SAGD Technologies and Resulting Changes in Economics

2016 Sluggin It Out Conference

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Overview

- **Operating Projects**
  - Netback prices at various WTI assumptions
  - Reported operating costs
  - Break-Even – short term pricing fluctuations
  - Break Even – sustained low pricing environment
- **Impact of new technology in the current environment**
  - Subcool and Pressure Management - Better Downhole Monitoring/Measurement
  - Fluid Control Devices/New Start Up Procedures
  - NCG Co-Injection and Infill Wells

Pricing – Low WTI Environment

» Using typical transportation costs outlined by SAGD operators, we arrive at the following bitumen netback prices

	Bitumen Pricing (CAD)
40 WTI	17.27
45 WTI	20.79
50 WTI	24.32
55 WTI	27.84

» Product transportation costs estimated to be ~$5/bbl

  » Consistent with costs estimated by operators who are pipeline connected

Reported Operating Costs

- Summary of operating costs (excluding transportation and blending) for producing SAGD projects:
  - Best in class large producers have non-fuel costs in the $6-8/bbl range
  - Smaller projects more likely to incur costs in the $10/bbl+ range

Project	Operator	Production (bbl/d)	Non–Fuel Op Costs ($/bbl)	Fuel Gas Costs ($/bbl)	Total Op Costs ($/bbl)
Christina Lake	Cenovus	150,000	$5.69	$2.11	$7.80
Foster Creek	Cenovus	142,000	$9.21	$2.45	$11.66
Great Divide (Pod 1+2)	Connacher	7,000+8,000	$13.16	$4.41	$17.57
Jackfish (1,2,3)	Devon	93,000	$7.12	$2.75	$9.87
Christina Lake	MEG	87,000	$5.66	$2.86	$8.52
Lindbergh	Pengrowth	15,000	$7.66	$2.20	$9.86
Firebag + MacKay River	Suncor	217,000	$8.10	$3.35	$11.45
Arithmetic Average Excluding CLL			**$7.24**	**$2.65**	**$9.89**

Based on Q3, 2015 production data and Q4 company reported OPEX data
Jackfish and Lindbergh non-fuel and fuel OPEX estimated based on SOR and reported total OPEX estimates

Break-Even – SAGD OPEX

- Using the range of OPEX estimates previously noted, we can calculate that the cash cost break even at the field is $35-40/bbl WTI
  - These values do not include G&A, debt servicing etc. and as such total expenses would be somewhat higher
  - This break even price **DOES NOT** represent what is needed to sustain production over the mid to long-term
- Excluding G&A and debt servicing cost, field level "profit" is as follows for Large and Small projects

WTI Pricing	Field Level Profit ($/bbl) Large Projects	Field Level Profit ($/bbl) Small Projects
40 WTI	3.84	(0.22)
45 WTI	6.40	2.57
50 WTI	8.83	5.07

- Assuming reasonable estimates of non-field costs, true break even WTI is likely in the $45-55+/bbl range
  - Non-field expenses vary by company and can range between $6 to 15/bbl

Break-Even – Maintaining Capacity ❯

» In order to maintain production at current producing projects, WTI prices have to be robust enough that operators can profitably drill additional well-pairs to offset production decline

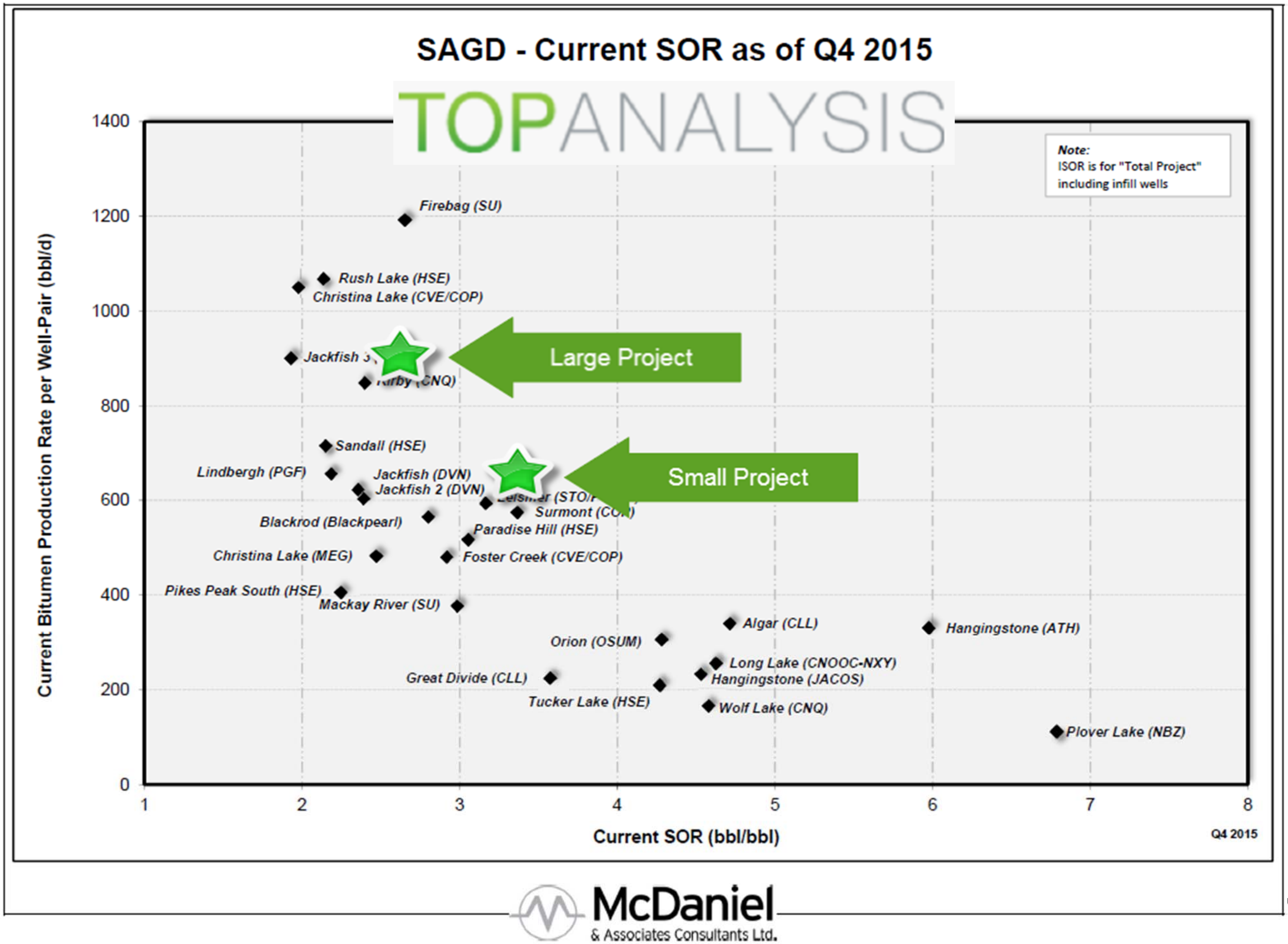
  » Assuming a 10% minimum before tax rate of return will be required to facilitate future drilling (likely somewhat optimistic!)

» Using reported OPEX, CAPEX and performance metrics, outlined below are the estimated break even prices for a “Large” SAGD project as well as a more typical “Small” project

WTI Pricing	Large Projects	Small Projects
Non Fuel OPEX	~$8/bbl	~$12/bbl
SOR	2.6	3.3
Well-Pair Productivity	900bopd	650bopd
WTI Break-Even	**~$42/bbl**	**~$50/bbl**

» Once non-field costs are included, breakeven is more reasonably in the $50-60/bbl+ range

Expectations vs Actual Results



Break-Even – Base Case

- Using the same economic parameters noted earlier for large and small producing SAGD projects, outlined below the NPVs at various prices
  - This will be used as a point of comparison when assessing the importance of new technologies

LARGE SAGD PROJECT	NPV@0% (MM$)	NPV@5% (MM$)	NPV@10% (MM$)	NPV@15% (MM$)
40 WTI	805	213	53	9
45 WTI	2,064	825	414	256
50 WTI	3,194	1,366	730	469
55 WTI	4,251	1,873	1,027	670

SMALL SAGD PROJECT	NPV@0% (MM$)	NPV@5% (MM$)	NPV@10% (MM$)	NPV@15% (MM$)
40 WTI	(1,488)	(920)	(629)	(463)
45 WTI	2	(204)	(213)	(183)
50 WTI	1,396	471	183	83
55 WTI	2,571	1,046	525	318

Importance of New Technology

- Any increase in production or reduction in SOR in this pricing environment is important. We will examine several advancements that could lead to better performance in the next few slides.

Down Hole Monitoring/Pressure Optimization

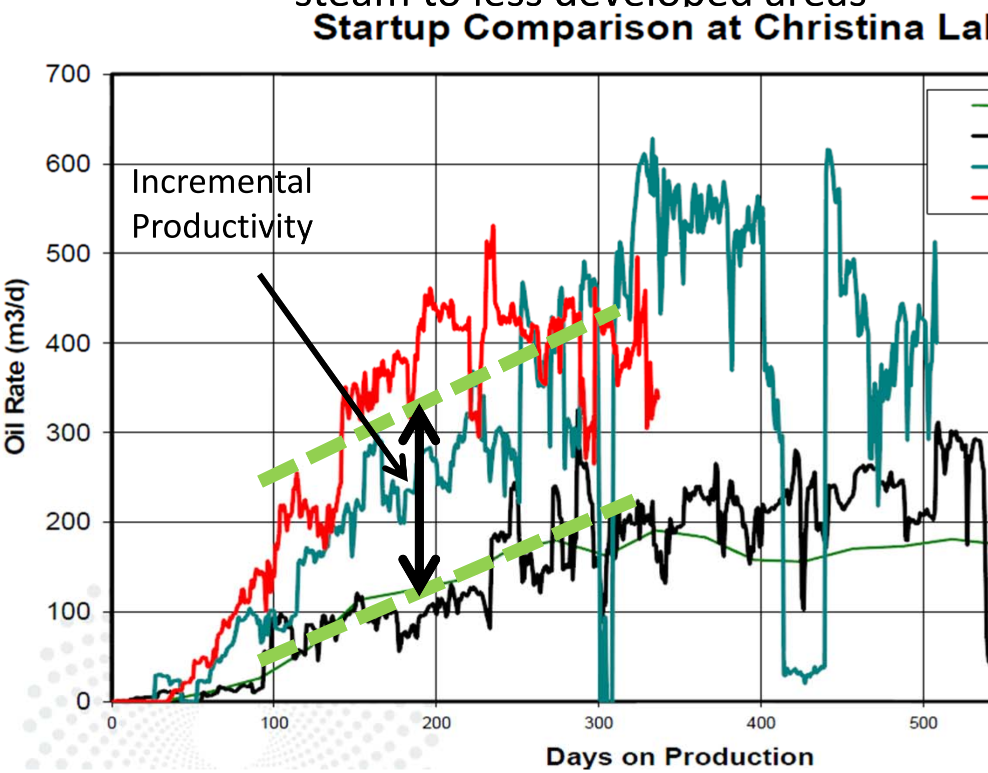
- Several examples of companies managing subcool or reservoir pressure in order to increase productivity or manage thief zones
  - Pad 8 of Long Lake , reduced sub cool and saw oil rates increase by 3X and SOR decrease by 60%
  - Cenovus Christina saw increases in pressure of its bottom water due to water disposal in the zone from 2002-2006. Has since moved disposal and mitigated issue
  - Conoco Surmont has had to decrease operating pressure to manage interaction with their top water zone from 4,000 kpa in 2007 to 2,000 kpa today
  - Cenovus Foster Creek has an ongoing pressure sink project in the eastern portion of their lands
  - All projects need to optimize pressure between pads – now that we have more multi well projects this has become more of an issue

Fluid Control Devices

- » Recognizing that subcool management is an important and ongoing concern for all SAGD producers, there are a number of new technologies that may assist in optimizing subcool and improving reservoir performance
  - » Outflow Control Devices (OCD)/Steam Distribution Systems
  - » Inflow Control Devices (ICD)
- » Commercialization of these technologies is particularly important to companies that have existing well-pairs with poor wellbore conformance and for the future development of less ideal reservoirs

Outflow Control at Cenovus – Christina Lake

- The purpose of OCDs and Steam Distribution Systems is to more evenly distribute and regulate steam injection along the well-pair
  - Pressures/injection along the injector can be regulated in order to direct steam to less developed areas



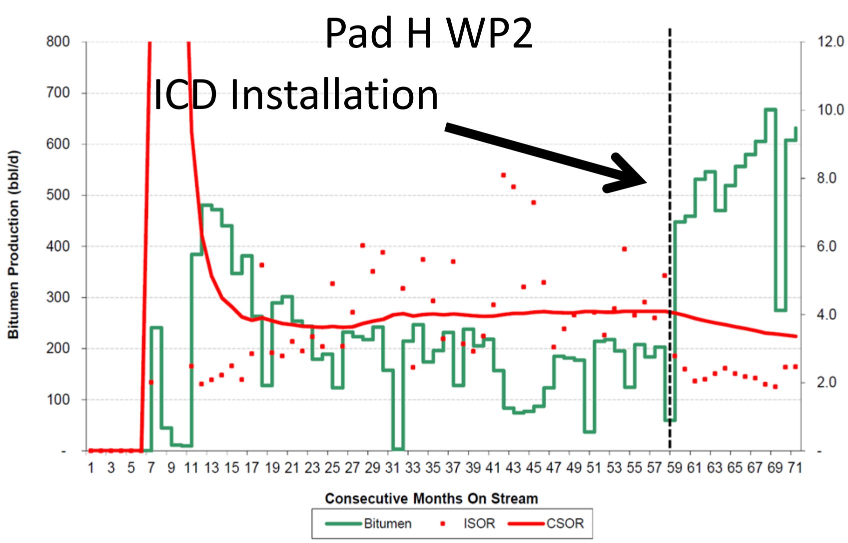
Flow Control Devices at Suncor – MacKay River

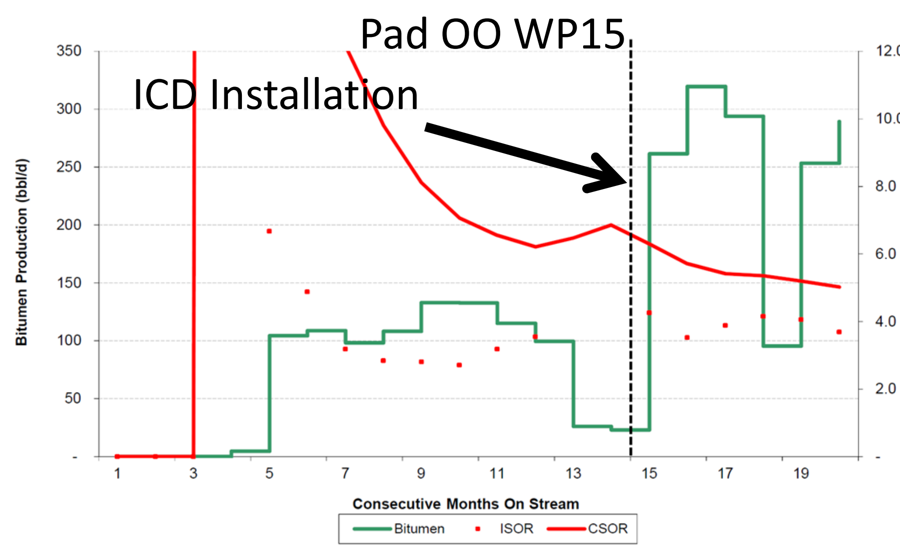
» ICDs are used as a direct means of homogenizing subcool along the producing well

» Suncor has installed ICDs at 16 well pairs at MacKay River

  » For the majority of the more mature ICD installations, well-pairs have demonstrated considerable success

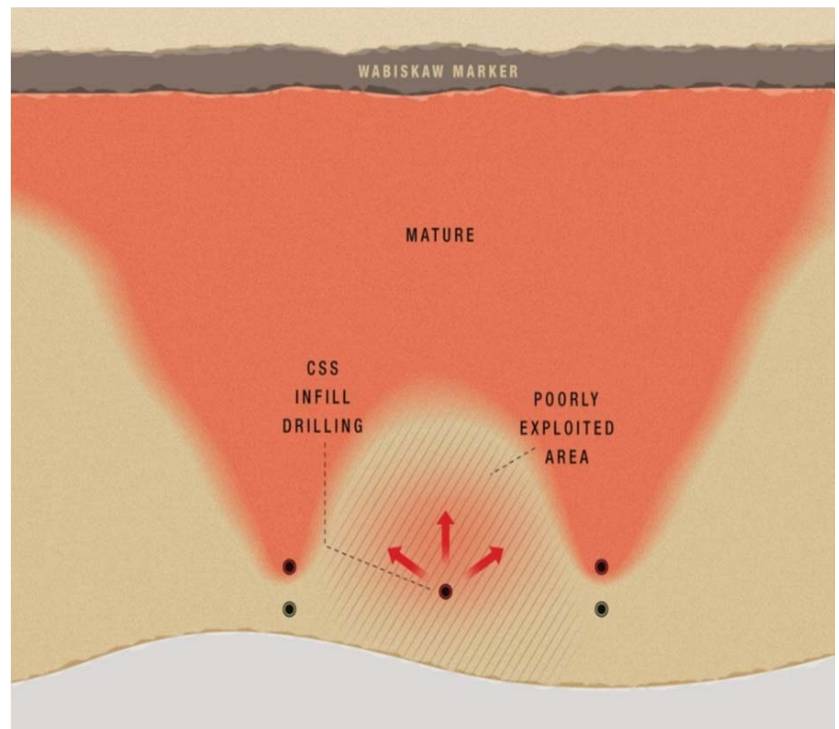
  » More recent ICD installations have shown mixed results to date. However, cooler sections of the wells are expected to heat up and improve conformance. Performance is expected to improve after more time.





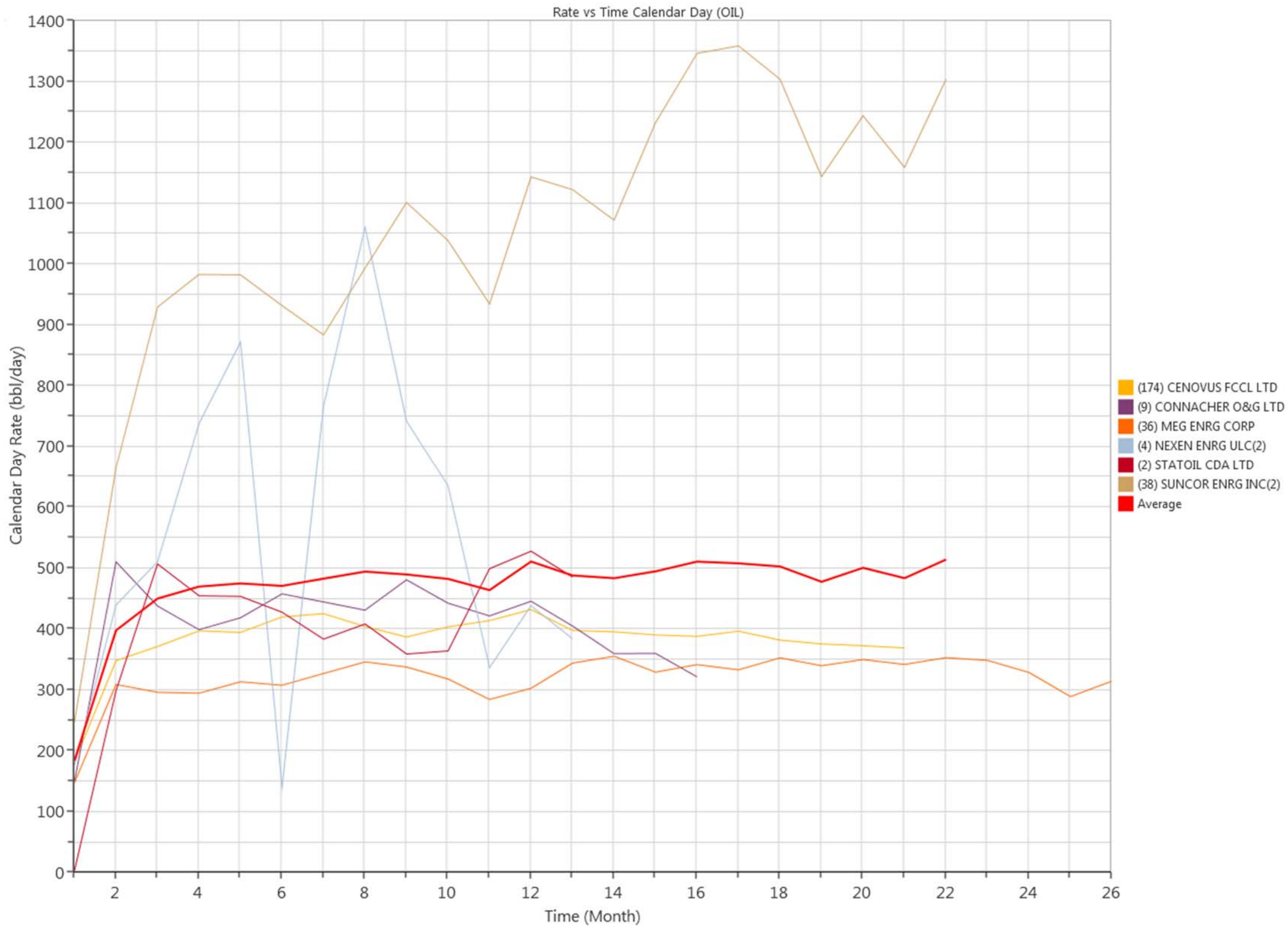
Infill Wells (Wedge Wells)

- Infill wells are being implemented in a number of reservoirs in order to recover the poorly exploited bitumen that lies between conventionally spaced well-pairs, 90-120m
- Operators actively implementing infill wells include:
  - Cenovus – Foster Creek and Christina Lake
  - Suncor – Firebag
  - MEG – Christina Lake
  - Connacher – Great Divide
- Early results from all projects are promising, with increases in Pad level productivity and reduced SORs being noted
- Incremental 3-10% recovery expected
- Empirical evidence of better performance from tighter spacing not yet available



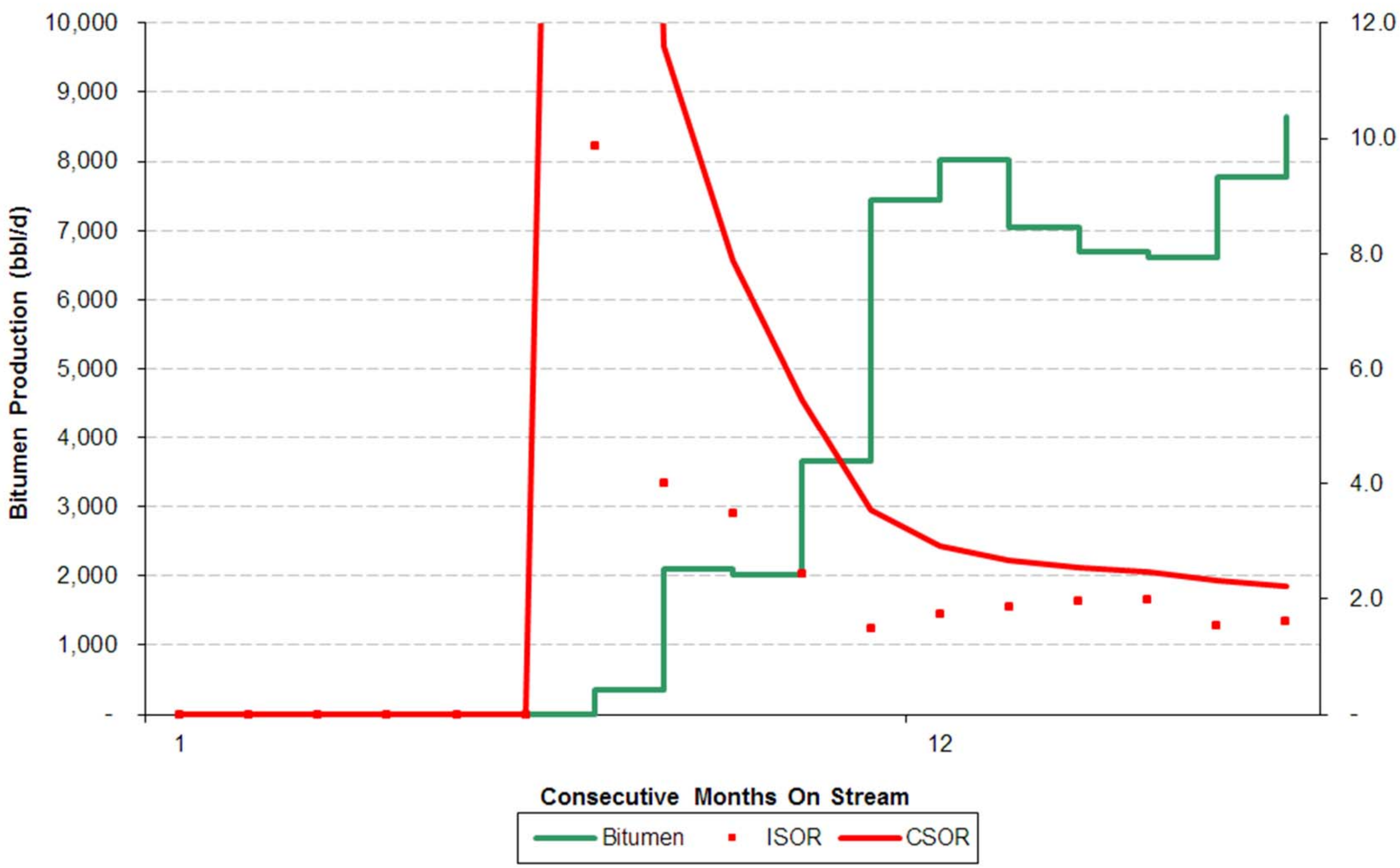
Infill Wells (Wedge Wells)

» Average infill well rates 500-1,300 bopd. Very material uplift when contrasted with peak well pair rates of 500-1,500 bopd



New Start Up Techniques

- » Cenovus believes that increased conformance from new start up techniques could result in limited requirement for new wedge wells going forward.
- » Most recent pad, W08 has peak rates of 1,700 bopd per well pair



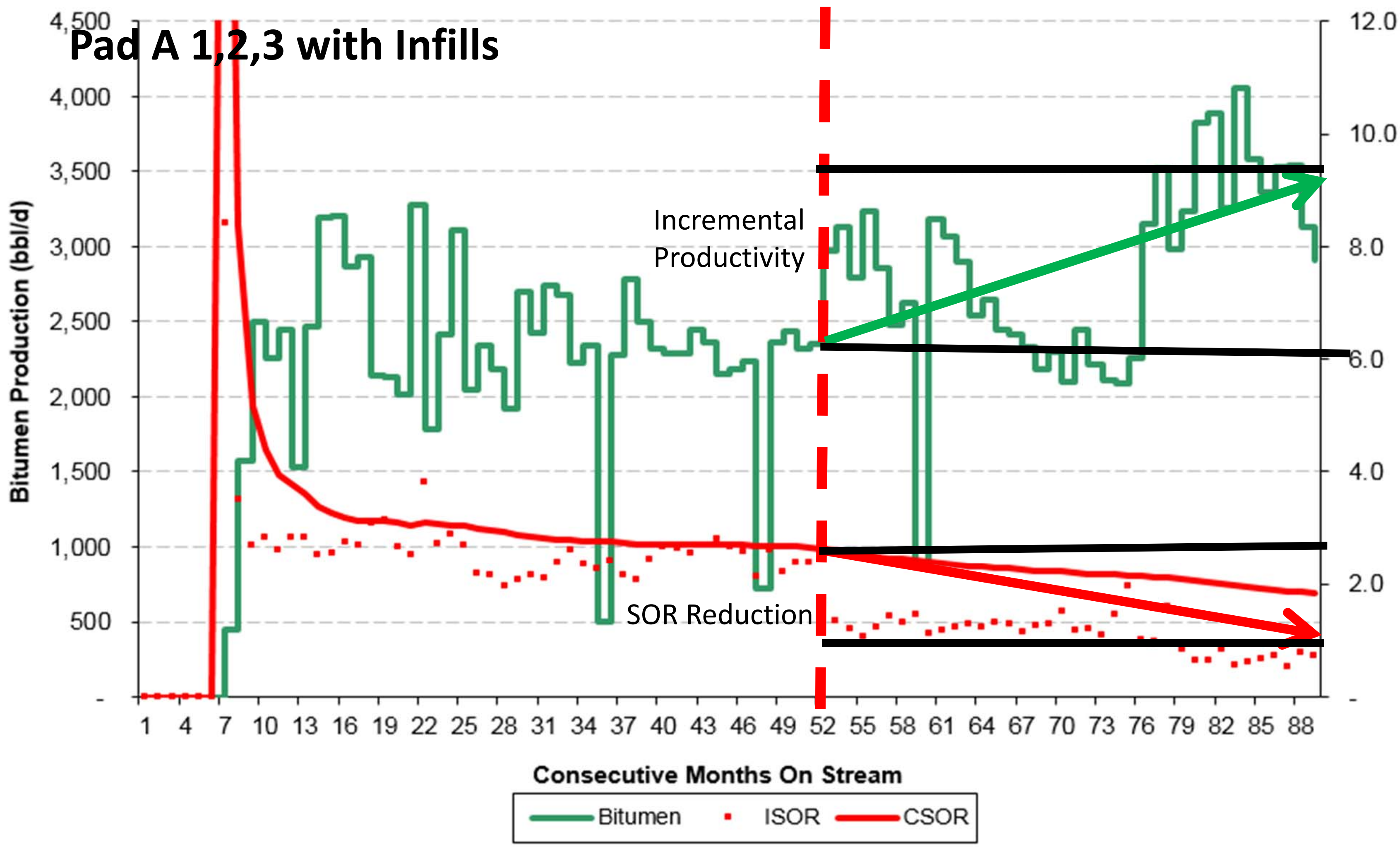
New Start Up Techniques

» Peak rate from the newest Foster Creek pad is better than all vintages of SAGD well pairs

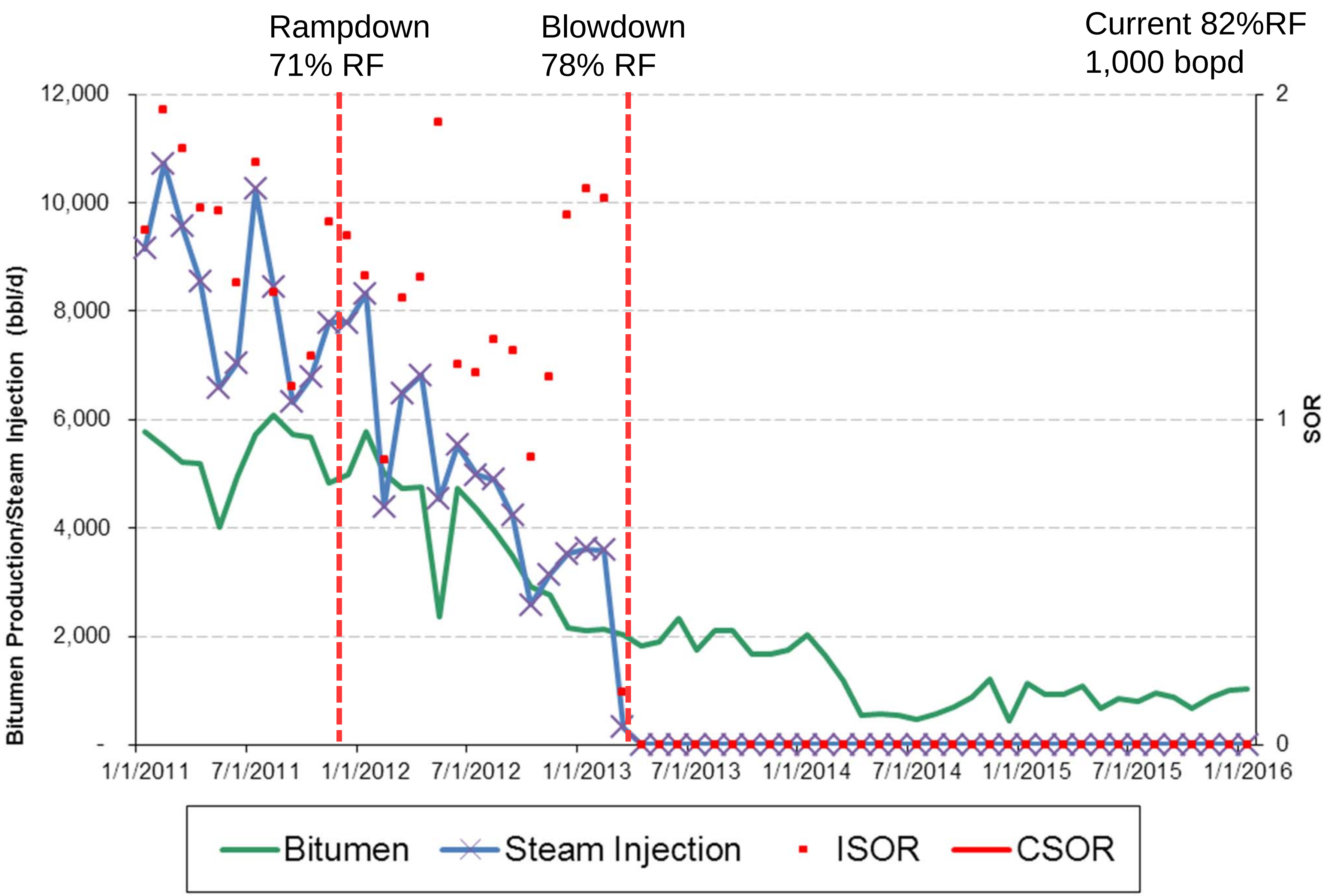
Late Stage Non-Condensable Gas Injection

- Late stage non-condensable gas (usually methane) is fairly straightforward and is used late in the life of a well-pair to maintain reservoir pressure while reducing steam injection
- Operators implementing co-injection include:
  - Cenovus, Connacher, JACOS, Suncor, MEG, Devon
- In addition to providing pressure support, methane accumulates at leading edges of steam chamber and provides thermal insulation to chamber, thereby reducing SOR

Infills + NCG: Christina Lake (MEG)



Foster Creek Pad C Blowdown



SAGD Technologies - Summary

- Using the same economic parameters noted earlier for large and small SAGD projects, we have assumed the following:
  - Pressure management: 10% incremental productivity
  - Flow control devices: 25% incremental productivity
  - Co-injection and infills: 25% reduction in SOR and a 7% increase in overall recovery

Comparing SAGD Development Technology

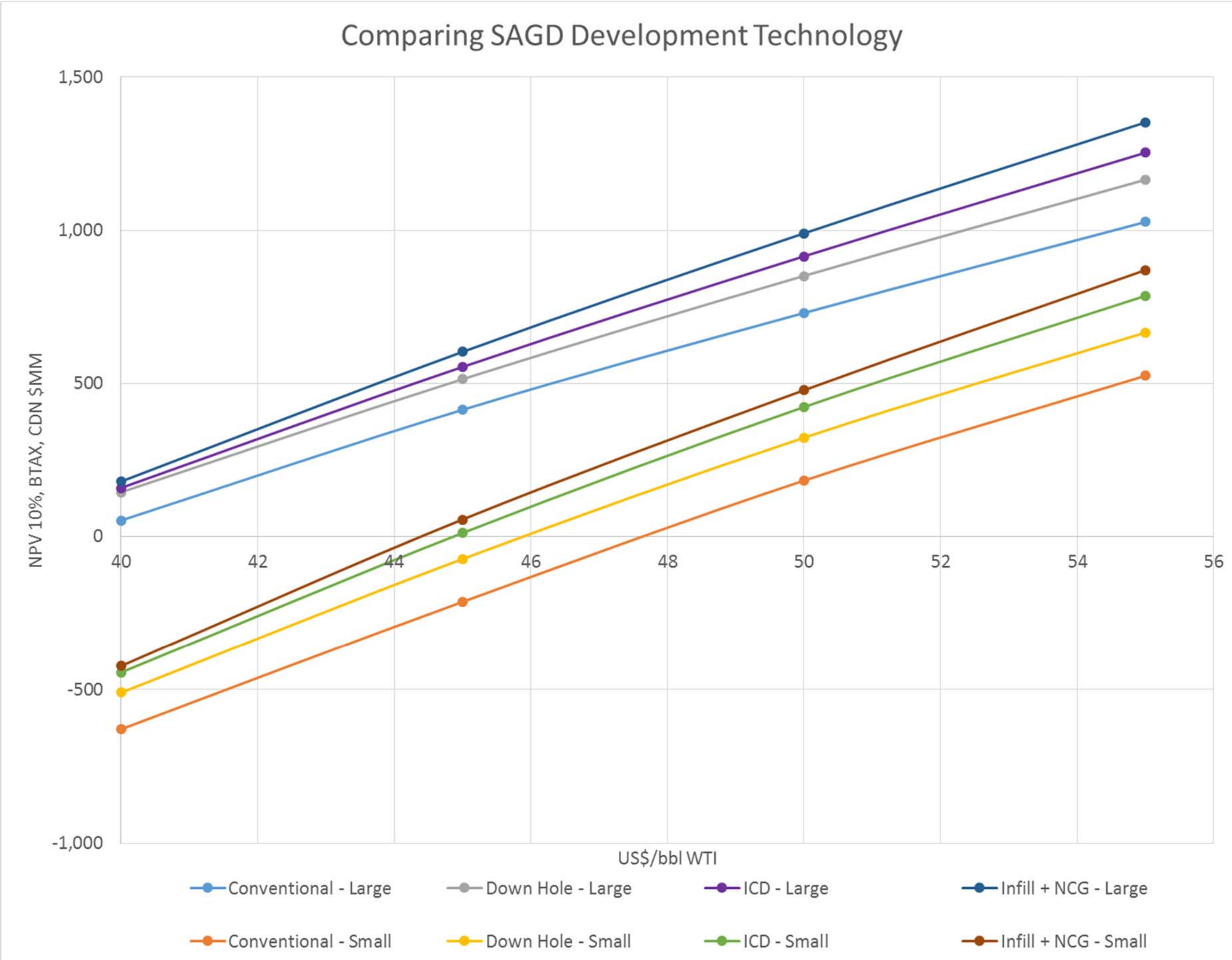
- Comparing NPV 10%, BTAX, CDN $MM for SAGD development technology against conventional SAGD

LARGE SAGD PROJECT	Conventional	Better Monitoring	FCDs	Infill + NCG
40 WTI	53	145	159	180
45 WTI	414	514	554	603
50 WTI	730	851	915	990
55 WTI	1,027	1,165	1,253	1,352

SMALL SAGD PROJECT	Conventional	Better Monitoring	FCDs	Infill + NCG
40 WTI	(629)	(510)	(444)	(423)
45 WTI	(213)	(73)	12	56
50 WTI	183	323	423	478
55 WTI	525	666	786	870

- Enhanced SAGD development technologies improve breakeven WTI economics by $1-2/bbl for larger SAGD projects and $2-3/bbl for smaller projects
  - Increased per-well productivity
  - Decreased overall SOR

Comparing SAGD Development Technology



Conclusions

- Economics of SAGD projects are challenged in this pricing environment
- Advances in pressure and sub cool management, fluid control devices, infill wells and natural gas co-injection should help the economics of existing projects
- Advances in start up procedures could increase conformance to the point where infill wells are no longer required

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Thank you to Jared Wynveen and Kyle Walmsley for their help

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