Valuing Renewables as a Long-Term Price Hedge, Even in an Era of Low Natural Gas Prices

Mark Bolinger
Lawrence Berkeley National Laboratory

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Introduction

- Low natural gas and wholesale power prices make it harder for wind and other renewable power technologies to compete on price alone (despite recent improvements in their cost and performance)
- Renewables may increasingly need to rely on other attributes, such as their “portfolio” or “hedge” value, to help justify future deployment
- This work investigates whether wind power in particular can serve as a cost-effective hedge against rising natural gas prices, given the significant reduction in gas prices in recent years, coupled with expectations that gas prices will remain low for years to come
- It does so by comparing prices from a sizable sample of long-term wind power purchase agreements (PPAs) to a range of long-term natural gas price projections

Roadmap

I. Thoughts on LCOE, LACE…and PPA prices

II. Overview and Analysis of the LBNL Wind PPA Sample

III. Natural Gas Prices: Low By Historical Standards, But Difficult to Lock In Over Longer Terms

IV. Comparison of Wind PPA Prices to Natural Gas Price Projections

V. In Their Own Words: Wind Buyers on Wind's Long-Term Hedge Value

Thoughts on LCOE, LACE…and PPA Prices

Advantages of PPA prices (relative to LCOE, or perhaps even LACE):

- PPA prices are actual data points – not estimated/calculated (LCOE) or modeled (LACE)
- More reliable/verifiable than most inputs to LCOE equation, and also cut directly to the chase (if purpose of calculating LCOE is to proxy PPA price)
- They reflect current market conditions, including policy, incentives, cost, finance, demand, and competition – some of which are not easily captured by LCOE or LACE
- Can approximate LCOE (post-incentive) when PPA is long-term and market is competitive
- Can approximate LACE in states/regions where "value-based" (as opposed to "cost plus") pricing occurs
- Can account for time-differentiated energy value through time-of-delivery pricing
- Price escalators not a problem – full-term PPA price streams can be levelized (like LCOE)

Disadvantages of PPA prices:

- Often proprietary or hard to piece together
- Pricing reflects current or near-term conditions – not really a forecasting tool
- Not as useful as LACE in estimating future value of energy

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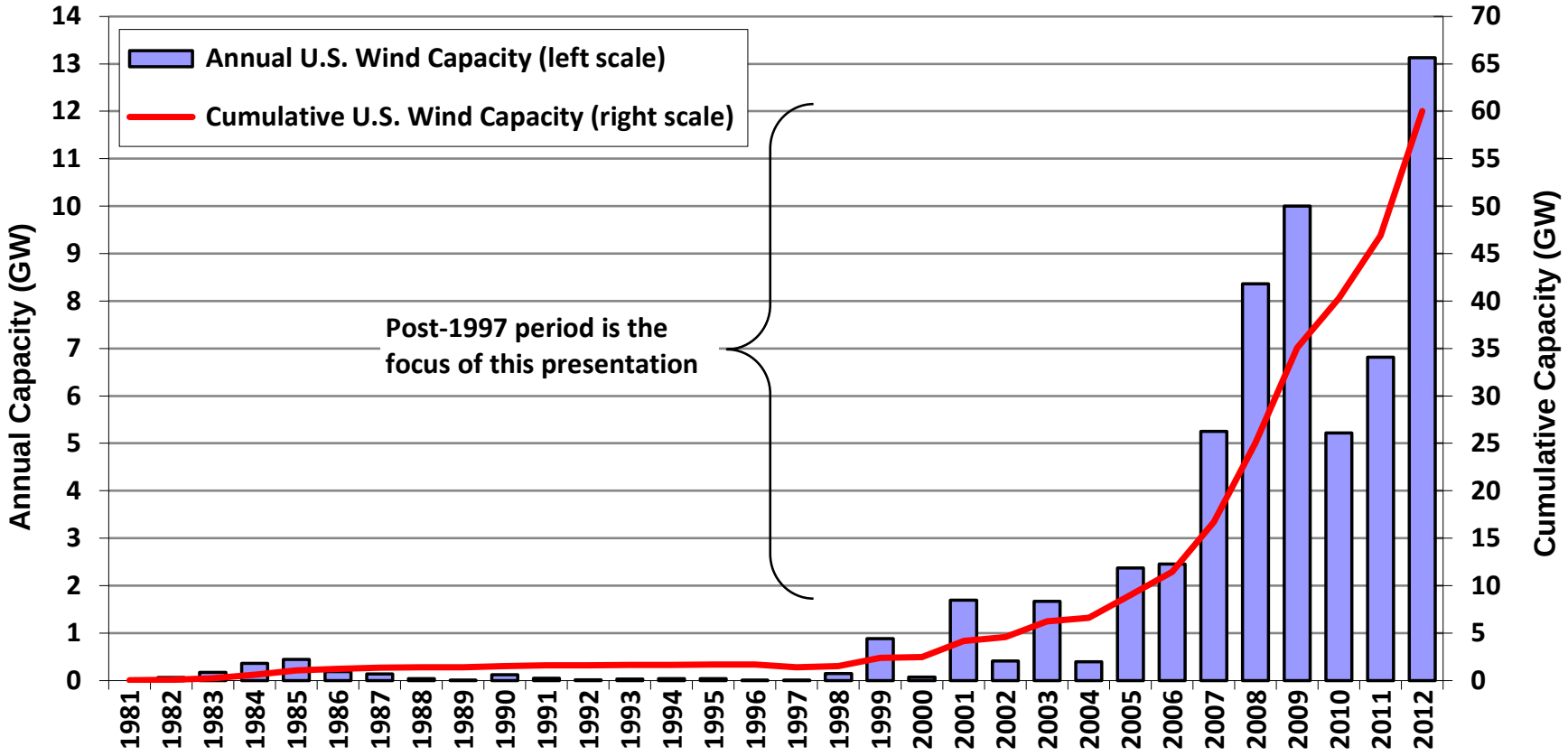
Wind PPA Sample is Drawn from Universe of Projects Built From 1998 Through 2012



- 60 GW of wind in the US, 98% of which have been built since 1997
- This study focuses on full-term (and levelized) PPA prices from a subset of projects built from 1998 through 2012

Certain Types of Wind Projects Are Ineligible for the PPA Sample

- **Merchant projects** (i.e., those that sell their power on the spot market, without a contract) are excluded, because their future revenue is unknowable by definition
- **Projects that sell RECs separately from energy** are generally excluded (unless the separate REC sale price is known) for the same reason
- **Projects built in Alaska, Hawaii, and Puerto Rico** are excluded, because challenging construction environments and isolated power markets can result in PPA prices that are anomalous
- **Utility-owned projects** are excluded because there is no sale of power on the wholesale market (no PPA)
- **Behind-the-meter projects** are excluded because there is generally no sale of power involved (no PPA)

LBNL Wind PPA Sample is Sizable: 71% of Total Possible Universe (in MW)

Possible Post-1997 Sample = 35,380 MW

+ 58,878 MW were built in the U.S. from 1998-2012 (98% of ***all*** US MW)
– 389 MW built in Alaska, Hawaii, and Puerto Rico (assumed outliers)
– 13,750 MW are merchant or semi-merchant (with no PPA)
– 9,085 MW are utility-owned (therefore no PPA)
– 274 MW are on-site (behind the meter, with no PPA)
= 35,380 MW possible sample of PPAs from 1998-2012

Actual LBNL Sample = 25,115 MW (306 contracts)

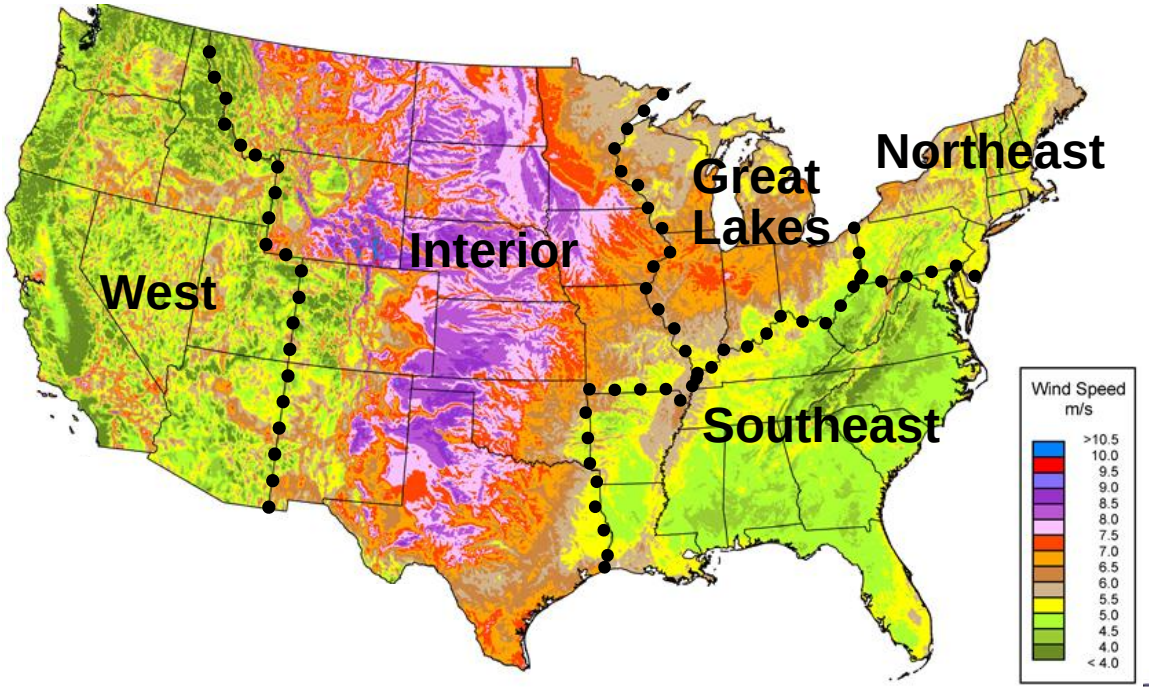
Missing from Sample = 10,265 MW (35,380 – 25,115)

- Texas projects heavily under-represented (ERCOT not subject to FERC reporting requirements)
- Sample will grow as more information about existing projects comes to light (and as new projects come online)

Wind PPA Sample is Broadly Representative

Region	Possible PPA Universe (MW)	LBNL PPA Sample (MW)	Sample Representation (%)
West	8,973	6,835	76%
Interior	20,404	14,802	73%
Great Lakes	4,308	2,356	55%
Southeast	369	268	73%
Northeast	1,326	855	64%
Total U.S.	**35,380**	**25,115**	**71%**

- 71% representation nationwide
- Three regions >70%
- Other two at 64% (Northeast) and 55% (Great Lakes)



PPAs in Sample are Stable-Priced and Long-Term

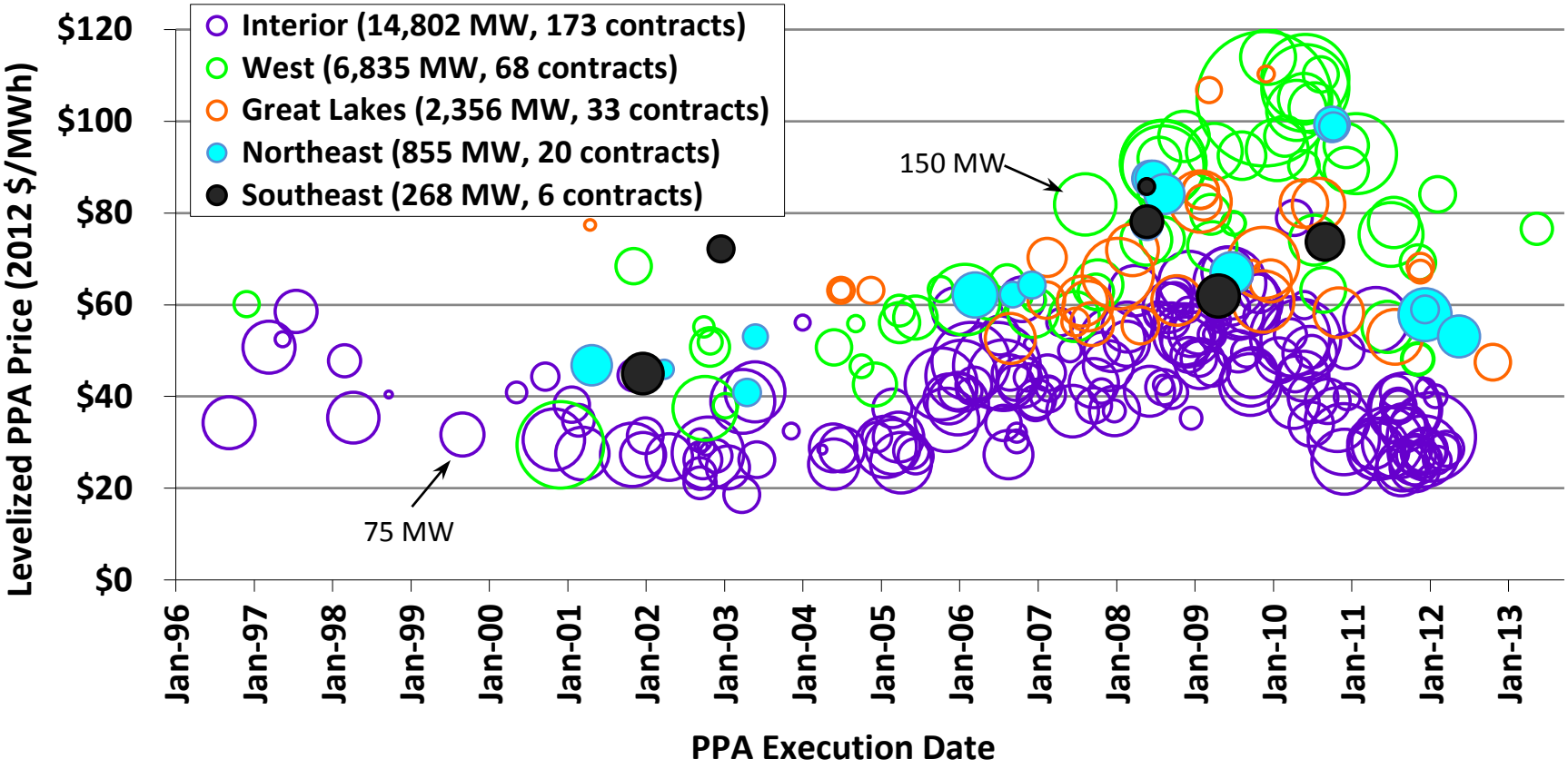
Contract Price Characteristics*			Sample Characteristics	
Annual	Seasonal	Diurnal	# MW	% MW
Flat	Flat	Flat	11,952	48%
Flat	Flat	Variable	1,636	7%
Flat	Variable	Flat	75	0%
Flat	Variable	Variable	1,017	4%
Escalates	Flat	Flat	8,083	32%
Escalates	Flat	Variable	122	0%
Escalates	Variable	Flat	423	2%
Escalates	Variable	Variable	923	4%
De-Escalates	Flat	Flat	211	1%
Mix	Flat	Flat	673	3%
			Total: 25,115	**100%**

**in nominal dollar terms*

- 59% (of MW in the sample) feature flat annual pricing (48% are *totally* flat)
- Another 38% escalate annually, but at a pre-defined rate (often pegged to inflation)

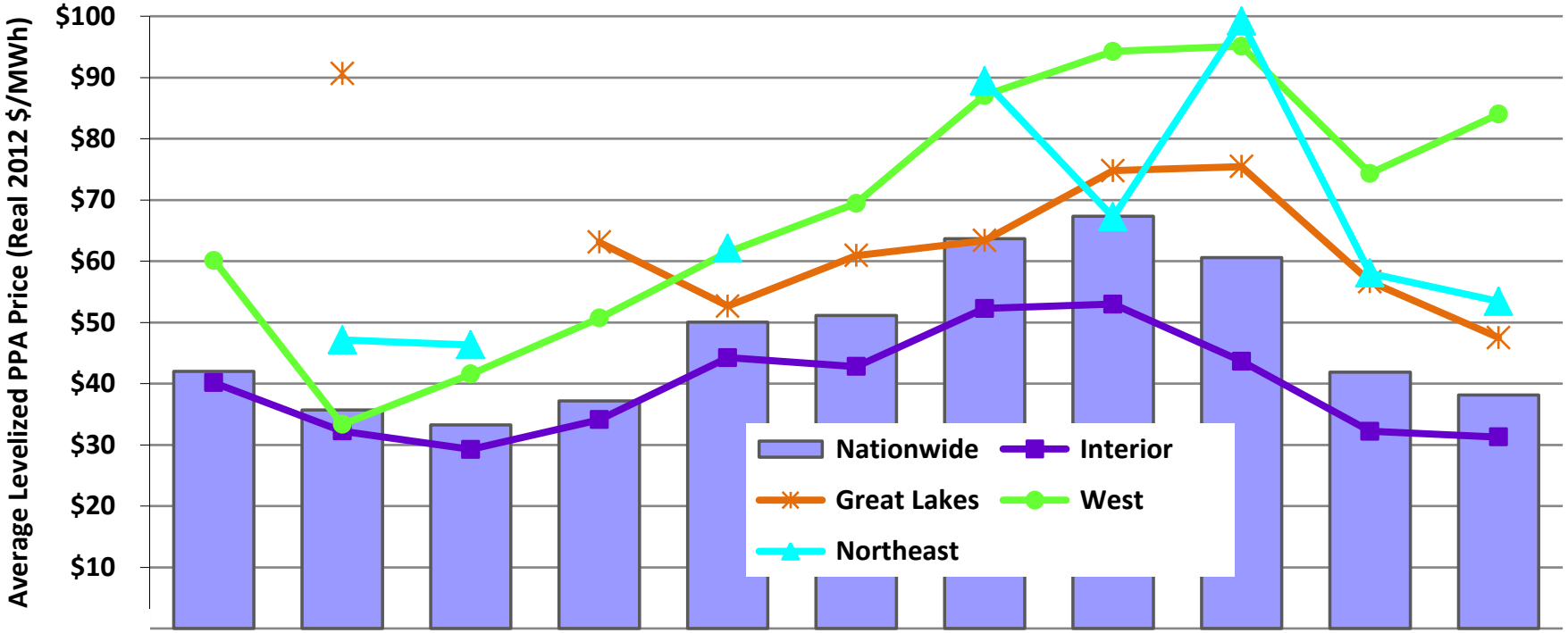
- 10% vary prices seasonally and 15% vary prices diurnally (8% vary prices both seasonally and diurnally)
  - Stands in stark contrast to utility-scale solar market, where 64% of LBNL solar PPA sample varies prices both seasonally and diurnally
  - Time-of-delivery pricing in CA benefits solar (over wind) by ~$25/MWh
- 20-year contracts are by far the most common (followed by 25-year): 85% of MW in sample have contract terms of 20 years or longer

Since 2009, Cost and Capacity Factor Improvements Have Enabled Lower PPA Pricing



- In general, the Interior is a low-priced region, the West is a high-priced region (value-based pricing?), and the others lie somewhere in between
- Recent levelized PPA prices rival lows set a decade ago

A Smoother Look at the Time Trend



PPA Year:	1996-99	2000-01	2002-03	2004-05	2006	2007	2008	2009	2010	2011	2012
Contracts:	10	17	24	30	30	26	39	47	40	34	8
MW:	553	1,249	1,382	2,190	2,311	1,781	3,465	3,982	3,999	3,533	630

Within each time period (based on PPA execution date), PPA price streams are first generation-weighted, and then the resulting generation-weighted average price stream is levelized over the composite contract period.

Time trend closely follows trends in turbine prices and installed project costs over the past decade: a significant increase from 2003 through 2009, followed by a sharp decrease since 2009

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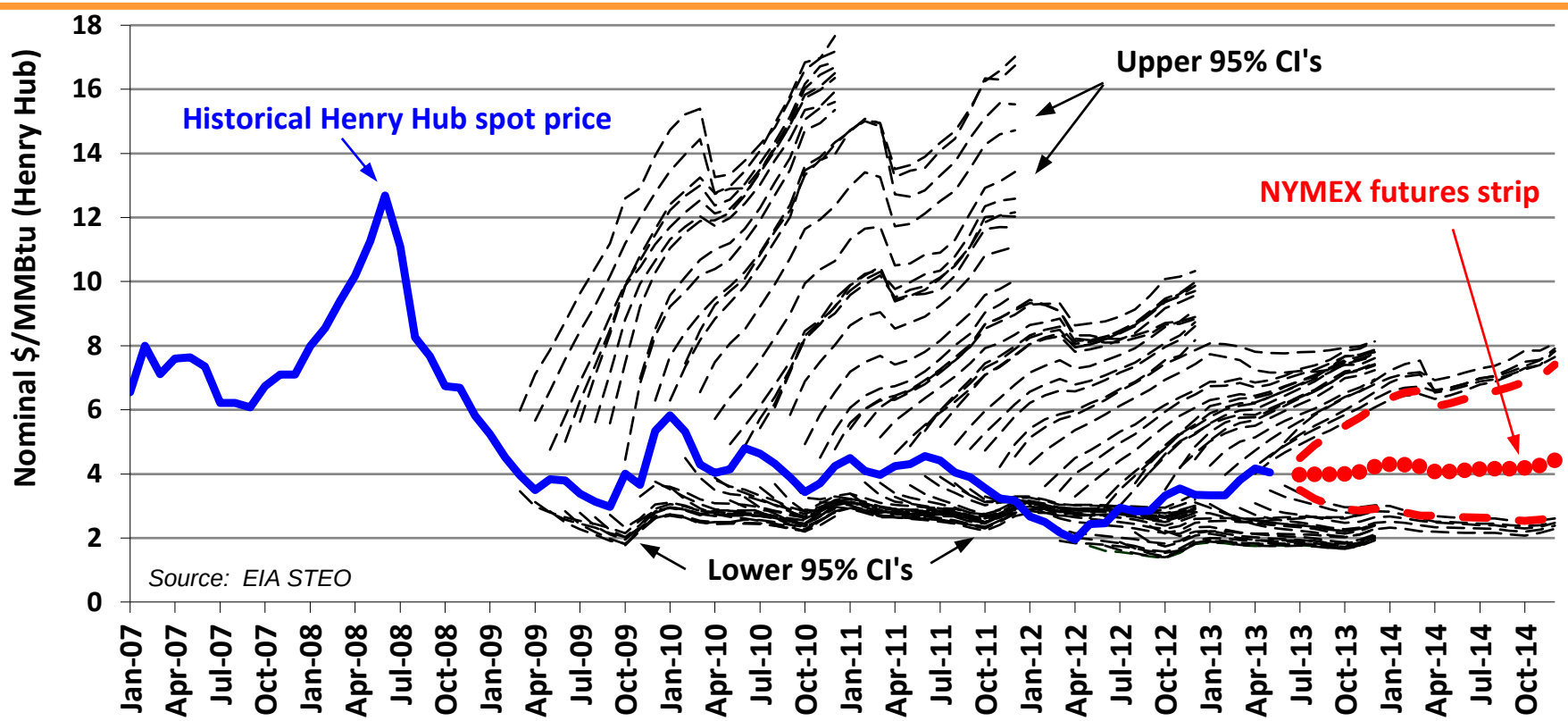
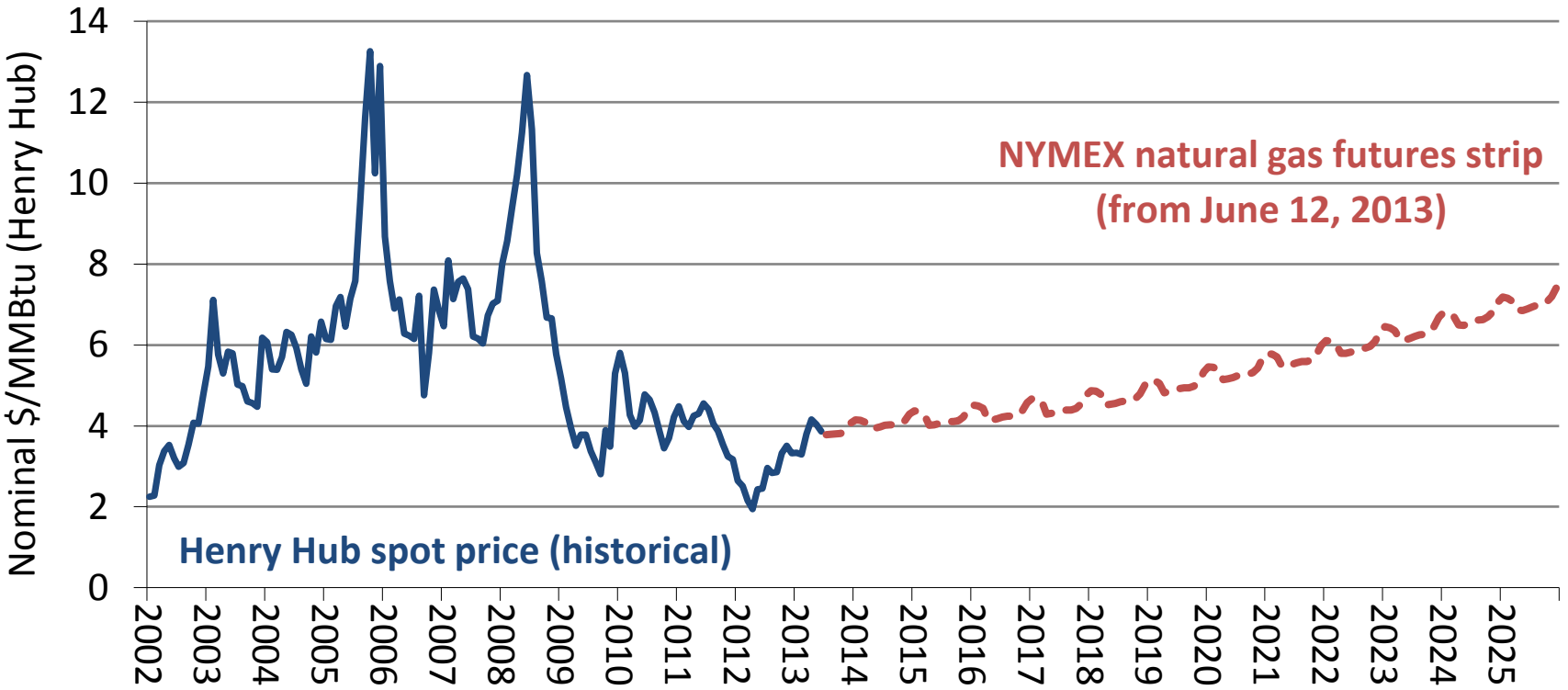
Gas Prices Cannot Go Much Lower: $0 Absolute Floor, $2 Effective Floor(?)



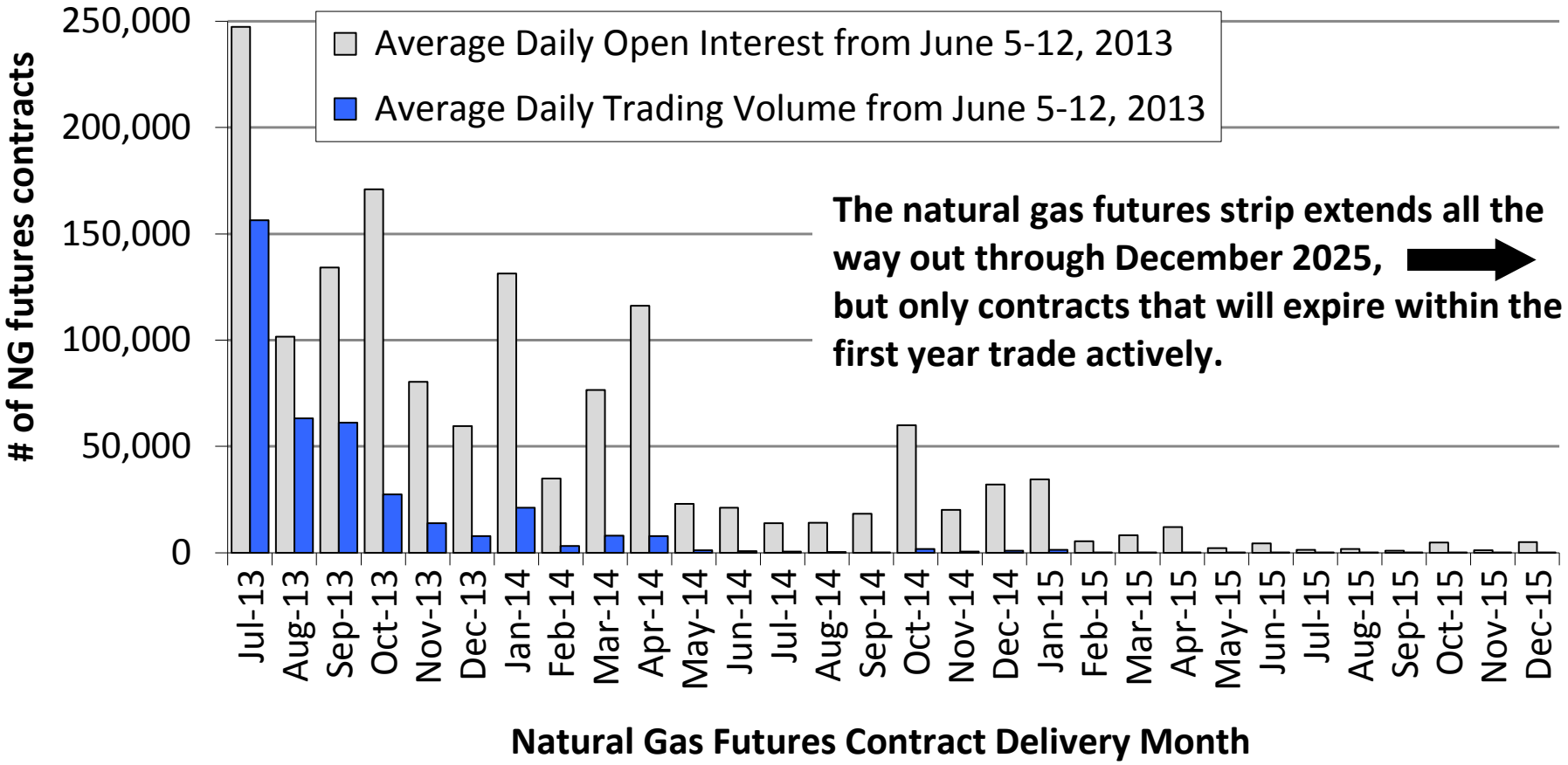
- Dashed lines represent 95% confidence intervals around the futures strip (as derived from the price of options on gas futures) at monthly intervals
- ***Risk is skewed towards higher prices*** (though the *degree* of skew has shrunk)

But It's Hard To Lock In Today's Low Prices, Because the Futures Curve is Upward Sloped…



- Because the futures strip is upwards sloping (implying higher expected spot prices in the future), it is difficult to lock in today's low spot gas prices
- One could buy a series of "in the money" call options with strike prices below the futures strip, but the "intrinsic value" embedded in the options premium will negate the lower strike price, leaving you no better off than the futures strip

…And The Futures Market Is Illiquid After Just A Few Years



Trying to lock in any serious amount of volume via the futures strip may be problematic out beyond a year or two.

Physical Gas Supply Deals Are Possible, But…

1) **Are not very liquid and impose significant counterparty risk (more so than with an exchange, where this risk is spread)**
2) **Generally do not exceed 10 years**
3) **Provide similar pricing to the futures strip (upward slope)**

Example: In Dec. 2010, the CO PUC approved a 10-yr, fixed-price (with escalation) physical gas contract between PSCo and Anadarko

- Afterwards, PSCo said: "The limitations on these types of long-term contracts include negotiating the ***additional collateral requirements triggered by the inherent increase in counter-party risk*** (created by fixing a gas price over an extended contract term) and by the market's appetite for these types of transactions being ***limited to generally a 10-year time horizon***." *[Page 3 of "Report of Public Service Company of Colorado Regarding Long-Term Gas Supply Options" filed December 29, 2011]*
- PSCo/Anadarko contract pricing largely mirrors the basis-adjusted NYMEX futures strip at that time

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Simplifying Assumption: Wind Offsets Only the Fuel Costs of Gas-Fired Generation

Considers wind a source of energy (a "fuel saver"), *not* capacity:

- Conservative approach that ignores wind's (limited) capacity value
- Seems to be how at least some utilities (e.g., PSCo) think of wind

To further simplify, comparison ignores other wind benefits…

- Ignores wind's criteria pollutant and carbon benefits (REC value)
- Ignores offset of gas-fired generation's *non-fuel* variable O&M costs

…but it also ignores wind integration and transmission costs

- Integration costs are generally low and area-specific – and may not even be readily quantifiable (a growing recognition among analysts)
- Transmission costs can be significant, but are project-specific and may not be borne by the wind buyer or seller, depending on cost allocation

Bottom Line: This is not intended to be a full-blown social analysis – the comparison is simply ***wind PPA prices vs. projected natural gas fuel costs***, in order to focus on hedge value

Net Impact of Simplifying Assumptions Could Be Largely a Wash

Subtract from wind PPA price (rough estimates from the literature):

- Wind's capacity value: $0-$15/MWh
- REC value: $5-$10/MWh
- Variable non-fuel O&M costs for gas-fired generation: $1-$3/MWh

Add to wind PPA price (rough estimates from the literature):

- Balancing cost: $2-$5/MWh
- Transmission cost: $10-$15/MWh

In total (based on rough estimates above):

- Subtract from wind PPA price: -$6/MWh to -$28/MWh
- Add to wind PPA price: +$12/MWh to +$20/MWh

NET RESULT: Simplifying assumptions largely net out – or at least the net impact does not seem to be large or uni-directional

Overview of Data Needed For Comparison

1. Wind PPA Prices

The most recent contracts – those executed in 2011 or 2012 – from the LBNL wind PPA sample described earlier

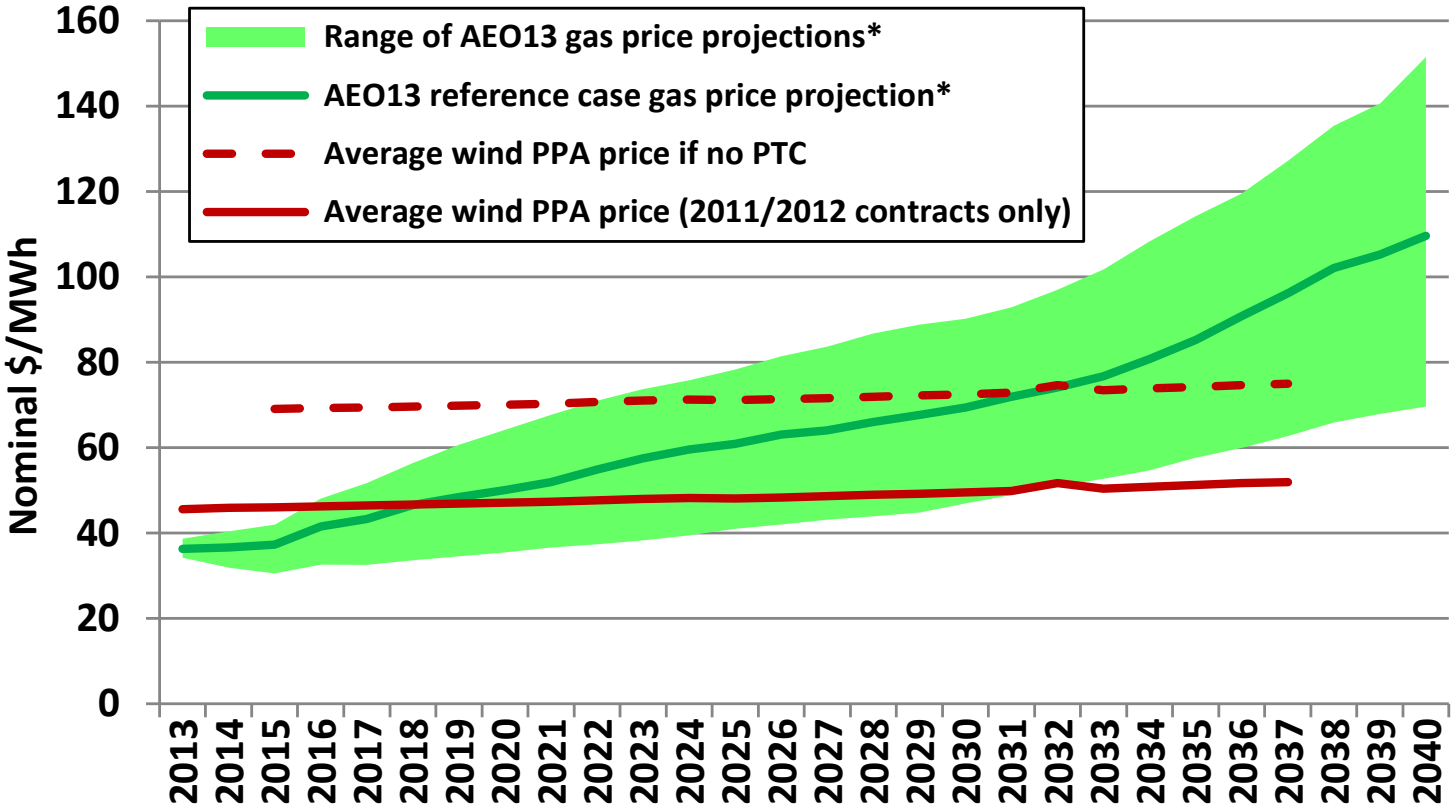
2. Projected Natural Gas Fuel Costs

A range of three different EIA projections of natural gas prices delivered to electricity generators:

- AEO 2013 reference case
- AEO 2013 high oil and gas resource case (=low end of price range)
- AEO 2013 low oil and gas resource case (=high end of price range)

Fuel cost projections are translated from $/MMBtu into $/MWh terms using average heat rates implied by the AEO 2013 modeling output

Most Recent PPAs in LBNL Sample Illustrate Wind's Long-Term Hedge Value



Wind PPA sample includes 42 PPAs signed in 2011 or 2012 and totaling 4,136 MW

**Fuel cost projections are translated from $/MMBtu into $/MWh terms using average heat rates implied in the AEO13 modeling output*

- Wind as a "fuel saver" is above market at present (on average), but penetrates the fuel cost range in 2016 and increasingly provides hedge value thereafter
- Without the PTC, wind as a "fuel saver" would be less compelling (even at today's low wind prices), but would still provide some long-term hedge value

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Wind Buyers In Their Own Words: PSCo on Wind's Long-Term Hedge Value

- "The wind generation is a source of fuel or energy, it's not a source of capacity…When we look at dispatching on the wind, or dispatching on gas, it doesn't matter. It's providing the energy. That's what this [Limon II wind contract] is really a play on, a play on energy."
- "Whenever wind energy is generated from the Limon II [wind] facility, it will displace fossil-fueled energy on the Public Service system, mostly energy generated from natural gas. We think of this wind contract as an alternative fuel, with known contract pricing over 25 years that will displace fuels where the pricing is not yet known. That is the essence of the fuel hedge."
- "We typically don't have a lot of long-term natural gas contracts…especially ones that go out 25 years. So this [the Limon II wind contract] is basically providing a long-term fuel contract or energy contract at known prices."

[Remarks of Kurtis Haeger (Managing Director of Wholesale Planning, PSCo) during Limon II proceeding before the Colorado Public Utilities Commission]

Wind Buyers In Their Own Words: Google on Wind's Long-Term Hedge Value

- "We see value in getting a long-term embedded hedge. We want to lock in the current electricity price for 20 years. We are making capital investment decisions [regarding data centers] on the order of 15 to 20 years. We would like to lock in our costs over the same period. Electricity is our number one operating expense after head count."
- "We are signing [conventional] contracts with three to five years of fixed pricing, but over the life of the data center, those will reset. We are short-term fixed and long-term floating, so it [wind] will not be a perfect hedge in the near term. We are less concerned about hedging our cash flows on a quarter by quarter basis. We are more concerned about the long term."
- "We are losing considerable amounts of money on every [wind] MWh [in the near term]. We just want to ensure the project is there in the later years."

[Remarks of Ken Davies (Google) as recorded in "Battle Over Power Contracts", Project Finance Newswire, November 2011, pp. 57-58]

Thank You!

The report on which this presentation is based can be downloaded at:
http://emp.lbl.gov/sites/all/files/lbnl-6103e.pdf

Mark Bolinger
Lawrence Berkeley National Laboratory
MABolinger@lbl.gov

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