“Novel Methods for Better Cost Performance"

LARICINA
ENERGY LTD.

In Conjunction with the University of Calgary

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Thank you

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Outline

Introduction — Recap from Athabasca Oil Sands Conference and Exhibition, Edmonton Sept 2009.

Theory — What we can learn from other industries.

Evidence — What we've been working on and how it applies to our evidence…

Lessons Learned — Interpretation. Lessons to learn and emulate.

Conclusions — How to excel in project performance and more!

Introduction - Recap

- We know that we don´t know so much about *In Situ* project costs. Only 30 year track record!

- *Closing the knowledge loop*
  Learning from our mistakes…
  Repetitive experience?
  Are we doing our best at retaining knowledge?

  Is it enough?

- Does “everyone” understand the scope of the project?

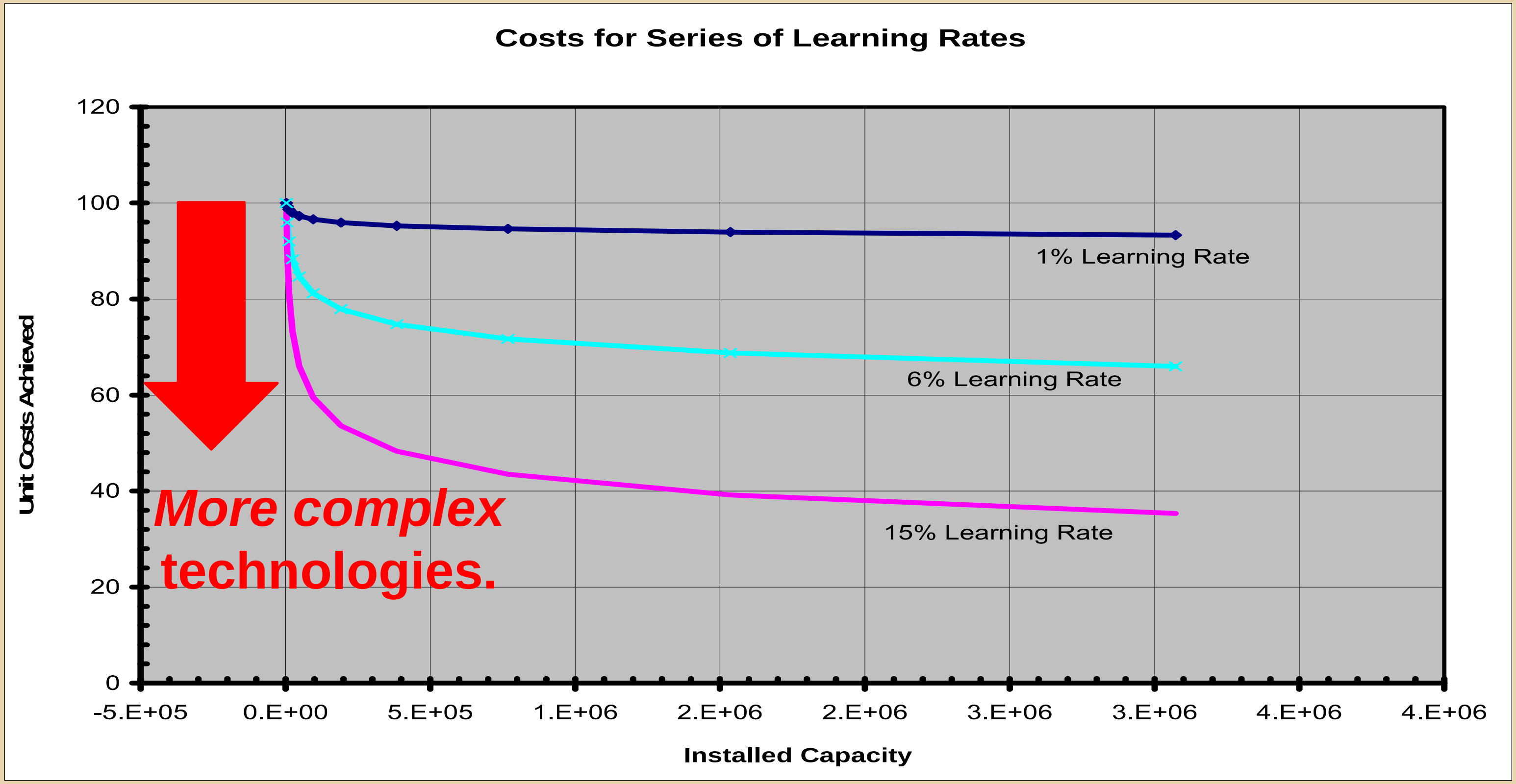
- Does our project/property have the scale and size to capitalize on long term cost reductions?

SAGD Developments

- We know that SAGD developments are:
  - Constant technological adjustments,
  - Projects with “Complexity”,
  - Magnified cost,
  - Increased risk.
- We can learn from similar industries.
  - Chemical processing plants,
  - Refining technologies,
  - Energy technologies…
- Applying the theory to SAGD.
  - Can we predict this behavior in our projects?

Learning Rates

- Typical learning rates for other industries



Source: Yeh & Rubin

Theory: Prior Studies

Table 2
Reported energy-related learning rates[a]

Technology	Country/region	Time period	Estimated learning rate (%)	Performance measure (dependent variable)	Experience measure (independent variable)	Reference/data source
Retail gasoline processing	US	1919–1969	20	sp. prod. cost ($/bbl)	cum. prod. (bbl)	Fisher (1974)
Crude oil at the well	US	1869–1971	5	sale price ($/bbl)	cum. prod. (bbl)	Fisher (1974)
Coal for electric utilities	US	1948–1969	25	sale price to utility ($/ton)	cum. prod. (tons)	Fisher (1974)
Electric power production	US	1926–1970	25	sale price ($/kWh)	cum. prod. (kWh)	Fisher (1974)
Solar PV	EU	1985–1995	35	sp. prod. cost (ECU/kWh)	cum. prod. (TWh)	IEA (2000)
Wind power	US	1985–1994	32	sp. prod. cost ($/kWh)	cum. prod. (TWh)	IEA (2000)
Wind power	EU	1980–1995	18	sp. prod. cost ($/kWh)	cum. prod. (TWh)	IEA (2000)
Wind power	Germany	1990–1998	8	sp. inv. price ($/kW)	cum. cap. (MW)	IEA (2000)
Wind power	Denmark	1982–1997	4[b]	sp. inv. price ($/kW)	cum. cap. (MW)	IEA (2000)
Electricity from biomass	EU	1980–1995	15	sp. prod. cost ($/kWh)	cum. prod. (TWh)	IEA (2000)
Supercritical coal	US	n.a.	3	sp. prod. cost ($/kWh)	cum. prod. (TWh)	IEA (2000); Joskow and Rose (1985)
GTCC	EU	n.a.	4	sp. prod. cost ($/kWh)	cum. prod. (TWh)	IEA (2000); Claeson (1999)
Solar PV modules	World	1976–1992	18	sale price ($/$W_{peak}$)	cum. sales (MW)	IEA (2000)
Solar PV modules	EU	1976–1996	21[c]	sale price ($/$W_{peak}$)	cum. sales (MW)	IEA (2000)
Ethanol	Brazil	1978–1995	22[d]	sp. sales price ($/boe)	cum. prod. (cubic meters)	IEA (2000)
Coal power plants	US	1960–1980	1.0–6.4[e]	sp. inv. cost ($/kW)	cum. cap. (units)	Joskow and Rose (1985)

[a]Note: sp. = specific; inv. = investment; cum. = cumulative; cap. = capacity; prod. = production.
[b]Based on Neij (1999). The learning rate of 4% considers only wind turbines equivalent to 55 kW or larger. The 8% learning rate reported in Table 1 for Neij's data includes all Danish wind turbines.
[c]21% is the learning rate for the "stability" stage described in the text. For the "development" and "price umbrella" stages the learning rate is 16%. For the "shakeout" stage it is 47%.
[d]22% is the learning rate for the "stability" stage described in the text. For the "development" and "price umbrella" stages the learning rate is 10%. For the "shakeout" stage it is 53%.
[e]Joskow and Rose estimate a range of learning rates for different utilities, architect-engineering firms, and technology categories, after accounting for inflation, plant size, the inclusion of scrubbers or cooling towers, whether certain structures are indoors or out, and whether a unit is the first on a site.

Prior learning in petroleum industry.
Where is the SAGD learning curve?

Learning Rate Prediction

Complexity as a tool for prediction.

- What degree of *complexity* does a SAGD plant have?
- What degree of *complexity* does a core hole have?
- What about a wellpad?
- What about a compression project?

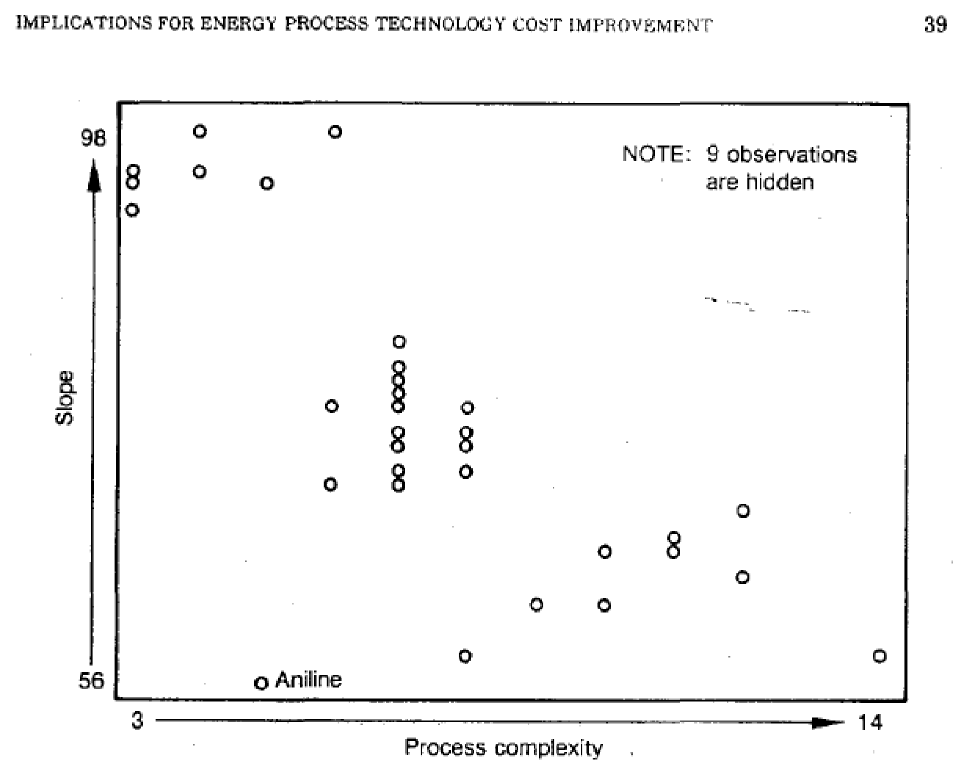


Fig. 7—Process complexity and cost improvement

Source: Edward Merrow (RAND Corporation)

Complexity Theory

What is *complexity*?

- For the purpose of scaling process *complexity*, the number of steps can be counted as either the number of pieces of major equipment or the number of process blocks in which major physical or chemical operations occur.
- Using this methodology for SAGD we have arguably 6-9 steps, depending on what is counted.

Complexity Theory

What is *complexity*?

SAGD is *complex*: 20 -30% reductions might be obtained

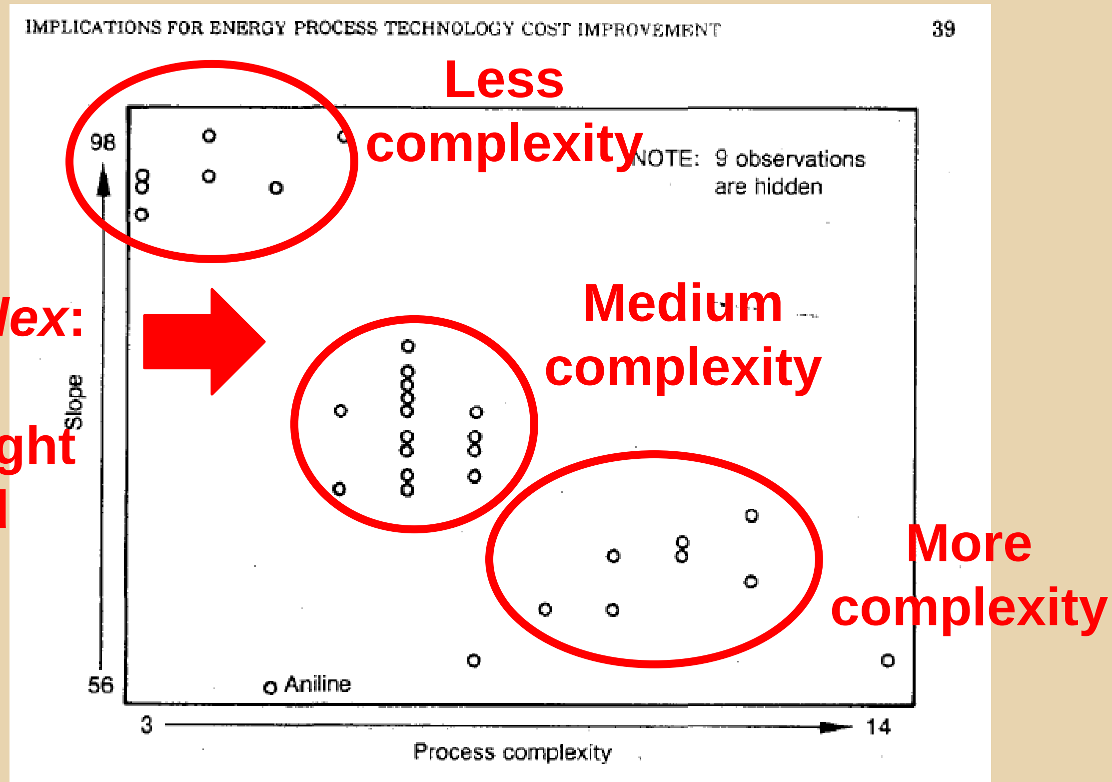
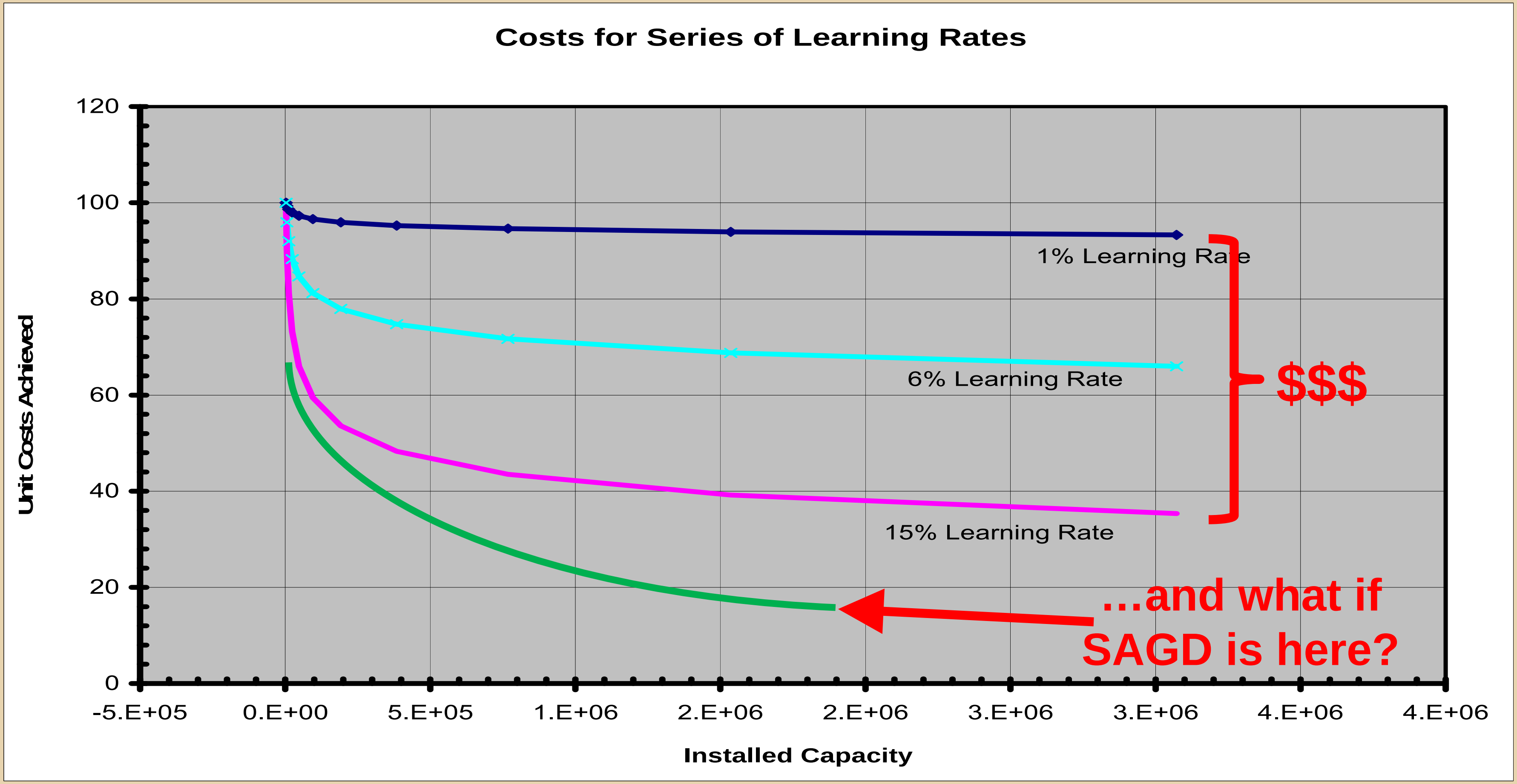


Fig. 7—Process complexity and cost improvement

Source: Edward Merrow (RAND Corporation)

Learning Rates – SAGD?



Source: Yeh & Rubin

Evidence

Learning

Evidence that learning is occurring at a project to project level, and even within the project.

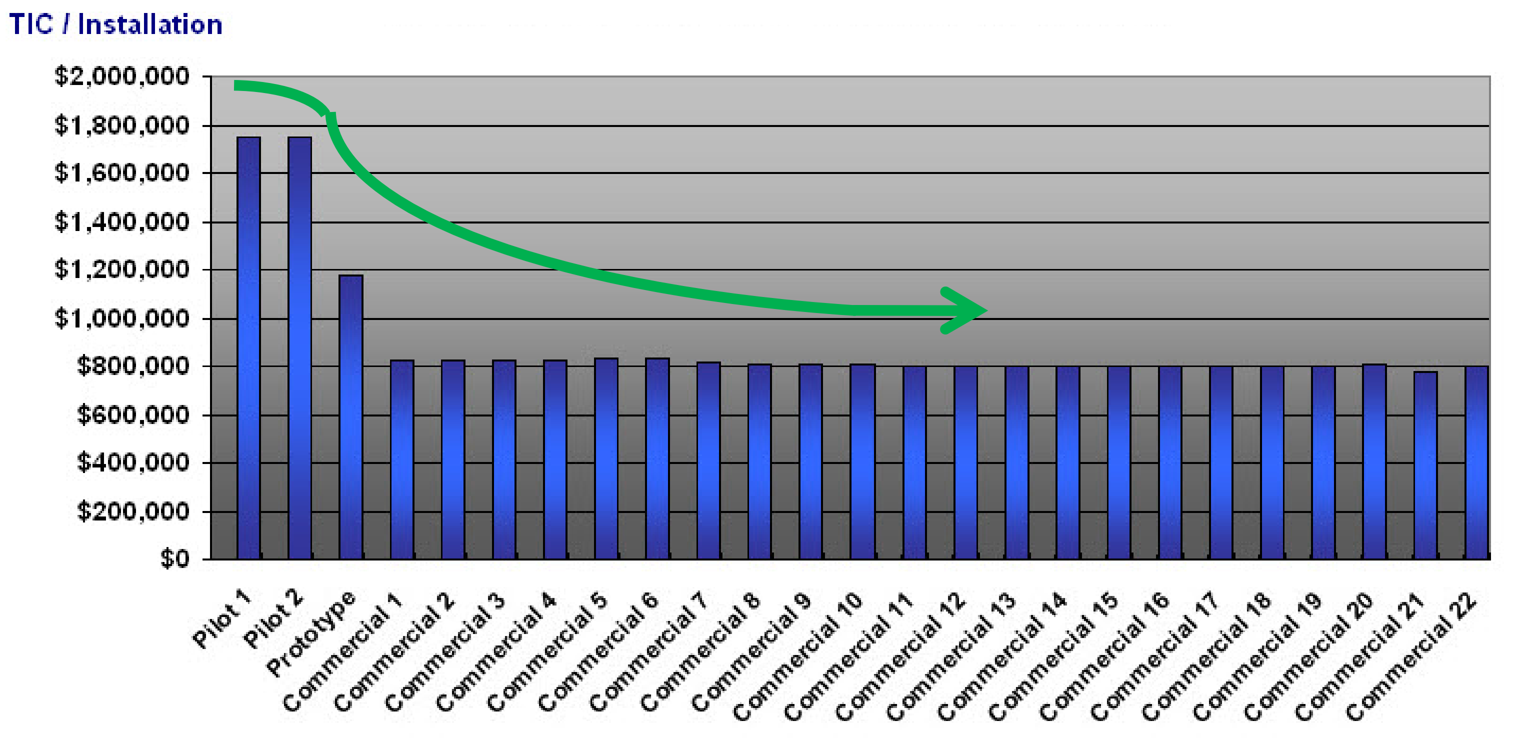
Observing the field

SAGD applications; annulus gas compression, core drillings, pumps installations, pad developments etc.

There are some great examples to learn from!

Evidence: Gas Compression & Pumps

Annulus Gas Compression Projects (IMV Projects)



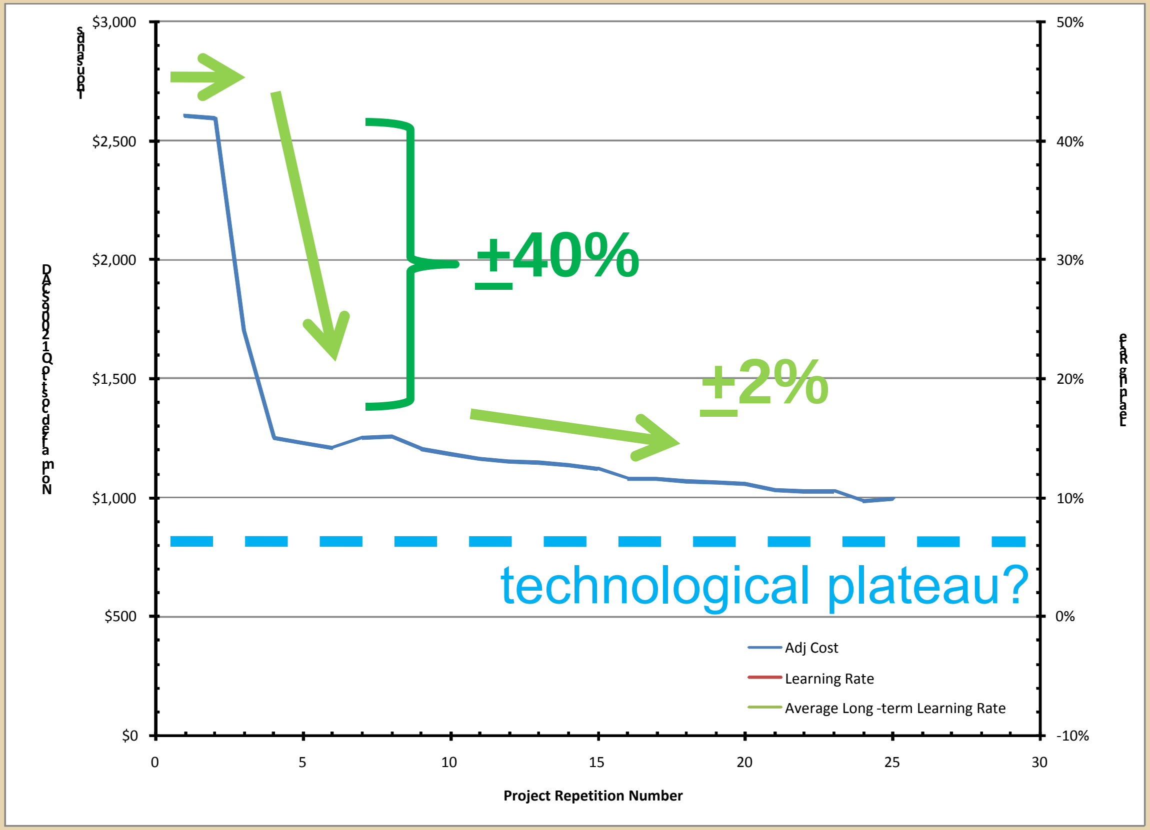
– Lets take a closer look…

Source: IMV – Wood Group Calgary

Evidence: Gas Compression & Pumps

Annulus Gas Compression Projects (IMV Projects)

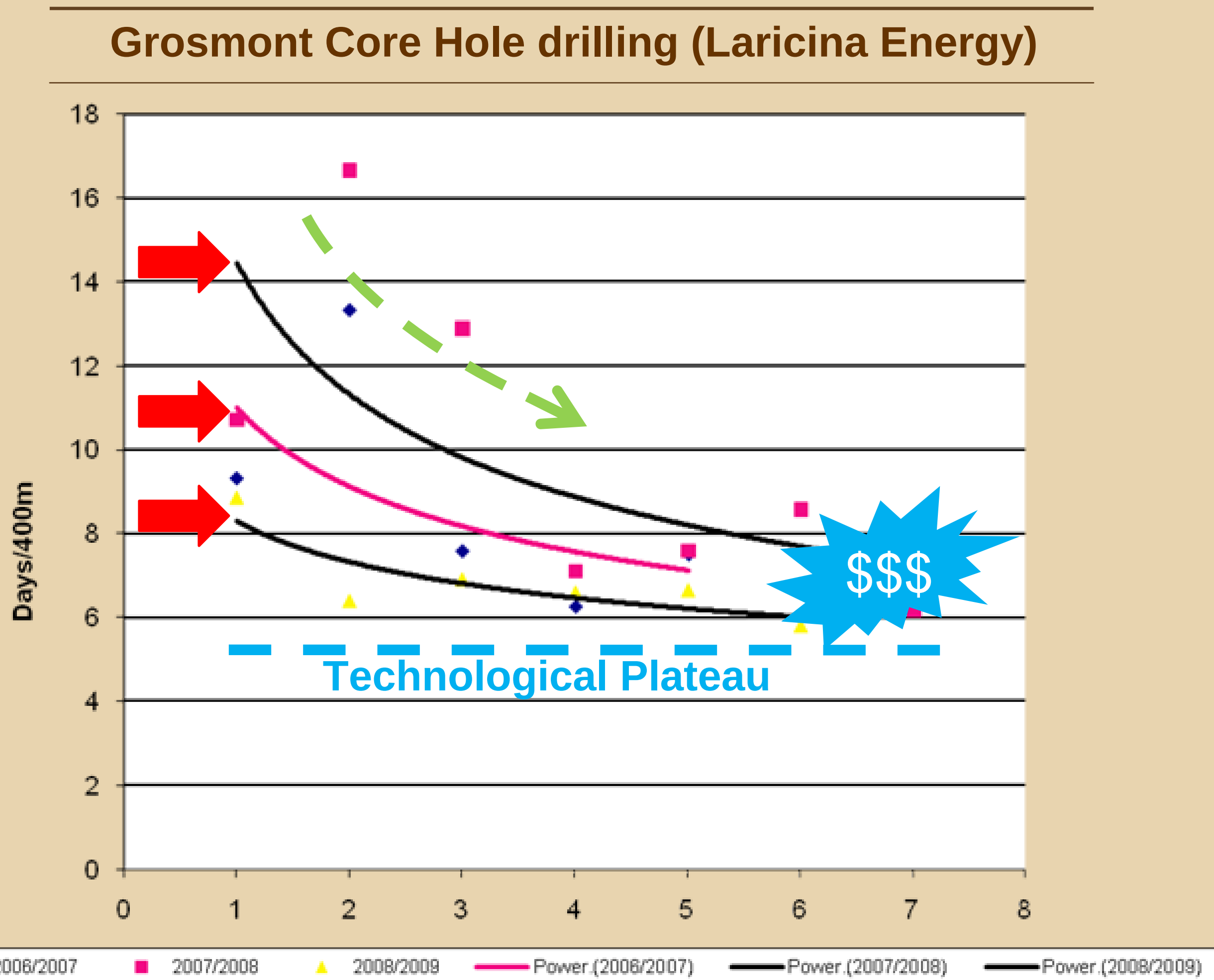
- Series of repeats (up to 25 repeats in 4 years)
- First unit replicated, and the following developed
- After the first three repetitions costs dropped below 40%, and 2% afterwards
- Consistent suppliers, design, equipment and construction.



Source: IMV – Wood Group Calgary

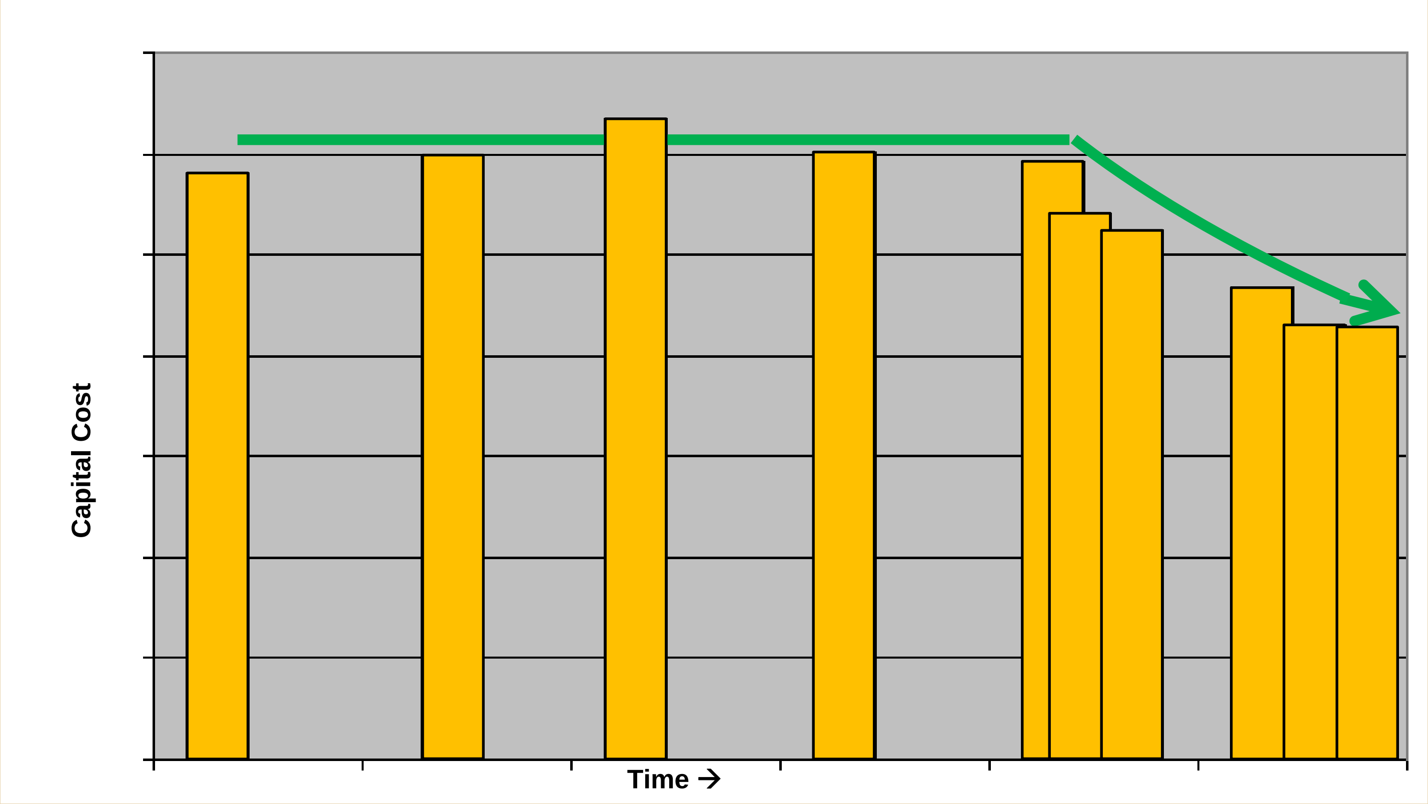
Evidence: Grosmont Core Holes

- High initial learning rates.
- Decreasing learning over time.
- 15 - 20% per repeat, forecasting 67% cost reduction
- Organizational forgetting
- Where is the technological plateau?



Lessons Learned: Pad Developments

SAGD Pads – Pad dollars per well pair



Frequent repetitions bring cost reductions.

Source: IMV – Wood Group Calgary

Lessons Learned: SAGD Facilities

A: Cost Curve of project built with initial understanding

B: Cost Curve of a subsequent "tighter" understanding

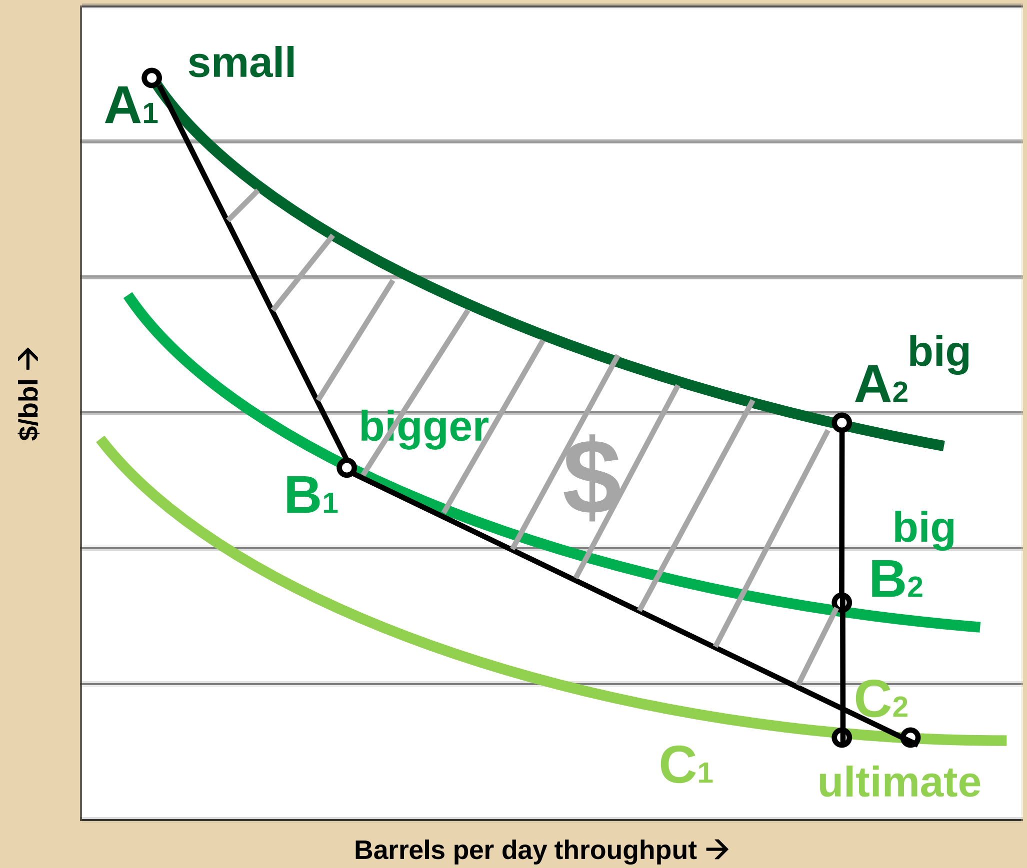
C: Cost Curve of "ultimate" understanding

$$\sum_{CAP} A_1+B_1+C_1=\sum_{CAP} A_2+B_2+C_2$$

$$\sum_{\$} A_1+B_1+C_1 \ll \sum_{\$} A_2+B_2+C_2$$

iff, Learning Rate > Cost of Capital

CAPEX on SAGD Facilities



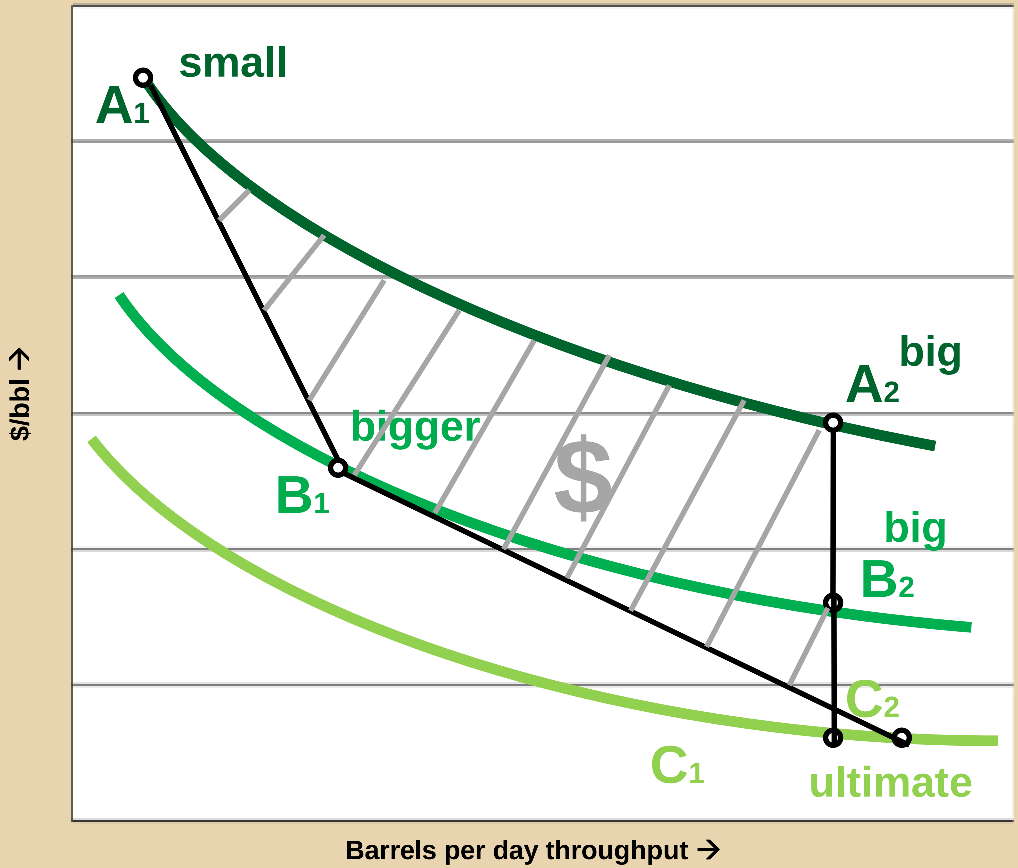
Source: Laricina Energy Ltd.

Lessons Learned: SAGD Facilities

- What can we gain from learning?

- Capital intensity:
  - Where do we want it more intense?
  - Take our time for learning effects…
  - Biggest projects take place after the learning has taken hold.

CAPEX on SAGD Facilities



Source: Laricina Energy Ltd.

Lessons to learn and emulate

What do in situ *success stories* tell us:

- ✓ Small projects with large potential; scalable and repeatable operations that enable technical advancement.
- ✓ Reuse of design in subsequent phases - It is wise to repeat yourself…
- ✓ Demonstrations of cost savings despite escalations.

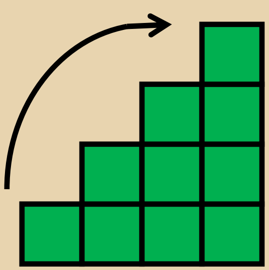
Learning about learning…

✓Closing the learning loop and a consistent use of staff and suppliers for design, equipment and construction.

✓Working harder at learning can benefit our projects: CAPEX account for 40% of the per-barrel NPV

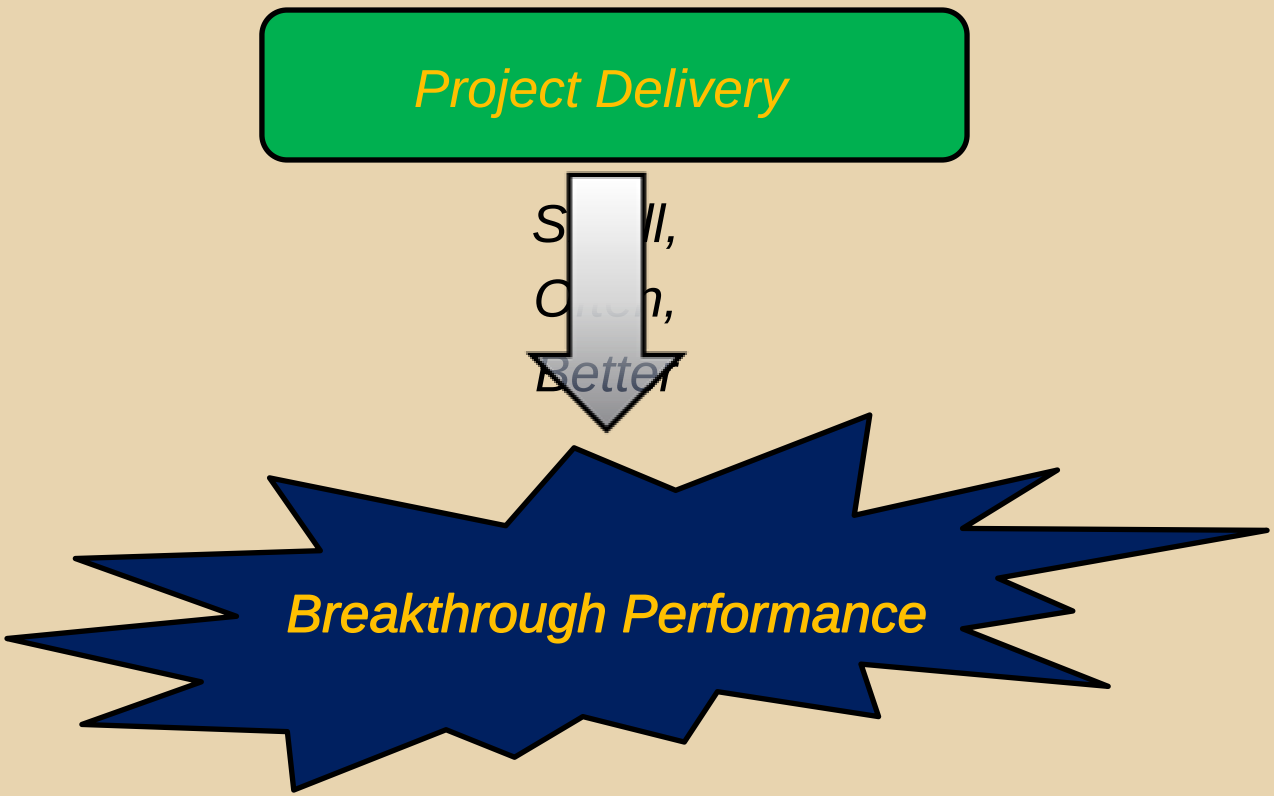
Scale and Size: Why small is good

✓Economy of scale is the primary reason for building megaprojects. This is not necessarily the case when we take a close look at cost and revenue on a project life-cycle perspective.



What can we do (to excel)?

How to excel in performance?



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Thank you!

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