

Benchmarking Gas Monetization: A Path Forward for Gas-to-Liquids

Gas-to-Liquids Technology Forum 2013
July 2013



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Outline

▶ **Path Forward for Gas-to-Liquids**

▶ About ADI Analytics

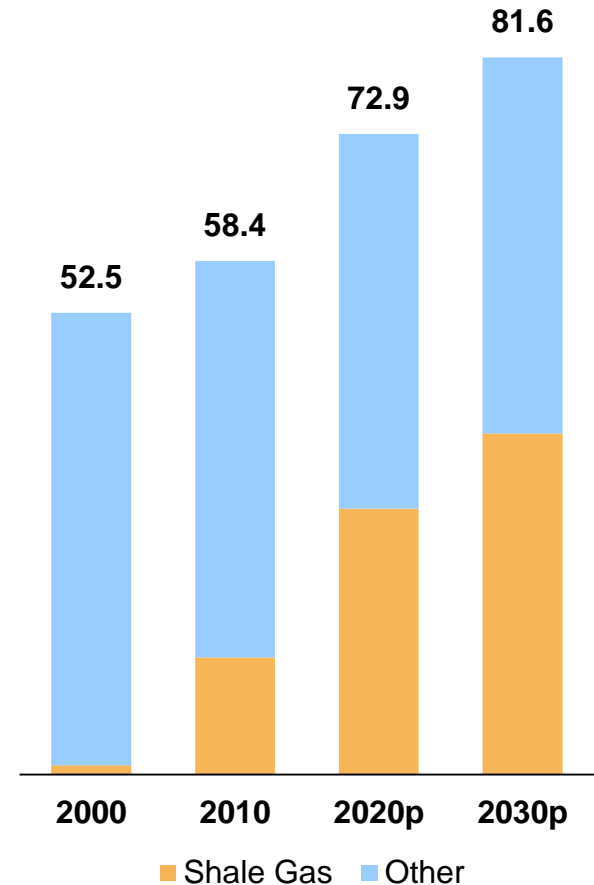
The rapid development of unconventional resources in North America is driving up natural gas supply

North American Shale Gas Basins



Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI. Updated: May 9, 2011

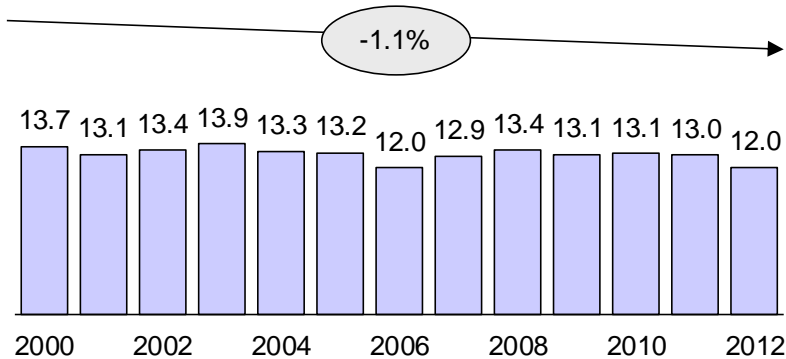
U.S. Natural Gas Supply (Billion Cubic Feet Per Day)



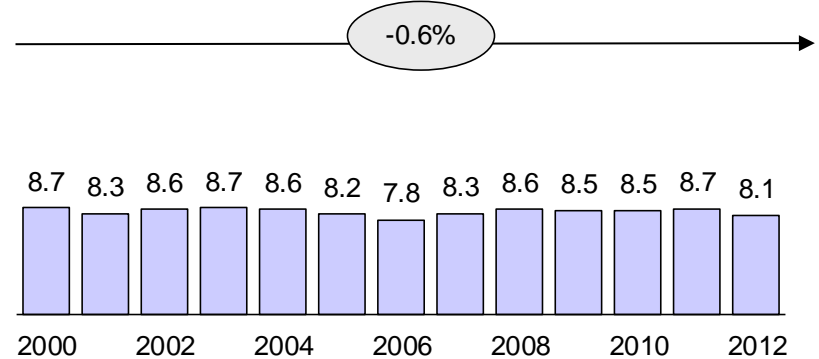
Source: U.S. Department of Energy; EIA Annual Energy Outlook 2013

However, North American demand for gas is stagnant or even declining, with use for power being the sole bright spot

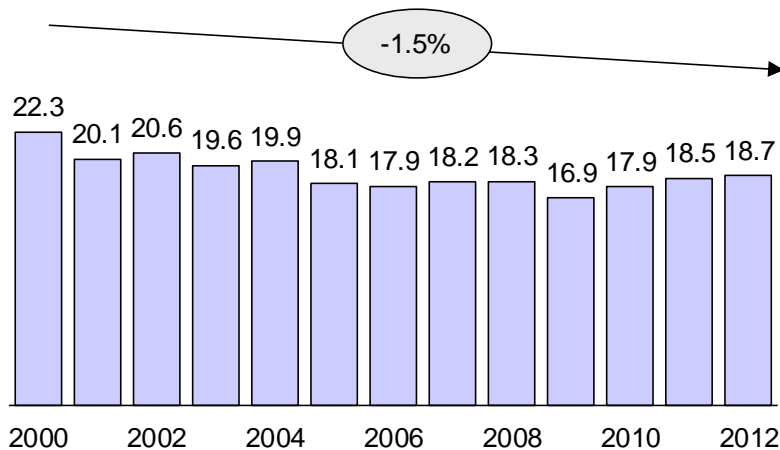
Residential Natural Gas Demand
(Billion Cubic Feet Per Day)



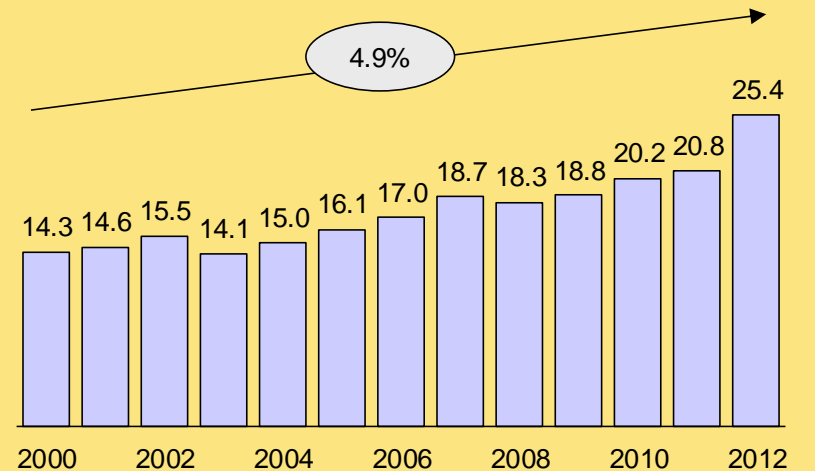
Commercial Natural Gas Demand
(Billion Cubic Feet Per Day)



Industrial Natural Gas Demand
(Billion Cubic Feet Per Day)



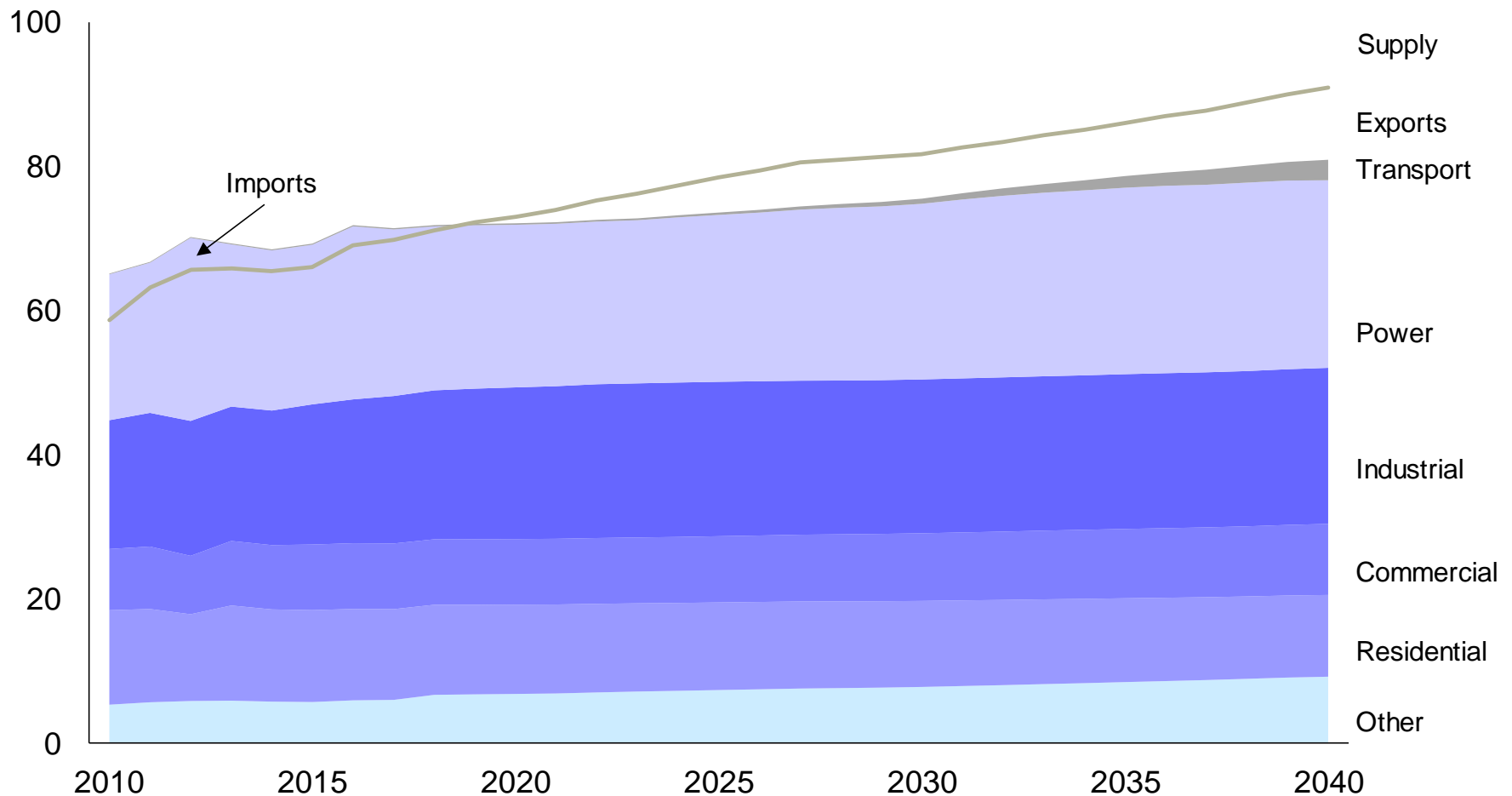
Natural Gas Demand for Power
(Billion Cubic Feet Per Day)



Source: EIA Annual Energy Outlook, 2013

Consequently, projected supply is expected to outstrip business-as-usual demand for natural gas

U.S. Natural Gas Demand Scenarios
(Billion Cubic Feet Per Day)



Source: EIA Annual Energy Outlook, 2013

As a result, natural gas prices have declined recently and ...

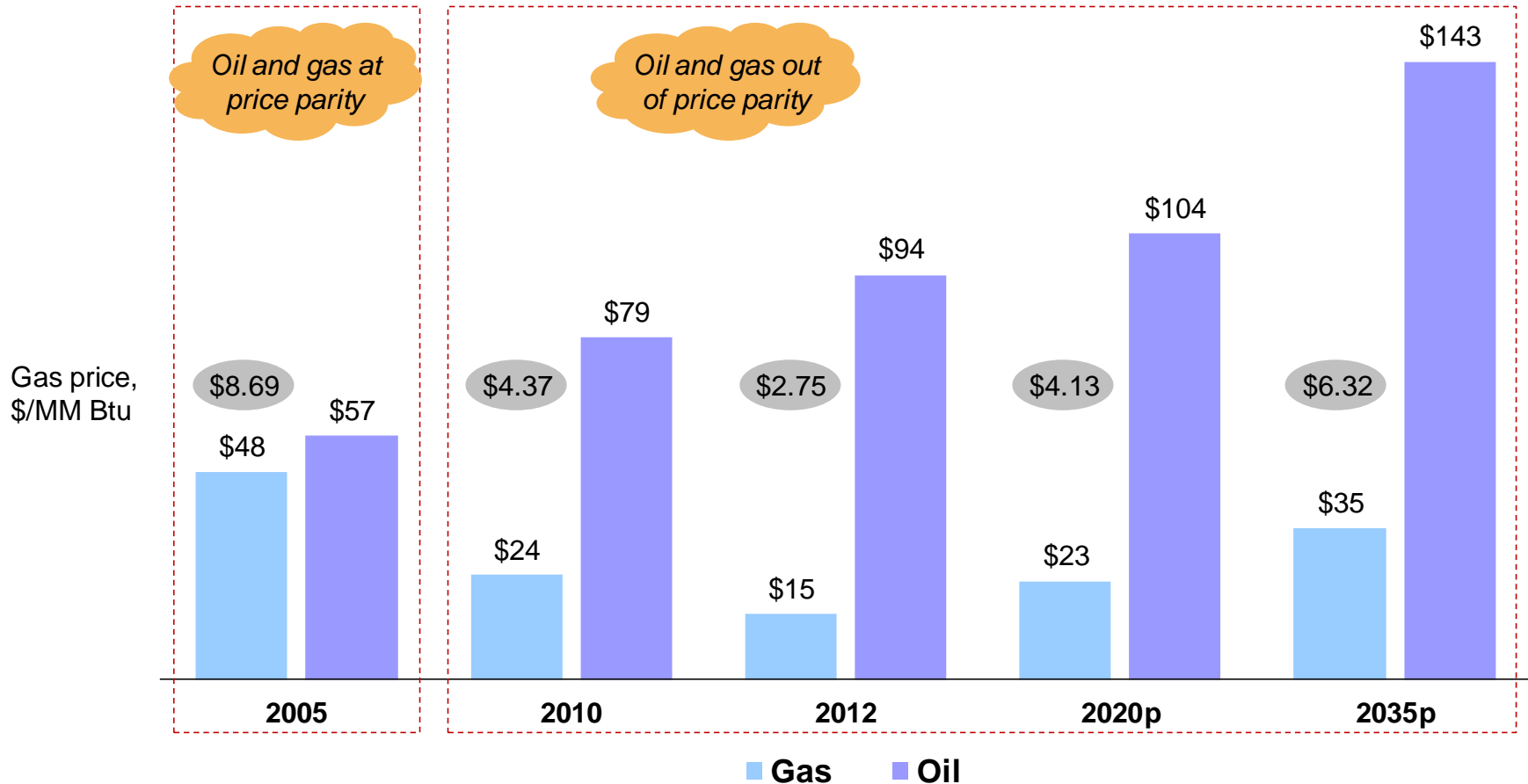
Natural Gas Price
(Henry Hub, \$ / Million Btu)



Source: EIA

... Altered oil-gas price parity spurring interest in gas monetization

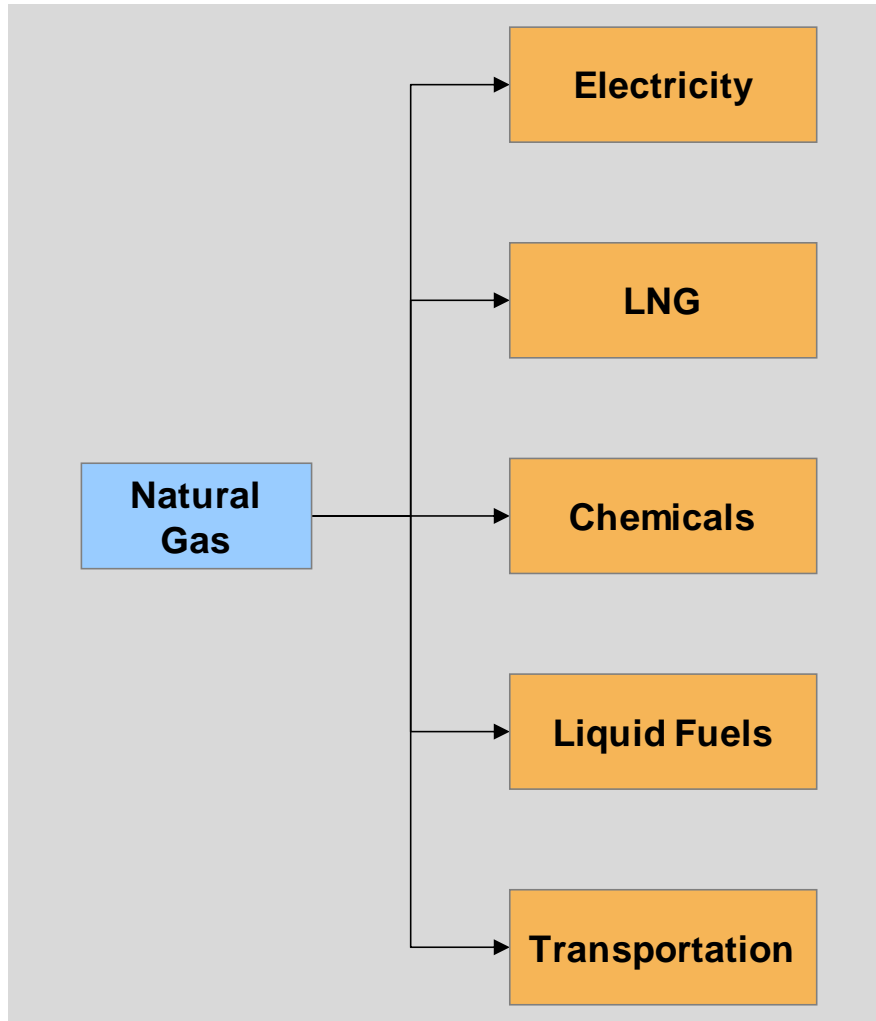
U.S. Natural Gas and Oil Prices
(U.S. \$ / BOE)



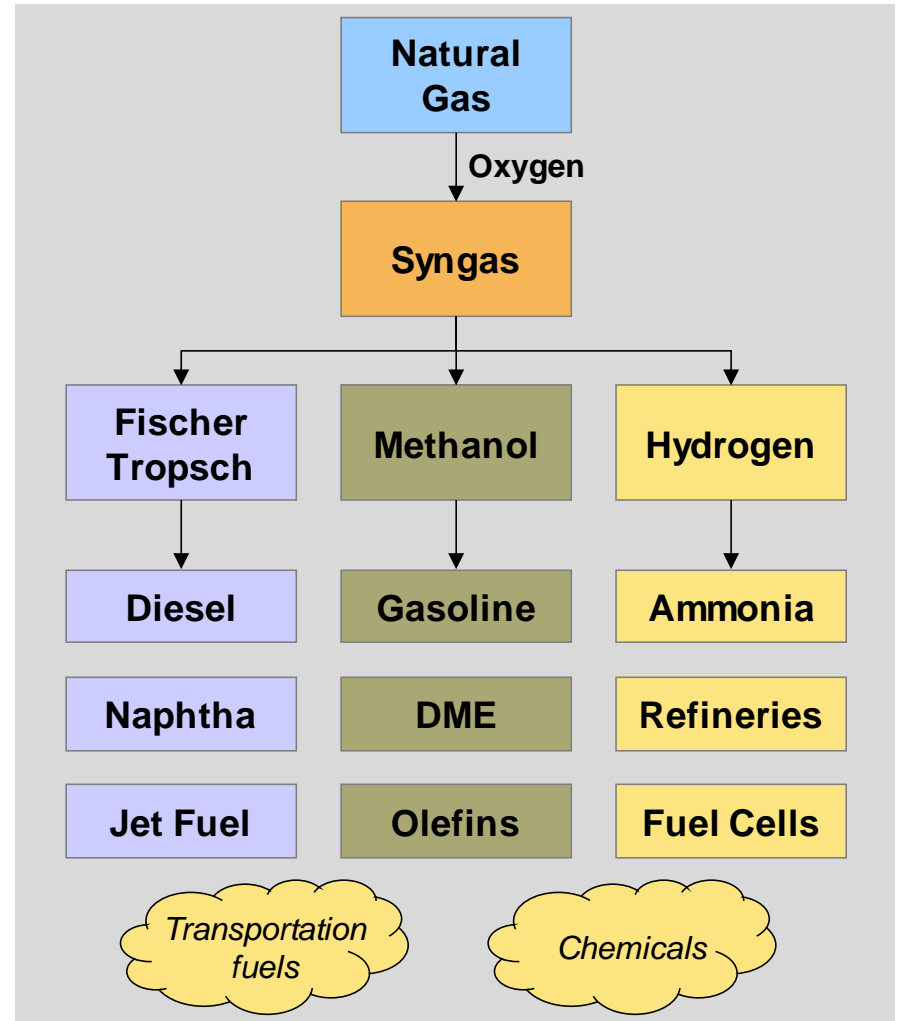
Source: EIA Annual Energy Outlook, 2013

ADI Analytics has benchmarked a number of options and processes to utilize, convert, and monetize natural gas

Gas Utilization Options

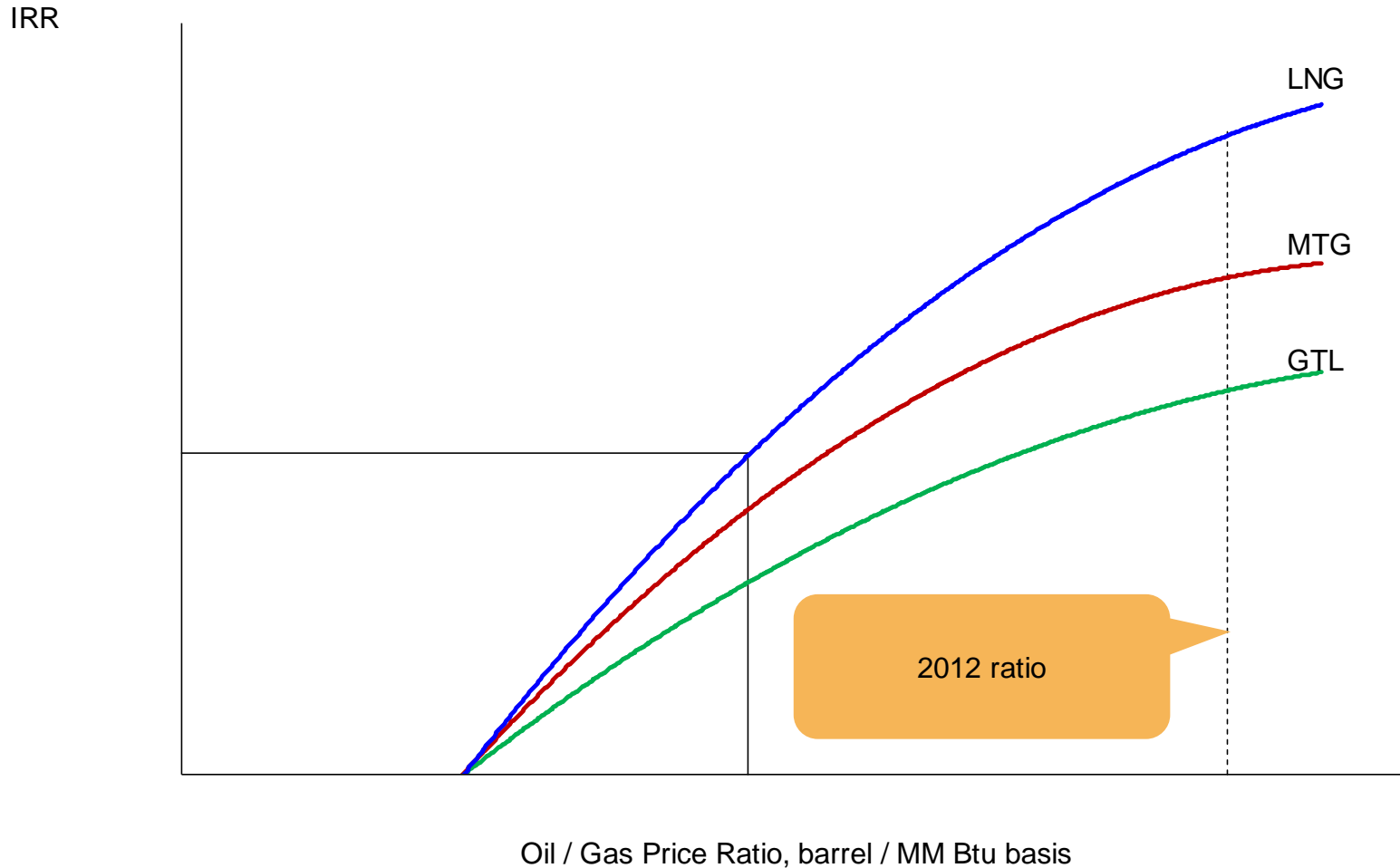


Gas Conversion Processes



In North America, LNG export projects offer very attractive returns followed by MTG and GTL projects

Gas Monetization IRRs Vs. Oil/Gas Price Ratio
(U.S. Gulf Coast, 35% Taxes, No Debt)



Source: ADI Analytics Research

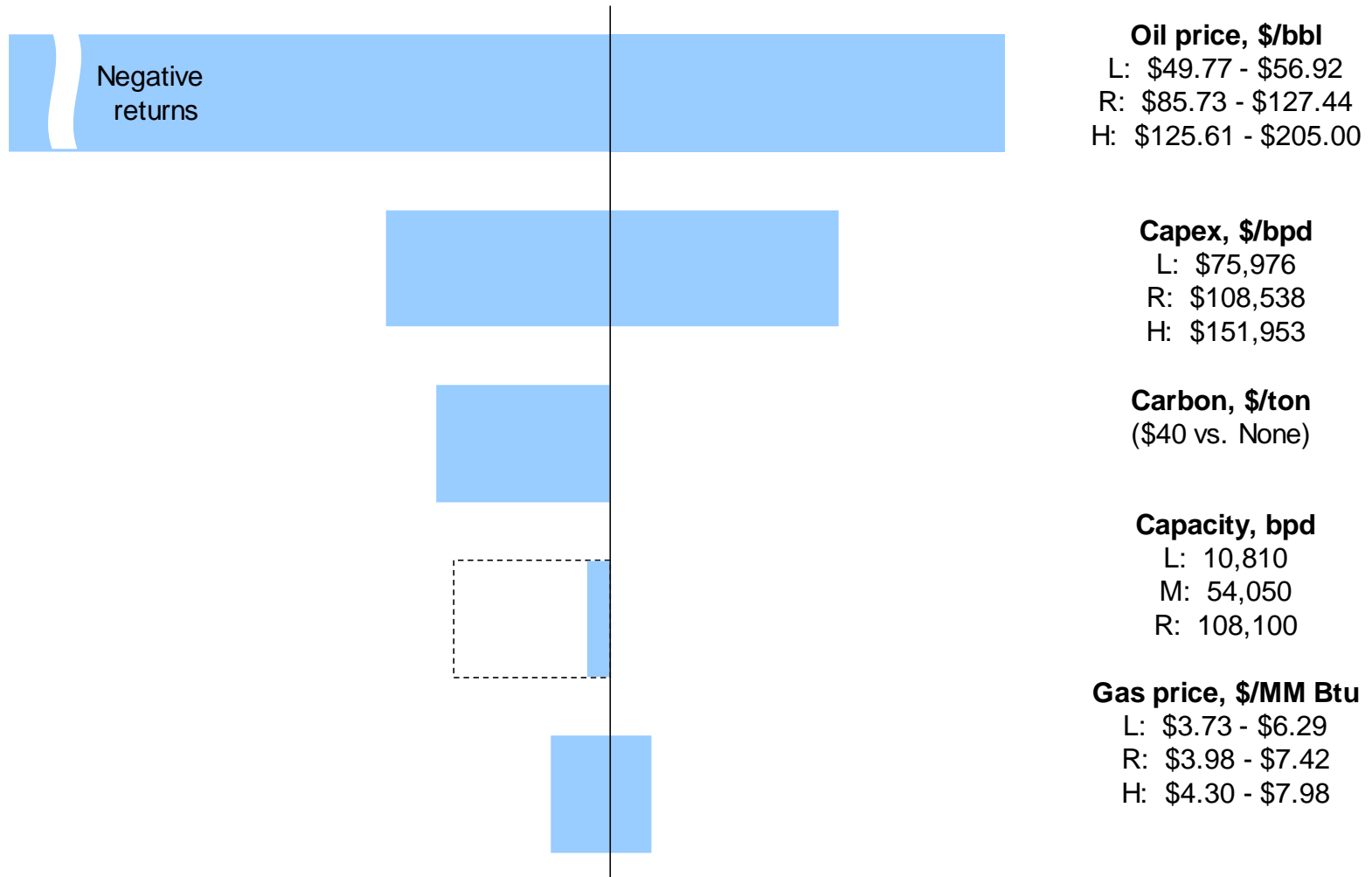
Key takeaways

1

Conventional, large-scale GTL projects in North America will find it difficult to compete with LNG export projects on the basis of economic returns

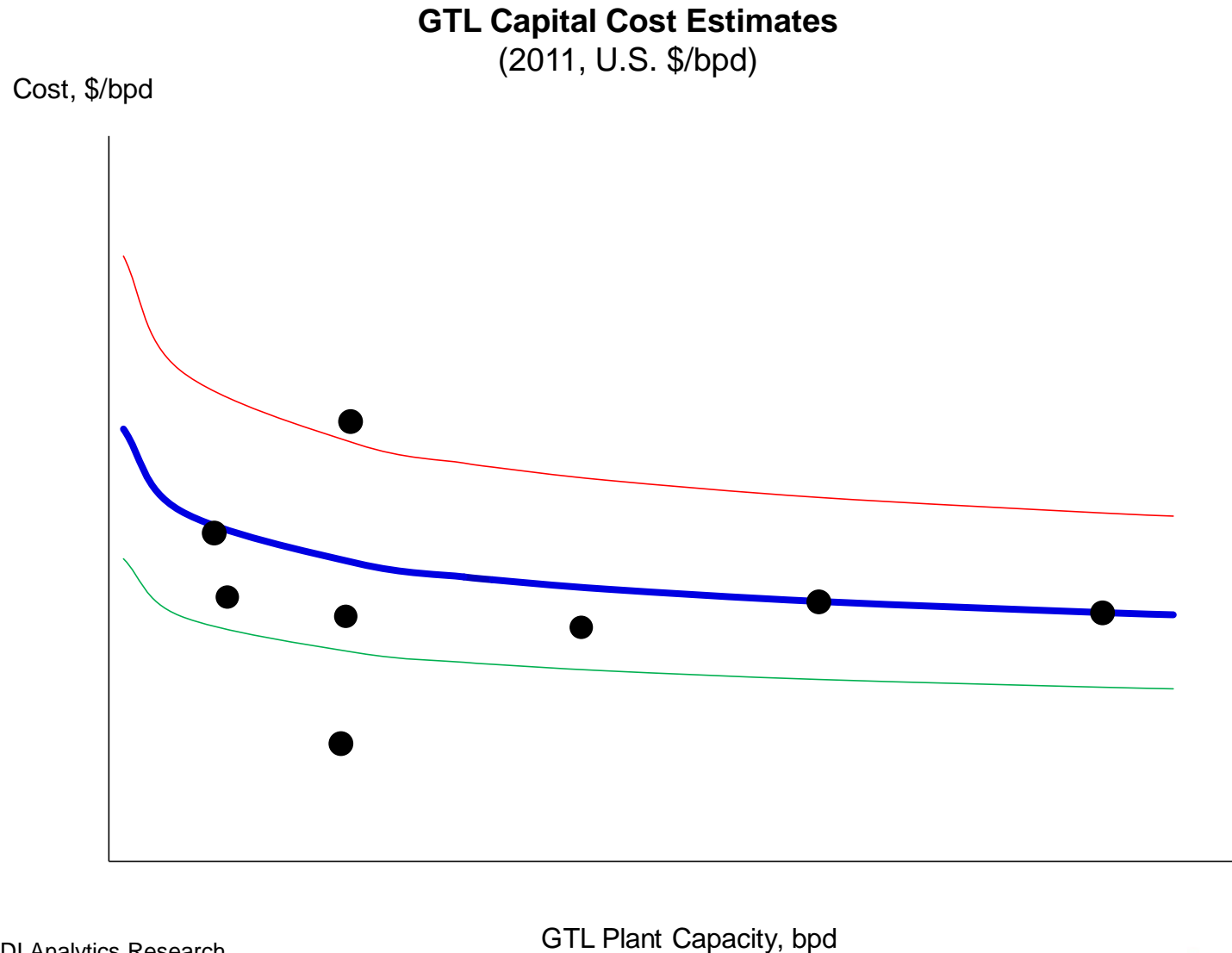
Capex is the primary controllable variable for GTL returns

IRR Variations for USGC GTL Plant (108,100 bpd, Reference Case, 35% Taxes, No Debt)



Source: ADI Analytics Research

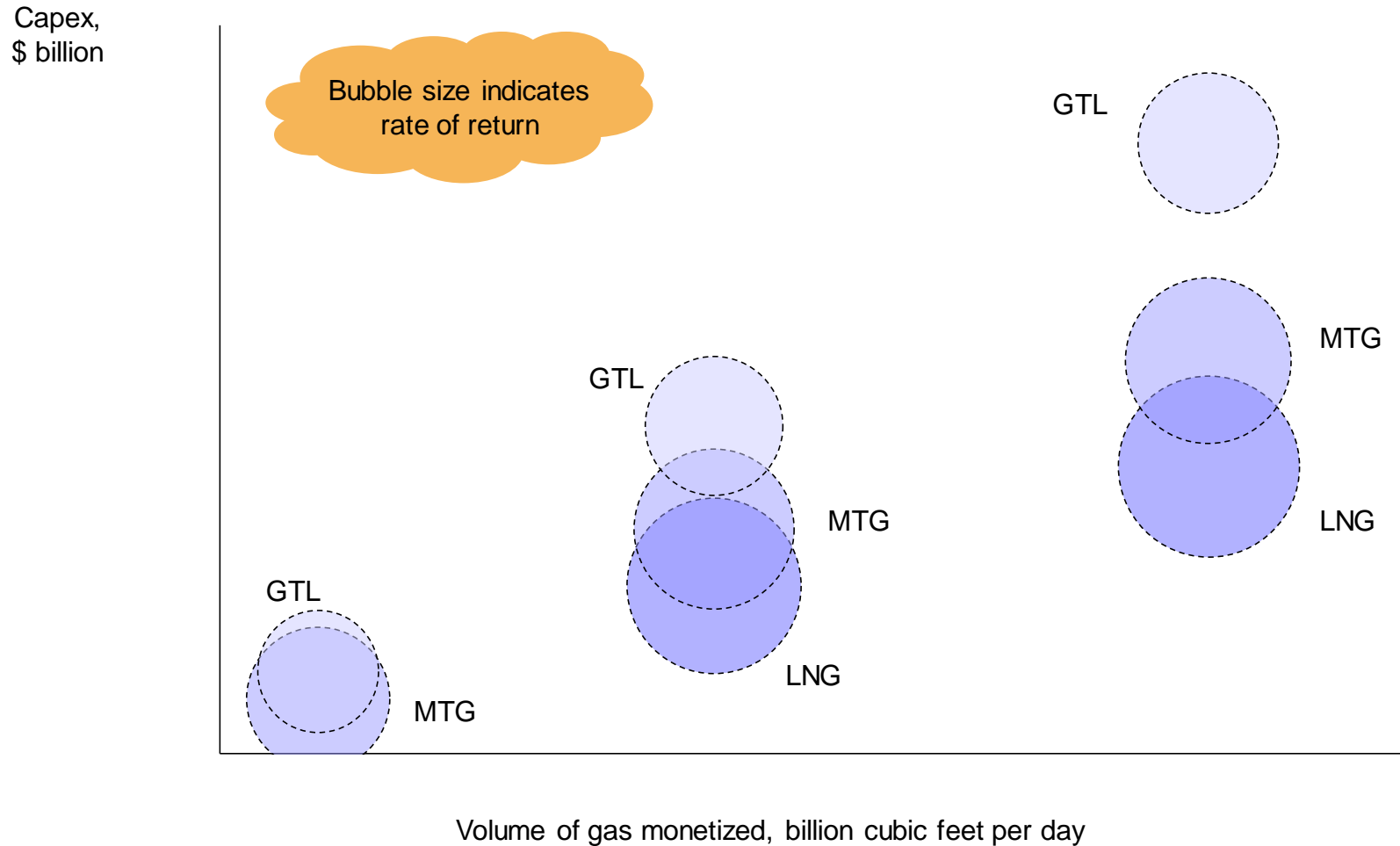
Capital costs of traditional, large-scale GTC projects follow the typical economies-of-scale power laws and ...



Source: ADI Analytics Research

... GTL projects have the highest capital costs relative to LNG and MTG projects to monetize a given volume of gas

Volume of Gas Monetized Vs. Capex and Return
(U.S. Gulf Coast, Reference Price / Capex, 35% Taxes, No Debt)

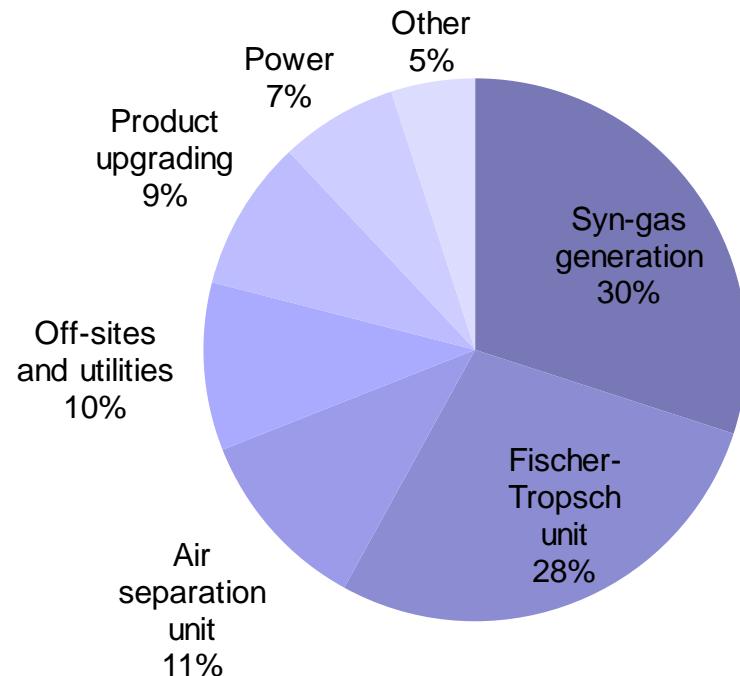


Source: ADI Analytics Research

Syn-gas generation followed by Fischer-Tropsch units account for a major portion of GTL capital costs

GTL Plant Capital Cost Breakdown

| Component | Base Case | Range |
|-------------------------|-----------|--------|
| Air separation unit | 11% | 10-12% |
| Syn-gas generation | 30% | 22-38% |
| Fischer-Tropsch unit | 28% | 24-38% |
| Product upgrading | 9% | 8-11% |
| Power | 7% | 7-8% |
| Off-sites and utilities | 10% | 9-11% |
| Other | 5% | 3-8% |



Source: ADI Analytics Research

Key takeaways

1

Conventional, large-scale GTL projects in North America will find it difficult to compete with LNG export projects on the basis of economic returns

2

High capital costs significantly impact economic returns and innovations that cut costs especially that of syn-gas generation will be important breakthroughs

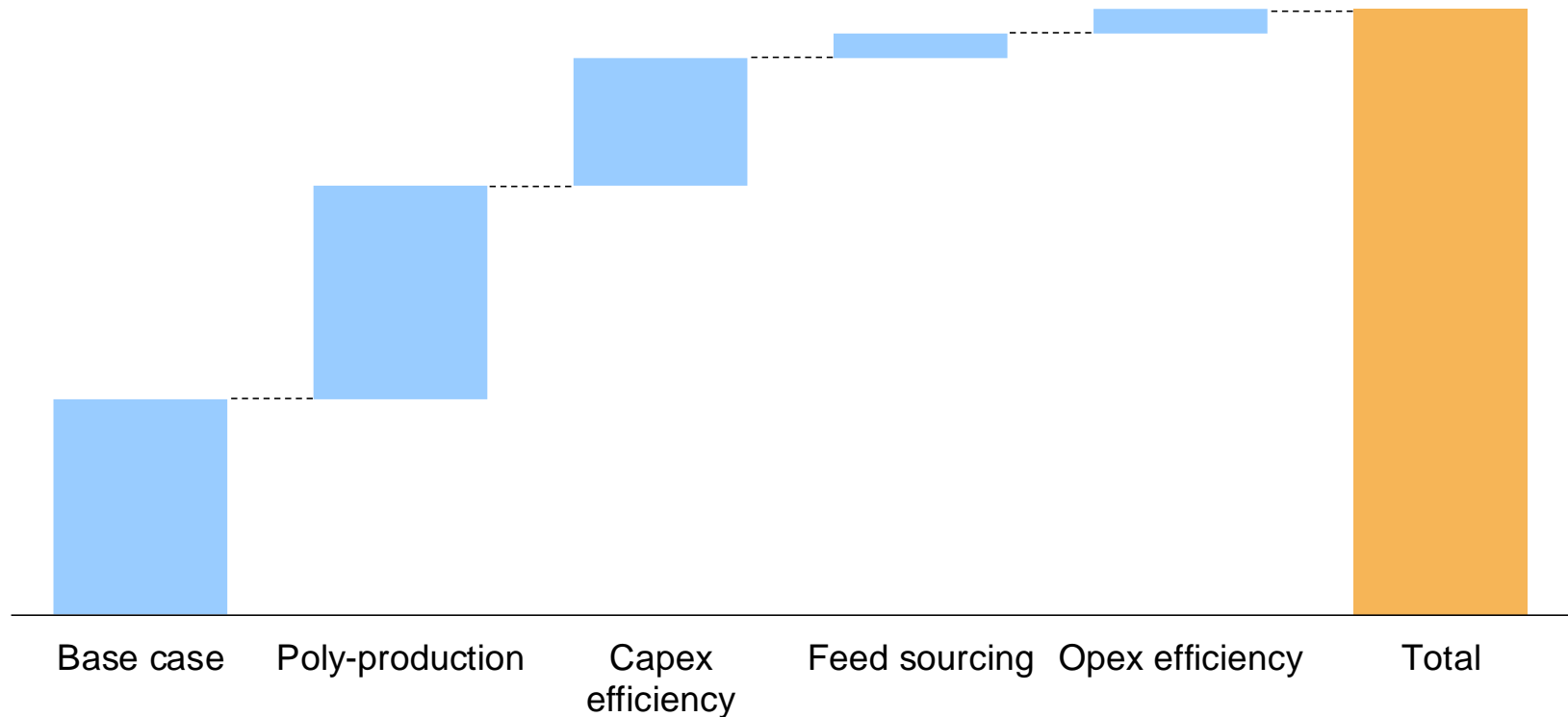
Even so, ADI Analytics believes that GTL can be competitive in many cases by combining various ideas and ...

| | | |
|---------------------------------|--|-------------------------------|
| Commercial structures | <ul style="list-style-type: none">▪ Integrated projects▪ Cross-owned joint ventures▪ Contracts with upside sharing▪ Ownership by all stakeholders | Lowers hurdle rate 1% - 5% |
| Capital cost efficiency | <ul style="list-style-type: none">▪ Small projects▪ Modular plants▪ Disciplined EPC▪ Brownfield / co-location / poly-production | Reduces capex 5% - 20% |
| Operating cost reduction | <ul style="list-style-type: none">▪ Brownfield / co-located / poly-production | Reduces opex 5% - 20% |
| Other drivers | <ul style="list-style-type: none">▪ Portfolio development▪ Stranded gas monetization▪ Technology / competency access | Lowers hurdle rate 1% - 5% |

Source: ADI Analytics Research

... Offer compelling economic returns to many, if not all, investors

Potential Improvements in IRRs of Small-Scale GTL Projects
(Internal Rates of Return, U.S. Gulf Coast, 10,810 bpd)



Source: ADI Analytics Research

Key takeaways

1

Conventional, large-scale GTL projects in North America will find it difficult to compete with LNG export projects on the basis of economic returns

2

High capital costs significantly impact economic returns and innovations that cut costs especially that of syn-gas generation will be important breakthroughs

3

Even so, there most likely are opportunities to build economically meaningful smaller-scale GTL projects by thinking differently and creatively

Outline

▶ Path Forward for Gas-to-Liquids

▶ **About ADI Analytics**

ADI Analytics is a boutique consulting firm serving energy and chemical companies with passion, rigor, and expertise

| | Markets | Technology | Operations | Functions |
|------------------------|--|---|---|--|
| Oil & Gas |  <p>Exploration</p> |  <p>Production</p> |  <p>Refining</p> |  <p>Distribution</p> |
| Power & Mining |  <p>Coal</p> |  <p>Generation</p> |  <p>Transmission</p> |  <p>Carbon</p> |
| Renewables & Cleantech |  <p>Biomass</p> |  <p>Solar</p> |  <p>Wind</p> |  <p>Geothermal</p> |
| Chemical & Industrial |  <p>Plastics</p> |  <p>Materials</p> |  <p>Auto</p> |  <p>Manufacturing</p> |

Our value proposition – deep expertise, proprietary analytics, and cost-effective rates – is designed to help clients succeed



Bring frontline industry **expertise**

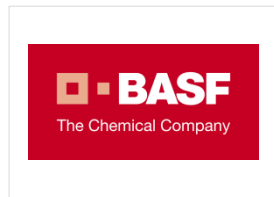


Lead with content, data, and **analytics**

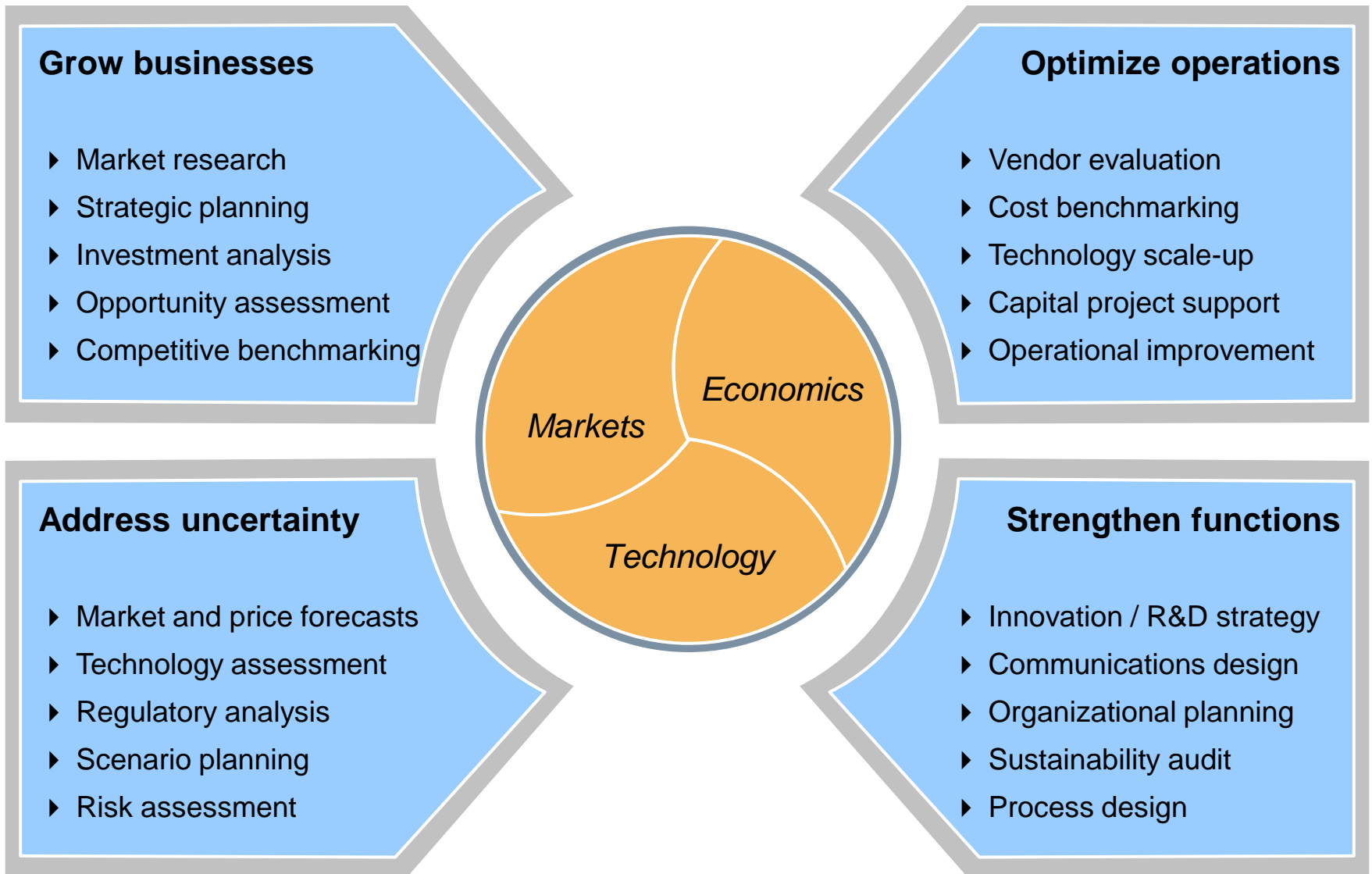


Deliver value with **cost-effective rates**

Fortune 500 and mid-sized companies, start-ups, investors, and governments have hired us to shape decisions globally



ADI Analytics offers a variety of consulting services to help clients with issues in markets, economics, and technology



In five years, ADI Analytics has served ~40 clients through 100+ engagements in energy and chemicals across the world

OILFIELD SERVICES

- ▶ Forecasted OCTG pricing for vendor
- ▶ Evaluated new drilling tech for US DOE
- ▶ Sized “green” drilling fluids for OFS player
- ▶ Sized oil spill market for new tech start-up
- ▶ Led oilfield tanks due diligence for PE firm
- ▶ Surveyed sourcing trends for proppant firm

UPSTREAM / E&P

- ▶ Listed ops excellence ideas for NOC
- ▶ Audited upgrader for oil sands producer
- ▶ Sized Australian CBM for new EOR firm
- ▶ Created investment thesis for Asian firm
- ▶ Designed R&D strategy for oil / gas major
- ▶ Planned CSR / HSE / GA strategy for E&P

MIDSTREAM / LNG / GAS MONETIZATION

- ▶ Reviewed floating LNG tech for NOC
- ▶ Benchmarked large / small GTL for VC
- ▶ Sized pipeline coatings market for VC firm
- ▶ Analyzed gas monetization plans for major
- ▶ Ranked 15 NA LNG projects for Japan firm
- ▶ Forecasted Asian LNG demand for licensor

SHALE GAS / TIGHT OIL / UNCONVENTIONAL RESOURCES

- ▶ Sized waste disposal strategies in shale basins for E&P firm
- ▶ Estimated economic benefits of shale gas for a state agency
- ▶ Analyzed resource and players in Argentina shale for investor
- ▶ Analyzed resource and players in US shale basins for investors
- ▶ Designed fit-for-purpose operational model for new shale gas BU
- ▶ Conducted scenario planning on fracking regulations for E&P firm
- ▶ Developed shale gas JV plan and identified partners for Asian E&P
- ▶ Identified operational and innovation gaps in Marcellus shale for PE

DOWNSTREAM / FUELS / REFINING

- ▶ Led licensor selection plan for refiner
- ▶ Valued 20 refineries for Asian investor
- ▶ Forecasted fuel regulations for licensor
- ▶ Sized catalyst market for chemical major
- ▶ Analyzed sustainability indices for refiner
- ▶ Reviewed asphalt / bitumen trends for user

BIOFUELS / ALTERNATIVE ENERGY

- ▶ Optimized ethanol blending for refiner
- ▶ Estimated LCAs of biofuels for start-up
- ▶ Benchmarked power trains for automaker
- ▶ Framed bio-oil pricing strategy for start-up
- ▶ Assessed LNG as diesel substitute for VC
- ▶ Benchmarked 20 biofuel techs for oil major

CHEMICALS / MATERIALS

- ▶ Forecasted butadiene supply for lube firm
- ▶ Screened C4-5 investments for Asian firm
- ▶ Estimated NGL supply for Canadian major
- ▶ Studied carbon black market for tire maker
- ▶ Identified white spaces in sulfur for US firm
- ▶ Modeled ammonia/methanol IRRs for NOC

COAL / MINING

- ▶ Valued Australian mine for coal major
- ▶ Assessed coal monetization for EPC firm
- ▶ Led ops improvement for Asian coal miner
- ▶ Studied polygeneration with IGCC for DOE
- ▶ Sized Asian met coal demand for US miner
- ▶ Evaluated rare earth substitutes for VC firm

POWER / ELECTRICITY

- ▶ Assessed 6 CCS techs for coal fleet owner
- ▶ Profiled demand response market for utility
- ▶ Benchmarked energy storage techs for VC
- ▶ Analyzed smart grid standard for India govt
- ▶ Modeled coal / gas economics for end user
- ▶ Forecasted gas demand for power for NOC

RENEWABLE POWER / CLEANTECH

- ▶ Benchmarked battery techs for PE firm
- ▶ Assessed green building techs for NIST
- ▶ Sized US offshore wind market for EPC
- ▶ Developed India strategy for solar player
- ▶ Studied geothermal supply chain for DOE
- ▶ Modeled LCOE of all renewables for DOE

In addition, ADI Analytics offers insightful multi-client studies and advisories to help clients accelerate decision making

Gas Monetization Advisory Service

Focus Areas

- ▶ Gas supply
- ▶ Gas demand
- ▶ Worldwide LNG
- ▶ Power / electricity
- ▶ Fuels (GTL, MTG)
- ▶ Methanol / chemicals
- ▶ Transport (CNG/LNG)
- ▶ Oil / gas price relationship

Key Analytics

- ▶ Technology appraisals
- ▶ Project profiles, returns
- ▶ Costs, economics, IRRs
- ▶ Supply, demand, pricing
- ▶ Competitive landscapes
- ▶ Risk analysis / mitigation
- ▶ Review of firm strategies
- ▶ Regulatory / policy watch

Deliverables

- ▶ Monthly briefs
- ▶ Quarterly calls
- ▶ Annual summary
- ▶ Data spreadsheets
- ▶ Access to expert team
- ▶ Subscriber workshops

[Download Prospectus](#)

Our Products Offer Actionable Benefits

- ▶ Enable focus on decision making
- ▶ Provide an independent, expert viewpoint
- ▶ Based on a rigorous, fact-based methodology
- ▶ Delivered quickly, cheaply, and collaboratively



Refueling North America with LNG

Spring 2013

[Prospectus](#)



Assessing Opportunities in Bio-Based Chemicals

Spring 2013

[Prospectus](#)



Benchmarking shale gas monetization options

Spring 2012



Innovation needs in Marcellus shale

Fall 2011



Economics of carbon conversion and utilization

Fall 2010



Supply outlook for advanced biofuels

Spring 2010



Strategic overview of geothermal energy

Fall 2010

Finally, our flexible on-demand “small project” services help clients quickly fill gaps by leveraging our databases and...

| Cost Analytics | Tech Analytics | Policy Analytics | Workshop |
|--|---|---|---|
| <p>Capex and opex for various technologies</p> <p>Feed / product price forecasts and history</p> <p>Customized cost and process models</p> | <p>Technology maturity and value appraisals</p> <p>IP due diligence and competitive position</p> <p>Innovation needs and tech road maps</p> | <p>Issue, regulatory, legislative tracking</p> <p>Rule, bill, and ANPR impact analysis</p> <p>Advocacy briefings and white papers</p> | <p>Quarterly workshop service for execs to brainstorm strategic energy issues</p> <p>Custom classroom and online training</p> |
| Typically 1 - 2 days | 3 - 5 days | 3 - 5 days | ½ - 2 days |

Select examples from our wide coverage of oil, gas, chemicals, coal, power, and renewables

- ▶ Biofuels
- ▶ Batteries
- ▶ Crack spreads
- ▶ Ethane crackers
- ▶ LNG, GTL, MTG
- ▶ E&P / F&D costs

- ▶ Fuel cells
- ▶ Gasification
- ▶ Water treatment
- ▶ Modular nuclear
- ▶ Geothermal EGS
- ▶ Biomass pyrolysis

- ▶ Economic impacts of fuel regulations
- ▶ Review of fracking regulations
- ▶ Renewable Portfolio Standards review
- ▶ NSPS coal impacts

- ▶ Biofuels
- ▶ Shale gas
- ▶ Carbon trading
- ▶ Gas monetization
- ▶ Renewable power
- ▶ Geothermal energy

...The ADI Analytics team's blue-chip credentials and creative thought leadership on energy and chemical industry issues

| E&P / SHALE GAS / UNCONVENTIONALS | LNG / GTL / GAS MONETIZATION | RENEWABLES / ALTERNATIVE ENERGY | FUELS / REFINING / CHEMICALS |
|--|--|---|--|
| Global unconventional resources January 2013 Keynote Speech | Benchmarking GTL and LNG technologies October 2012 Invited Speaker | How hot is geothermal power October 2010 Guest Speaker | New opportunities in refining and chemicals March 2013 Conference Paper |
| Innovation needs in the shale gas sector December 2011 Keynote Speech | Business models for floating LNG September 2012 Keynote Speech | Strategic outlook of renewable energy June 2012 Conference Paper | Refining Impacts of Unconventional Oil March 2013 Panel Session |
| Shale gas and coal linkages November 2012 Panel Speaker | Outlook for unconventional LNG January 2012 Panel Leadership | Toward affordable renewable energy October 2011 Conference Paper | Advanced biofuels supply outlook March 2011 Keynote Speech |
| Why India is not in play for Big Oil January 2010 Newspaper Op-Ed | Monetizing value from shale gas resources September 2012 Keynote Speech | Nuclear power: Charged up again February 2011 Newspaper Op-Ed | Economics of fuel regulations March 2011 Conference Paper |

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