

2012 BPA Rate Case Customer Workshop

AURORA
September 14, 2010



Introduction

- Purpose of this workshop
 - Introduce inputs being examined that could replace AURORA defaults for market price forecasting at BPA
- Note that the information provided is a set of working data. It points out some of the changes to AURORA default data that we are considering. The information contained is a work in progress and is subject to change for the Initial Proposal.



What is AURORA?

- AURORA is electricity market forecasting software that simulates WECC-wide dispatch (a production-cost model)
 - AURORA includes a default dataset that “out of the box” can produce a forecast
 - AURORA simulates the dispatch of every generator in WECC
 - AURORA includes a forecast of generators that will be built in WECC and dispatches those generators when they are operational within the timeframe of an AURORA study



Why We Change Default Data in AURORA

- We have always updated default data when appropriate, some of the reasons include:
 - AURORA has a biannual update to the default dataset. Some updates, such as natural gas price forecast, are done on a much more regular basis at BPA.
 - BPA monitors market information and uses it to inform AURORA inputs.
 - BPA has some information that has greater detail than the defaults, e.g. regional hydro generation from HydSim.
 - We implement risk modeling, i.e. varying inputs to test a range of possible future market prices. This allows us to forecast expectation of market prices and assign probabilities to market price levels.



Changes to AURORA Defaults

- Changes that were included in the market price risk modeling for WP-10 that may be included in BPA-12 with the underlying data having been updated:
 - HydSim 70 water year PNW regional hydro generation potential
 - Northwest and California Load variability
 - Natural gas price variability
- Other model changes that are being investigated:
 - Transmission variability
 - Wind variability
 - CGS variability
 - Modeling of the impact of AB 32 in California
 - RPS-based WECC-wide generation build forecast
- Changes to BC and California Hydro records are being researched



HydSim 70 Water Year PNW Regional Hydro Generation Potential

- AURORA uses a HydSim record that gives the total potential generation for the regional hydro system
 - Note: this does not translate directly to hydro generation output in AURORA, not all potential hydro energy is used
- The table on the right gives the averages of the potential record by month and for the whole record

	MW
Oct	11243
Nov	13619
Dec	15509
Jan	17472
Feb	16393
Mar	15214
1-Apr	16969
16-Apr	17251
May	20483
Jun	20155
Jul	16198
1-Aug	13498
16-Aug	12147
Sep	11527
Annual	15638

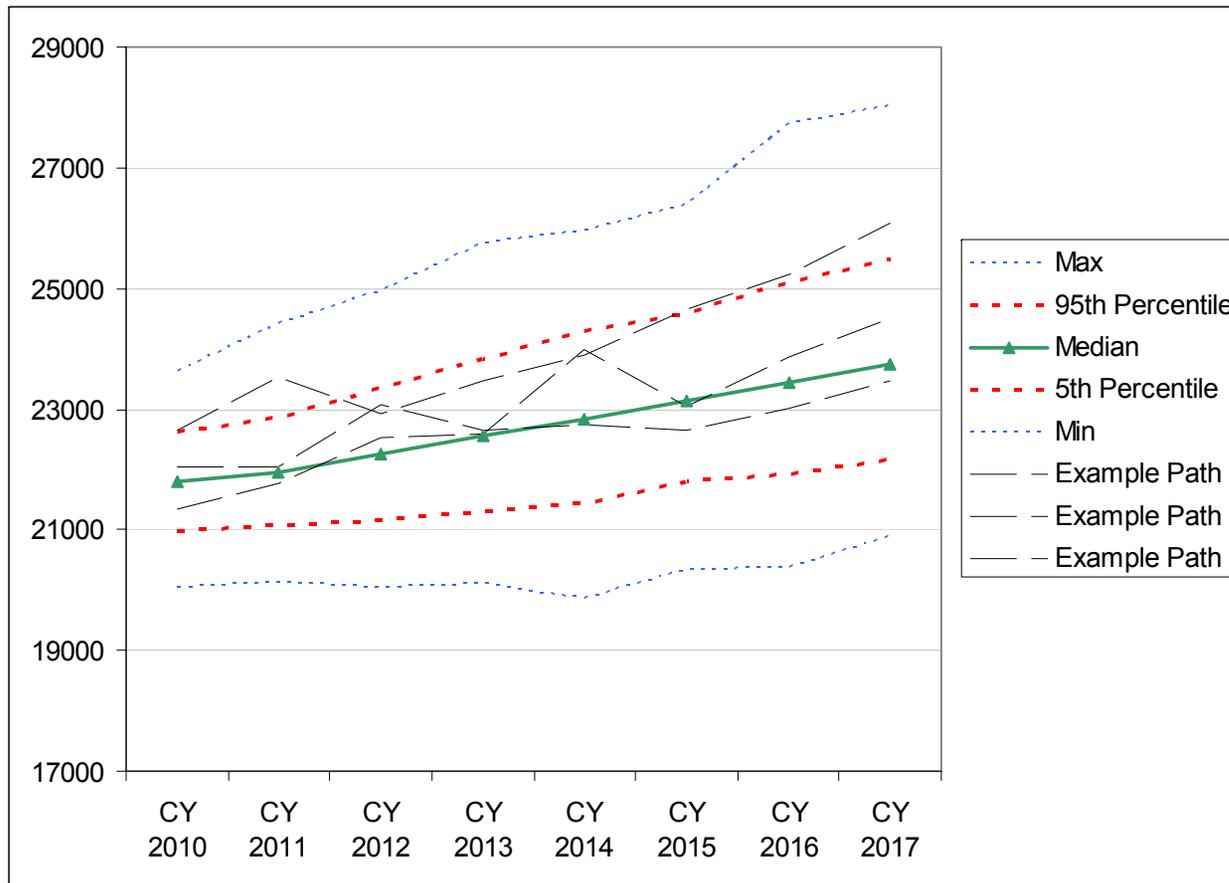


Load Variability

- AURORA uses a load forecast and a risk model as input
- Regional loads for the Northwest are based on AURORA defaults
- California loads are based on CEC data
- Risk models are used to capture variability of the loads in both the Northwest and California



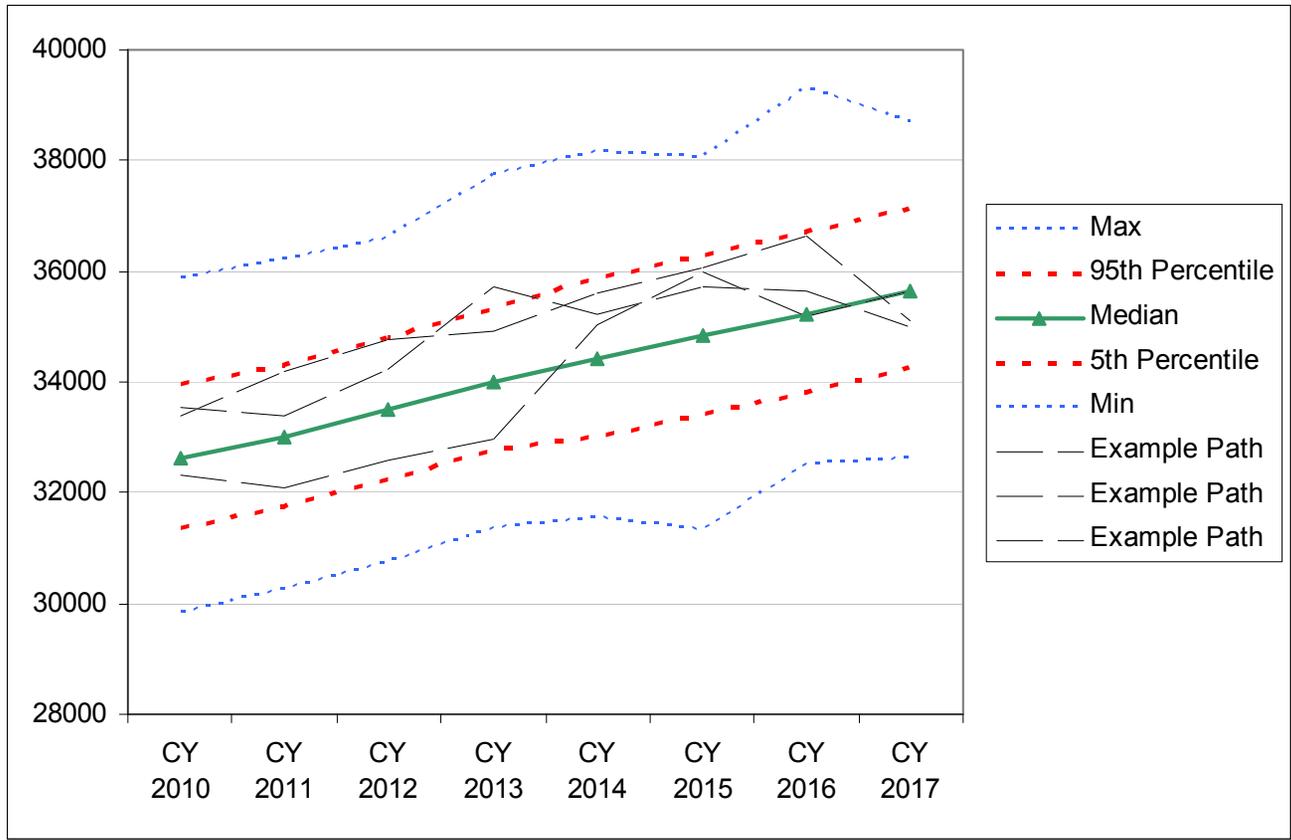
PNW Load Variability



Median Load	
2010	21786
2011	21957
2012	22260
2013	22556
2014	22839
2015	23141
2016	23437
2017	23746



California Load Variability



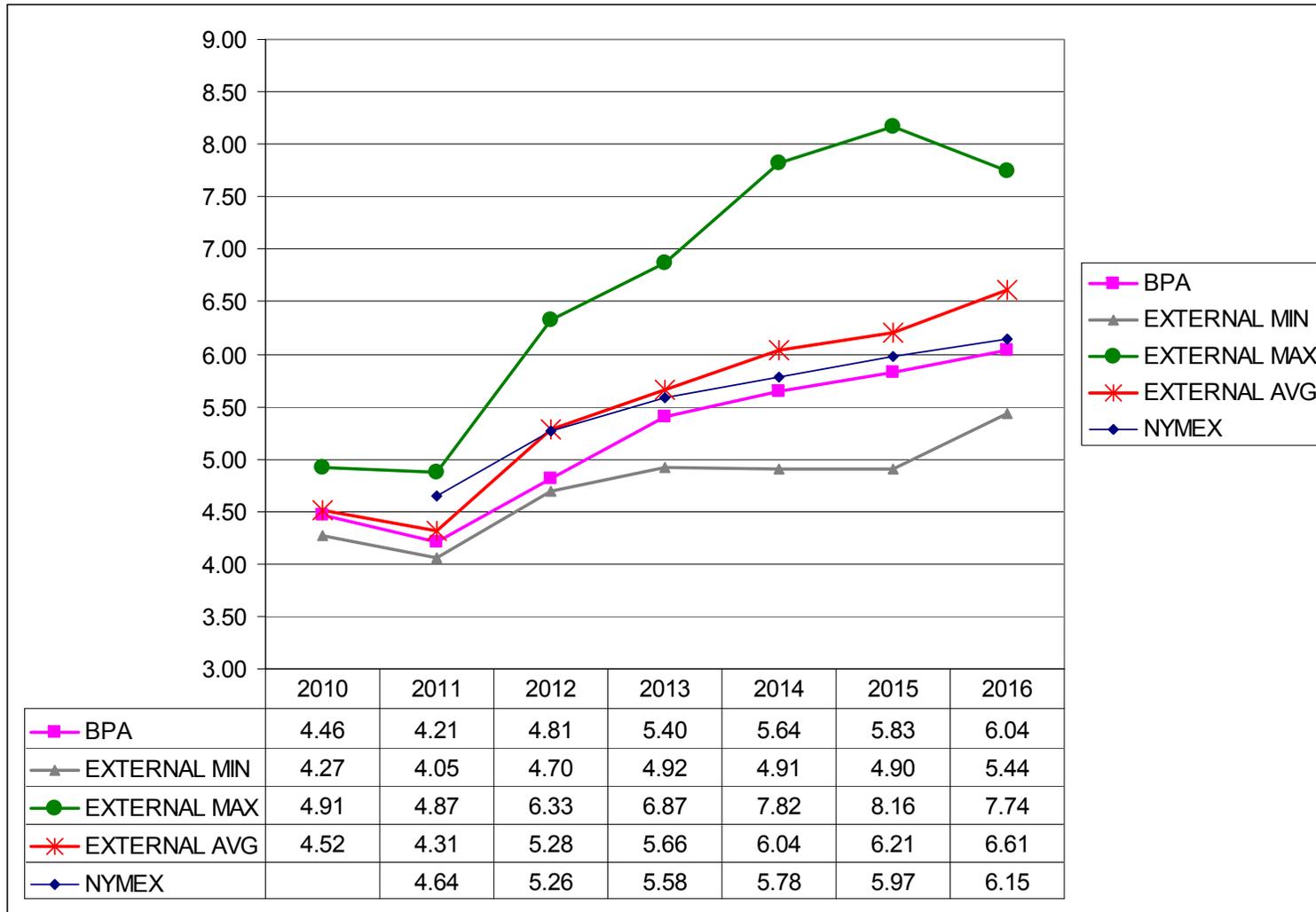
Median Load	
2010	32640
2011	32997
2012	33495
2013	34010
2014	34409
2015	34823
2016	35238
2017	35651



Draft Natural Gas Forecast



BPA Henry Hub price outlook (nominal \$/MMbtu)



Caveats

- Subject to revision for Initial Proposal
- While clear consensus exists for short term, long term characterized by numerous uncertainties, each of which has a potentially dramatic effect on prices
- Divergence of external forecasts likely reflects probabilistic analysis of these uncertainties
- NYMEX does not equal cash!



Current state

- Supply: “Shale gale” dominant factor in market
 - Abundance of supply at low costs
 - Advances in drilling technology
 - Rush to production
 - High levels of production despite low prices
- Demand: Where will it come from?
 - Economic recession persistent with slower than expected recovery
 - Because of high levels of both supply and storage, large incremental growth necessary to provide upward pressure on prices
 - Tough to imagine scenarios that create this demand without significant policy implementation



Near term (2010-2011)

- Hot summer in most of nation provides no support for prices – large decline in both cash and futures markets during last 3 months
- Unchecked production with persistently high storage
- Mild winter and associated withdrawals projected for East Coast demand markets
- Sluggish recovery with little to no improvement in industrial or power sector demand
- 2011 consensus opinion in very tight range at depressed levels relative to 2010



Medium Term (2012-2013)

- Modest strengthening of prices over this period
- Economy should be on a better track by this point
- Demand increase led by power sector as coal-to-gas switching continues
- Recovery or medium/long term growth prospects for Industrial debatable – especially in dry gas (natural gas liquids potentially another story but major infrastructural issues)
- Producers able to exercise greater degree of control over market and attempt to restore supply/demand balance
- Higher price threshold for encouraging independent production
- Upward price trajectory supported by EPA emission regulations and continuing growth of renewables



Long term (2014-2016)

- Overall flattening of price
- Journey towards price equilibrium – in this equilibrium, supply still main driver of prices
- Pipeline development and flows from major shale plays establish clearer correlation of demand centers with regionalized supply areas
- Expect lower seasonal volatility
- Pipeline constraints gradually lower, further reducing seasonal or event driven volatility

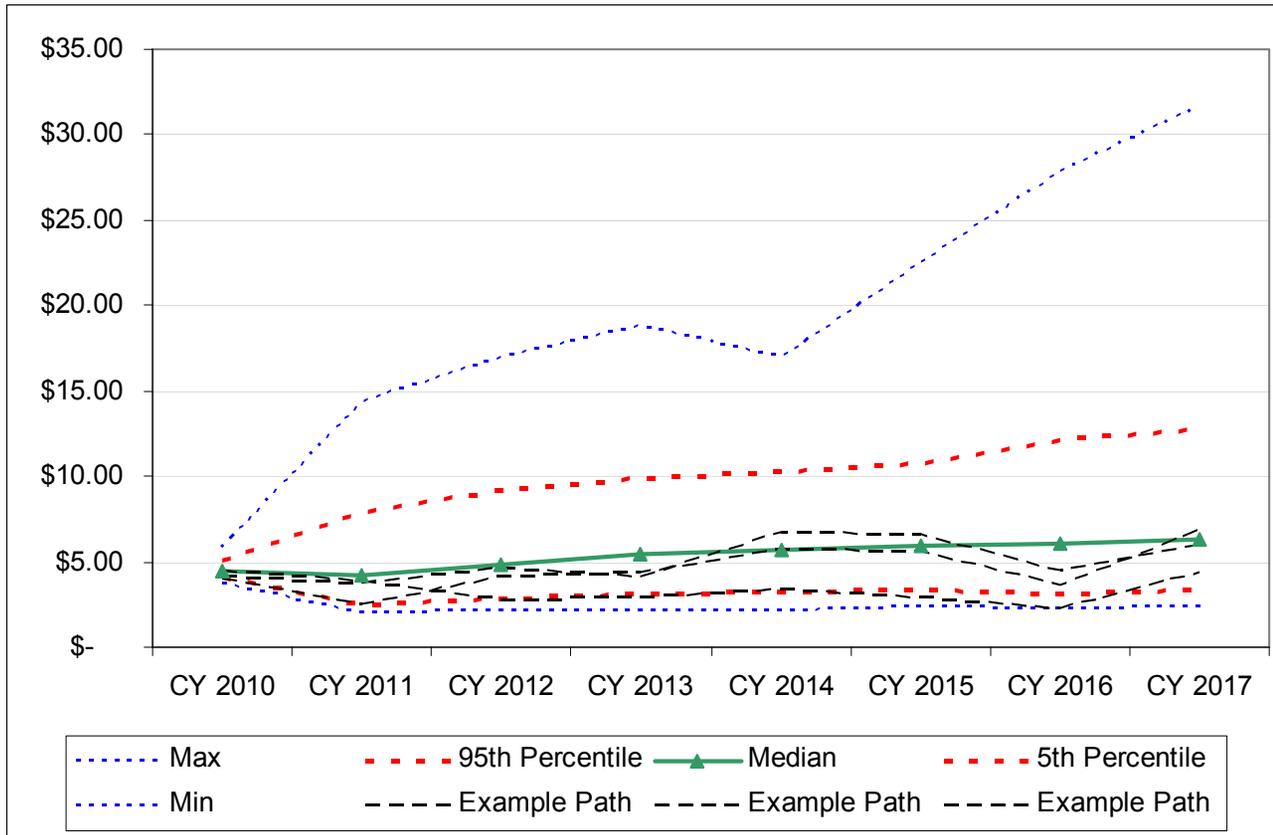


Future Uncertainties

- EPA study on hydraulic fracturing
 - Initial study results planned for late 2012
 - Event most likely to both occur and have definitive effect on industry
- Major policy initiatives
 - Further emissions controls / large scale energy bill
 - Investment in natural gas vehicles
 - Increased construction of CCGTs to accompany growing amount of wind generation
- Other factors
 - Domestic manufacturing growth could exceed estimates
 - Further incremental technologic advances in drilling techniques
 - Worldwide demand for LNG distorts breakeven price for LNG export
 - Consolidation of industry and tough regulatory environment



Natural Gas Variability



Note: Prices in Nominal \$

	5th-Perc	Median	95th-Perc
2010	\$ 4.07	\$ 4.47	\$ 5.01
2011	\$ 2.49	\$ 4.25	\$ 7.87
2012	\$ 2.79	\$ 4.86	\$ 9.12
2013	\$ 3.13	\$ 5.49	\$ 9.84
2014	\$ 3.24	\$ 5.72	\$ 10.27
2015	\$ 3.38	\$ 5.93	\$ 10.72
2016	\$ 3.14	\$ 6.11	\$ 12.10
2017	\$ 3.29	\$ 6.28	\$ 12.68



Possible Approach to Transmission Variability

- Three transmission paths gamed
 - COI North to South (AC – 4800 MW in AURORA)
 - DC Intertie North to South (DC – 3100 MW in AURORA)
 - BC Intertie North to South (BC – 3150 MW in AURORA)
- 200 games with transmission transfer capability limited based on transmission scheduling limit
- Average percentage rating of transmission lines shown below
 - AURORA defaults to 80% for COI and DC line and 100% for BC line

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AC	88.4%	86.1%	80.3%	78.1%	80.8%	82.4%	88.8%	89.3%	81.9%	82.3%	82.4%	87.5%
DC	73.3%	72.1%	66.6%	79.7%	84.3%	86.2%	83.9%	86.4%	75.3%	32.2%	56.7%	76.4%
BC	79.3%	77.1%	70.0%	66.8%	63.6%	61.7%	66.9%	75.5%	68.7%	70.0%	70.4%	74.3%



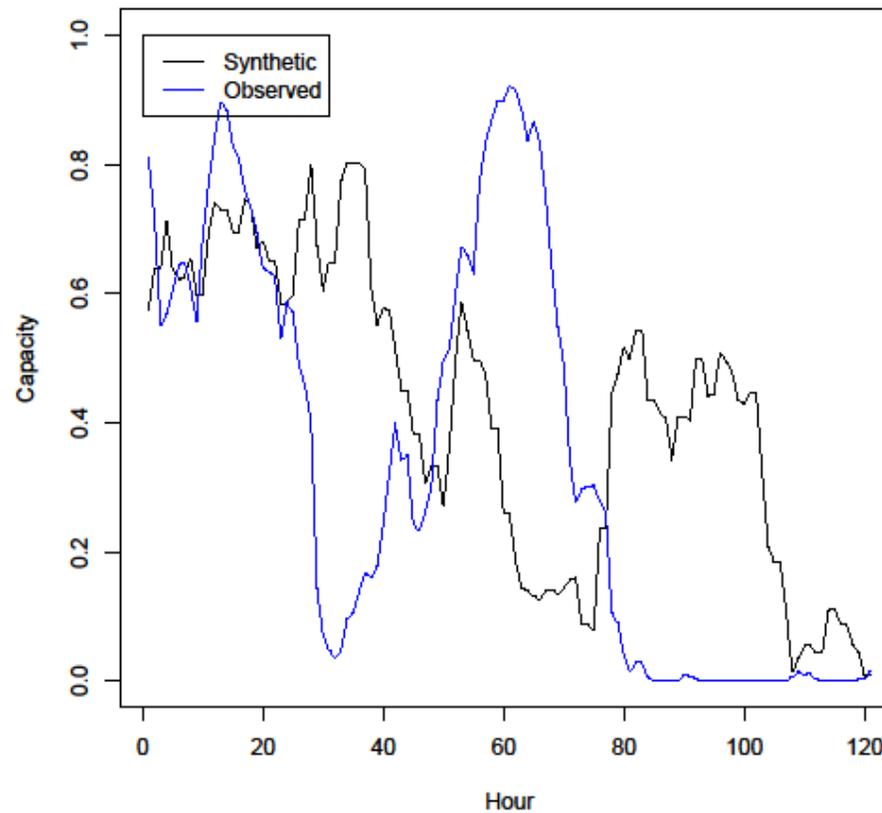
Possible Approach to Wind Variability

- 30 wind games created with a kth-Nearest-Neighbor (kNN) algorithm (also known as a local bootstrap) to have a realistic hourly wind shape and be consistent in monthly energy and annual energy variations seen in the BPA wind fleets historical record.

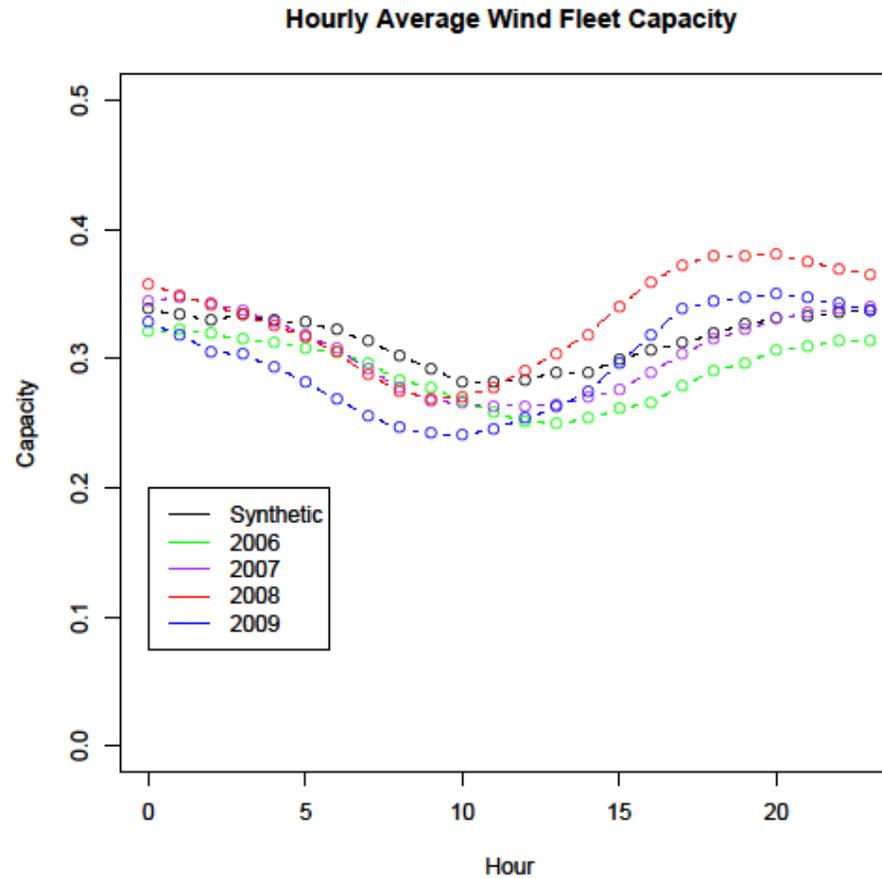


Example Wind Game Summary

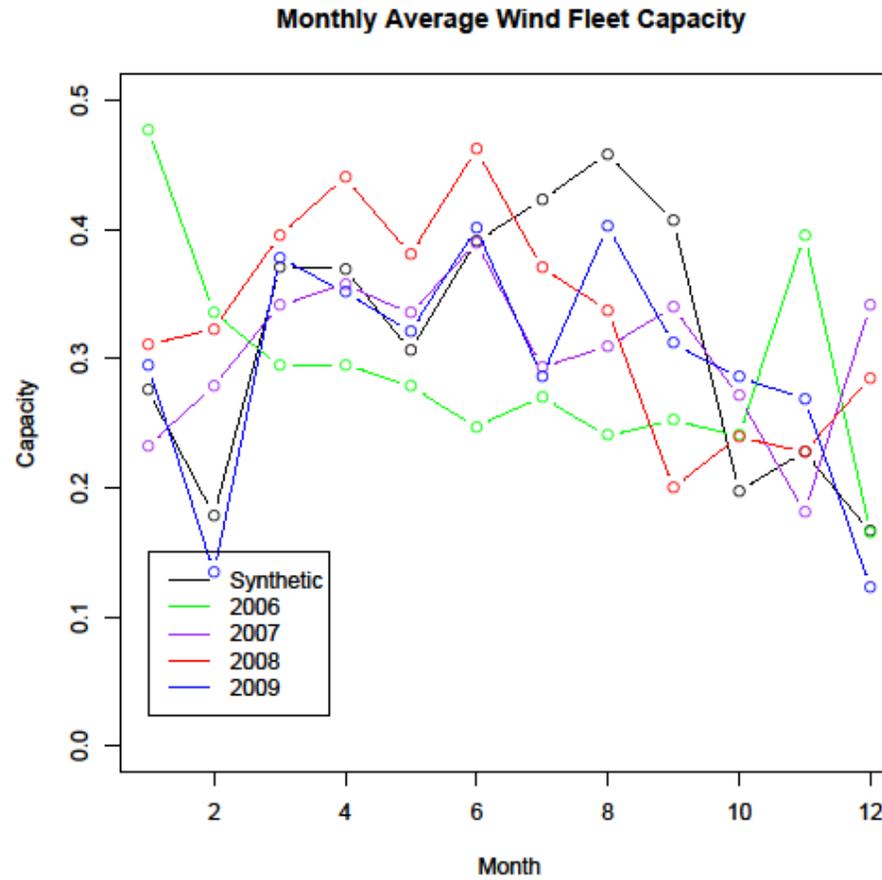
Example 5 Day Wind Capacity Record



Example Wind Game Summary

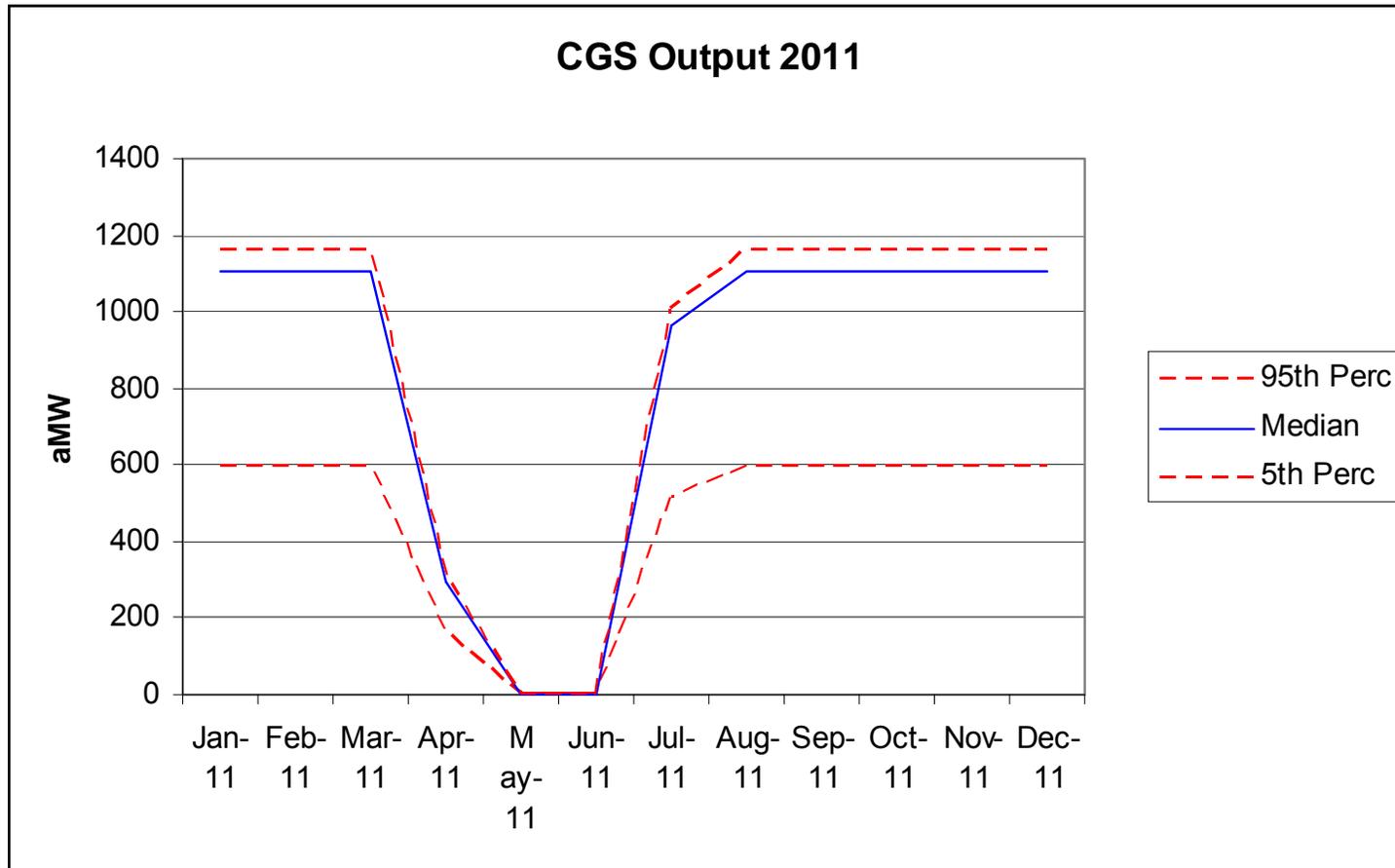


Example Wind Game Summary



CGS Variability

- AURORA CGS gaming scheme updated to match the inventory gaming as used in the WP10 rate case



Proposal for California Carbon Emission Price

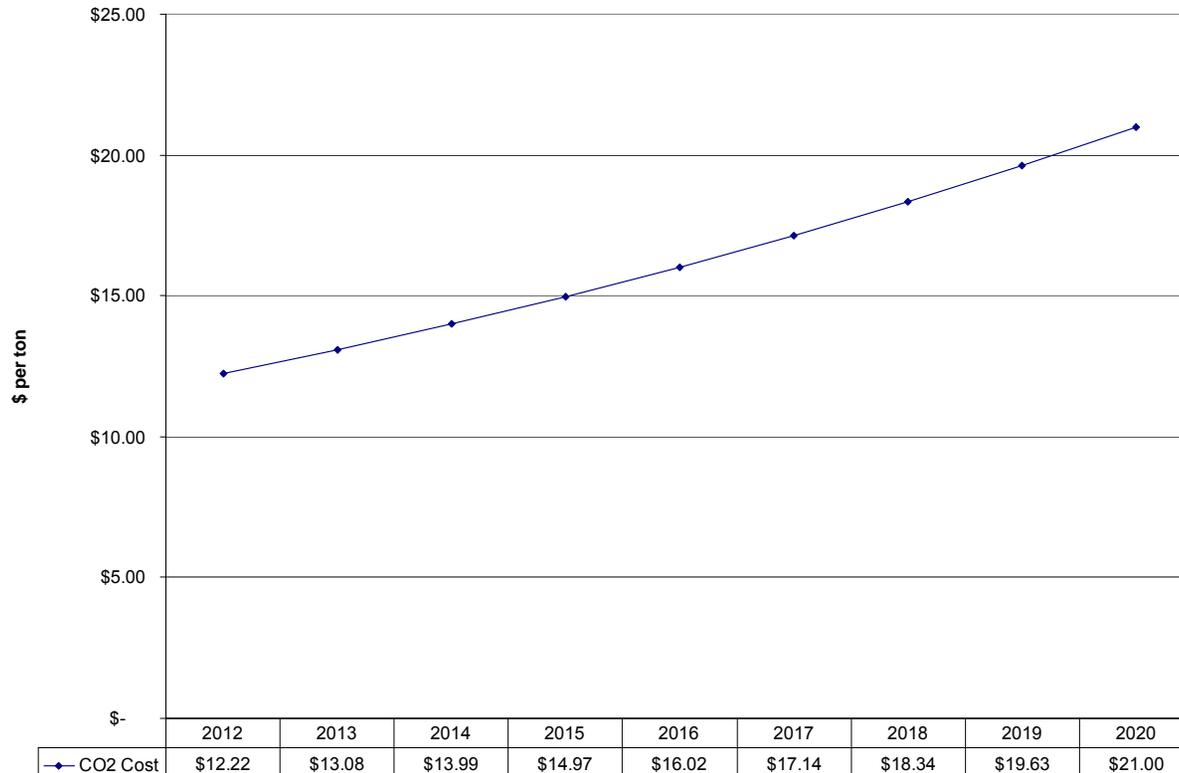
- Implemented in the model as a direct emission price on California generators
- Imported power is given a 1000 lb/MWh price which is added to wheeling charges on transmission lines going into California
- Low-level carbon price is included as a conservative assumption
- Currently modeling carbon pricing as starting in 2012, should this be shifted?
- Other ideas?



Proposal for California Carbon Emission Price

- California generators have a carbon price associated with emissions based on a CARB forecast. AURORA has a default carbon price forecast that is replaced in California by these figures and set to zero for other generators.

CARB CO2 Cost Projection



RPS-based WECC-wide Generation Build Forecast

- BPA implemented a RPS-based resource build forecast based on System Optimizer a capacity expansion model is used to:
 - simultaneously consider generation and transmission alternatives
 - develop long-term 20-30 year resource plans including type, size, location, and timing of capital projects
 - access production cost details
 - evaluate a range of investment choices including renewables, DSM, unit retirements, and transmission upgrades
 - consider imports and exports between regions

...given a reserve margin requirement or an LOLP constraint



RPS-based WECC-wide Generation Build Forecast

