CBM Potentiality and Prospects in India

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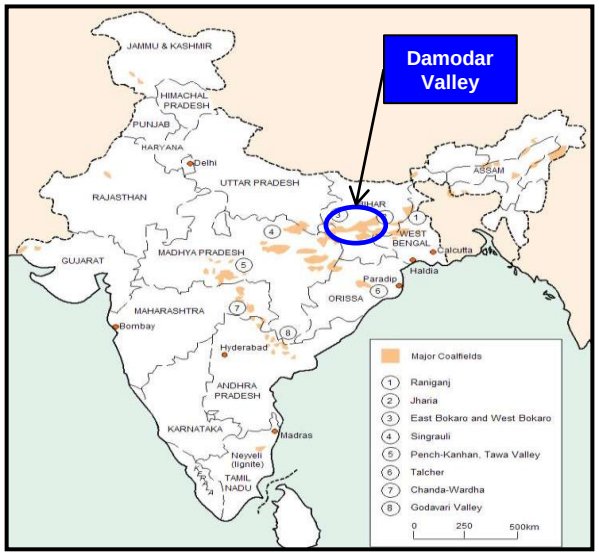
Presentation Title

1. Overview of India's CBM Resources
2. Essar's Raniganj CBM Project
3. CBM Potential of CIL Areas (Jharia and Raniganj)

Overview of India's CBM Resources

Overview of India's CBM Resources



- India's coalfields contain an estimated 120 Tcf of CBM distributed across 44 coalfields.
- The bulk of the resource is contained in the Damodar Valley Coalfields, the major coal mining province.
- Since 2001, 33 CBM blocks have been awarded on an international tender basis.
- Last year, the Indian government removed price controls from CBM, and producers are now realizing $6.00 to $10.00/Mcf.
- Gas authority of India (GAIL) recently extended the HBJ Pipeline into the Damodar Valley Region through URJA Ganga Pipeline Project. The pipeline is in advanced stage of construction. It will supply for industrial use and cooking gas for household in eastern states of U.P., Bihar, WB, Jharkhand & Odisha

India

Over 600 CBM wells have been drilled in India, and this number is expected to double in the next several years as a result of developing infrastructure.

Major Active Projects			
Company	**Project**	**Status**	**Market**
ESSAR Oil	Raniganj East	300 wells drilled and producing; 150 more wells planned; current production is 35+ MMcfd	GAIL Pipeline
Great Eastern Energy	Raniganj South	150 wells drilled, 100 producing; 100 wells planned; current production 10 MMscfd; Gas Price of $10.00/Mcf	Local industries, steel plants, GAIL Pipeline
Reliance Industries	Sohagpur	340 wells drilled; started selling gas into the pipeline in early 2019	GAIL Pipeline
Reliance ADA/Geopetrol	Sohagpur	Series of core wells; 2 production wells; currently planning a 15 well pilot	Power generation
Prabha Energy/ Oil and Natural Gas Corp./ Indian Oil Corporation Ltd.	North Karanpura	68 production wells planned to be drilled. 32 wells drilled and 22 completed, currently under dewatering.	Local usage around Hazaribagh and feed to Urja Ganga Pipeline Project

Essar's Raniganj CBM Project

Leadership in Unconventional Space – Essar Oil and Gas

Pioneers of CBM in India

First CBM wells drilled and tested in early 90's (Gujarat-Mehsana lignites)
Developed State of the Art Technology

Prolific Blocks/Assets

- One Production Asset (CBM Raniganj East)
- Upside in Shale Potential
- One Exploratory acreage
- Un-conventional gas resource (~15 TCF)
- Estimated recoverable resources (~4 TCF)

Strategic Location

- Proved coal basins
- In Place (Gas Evacuation Infrastructure)

Development benefits

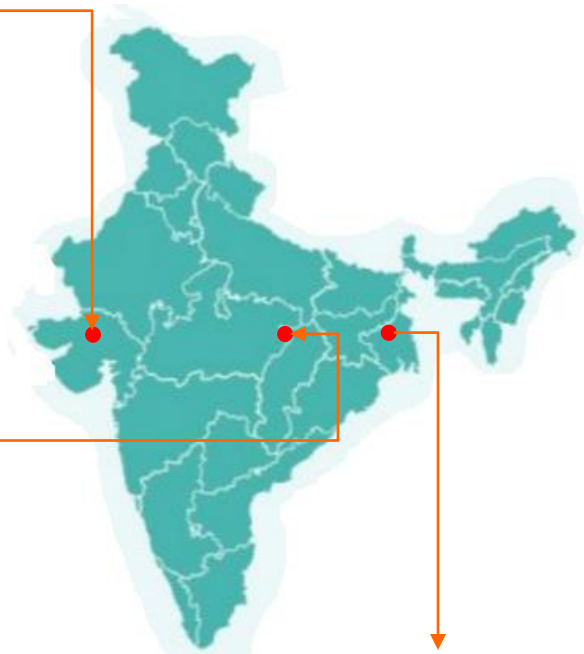
- 2017 CBM early monetization policy
- 2018 SIMEX Policy

Mehsana

- CBM Resource 2 TCF
- Recoverable 0.8TCF (ARI 2019, 2C)

Sohagpur

- CBM Resource 0.6 TCF
- Recoverable 0.3 TCF (DGH)



Raniganj

CBM	Shale Gas
CBM Resource 4 TCF	Resource 8TCF
Recoverable 1.37 TCF (NSAI 2016, 3P + 2C)	Recoverable 1.6 TCF (USTDA\ARI 2019)

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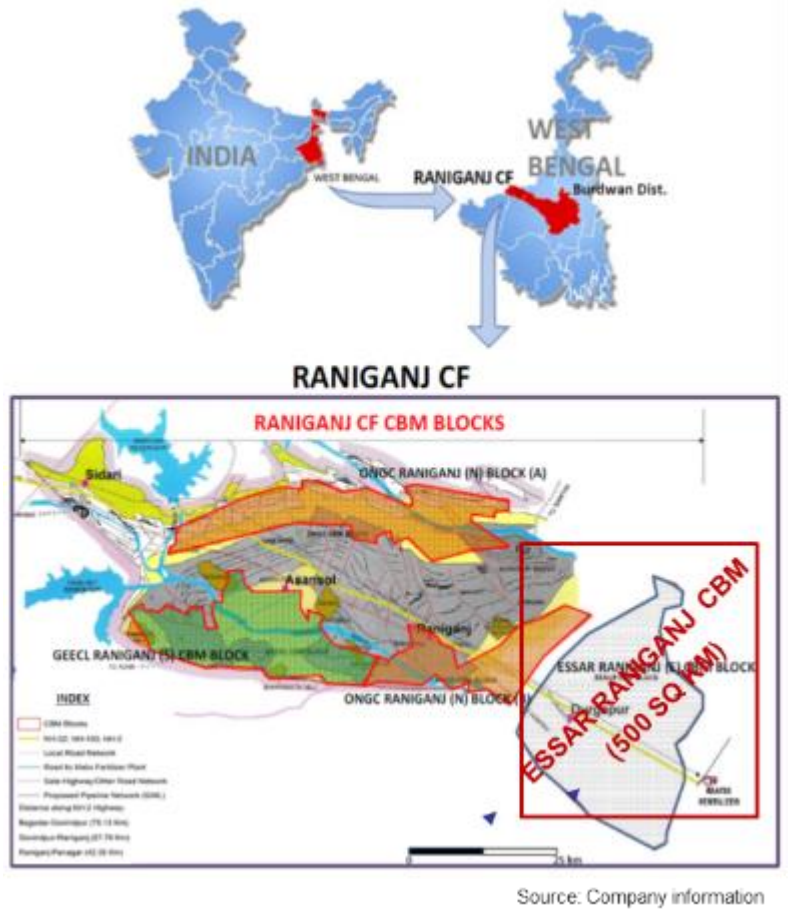
Raniganj East CBM - Anchor Production Asset

- **Block awarded on 26th July 2002**
  - Project commissioned with 348 wells and related facilities as on April 1, 2018
  - Compression facilities for 2.1 MMscmd in place
  - 300 KM of operational pipeline network (~65km Customer; ~235km Infield)
  - Total investment made : ~USD 579 mn
  - Total equity invested : USD 383 mn (66%)
  - Achieved peak Production of above 1 mmscmd in CY 2017 (First in any CBM Block in India)

- **Current Status**
  - Production of ~0.5 mmscmd from around 200 producing wells
  - Compression facilities:
    - 4GGS (capacity 2.1 MMscmd)
    - 1MCS (capacity 3 MMscmd)
    - 1CNG Station (capacity 48000 scmd)

Block Location Map



Source: Company information

Raniganj Block – Historical Production

Particulars	Produced (Bcf)
FY 2011	0.15
FY 2012	0.31
FY 2013	0.47
FY 2014	1.25
FY 2015	3.23
FY 2016	8.35
FY 2017	13.59
FY 2018	11.60
FY 2019	6.98
FY 2020(April-Sept)	2.81
Total	**48.74**

Peak production of above 1 MMSCMD achieved in early CY 2017

Essar Field Facilities

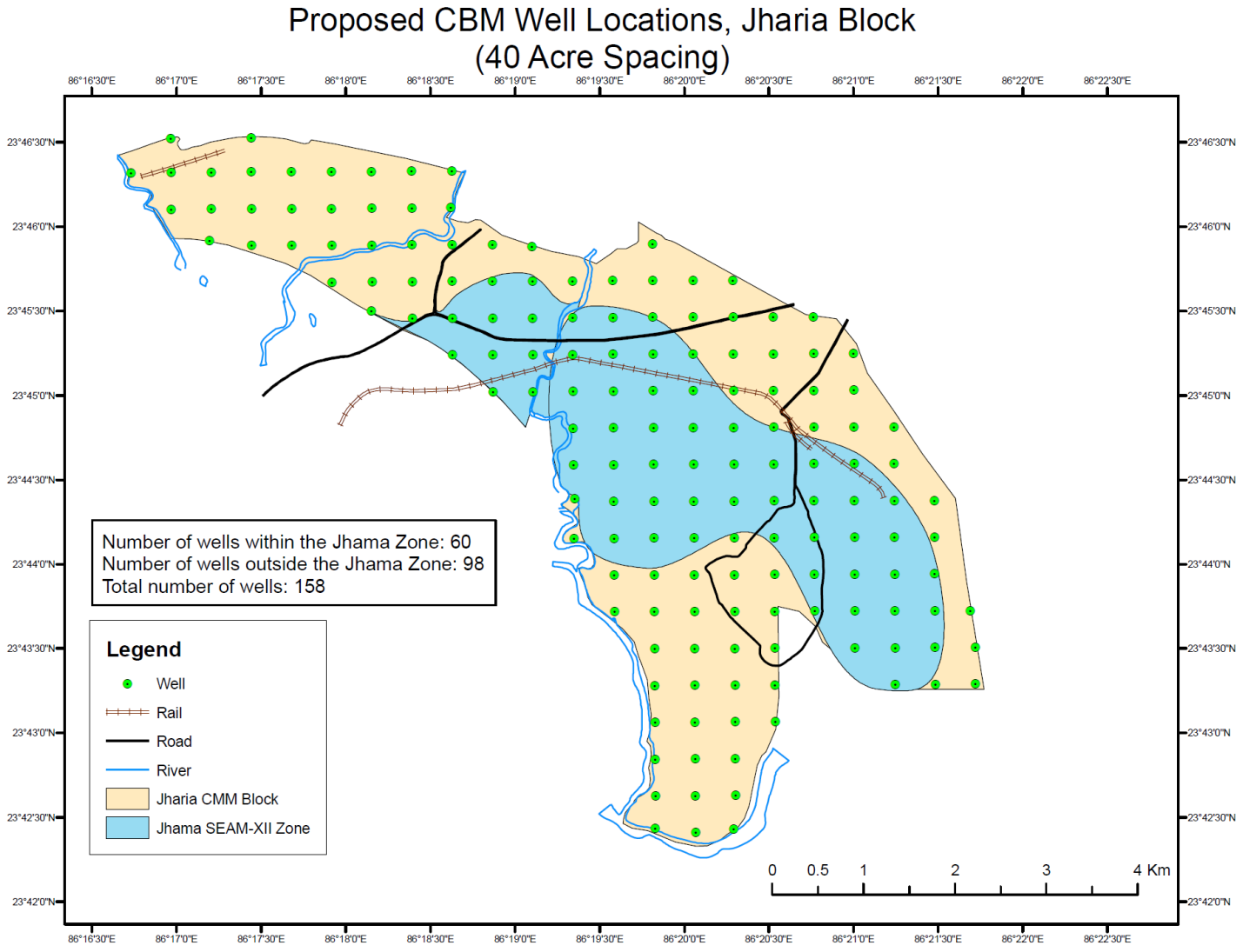
Main Compressor Station

Well Cluster Separation

Well Site

CBM Potential of CIL Areas (Jharia and Raniganj)

Overview of Field Development Plan – Jharia Coal Field



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Reservoir Parameters for Jharia Block

Reservoir Simulation Parameters for Jharia CBM Block					
RESERVOIR PARAMETERS	**Imperial**			**Metric**	
COAL DENSITY	lb/ft^3	77.9		gm/cc	1.25
PRESSURE GRADIENT	psi/ft	0.433		kPa/m^3	9.80
CLEAT POROSITY	%	0.5		%	0.5
CLEAT WATER SATURATION	%	100		%	100
CLEAT PERMEABILITY	md	0.5		md	0.5
LANGMUIR COEFFICIENTS					
LANGMUIR VOLUME	ft^3/ton	751		m^3/tonne	23.4
LANGMUIR VOLUME	scf/ft^3	29.3		sm^3/m^3	29.3
LANGMUIR PRESSURE	psia	722		kPa	4978
SORPTION TIME	days	1.5		days	1.5
RESERVOIR TEMPERATURE	F	115		C	46.1
CLEAT SPACING	in	2.6		cm	6.5
PORE VOLUME COMPRESSIBILITY	/psi	3.00E-06		/kPa	4.35E-07
MATRIX SHRINKAGE COMPRESSIBILITY	/psi	1.00E-06		/kPa	1.45E-07
COMPLETION & STIMULATION	Vertical stimulated well (skin: -3)				
WELL OPERATION	400 BWPD with 30 psia (BHP) minimum pressure constraint				

Reservoir Parameters for Jharia Block (Cont'd)

All Seams Including XV and Below

Layer	Seam(s)	Depth (ft)	Thickness (ft)	Gas Content (scf/ton)
1	XVT/XVB	1818	21.2	421.6
2	XVComb	1922	27.2	537.6
3	VIIT/VIIA/XII/VIIIB	2379	50.1	287.5
4	XI/VIII	2583	36.2	314.5
5	X	2704	11.9	679.2
6	IX	2814	9.4	531.8
7	VIIIC/VIIIB/VIIICOMB	2890	51.3	261.1
8	V/VI/VII, V/VI, VII	2941	178.1	461.3
9	IVB/IVT/IV	3119	34.0	378.0
10	III/II/I/L	3153	127.8	431.4
11	IX/X	3917	36.1	752.2

Seams XV and Below / Excluding Seams XII and XI

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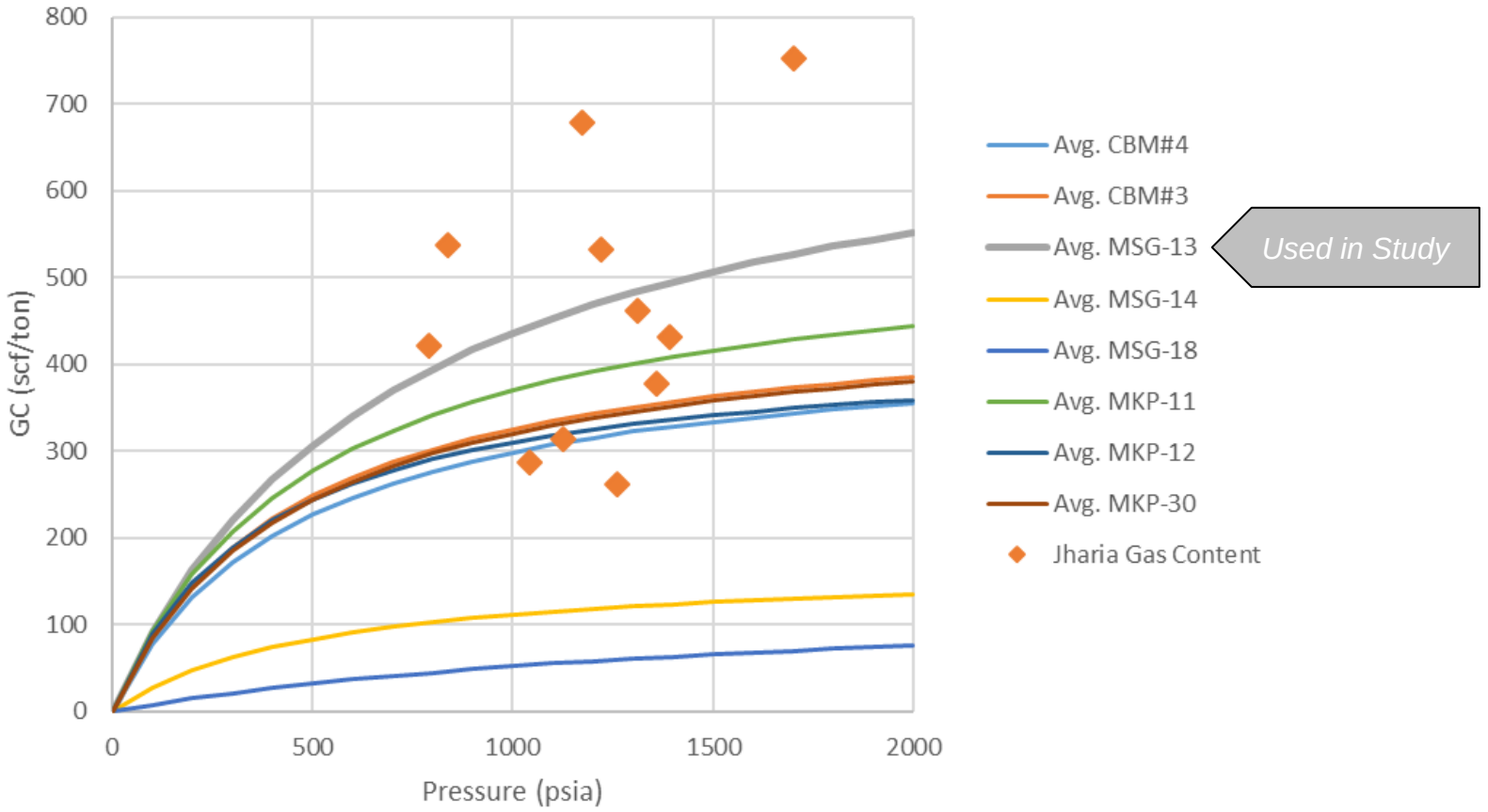
Methane Isotherm and Gas Contents Used in Simulation - Jharia



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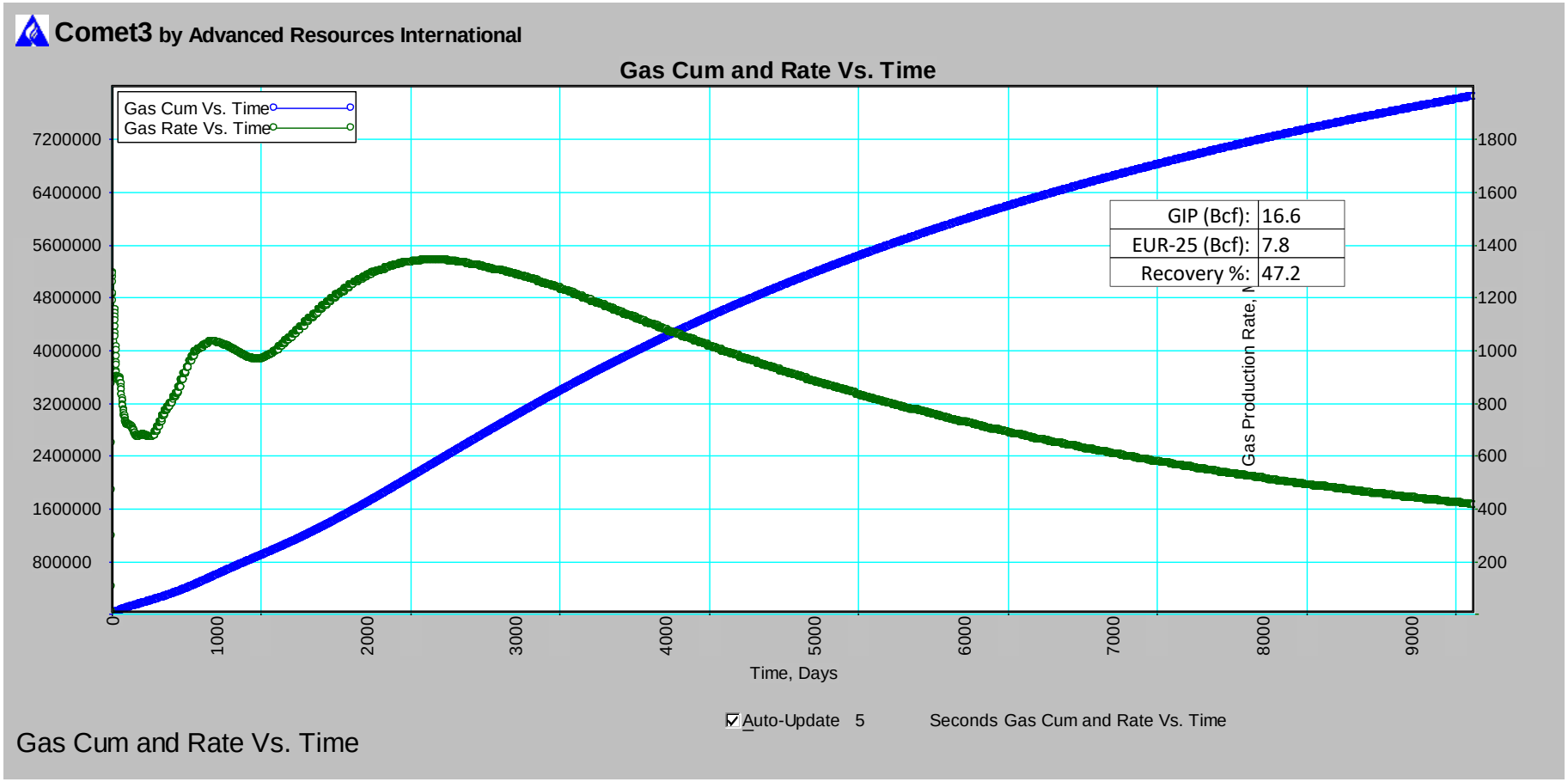
Simulation Results (all seams): Gas Production - Jharia



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Production Forecasts - Jharia

- The field production profiles for gas and water from the Jharia CMM block were generated using the single-well production profiles obtained from the reservoir simulation study. A summary of the single-well simulation results is shown in the table to the right.
- The field-wise gas and water production profiles and the drilling schedule for each area are presented in the following slide. A tabular summary of the drilling schedule by area is also presented to the right.

Summary of Single Well Simulation Results

	Non-Jharma Area	Jharma Area
Model Area (ac)	40	40
No. Seams	19	17
Model Layers	9	8
Total Coal Thickness (ft)	330	303
TVD (ft)	3,125	3,125
Peak Water Rate (BWPD)	280	265
Total Water Production (MBbls)	351	322
Peak Gas Rate (Mcfd)	917	892
Peak Gas Month	63	62
Total Gas Production (MMcf)	4,994	4,667
GIP (MMcf)	9,180	8,470
Recovery (%)	54.4	55.1

Drilling Schedule for Development of Jharia CMM Block

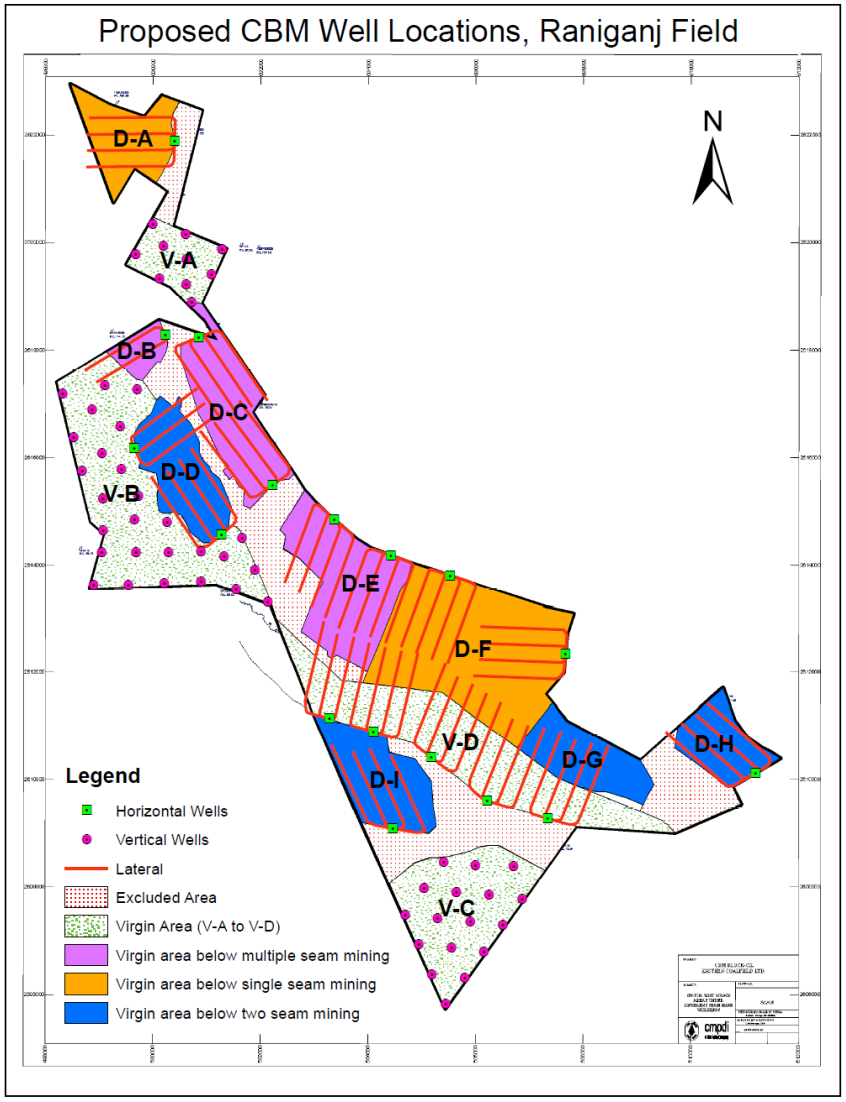
Project Year	Wells Drilled			Cumulative Wells		
	Non-Jharma	Jharma	Total	Non-Jharma	Jharma	Total
1	5	5	10	5	5	10
2	0	0	0	5	5	10
3	12	12	24	17	17	34
4	12	12	24	29	29	58
5	12	12	24	41	41	82
6	12	12	24	53	53	106
7	17	7	24	70	60	130
8	24	0	24	94	60	154
9	4	0	4	98	60	158

Capital and Operating Cost Assumptions - Jharia

Capital Cost			**$,000**
Location Cost (total land = 237-ac at $55.5M)	Per Well		351.00
Civil	Per Well		40.00
Geologic & Geophysical	Per Well		7.50
Vertical Well Cost	Per Well		724.10
Surface Facility			
Well Surface Facility	Per Well		100.00
Infield Pipeline	Per Well		30.00
Gas Gathering Station	Per GGS Capacity, MMSCMD	0.4	6,450
Water Treatment	Per RO Plant Capacity, SCMD	3,000	12,500
G&A			10.0%
Contingency			7.5%
Commercial Bonus	Payable in Year	1	300

Operating Cost		
Normal Well Operation	$/Well/Month	1,000
Electricity	$/Well/Month	200
Well & Pump Maintenance	$/Well/Month	600
Gas Compression	$/mcf	0.10
Water Treatment & Disposal	$/BBL	0.10
Fuel Requirement & Processing Losses		4.0%

Overview of Development Plan – Raniganj Coalfield

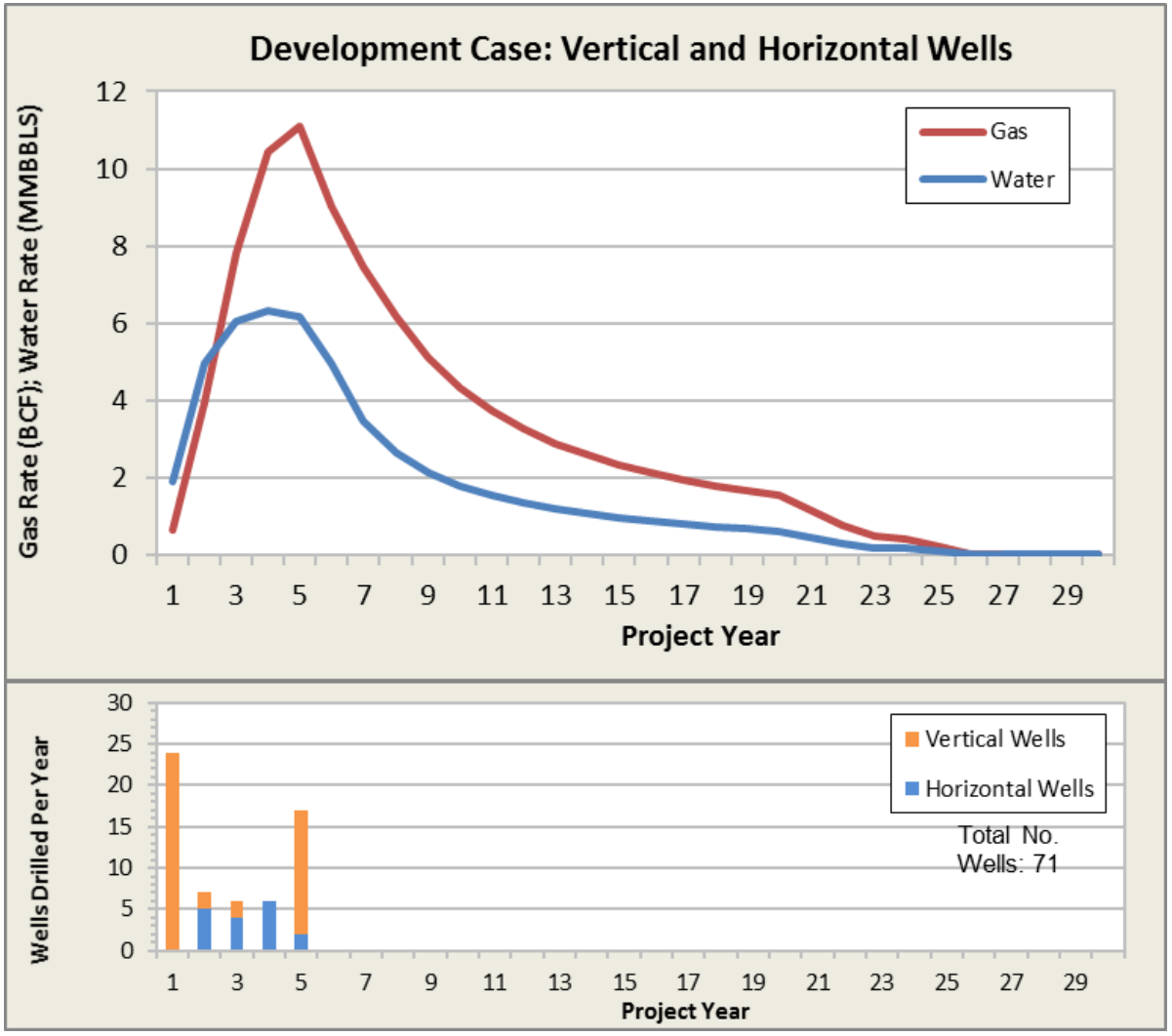


- The map to the left shows the well locations proposed in the field development plan.
- Field development is assumed to begin in area V-B and progress outward from this point to optimize construction of surface facilities and gathering lines.
- Following area V-B, drilling will progress as follows: D-D, D-B, D-C, V-A, D-A, D-E, D-F, V-D, D-H, D-I, and V-C.
- Gas and water production forecasts assume vertical wells drilled at a rate of 2 wells per month, with each horizontal leg drilled at a rate of 1 every 2 weeks (e.g., one horizontal well consisting of 4 lateral legs to be drilled in 2 months).
- See the following slides for per-well recoveries and production profiles as determined via reservoir simulation.

Reservoir Parameters for Raniganj Block

Reservoir Simulation Parameters for Raniganj CBM Block - Developed Area								
	Top Depth	Thickness	Reservoir Pressure	Langmuir Volume		Langmuir Pressure	Gas Content	
Seam	(ft)	(ft)	(psia)	(scf/ton)	(scf/cf)	(psia)	(scf/ton)	(scf/cf)
LOCAL	725	7.2	314	287	12.3	283	114	4.9
R-VII	791	7.3	343	287	12.3	283	118	5.1
R-VII A	869	3.8	376	287	12.3	283	123	5.3
R-VI	1050	9.8	454	287	12.3	283	168	7.2
R-V	1150	6.6	498	287	12.3	283	174	7.4
R-IV	1696	11.4	734	287	12.3	283	197	8.4
R-III T	1910	3.9	827	287	12.3	283	203	8.7
R-IIIB1	2061	6.1	892	287	12.3	283	207	8.9
R-IIIB2	2086	5.7	903	287	12.3	283	208	8.9

Production Forecast: Vertical and Horizontal Well Development Case



Capital and Operating Cost Assumptions

Capital Cost			**$,000**
Location Cost	Per Well		60.00
Geologic & Geophysical	Per Well		7.50
Vertical Well Cost	Per Well		744.00
Horizontal Well Cost	Per Well (V portion)		239.40
	Per Well (1 H Lateral(s))		500.00
Surface Facility			
Well Surface Facility	Per Well		100.00
Infield Pipeline	Per Well		30.00
Gas Gathering Station	Per GGS Capacity, MMSCMD	0.4	6,450
Water Treatment	Per RO Plant Capacity, SCMD	3,000	12,500
G&A			5.0%
Contingency			7.5%
Commercial Bonus	Payable in Year 3		300

Operating Cost		
Normal Well Operation	$/Well/Month	1,000
Electricity	$/Well/Month	200
Well & Pump Maintenance	$/Well/Month	600
Gas Compression	$/mcf	0.10
Water Treatment & Disposal	$/BBL	0.10
Fuel Requirement & Processing Losses		4%
G&A		5.0%

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