

4th Iraq Energy Forum

Al Rasheed Hotel Baghdad

The Power & Gas Challenge for Iraq

A Presentation & Discussion

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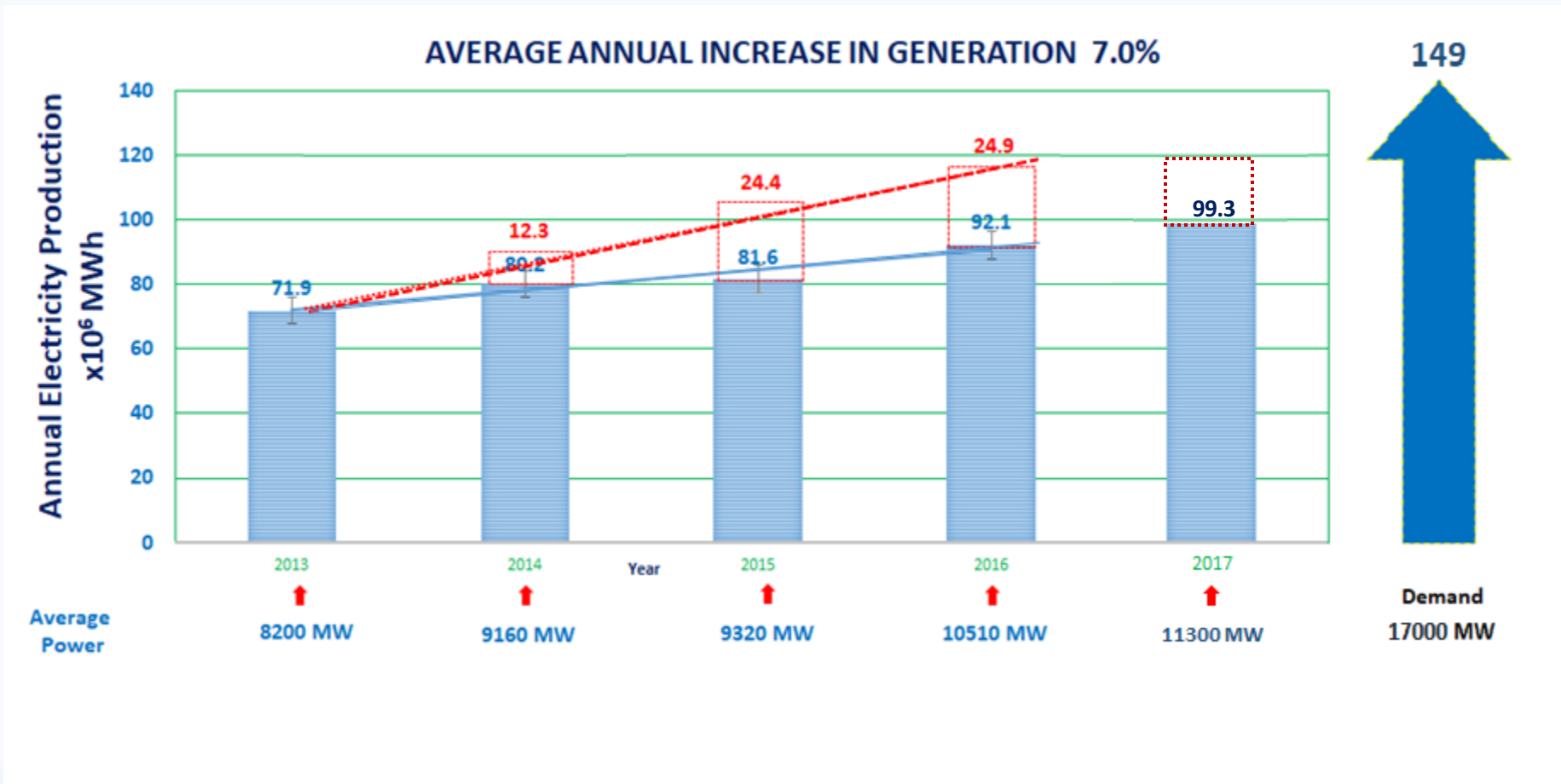
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IRAQ'S ANNUAL ELECTRICAL ENERGY GENERATION (2013-2017) (EXCLUDING KRG)



Intervention of ISIS in June 2014 reduced the available generation capacity by the figures shown in **RED**. Without this disruption by the terrorists the demand/supply gap in 2016 would have been circa 12% instead of 42 %.

Average Annual Increase in Demand \approx 6 %. Therefore, Average Power Demand in 2023 is Expected to be 22,500 MW.

This Would be Double the Energy Generated in 2017 and Requires the Addition of 16000 MW of New Capacity.

Estimate of Fuel Used for Electricity Generation in Iraq in 2017



- Iraq's total electricity despatched during 2017 was 9.928×10^9 kWh. This implies an average generation capacity of 11,334 MW. Subtract circa 1300 MW to account for Iraq's hydroelectric generation and imported electricity from Iran.
- Assuming the heat rate (HR) for steam and Simple Cycle thermal plants to be 11 MJ/kWh. This implies an average efficiency of 33% for conversion of chemical energy to electrical energy.
- Rate of chemical energy required to generate 10'000 MW is 10.0×10^6 kW x 11 MJ/kWh = 110 TJ/h = 2.64 PJ/day.
- Remember 1 BOE = 5800 scf = 6000 MJ = 5.8 mmBTU.
- Therefore, 2.64 PJ/day is equivalent to 440,000 BOE/day was burnt during 2017 for power generation.
- Based on Actual Data of Fuel Burnt from Ministry of Electricity (MOE). Amount of Gas used for Power Generation during 2017 was 989 mmscfd including North Gas, South Gas, Basra Gas and imported Gas from Iran.

BOED

- Natural Gas 170,000 Data from MOE
- Crude Oil 150,000 Data from MOE
- Heavy Fuel Oil 92,000 Data from MOE
- Light Distillate Oil 21,000 Data from MOE
- Total : 433,000 This agrees well with above estimate of 440,000 BOED.

- MOE's Estimate of Crude Oil to be Burnt for Power Generation in 2018 is 194,000 BOED Whose Current Value is 11 MUSD/d. i.e. 4.1 BUSD/year (Assuming Brent at 65 USD /bbl and Iraqi Crude Oil Sells at 57 USD/bbl, which is Brent - 8 USD)

Conversion of Open Cycle (OC) Plants to Combined Cycle (CC) by 2023



- Currently only one plant is operational in Iraq (excluding KRG).
- An additional 3.5 GW of generation capacity could be obtained from the conversion of GE Frame 9E OC plants to CC with no additional fuel requirements.
- An additional 1.2 GW of generation capacity could be obtained from the conversion of Siemens 2000E and 4000F OC plants to CC with no additional fuel requirements.
- Total additional power generation capacity foreseen from conversion of OC to CC by 2023 is 4.7GW.
- If the fuel for all these plants is switched from liquid to Natural Gas, then an additional power output of 1500 MW could be obtained together with enhanced availability and reliability plus much reduced maintenance costs as well as a positive environmental impact.

**Additional Power Generation Capacity from Projects Under Construction
Plus Investment Projects Plus OC to CC Conversion Projects
Could Be Made Available by 2023**



	<u>MW (ISO)</u>
1. Samawa + Nasiriya OC plus CC (Currently Under Construction by GE)	1,500
2. Balad (Steam Power Plant Under Construction) 4 X 300 MW	1,200
3. Various Approved IPP Investment Projects (Under Construction)	6,000
4. Conversion of Existing OC Plants to CC (Require Financing)	4,700
5. Additional IPP Projects Based on Gas to Power (GTP)	3,000
6. Anbar CC Power Plant 4 x GT 26	1500
	Total 17,900

**This Additional Capacity if installed, Could Cover the Power Generation Deficit by 2023.
Estimated Financing Requirements for Item 4 circa 6 BUSD.
Additional NG Requirements for the Above Projects circa 2000 mmscfd.**

Natural Gas Imported From Iran



- Iran NG Became Available in July 2017.
- Price per million Btu is $0.1088 B + 0.08$, Where B is Brent Price in USD/bbl.
- Brent is Currently at 65 USD/bbl
- Price of Iranian NG today/mmbtu = 7.152 USD which amounts to 42.9 USD/BOE
- Iraqi Crude Would Sell at circa 57 USD/bbl (Saving of 14.1 USD/bbl)
- 1 mmbtu = 1055 MJ
- 1 MJ of NG = 0.678 cents (US)
- All Simple Cycle and Steam Cycle Plants in Iraq Have a Heat Rate of 11 MJ/kWh. CC Plant Heat Rate is 7.0 MJ/kWh.
- Cost of Iranian NG/kWh = 7.46 cents (US) for Open Cycle and 4.75 cents(US) for Combined Cycle.
- Current Imported Quantity of Iranian NG is 10 mcmd or 360 mmscfd. Cost to MOE is 2.6 MUSD/day.
- Accordingly current IPP CC Power Plant with a Brent average price of 65 USD/bbl currently costs of 3.7 cents per kWh then add a further 4.75 cents for Iranian gas. Therefore, overall cost to the MOE 8.45 cents/kWh or 84.5 USD/MWh for power generated.



Available Associated Gas South of Iraq

Oil Field	Captured Gas	Flared Gas	Total (mmscfd)
1 North Rumaila	165	425	590
2 South Rumaila	217	263	480
3 Zubair	247	86	333
4 WQ1	67	175	242
5 WQ2	8	170	178
6 Majnoon	70	65	135
7 Halfaya	40	90	130
8 Bin Omar	68	32	100
9 Lehais	23	50	73
10 Misan	5	65	70
11 Garraf	2	52	54
12 Artawi	0	44	44
13 Nasiriya	0	35	35
Total:	912	1552	2464

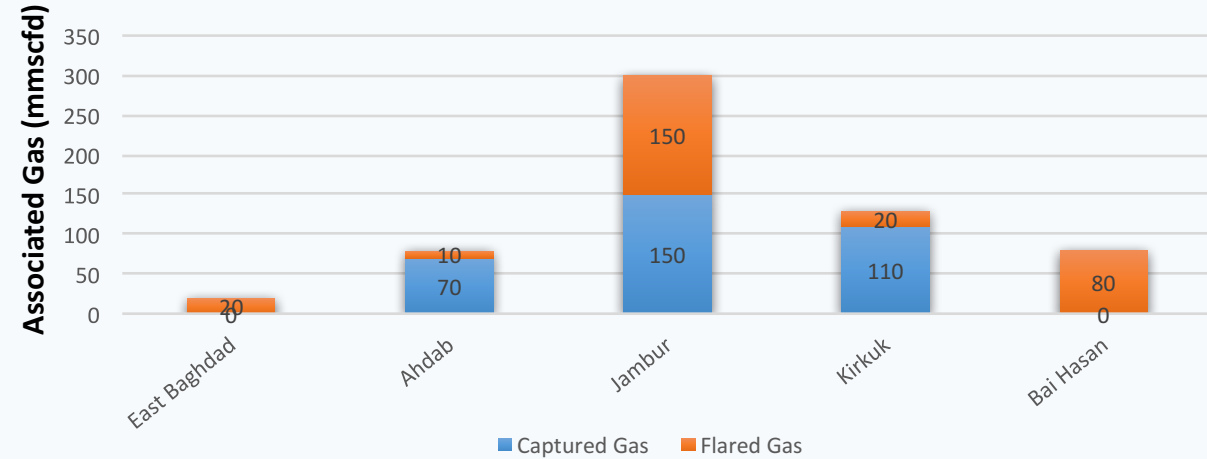


South Gas Plus Basra Gas Processing Capacity 1000 mmscfd. Current Production only 700 mmscfd.
Additional Gas Processing Capacity Required for Basra Gas Company 650 mmscfd.
Additional Associated Gas Processing Capacity Required for Other Oil Fields 850 mmscfd.



Available Associated Gas Mid and North Iraq (Excluding KRG)

Oil Field	Captured Gas	Flared Gas	Total (mmscfd)
1 East Baghdad	0	20	20
2 Ahdab + Badra	70	10	80
3 Jambur	150	150	300
4 Kirkuk	110	20	130
5 Bai Hasan	0	80	80
Total:	330	280	610



Gas From Ahdab + Badra Currently Supplies Wasit Steam Power Plant

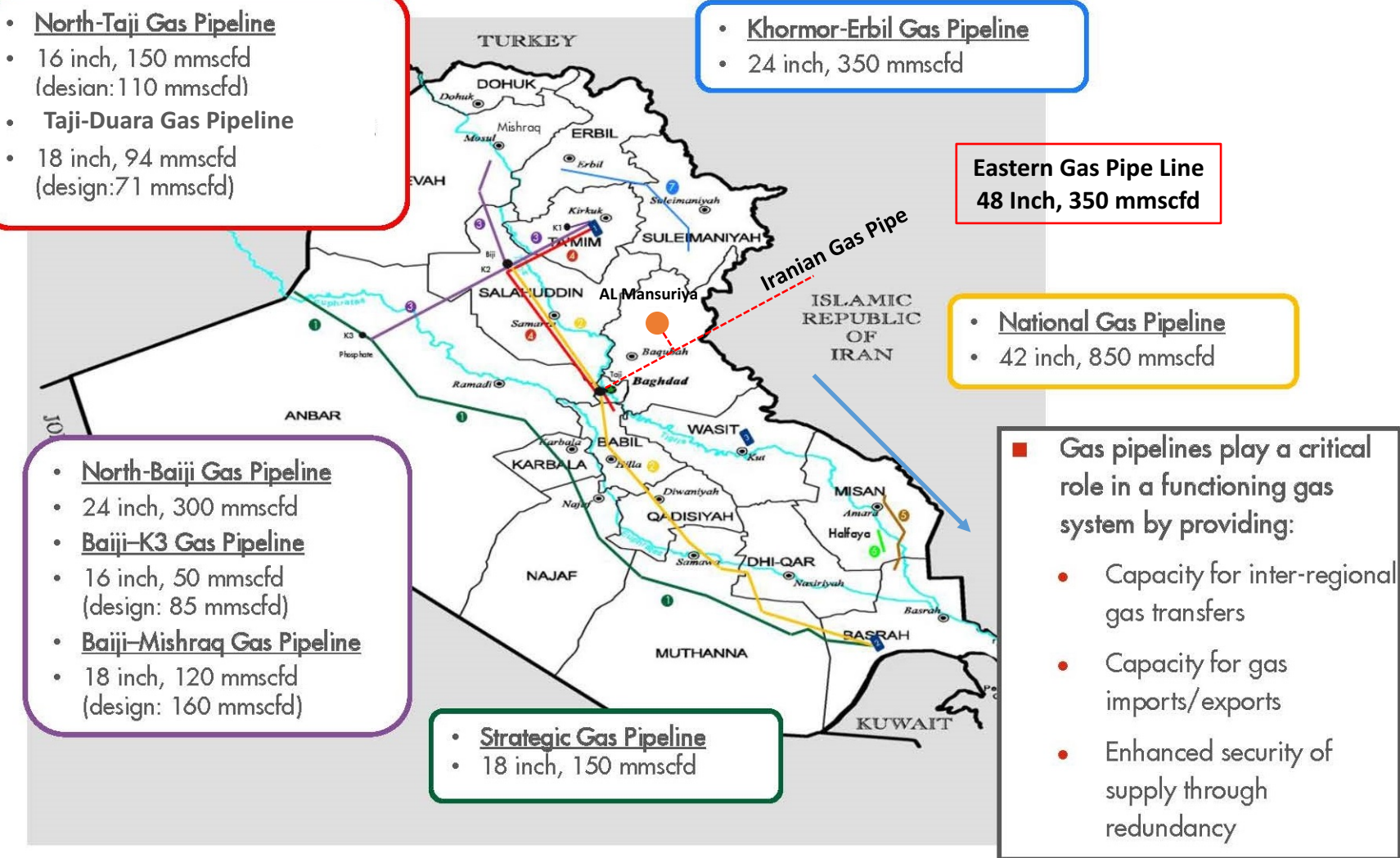
North Gas Processing Capacity 2 x 200 mmscfd. Current Production only 130 mmscfd due to lack of crude oil production and interruption of 16-inch pipeline to the South (Taji).

Additional Associated Gas Processing Capacity Required 200 mmscfd.



Iraq's Existing Dry Gas Pipeline Connects North & South

Iraq Existing Dry Gas Pipeline Network



So What Needs To Be Done?



Thank You For Your Attention



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