Bottlenecks to Buildouts

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- **Energy Security**

Bottlenecks to Buildouts

Simulating Infrastructure Growth with Auto-Expand

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Simulating Infrastructure Growth with Auto-Expand

1. Auto-Expand Background
2. Scenario Set-up
3. Henry Hub Compare
4. Production Area Price Compare
5. Summary

Auto-Expand History

GPCM informs users of instances when flows across the various arcs in the model reach their capacities and additional capacity would be desirable. The marginal value of adding more capacity on such arcs is reported as “Economic Rent”. Prior to 2014 users interested in identifying potential expansion projects that could address these congestion points would have to do so by trial-and-error. They found that increasing capacity at one point in the network often just resulted in another constraint elsewhere. Because of the complexity of the grid, it was difficult to come up with a strategy for handling these bottlenecks.

To address this issue, RBAC developed new GPCM functionality called “Auto-Expand”. Users can selectively allow future pipeline expansions when the economic rents on one or more arcs of a pipeline exceed a “hurdle cost” set by the user. Auto-expansion reports show the analyst which pipelines need to expand in order to meet the market demands of that scenario. It also differentiates between those needed expansions which are very small and could be handled with existing pipeline capacity, those which are seasonal, and those which are both significant and year-round. Users can then choose to incorporate some of these changes into their own standard “reference case”. One can also run the scenario with Auto-Expand set to OFF, as in the original use of GPCM.

Auto-Expand Theory

Is the Pipeline Zone allowed to Auto Expand?

Is the current month/year eligible for Auto Expand?

Is the Pipeline Zone experiencing 100% utilization rates?

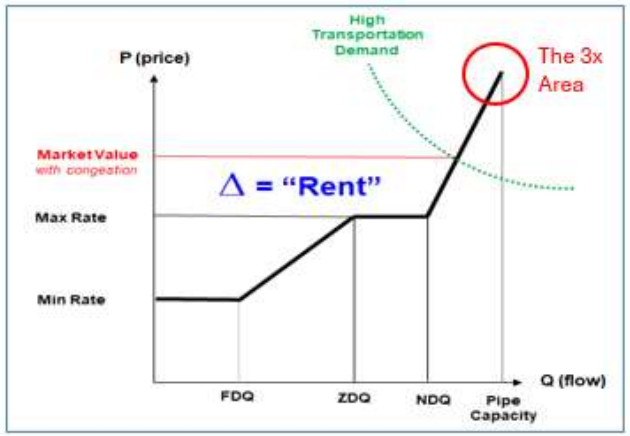
For each month & zone: Are rates ≥ 3 x Max Rates (or $0.20 for zones w/Max Rates = 0)?

Are the Pipeline Links experiencing 100% utilization rates?

For each month & pipe link: Are Unit Costs ≥ 3 x Unit Costs (or $0.20 for zones w/Unit Costs = 0)?

Expand pipeline zone or pipe link, up to specified limit

Exogenous analysis can be used to determine approximate economic cost of expansion – e.g., what tariff rates are required to achieve a desired return on capital



Auto-Expand Exclusions

Auto-Expand is turned off in the following states:

- California
- Connecticut
- Maine
- New Hampshire
- New Jersey
- New York
- Vermont

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Scenario Set-up

	Incremental Change From RBAC Base Case				
	Comparative Analysis	Economic Hurdle	AutoExpand Percentages		
			2029	2039	2049
RBAC Base Case	Status Quo	3x Max Rate	50%	75%	100%
Auto Expand 1	Turning Auto Expand on in New England and California	3x Max Rate	50%	75%	100%
Auto Expand 2	Adjusting the Economic Hurdle to Expansion in the Forecast Period	1.5 Max Rate	50%	75%	100%
Auto Expand 3	Adjusting the Percentages that Pipelines can expand in the Forecast Period	3x Max Rate	100%	250%	500%
Auto Expand 4	Adjusting the Economic Hurdle to Expansion in the Forecast Period	1x Max Rate	50%	75%	100%

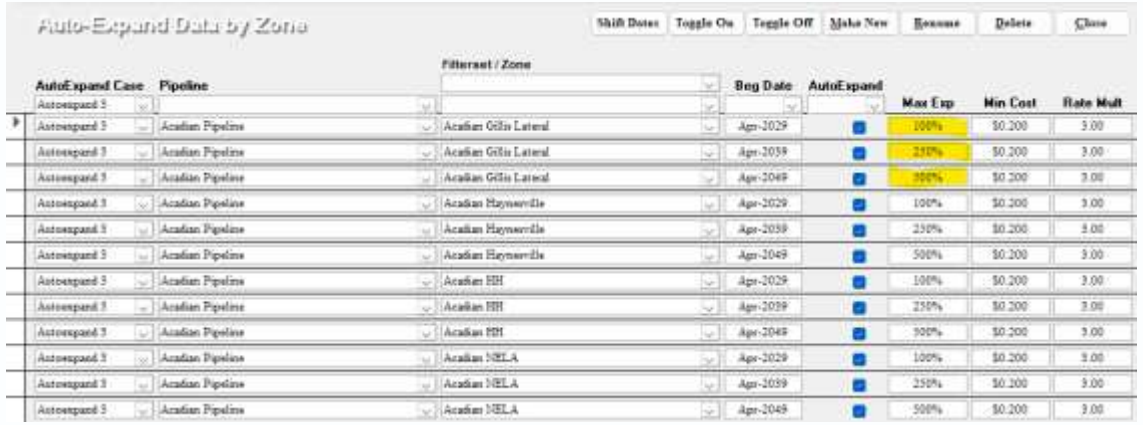
Auto-Expand 1

- Creating a new Auto-Expand “Sub Case” with no states excluded is as simple as:
  - Click Make New
  - In the Auto-Expand drop down select No
  - Check the boxes
  - Select your new Sub Case in the Control Panel
  - Execute Scenario

Auto-Expand 2

- Creating a new Auto-Expand “Sub Case” based on Auto-Expand 1
  - Click Make New
  - Click on Datasheet view
  - Click in the upper left-hand corner and copy to excel
  - Adjust the “Rate Mult” field down to 1.5
  - Delete existing Auto-Expand data and paste back in
  - Select your new Sub Case in the Control Panel
  - Execute Scenario

Auto-Expand 3



- Creating a new Auto-Expand “Sub Case” based on Auto-Expand 1
  - Click Make New
  - Click on Datasheet view
  - Click in the upper left-hand corner and copy to excel
  - Adjust the “Max Expand” fields down to 100%, 250%, and 500%
  - Delete existing Auto-Expand data and paste back in
  - Select your new Sub Case in the Control Panel
  - Execute Scenario

Auto-Expand 4

- Creating a new Auto-Expand “Sub Case” based on Auto-Expand 1
  - Click Make New
  - Click on Datasheet view
  - Click in the upper left-hand corner and copy to excel
  - Adjust the “Rate Mult” field down to 1
  - Delete existing Auto-Expand data and paste back in
  - Select your new Sub Case in the Control Panel
  - Execute Scenario

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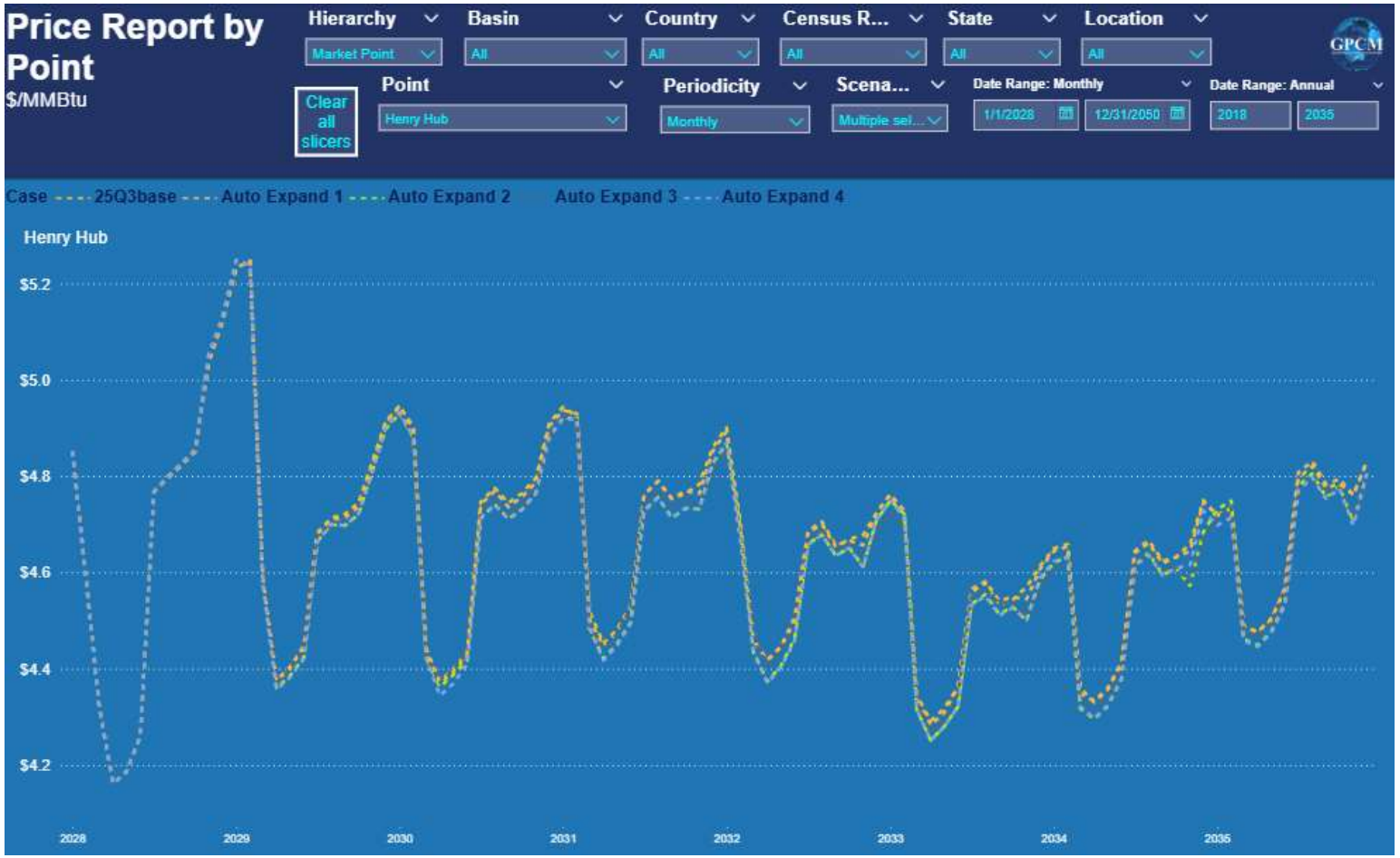
Henry Hub



Looking at Henry Hub we see that each scenario lowers prices, but to varying extents. Scenario 1, with New England and California Auto-Expand turned on had the least. Followed by Auto-Expand 3 where we adjusted the max increase percentages. Interestingly enough, Auto-Expand 2 and 4 had the largest and similar impacts.

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Eastern Gas Southpoint

We see a different trend emerging in the producing regions constrained by take-a-way capacity. Lower and less stringent Auto-expand assumptions raise prices in these regions as greater exposure to premium markets. With Auto-Expand 4 and 3 having the largest impacts to these pricing hubs

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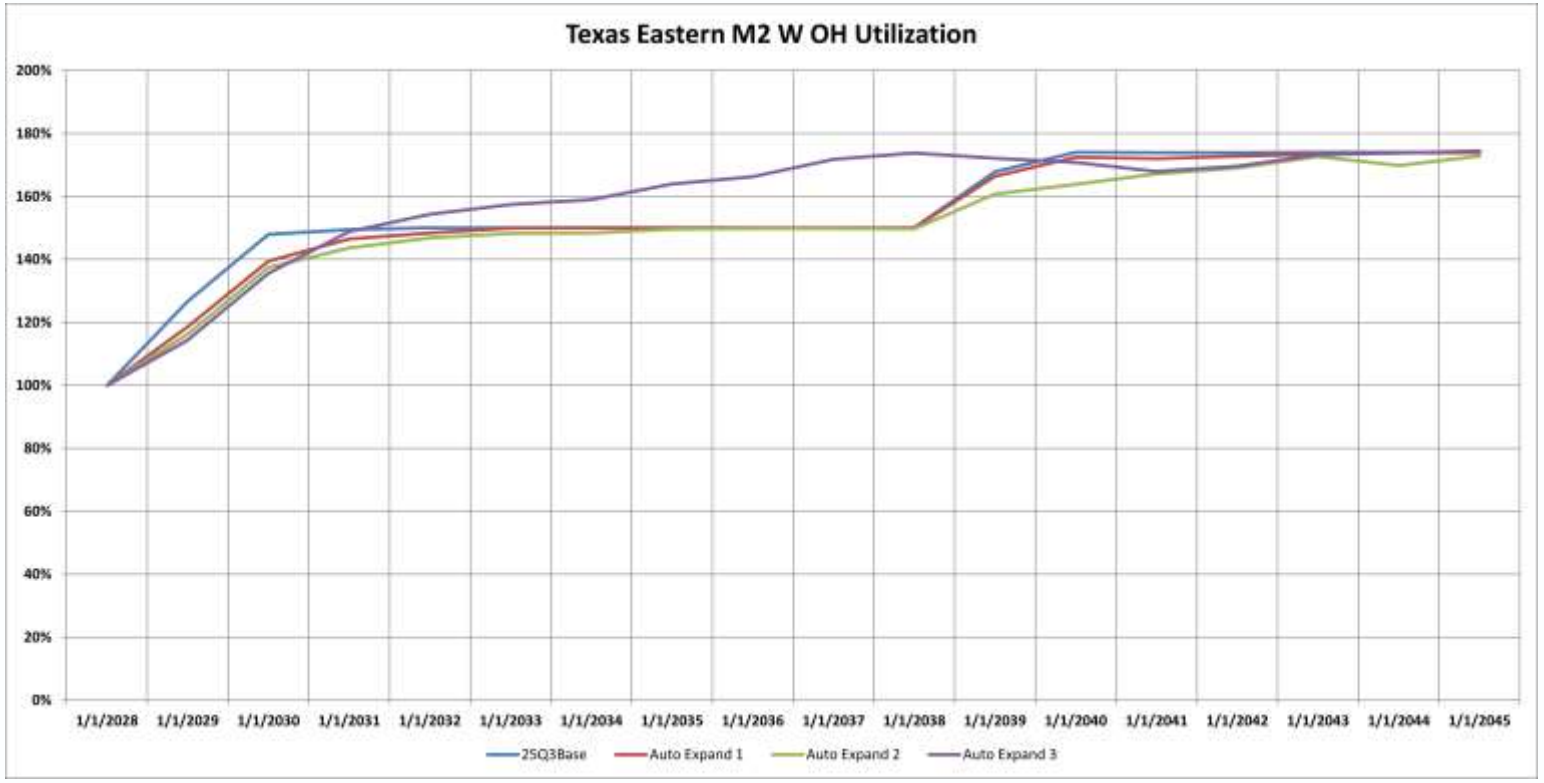
Summary - Utilization



Texas Eastern M2 W OH was one of the most impacted zones in our study. With Auto-Expand 3 and its large percentage increases being impactful in the first series of expansions. Post 2039 and the second series of expansions, we see a normalization scenario impacts. As if Auto-Expand is needed in real life, but only to a certain extent.

GPCM Case Study – Auto-Expand

Summary

- More transportation capacity is needed in the United States. With particular emphasis on the producing regions. By reducing or even eliminating regulatory hurdles, all parties benefit. Consumers experience lower gas costs, producers realize higher profits as reduced bottle necks allow more exposure to consuming markets, and transporters move more volume.
- While more transportation is needed, addition study is needed for exactly how much and where. The use of Auto-Expand's functionality is very useful in this effort and RBAC will continue to explore this futher in the future.

GPCM Auto-Expand Case Study

Questions?

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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**