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Docket Number:	17-IEPR-04
Project Title:	Natural Gas Outlook
TN #:	221393
Document Title:	Presentation - North American Market Gas Trade Modeling Results
Description:	Presentation by Anthony Dixon of CEC
Filer:	Raquel Kravitz
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	10/5/2017 1:34:09 PM
Docketed Date:	10/5/2017

California Energy Commission

North American Market Gas Trade Modeling Results

Integrated Energy Policy Report Workshop

California Energy Commission

October 9, 2017

Anthony Dixon
Supply Analysis Office
Energy Assessments Division

North American Market Gas-Trade (NAMGas) Revised Results

- Preliminary results at the April 25, 2017, *IEPR* Workshop
- Updated the NAMGas model to reflect current data and information
  - Turned off additional pipeline capacity for:
    - All pipelines in California
    - All interstate pipelines feeding California
  - Updated the proved and potential natural gas reserves with latest Potential Gas Committee (PGC) data
    - Reserves increased approximately 6 percent

NAMGas Revised Results:

- Incorporated DAO's 2017 California Energy Demand preliminary forecasted natural gas demand data
  - California-specific
  - Residential, commercial, industrial, transportation sectors
- Incorporated Energy Commission's forecasted WECC natural gas demand in the power generation sector
- Updated small "m" to include 2016 EIA data
  - Residential, commercial and industrial natural gas demand outside of California
  - Natural gas demand for power generation outside of WECC

Major Model Inputs: Demand

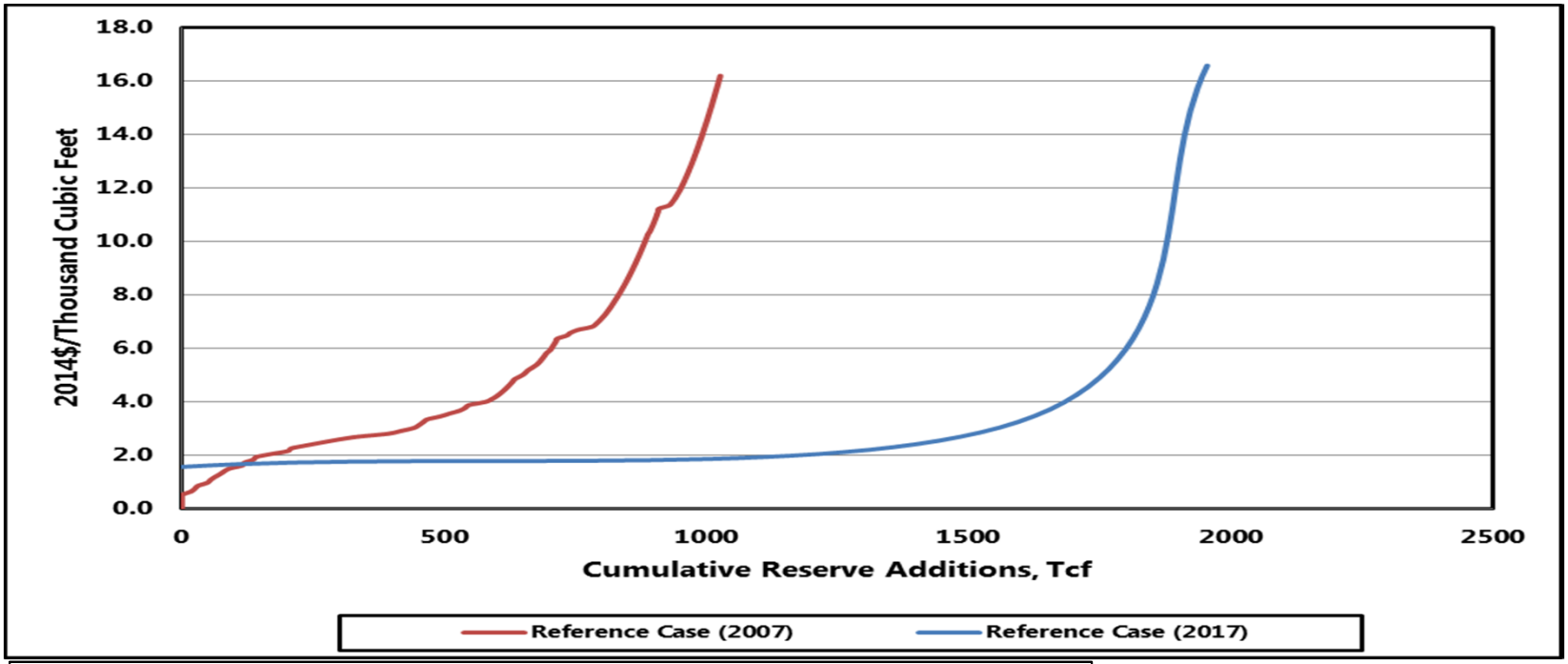
Demand in Five Disaggregated Sectors:

- Residential
  - Key factors: Recent historical demand for natural gas, population, natural gas price, income, heating oil price, and cold and hot weather
- Commercial
  - Recent historical demand for natural gas, income, natural gas price, population, heating oil price, and cold and hot weather
- Industrial
  - Key factors: Recent historical demand for natural gas, natural gas price, industrial production, and cold weather

Major Model Inputs: Demand

- Power generation key factors:
  - Natural gas, coal, and fuel oil cost;
  - coal, nuclear, hydroelectric and renewable generation,
  - and hot weather
- Transportation key factors:
  - Recent historical demand for natural gas, income, natural gas price, and population
  - Applied outside California
- Estimated elasticity
  - Residential, commercial, industrial, power generation and transportation
  - Range of elasticity ~ 0.5298-1.2363. (Baker Institute)

KEY DRIVERS SUPPLY SIDE
U.S. SUPPLY COST CURVE



Sources: California Energy Commission; Baker Institute; National Petroleum Council.

- Supply cost profile is major input parameter for the natural gas model
  - Technology shifting the supply cost profile
    - More resources are available at lower cost

NAMGas Model

Simplified View:

Natural gas supply basins
Connected to
Interstate and Intrastate Pipelines
Connected to
Demand centers

↓

Model iterates through all time periods and all regions

↓

Produces estimates of U.S. supply, demand and hub prices

NAMGas Revised Results:

- In the revised model runs, constructed three scenarios:
  - High Demand Case
  - Mid Demand Case
  - Low Demand Case

- Referred to as the “IEPR COMMON CASES”

Natural Gas Common Cases: Key Assumptions 2017

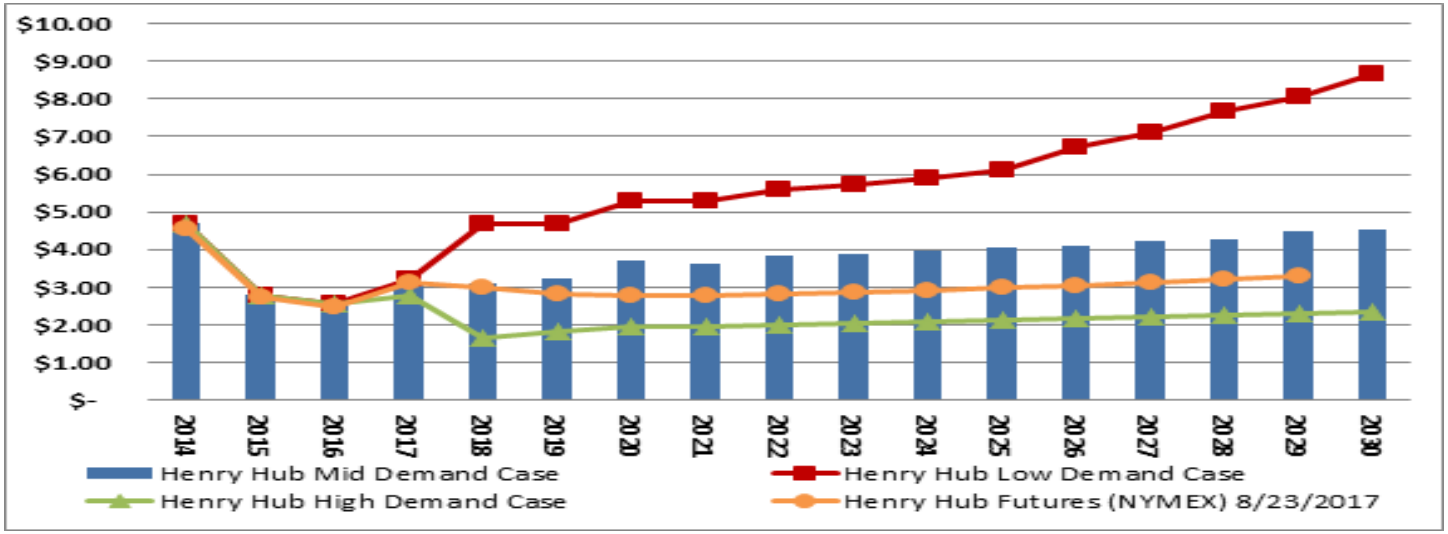
Input Category	High Demand	Mid Demand	Low Demand
GDP/GSP	High Case in EIA's 2016 Energy Outlook: 2.8% Annual GDP Growth	Reference Case in EIA's 2016 Energy Outlook: 2.2% GDP Growth	Low Case in EIA's 2016 Energy Outlook: 1.6% Annual GDP Growth
Additional Achievable Energy Efficiency	2015 IEPR Low for Residential, Commercial, and Industrial Gas Demand	2015 IEPR Mid for Residential, Commercial, and Industrial Gas Demand	2015 IEPR High for Residential, Commercial, and Industrial Gas Demand
Renewables	50% by 2030 for CA Other US States Meeting RPS Targets	50% by 2030 for CA Other US States Meeting RPS Targets	50% by 2030 for CA Other US States Meeting RPS Targets
Coal Retirement Through 2050 (EIA)	73 GW	53 GW	33 GW

Natural Gas Common Cases: Key Assumptions 2017

Input Category	High Demand	Mid Demand	Low Demand
Resource Capital Costs	50% Lower Than 2016 Inputs	2016 Inputs	50% Higher Than 2016 Inputs
Resource O&M Costs	50% Lower Than 2016 Inputs	2016 Inputs	50% Higher Than 2016 Inputs
Proved Supply Forward Costs	50% Lower Than Reference Case (2018 And After)	Estimate Based on Hub Prices	50% Higher Than Reference Case (2018 And After)

NAMGas Revised Results:

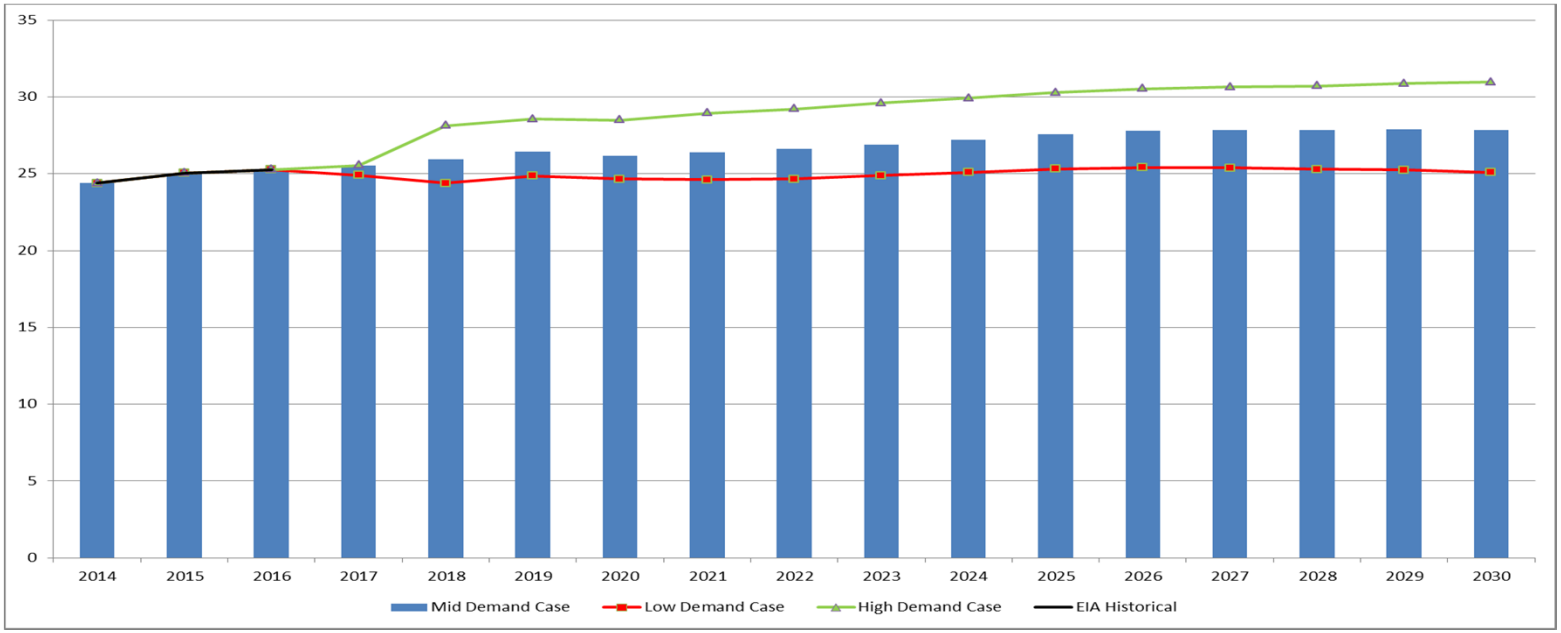
IEPR Common Cases for Henry Hub Pricing Point (2016$/MCF) and
Henry Hub Futures (NYMEX) Prices as of 8/23/17



- Mid Demand case growing at about 2.0% per year, reaching $4.50 in 2030
- Futures prices track is essentially flat and slightly lower
- High Demand case also flat, hovering around $2.00
- Low Demand prices near $9.00 per Mcf due to high resource recovery costs and lower resource availability

NAMGas Revised Results:

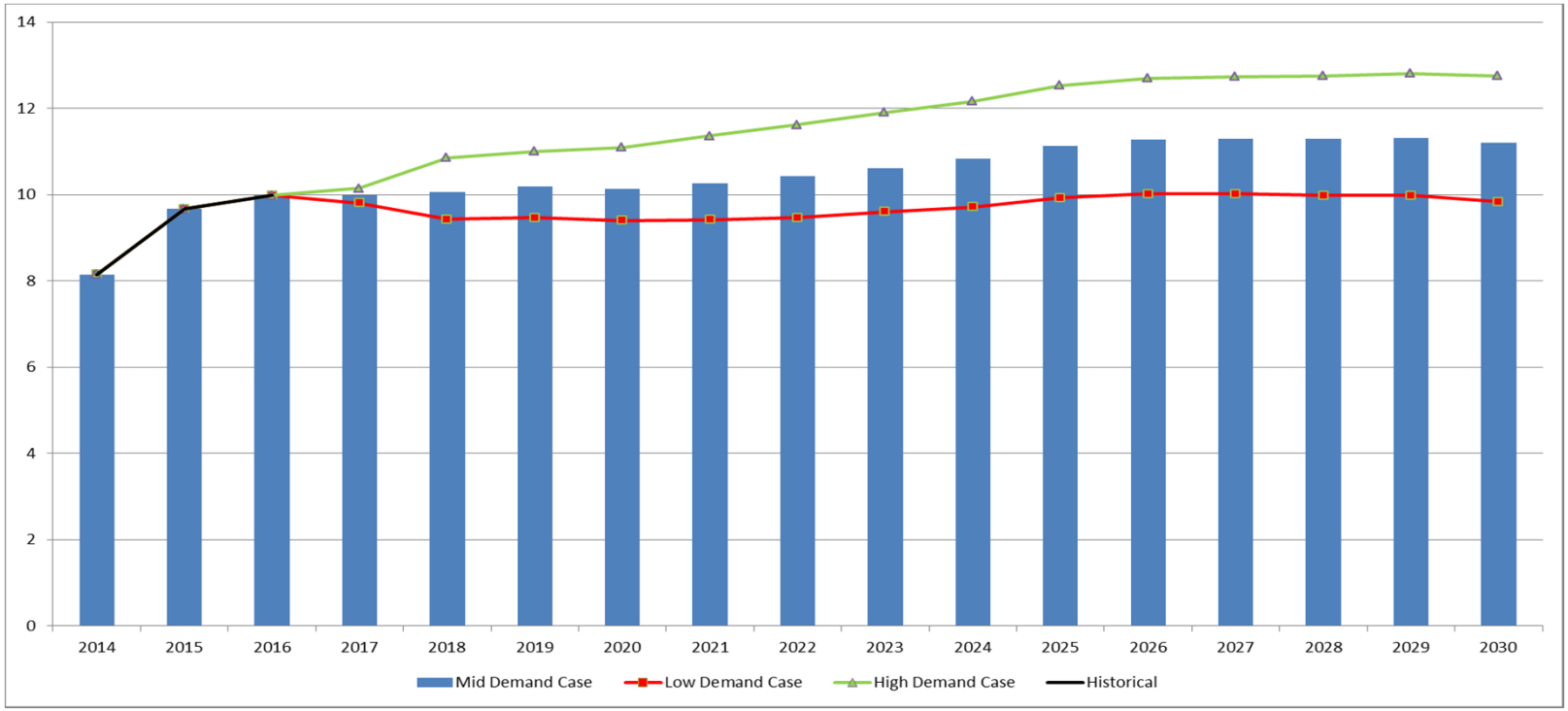
U.S. Natural Gas Demand (Trillion Cubic Feet [Tcf]/year)



- U.S. natural gas demand growing steadily
  - Annual growth rate in mid demand case about 0.7%
  - Mainly driven by natural gas demand in the power generation sector (0.9%) and industrial sector (0.7%)
  - Demand forecasted to grow from 25.27 Tcf (2016 EIA estimate) to 27.83 Tcf in 2030

NAMGas Revised Results:

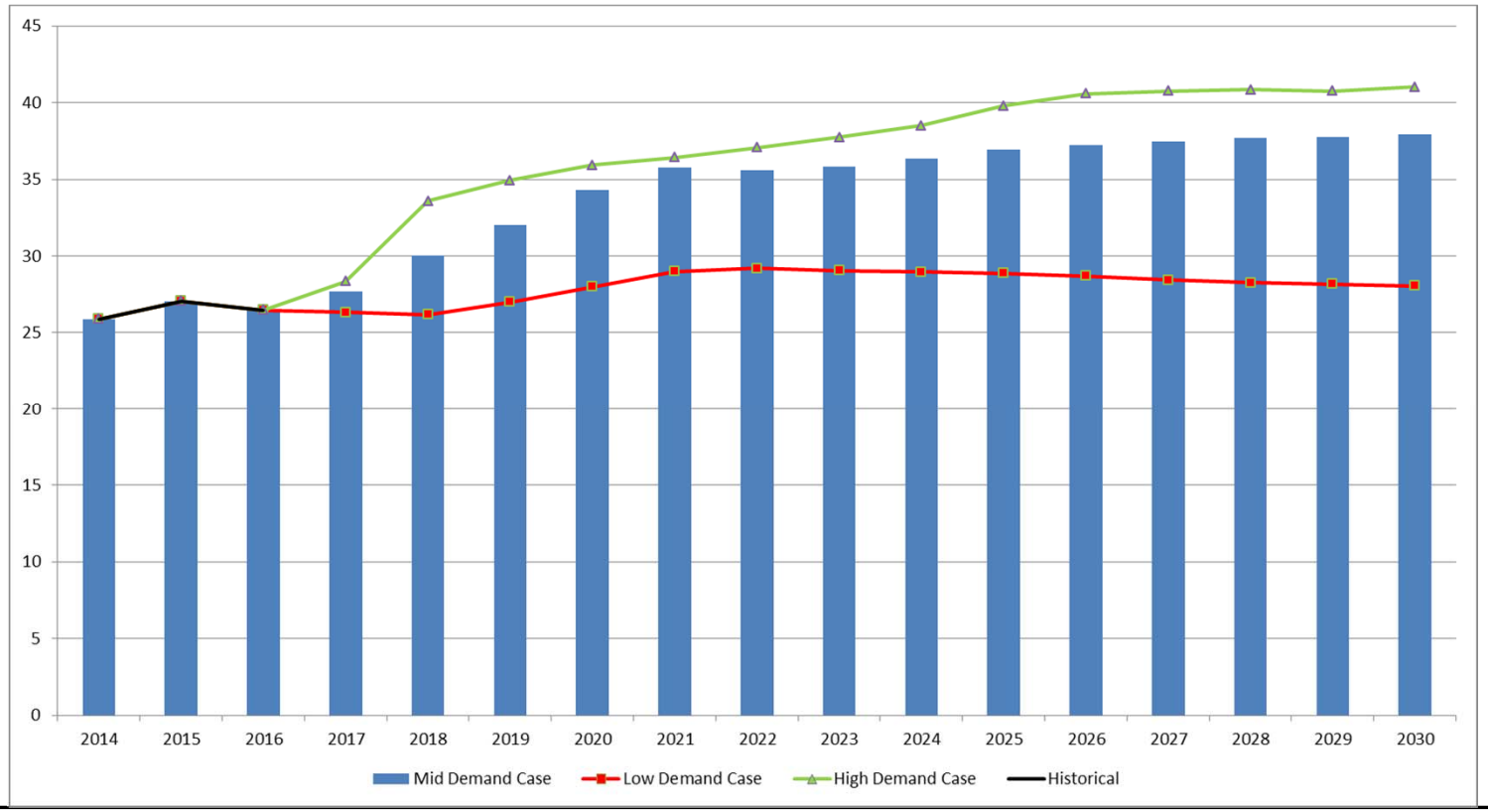
U.S. Power Generation Demand for Natural Gas (Tcf/year)



- Responsiveness to prices
  - In High Demand case, natural gas demand increases to 12.75 Tcf/year in 2030
    - U.S. power generation demand 9.98 Tcf/year in 2016 (EIA estimate)

NAMGas Revised Results:

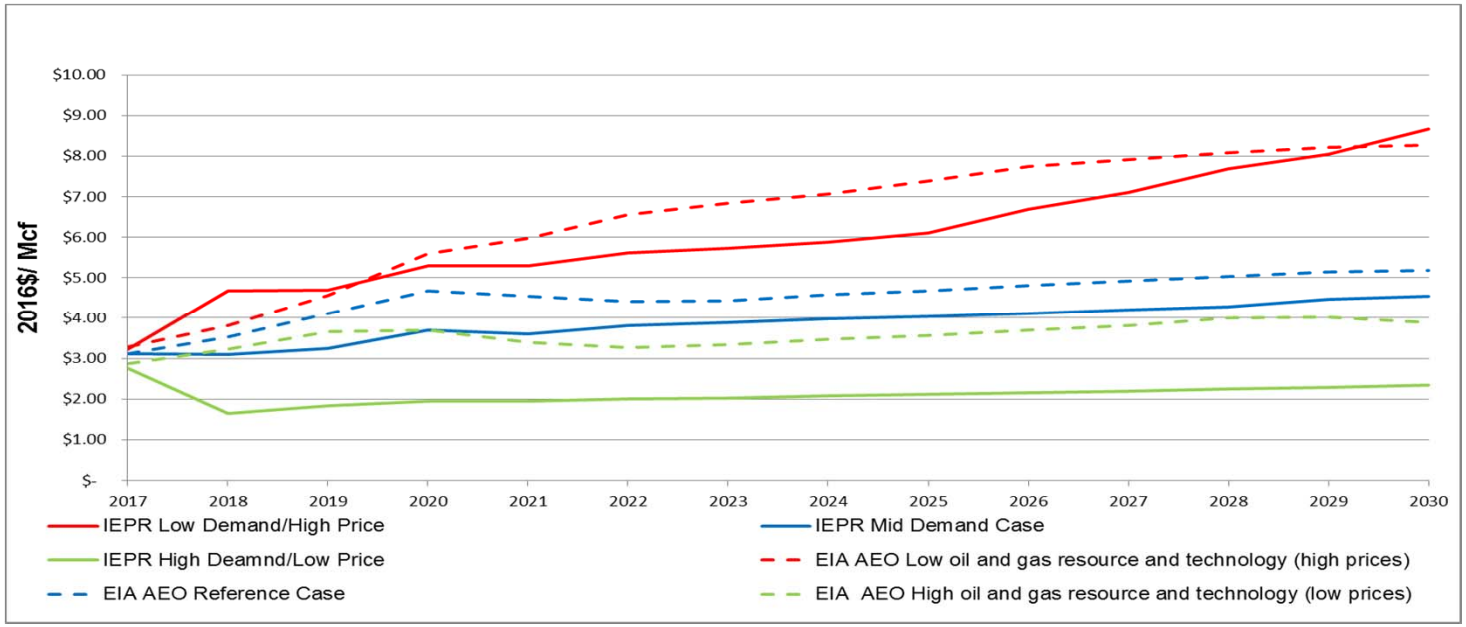
U.S. Natural Gas Production (Tcf/year)



- High production in the high demand case is driven by lower production costs and higher overall demand

NAMGas Revised Results:

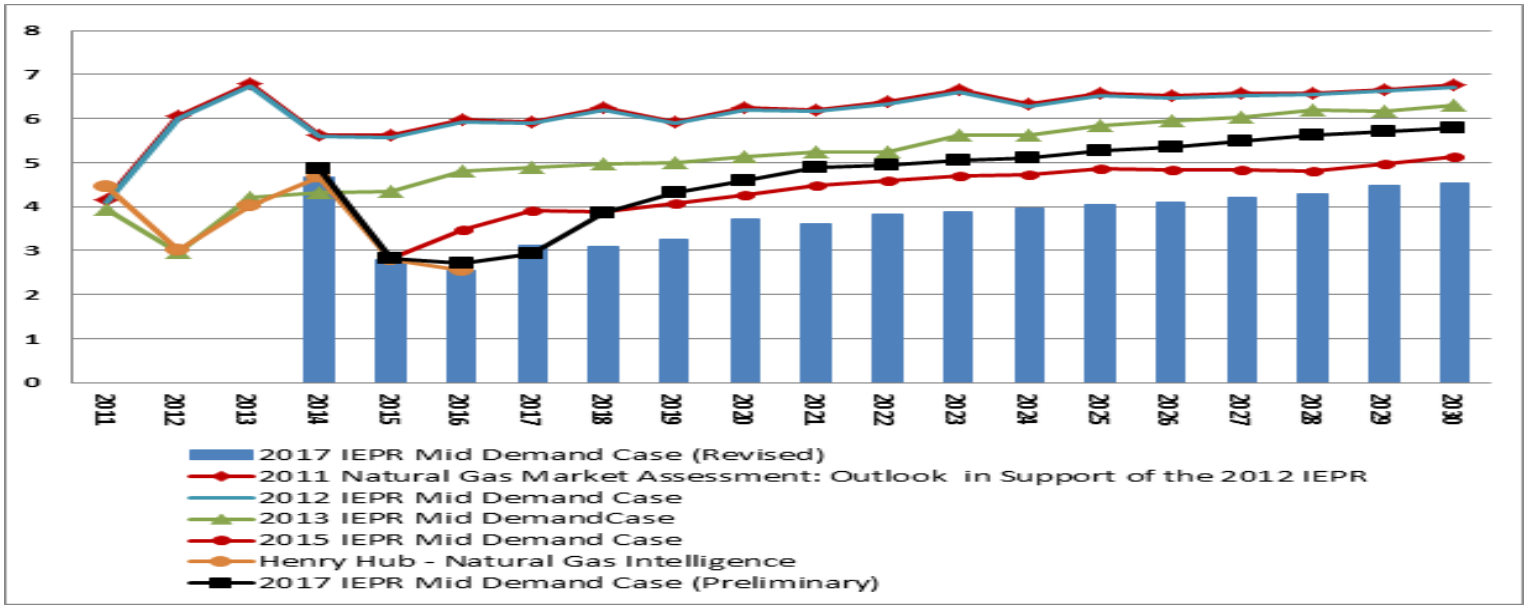
Comparison of Forecasted Henry Hub Prices by CEC and EIA (2016$/Mcf)



- CEC Mid Demand case price forecast (solid blue line) tracks EIA's Reference case (DASHED BLUE LINE)
- Lower by about $0.40 - $0.90 (Mid Demand/Reference Cases)
- Different models, Energy Commission's has lower cost of finding and developing and production assumed.

NAMGas Revised Results:

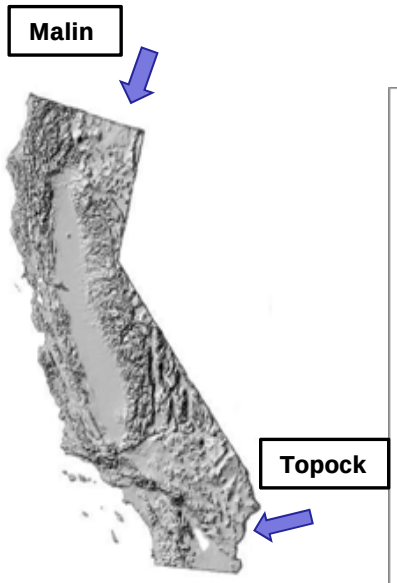
CEC Forecasted, Actual, and Futures Prices for
Henry Hub (2016$/Mcf)

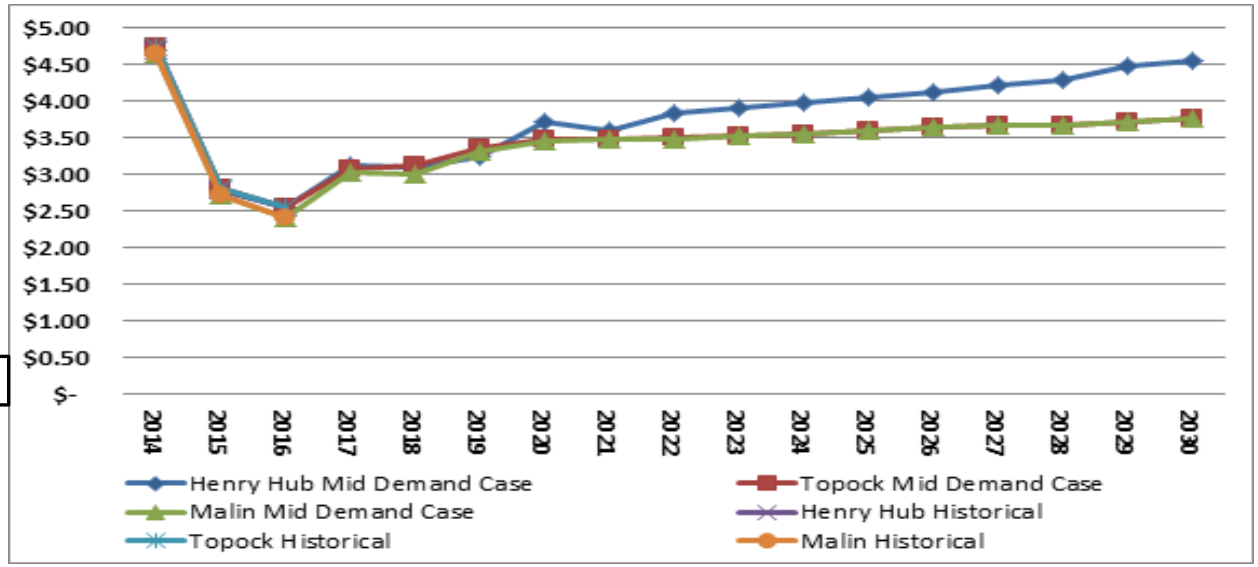


- Compared previous modeling efforts to 2017 revised results
- 2017 revised results are lower
- Since 2006, the PGC increasing the potential natural gas reserves estimates due to technology implementation

NAMGas Revised Results:

Mid Demand Case Prices for Henry, Topock, and Malin Hubs (2016$/MCF)





- Topock and Malin prices trade at a discount to Henry Hub
- Competition at Malin, gas from Rockies on Ruby pipeline against gas from Canada on Gas Transmission North
- Combined volumes at Malin compete with Southwest trying to satisfy CA's demand. (Also, renewables flattening/pushing natural gas demand lower)

California Supply Portfolio

- Redwood Path, Kern and Southern Trails continue to run near capacity
- Declining supplies at Ehrenberg due to competition with Mexico
- Topock remains the marginal supply hub

U.S. CONCLUSIONS

- Natural gas demand grows at an annual rate of 0.8 percent between 2017 and 2030, reaching 27.83 Tcf/Year in the Mid Demand case.
- Henry Hub prices reach $4.50 Mcf (2016$, Mid Demand Case) by 2030, a 2 percent annual average growth.
- Natural gas demand for power generation grows at an annual average rate of 0.9 percent, reaching 11.2 Tcf in 2030.
- Production annual average growth rate is 2.52 percent, reaching 37.9 Tcf in 2030.
- Forecasted to become a net exporter of natural gas by 2018, reaching 4.3 Tcf in 2030. Much of the exports are LNG and exports to Mexico.

Upcoming Work for the 2019 IEPR

- Update proved and potential resources with 2016 PGC report
- Update pipeline capacities and infrastructure build out
- Update historical demand data
- Incorporate final CED data

Thank you!

QUESTIONS OR COMMENTS?

anthony.dixon@energy.ca.gov / 916-654-4882