



Gas Exploration and Development Strategies in the Western Canada Sedimentary Basin

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ABSTRACT

The Western Canadian Sedimentary Basin (WCSB) is a major source of natural gas supply for the North American market, with Y2000 basin productivity at more than 16 Bcf/d. Significant natural decline requires that in excess of 3 Bcf/d of new supply must be added each year simply to maintain constant basin deliverability. In addition, the average rate added per well continued to decrease while the initial decline rate increased. During the decade of the 1990s, over 25 Bcf/d of new western Canadian gas deliverability was added, from over 42,000 new producing well events.

Based on the year of pool discovery and the year that the area was first connected to the delivery system, there are four definable Exploration and Development

strategies. Each of the four strategies (Exploration, Connection, Development and Renewal) contributed a significant amount of gas rate additions. What role will exploration and development strategies play in future gas supply?

This paper illustrates the trends in gas supply additions over the last decade, including a view of the geographic distribution, as well as other attributes. There is also a comparison of the portfolios of E&D strategies that operators employed. A brief synopsis of the methodology followed to determine a consistent measurement of gas rate-additions is also presented.

Careful analysis of the historical results has yielded useful insights for operators as they make their choices about their future activities.

INTRODUCTION

The Western Canadian Sedimentary Basin (WCSB) is a critically important source of natural gas supply for Canada and the United States. In the year 2000, the WCSB produced over 23% of the gas consumed in these nations.

Gas supply from the WCSB increased substantially over the past decade. From a level of 8 Bcf/d in the mid 1980s, marketable natural gas deliveries increased to over 16 Bcf/d in 2000. To achieve this growth in production, and compensate for the natural decline in production from existing wells, operators in Western Canada added significant new deliverability. Over 42,000 gas wells were brought onstream during the 1990s, contributing, in aggregate, 25.1 Bcf/d in rate additions.

Supply replacement in the WCSB will be a challenge as natural decline creates a large gap in productivity each year. At 1999 production levels and decline rates, 3.3 Bcf/d must be added yearly simply to replace decline. The production gap is growing larger each year because total decline rate is increasing. The average decline rate has risen from 17-18% per year in the early 1990s to over 26% per year at the end of the decade. The increase in decline rate was basin-wide and was observed to increase in all sources of new gas supply (by strategy employed, by geographic region, by stratigraphic group and by reservoir depth).

In addition, the supply contribution of the average new well to fill the production gap has been decreasing. The average rate added by a well in its first year has decreased from over 700 Mcf/d in 1995 to less than 350 Mcf/d in 2000. The decrease in average rate per well is also basin-wide and was also observed in all sources of gas supply.

EXPLORATION AND DEVELOPMENT STRATEGIES

Exploration and Development (E&D) strategies describe the patterns of investment decisions and actions over time that add gas supply to the basin through drilling, completion, re-completion and connection of new gas producing well events. E&D strategies are vital to fill the supply gap created by natural decline. Corporate strategies based upon acquisition of producing assets do not add new production to the basin.

E&D strategies are the choices that individual operators make between investment alternatives for adding gas production in the WCSB. As the name implies, the two strategies commonly identified have been Exploration for undiscovered pools and Development of discovered pools.

Operators make these strategy choices based on their perception of the undiscovered potential of the WCSB, their access to under-developed pools, economic and competency factors. Is the Western Canada Sedimentary Basin so mature that most of the future gas supply will come from development of discovered pools? Is the remaining undiscovered potential and cost of finding sufficiently attractive to bring on significant new gas supply through exploration for new pools?

What firms believe about the answers to these questions governs whether and how they invest to increase gas supply in Western Canada. What is the history of industry's preferred strategies during the growth in gas supply in the 1990s? What are the trends in strategic choices? These questions were addressed as part of a comprehensive study of Western Canadian gas supply¹.

To observe trends in supply additions by E&D strategy, a robust strategy classification system applicable to publicly-available data is required. The classification scheme of E&D strategies should satisfy the following criteria:

- Exhaustive, mutually exclusive classes
- Simple to understand and easy to apply to public data
- Distinguishes type of risk and type of capital at risk
- Fixed reference point in time - can be applied prospectively to planned investments or retrospectively to results
- Applies to all investments or wells consistently across basin

CURRENT ANALYSIS OF E&D STRATEGIES IS INADEQUATE

Corporate E&D Strategy Information

Information on corporate E&D strategy is not disclosed publicly in a form sufficiently consistent to be used for observing trends. Private firms are not required to publicly disclose information regarding E&D strategy. Publicly traded firms generally report the number of wells drilled (effort) and completion status (results) for Exploration and Development classes. Depending on the listing jurisdiction, publicly traded firms may also report capital expenditures (effort) by strategy category of Exploration or Development. The reserves additions from new discoveries that are credited to Exploration are often limited to the spacing unit of the exploratory well while most of the reserves additions from follow up wells are credited to Development activity.

A consistent industry-wide definition for Exploration and Development is not used in the planning and budgeting

for capital investments and measuring results, in the financial and tax accounting for expenditures nor in the very functions of organizational units labeled Exploration and Development. These inconsistencies occur both between groups within firms and also between operators.

Strategy planning for capital investment is often performed on a portfolio of projects which are characterized on the basis of chance of failure and capital at risk. Operators may have a target risk profile or proportion of capital allocated to projects with a higher risk of loss. Management teams have different levels of risk aversion. Perception in the equity and debt markets of Exploration as “risky” may cause some E&P management teams to minimize investment in, or reporting of, Exploration activity.

Public E&D Strategy Data

Public E&D data is inappropriate and inconsistent. Public data on E&D activity is reported in two ways. The Canadian Association of Petroleum Producers (CAPP) reports annual expenditure data by province for a variety of Exploration and Development expense categories. This data is of limited use for identifying trends in gas additions for three reasons:

- it is reported at the provincial level, not the well level
- seismic and land expenses for Development are included with Exploration
- gas intent expenditures are not distinguished from oil intent

Lahee Classification

The second approach to measuring E&D strategy from public data is using the Lahee classification² on a well basis. At the time of licensing, every well is assigned to a well class which distinguishes wells drilled to develop or extend discovered pools (Development) from wells drilled to establish production from undiscovered pools (Exploration). The well class is, at best, a measure of pre-drill “intention” of well and hence a measure of exploration effort. Lahee class data is available on well basis from public well databases and on an aggregate basis by province from CAPP and provincial agencies.

The Lahee classification has not been applied consistently and is not a reliable series of data. First, the definition of well classes is not consistent between provincial agencies and data sources. Secondly, even within provincial agencies, the well class definitions have changed over time, have been applied inconsistently and have been adjusted retroactively based on the well outcome. Since 1997 in Alberta, the assignment of well classification has been the responsibility of the well

operators themselves, ensuring inconsistencies between operators.

The outcome of successful wells is ambiguous. Did the exploration well result in a discovery in the intended new pool, a serendipitous discovery in a new pool or was the well completed in a previously discovered pool? Of over 6000 pools “discovered” in Alberta since 1989 and on production before year end 1999, only 66% of the marketable reserves were discovered by exploratory class wells. Almost half of the new pools and about one third of the new marketable reserves were “discovered” by development wells.

The Lahee classification system does not provide a fixed reference point in time to identify wells in newly discovered pools. As a result, development wells in a recently discovered pool are not distinguished from those in an older pool.

Capital at Risk

E&D strategy analysis based only on drilling risk and cost is incomplete. The Lahee class approach addresses the difference in risk of drilling a dry hole and the drilling capital at risk. Based on data from CAPP³, only 18% of gas capital expenditures are at risk for Exploration drilling and 28% of gas capital expenditures for Development drilling. To connect pools to market, operators must make significant investments in transmission lines, gathering systems, gas compression and processing. The capital at risk for field equipping and gas plants is estimated to be 36% of gas capital expenditures, twice as much as exploratory drilling. Infrastructure and development expenditures are not risk free. If the pool fails to perform as forecast, operators fail to achieve their forecast economic targets.

NEW MODEL BETTER CHARACTERIZES A CONTINUUM OF RISK AND INVESTMENT

A new classification of investments and gas wells onstream provides an improved description of E&D strategies. The classification (Figure 1) identifies four E&D strategies: **Exploration, Connection, Development and Renewal.**

The key dimensions of the classification are **Discovery and Expansion.** The discovery dimension is divided into the choice of investing in developing old pools or in searching for new pools. The expansion dimension distinguishes the choice of investing in old, previously connected areas or in new, previously unconnected areas. The general sequence of investment for an area or project is shown by the clockwise arrow starting in the Exploration quadrant. Areas and pools are classified as new or old with reference to a fixed date.

At first, the only investment choice in a new area is to explore for new pools. This strategy is **Exploration**. Successful exploration requires operators to manage the risk of investing too much capital and finding insufficient reserves to proceed to the next stage.

After the initial discovery, the next choice is to invest in connecting the now-discovered “old” pool in the new area into the gas gathering, processing and transmission infrastructure. This strategy is **Connection**. Successful operators must manage the risk of insufficient deliverability and reserves relative to the capital invested in equipping, gathering, plant and compression.

Once a pool has been discovered and an area connected, the next stage of investment is to sustain and increase supply through **Development** strategy. Although the risk of drilling a dry hole is low in Development strategy, the value of the incremental deliverability and reserves brought on by new wells in old fields must exceed the capital cost and provide sufficient return.

The final stage in the investment life cycle of an area is **Renewal**. Significant potential remains for undiscovered “new” pools in mature “old” areas of the basin where new technology and new concepts can be applied to under-explored zones. Although dry hole risk may be as high as the Exploration stage, capital at risk in the Renewal stage is likely lower due to prior investments in land, seismic, wells, gathering and processing infrastructure.

An investment can be classified by answering the simple questions: Is this investment in a discovered pool? Is this area currently on production?

APPLICATION TO WESTERN CANADA

The results of a well can be classified retrospectively by answering two simple questions. Did the well discover a new pool relative to the reference date? Did the township or BC block produce gas before the reference date?

For the purposes of this study, a cutoff point on the **Expansion** scale was set at 1989/1990. All townships connected prior to 1990 were classed as ‘old’ areas. All townships that have been connected since 1989 were classed as ‘new’ areas. Similarly, the cutoff point on the **Discovery** scale was set at 1984/1985. All pools discovered prior to 1985 were classed as ‘old’ pools. All pools discovered subsequent to 1984 were classed as ‘new’ pools. A five year lag between discovery year and onstream date was considered a reasonable assumption for pools discovered in 1985 to 1989. Due to low prices, cash flow and limited export capacity, few of the pools discovered during this period were connected until the 1990s.

Rate Additions by Strategy

During the 1990s, over 42,000 well events were brought onstream. Each of the well events was classed into one of the four strategy groups. Of the total 25.1 Bcf/d added, 30% each was classed as Exploration and Development. As shown in Figure 2, the remaining 40% was split evenly between Connection and Renewal. Although common understanding is that the basin is ‘mature’, 50% of the gas supply added in the decade came from new pools and, more impressively, 50% came from new, previously unconnected areas.

Rate Additions by Township

There were almost 3900 townships and BC blocks with wells that commenced production during the 1990s. Most of these townships had rate additions from more than one class. Figure 3 provides a map of the WCSB showing the predominant E&D strategy in each of the townships/blocks.

All four strategies were effective at adding supply throughout the basin. The extraordinary expansion of the producing area of the basin since 1989 is shown by the townships onstream since 1989 which are indicated by the Exploration (red) and Connection (orange) strategies. These newly connected areas were more common in the northern and eastern regions of the basin than in the southern regions. Although the Renewal strategy (yellow) and Connection strategy (orange) did not add as much rate as the two major E&D strategies, townships where these strategies were effective were distributed widely in the basin. These strategies provided the opportunity to add significant supply from many parts of the basin.

Rate Addition Trends

The total volume of rate additions has trended upwards on an annual basis, from a decade-low of 1.1 Bcf/d in 1992 to record level rate additions of 3.6 Bcf/d in 2000. Figure 4 illustrates a significant trend to rate additions from new pool discoveries. The portion from new discoveries in new areas (Exploration) plus new discoveries in previously connected areas (Renewal) has increased from less than 30% to more than 60% of the total volume. Although older areas still represent a strong component for basin supply, a sustainable portfolio for gas production growth requires a significant discovery component.

Operator Rate Additions by Strategy

Corporate merger and acquisition activity has been a significant part of the Western Canadian gas industry. This consolidation activity has been especially prevalent through the past decade. Over 1300 operators were

responsible for drilling and connecting the gas wells onstream in the 1990s. Many of those initial operators have been acquired corporately or divested their properties and exited the gas business in the WCSB. To obtain a more complete picture of the E&D strategies of the current successor operators, it was necessary to include with them the wells brought onstream by their corporate predecessors. The top 56 operators, as at July 2001, include the results for over 140 predecessor companies. The rate additions from these 56 operators were significant, at 19.2 Bcf/d (76% of the industry total).

Each operator made a selection of investment choices, which leads to a portfolio of rate addition results. Most operators sourced rate additions in each of the four strategy classes.

The combined portfolios of rate additions for each of the operators plot as a series of points on Figures 5 and 6. Each point represents, for individual operators, the portion of rate additions from new areas and the portion of rate additions from new discoveries. The location, on this strategy diagram, of each uniquely defined operator positions that operator relative to the industry average for the decade and relative to any other operator. The industry average position was 50% new pools, 50% new areas.

There was a wide range of strategies employed by operators. The larger operators have diversified portfolios that combine rate additions from a number of E&D strategies. These diversified portfolios plot closer to the industry average and farther from extreme positions at the edge of the graph. Larger established operators owned and controlled legacy properties containing 'old' pools for rate additions from Connection and Development strategies. Few of the smaller emerging operators had access to legacy properties to blend in their portfolio. As a result, emerging operators were often highly focused on Exploration or Renewal strategies and in competitive niches. These niche strategies plot near the edges of the diagram with many operators in the Exploration quadrant.

CONCLUSIONS

The new strategy classification model has been shown to be an improvement over previous methods for analyzing the trends in supply additions. The E&D model has the following advantages:

- Application is simple and consistent
- Clear definition of how capital is at risk and what must be managed to achieve success
- Applicability to any defined grouping of wells
- Matching stages of capital investment in projects

- Effective for planning, budgeting and measuring results

When applied to public well data, the model also has the following advantages:

- Based on results, not on intent
- Reflects pool discoveries, not just single wells
- Fixed reference point in time

Application of the model to the public data results from all operators in the Western Canadian basin permits the development of useful insights into the overall trends that are occurring. It also provides insights into the performance of individual operators.

All four E&D strategies have made significant contributions (in excess of 5 Bcf/d each) to the growth in Western Canadian gas supply. Each of the strategies added rate in geographic concentrations sufficient to create core areas for operators. Further, all strategies were widely distributed throughout the basin and all geographic regions hosted a mix of E&D strategies.

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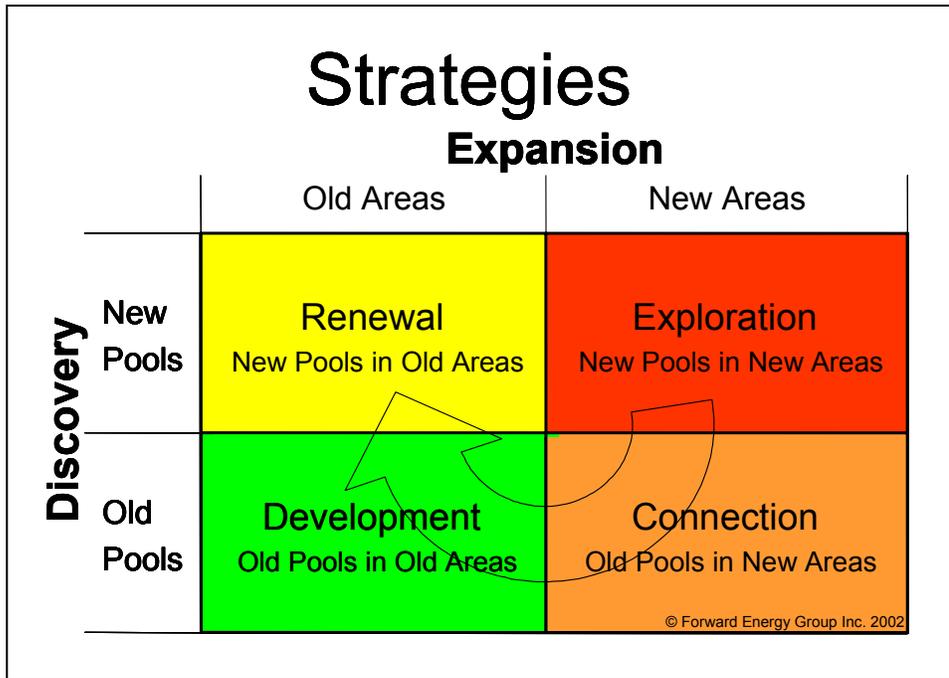


Figure 1

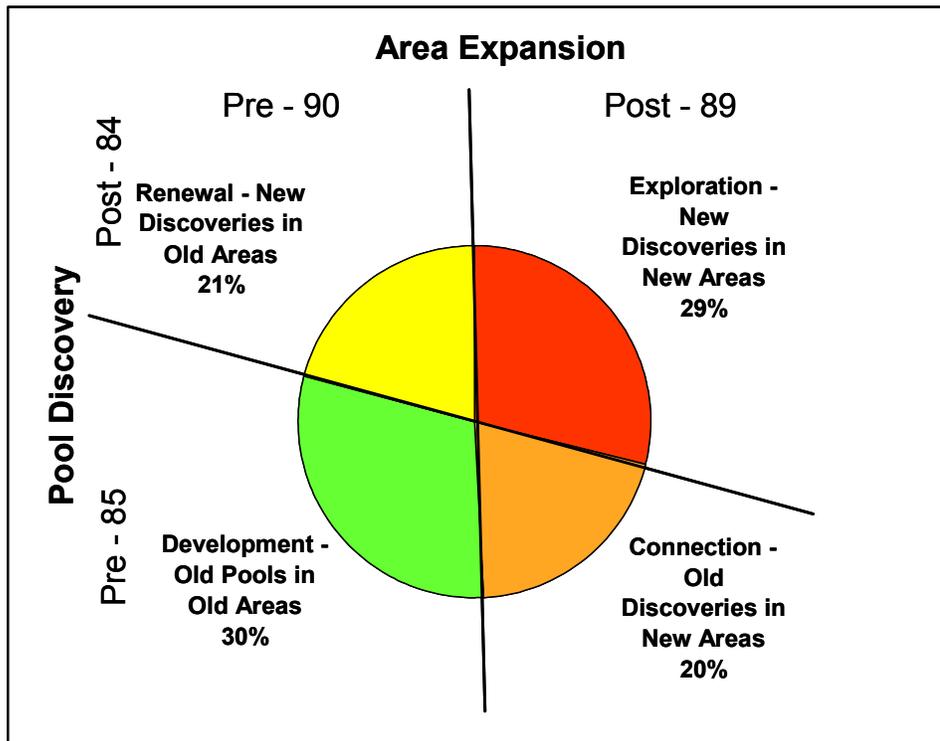


Figure 2

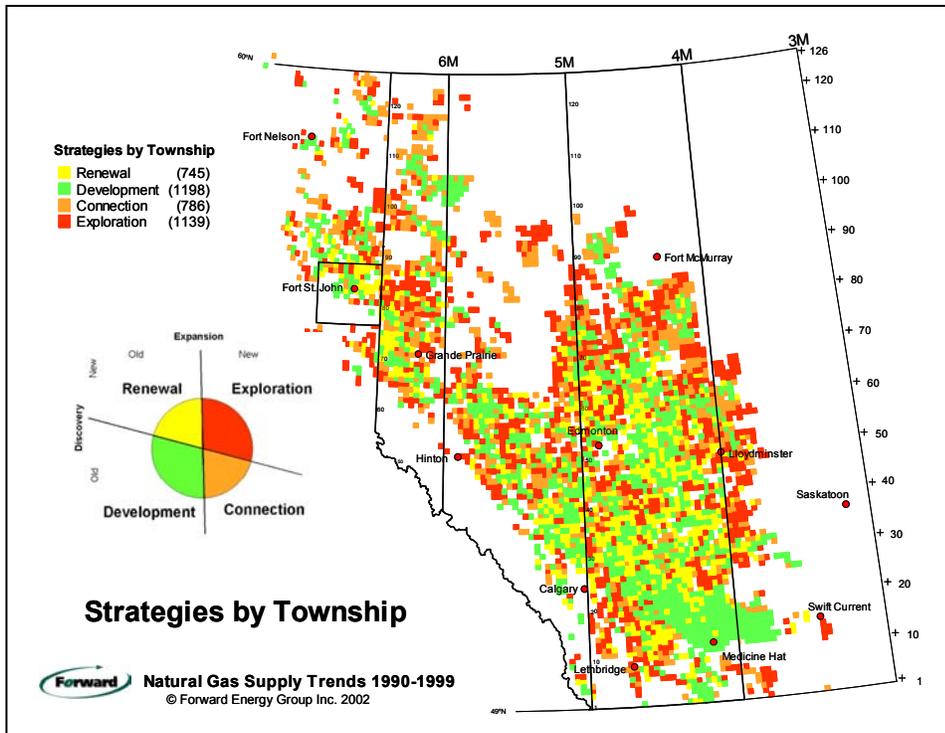


Figure 3

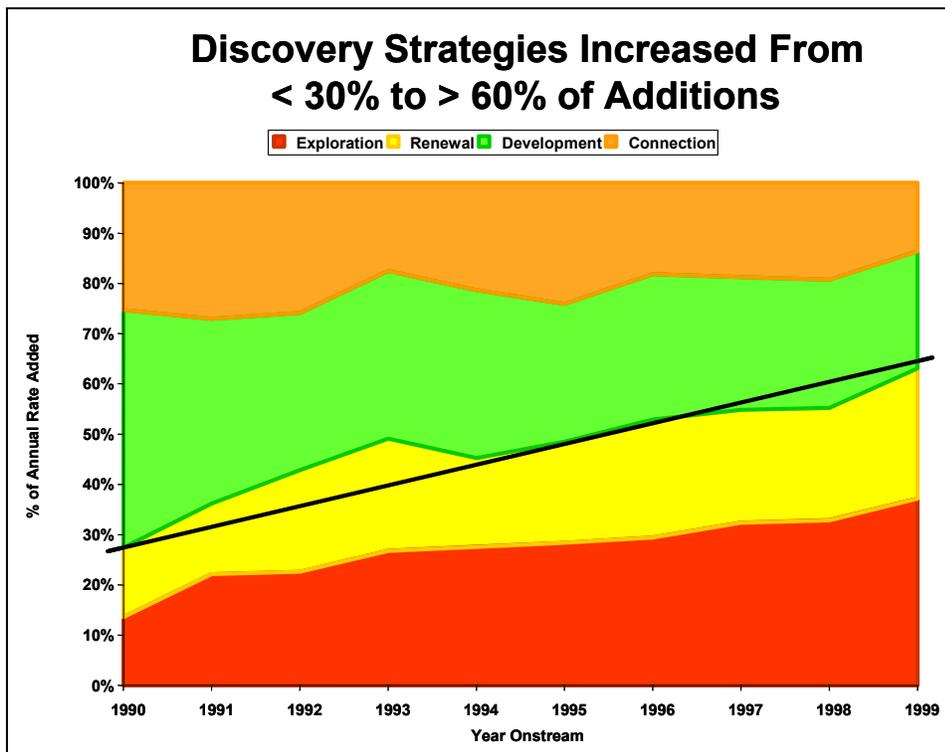


Figure 4

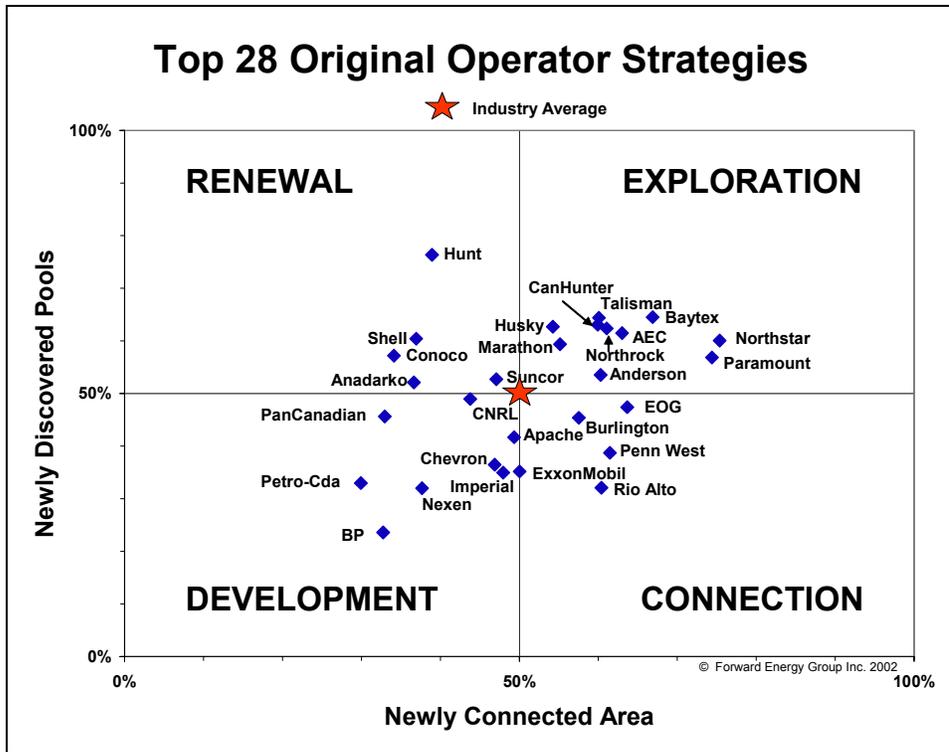


Figure 5

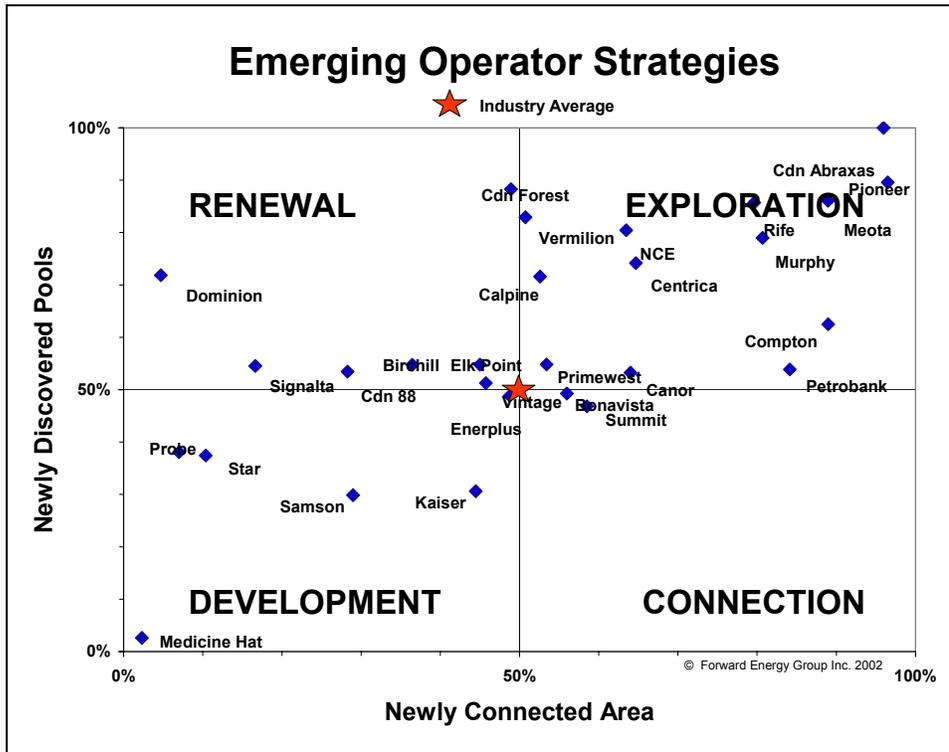


Figure 6