"Road Map" to Natural Gas Demand-Related Assmptions for Staff's Proposed Natural Gas Market Assessment; For Discussion at April 19, ***2011 IEPR*** **staff workshop**

		Reference Case and Scenarios								
		Focus on national drivers that lead to*		Focus on CA drivers that lead to @				Single-variable Sensitivity+	Single-variable Sensitivity#	Case not question-focused
	Case No:	A	B	C	D	E	F	G	H	Reference Case
Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		High Gas Price Case (output price is high, not input)	Low Gas Price Case (output price is low, not input)	High CA Gas Demand Case (output demand is high, not input)	Stressed **High** CA Demand Case (higher econ/demo; lower temps, hydro-generation)	Low CA Gas Demand Case (output demand is low, not input)	Stressed **Low** CA Demand Case (higher econ/demo; higher temps, hydro-generation)	Increased Environmental Mitigation Cost for Drilling and Production Case	Reduced Pipeline Pressure Case	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Reference Case Values	Slower GDP and Manufacturing Output	Higher GDP growth	Higher GDP growth	Lower GDP growth	Lower GDP growth	Reference Case Values	Reference Case Values	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Reference Case Values	Reference Case Values	Higher CA Population Growth	Higher CA Population Growth	Lower CA Population Growth	Lower CA Population Growth	Reference Case Values	Reference Case Values	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income									
Weather	Temperature - degree days	Reference Case Values	Reference Case Values	Reference Case Values	Colder winter and hotter summer than in Reference Case	Reference Case Values	Warmer winter and cooler summer than in Reference Case	Reference Case Values	Use extreme weather so can see how lower capacity affects system at limits	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	Reduce the coefficient on gas' share of electricity demand	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values OR Reverse the sign on Renewables	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	Reference Case Values	Reference Case Values	Low Hydro increases CA gas demand by 15%	Reference Case Values	High Hydro reduces CA gas demand by 12%	Reference Case Values	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	GHG and other EPA regs further push out coal	More Nukes or CCS allow Reduction in Gas Burn	Reference Case Values	Reference Case Values	Carbon adder on CA gas consumption?	Carbon adder on CA gas consumption?	Reference Case Values	Reference Case Values	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	Reference Case Values	High EE reduces electricity and gas demand growth by half	Only half of load reduction desired by EE is achieved	Only half of load reduction desired by EE is achieved	EE reduces CA demand growth to 1% -- reality check with DAO	EE reduces CA demand growth to 1% -- reality check with DAO	Reference Case Values	Reference Case Values	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	50% fewer Renewables	Grow Renewables Excl Conv Hydro to 20% of US Demand	Assume CA gets only to 25% Renewables	Assume CA gets only to 25% Renewables	Assume CA gets to 50% Renewables	Assume CA gets to 50% Renewables	Reference Case Values	Reference Case Values	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Reference Case Values	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Reference Case Values	Reference Case Values	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Reference Case Values	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Impact depends on assumed fuel source and efficiency	Reference Case Values	Reference Case Values	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	Go to top of 95% conf interval on all demand coefficients	Go to bottom of 95% conf interval on all demand coefficients	n/a	n/a	n/a	n/a	n/a	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	PCB ANPR requires major U.S. pipeline replacement and/or impose adder such as proposed in PA ($0.40 to $0.80 per MMBtu)	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Could add PA Compliance Charge ($0.40 to $0.80 per MMBtu) to O&M Cost	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	could either add cost to PG&E backbone OR reduce capacity	**None**
Supply	Technology	Slow the technology growth factor … by half?	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Could shift supply curves leftward to reduce supply available as public concern limits drilling	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Reference Case Values	Could shift supply curves leftward to reduce supply available as public concern limits drilling	Reference Case Values	**RWGTM Supply Curves**

* Explore California's potential vulnerabilities, or opportunities, across a plausible range of conditions that could drive future wholesale market gas prices

@ Explore California's potential vulnerabilities, or opportunities, across a plausible range of conditions that could drive future California gas demand, costs, and infrastructure additions

\+ Explore potential effects on natural gas price and supply of uncertainties related to possible constaints/environmental mitigatiion costs assigned to shale gas development.

\# Explore potential effects on supply adequacy/price of uncertainties related to pressure reductions in gas pipelines.

Reference Case

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income	
Weather	Temperature - degree days	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	**None**
Supply	Technology	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	**RWGTM Supply Curves**

High Price Case

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		High Gas Price Case (output price is high, not input)	Rice University CA-specific Constrained Reference Case
Economy/ Demographics	GDP	Reference Case Values	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Reference Case Values	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Reference Case Values	**Average 1989 to 2009 NOAA Recorded by state**
Electricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values OR Reverse the sign on Renewables	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	GHG and other EPA regs further push out coal	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	Reference Case Values	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	50% fewer Renewables	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Reference Case Values	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Reference Case Values	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	Go to top of 95% conf interval on all demand coefficients	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	PCB ANPR requires major U.S. pipeline replacement and/or impose adder such as proposed in PA ($0.40 to $0.80 per MMBtu)	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Slow the technology growth factor … by half?	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Could shift supply curves leftward to reduce supply available as public concern limits drilling	**RWGTM Supply Curves**

Low Price Case

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		Low Gas Price Case (output price is low, not input)	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Slower GDP and Manufacturing Output	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Reference Case Values	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Reference Case Values	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reduce the coefficient on gas' share of electricity demand	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	More Nukes or CCS allow Reduction in Gas Burn	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	High EE reduces electricity and gas demand growth by half	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Grow Renewables Excl Conv Hydro to 20% of US Demand	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Impact depends on assumed fuel source and efficiency	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Impact depends on assumed fuel source and efficiency	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	Go to bottom of 95% conf interval on all demand coefficients	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Reference Case Values	**RWGTM Supply Curves**

High CA Gas Demand

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		High CA Gas Demand Case (output demand is high, not input)	Rice University CA-specific Constrained Reference Case
Economy/ Demographics	GDP	Higher GDP growth	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Higher CA Population Growth	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Reference Case Values	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	Reference Case Values	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	Only half of load reduction desired by EE is achieved	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Assume CA gets only to 25% Renewables	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Impact depends on assumed fuel source and efficiency	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Impact depends on assumed fuel source and efficiency	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Reference Case Values	**RWGTM Supply Curves**

Low CA Gas Demand

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		Low CA Gas Demand Case (output demand is low, not input)	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Lower GDP growth	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Lower CA Population Growth	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Reference Case Values	**Average 1989 to 2009 NOAA Recorded by state**
Electricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	Carbon adder on CA gas consumption?	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	EE reduces CA demand growth to 1% -- reality check with DAO	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Assume CA gets to 50% Renewables	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Impact depends on assumed fuel source and efficiency	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Impact depends on assumed fuel source and efficiency	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Reference Case Values	**RWGTM Supply Curves**

Stressed CA High Gas Demand

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		Stressed **High** CA Demand Case (higher econ/demo; lower temps, hydro-generation)	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Higher GDP growth	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Higher CA Population Growth	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Colder winter and hotter summer than in Reference Case	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Low Hydro increases CA gas demand by 15%	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	Reference Case Values	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	Only half of load reduction desired by EE is achieved	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Assume CA gets only to 25% Renewables	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Impact depends on assumed fuel source and efficiency	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Impact depends on assumed fuel source and efficiency	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Reference Case Values	**RWGTM Supply Curves**

Stressed CA Low Gas Demand

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		Stressed **Low** CA Demand Case (higher econ/demo; higher temps, hydro-generation)	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Lower GDP growth	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Lower CA Population Growth	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Warmer winter and cooler summer than in Reference Case	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	High Hydro reduces CA gas demand by 12%	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	Carbon adder on CA gas consumption?	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	EE reduces CA demand growth to 1% -- reality check with DAO	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Assume CA gets to 50% Renewables	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Impact depends on assumed fuel source and efficiency	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Impact depends on assumed fuel source and efficiency	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Reference Case Values	**RWGTM Supply Curves**

Increased Environmental Mitigation Costs
Single Variable Sensitivity

Below are Key Drivers for Which Assumptions are Selected and Combined to Create the Cases in Each Column		Increased Environmental Mitigation Cost for Drilling and Production Case	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Reference Case Values	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Reference Case Values	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Reference Case Values	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	Reference Case Values	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	Reference Case Values	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Reference Case Values	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Reference Case Values	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Reference Case Values	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Could add PA Compliance Charge ($0.40 to $0.80 per MMBtu) to O&M Cost	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	Reference Case Values	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Could shift supply curves leftward to reduce supply available as public concern limits drilling	**RWGTM Supply Curves**

Reduced Pipeline Pressure
Single Variable Sensitivity

Below are Key Drivers for Which Assumptions are Selected and Combined to		Reduced Pipeline Pressure Case	**Rice University CA-specific Constrained Reference Case**
Economy/ Demographics	GDP	Reference Case Values	**IMF through 2015; after GDP grows using relation between US and UK historical growth at different per capita income levels, converging across countries over time**
	Population	Reference Case Values	**UN median case 2008 Revision avg growth to 2050 = 0.703% http://esa.un.org/unpd/wpp2008/all-wpp-indicators_components.htm**
	Personal Income		
Weather	Temperature - degree days	Use extreme weather so can see how lower capacity affects system at limits	**Average 1989 to 2009 NOAA Recorded by state**
Electiricty, Natural Gas and Fuel Prices	Initial Electricity price by sector and elasticities	Reference Case Values	**elasticity of higher electricity demand = 1.089**
	Initial gas price by sector and elasticities	Reference Case Values	**own price elasticity for NG is -0.442**
	Cross-price elasticities for substitute fuels (e.g., oil)	Reference Case Values	**oil = 0.238 & coal = 0.108 & Renewables = -0.189**
Precipitation	Amount of Hydroelectric generation	Reference Case Values	**No Explicit Precip Assumption other than renewables INCLUDING conv hydro and use of CA/US historical relationship between renewables and total electricity generation**
GHG and Energy Policy Incentives & Constraints (These drivers affect gas demand via their effects on end use gas demand, end use electricity demand, and/or electricity supply alternatives).	GHG Regulations	Reference Case Values	**None but gas-fired gen grows as much as if GHG were in place**
	Energy Efficiency	Reference Case Values	**US load grows at 1.12% compared to EIA Fig 69 3-yr rollng avg in same range; CA grows at 1.61%**
	Central Station Renewable Generation	Reference Case Values	**Renewables Excl Conv Hydro becomes 12.5% of U.S. portfolio by 2040 and 44% of CA (reality check against CA gas burn)**
	Combined Heat & Power	Reference Case Values	**AEO 2010 shows CHP purch and own use but not by generation fuel/not explicitly broken out in RWGTM**
	Distributed Generation	Reference Case Values	**all initially as assumed in AEO 2010 reference case (Zero DG in AEO 2010)/not explicitly broken out in RWGTM**
	Transportation Electricity/NG Use	Reference Case Values	**AEO 2010 shows electricity demand for transportation in CA of 0.49 Gwh growing at 4.1%/not explicitly broken out in RWGTM**
	Other	n/a	**N/A**
Environmental Protection and Public Safety	Environmental Compliance Costs	Reference Case Values	**includes Marcellus NY moratorium + limits on Montana Front Range + no OCS expansion**
	Public Safety Compliance costs	could either add cost to PG&E backbone OR reduce capacity	**None**
Supply	Technology	Reference Case Values	**Learning factor rate: approx. 1%/yr improvement**
	Production Cost	Reference Case Values	**RWGTM Supply Curves**