



GPCM Workshop: Demand

November 15, 2024

The Leader in Energy Market Simulation Systems

Providing energy companies, consultants, and regulators advanced tools to support:

- **Investment and M&A Strategy**
- **Environmental and Sustainability Goals**
- **Credible Risk Analysis**
- **Trading Strategy**
- **Policy Development and Assessment**
- **Energy Security**

GPCM Workshops

Demand

November 15, 2024

Robert Kachmar

Senior Natural Gas Analyst

Demand Workshop Overview

RBAC's Demand
Curve Development
Methodology

Modifying
Curves/Assumptions

Result Analysis



GPCM Demand Workshop

RBAC's Demand Curve
Development Methodology

Demand Curve Development

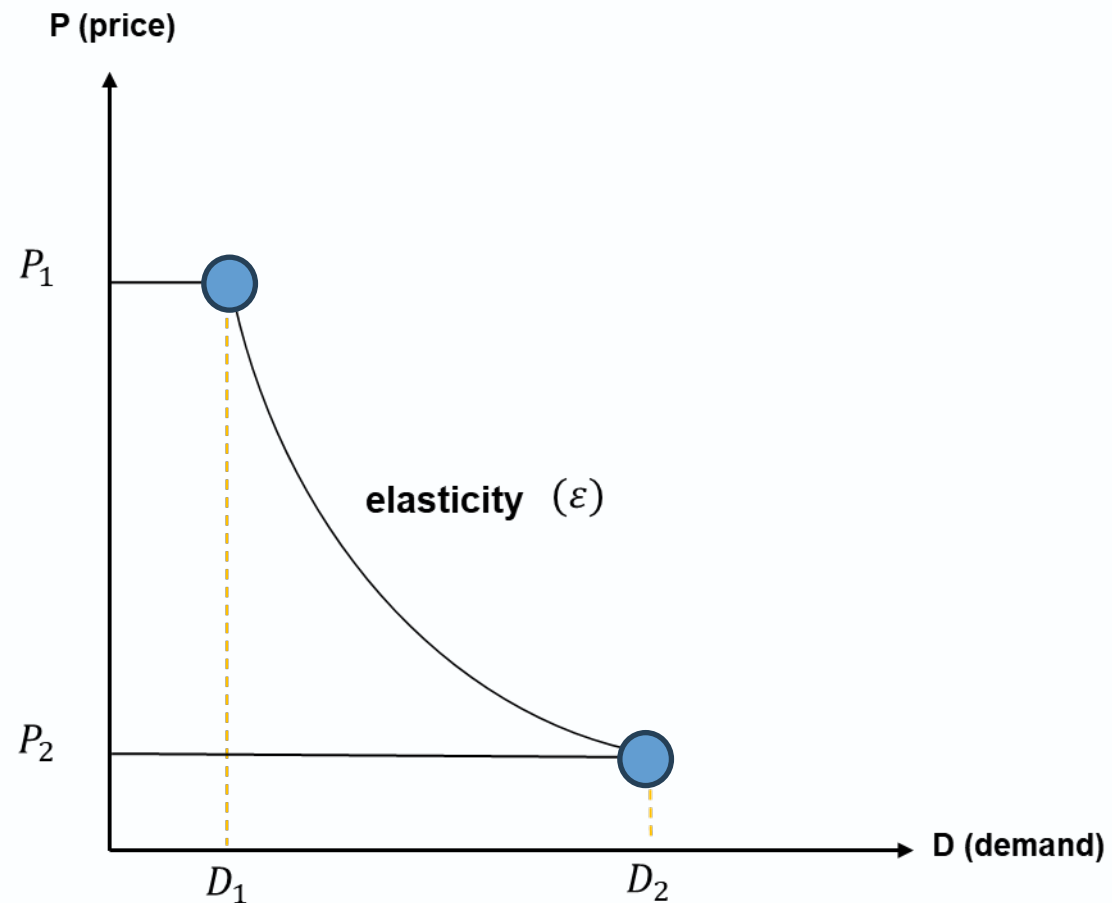
Demand forecasts use regression-based forecasting

- Residential
- Commercial
- Industrial

Power Sector demand curves (midpoint demand) are input directly into the demand case builder; base case uses AEO demand forecast with GPCM researched modifications – can also be obtained from Power Models via PMI

A general rule →

- Use Demand Case Builder when you want to change macro level assumptions with specific results in mind



Demand Regressions Constructed by STATE and SECTOR

$$y = f(x_1, x_2, x_3, \dots, x_n) + \delta$$

dependent variable

independent driver variables

unexplained error

$$\text{Demand} = \alpha \cdot x_1^{\epsilon_1} \cdot x_2^{\epsilon_2} \cdot x_3^{\epsilon_3}$$

constant

price

Weather

market size / growth
(e.g., population, customer count, GDP, GSP)

elasticity

Driver Variables, Constant Terms, and Elasticities Vary

The EIA 2023 Annual Energy Outlook

- Projection and Analysis of Energy Supply, Demand and Prices through 2040 based on existing legislation without assumption of future congressional action or technological advancements.
- Released March 2023
- Utilized the National Energy Modeling System (NEMS).
 - Implemented in 1994
 - Being phased out
- Faced the daunting task of incorporating historic levels of clean energy investments (IRA) into an energy system ravaged by major geo-political events.
- Represents a best guess under nominal conditions.

eia
Independent Statistics and Analysis
U.S. Energy Information
Administration

Annual Energy Outlook

AE02023



Electricity Generation in the 2023 AEO



23Q2base
was the first
GPCM
release
incorporating
the 2023 AEO

This AEO projected Gas
Fired Electric Generation to
decrease sharply due to
the influx of money from
the Inflation Reduction Act
into the Renewables Sector

This decline
has not yet
materialized

Source: RBAC, Inc. Visual Analytics

Current GPCM Outlook vs 2023 AEO

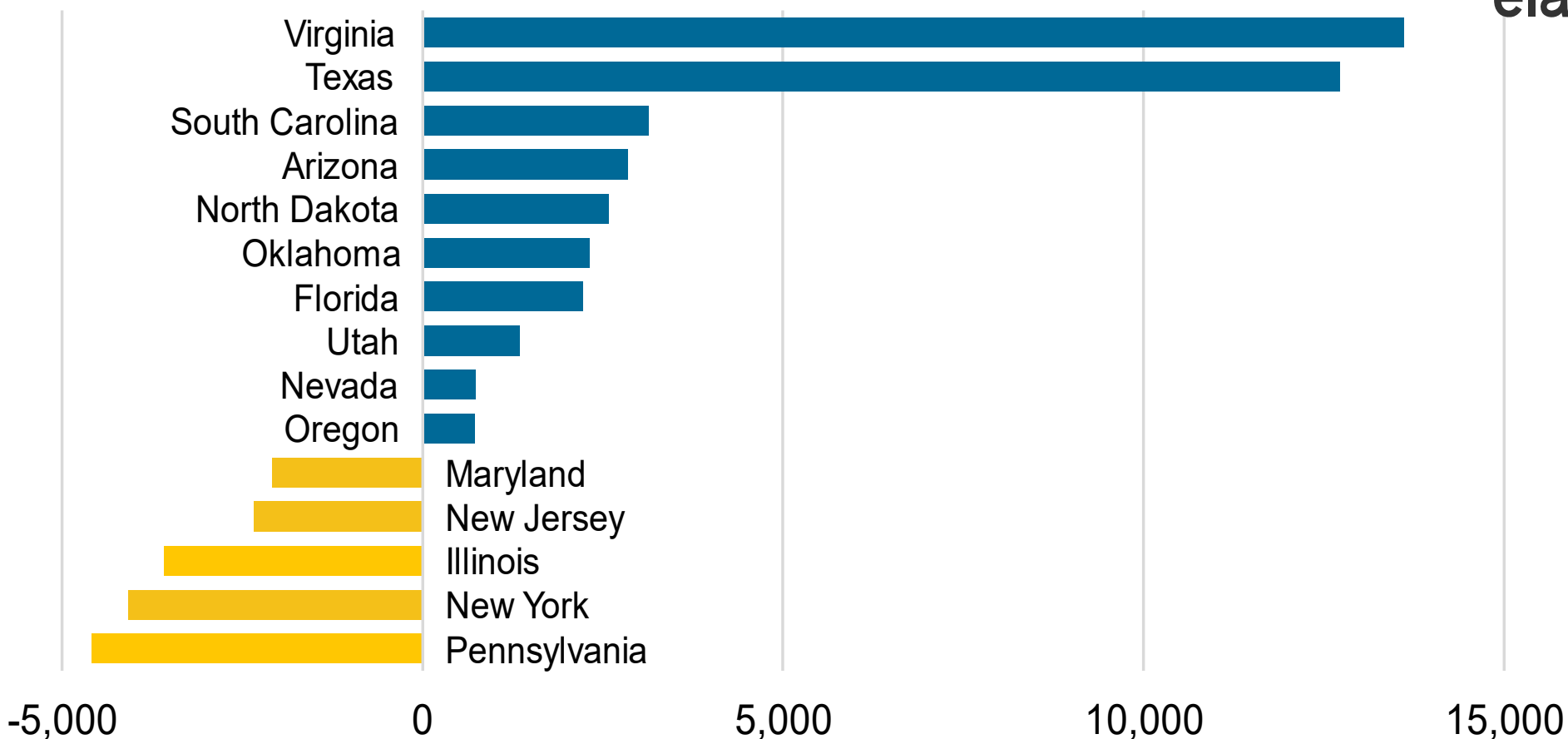


- RBAC has made adjustments to the AEO by Census Region based on in-house research and observed trends. With specific attention paid to Mid-Atlantic, South Atlantic and East South Central Census Regions.
- The 24Q3base Release has a conservative estimate of an additional ~6bcf/d of ELC Generation demand to support continued electrification, incremental data center demand, and AEO being to low relative to recent actualizations.

Source: RBAC, Inc. Visual Analytics

Electric Generation Trends

Select states by growth in commercial sector electricity consumption (2019–2023)
change in annual sales of electricity to commercial customers, gigawatthours (GWh)



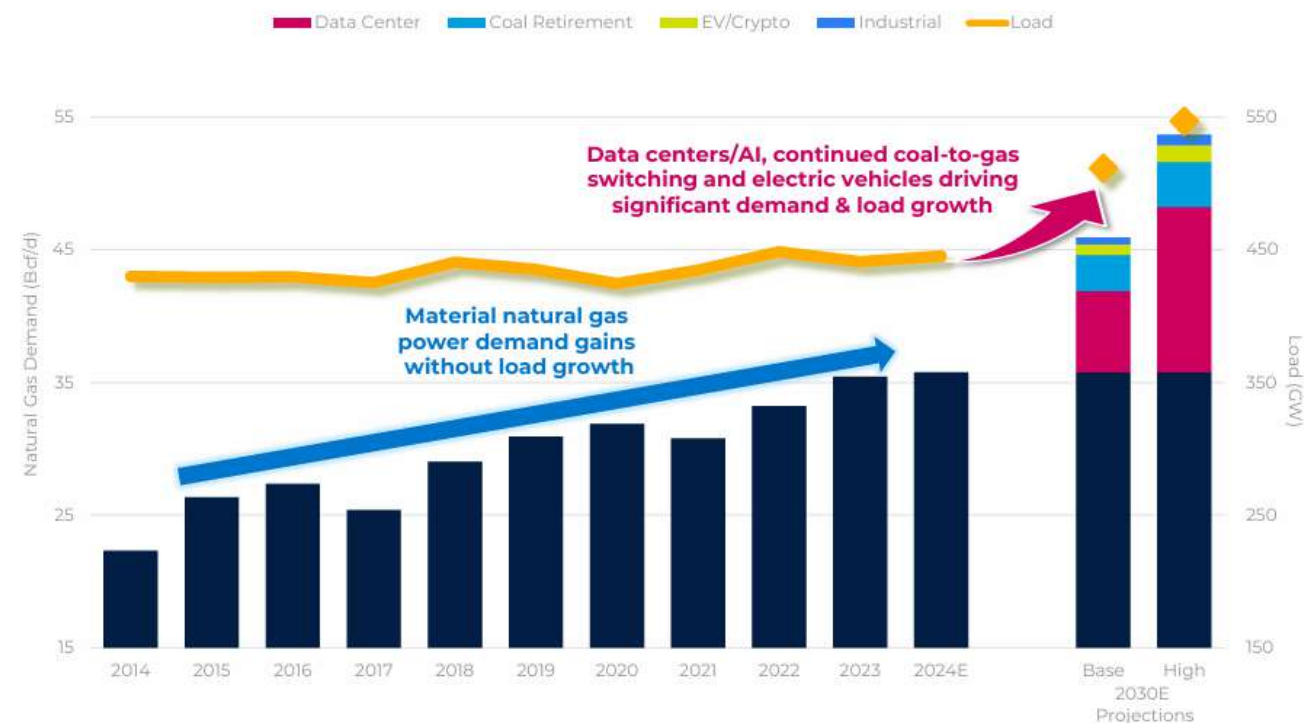
Source: EIA

More Bullish Demand Center Growth Projections

Data Center Demand Becoming the Cornerstone to Natural Gas Bull Case

Structural, baseload power demand growth occurring at the doorstep of EQT's assets

MATERIAL U.S. GAS-POWER DEMAND AND LOAD GROWTH⁽¹⁾



PROLIFERATION OF DATA CENTER AND ARTIFICIAL INTELLIGENCE PROJECTED TO DRIVE HUGE INFLECTION IN LOAD GROWTH

- U.S. gas-fired power demand grew by almost 14 Bcf/d from 2014 - 2024 with minimal underlying load growth as natural gas took market share from coal
- Data center and artificial intelligence booms, along with additional coal retirements, should drive a further **~10 Bcf/d of incremental natural gas demand by 2030**
- More aggressive data center build-out scenario drives plausible upside to **~18 Bcf/d of incremental natural gas demand by 2030**

There are a wide range of projections, with natural gas producer EQT having one of the more bullish outlooks. With a base projection of ~10bcf/d of incremental demand by 2030, EQT is significantly higher than the RBAC, Inc. base case. A more aggressive data center build out scenario projects ~18bcf/d of incremental natural gas fired electric generation.



¹ Sources: EIA and EQT research. Bcf/d calculated using 7 MMBtu/MWh heat rate.

16



GPCM Demand Workshop

Modifying Curves/Assumptions

Developer Mode

GPCM® Market Simulator for North American Gas & LNG™

Version 12.3.4.16

Scenario **24Q3base** Linked Database C:\Users\RobertKachmar\Desktop\Projects\2024 User Conference\Data Cer Split? ☒ Size(MB) 717

Scenario Subcases

Supply:	24Q3base	Storage_Available:	24Q3base
Demand:	24Q3base	Storage_Plan:	24Q3base
Pipeline_Available:	24Q3base	Storage_Data:	24Q3base
AutoExpand_Data:	24Q3base	Storage_Link:	24Q3base
Pipeline_Zone:	24Q3base	Balancing Case:	24Q3base
Pipeline_Link:	24Q3base	CO2 Case:	24Q3base
Supply_Link:	24Q3base	Crossborder Case:	24Q3base
Demand_Link:	24Q3base		
Interconnect_Link:	24Q3base		

Note: Entries in red have been modified since this scenario was last run.

Execution Parameters

Scenario Start: Jan-2015
 Scenario Finish: Dec-2050
 Discount Rate: 0.0700
 Continuation? ☐
 Based on:
 Continued From:
 Autoexpand? ☒
 Note: Auto-Expansion settings are now defined at the pipeline zone level using the AutoExpand Data table.

Execution Summary

Start Time: 10/29/2024 1:28 pm
 Run Time: 80948
 # of Variables: 6,141,680
 # of Equations: 2,864,785

Real \$ Year for linked DB is 2023

Description

Using the most recent 24Q3base Release as a starting point, we are going to create two additional scenarios reflecting EQT's base and EQT's high case. From there we will compare these to 24Q3base as well as the 23Q2base, which is the unmodified AEO Outlook.



Step 1 – Create new scenario based on 24Q3base and export into Split DB

GPCM - Control Panel - RBAC, Inc.

File **GPCM** Home Create External Data Database Tools Help Tell me what you want to do

Database Scenario Builders Data Inputs Execute Reports Windows Help View Form View Import from Excel Export to Excel Cut Copy Paste Can't Undo Refresh All A-Z Ascending Z-A Descending

Click GPCM® Market Simulator for North American Gas & LNG™ *Developer Mode*

Version 12.3.4.16 Exit

Scenario **24Q3base** Linked Database C:\Users\RobertKachmar\Desktop\Projects\2024 User Conference\Data Cer Split? ☒ Size(MB) 717

Scenario Subcases				Execution Parameters		Execution Summary	
Supply:	24Q3base	Storage_Available:	24Q3base	Scenario Start:	Jan-2015	Start Time:	10/29/2024 1:28 pm
Demand:	24Q3base	Storage_Plan:	24Q3base	Scenario Finish:	Dec-2050	Run Time:	80948
Pipeline_Available:	24Q3base	Storage_Data:	24Q3base	Discount Rate:	0.0700	# of Variables:	6,141,680
AutoExpand_Data:	24Q3base	Storage_Link:	24Q3base	Continuation?	☐	# of Equations:	2,864,785
Pipeline_Zone:	24Q3base	Balancing Case:	24Q3base	Based on:			
Pipeline_Link:	24Q3base	CO2 Case:	24Q3base	Continued From:			
Supply_Link:	24Q3base	Crossborder Case:	24Q3base	Autoexpand?	☒		
Demand_Link:	24Q3base			Note: Auto-Expansion settings are now defined at the pipeline zone level using the AutoExpand Data table.			
Interconnect_Link:	24Q3base			Real \$ Year for linked DB is 2023			

Note: Entries in red have been modified since this scenario was last run.

Description

Step 1 – Create new scenario based on 24Q3base and export into Split DB

GPCM - Control Panel - RBAC, Inc.

File

GPCM

Home

Create

External Data

Database Tools

Help

Tell me what you want to do

Database

Scenario

Builders

Data_Inputs

Execute

Reports

Windows

Help

View

Form View

Import from Excel

Export to Excel

Cut

Copy

Paste

Can't Undo

Refresh All

Ascending

Descending

Click

GPCM® Market Simulator for North American Gas & LNG™

Version 12.3.4.16

Exit

Developer Mode

Scenario

24Q3base

Linked Database

C:\Users\RobertKachmar\Desktop\Projects\2024 User Conference\Data Cer

Split?

☒

Size(MB)

717

Scenario Subcases

Supply:

24Q3base

Storage_Available:

24Q3base

Demand:

24Q3base

Storage_Plan:

24Q3base

Pipeline_Available:

24Q3base

Storage_Data:

24Q3base

AutoExpand_Data:

24Q3base

Storage_Link:

24Q3base

Pipeline_Zone:

24Q3base

Balancing Case:

24Q3base

Pipeline_Link:

24Q3base

CO2 Case:

24Q3base

Supply_Link:

24Q3base

Crossborder Case:

24Q3base

Demand_Link:

24Q3base

Interconnect_Link:

24Q3base

Note: Entries in red have been modified since this scenario was last run.

Execution Parameters

Scenario Start:

Jan-2015

Scenario Finish:

Dec-2050

Discount Rate:

0.0700

Continuation?

☐

Based on:

Continued From:

Autoexpand?

☒

Note: Auto-Expansion settings are now defined at the pipeline zone level using the AutoExpand Data table.

Execution Summary

Start Time:

10/29/2024 1:28 pm

Run Time:

80948

of Variables:

6,141,680

of Equations:

2,864,785

Real \$ Year for linked DB is 2023

Description

Export a New Scenario

The screenshot displays the GPCM® Market Simulator for North American Gas & LNG™, Version 12.3.4.16, in Developer Mode. The interface includes a menu bar (File, GPCM, Home, Create, External Data, Database Tools, Help) and a toolbar with icons for View, Form View, Import from Excel, Export to Excel, Cut, Copy, Paste, Can't Undo, Refresh All, and sorting options (Ascending, Descending). The main window shows the Scenario dropdown set to '24Q3base', the Linked Database path, and the Size (MB) as 717. A dialog box titled 'Export Scenario - Closing in 10...' is open, asking 'Do you want to export or cancel?' with options for 'Single file', 'Multi-file', and 'Cancel'. The background interface also shows 'Scenario Subcases' (Supply, Demand, Pipeline_Available, AutoExpand_Data, Pipeline_Zone, Pipeline_Link, Supply_Link, Demand_Link, Interconnect_Link) and 'Parameters' (Jan-2015, Dec-2050, 0.0700). The 'Execution Summary' panel shows Start Time: 10/29/2024 1:28 pm, Run Time: 80948, # of Variables: 6,141,680, and # of Equations: 2,864,785. A note at the bottom states: 'Note: Entries in red have been modified since this scenario was last run.'

Click the
Scenario
dropdown

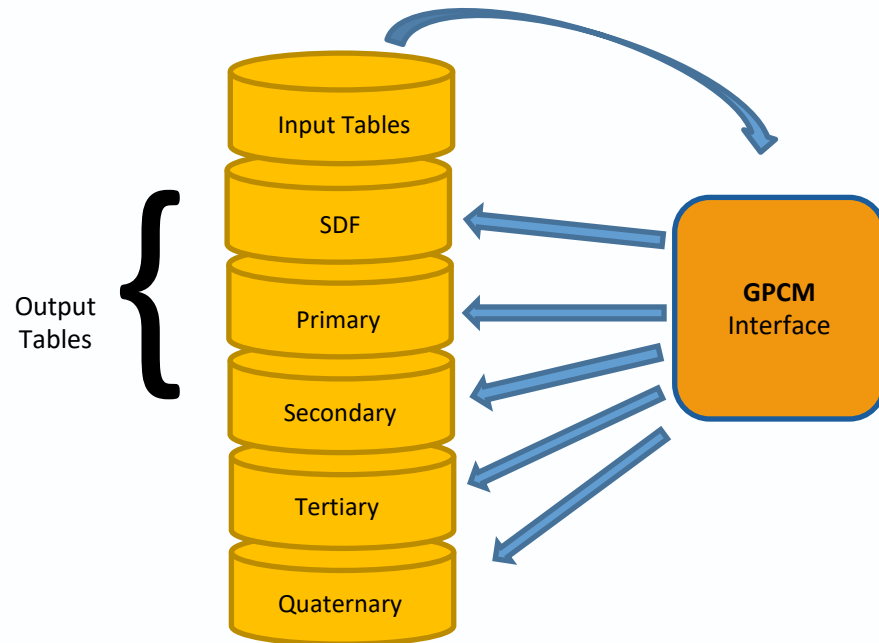


Click on
Export
Scenario



Export
Scenario as a
Multi-file DB

Benefits of a Split DB



Every year of your run adds approximately 45 megabytes to the size of the database.

Running a single 40-year scenario, or multiple scenarios that add up to 30-40 years will cause the database to run up against the **maximum database size** in Microsoft Access.

If we split the database – this is now **spread across six databases**.

Splitting the database into multiple files allows GPCM to store many more results without running into the database size limit of Microsoft Access.



Step 2 – Make new Demand Scenarios

File GPCM Home Create External Data Database Tools Help Tell me what you want to do

Database Scenario Builders Data_Inputs Execute Reports Windows Help

View Form Import Export Cut Copy Paste
View View from Excel to Excel

Can't Undo Refresh All

Ascending Descending

GPCM® Market Simulator for North American Gas & LNG™ *Developer Mode*

Version 12.3.4.16 Exit

Scenario **24Q3base** Linked Database C:\Users\Robert\Kachmar\Desktop\Projects\2024 User Conference\Data Cer Split? ☒ Size(MB) 717

Scenario Subcases				Execution Parameters		Execution Summary	
Supply:	24Q3base	Storage_Available:	24Q3base	Scenario Start:	Jan-2015	Start Time:	10/29/2024 1:28 pm
Demand:	24Q3base	Storage_Plan:	24Q3base	Scenario Finish:	Dec-2050	Run Time:	80948
Pipeline_Available:	24Q3base	Storage_Data:	24Q3base	Discount Rate:	0.0700	# of Variables:	6,141,680
AutoExpand_Data:		Storage_Link:	24Q3base	Continuation?	☐	# of Equations:	2,864,785
Pipeline_Zone:		Balancing Case:	24Q3base	Based on:			
Pipeline_Link:		CO2 Case:	24Q3base	Continued From:			
Supply_Link:		Crossborder Case:	24Q3base	Autoexpand?	☒		
Demand_Link:				Note: Auto-Expansion settings are now defined at the pipeline zone level using the AutoExpand Data table.			
Interconnect_Link:				Real \$ Year for linked DB is 2023			

Note: Entries in red have been modified since this scenario was last run.

MAKE NEW DEMAND CASE

New_Case_Name: EQT base

Based_On_Case:	24Q3base	
----------------	----------	--

Randomizing Frac: 0.00

Randomizing Period: Nov-2024 thru Dec-2050

NOTE: when adjusting LNG Export or Lease and Plant Fuel, you must enter either the specific customer name or the sector (EXP or LPF) or the record will be ignored.

Double-click for more info.

Clear Old Records

[illegible]

Demand Make – New EQT High

MAKE NEW DEMAND CASE

New_Case_Name:

Based_On_Case:

Randomizing Frac:

Randomizing Period: thru

NOTE: when adjusting LNG Export or Lease and Plant Fuel, you must enter either the specific customer name or the sector (EXP or LPF) or the record will be ignored.

Double-click for more info.

[Clear Old Records](#)

Cust_Name	Sector	Demand_Area	State	Census_Regior	Basin_Group	Other	ISO/RTO	NERC	Country	North_America	From	Thru	QMult	QAdd	PMult	Elasticity
	ELC								USA		Jan-2025	Dec-2025	1.180	0	1.000	
	ELC								USA		Jan-2026	Dec-2026	1.290	0	1.000	
	ELC								USA		Jan-2027	Dec-2027	1.310	0	1.000	
	ELC								USA		Jan-2028	Dec-2028	1.320	0	1.000	
	ELC								USA		Jan-2029	Dec-2029	1.350	0	1.000	
	ELC								USA		Jan-2030	Dec-2030	1.360	0	1.000	
	ELC								USA		Jan-2031	Dec-2031	1.350	0	1.000	
*													1.000	0	1.000	

Record: 1 of 7 [No Filter](#)

[Make New](#)

[Cancel](#)



Step 3 – Make New Scenarios for the Demand Cases and Execute

Developer Mode

GPCM® Market Simulator for North American Gas & LNG™

Version 12.3.4.16

Scenario **EQTbase** Linked Database C:\Users\RobertKachmar\Desktop\Projects\2024 User Conference\Data Cer Split? ☒ Size(MB) 717

Scenario Subcases

Supply:	24Q3base	Storage_Available:	24Q3base
Demand:	EQT base	Storage_Plan:	24Q3base
Pipeline_Available:	24Q3base	Storage_Data:	24Q3base
AutoExpand_Data:	24Q3base	Storage_Link:	24Q3base
Pipeline_Zone:	24Q3base	Balancing Case:	24Q3base
Pipeline_Link:	24Q3base	CO2 Case:	24Q3base
Supply_Link:	24Q3base	Crossborder Case:	24Q3base
Demand_Link:	24Q3base		
Interconnect_Link:	24Q3base		

Note: Entries in red have been modified since this scenario was last run.

Execution Parameters

Scenario Start:	Jan-2015
Scenario Finish:	Dec-2030
Discount Rate:	0.0700
Continuation?	☐
Based on:	
Continued From:	
Autoexpand?	☒

Note: Auto-Expansion settings are now defined at the pipeline zone level using the AutoExpand Data table.

Execution Summary

Start Time:	11/7/2024 2:55 pm
Run Time:	3953
# of Variables:	2,686,579
# of Equations:	1,251,049

Real \$ Year for linked DB is 2023

Developer Mode

GPCM® Market Simulator for North American Gas & LNG™

Version 12.3.4.16

Scenario **EQTHigh** Linked Database C:\Users\RobertKachmar\Desktop\Projects\2024 User Conference\Data Cer Split? ☒ Size(MB) 717

Scenario Subcases

Supply:	24Q3base	Storage_Available:	24Q3base
Demand:	EQT High	Storage_Plan:	24Q3base
Pipeline_Available:	24Q3base	Storage_Data:	24Q3base
AutoExpand_Data:	24Q3base	Storage_Link:	24Q3base
Pipeline_Zone:	24Q3base	Balancing Case:	24Q3base
Pipeline_Link:	24Q3base	CO2 Case:	24Q3base
Supply_Link:	24Q3base	Crossborder Case:	24Q3base
Demand_Link:	24Q3base		
Interconnect_Link:	24Q3base		

Note: Entries in red have been modified since this scenario was last run.

Execution Parameters

Scenario Start:	Jan-2015
Scenario Finish:	Dec-2030
Discount Rate:	0.0700
Continuation?	☐
Based on:	
Continued From:	
Autoexpand?	☒

Note: Auto-Expansion settings are now defined at the pipeline zone level using the AutoExpand Data table.

Execution Summary

Start Time:	11/7/2024 4:05 pm
Run Time:	2074
# of Variables:	2,686,195
# of Equations:	1,250,857

Real \$ Year for linked DB is 2023



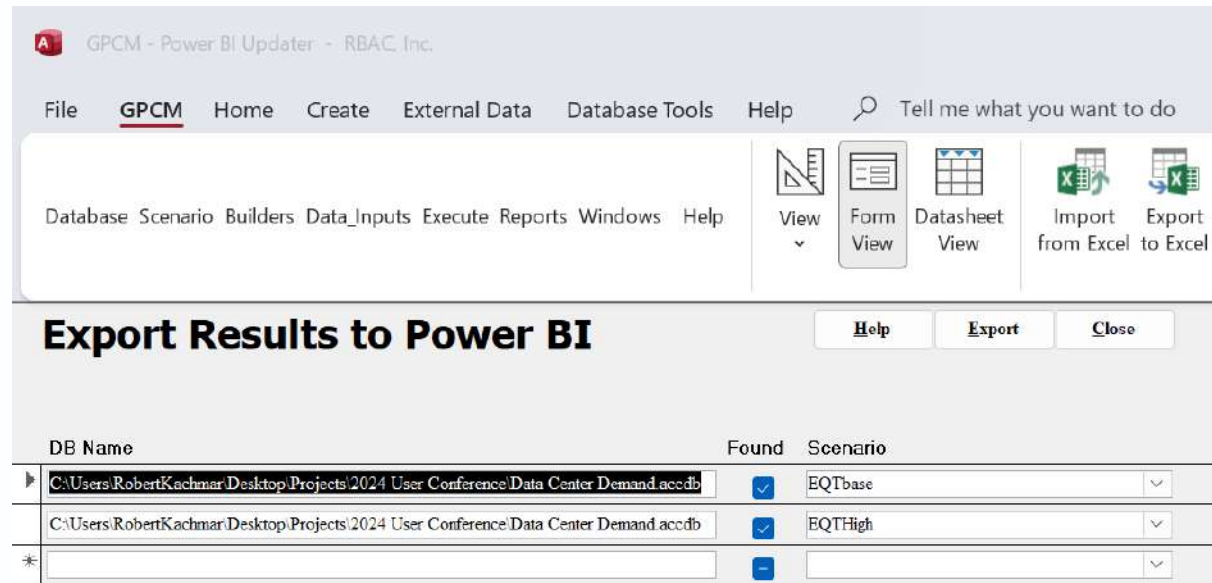
Results Analysis



Power BI



Export Scenario Results to PBI



Reports



GPCM
PowerBI
Interface



Export

Demand Changes in US ELC Gen



Supply Change in Aggregate



Price Changes in Major Consuming Regions



LNG Exports



Take-a-ways

Supply

- There is a sufficient resource base to accommodate the additional demand resulting from continued electrification and data center demand.

Price

- There would be significant pricing impacts in every consuming region. Raising costs for every sector.

LNG

- There is a minimal impact on LNG Exports out of North America as Export facilities effectively become price takers under “take or pay” contracts.

Unknowns

- The distribution of additional data center demand is difficult to predict but will have a significant impact on basis and regional pipeline flows.

QUESTIONS?





RBAC, Inc.

www.rbac.com

(281) 506-0588

contact@rbac.com

RBAC leads the market in global and regional gas and LNG market simulation and predictive analytics in support of corporate investment and M&A strategy, ESG, risk analysis, planning, and commodity trading. Our products and expertise help companies go beyond the narratives and hype to identify the opportunities and define the risks inherent in the uncertainties of energy transition using reality and fact-based fundamentals and analysis.

We continuously enhance our market simulation systems with the latest software and computer technology while applying the best of mathematical economics to assist our clients achieve their goals. This is especially needed as we see fundamental shifts taking place in the energy industry to achieve energy transition goals and meet increasingly demanding requirements of ESG. We provide regularly scheduled updates of our simulation systems and databases to keep our clients up-to-date with the most current market information. We enhance the functionality of our systems to enable our customers to simulate the effect of new regulations or industry requirements.

Our aim is to continue to lead the market in best practices which raise the standard of market simulation, enabling rapid and flexible scenario generation, sensitivity analysis, risk-assessment and forecasting, giving clients the edge in the rapidly changing energy market.

Those using RBAC's products and services include energy industry firms and consultants, as well as government agencies involved with energy, transportation, and the environment.

RBAC's principal products include:

- **GPCM® Market Simulator for North American Gas and LNG™** focused on the North American gas & LNG markets. GPCM is the industry standard market simulator for North American gas.
- **G2M2® Market Simulator for Global Gas and LNG™** for simulating increasingly integrated gas and LNG markets worldwide.
- **Gas4Power®** for integrating gas and power market fundamentals to produce credible forecasts for both.
- **NGL-NA®** Market Simulator for North American Natural Gas Liquids

With RBAC's advanced simulation systems, licensees can create and run scenarios involving bio-methane (Renewable Natural Gas – RNG) mixed with natural gas and to assess the implications of carbon taxes and markets on supply, demand, and prices. Future enhancements will include the ability to simulate the advent of a future hydrogen market with both pure hydrogen pipelines as well as mixtures with methane. The Energy Analyst of today and the future needs these kinds of tools to conduct realistic assessments and help develop realistic strategies and plans to achieve the goals of the energy transition.

Dr. Robert Brooks founded RBAC in 1987 based on experience developing several well-respected predictive models for government and industry. He designed the first gas transportation model while getting his PhD at MIT and has led the industry ever since.

RBAC's staff includes industry-trained experts in natural gas supply and demand, transportation, storage, marketing, and trading. Our team applies its world-class expertise in mathematical modeling, statistical analysis, mathematical algorithm development, software engineering, and database design to current and future challenges, risks and opportunities in energy.

To find out more information about **GPCM** scan:



To schedule a meeting with RBAC email: contact@rbac.com