Canadian Natural Gas:

Past, Present and ….. a New Model for Predicting the Future

Dave Russum, P.Geol.

Geo-Help Inc and AJM Petroleum Consultants

University of Calgary Presentation,

February 2004

Presentation Format

- Canada's Resources and Reserves
- Current Trends in Production and Drilling
- A new Resource Development Model
- Predicting the Future and what it may look like
- Questions and Feedback

- More info: **www.geohelp.ab.ca**


"Major discovery at Ladyfern"
drilling pays off"
CONFUSION
"Sobering reserve report"
"We're running out of gas!"
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Petroleum Consultants

Some Definitions:

Gas: Combustible gas primarily methane

Gas Resources: The total quantity of gas without regard for whether it is technically, physically or economically producible

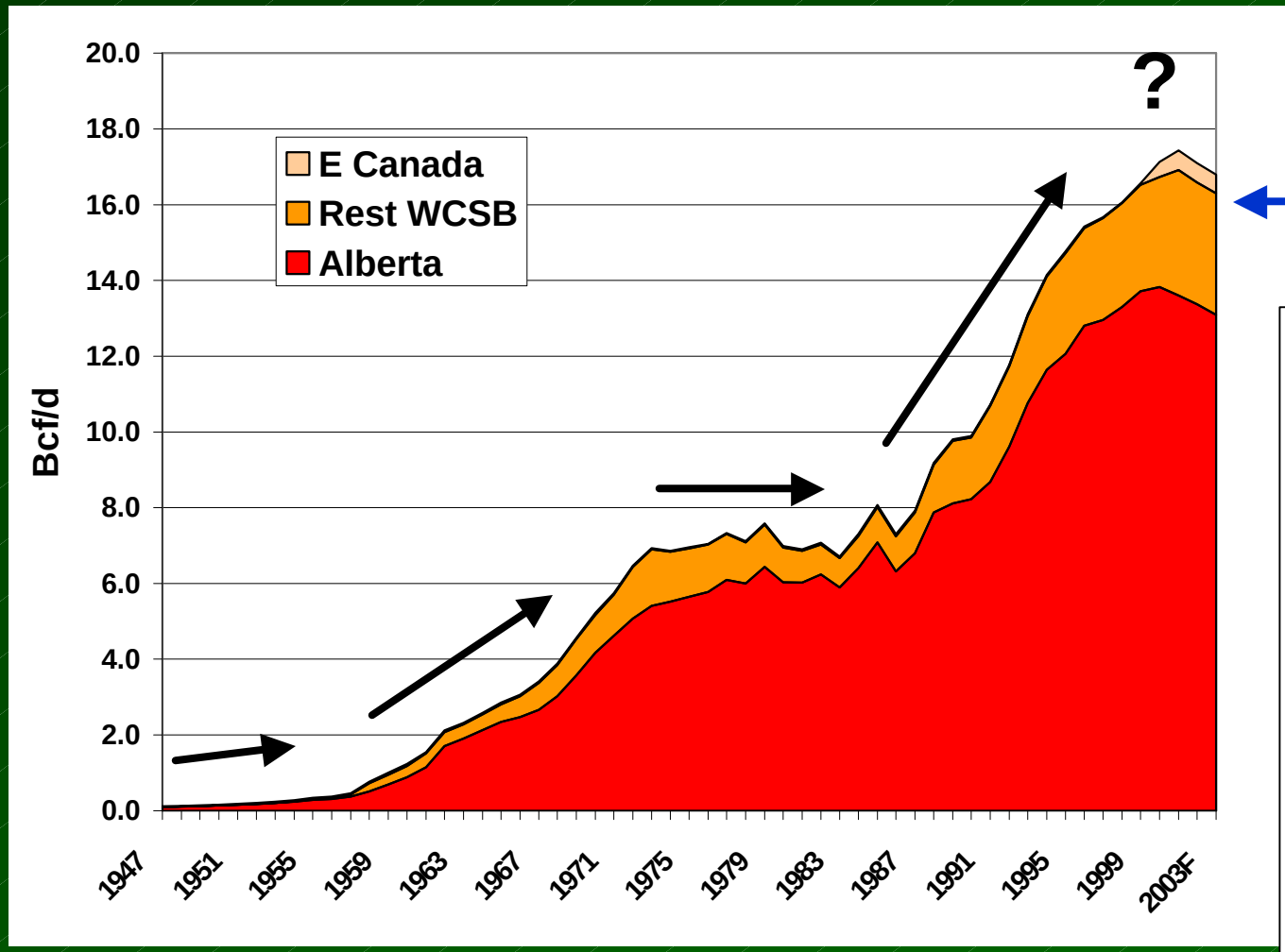
Gas Reserves: The portion of the known resources that can be technically, physically and economically produced with our current knowledge

Some Definitions Continued:

Conventional Gas: Gas in porous and permeable rock that typically flows without significant stimulation

Unconventional Gas: Gas in low porosity/permeability rock or adhering to the matrix that requires significant technical intervention to liberate examples: Coalbed methane, Gas hydrates

Canada's Natural Gas Production (Bcf/d Adapted from CAPP Data)



Stats Can Feb 2004

17.4Bcf/d = 6.3Tcf/Yr = 46.6 million Average Calgary homes

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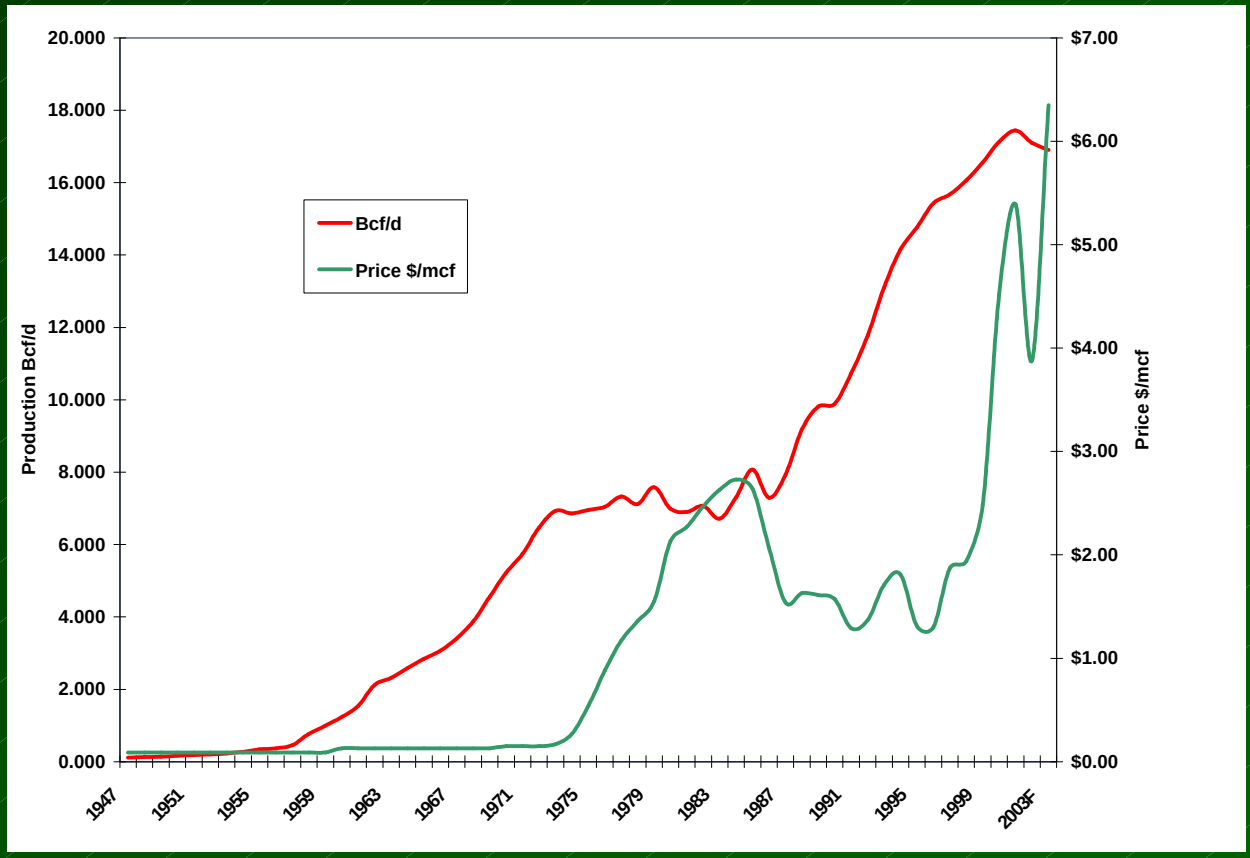
Production and Alberta Price

(AJM Data)



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Canada's Natural Gas Resources and Reserves

Resource Triangle

Conventional Reservoirs

Small Volumes
High Quality
Difficult to find
Easy to develop

Basin Maturity
Better Technology
(Higher prices)

Unconventional Reservoirs

Large Volumes
Low Quality
Easy to find
Difficult to develop

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Unconventional Resources

Coalbed Methane

- Gas trapped in coal (300+ Tcf?)

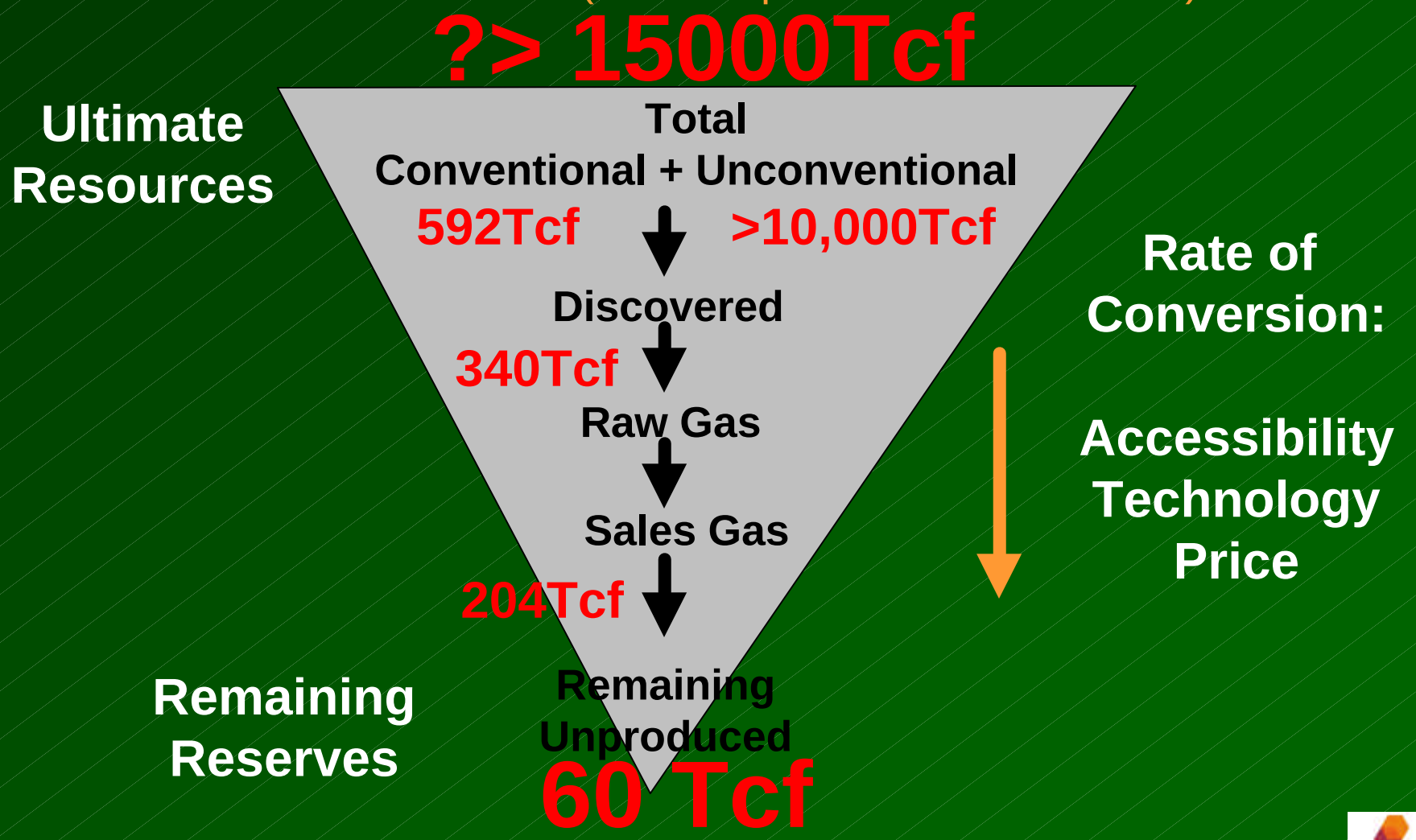
Gas Hydrates

- Gas trapped in ice crystals (>10,000 Tcf?)

Shale Gas
Tight Gas
} **Included with conventional?**

- Know the resource exists
- Low quality, challenging to extract
- Lack technology or economic incentive to extract
- Price will determine rate of development

Canada's Resources and Reserves (data adapted from CGPC 2001)



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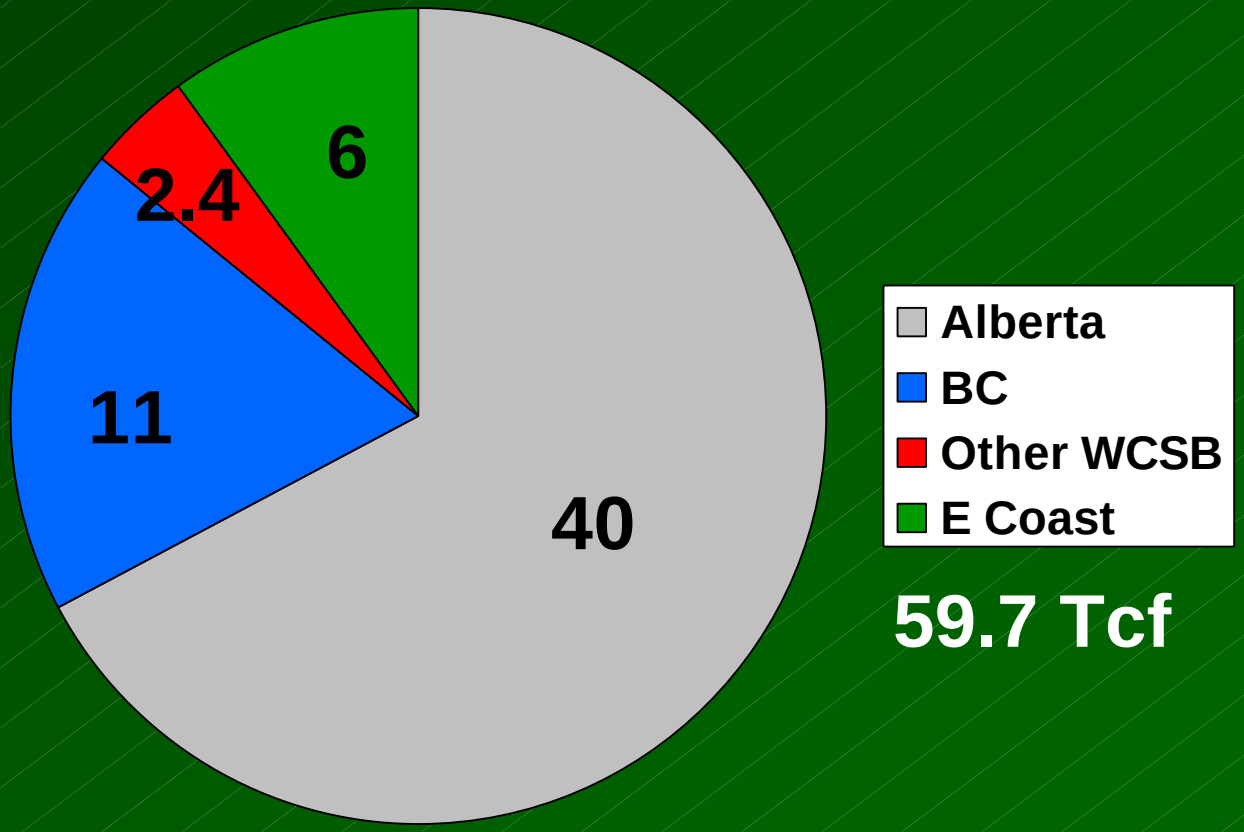
Canada's Remaining Accessible, Proven, Marketable Gas Reserves

(Estimated December 2002)



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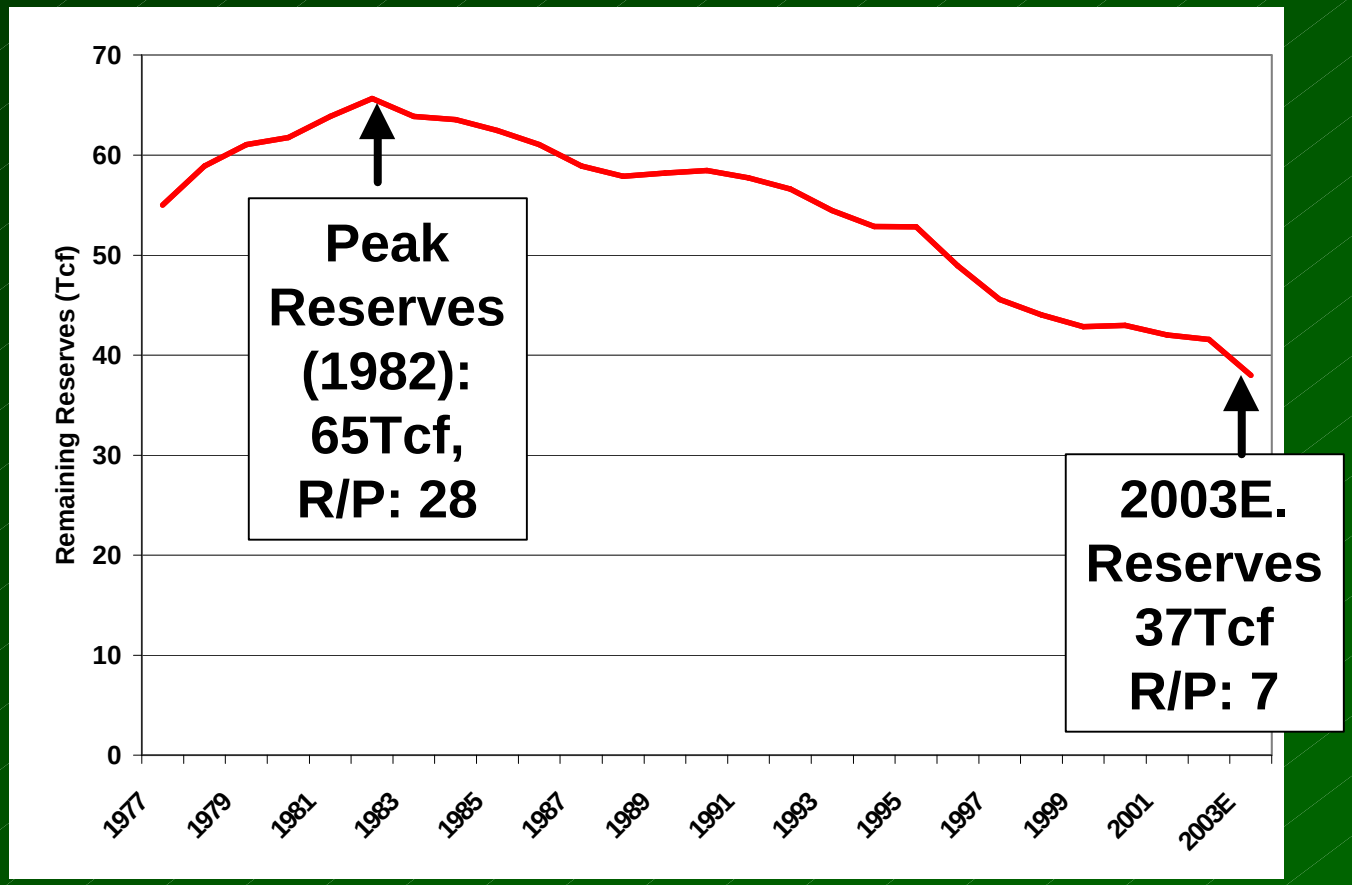
Alberta Remaining Reserves and R/P



Found more gas than produced only 3 years since 1982

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Reserve/Production Ratio

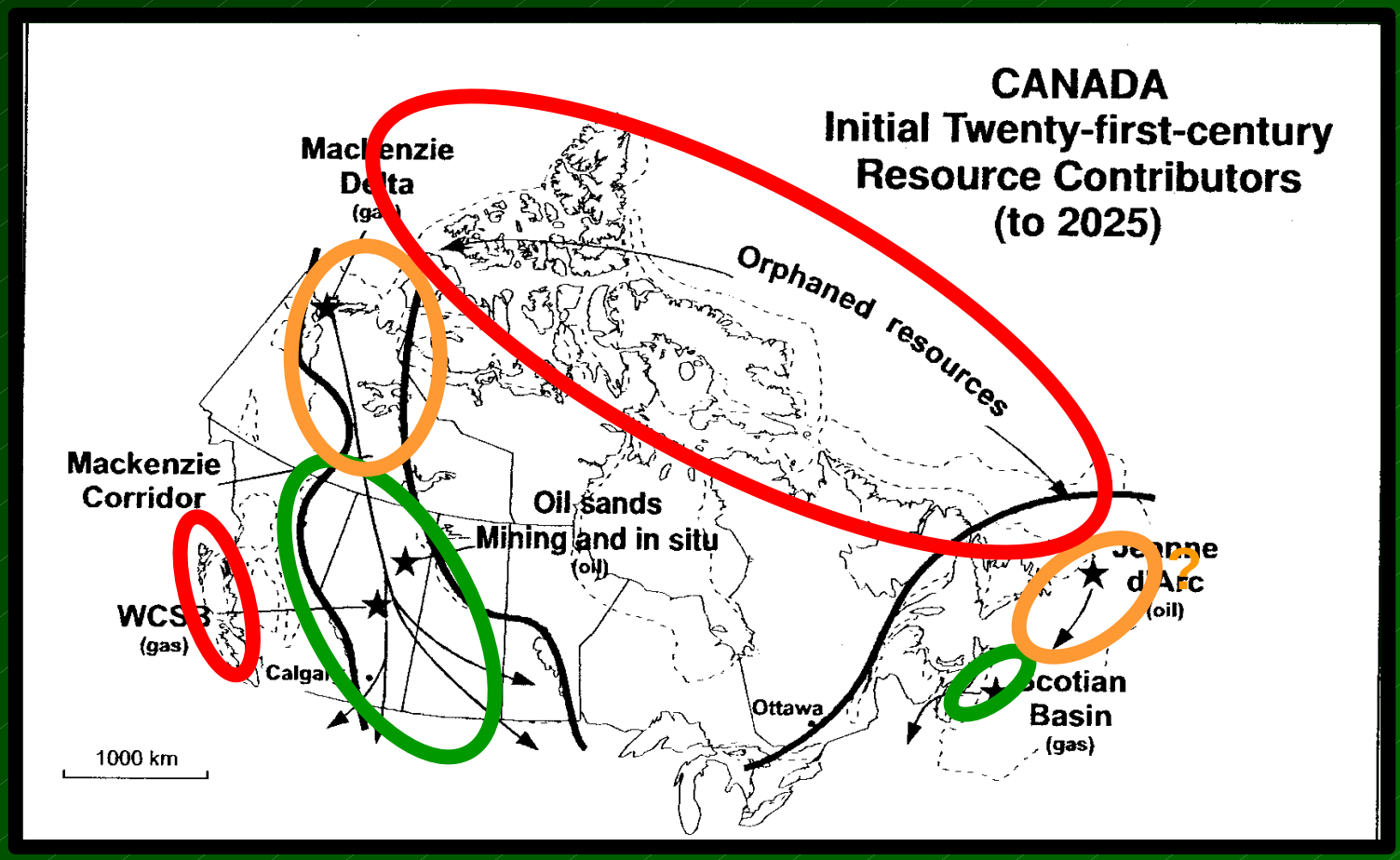
Reserve Life Index

Example 60Tcf Reserves/6Tcf Production per year = 10Years

Does not mean we will run out of gas in 10 years

- Time to produce ***current*** reserves at ***current*** rate
- Additions to Reserves or reduction in Production extends life

‘Orphaned’ Resources (Skipper, 2001)

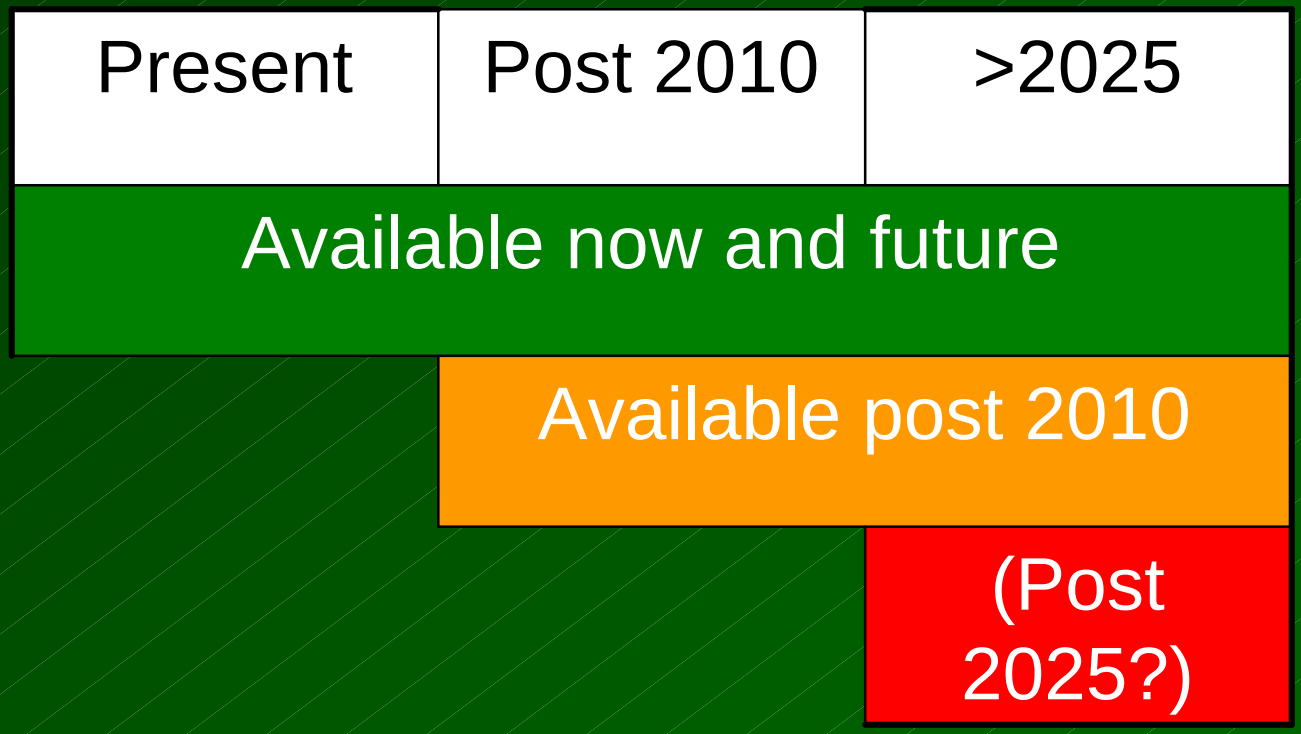


Understanding Remaining Gas Resources – Accessible and Economically Available

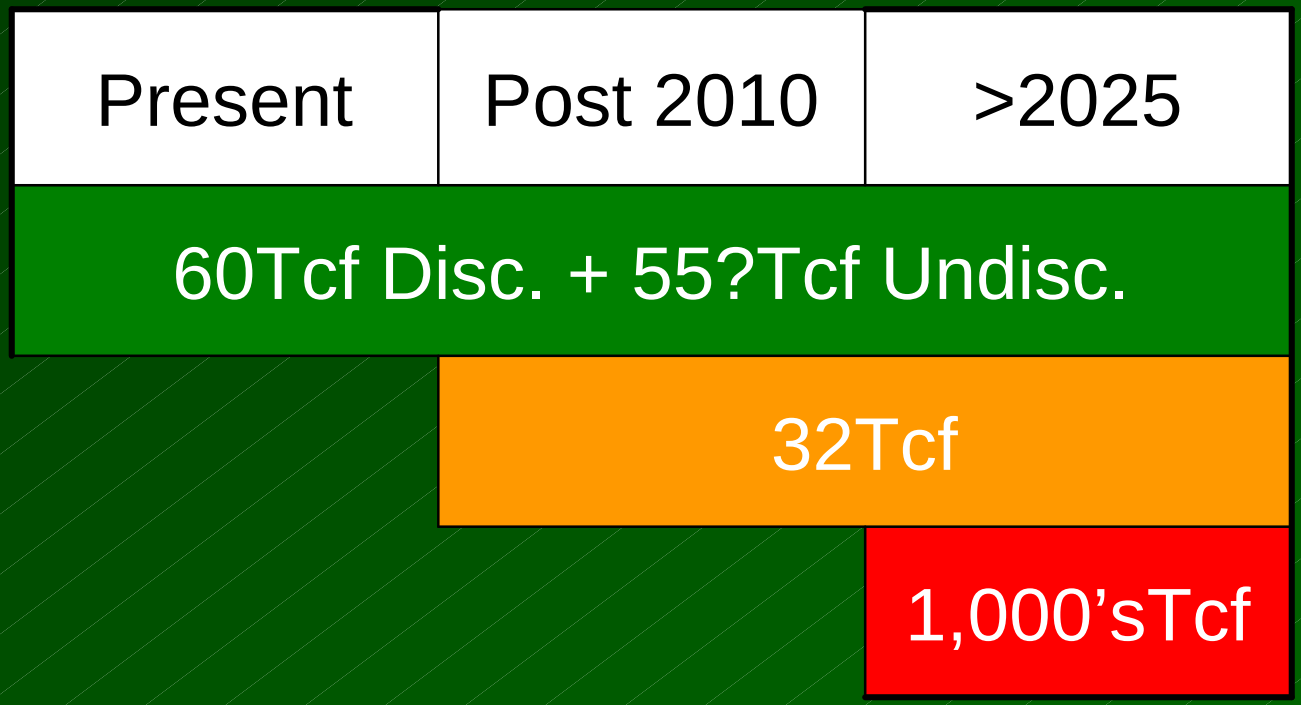
	Accessible	Accessible with restrictions	Inaccessible
<$6.00Cdn /mcf	Present	Future	Exclude
>$6.00Cdn /mcf	Future	Future	Exclude

Russum, CSEG Recorder, June 2003

Predicting future accessible resources

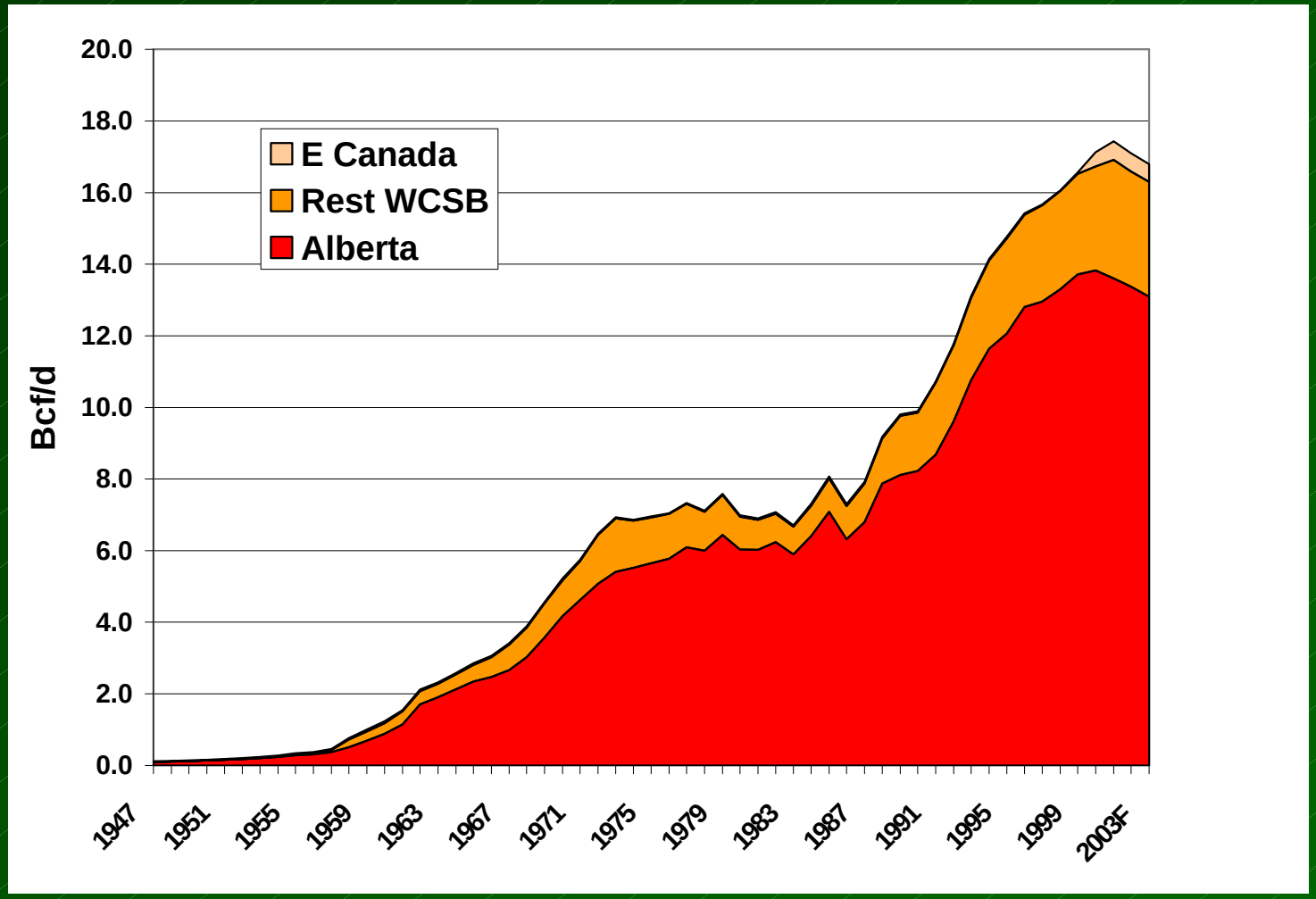


Approximate distribution of known resources



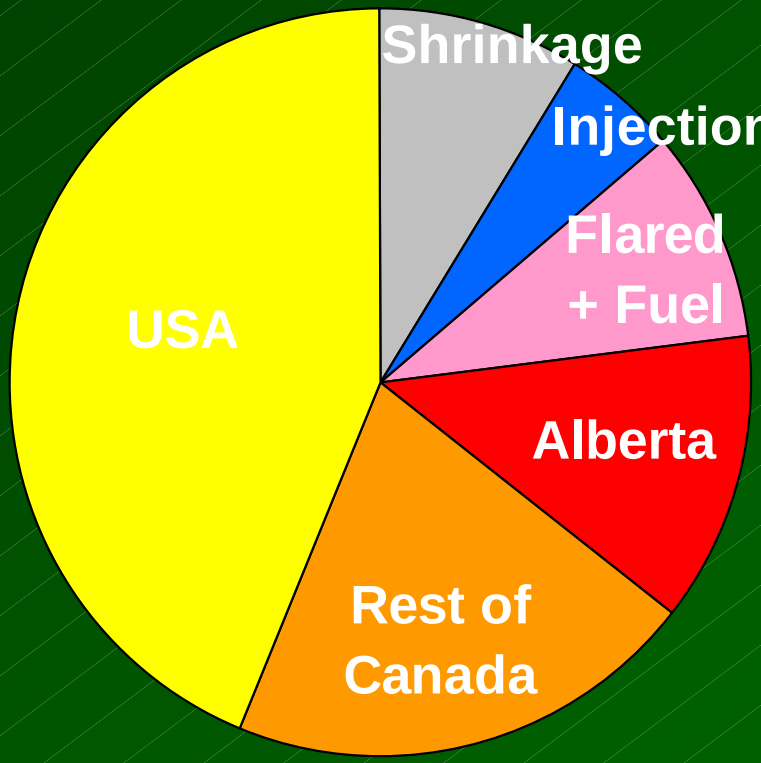
Canada’s Gas Production

Canada's Natural Gas Production (Bcf/d Adapted from CAPP Data)



Alberta

Where did Alberta's Gas Go in 2002? (AEUB ST-3)



Total: 6025 Bcf
Sales: 4657 Bcf

2654 Bcf
57%

760 Bcf
16%

1243 Bcf
27%

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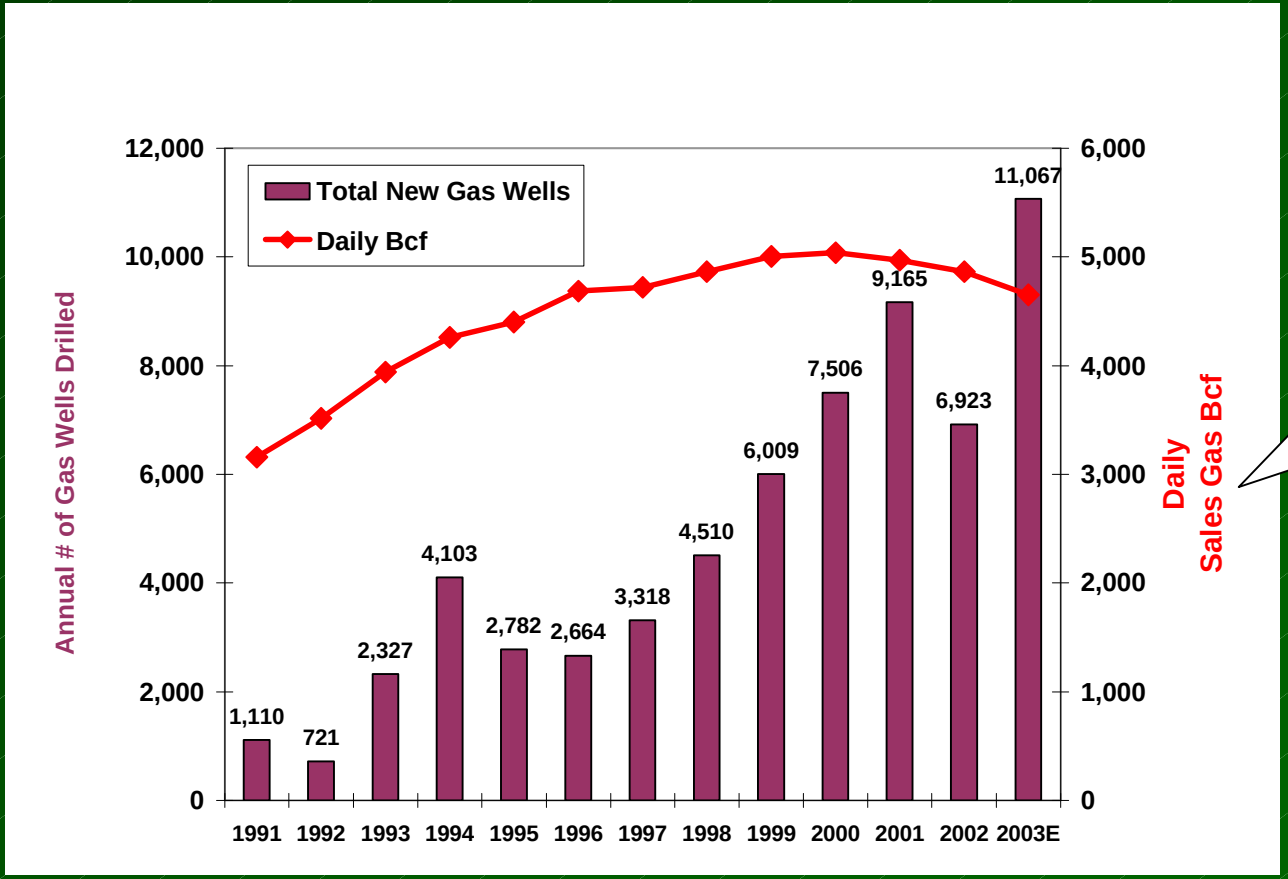
Alberta New Gas Drilling and Annual Gas Production (CAPP Data)



Should be Bcf/Yr

Alberta Gas 1992-2002

(AEUB Data)

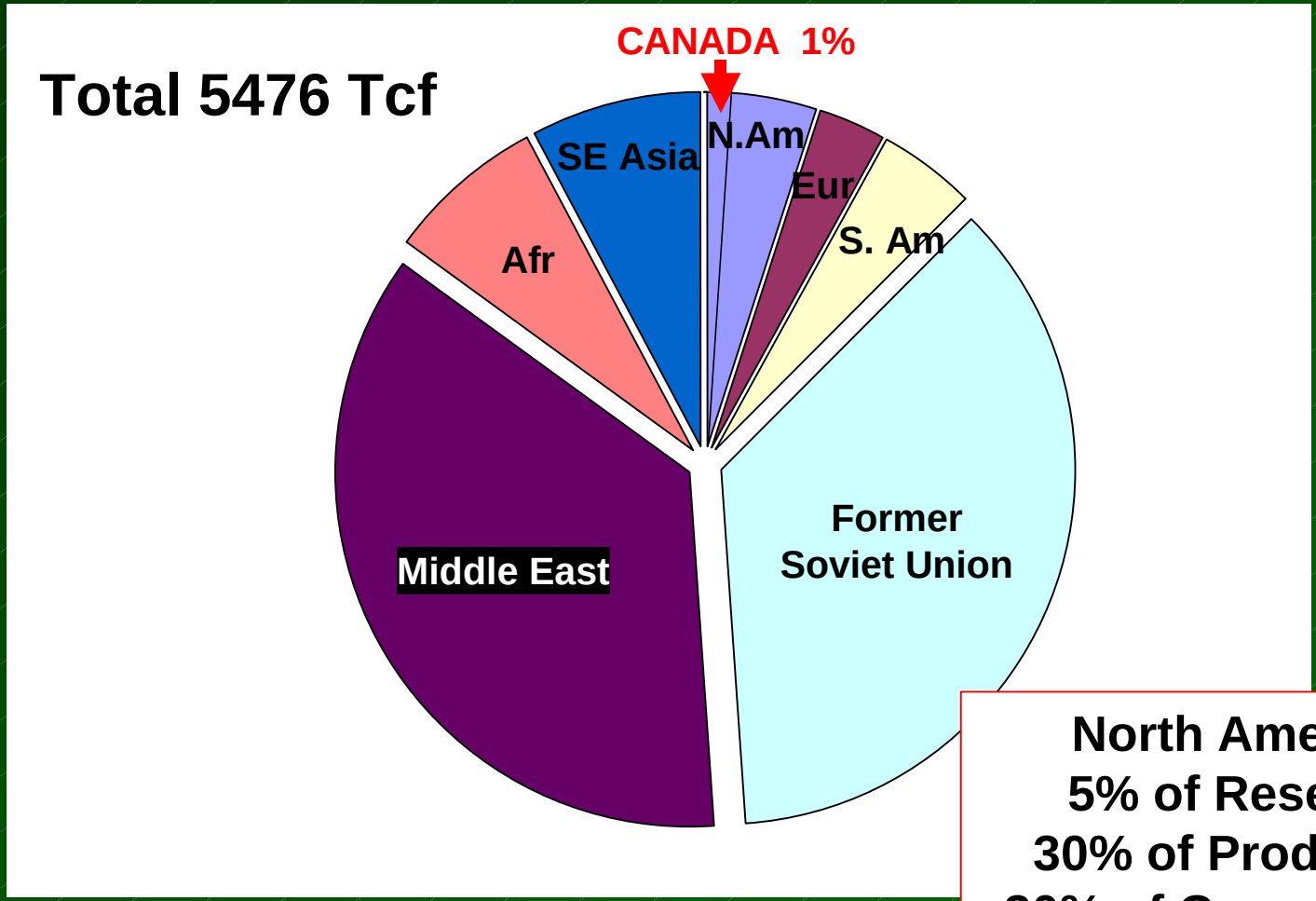
	1992	2002	**% Change**
Avg. IP of new wells	640mcf/d	250mcf/d	**-61%**
First year decline rate	29%	35%	**+21%**
# of new gas wells	721	6923	**+960%**
Avg. new well depth	1151m	1100m	**-4%**
Total Producing Wells	29,800	70,000	**+135%**
Total Production	3.6Tcf/Yr	5.0Tcf/Yr	**+39%**

Canada's Position in the world of Natural Gas

Canada Facts

- The 3rd largest producer of Natural Gas
- The 2nd largest exporter of Natural Gas
- 1% of the proven Natural Gas reserves in the World (18th place)
- The 3rd lowest R/P (9.8) after UK (6.2) and US (9.2).
  - Alberta's R/P is 7-8, (25 in 1986)
- Highest COF&D of any Country in the World

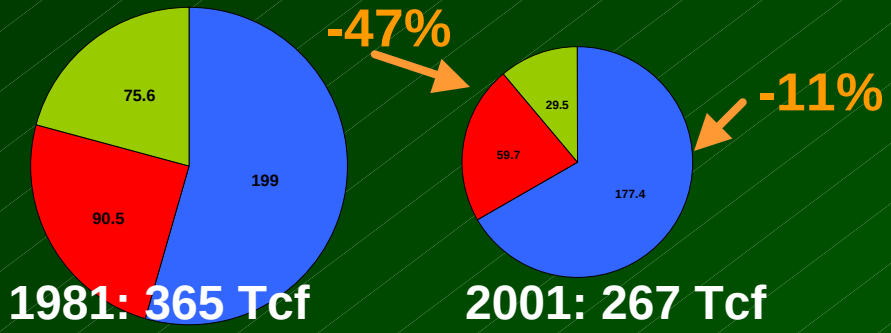
World Gas Reserves (BP, 2001)



North America:
5% of Reserves
30% of Production
30% of Consumption

North America

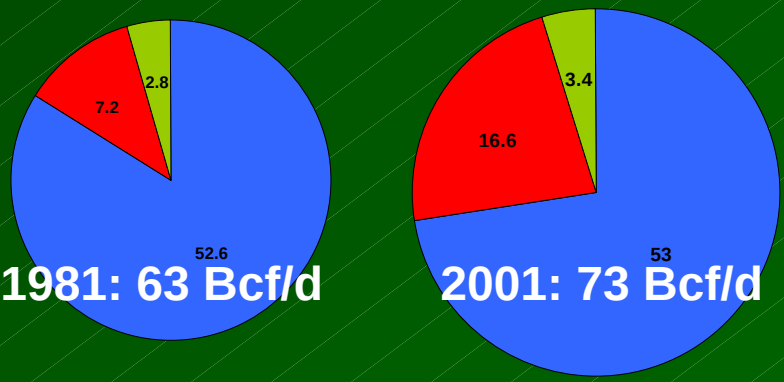
Reserves



1981: 365 Tcf

2001: 267 Tcf

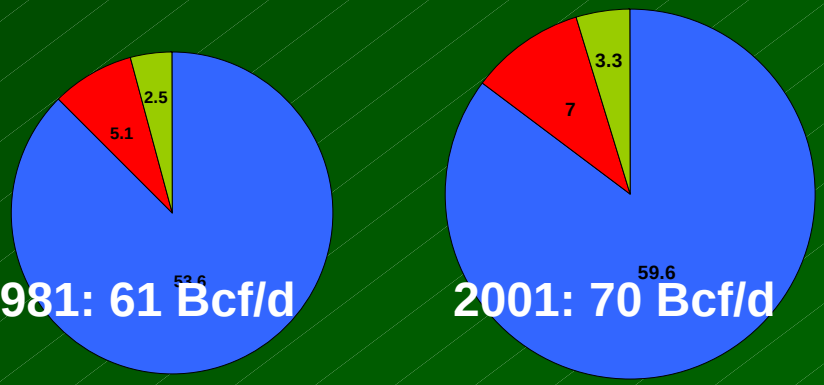
Production



1981: 63 Bcf/d

2001: 73 Bcf/d

Consumption



1981: 61 Bcf/d

2001: 70 Bcf/d

USA

Canada

Mexico

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Comments

- Natural gas industry in North America has become a ‘just in time’ industry – very vulnerable to fluctuations in supply and demand.
- We need to recognise that we may be a significant producer today but there is no guarantee that this will continue
- All levels of Industry and Government need to formulate a plan to ensure sustainability

Resource Development Model (RDM)

Dave Russum

Geo-Help Inc

June 2003

Resource Development Model - Intent

- A simple model to understand resource development
- Applicable to all non-renewable resources
- Applicable to renewable resources where production exceeds sustainable levels
- Relevant to a single project or to a total world assessment of a resource
- Provides some predictability to future trends

Resource Development Model (RDM) – 8 Stages

8. Abandonment
7. Reality
6. Decline
5. Peak
4. Growth
3. Development
2. Evaluation
1. Discovery

Knowing current stage of project can better predict future

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Stage 1: **Discovery**

- Idea
- Exploration
- Recognition of the Resource

Stage 2: **Evaluation**

- Determination of the economic viability of the resource
- Decision to proceed

Stage 3: **Development**

- Bringing the resource into production
  - Finding the market
  - Developing the infrastructure
  - Creating ability to process the resource

Stage 4: Growth

In an unregulated environment:

- **“Unbridled optimism” - Intense Competition**
- **Assumption of virtually unlimited future production**
- **Costs escalate**
- **Hasty investment decisions (herd mentality)**
- **High production to monetise resource**
- **Production accelerates beyond reasonable levels**

Stage 5: **Peak**

- Generally not recognised until afterwards
- Very short lived in a deregulated environment (eg. Ladyfern – <1 month)
- Early (knowledgeable) investors and operators may quietly exit

Stage 6: Decline

- "Denial" - Companies, workers, politicians, regulators and consumers predict and expect continued growth in production
  - "Current decline is temporary"
- Future predictions disconnected with current reality (often based on old data)
- High Spending based on unrealistic expectations
- Costs to maintain production increase
- Opinions that all is not rosy are not welcome

Stage 7: **Reality**

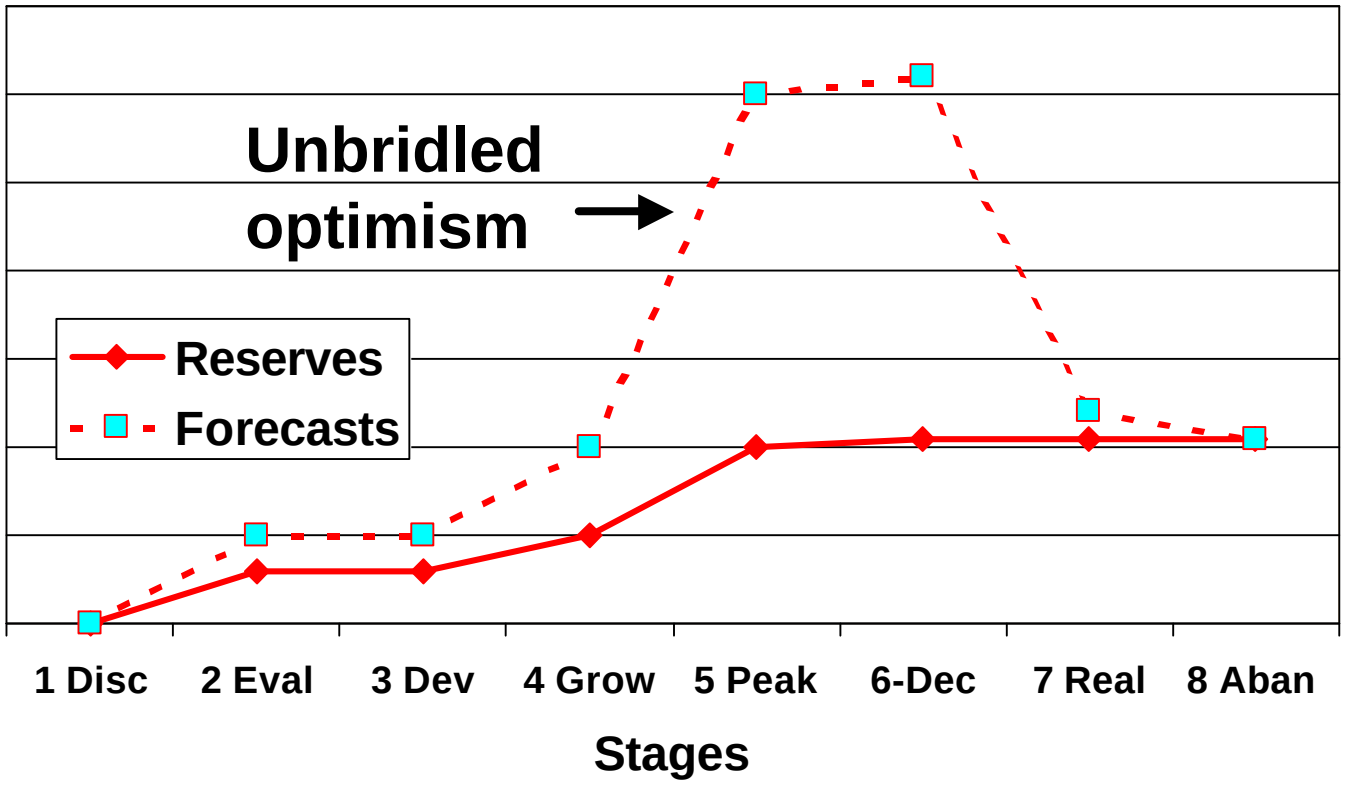
- **Limitations of resource recognized**
- **Opportunities inadequate for large operators**
- **Remaining quality resources become cash cow**
- **Quotas or regulations applied to extend the life of resource**
  - **Generally too little to late**
  - **Vehemently opposed by impacted Industry**
- **Government invests in R&D**
- **(Incentives introduced to encourage exploration)**
- **Rate of decline slows**
- **Small, low cost operators pursue remaining resources**

Stage 8: **Abandonment**

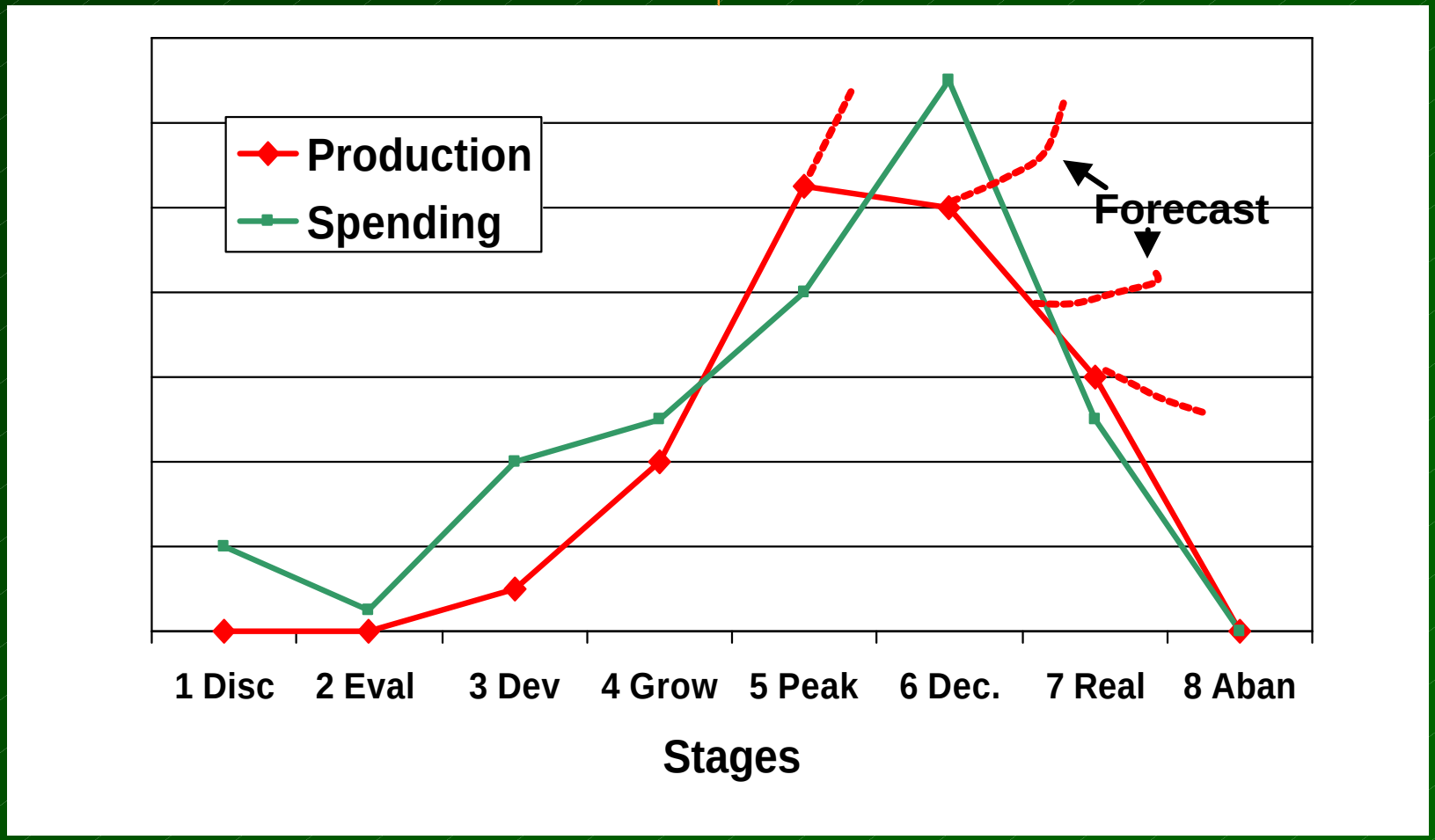
- Remaining resource is dispersed, low quality and expensive to extract.
- Production grinds to a halt
- Restoration often does not occur - creating the “ghost towns” that are common in former natural resource area.

Note: Resource not completely produced; not economically viable to extract what remains or a more viable alternative has been discovered.

Reserves - Actual and Forecast



Spending and Production Trends



Resource Development Model
– WELSH COALFIELDS

8. Abandonment (1980s)
7. Reality (1965-1980)
6. Decline (1900-1970)
5. Peak (1890?)
4. Growth (1850-1880)
3. Development (1850's)
2. Evaluation (2 years?)
1. Discovery (Pre 1850)

Current Stage: 8

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Stages

- Not consistent in length
- Stage may be skipped or take hundreds of years
- Will be some overlap of stages
- New technology or high prices may rejuvenate or extend an existing project/resource

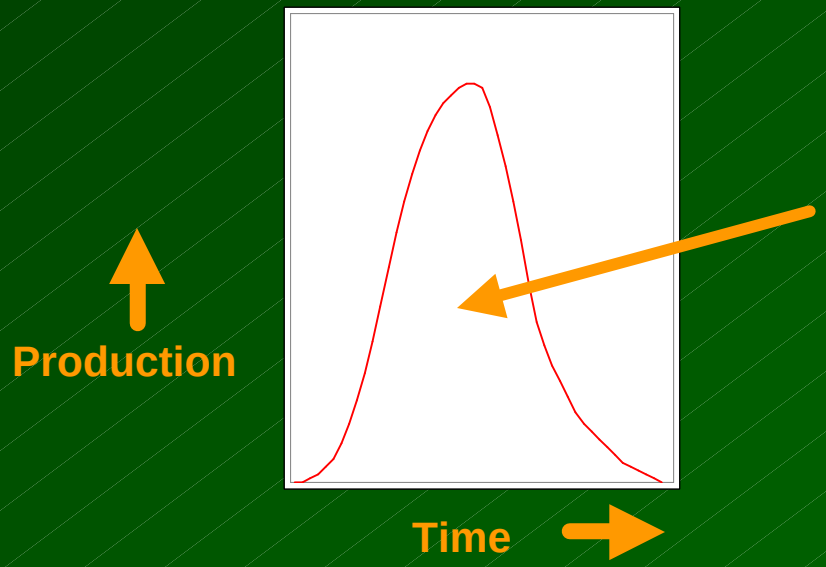
Caution – external influences will mask stages (eg. Deregulation, legislation, access, abnormal prices etc)

RDM and the Oil and Gas Industry

Dave Russum

Hubbert's Peak

Hubbert (1949) showed that for a finite resource a plot of production vs. time would have a peak



The higher the peak, the sooner and sharper the decline

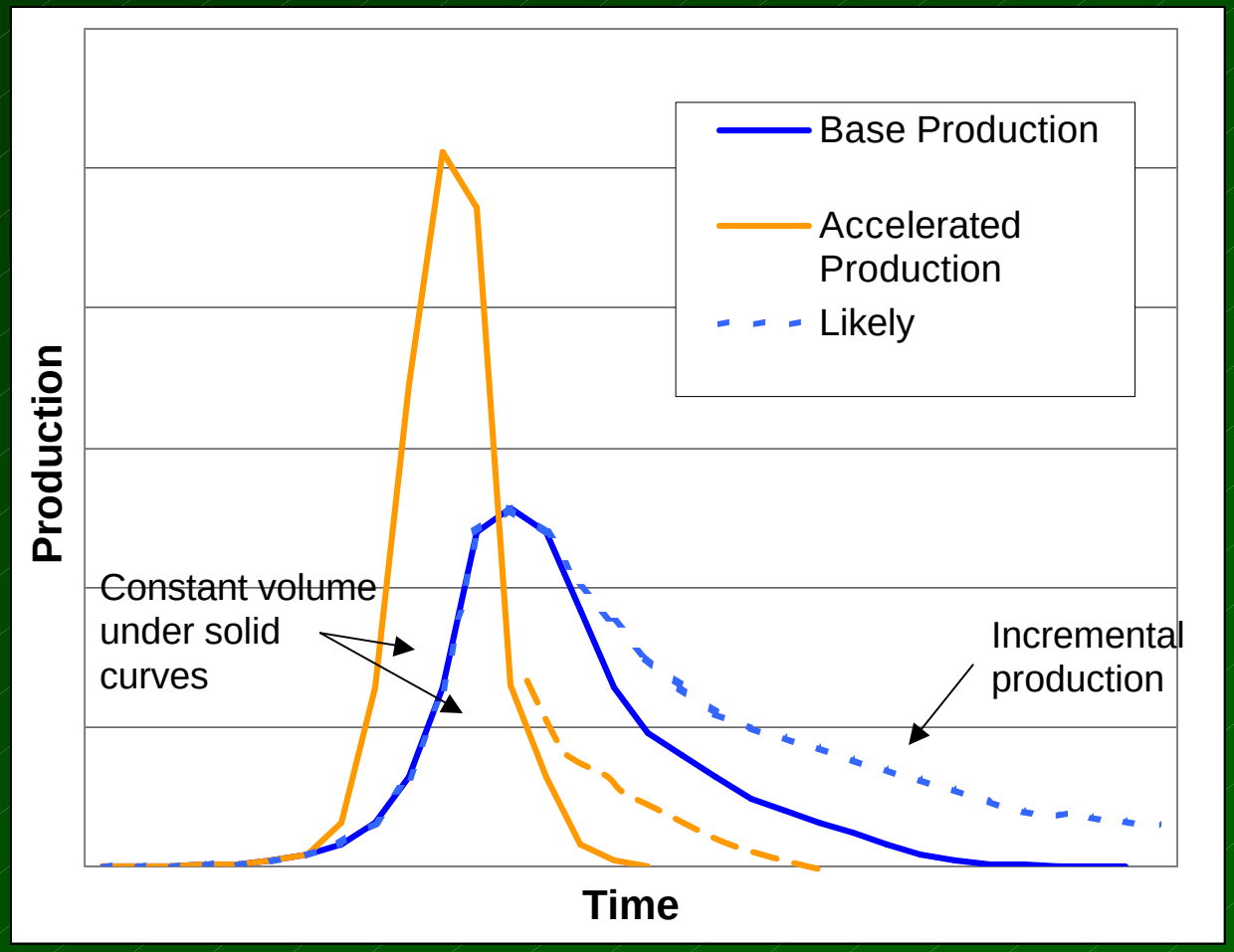
Hubbert's Success and Failure

- In 1956 he correctly predicted the peak for US Oil production in 1970
- In 1974 he incorrectly predicted world oil production to peak in 1995
  - 'Crying wolf'
  - 'Experts' can't predict next month's production

Why was Hubbert wrong?

- Hubbert was not wrong with the concept
- He was wrong with the timing because he miscalculated the potential resource (the volume under the curve)
- He did not take into account how, innovation, technology and higher price plus higher spending could increase the potential resource over time

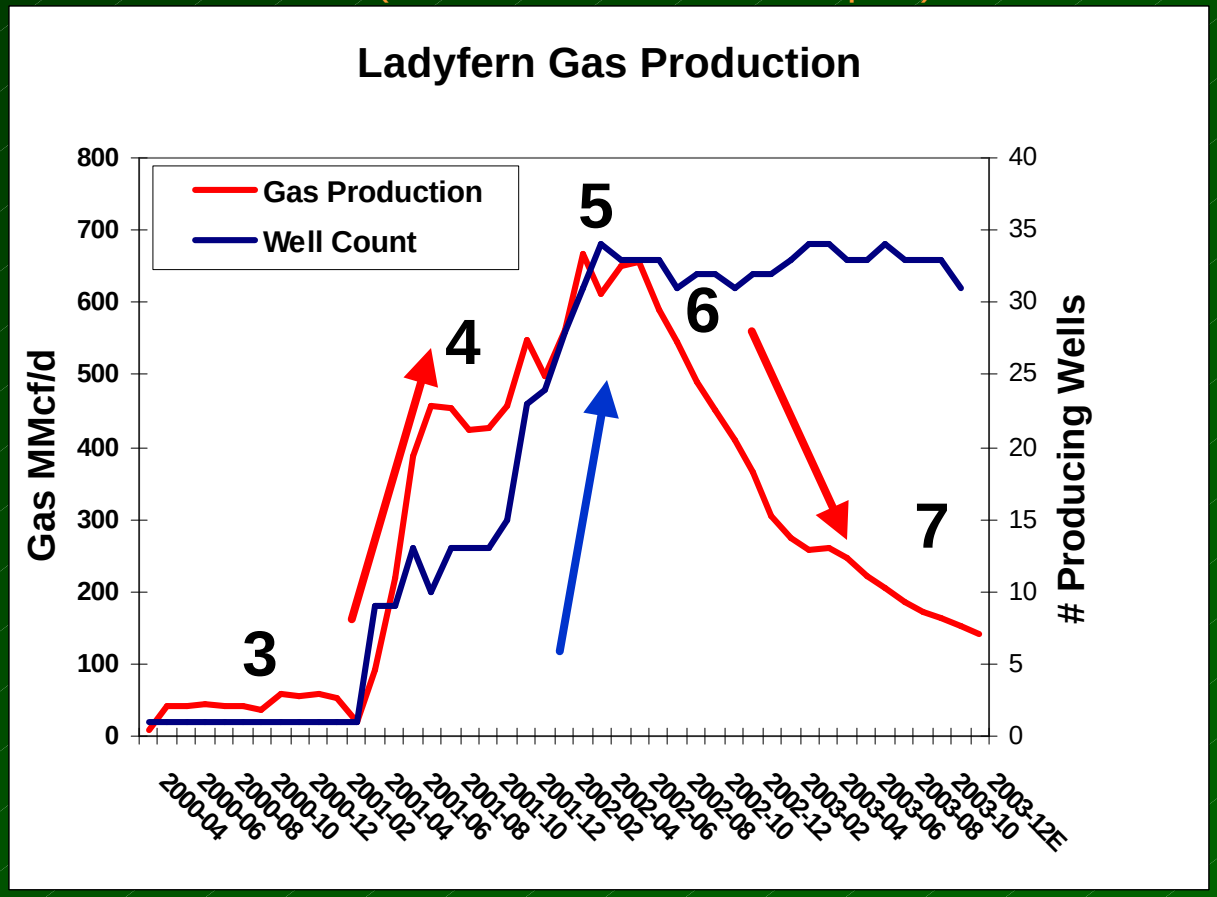
Production Profiles



Accelerated Case: GPP, technology do not have time to evolve, total production lower. (Future more Predictable)

Ladyfern

(Data from AJM 2003 Report)



Current Stage 7 (Reality)

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Resource Development Model – Ladyfern

8. Abandonment
7. Reality (Present)
6. Decline (1 day)
5. Peak (1 day?)
4. Growth (1.5 years)
3. Development (6 months)
2. Evaluation (1 week?)
1. Discovery (3 years)

Current Stage: 7

Why we need to do better than Hubbert

- If we could identify the RDM stage of a play, area, basin or the world it would help:
  - Identify upside or limitations of an area
  - Develop meaningful expectations for future production
  - Proactively identify supply problems
  - Provide more realistic planning for Governments and users of the product
- (Gas should be easier to predict than oil!)

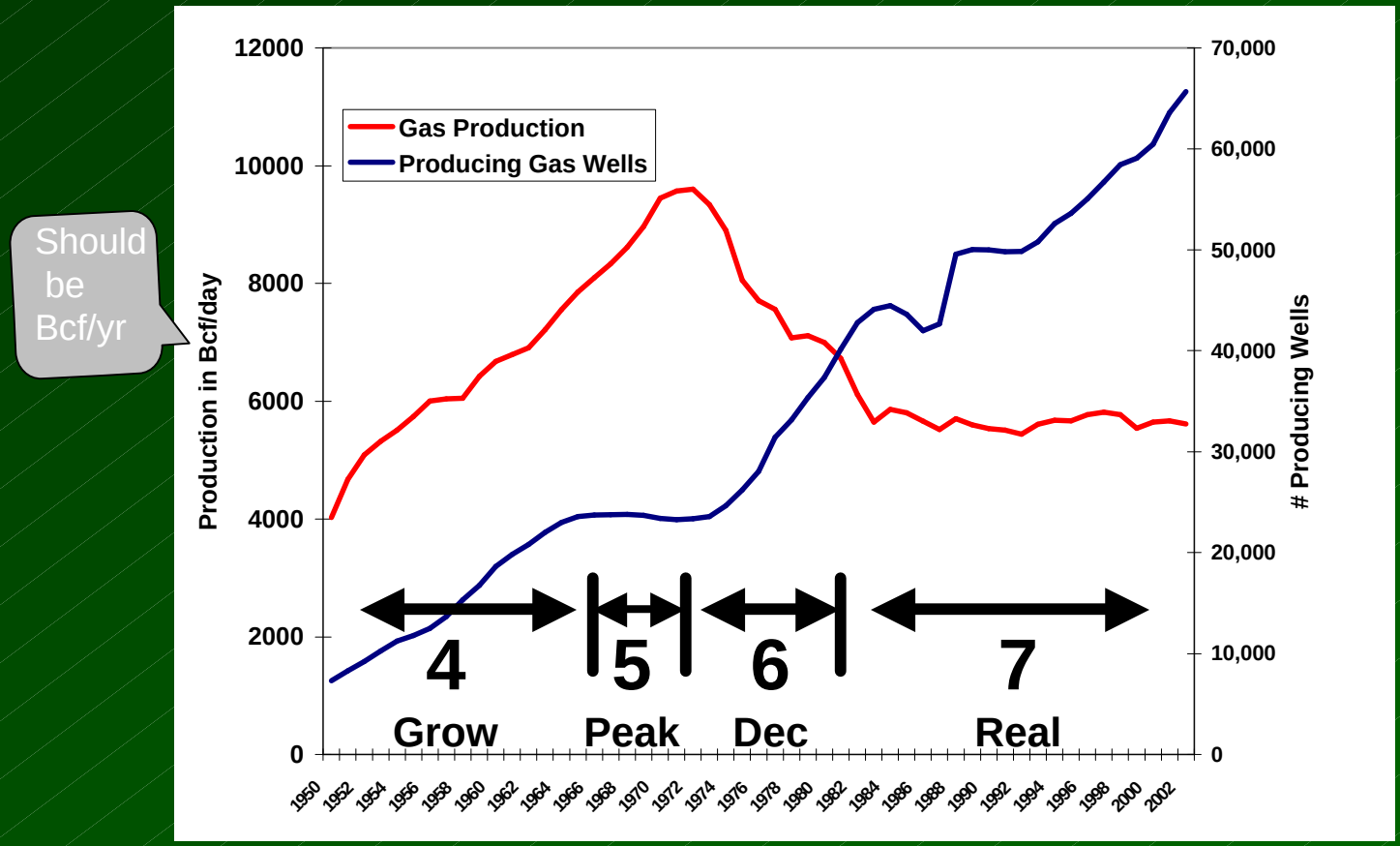
Applying the RDM to Oil and Gas Industry

- Production alone is oversimplification
- Need to understand historical perspective

Plus:

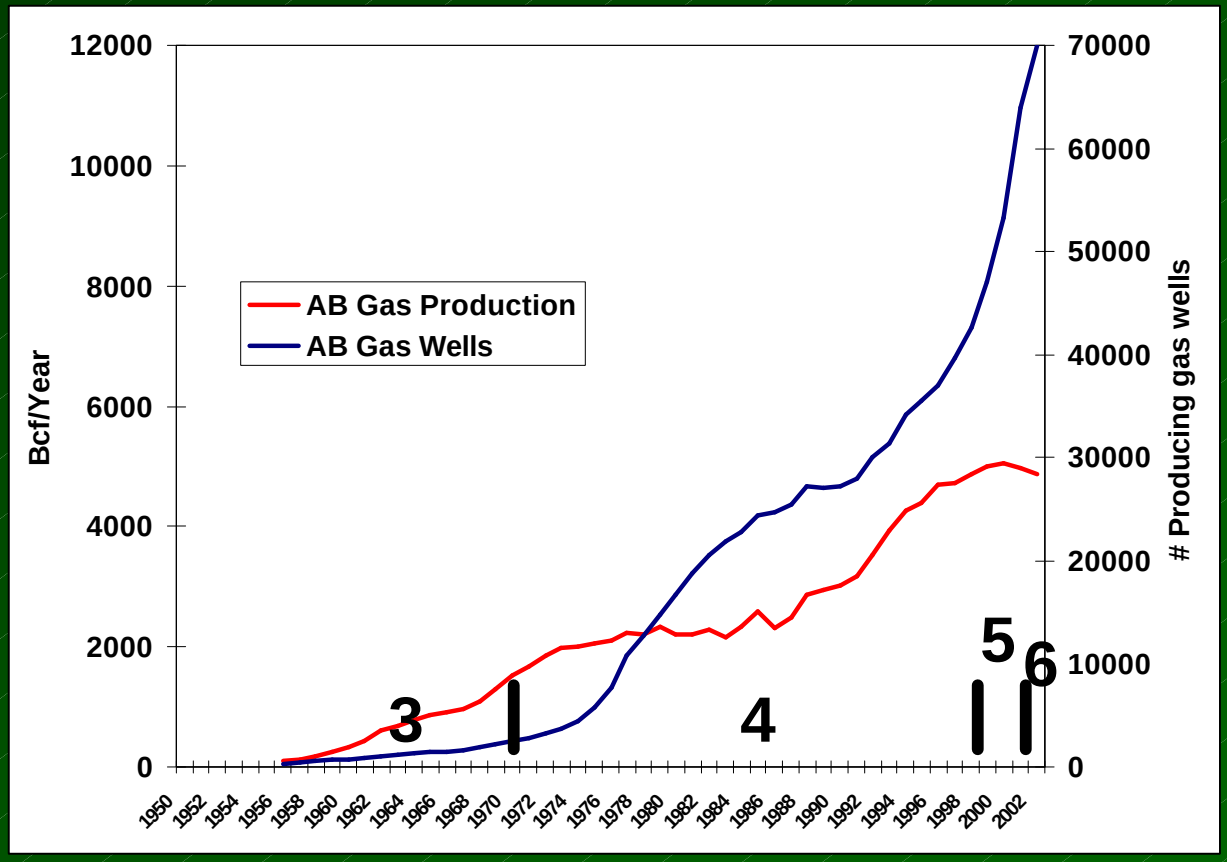
- Would like to measure spending
- Number of wells acts as a proxy to spending

Texas Onshore gas production (1950 to Present)



Current Stage: 7 (Reality)

Alberta gas production and gas wells (CAPP Data)



Current Stage: 6 (Decline) - Rapidly Moving to Reality

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Texas Onshore vs. Alberta Statistics

	Texas	Alberta
Area (sq. miles)	269,000	255,000
Cum Production	319Tcf	109Tcf
Peak Production Year	1971 (9.5Tcf) R/P = 15	2000 (5.1Tcf) R/P = 8
Remaining Reserves Peak Year	1971 (122Tcf) R/P = 15	1982 (65Tcf) R/P = 28
2002 Remaining Reserves	43Tcf	40Tcf
2002 Production	5.6Tcf R/P = 7.7	4.8Tcf R/P = 8.3
2002 Gas wells	65,686	70,000

Alberta is not as rich in natural gas as Texas!

Resource Development Model
– Alberta Gas

8. Abandonment
7. Reality
6. Decline (2001- Present)
5. Peak (2001)
4. Growth (1950-2000)
3. Development (1910- 1950)
2. Evaluation (20 years?)
1. Discovery (1880's)

Current Stage: 6

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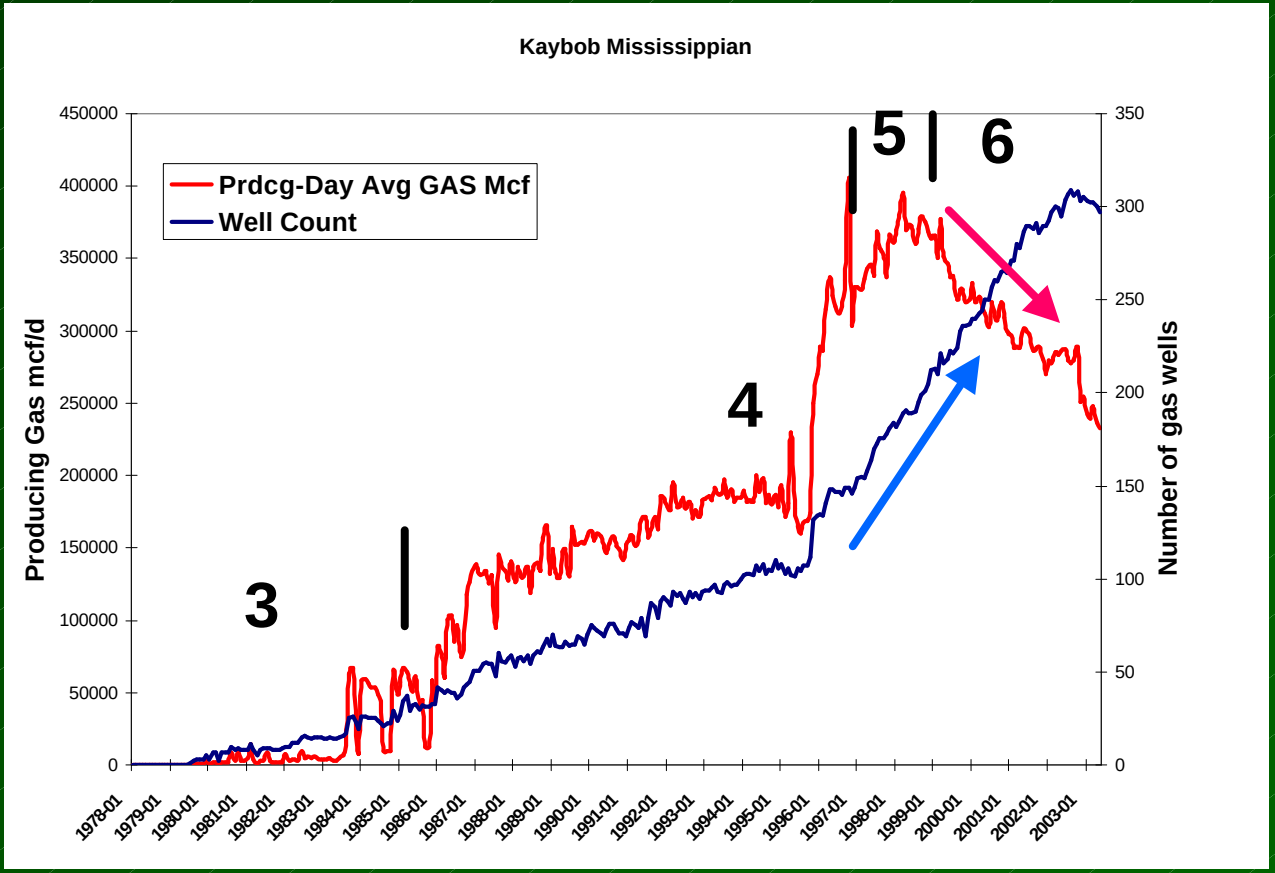
Improving the Model

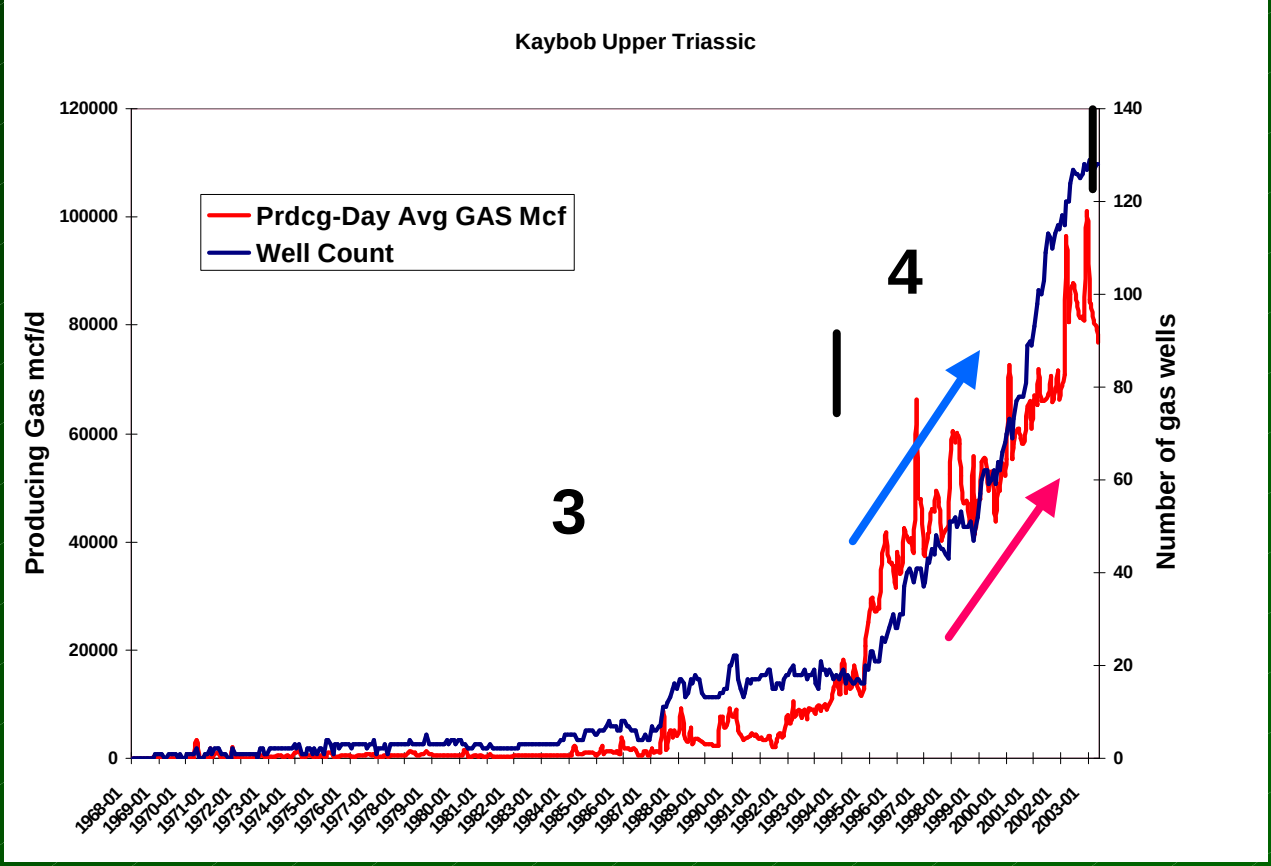
- Technology, regulations, new concepts, ease of access, maturity of area all impact
- Lumping/splitting of data will tend to mask results
- Need to place activity in historic context

Example of a formation/area in decline (Data from AJM 2003 Study)



Current Stage 6 (Decline)

Example of a formation/area still growing (Data from AJM 2003 Study)



Current Stage 4 (Growth)

Implications of trends

- Can plot trends on a pool, play, area, basin or worldwide basis
- Immature trends (low well counts and low productivity) still difficult to predict future (Look at well density?)
- Mature trends the decline in existing productivity is likely to be greater than any new additions

Note: Does not mean there are no opportunities left to be found <u>but</u> investment must be made with caution

Resource Development Model
– Mackenzie Delta Gas

8. Abandonment
7. Reality
6. Declinel
5. Peak
4. Growth
3. Development
2. Evaluation (1970-Present)
1. Discovery (1970's)

Current Stage: 2/3

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Canada's Hydrocarbon Stages

Stage	1 Disc	2 Eval	3 Dev	4 Grow	5 Peak	6 Dec	7 Real	8 Abn
AB Gas								
BC Gas								
Sask. Gas								
E. Coast Gas				?				
Mackenzie Gas								
CBM								
Gas Hydrates								
AB Oil - Light								
AB Oil - Heavy								
Tar sands								

Problem

- General trends can be identified from regional data but may be masking some very important underlying trends and opportunities
- How do we efficiently dig down through the data in real time?

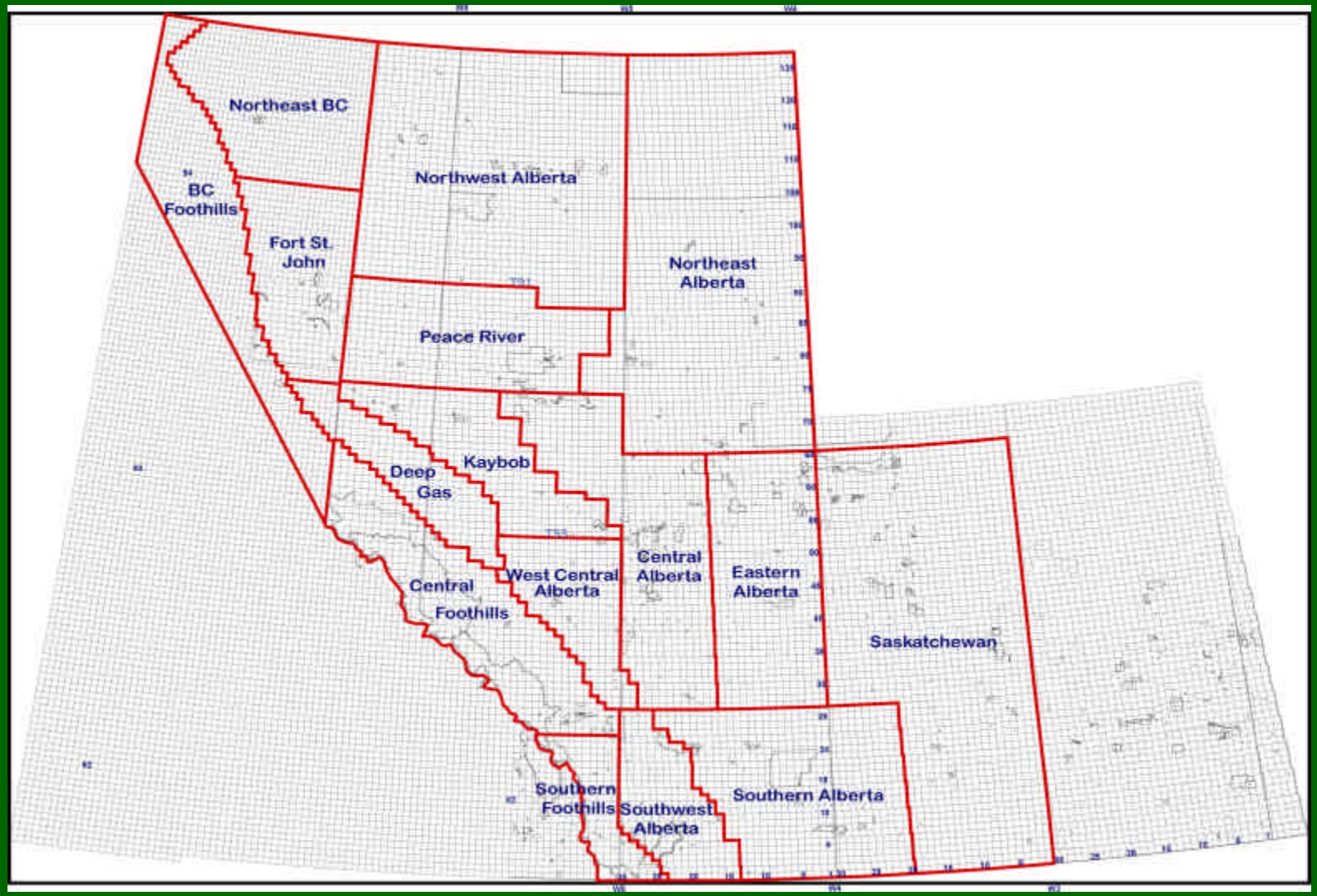
Solution

- AJM Petroleum Consultants have developed a web based Resource Potential Model - enables a Basin to be analysed in much greater detail
- Model incorporates:
  - Decline analysis at the well level
  - Geo-statistical analysis of production
  - Full-cycle economic analysis
  - Geological and engineering expertise
  - Up-to-date data

AJM Petroleum Consultants RPM Analysis

- WCSB divided into 16 geographic areas for gas (13 for oil) based on regional geological parameters.
- Each area is divided into 14 stratigraphic groups based on similar producing formations
- Provides 224 discrete sets of data that can be individually assessed or grouped

RPM: 16 Geographic Gas Areas



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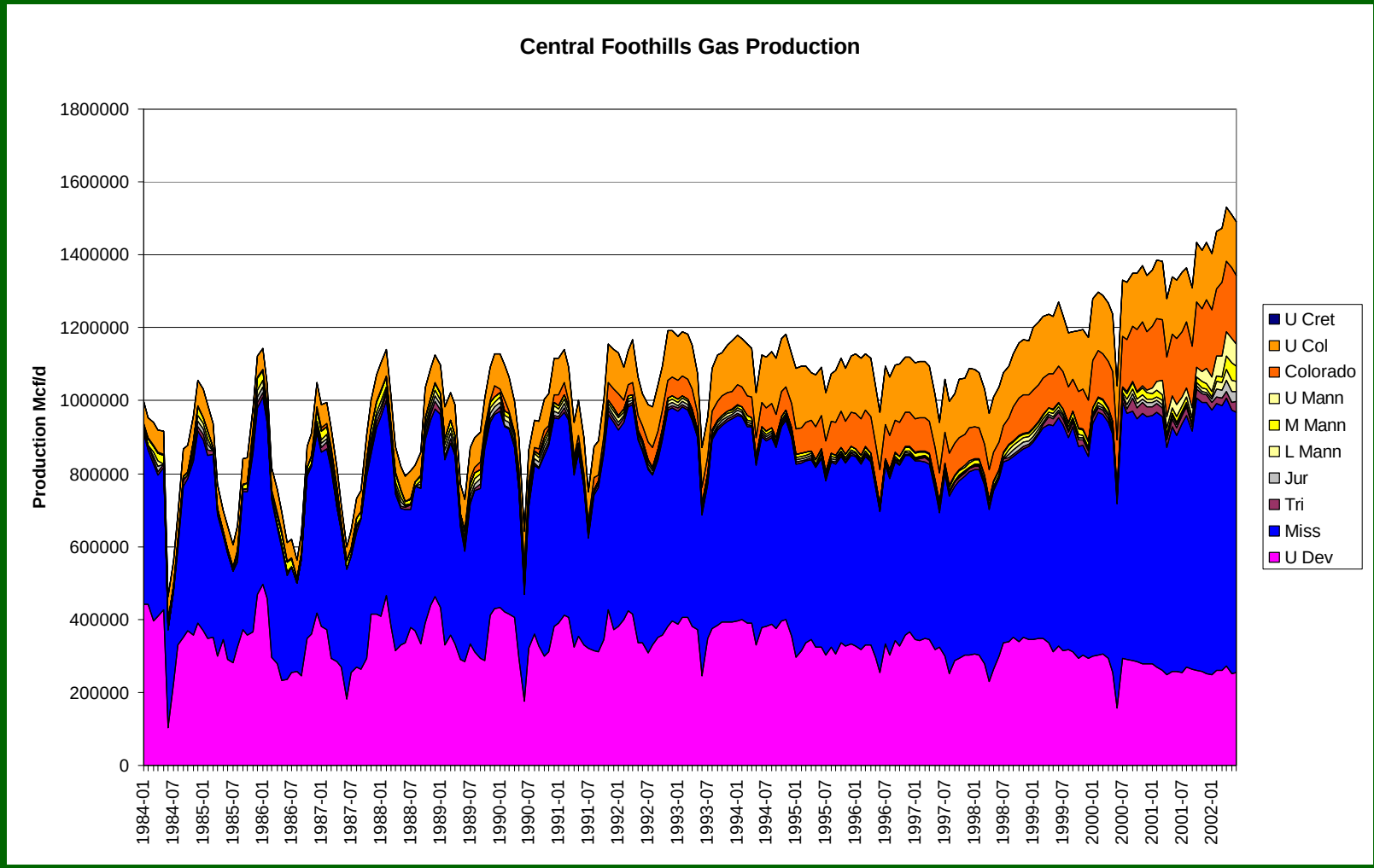
Results – Central Foothills



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RPM Results – Central Foothills (AJM 2003 Study)

Area Summary

Stratigraphic Group	Number of Evaluated Wells	Chance of Success	Resources Sales Volume (MMcfe)		Finding & Development Costs ($/Mcfe)	
			Unrisked	Risked	Unrisked	Risked
Upper Colorado	50	47%	2,270	1,067	0.98	2.15
Colorado	69	68%	3,678	2,501	0.81	1.26
Upper Mannville	13	39%	936	365	3.41	8.37
Middle Mannville	8	59%	3,649	2,153	0.92	1.60
Lower Mannville	8	48%	3,938	1,890	0.91	1.87
Upper Triassic	6	50%	6,678	3,339	0.75	1.48
Mississippian	96	61%	7,381	4,502	0.89	1.46
Upper Devonian	28	59%	13,626	8,040	0.54	0.91

Results Continued – Central Foothills (AJM 2003 Study)

Financial Indicators (Before Tax)

Stratigraphic Group	Number of Evaluated Wells	Chance of Success	Average Netback ($/Mcf) @ $4.00/Mcf	Break-Even Gas Price, $/Mcf	
				Unrisked	Risked
Upper Colorado	50	47%	2.50	2.00	4.62
Colorado	69	68%	2.51	1.78	2.77
Upper Mannville	13	39%	2.44	7.10	14.58
Middle Mannville	8	59%	2.46	2.46	3.67
Lower Mannville	8	48%	2.46	2.26	3.76
Upper Triassic	6	50%	2.10	2.32	3.52
Mississippian	96	61%	2.20	2.56	3.26
Upper Devonian	28	59%	2.02	2.12	2.77

Example of Play Area Stages WCSB

	1 Disc	2 Eval	3 Dev	4 Grow	5 Peak	6 Dec	7 Real	8 Abn
Play Area 1								
Play Area 2								
Play Area 3								
Play Area 224								

Relate play stages to recent activity, production and economics to gain more accurate understanding of future potential

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RDM (Resource Development Model) and RPM (Resource Potential Model)

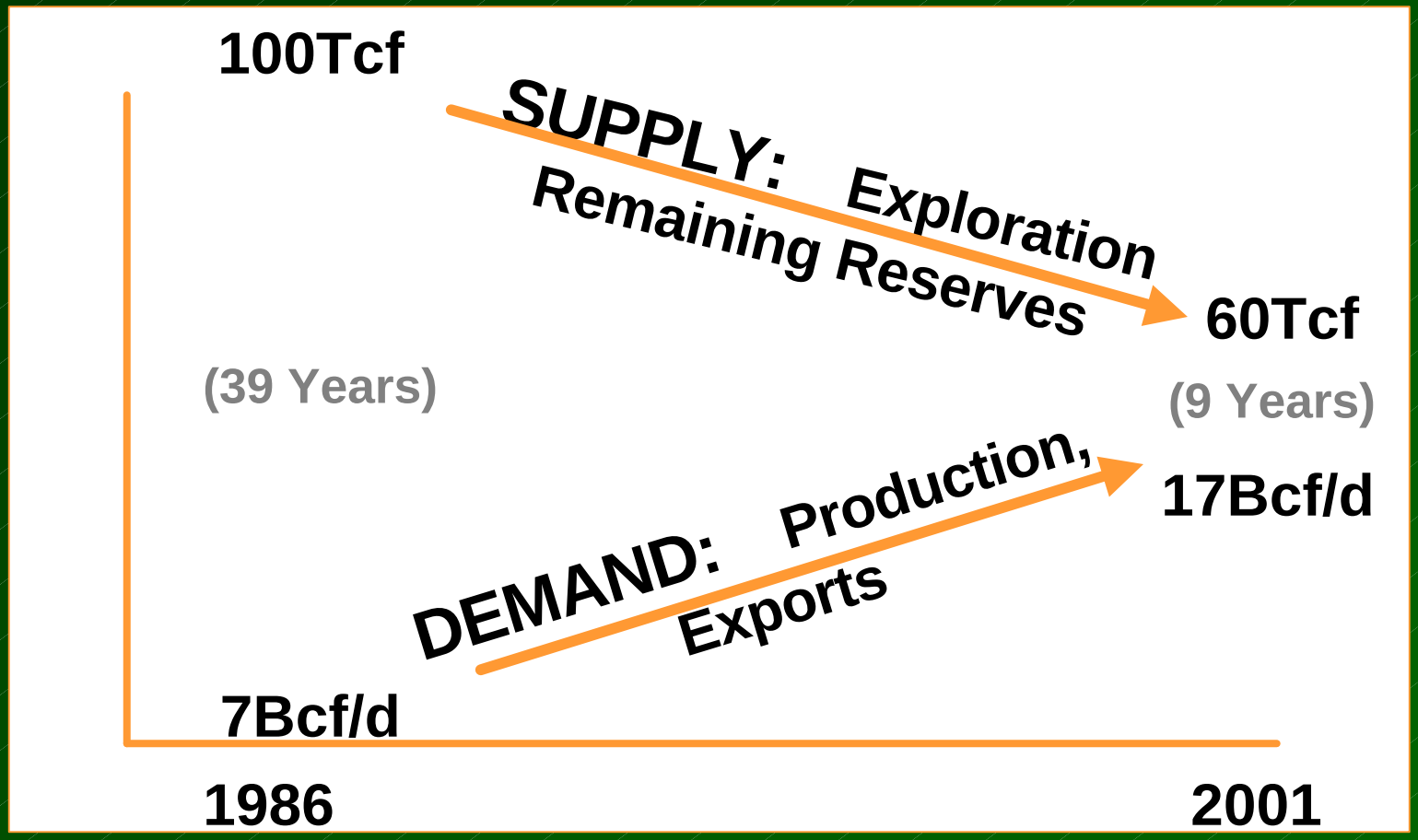
- RDM is not a panacea but provides some useful information at all scale
- Incorporating a well count acts as a proxy for spending (activity level) – provides insights into trends particularly as approach peak production
- Combining with a product like AJM's RPM creates an exceptionally powerful tool

Future Direction

- Merge the RDM and RPM data to confirm the peak BUT also the timing and extent of the decline and whether we will eventually reach a plateau of sustainable production.

Predicting future trends

Natural Gas In Canada – Where are we going?



FUTURE?

Kyoto?
El Nino?
NAFTA?
OPEC?
LNG?
Politics?
Terrorism?
N.Am Economy?

Prices

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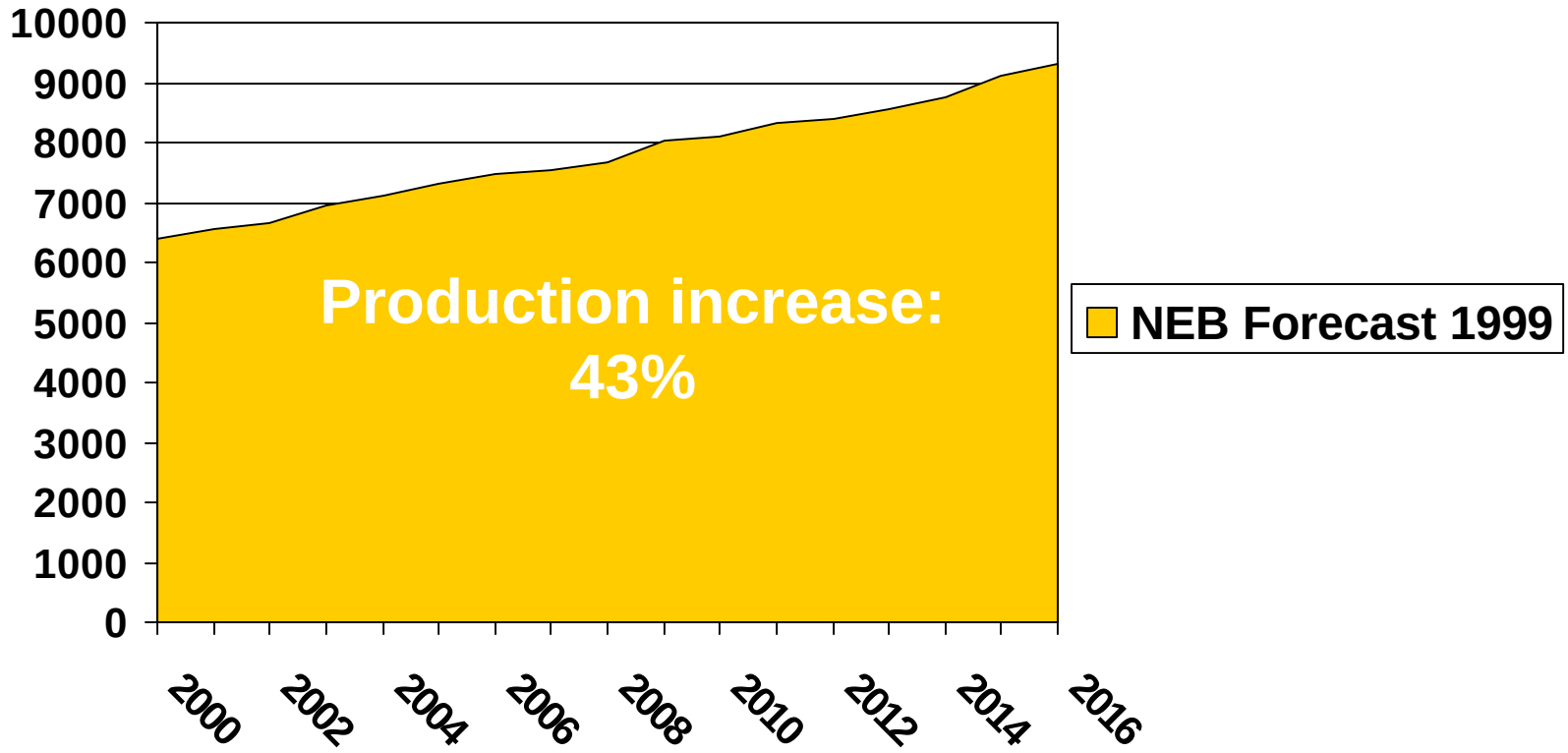
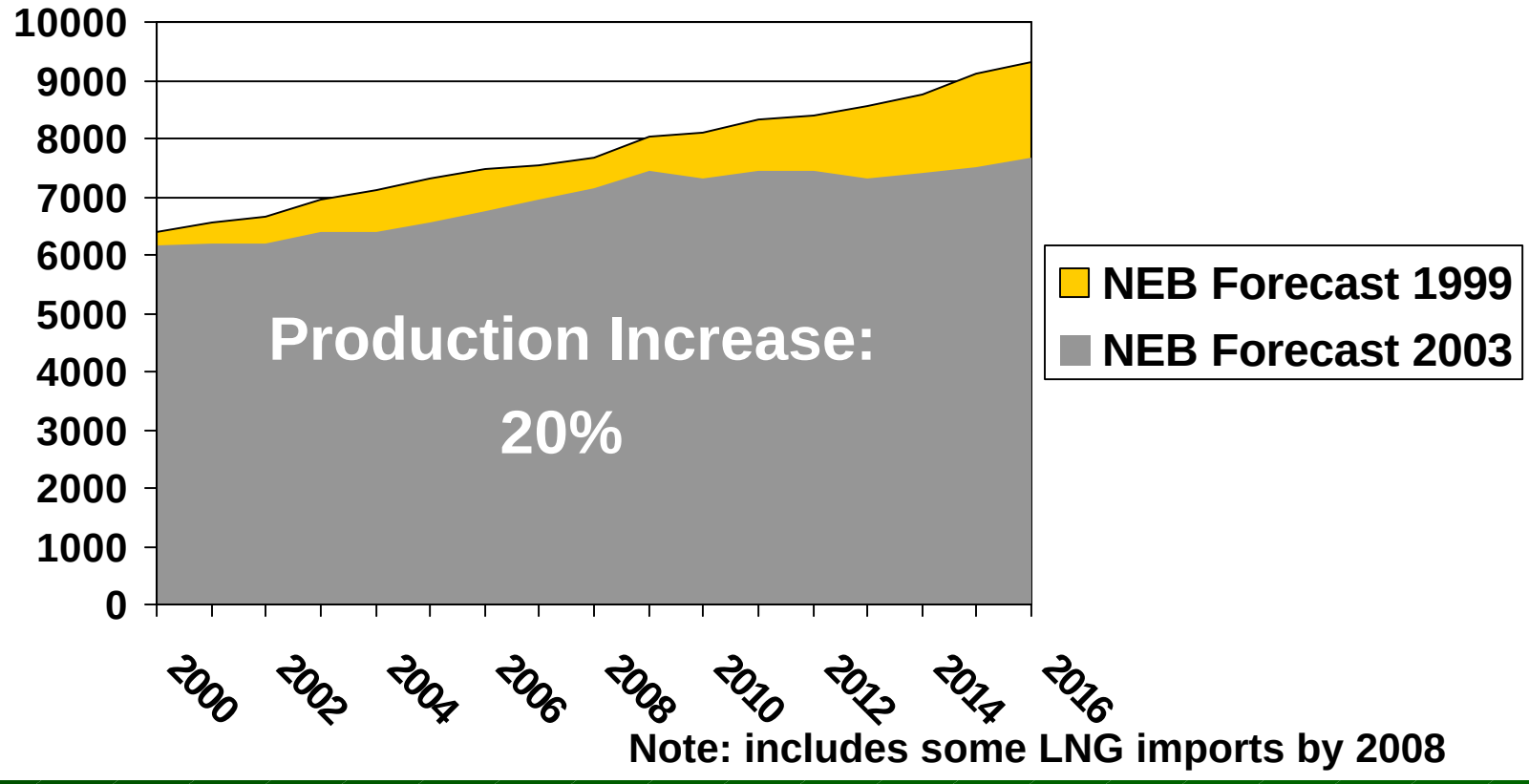
Canadian Gas Supply
NEB Forecast 1999 (Bcf/Yr)

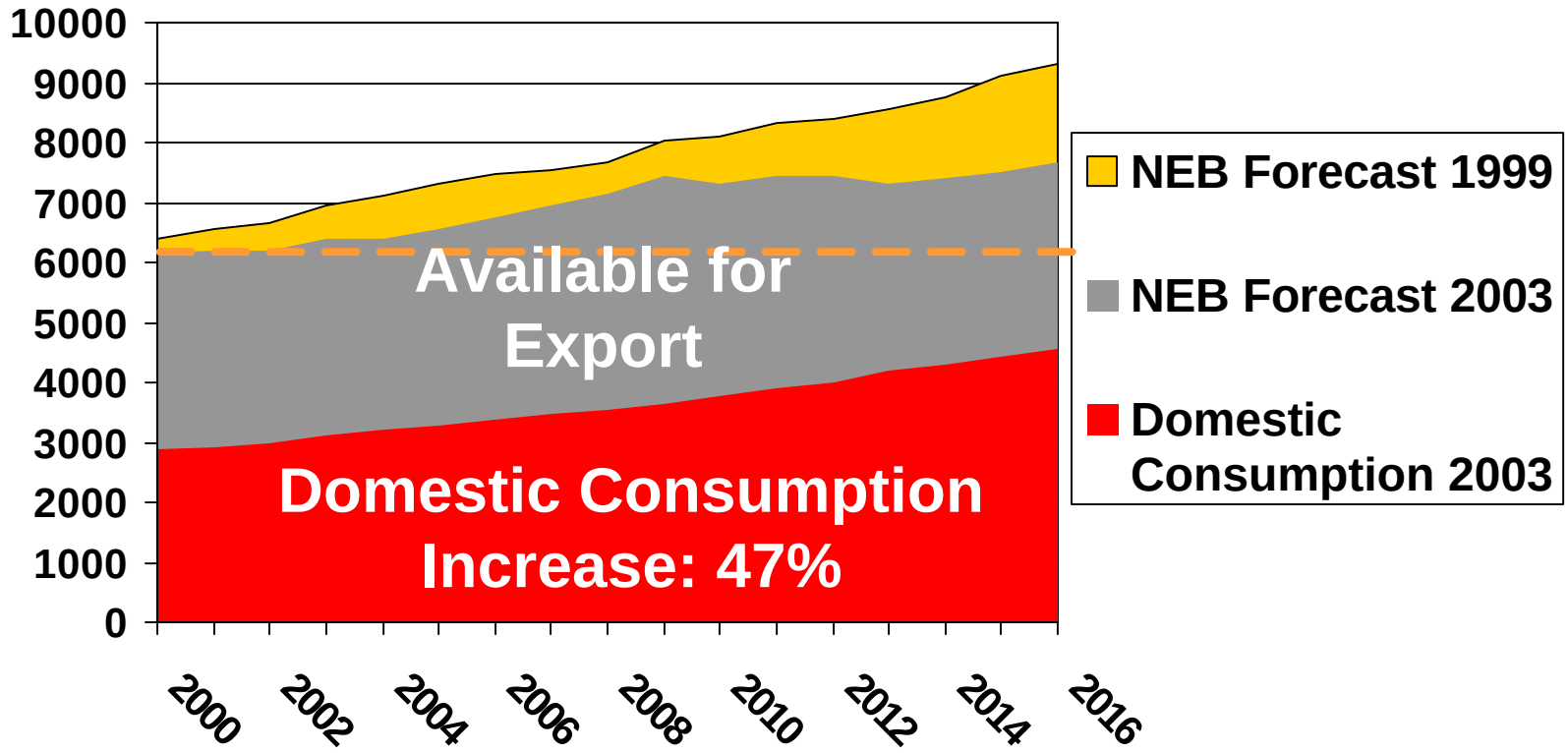


Canadian Gas Supply
NEB Forecast 2003 (Bcf/Yr)



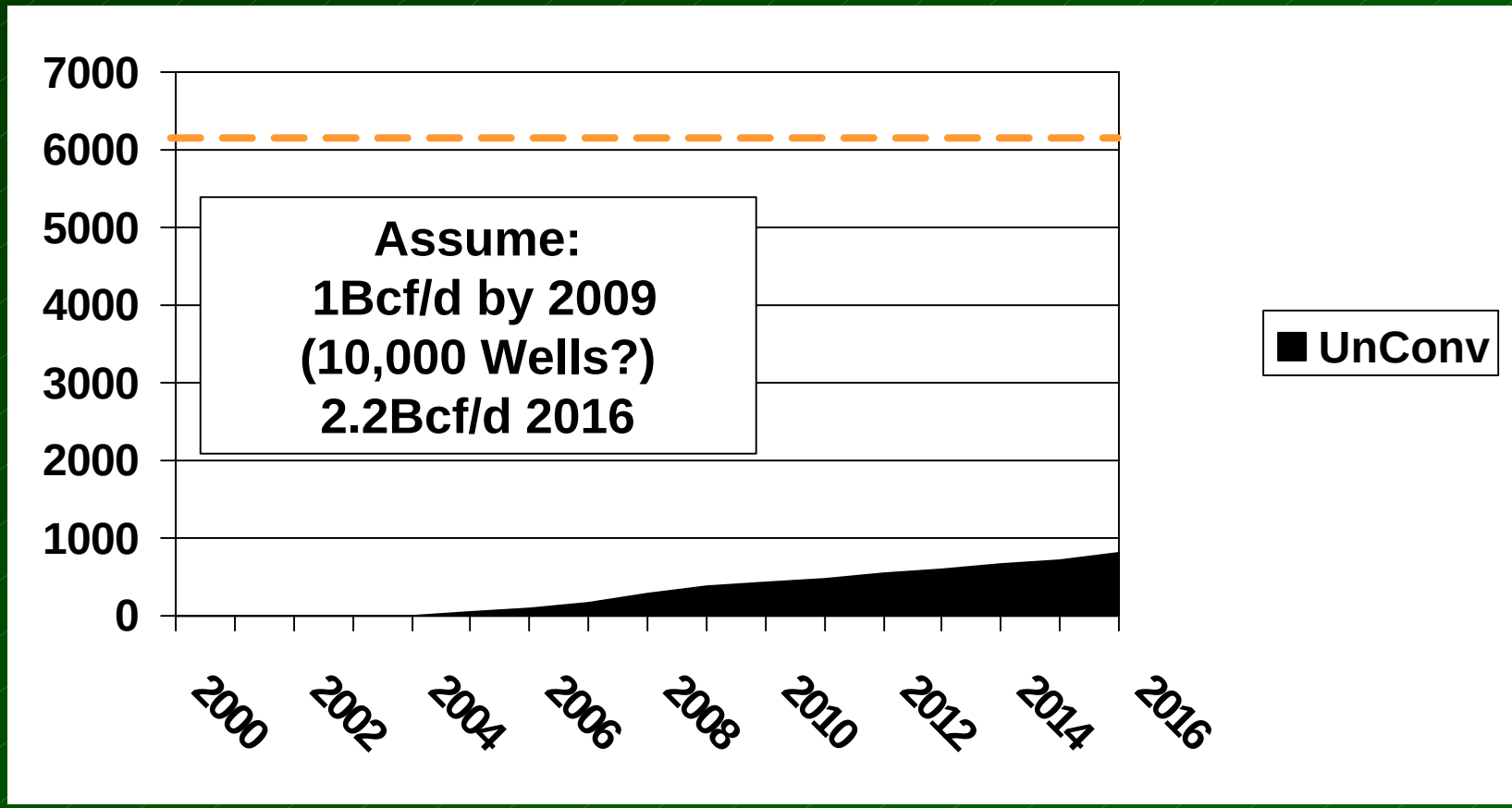
Note: includes some LNG imports by 2008

Canadian Gas Supply
NEB Forecast 2003 (Bcf/Yr)



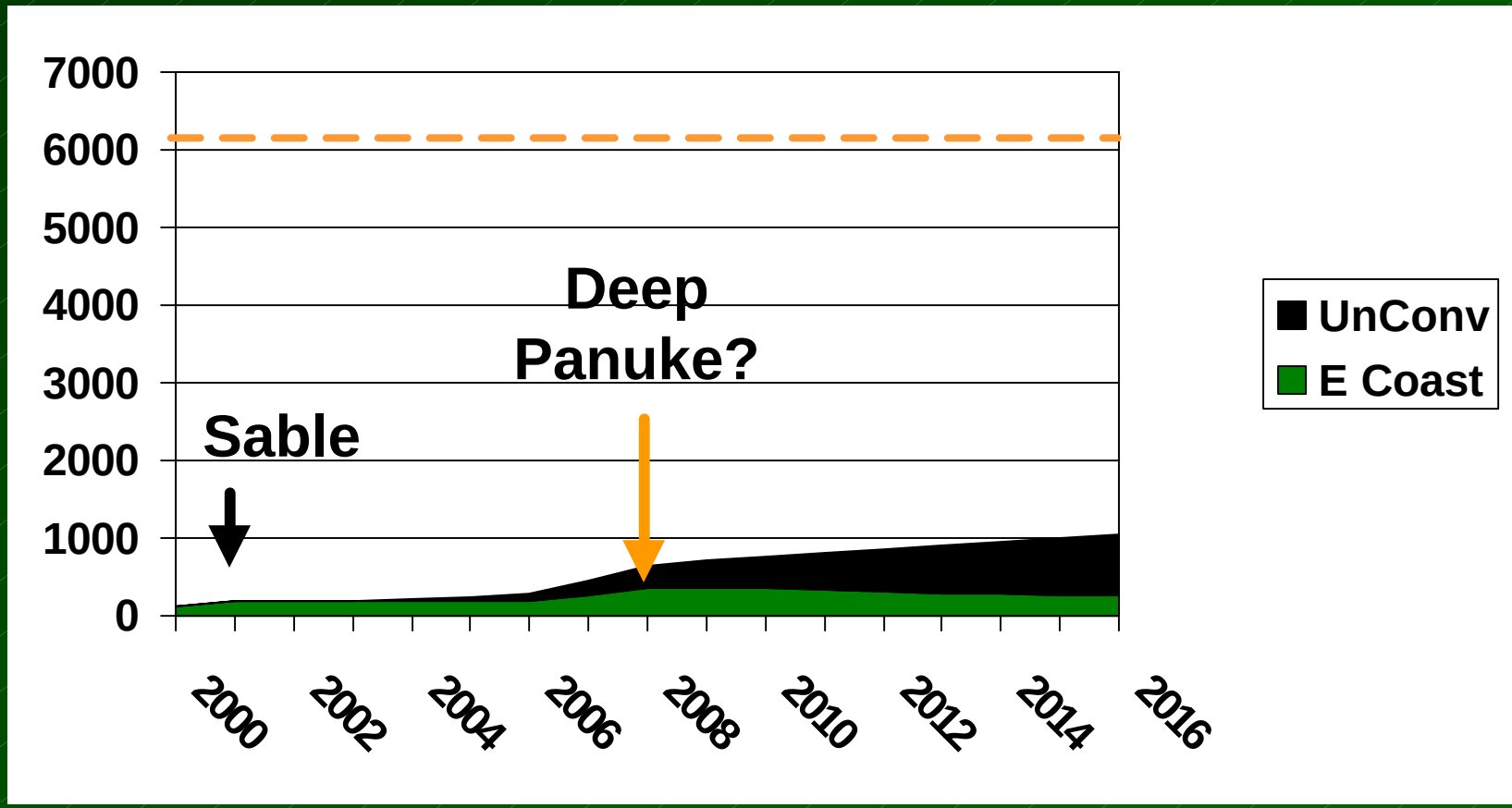
Note: includes some LNG imports by 2008

Future Marketable Gas Unconventional (Bcf/Yr)



Dave Russum, 2003

Future Marketable Gas East Coast (Bcf/Yr)



Dave Russum, 2003

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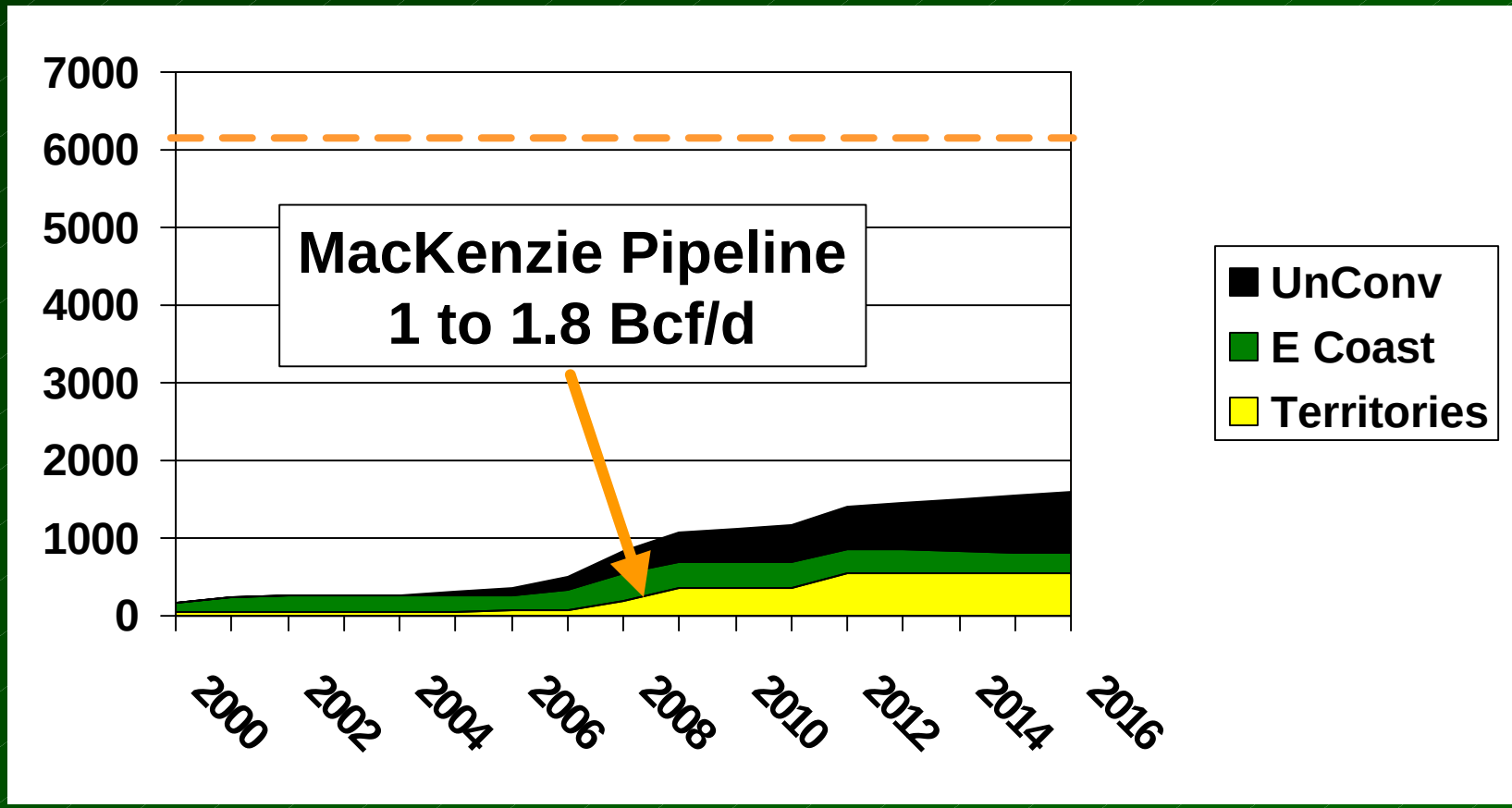
Future Marketable Gas Territories (Bcf/Yr)



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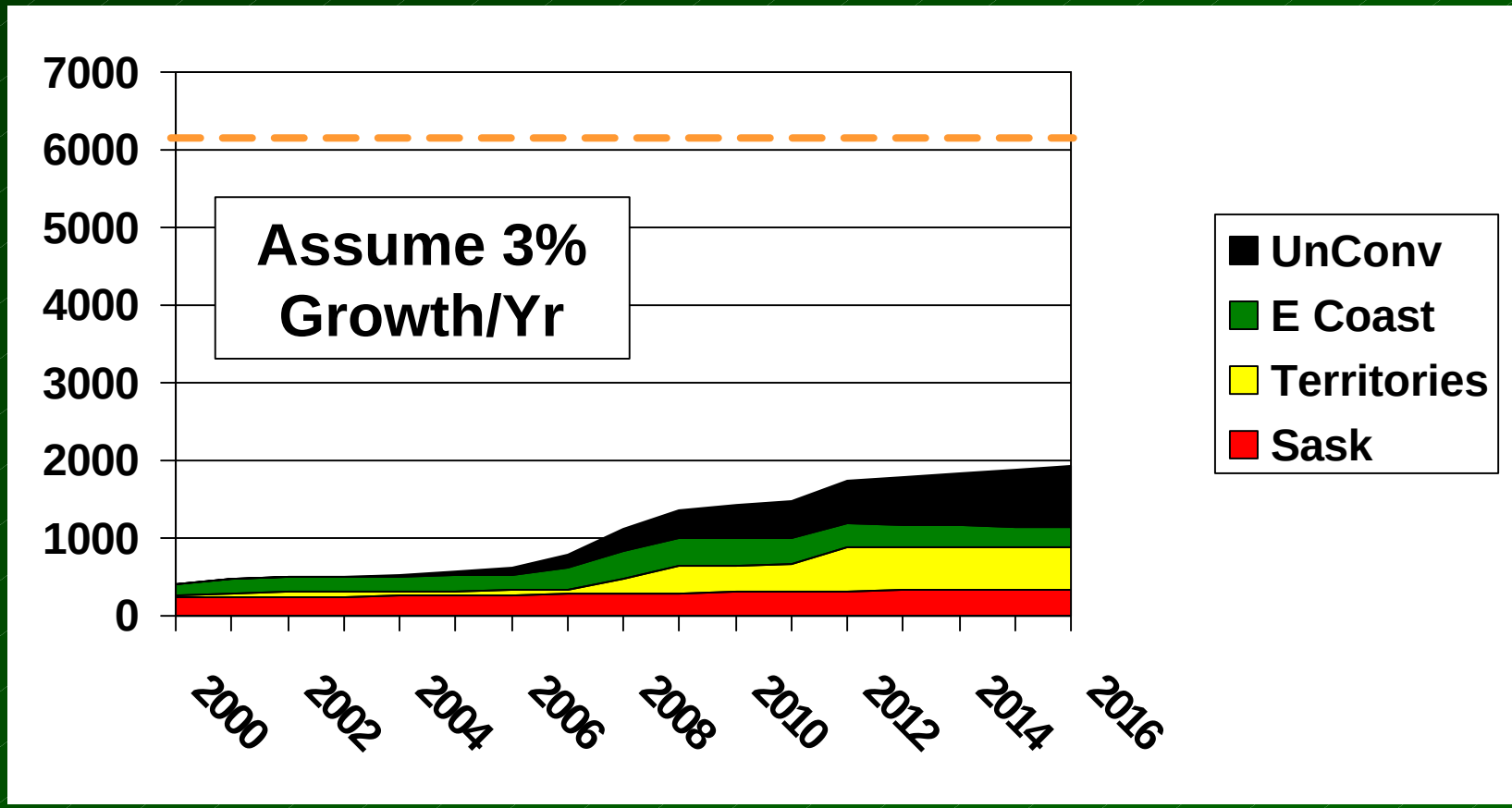
Future Marketable Gas Saskatchewan (Bcf/Yr)



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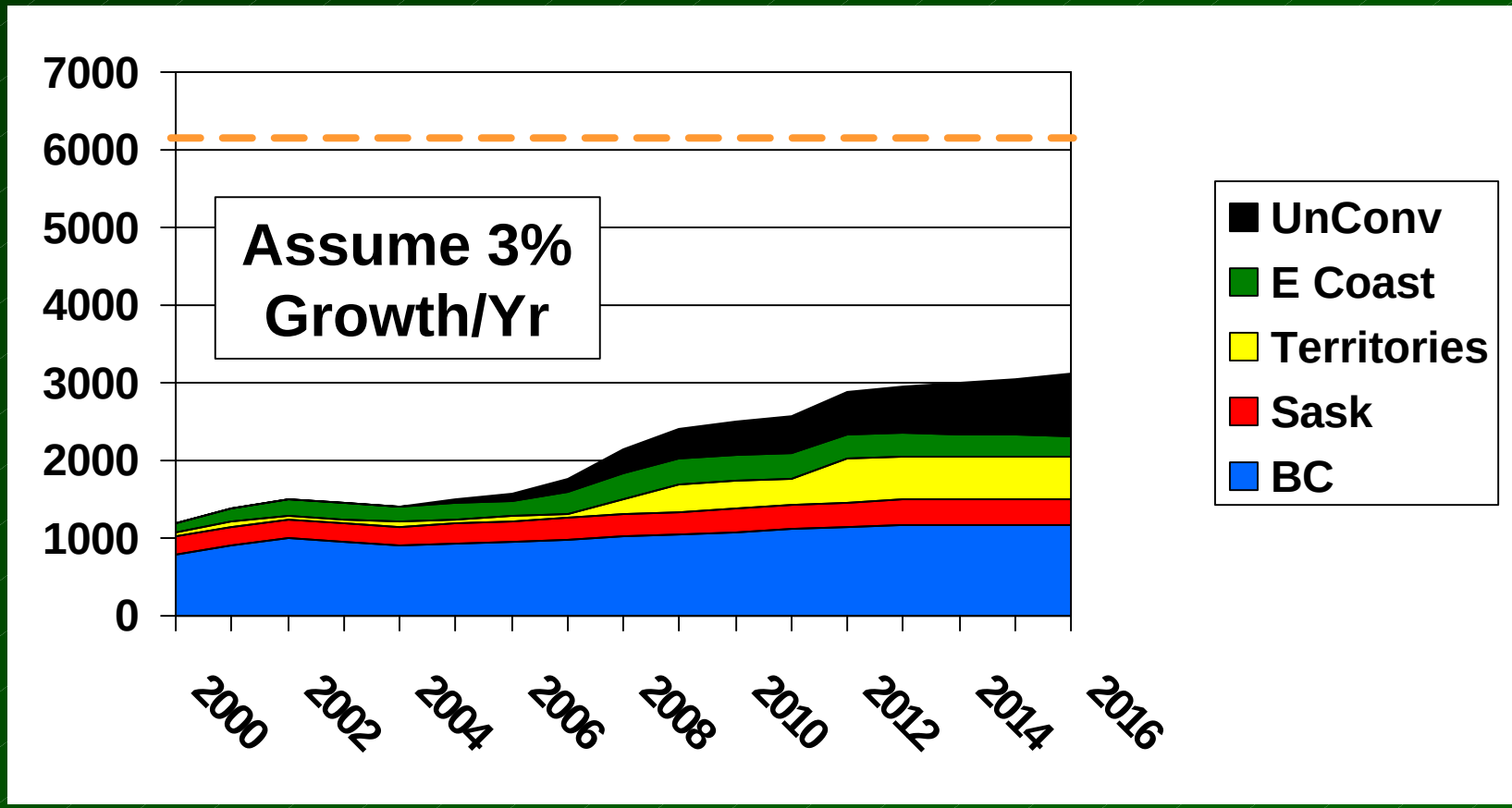
Future Marketable Gas British Columbia (Bcf/Yr)



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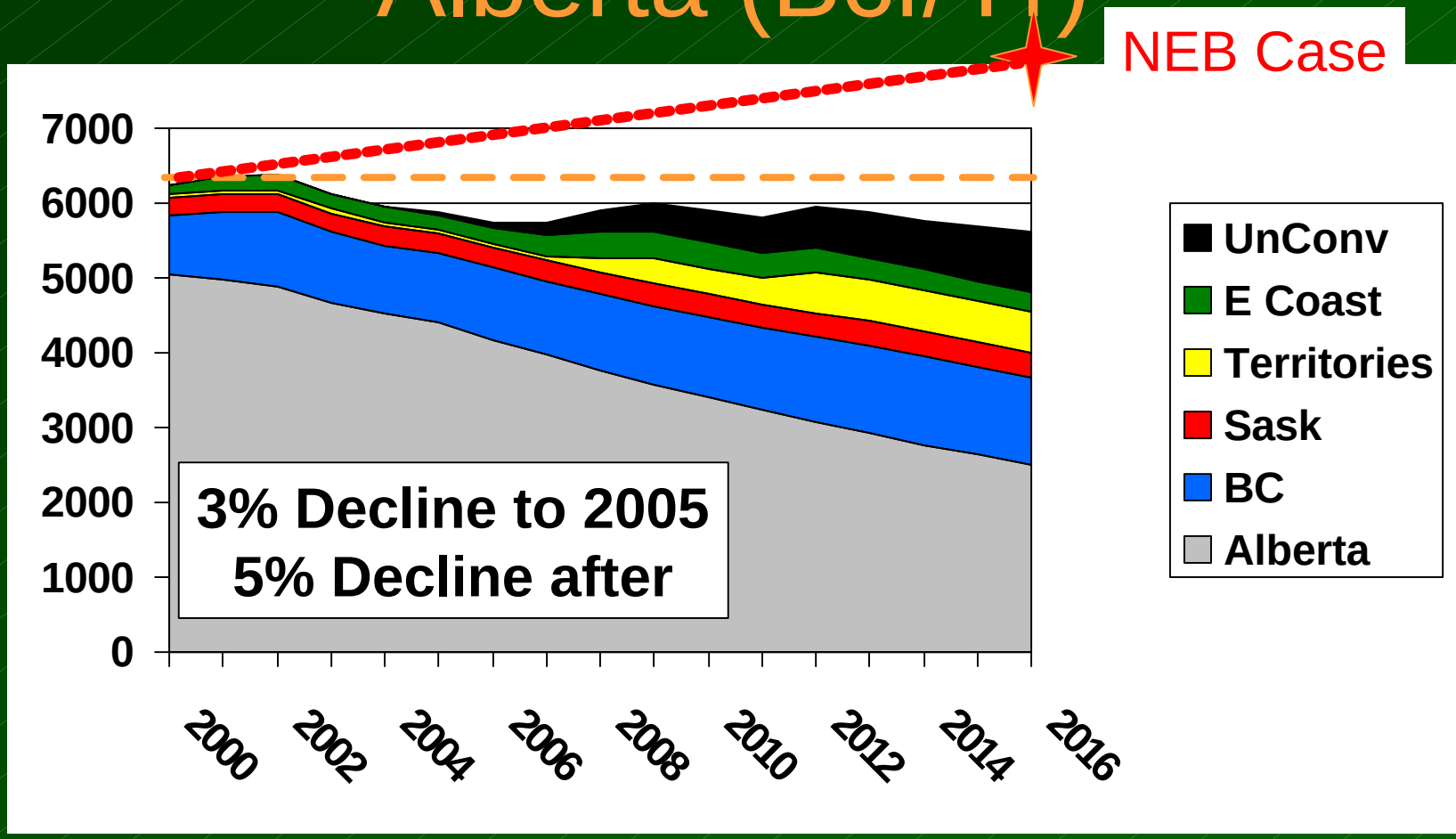
Future Marketable Gas Alberta (Bcf/Yr)



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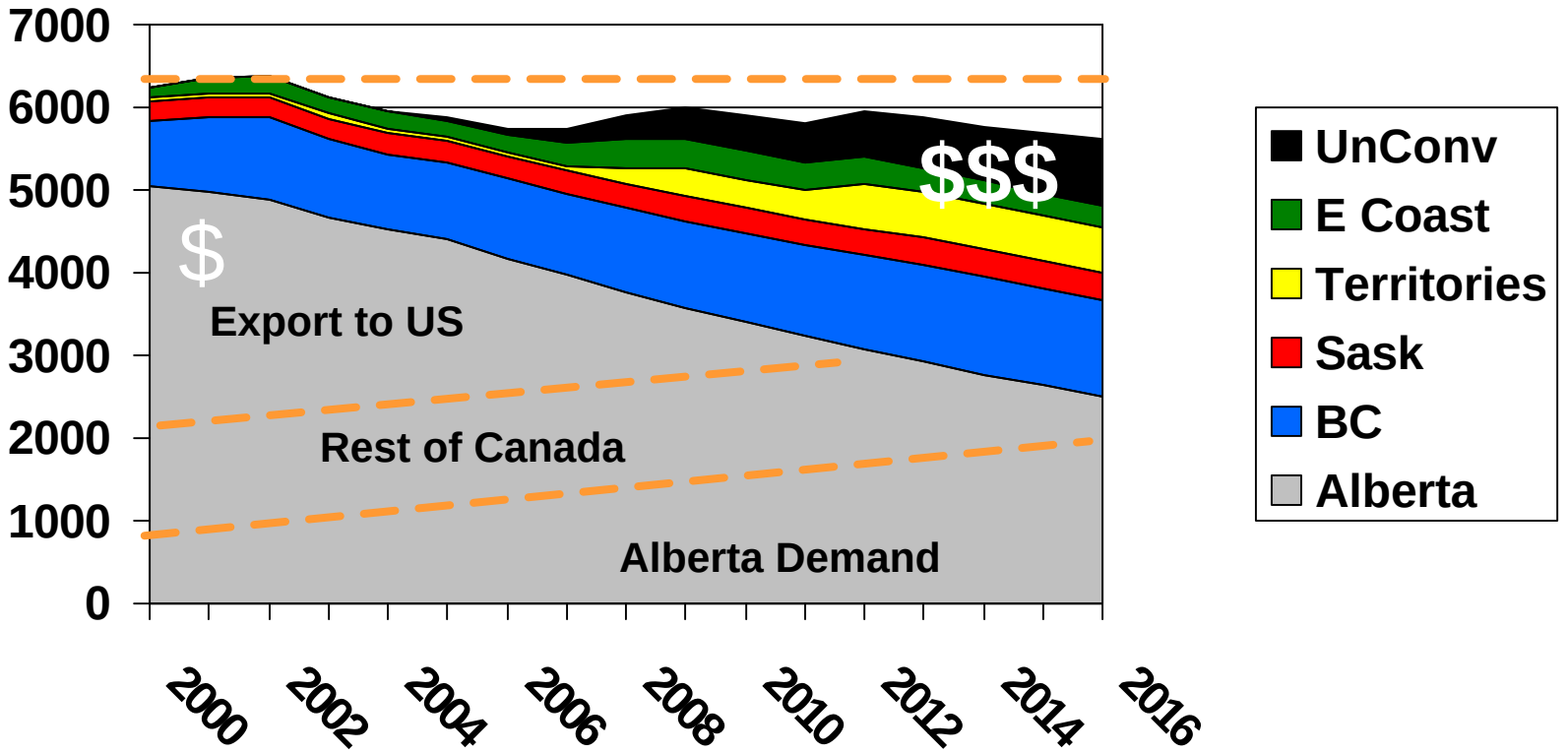
Future Marketable Gas Prediction (Bcf/Yr)



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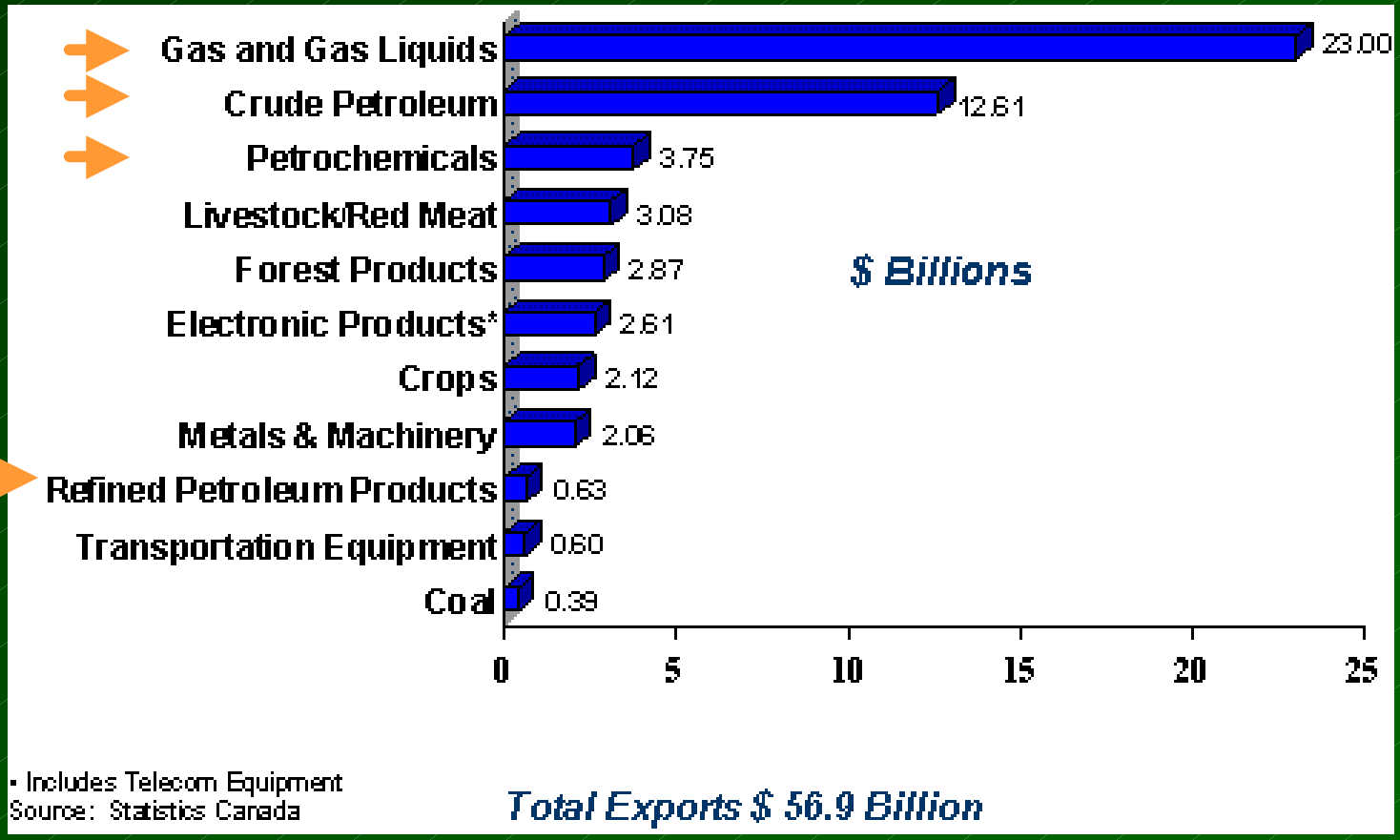
How Important is Natural Gas to Alberta? - Exports 2001



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Is there anything left to find?

YES!

(CGPC Estimate 246 TCf
Undiscovered Conventional gas in Canada
+ huge volumes of Unconventional Gas)

Will take research, money and patience to be successful

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Exploration

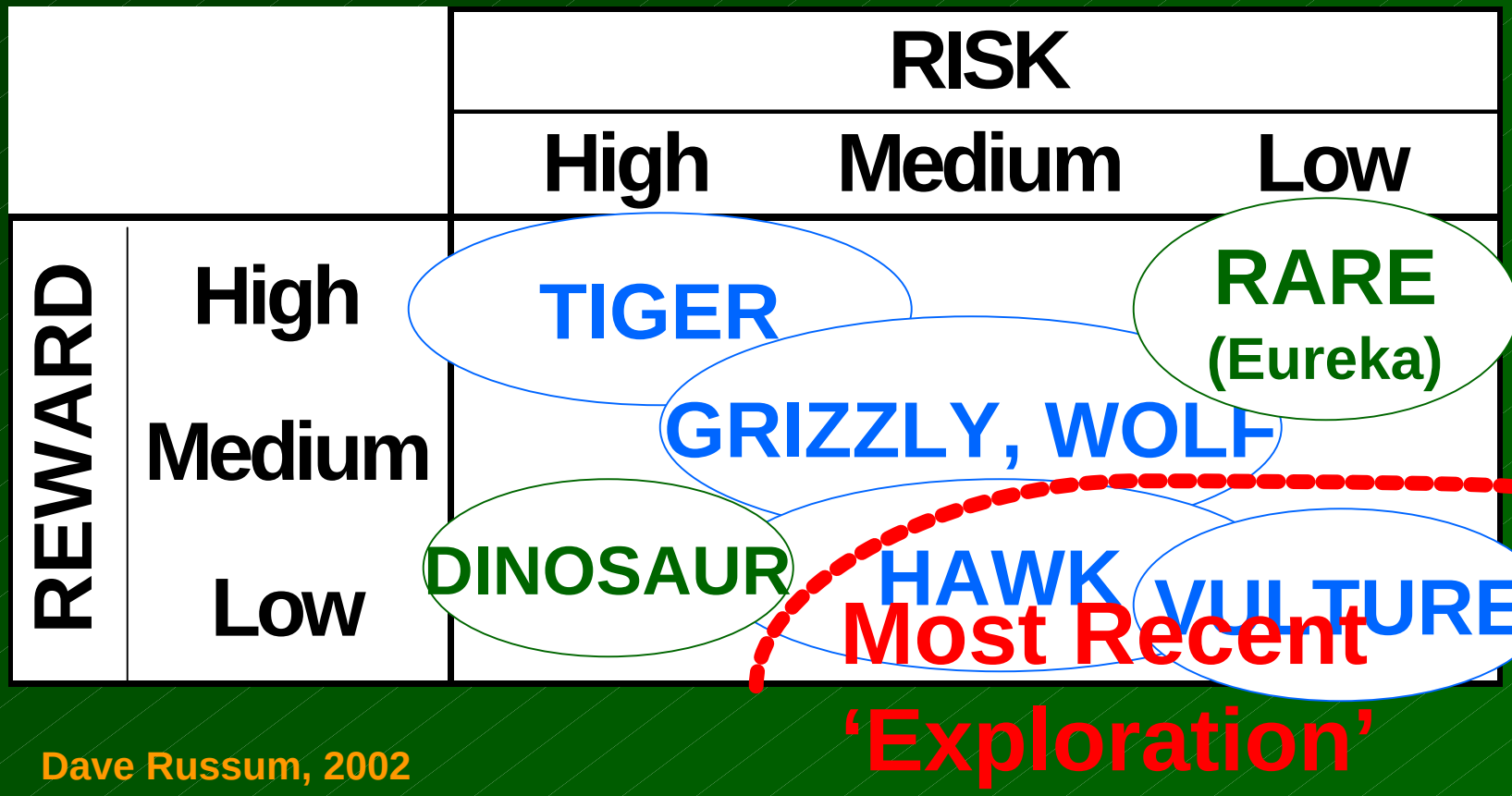
All Western Canada Exploration Statistics:

- 1992: 1570 Wells 50% Success Rate
- 2003: 4696 Wells 83% Success Rate

- How many Exploration wells did these top producers drill in 2003?
  - **BP, Chevron-Texaco, Imperial, Nexen, Shell, Suncor.**

- Answer: 29 (0.6% of all exploration)

Exploration Strategy - Risk and Reward Profile



Dave Russum, 2002

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Challenges to R&D and Exploration

- **Poor results** – WCSB Maturity,high COF&D., low IP, high decline
- **M&A activity** – Focus on short-term
- **Capital directed to mega projects** – tar sands
- **Domestic exploration competing with international opportunities**
- **Growth in energy trusts** – liquidating assets
- **Few 'mid-cap' companies or active majors**
- **Difficult to raise capital for long term exploration**

Result: Few active domestic exploration groups, even less research = less 'real' exploration and less progress on a serious problem

Reversing the Trends

- Cannot happen overnight!
- Requires Industry and Government Commitment
- Research
- Cooperation
- Incentives and Regulations?
- Skilled people
- Innovation
- Training

The Choice:

AN ENERGY PLAN

More and better R&D and Exploration

VS.

A decline in gas production

with implications for the North American energy picture

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Summary

- Canada is not running out of gas ***resources***
- We are rapidly depleting our accessible, cheap, natural ***gas reserves***
- We must slow this trend by either finding more or exporting less
- Expanded LNG transport could make gas a world commodity – bypassing expensive Canadian gas?

Welcome your feedback

Contact Dave Russum

More Information:

www.geohelp.ab.ca

www.ajma.net

Thank You