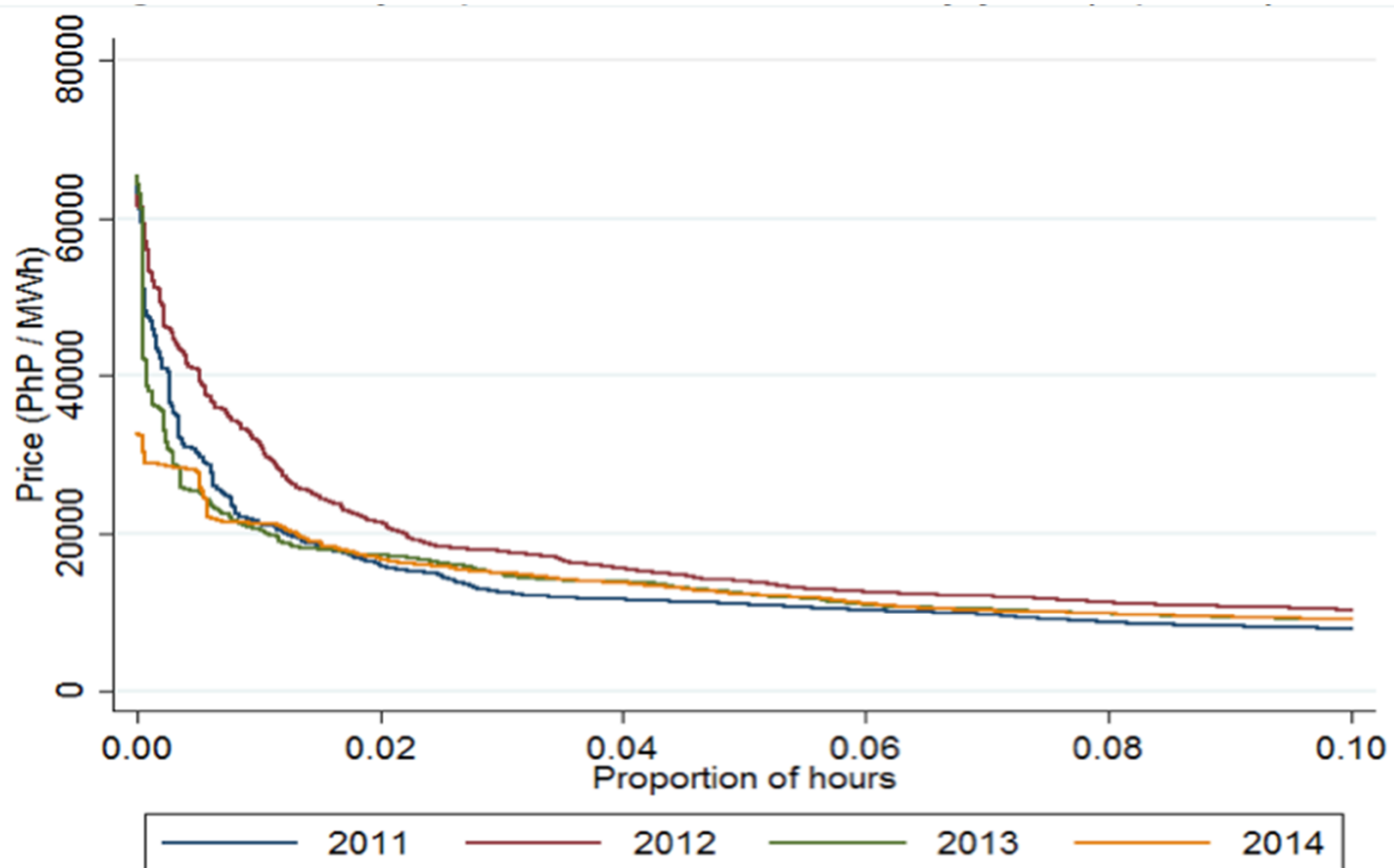
# Luzon price-duration curve (bottom 2%)



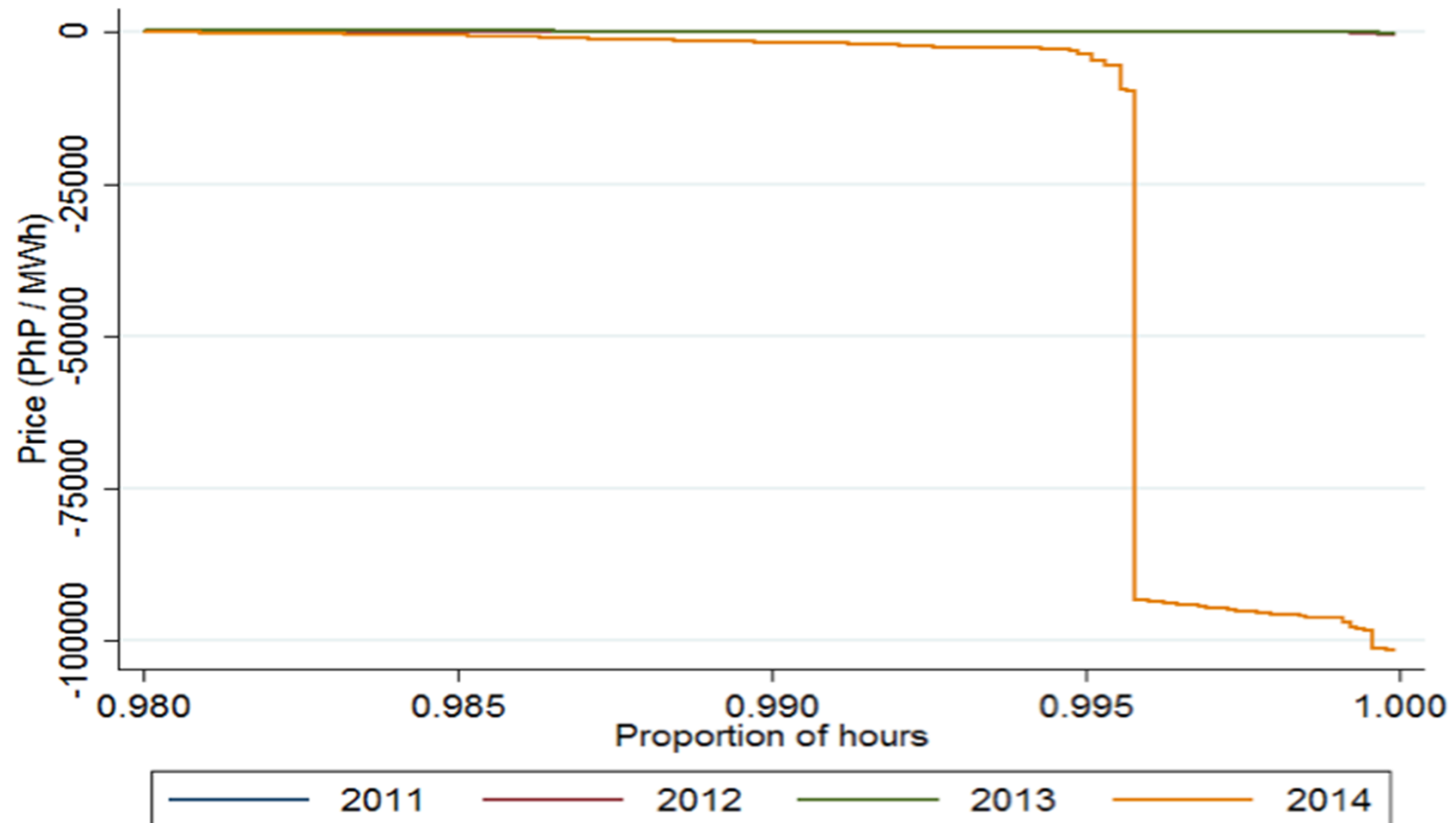
## Visayas price-duration curve (positive prices)



## Visayas price-duration curve by year (top 10%)



# Visayas price-duration curve by year (bottom 2%) $\mathcal{P}_W$



# Net revenue analysis

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- Net revenue analysis calculates the revenue in excess of short-run marginal cost (SRMC) over a set of hours; annually here
- This is viewed as the amount of revenue in excess of SRMC the market makes available to generators to cover their fixed cost
- SRMC is the change in generator cost for a one-unit increase or decrease in output
- The total is compared to the amount of revenue required in a typical year to pay generators' fixed costs, including a risk-adjusted rate of return on investment
- The analysis is usually done for a range of SRMC to provide guidance on the revenue possibilities across the year for different "types" of generation
- In some years the generators rate of return is higher than in other years for a myriad of factors including fuel costs, droughts, demand, outages, etc.

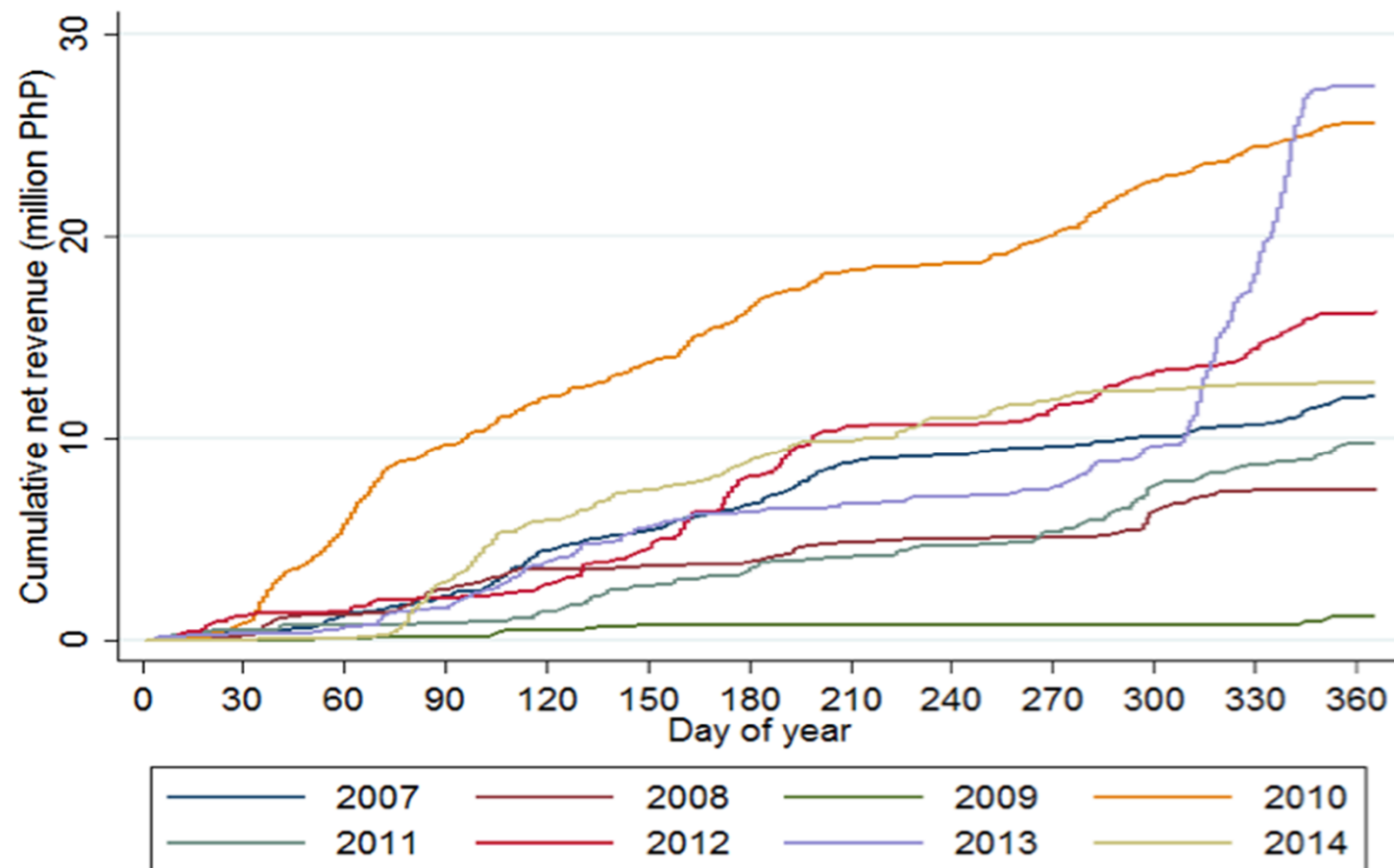
## Net revenue analysis, continued

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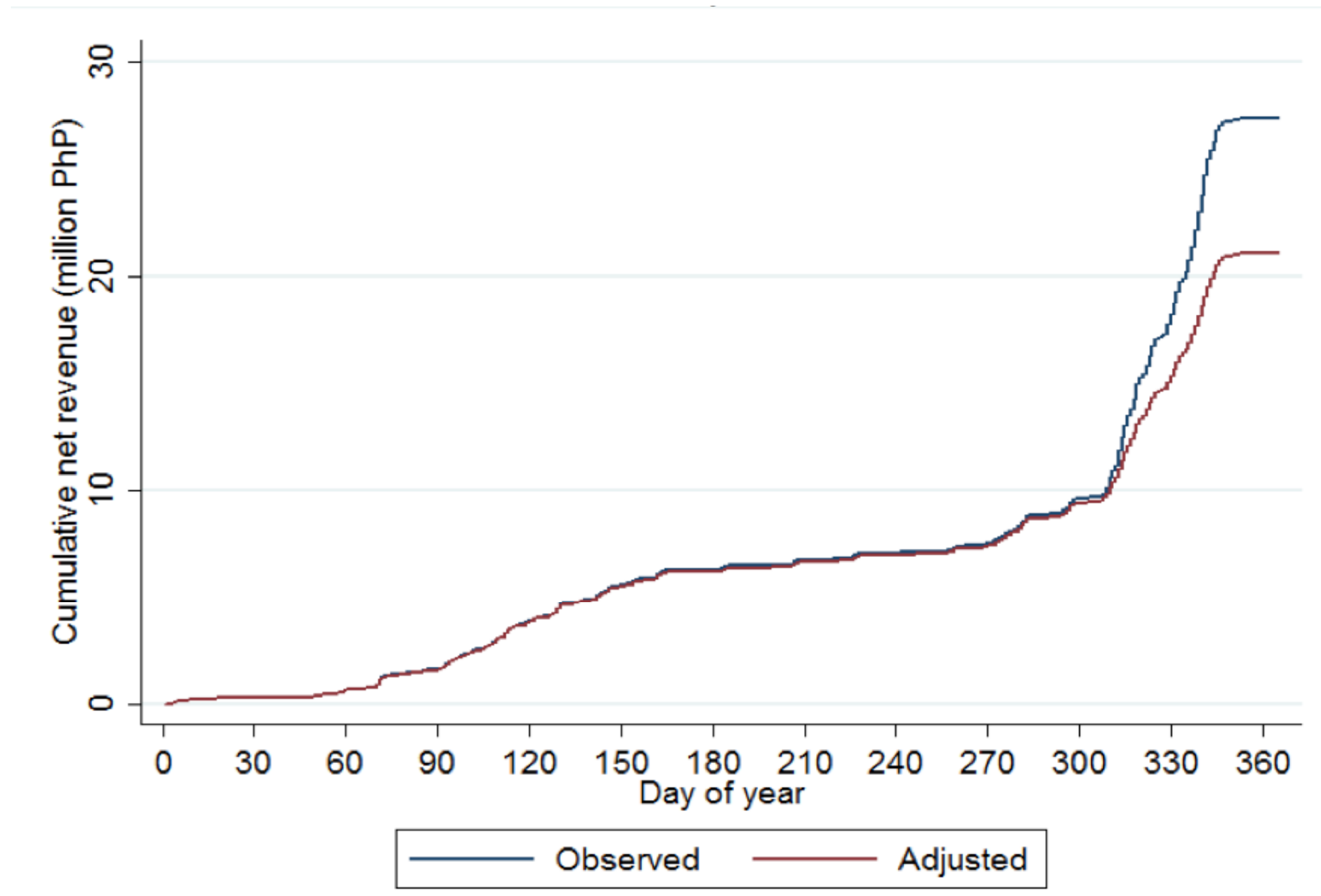
- Effective 26 December 2013, the offer price cap was lowered from PhP 62,000 to PhP 32,000
  - This has an impact on net revenues generators can expect to receive in the future
- A secondary market price cap was instituted in 2014
  - Under the final / current version, it binds when the 168-hour rolling average pool price reaches or exceeds PhP 9,000 (equivalent to the cumulative 168-hour pool price exceeding  $9,000 * 168$ )
  - When the secondary price cap binds, the pool price is limited to PhP 6,245 until the rolling average falls below PhP 9,000
  - This also has an impact on net revenues generators can expect to receive in the future



# Luzon cumulative net revenue, generator with PhP 5,000 SRMC by year



# Luzon cumulative net revenue for 2013, generator with $P_W$ PhP 5,000 SRMC, with/without adjusted offer cap



## Discussion and recommendations

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- Based on our review of market principles, practices in other jurisdictions, and WESM outcomes, we set out our recommendations regarding:
  - Suggested methodologies for the determination of the levels of the WESM offer and market price cap and floor for energy and the secondary energy market price cap, and
  - Suggested processes to implement and update the levels of the WESM offer and market price cap and floor for energy and the secondary energy market price cap.

## A reminder of what we were tasked with

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	Market cap	Offer cap	Secondary market cap	Market floor	Offer floor
Energy	Yes	Yes	Yes	Yes	Yes

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## Review of practices in other jurisdictions

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- Electricity markets tend to fall into two categories:
  - Energy-only and
  - Energy plus a capacity market mechanism
    - ❖ Typically capacity markets limit the generators ability to offer much above marginal costs as their capacity payments cover their fixed costs
- We have reviewed many of the markets in order to both discern the energy and operating reserve offer caps and floors and the rationale for setting these levels

# Review of practices in other jurisdictions (Draft)



Market	Max Energy Price Cap	Max Energy Offer Cap	Min. Energy Offer Floor	Max. OR Offer Cap	Min. OR Offer Floor	OR Demand Curve
IESO <sup>14</sup>	\$2000	\$2000	-\$2000	\$2000	\$0	Y
NY ISO <sup>24</sup>	-	\$1000	-\$1000	\$1000		Y
ERCOT <sup>34</sup>	-	\$9000	-\$250	\$9000	-\$250	Y
AESO <sup>4</sup>	\$1000	\$999.99	\$0	N/A	N/A	N
Australia	\$13,100	-	\$-1000			N
Cal ISO <sup>4</sup>	-	\$1000	-\$150	\$250	\$0	Y
ISO NE <sup>4</sup>	-	\$1000	-\$150			N?
MISO <sup>4</sup>	\$3500	\$1000	-\$500	\$100		Y
Singapore <sup>5</sup>	\$5000	\$4500	-\$4500	\$4250	\$0	
SPP <sup>64</sup>	-	\$1000	-\$500	\$100	-\$100	Y

## The cap: Demand-side approach: VoLL

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- In some electricity markets the energy offer cap is set at Value of Lost Load (VoLL). This is commonly called the demand-side approach.
  - Typically VoLL is set a very high value under the assumption that load places a high value on reliability
  - VoLL can be considered at the theoretical maximum price users are willing to pay to continue consuming
  - Markets like Australia, Singapore, and Texas to use the VoLL approach to setting the cap

## The cap: Supply-side approach

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- In other energy-only markets the price cap is set at a lower level on the expectation that the pricing-up of power will result in energy not being offered to the market at short-run marginal cost in at least some hours. This is called the supply-side approach.
  - While fixed cost revenues must be recovered for a viable market this changes the nature of the revenue available for generators to earn
  - An energy offer cap is based on the understanding that market prices will be impacted by pricing up
  - Revenues will be high enough to provide capacity for reliability
  - Alberta is an example of this approach

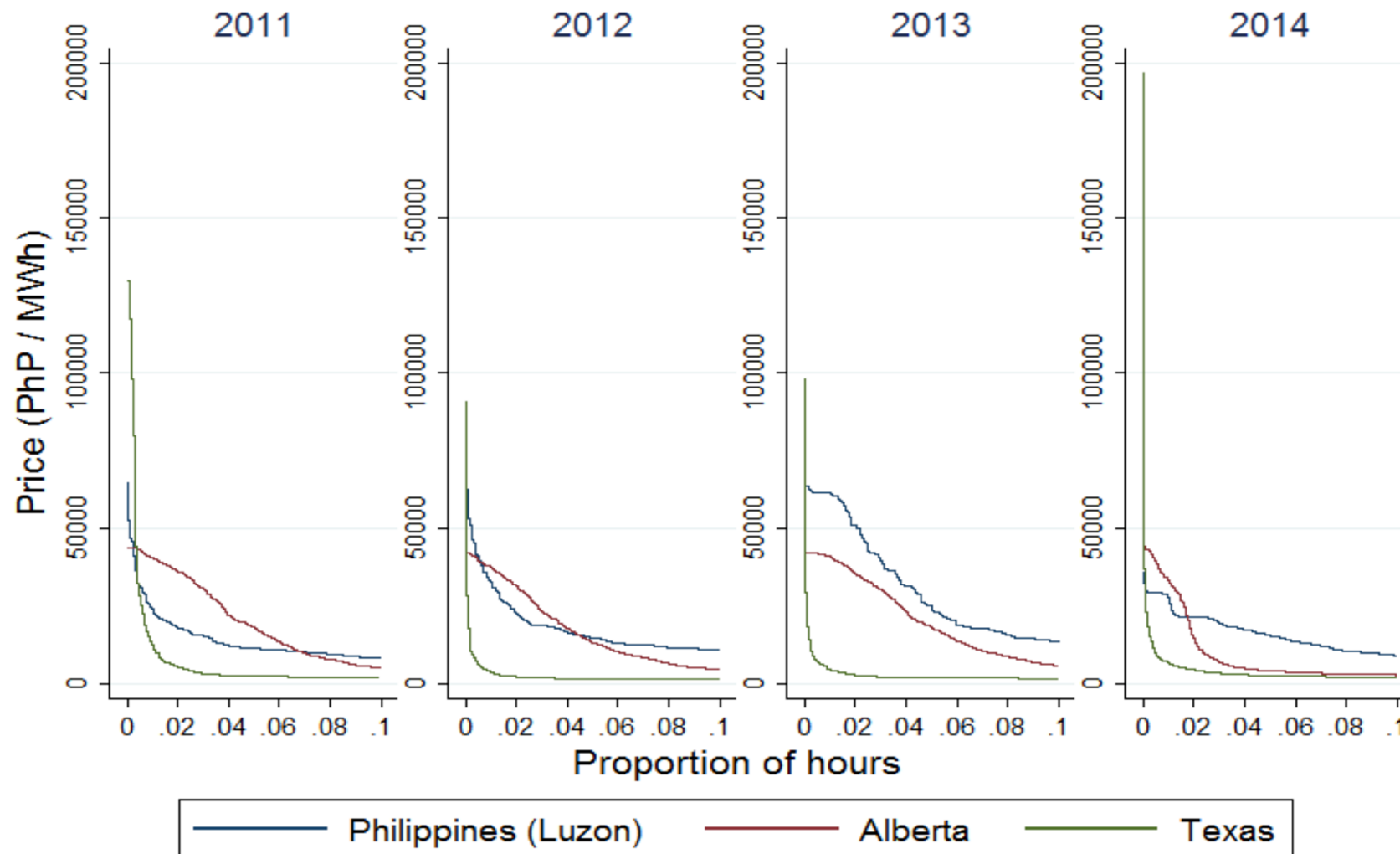


## VoLL versus supply-side approach

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- The offer and price caps must be sufficiently high to attract investment (and achieve efficient dispatch with the hour)
- The issue is not as much about the magnitude of the cap as it is about the revenue available for generators to earn
- We have examined the WESM in comparison to two other markets, the ERCOT which takes the VoLL approach and mitigates away much of the ability to exercise market power and the Alberta approach in which the cap is set based on the expectation of generators at times will price-up
- From our observations the WESM more closely approximates the Alberta market than the ERCOT market.
- We have reviewed all the submissions provided to the ERC and DOE in June of 2014 and met with several of the participants in July of this year to discuss the market and the study that we were undertaking
- We believe that policy must be based on the market that exists, not the market that theoretically could exist.

# Luzon, Alberta, and Texas price-duration curves



## Energy offer cap recommendation

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- **We recommend that the energy offer price cap in the WESM be determined in accordance with the supply-side approach**
- **We recommend that the energy offer price cap remain at 32,000 PhP and we provide a methodology for its review**
- Specifically, we recommend that the energy offer price cap be set at the price level that would be required by the highest short-run marginal cost generator likely to be need in the near-future
- We reviewed two possible peaking generation types, presently it is an oil-fired unit but in the future will likely be natural gas-fired
- Capital, finance and fuel costs are assumed to be taken as given
- The key electricity parameter is the fraction of time that such a generator would operate and in turn receive revenue
- The secondary market price cap is very influential and will be discussed later

## Illustrative example (draft parameter values)

Variable	Unit	NG	Oil
<b>Fuel cost</b>	PhP / MWh	5,000	13,600
<b>Variable O&amp;M</b>	PhP / MWh	320	320
<b>Annual fixed O&amp;M</b>	PhP / year	150,000	150,000
<b>Capital cost</b>	PhP / MW	70,000,000	22,000,000
<b>Lifespan</b>	Years	25	10
<b>WACC</b>	%	12	15

WACC = Weighted Average Cost of Capital

Variable	Unit	NG	Oil
<b>ANRR</b>	PhP / year	9,074,998	3,912,375
<b>SRMC</b>	PhP / MWh	5,320	13,920

ANRR = Annual Net Revenue Requirement is the yearly revenue in excess of variable cost a generator requires to cover its fixed cost

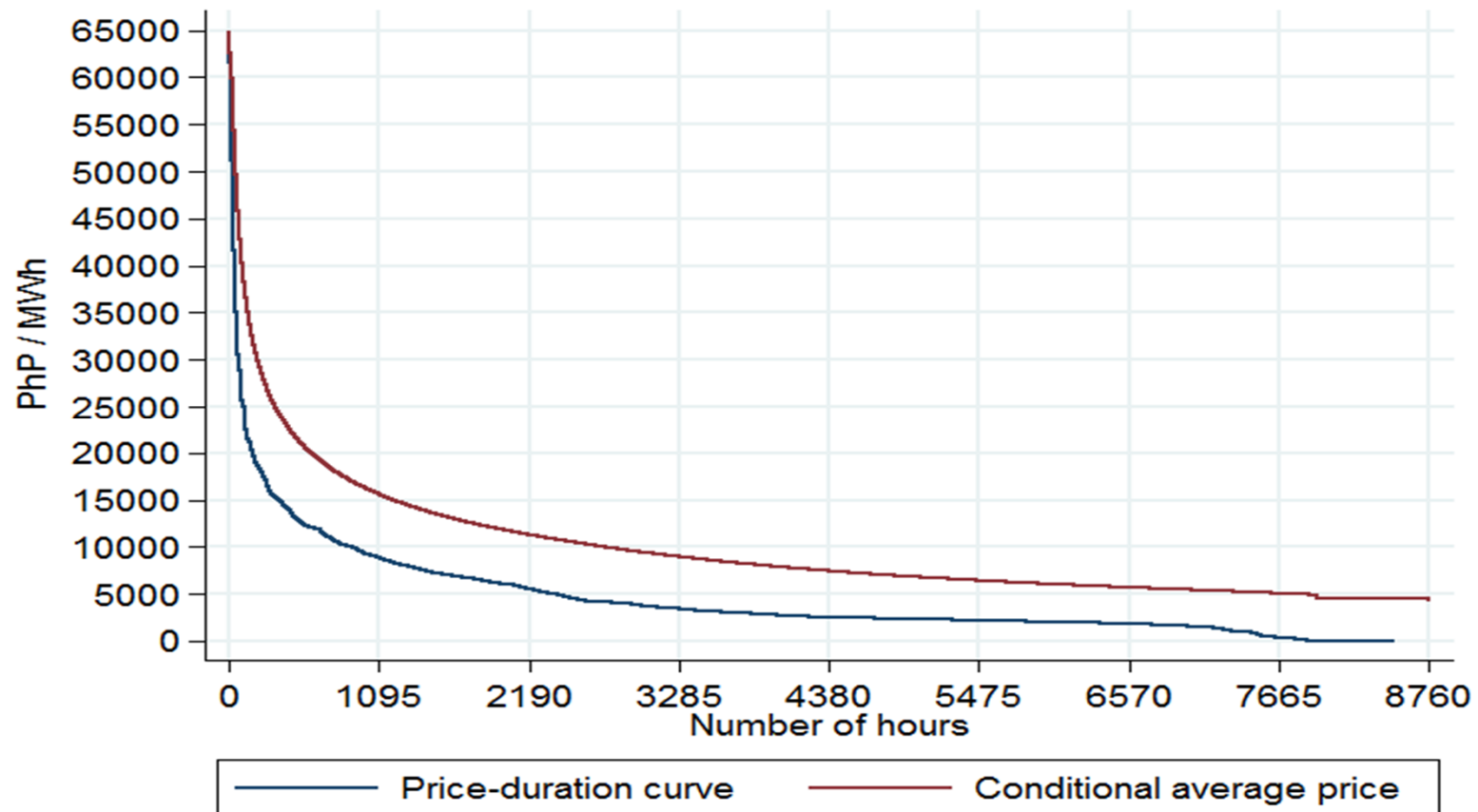


## Energy offer cap methodology

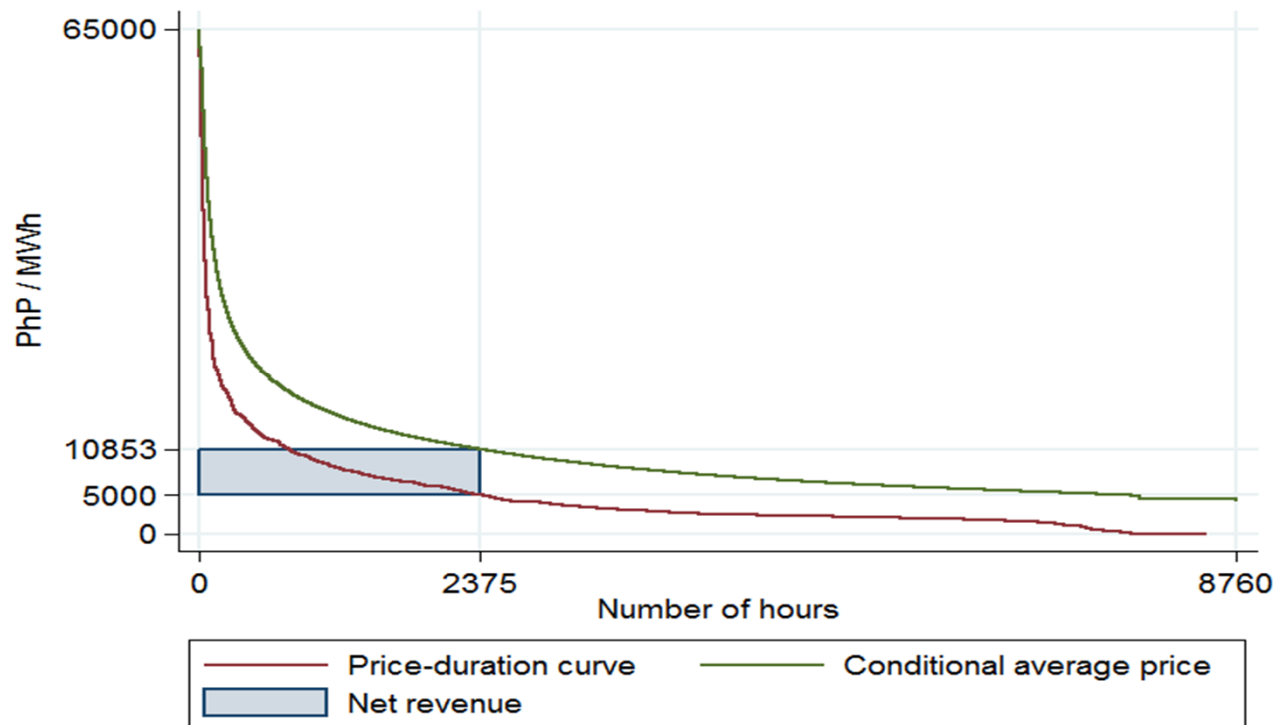
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- We do not believe it is appropriate in a market such as the WESM to form expectations about forward-looking market prices based on cost assumptions alone
- Instead, we use the information provided by the historical distribution of market prices in Luzon, over 72,000 hours of information
- We create a price duration curve (see next slide) of Luzon prices from June 26, 2006 through June 25, 2015
- We also determine the conditional average price
- While the price-duration curve illustrates the number of hours during which price is above a given level, the conditional average price curve identifies the average price during these hours
- We then can create a curve of net revenue by SRMC
- This can be compared to the previously calculated ANRR to determine if the cap provides sufficient revenue

# Price-duration and conditional average price curves

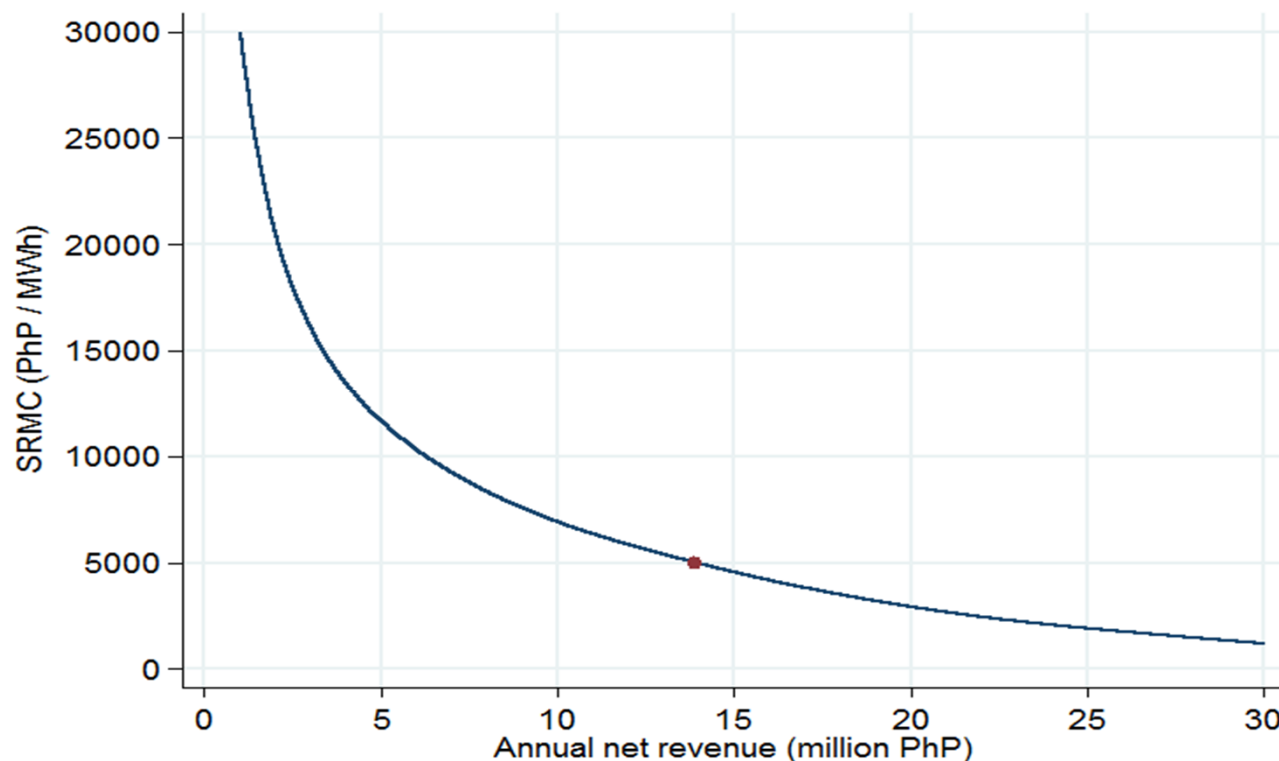


# Price-duration and conditional average price curves



- Consider a generator with  $SRMC = \text{PhP } 5,000$ ; offers as such
- There are 2,375 hours where the price is at least  $\text{PhP } 5,000$
- The conditional average of all of these hours is  $\text{PhP } 10,853$
- Net revenue is the  $(\text{conditional average price} - SRMC) * \text{hours utilized} = (10,853 - 5,000) * 2,375 = \text{PhP } 13,900,875$

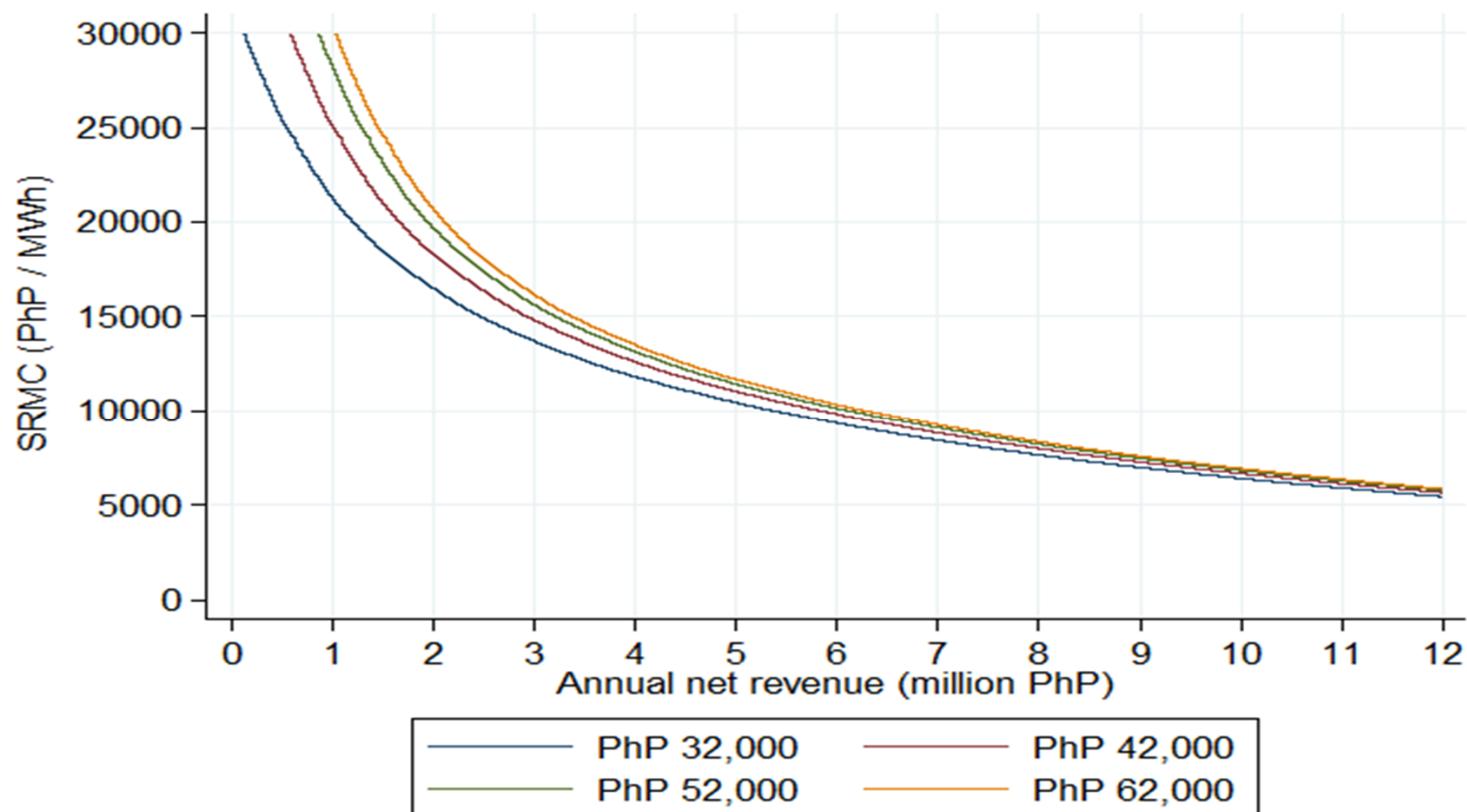
# Annual net revenue by SRMC



- It is straightforward from the curve above to calculate annual net revenue for any SRMC
- The red dot corresponds to a SRMC = PhP 5,000 generator's annual net revenue



# Net revenue for various offer price caps



➤ We then determined net revenue from various possible offer caps

# Energy market price cap recommendation

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- **We recommend that there not be a specific energy market price cap in the WESM**
- The energy market price cap is effectively limited by the presence of an energy offer price cap
- Due to the treatment of losses, congestion, and in the future the co-optimisation of energy and reserves it is possible at times for the market price to exceed the highest dispatched offer
- But as a market mitigating measure capping the energy offer effectively limits the energy market cap
- Capping both provides no material advantage
- This is a common feature of the markets reviewed



# Energy offer floor recommendation

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- The costs associated with output changes are significant
- Shut-downs and start-ups can be hard on equipment and can increase maintenance costs in the long-run if done frequently
- A large portion of the start-up cost can be due to increased wear and tear on the equipment
- Start-up costs vary widely by generating technology, some types of generators are designed for more frequent starts and stops such as gas combustion turbines
- Thus a generator with a high start-up cost may decide not to shutdown during low price periods if the cost of starting overwhelms the financial loss from producing below cost
- Once shut-down a generator can take several hours to re-start potentially missing revenue opportunities
- Generators that have pre-sold their output through contracts have little incentive to shut-down, other than buying back at a lower marginal cost and saving fuel



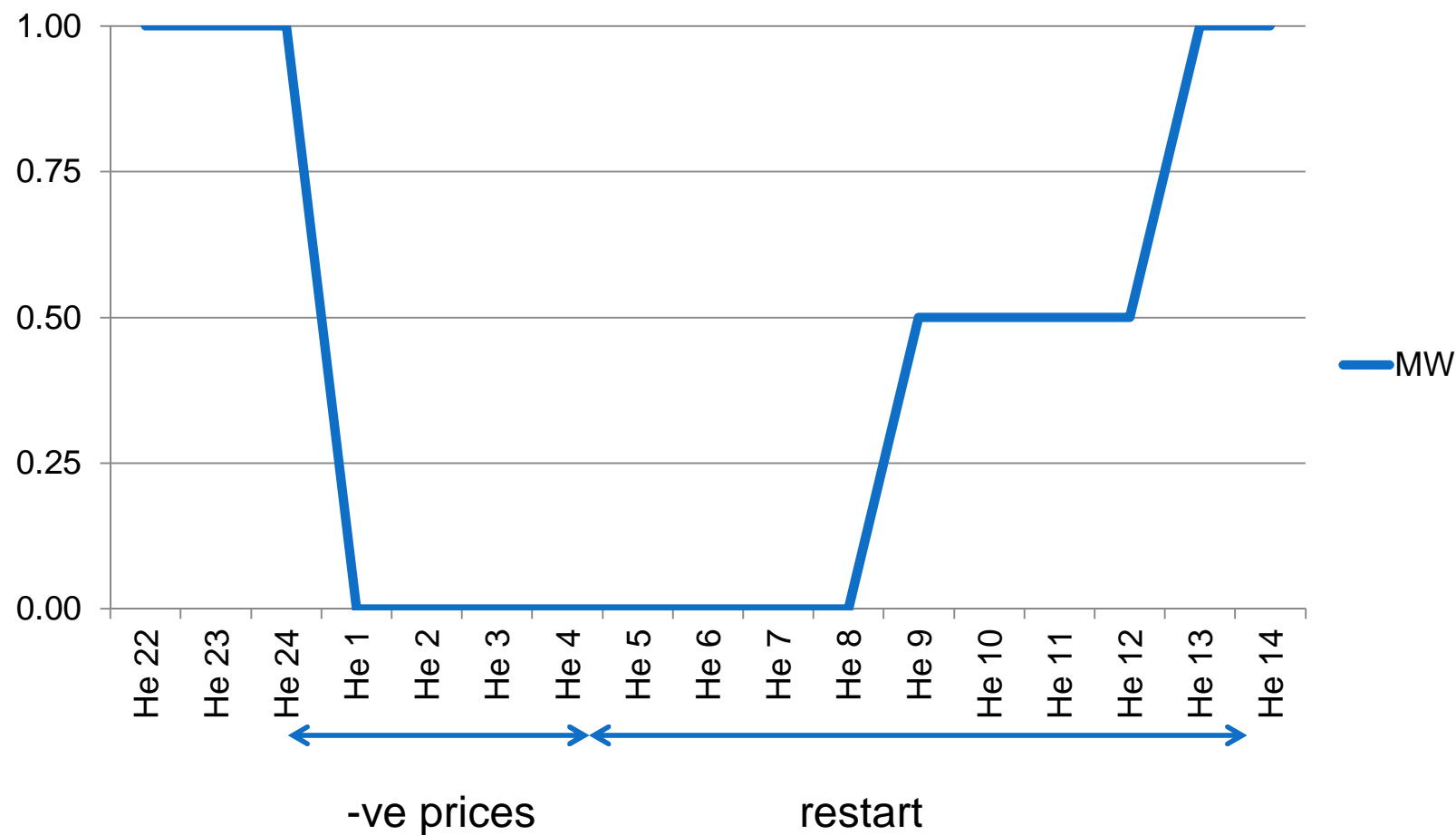
## Energy offer floor recommendation

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- **We recommend, based on practices in other jurisdictions and our analysis, establishing an offer price floor at –PhP 10,000**
- **Note: We provide no Guidance on Must Offer, Must Run, this is simply about deciding on a floor price for energy.**
- At present there is no formal lower floor so the floor is the lowest number the tool can consider, which is –PhP 99,999.99; prices settle negatively on average less than 1% of time
- For most commodities, producers have a positive marginal cost that can be avoided if production is avoided
- At times generators may be willing to sell at negative prices in order to obtain profit in other hours
- The floor price must be low enough that generators can be signaled by the market to dispatch off. In other words, they are losing more money than they will profit by staying on line.

# Energy offer floor methodology

1 MW generator shuts down due to negative prices, then re-starts



## Energy offer floor methodology

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Generator should shutdown if the cost to operate > Profit lost

Shut-down cost = PhP 1,000 / MW

Start-up cost = PhP 3,000 / MW

Hours shut-down = 4

Hours to start = 4

Hours to full load = 4

Average hourly opportunity loss = PhP 4,000 / MW

Profit avoided = shut down + start-up

+ hours to start \* avg hourly opportunity loss

+ 50%\* hours to full load \* avg hourly opportunity loss

= 1000 + 3000 + 4 \* 4000 + 0.5 \* 4 \* 4000

= PhP 28,000



## Energy offer floor methodology

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- Cost to shut down and start up are estimated from experience in other jurisdictions
- Hours to shutdown and start up are estimated from experience in other jurisdictions
- Big guess is on the opportunity loss.
- Therefore if cost to operate > 28,000 PhP shut-down
- Round this to -10,000 PhP and generator should theoretically shutdown
- **Note: We provide no Guidance on Must Offer, Must Run, this is simply about deciding on a floor price for energy.**

# Energy market price floor recommendation

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- **We recommend that there not be a specific energy market price floor in the WESM**
- The energy market price floor is effectively limited by the presence of an energy offer price cap
- Due to the treatment of losses, congestion and co-optimisation of energy and reserves it is possible at times for the market price to exceed the highest dispatched offer
- But as a market mitigating measure limiting the energy offer effectively limits the energy market floor
- Limiting both provides no material advantage
- This is a common feature of the markets reviewed





## Secondary market price cap for energy

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- The secondary energy market price cap is intended to protect consumers from market prices being “too high for too long” to be considered fair market outcomes
- Texas and Australia (NEM) have some kind of secondary cap
  - In Texas it is triggered when a peaking generator is determined to have received sufficient annual revenue to support investment
  - In NEM its function is somewhat similar to WESM
- We understand the need for market outcomes to be fair to consumers, or the market will not sustain itself; however, we believe the apparent need for the policy indicates the existence of a problem elsewhere in the market
- The secondary market price cap was emplaced as an immediate protection for consumers
- Over the longer term it may have a negative effect if generators cannot fully recover their costs as investment will be impeded



## Secondary market price cap for energy

Hours in which the secondary price cap bound

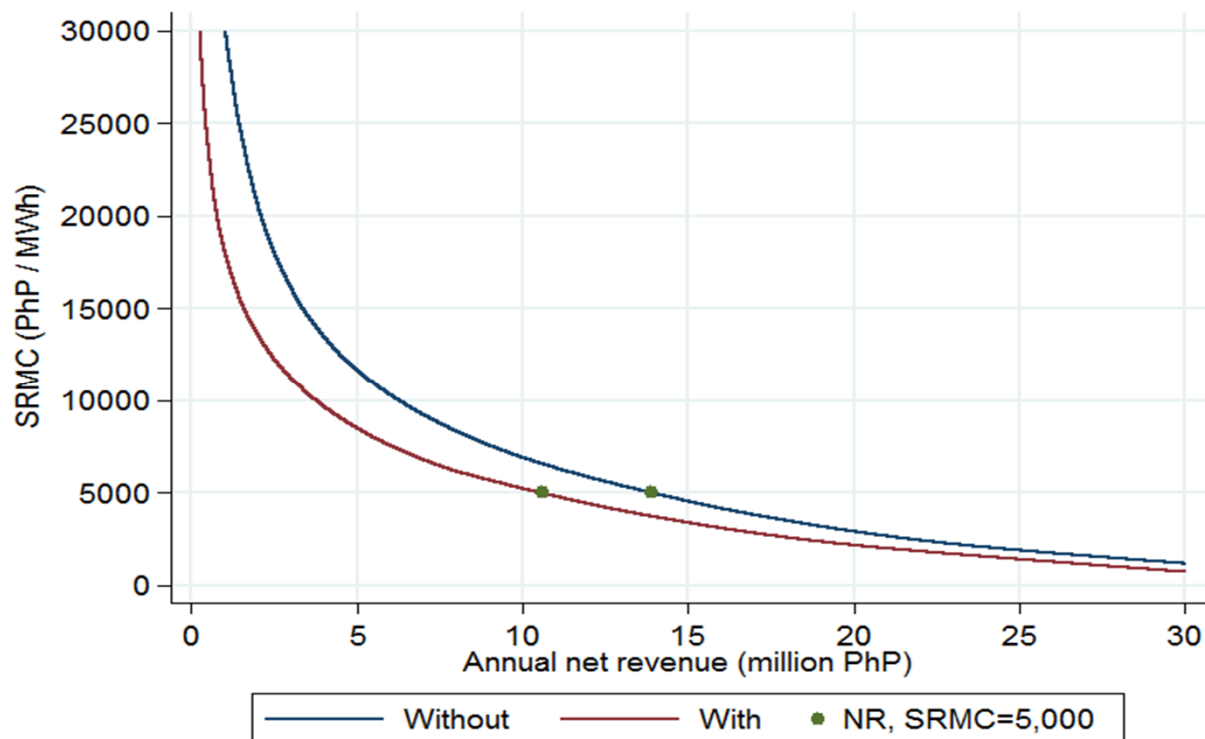
Year	Luzon	Visayas
2006	378	-
2007	60	-
2008	157	-
2009	0	-
2010	1,217	-
2011	100	106
2012	467	486
2013	977	0
2014	574	187

Annual observed and alternative prices in Luzon

Year	Observed	Alternative	Reduction
2006	4,550	4,298	5.5%
2007	4,224	4,212	0.3%
2008	3,007	2,955	1.7%
2009	1,697	1,697	0.0%
2010	6,577	5,783	12.1%
2011	3,921	3,878	1.1%
2012	5,004	4,799	4.1%
2013	5,952	4,138	30.5%
2014	4,611	4,227	8.3%

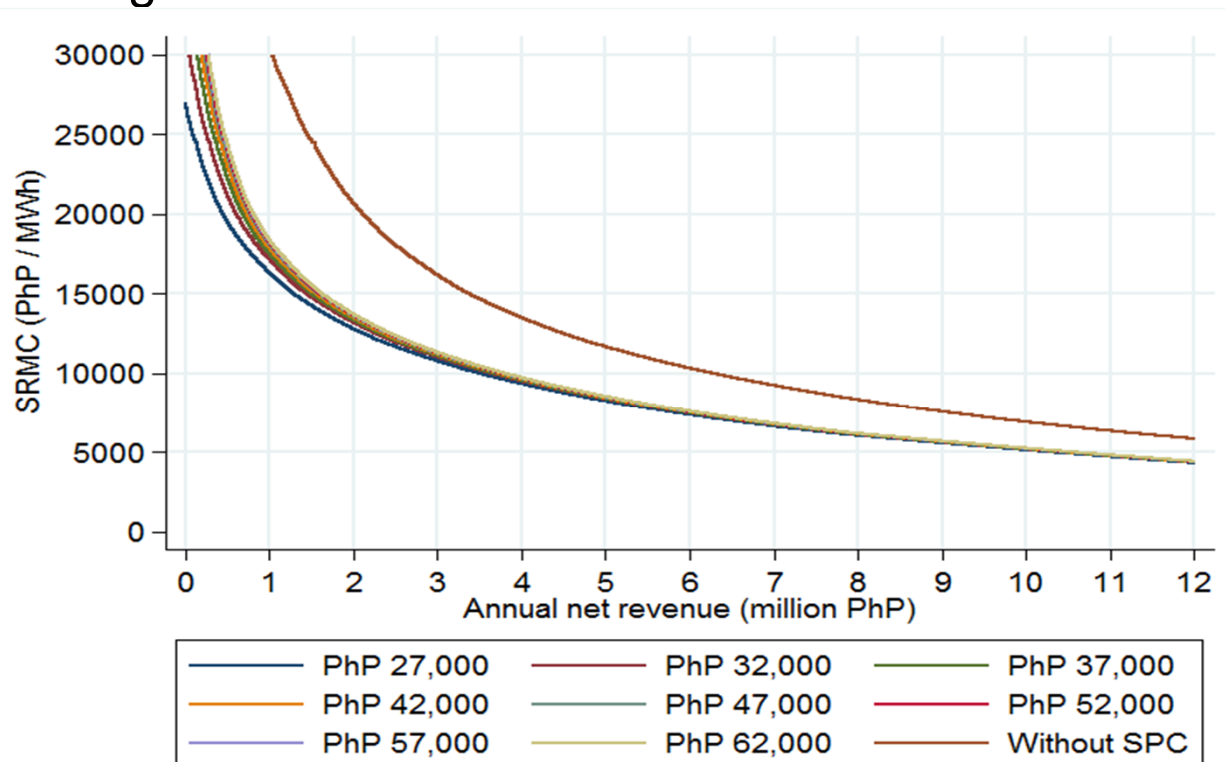
## Secondary market price cap for energy

- Using the same methodology for the market offer cap we then imposed the secondary price cap on the analysis
- For a generator with a SRMC of PhP 5,000, imposition of the secondary market price cap reduced net revenue from PhP 13.9 million to PhP 10.6 million



## Secondary market price cap for energy

- We then imposed different levels of price caps with the secondary price cap in play
- A simple cycle gas generator can obtain its ANRR with an offer cap as low as PhP 27,000; many pool prices would be PhP 27,000
- An oil-fired generator could never make its ANRR





## Secondary price cap recommendations

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- **We recommend the secondary price cap remain in place until the issues leading to its creation are resolved**
- **We recommend the WESM Tripartite Committee undertake a thorough analysis of possible solutions**

## Process for review

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- Principled, consistent market development supports investor interest
- Both the (i) methodologies that have been recommended and (ii) the levels of the nine specific caps and floors discussed above must be reassessed from time-to-time to ensure they continue to:
  - Adequately serve the mitigating purpose originally intended for them (and indeed to ensure that purpose remains) and
  - Are not undermining incentives for the efficient operation of and investment in the WESM
- The process for review may be considered as important as the levels themselves because of the potential impacts it could have on participants forward thinking

## Process for review, continued

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- **We recommend that the *methodology* used to set the levels of the various caps and floors be reviewed infrequently:**
  - Every five years (or so) or
  - When an important structural element of the incentives relevant to the WESM changes.
- For example, ERC contracts being changed to financial in nature may remove the need for the secondary price cap

## Process for review, continued

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- **We recommend that *level* of the various caps and floors be reconsidered periodically**
  - Such as annually or more frequently should one of the variables used in the methodology change materially, using the recommended methodology
  - Allow various caps and floors to be flexible enough to accommodate change such as fuel cost or exchange rate risk
  
- **We recommend that consideration be given to committing to not shifting the various price caps and floors toward zero during the periodic assessments**





## Boundary conditions

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- We have taken the market as is and only considered the role of the offer cap and floor
- Our work have revealed a number of characteristics of the market (that we treat as fixed) where we believe useful change should be considered but where, were this change to occur, there would be an impact on the recommendations we have made

## Boundary conditions, continued

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- Physical contracts
  - Potentially the shape of the physical contracts
    - ❖ Appears to be flat contract
    - ❖ Can lead to withholding via outages
  - Settlement of physical contracts
    - ❖ DU behaviour
    - ❖ Generator behaviour
- Natural gas supply arrangements
  - Impacts offer behaviour
  - Optimal use of a scarce resource