HYDROCARBON DEVELOPMENT INSTITUTE OF PAKISTAN

POTENTIAL OF UNCONVENTIONAL HYDROCARBON RESOURCES AND DEVELOPMENT IN PAKISTAN

BY

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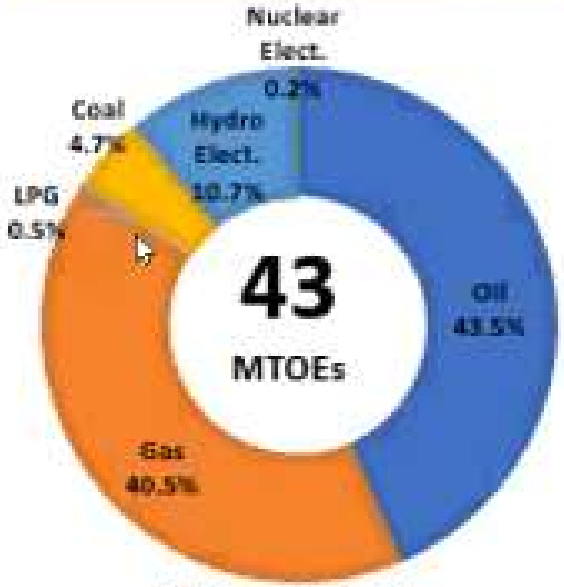
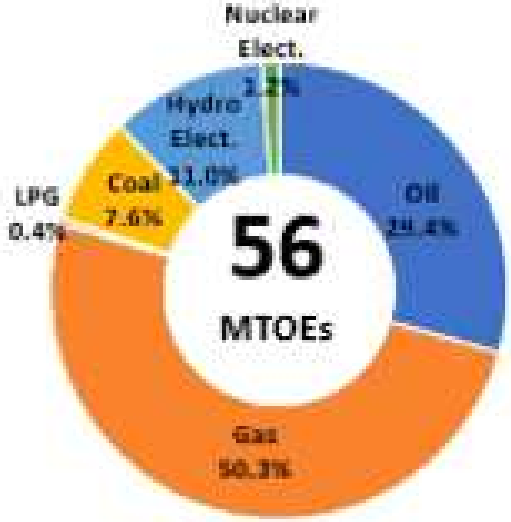
DECEMBER 17, 2022

ENERGY SUPPLIES FROM FY-2000 TO FY-2020

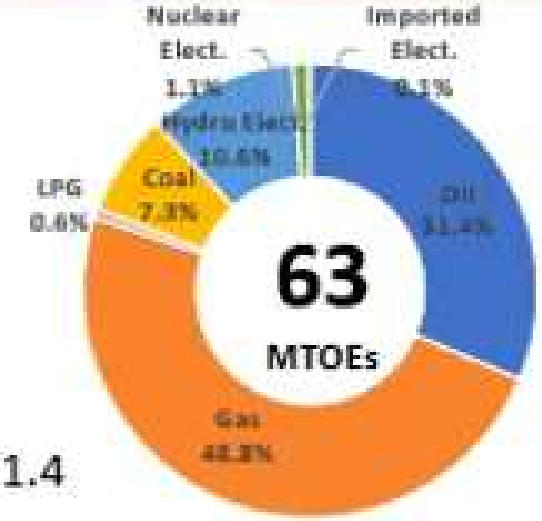
Energy



FY – 2000

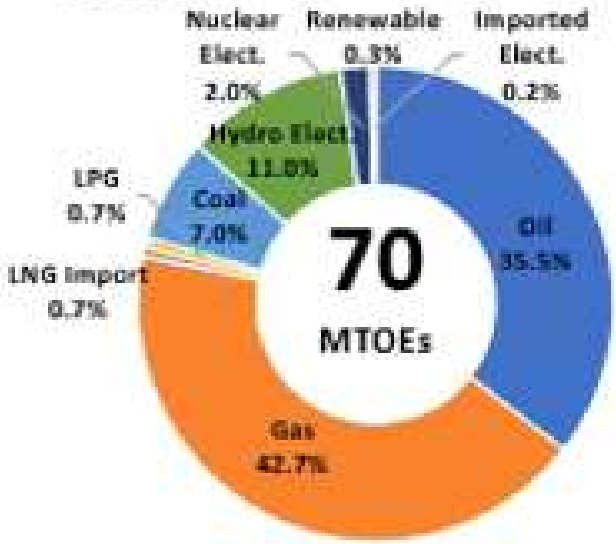


FY – 2005

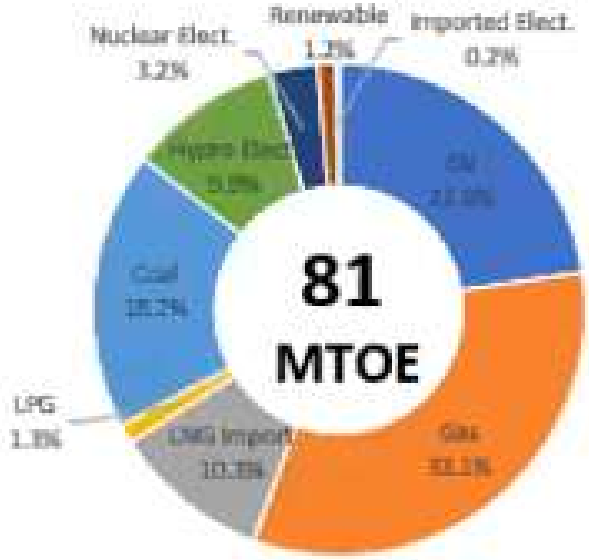


LNG 11.4

FY – 2010

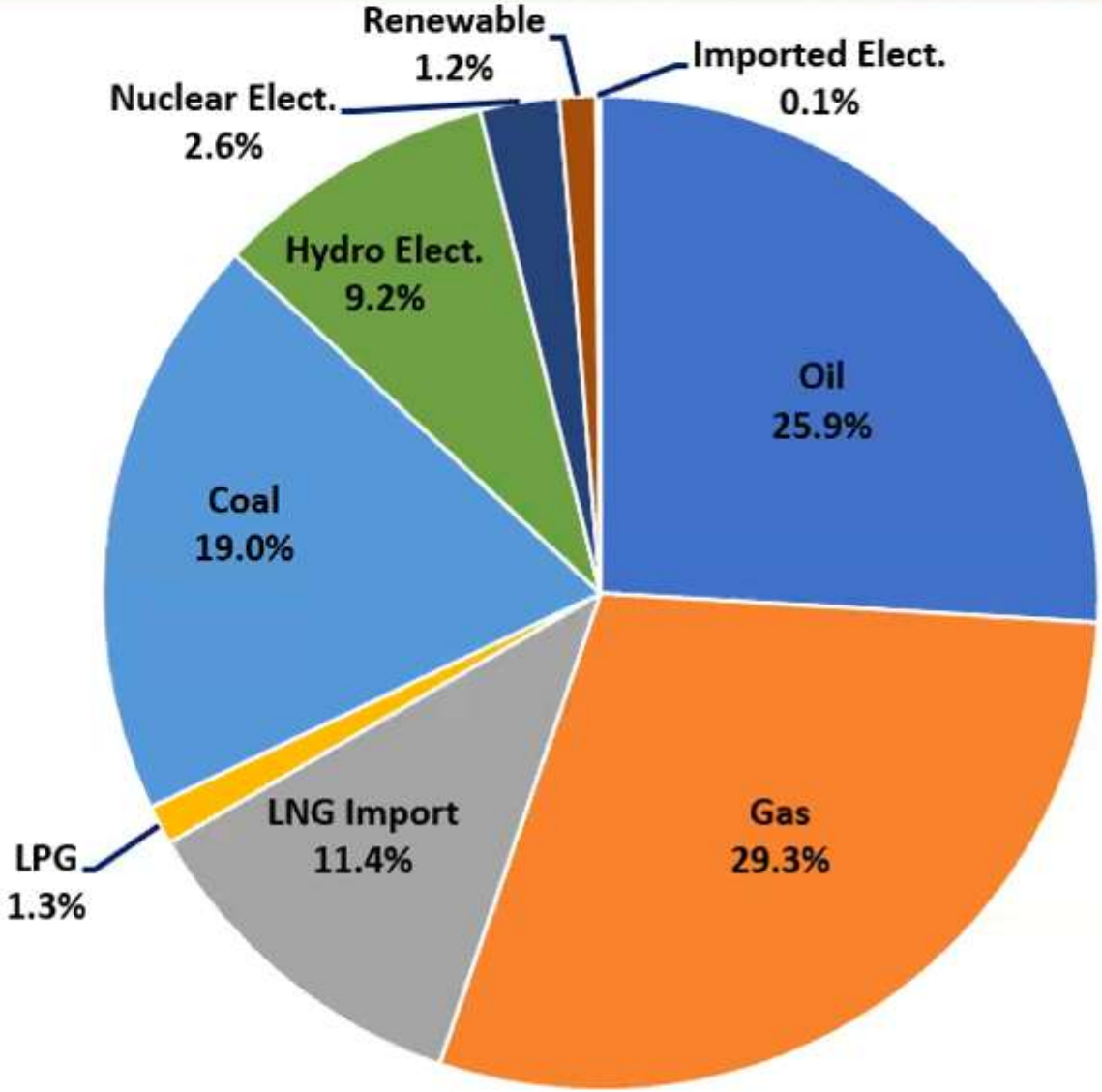


FY - 2025



FY – 2020

Pakistan's Primary Energy Supply Mix FY-2021
Total: 87 Million TOEs



Oil & Gas: 68%

Indigenous Supply: 45%

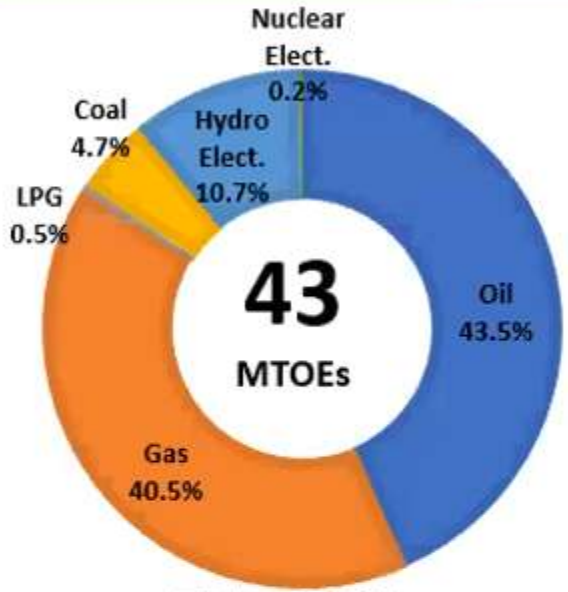
Import Supply:55%

Biggest Challenge

How to reduce Import of Energy

ENERGY SUPPLIES FROM FY-2000 TO FY-2020

Energy



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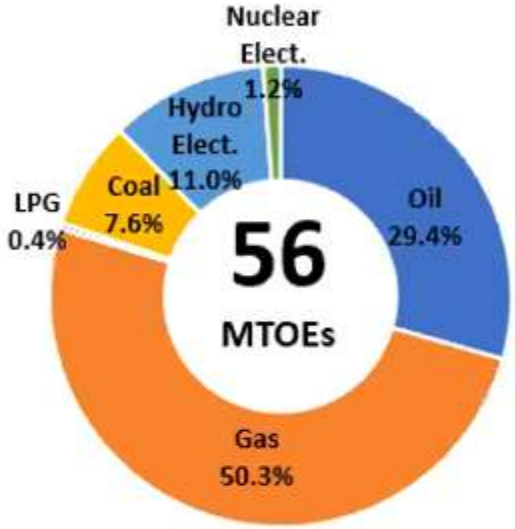

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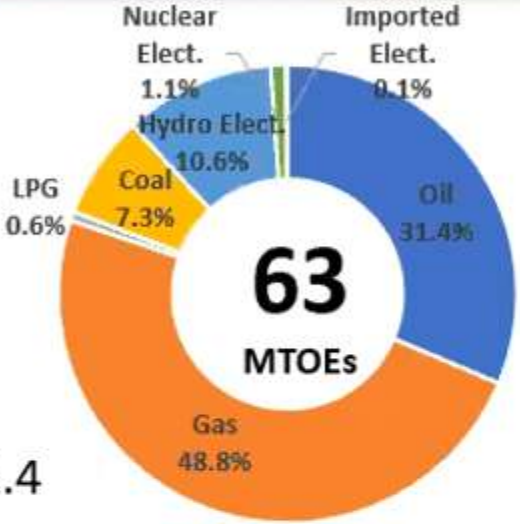

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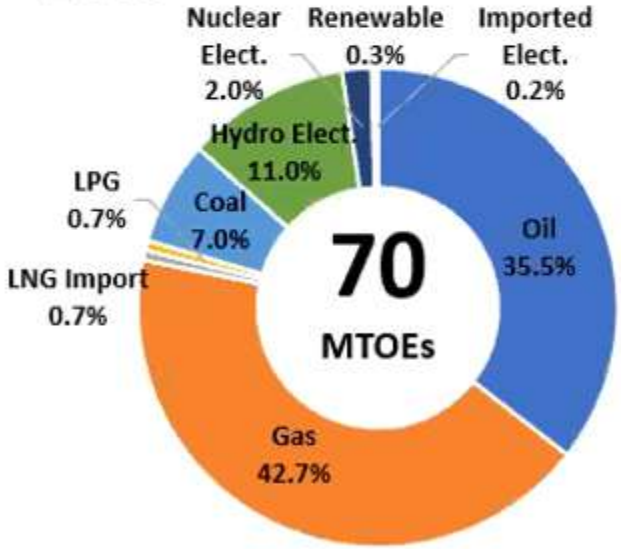

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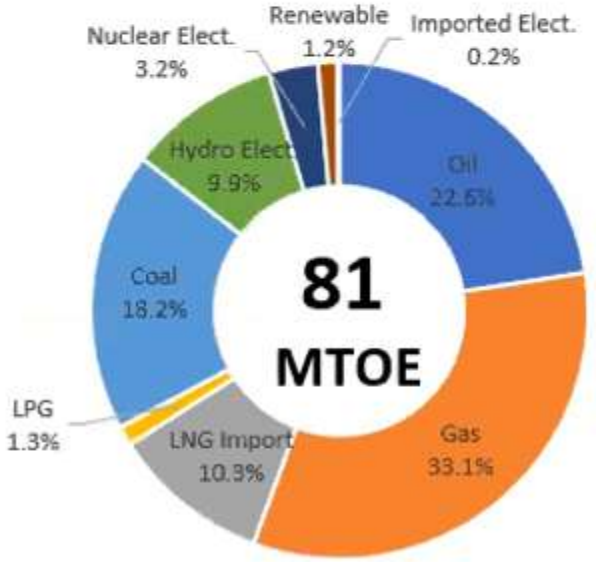
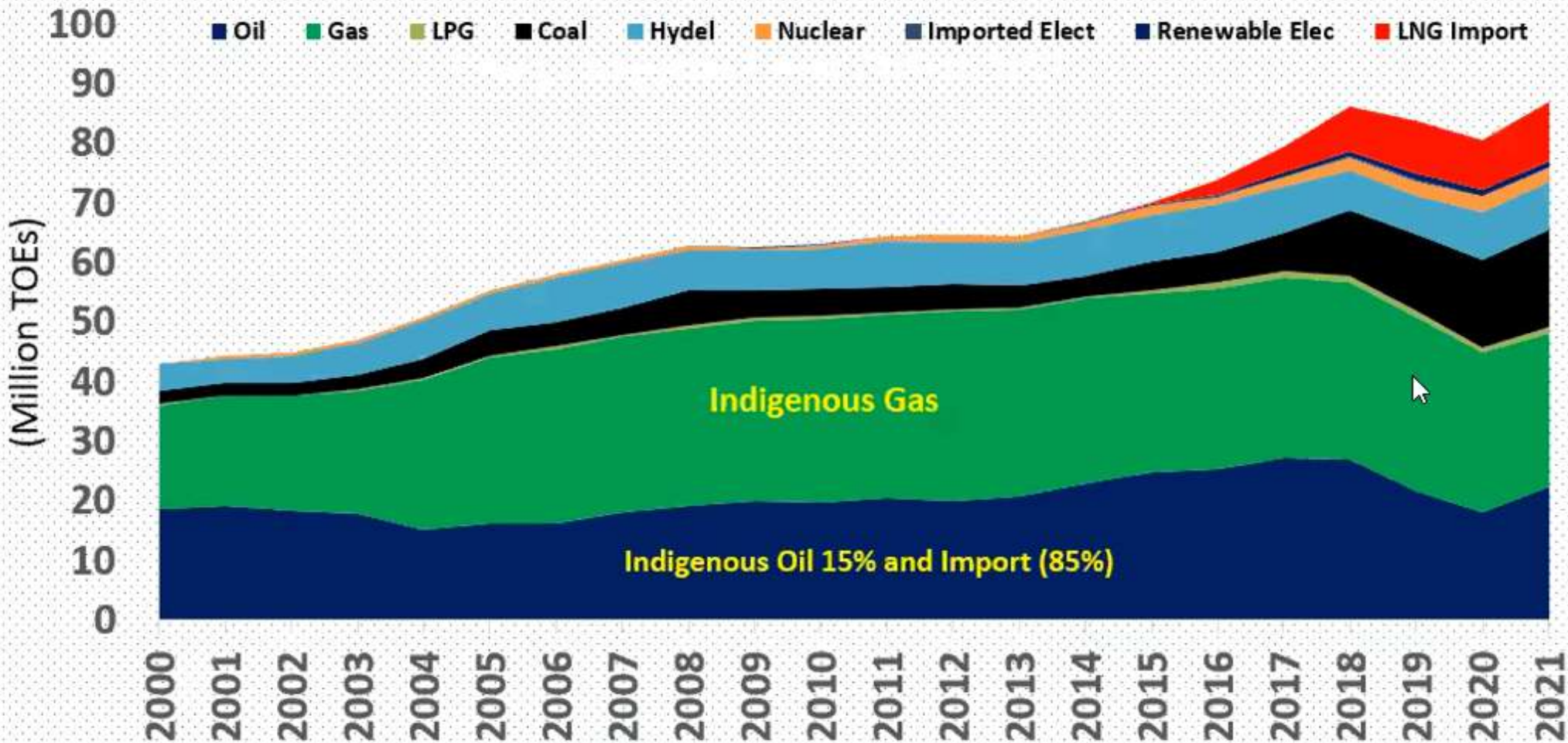
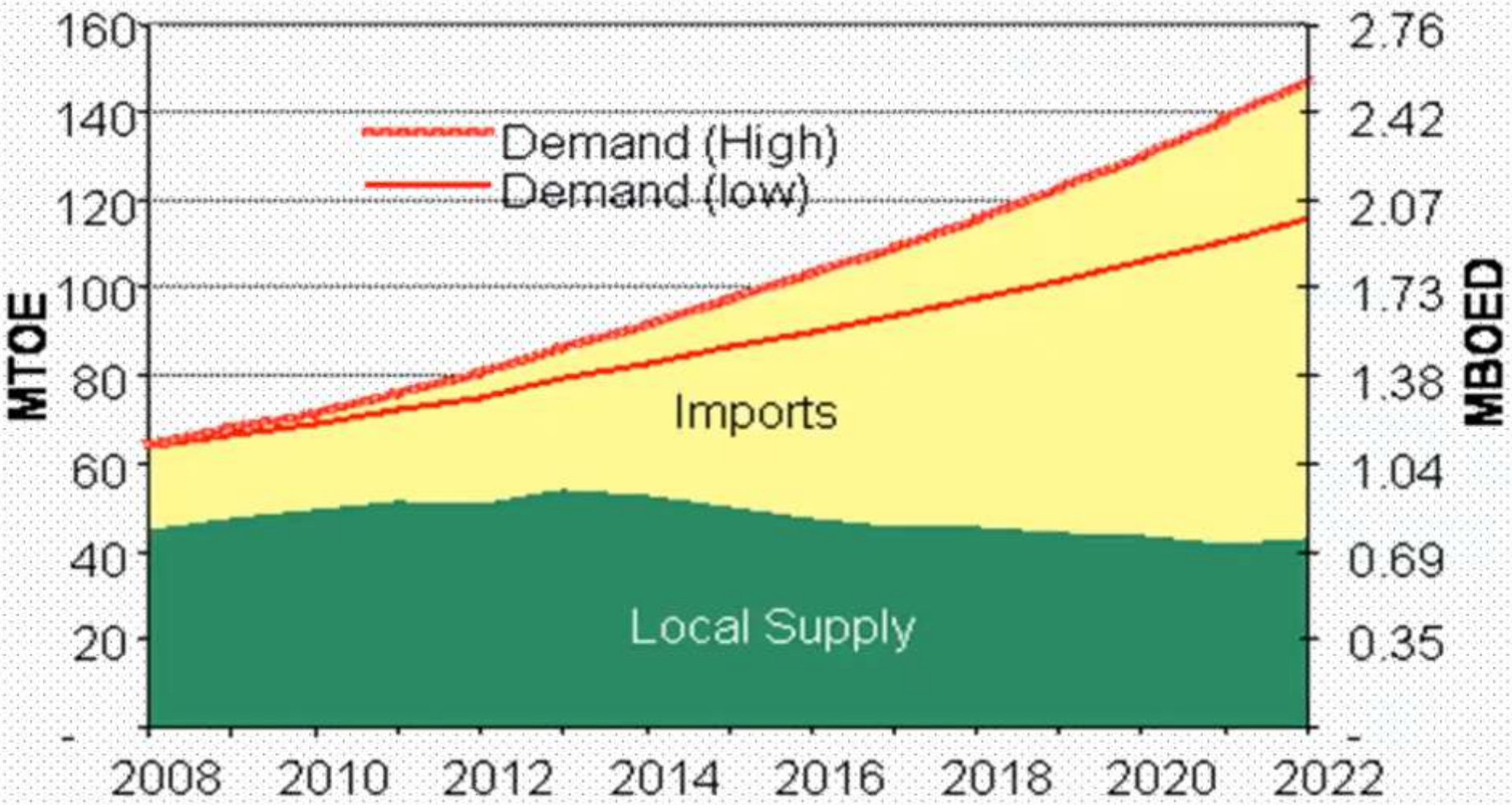


FY – 2020

ENERGY SUPPLY OVER THE YEARS



ENERGY OUTLOOK



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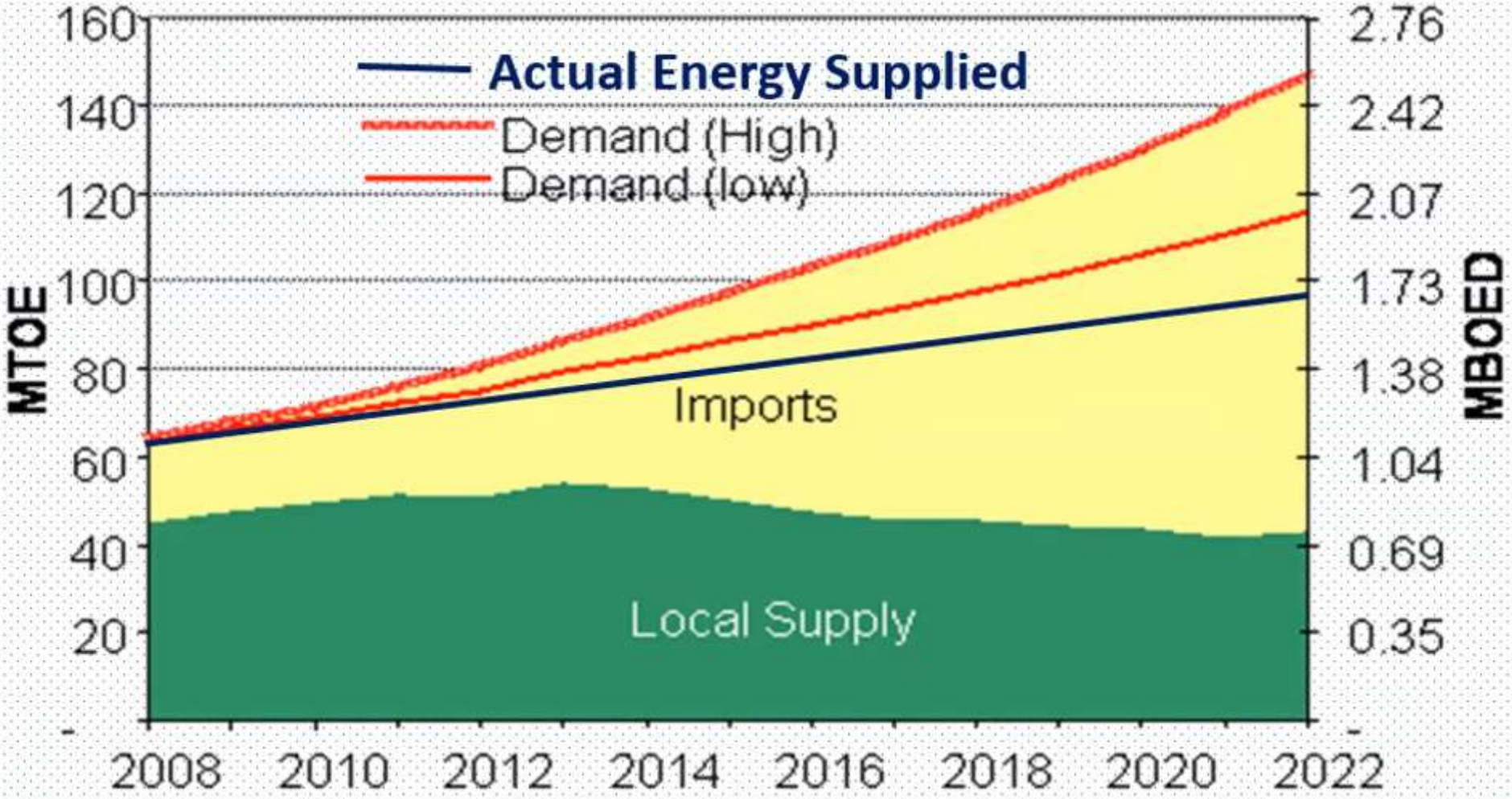

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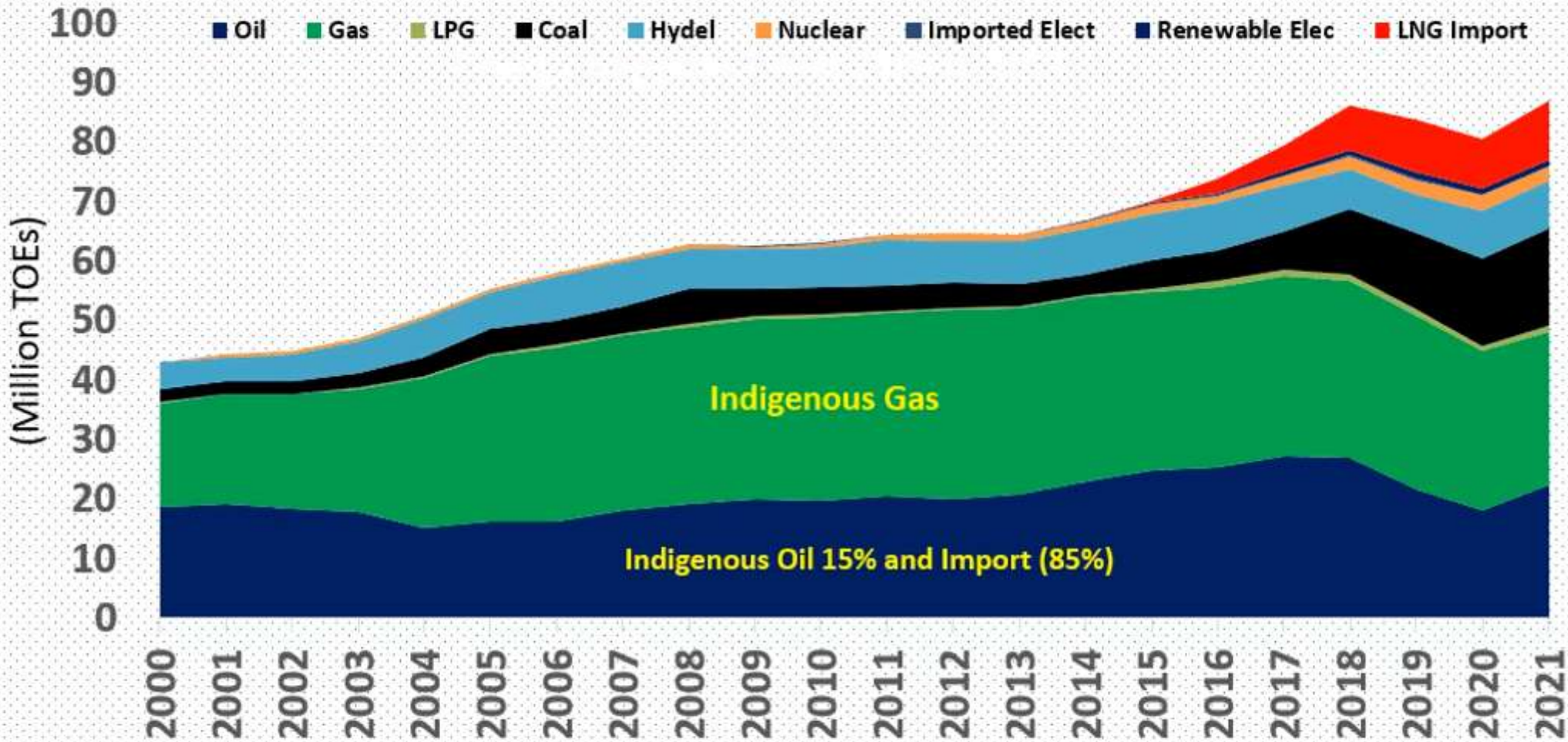

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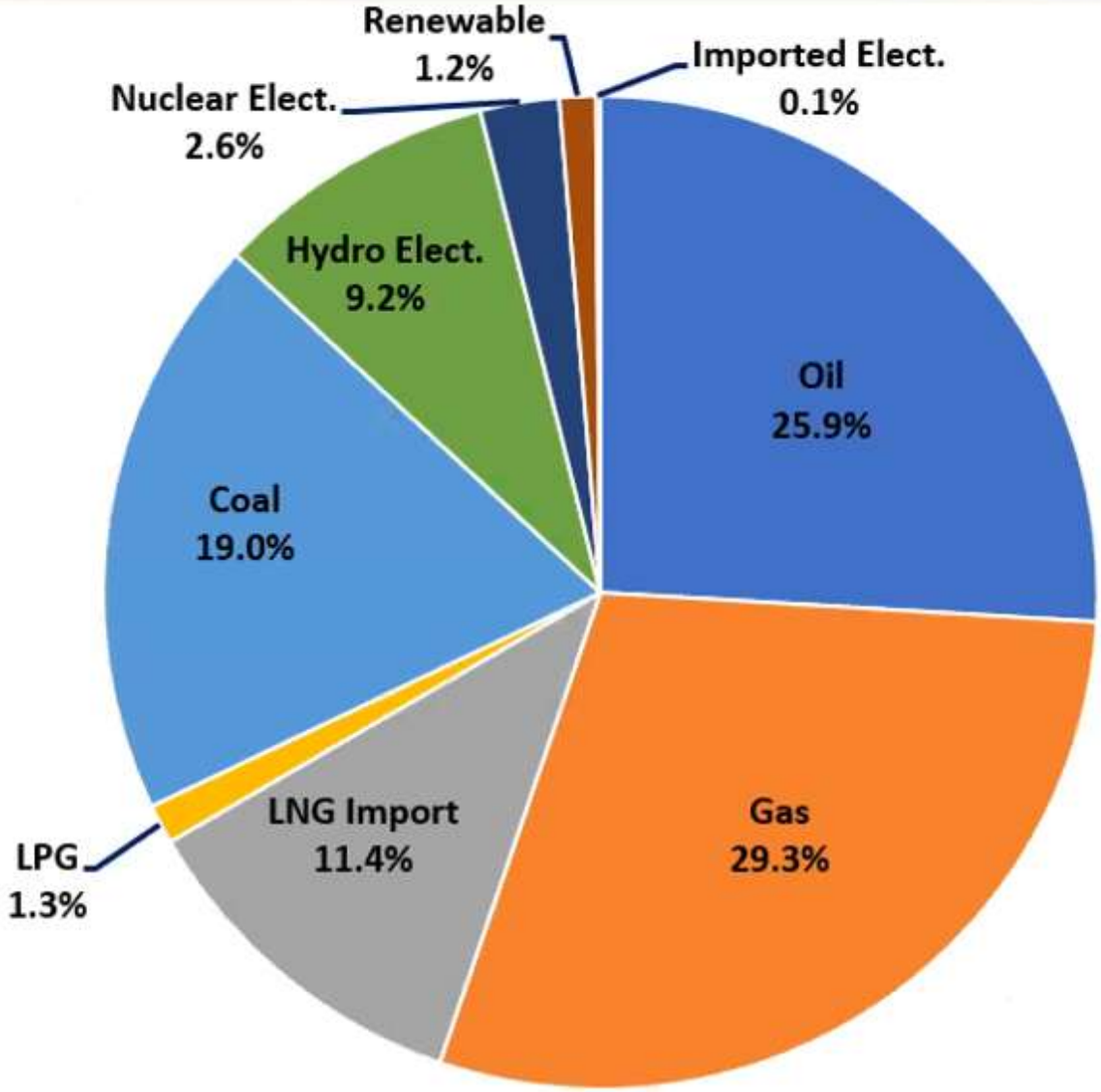

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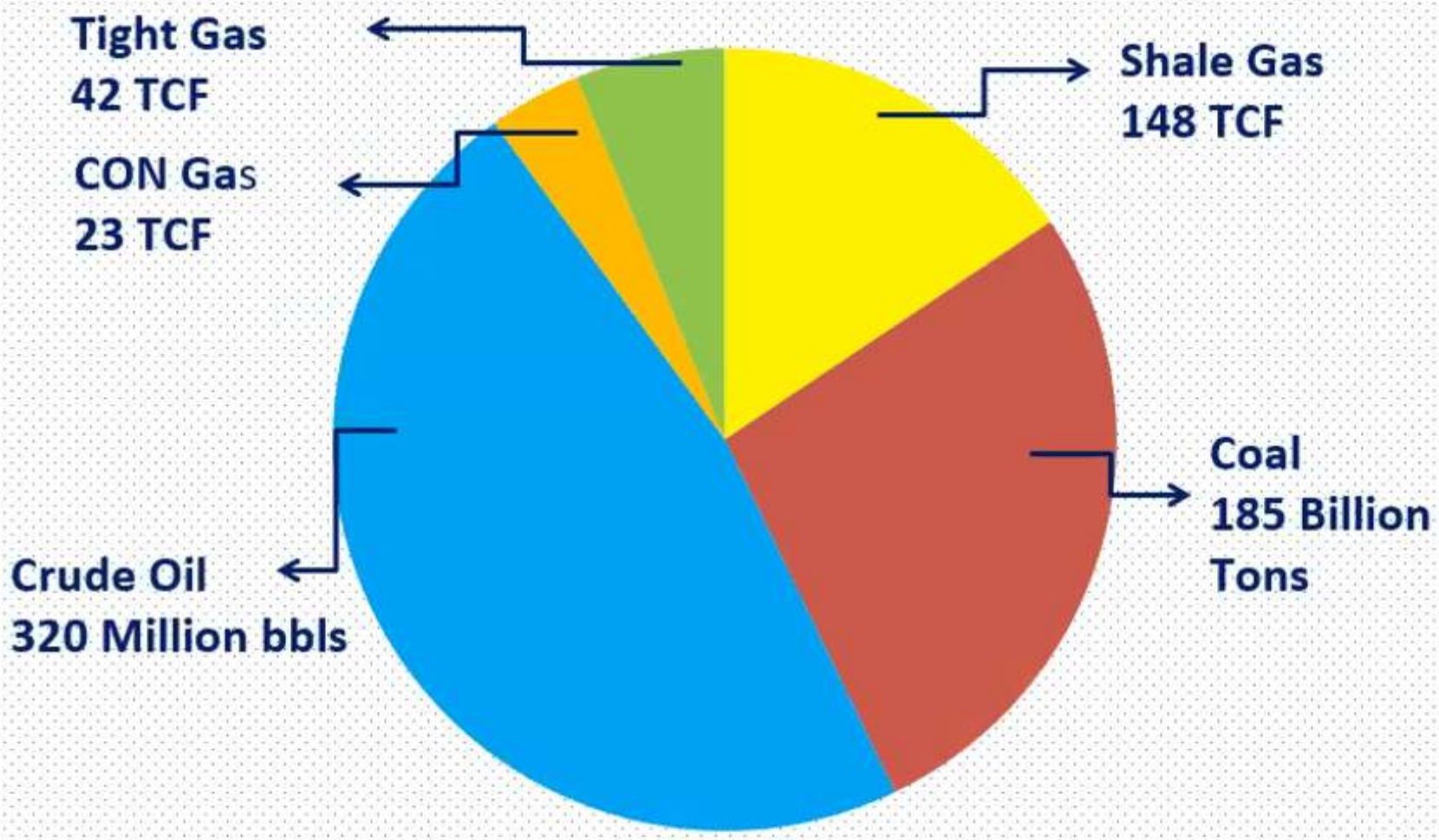
Biggest Challenge

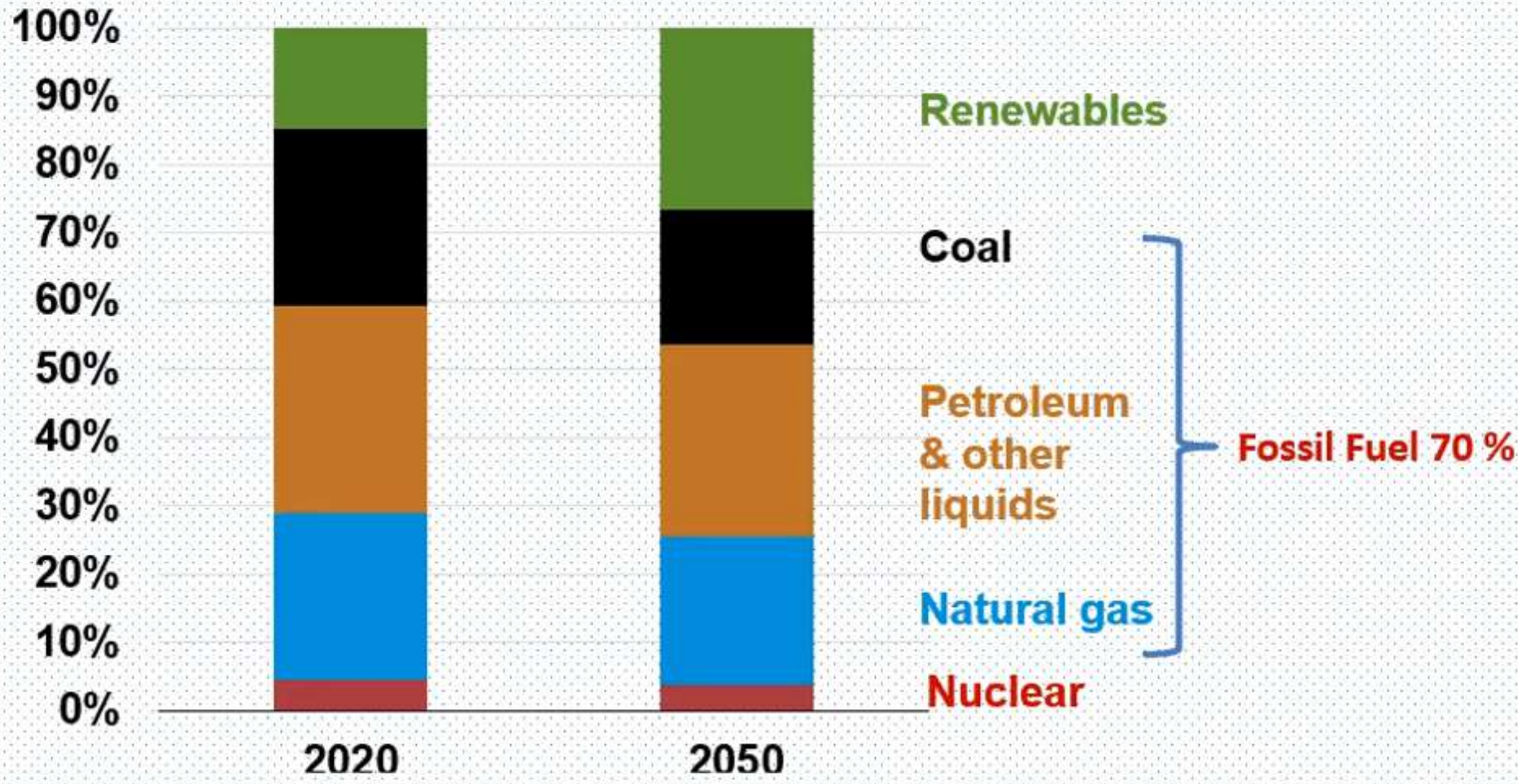
How to reduce Import of Energy

INDIGENOUS HYDROCARBONS RESERVES



Shale Oil 25 Billion bbl

WORLD ENERGY SUPPLY BY SOURCE (EIA 2021)



CONVENTIONAL OIL & GASRESOURCE POTENTIAL YET TO FIND

- **Total Gas Resources 66,265.00 BCF**
- **Total Oil Resources 3,585.00 MMbbl**
- **Indus and Baluchistan Basins (Pakistan Basin Study, 2009).**
- **GOP Announce Bidding Round to Invite National & Multiple National Companies For the Award of Exploration Blocks**

CURRENT STATUS OF INDIGNEOUS ENERGY RESOURCES

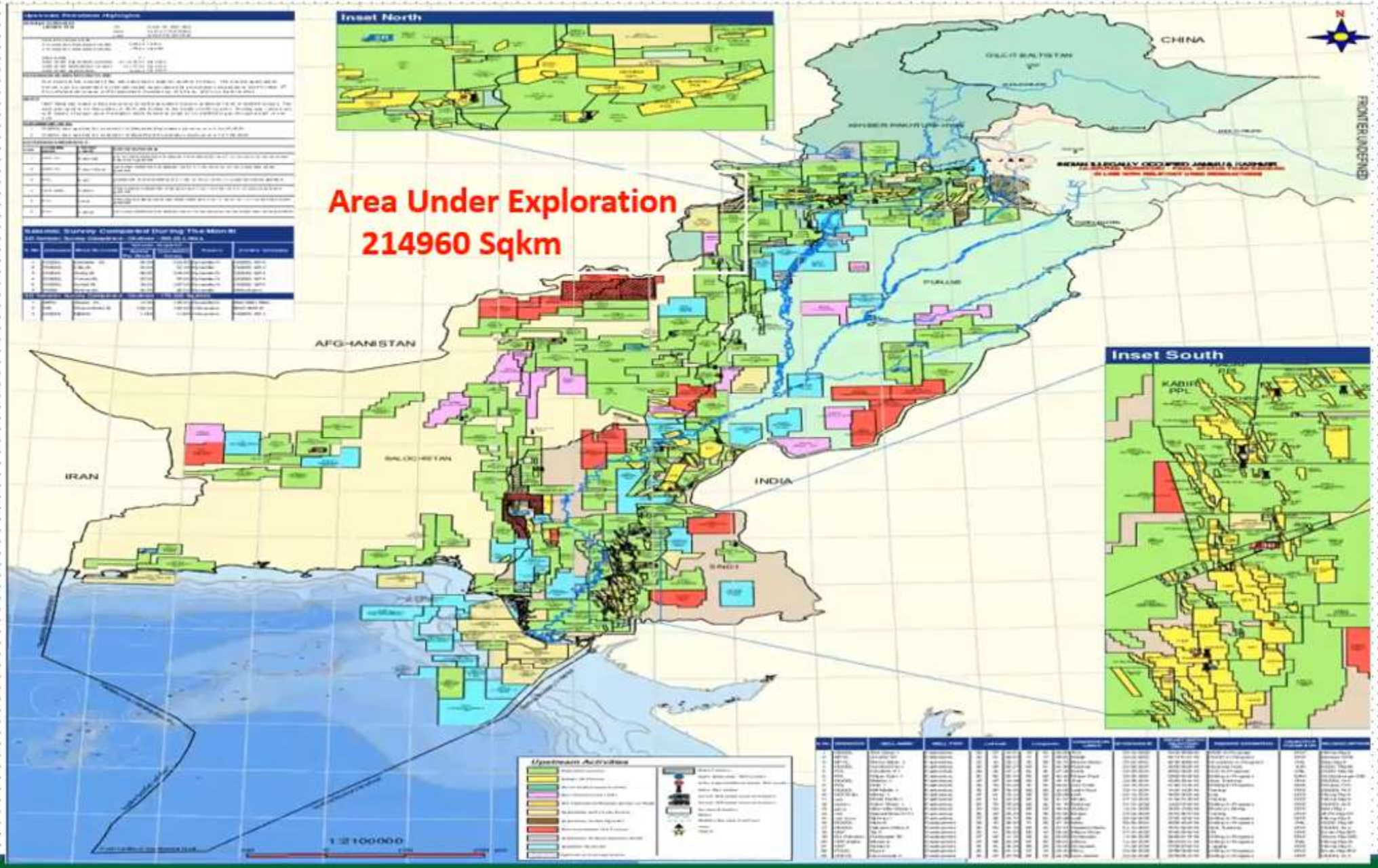
1. EXPLORAION OF OIL & GAS (CONVENTIONAL RESOURCES) SINCE 1866
    a) Exploration Activities in all four Provinces
    b) More than 2700 wells have been drilled
    c) 50 To 100 wells are being drilled every year
    d) Different Petroleum Policies Exist Since 1994.

UNCONVENTIONAL RESOURCES

1. TIGHT GAS ---- Policy Exist, Being Produced In Small Quantity
2. SHALE GAS ---- No Policy Exist, No Exploitation Yet
3. COAL
    I. COAL BED METHAN
    II. COAL TO LIQUID & GAS
    III. GEOTHERMAL ENERGY

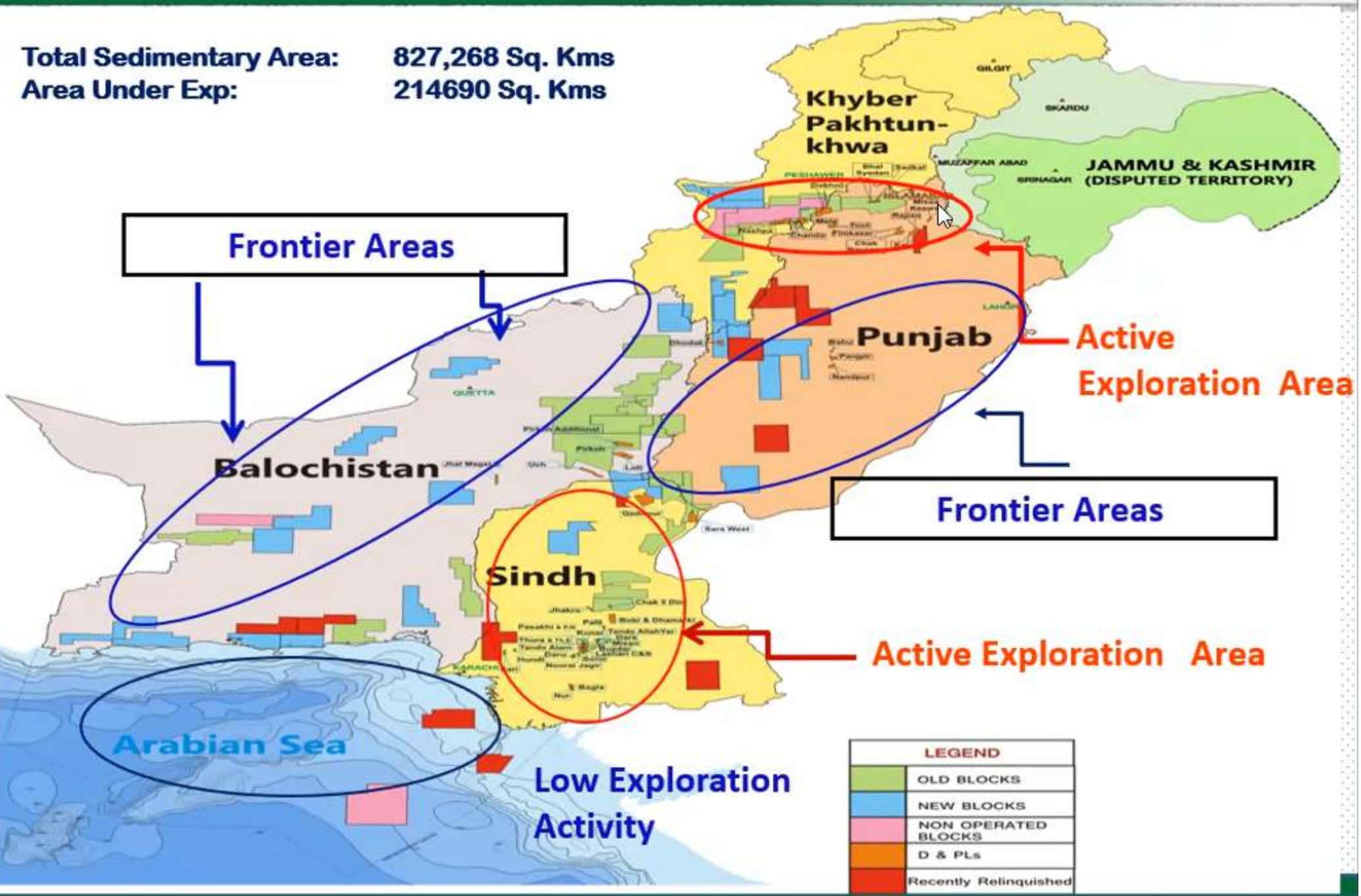
} NO WORK STARTED YET

EXPLORATION ACTIVITIES



EXISTING EXPLORATION FOR CONVENTIONAL OIL &GAS

Total Sedimentary Area: 827,268 Sq. Kms
Area Under Exp: 214690 Sq. Kms



CURRENT STATUS OF INDIGNEOUS / IMPORT ENERGY SUPPLY

	PRODUCTION	DEMAND/CONSUMED
OIL	70,000 BBL/D	435000 BBL/D
GAS	3,508 BCF/D	4 - 6 BCF/D
LPG	2032 M TON/D	4600 M.TONE/D
COAL LOCAL	9.3 Million TON/YEAR	
COAL IMPORT	18.85 Million TON/YEAR	
LNG IMPORT	222 BCF/YEAR 2020 -21	

UNCONVENTIONAL Reservoirs

Tight Reservoirs

- Sand Stone or Carbonate Reservoir with good Storage Capacity and fine to coarse Sediments
- Permeability ≤ 1 MD
- Not Source Rock
- Better chance of fracking
- Less Chance of Packing
- Better Productivity

Shale Reservoirs

- Sedimentary Rock with good storage capacity and very fine Sediments
- Permeability ≤ Nano darcy
- Source Rock & Reservoir
- Very Difficult to Frack
- More Chances of Packing
- Less Productivity
- Minerology Plays Important Role
- Radius of Drainage is very limited

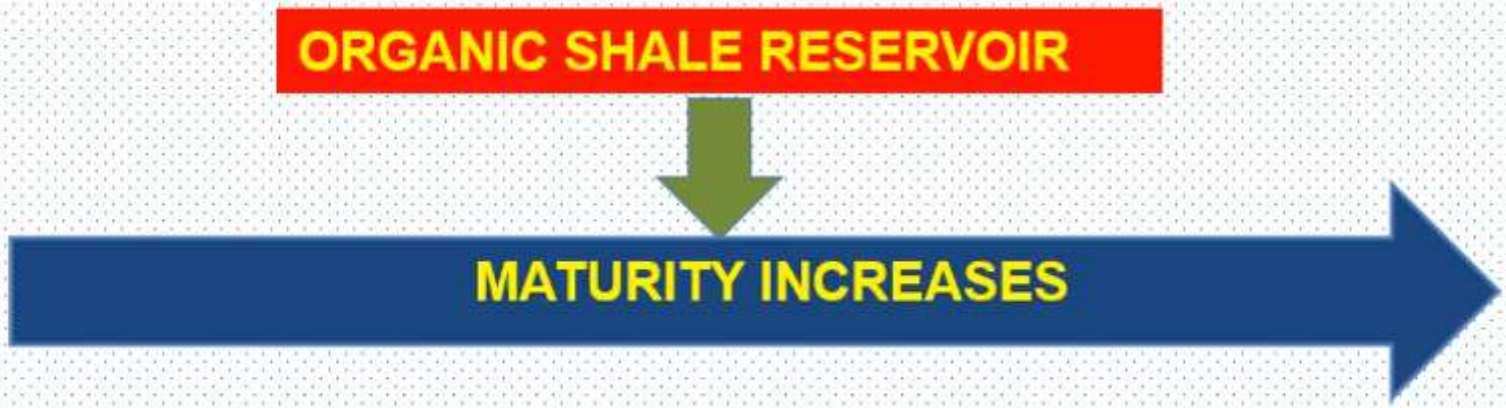
TRANSITION IN RESERVOIR CHARACTERISTICS

Conventional Gas
MilliDarcy range (>1mD)
Variable Fluid Type

Tight Gas
MilliDarcy to Micro Darcy range (<1mD)
Dry Gas – Wet Gas

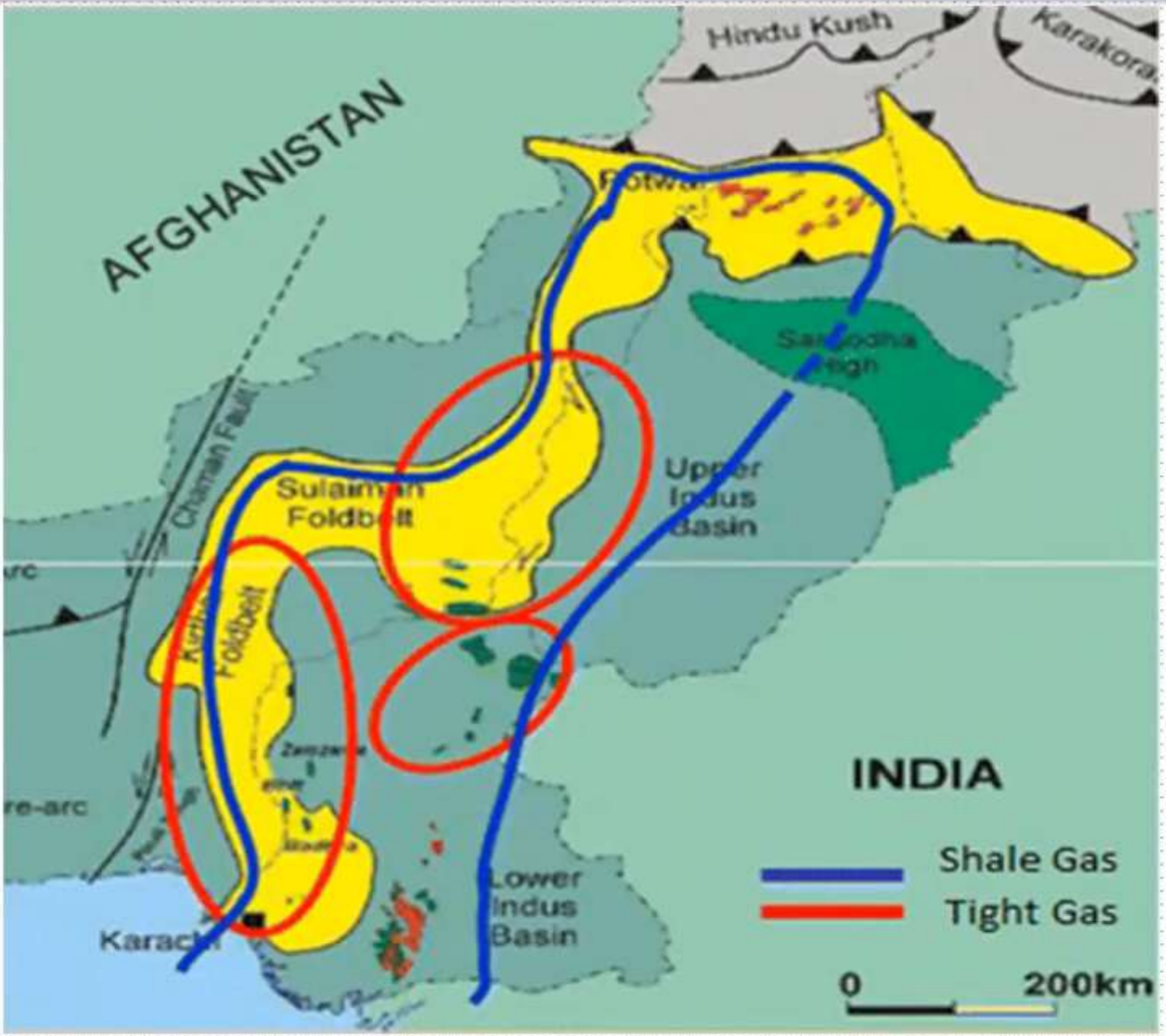
Shale Gas
Milli – Micro - Nano Darcy range
Dry Gas - Wet Gas
Major Free Gas – Minor Adsorbed Gas

EFFECTIVE SHALE RESERVOIR



LOW	MODERATE	HIGH
TOC < 1%	TOC = 1 - 2.5%	TOC > 2.5%
Phi < 2%	Phi = 2 - 6%	Phi > 6%
Clay > 50%	Clay = 50 - 30%	Clay < 30%
Sw > 65%	Sw = 65 - 40%	Sw < 40%

UNCONVENTIONAL RESERVOIRS DISTRIBUTUION IN PAKISTAN



POTENTIAL GEOLOGICAL SHALE HORIZONS IN PAKISTAN

➢ **Ghazij Formation** **Vastly Distributed-**	**Thickness (meters)** **100 -1200**	**Prospect**
➢ **Thalhar Shale** **Vastly Distributed –**	**45 – 100**	**Proven Potential**
Shale's of Massive Sand **Moderately Distributed –**	**10 – 60**	**Prospect**
➢ **Samber Formation** **Vastly Distributed –**	**500- 600**	**Proven Potential**
➢ **Chichali Formation** **Vastly Distributed –**	**35 – 130**	**Prospect**

PAKISTAN SHALE GAS RESOURCES

- GIP (TCF) Sembar, Ranikot, L .Goru, Ghazij 3721
- Risked GIP (TCF) 1095
- Risked Tech, Recoverable Gas (TCF) 148
- Risked OIP MM (bbl) 370
- Risked Technically Recoverable Resources MM (Bbl) 25.7

PAKISTAN SHALE GAS POTENTIAL
VS
USA SHALE GAS POTENTIAL

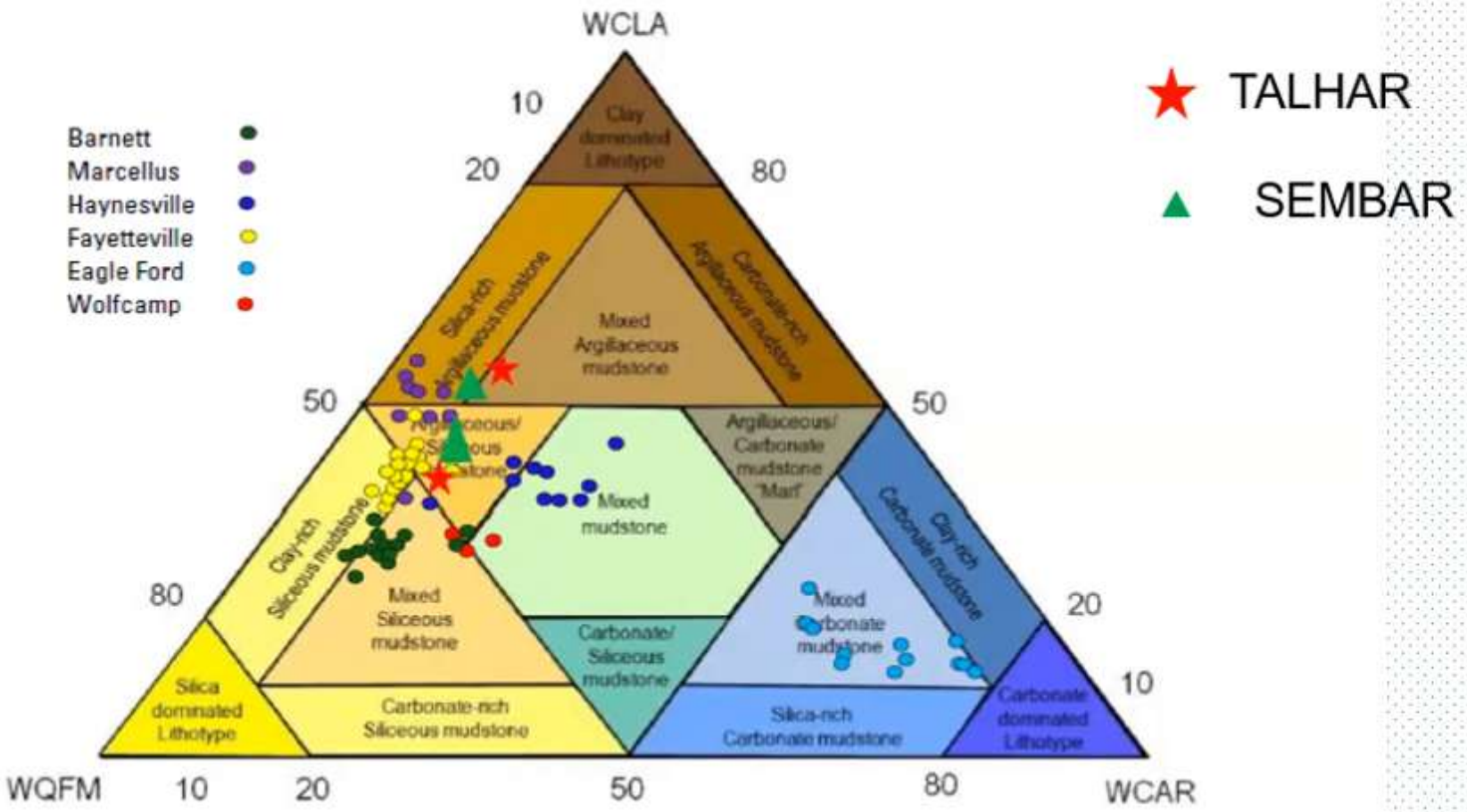
Canister Gas Content Ranking Guidelines	
▪ Poor	< 50 Scf/ton
▪ Moderate	50 - 100 Scf/ton
▪ Good	100 – 150 Scf/ton
▪ Excellent	> 150 Scf/ton

USA
- Barnett
- Marcellus

Pakistan
- Talhar
- Sembar

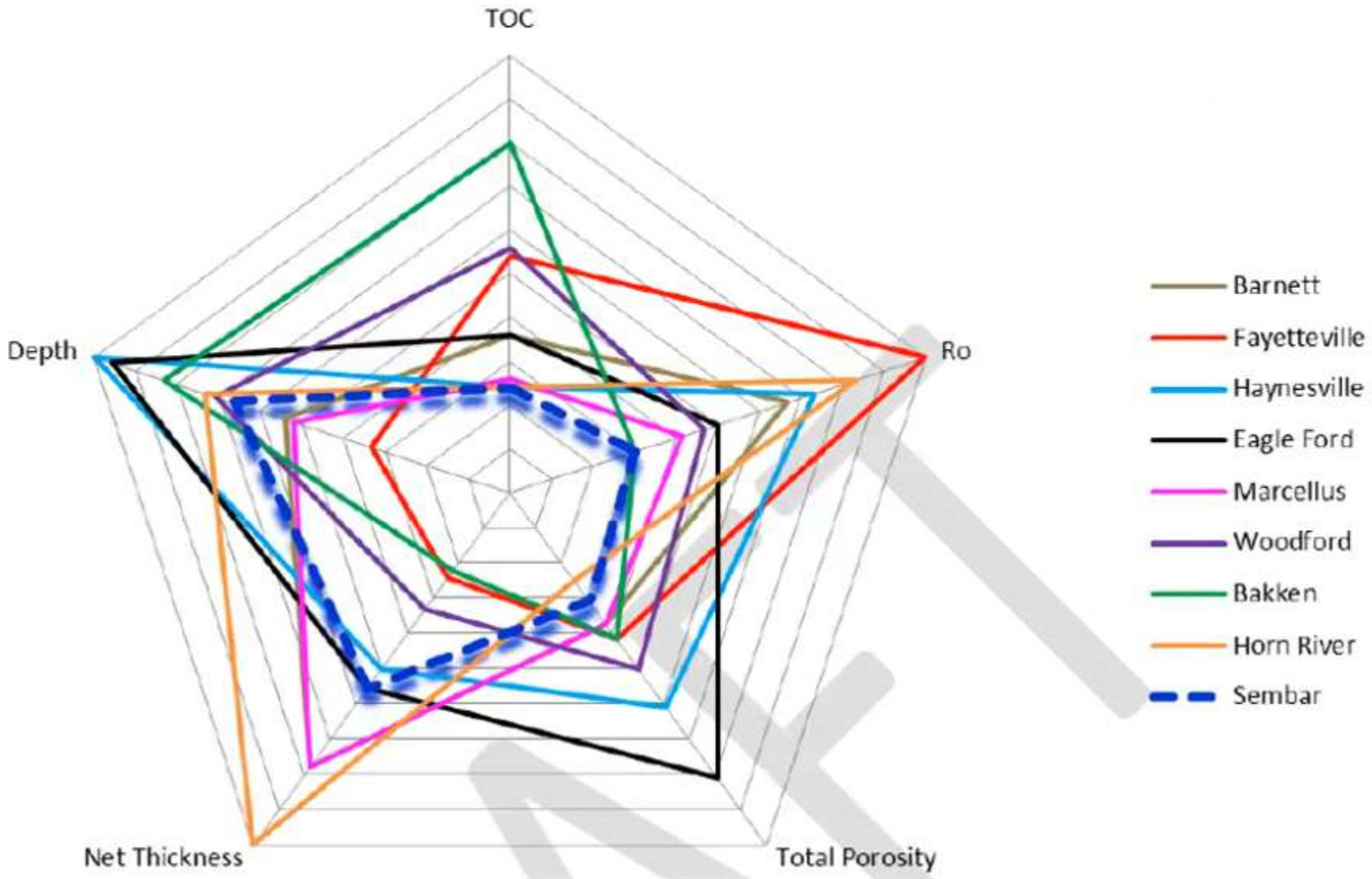
Parameter	Units	Min	Ave	Max
Gas Content	scf/ton	12.60	79.40	226.90
Gas Content	scf/ton	34.60	101.96	328.00
Gas Content	scf/ton	49.20	71.00	68.50
Gas Content	scf/ton	121.00	126.30	134.70

Pakistan Shale Gas Reservoir
VS
USA Shale Gas Reservoir



Comparison of different U.S. shale plays.

PAKISTAN SHALE GAS POTENTIAL WITH US SHALE



CHALANGES IN DEVELOPMENT OF SHALE GAS

- **Low Permeability Nature.**

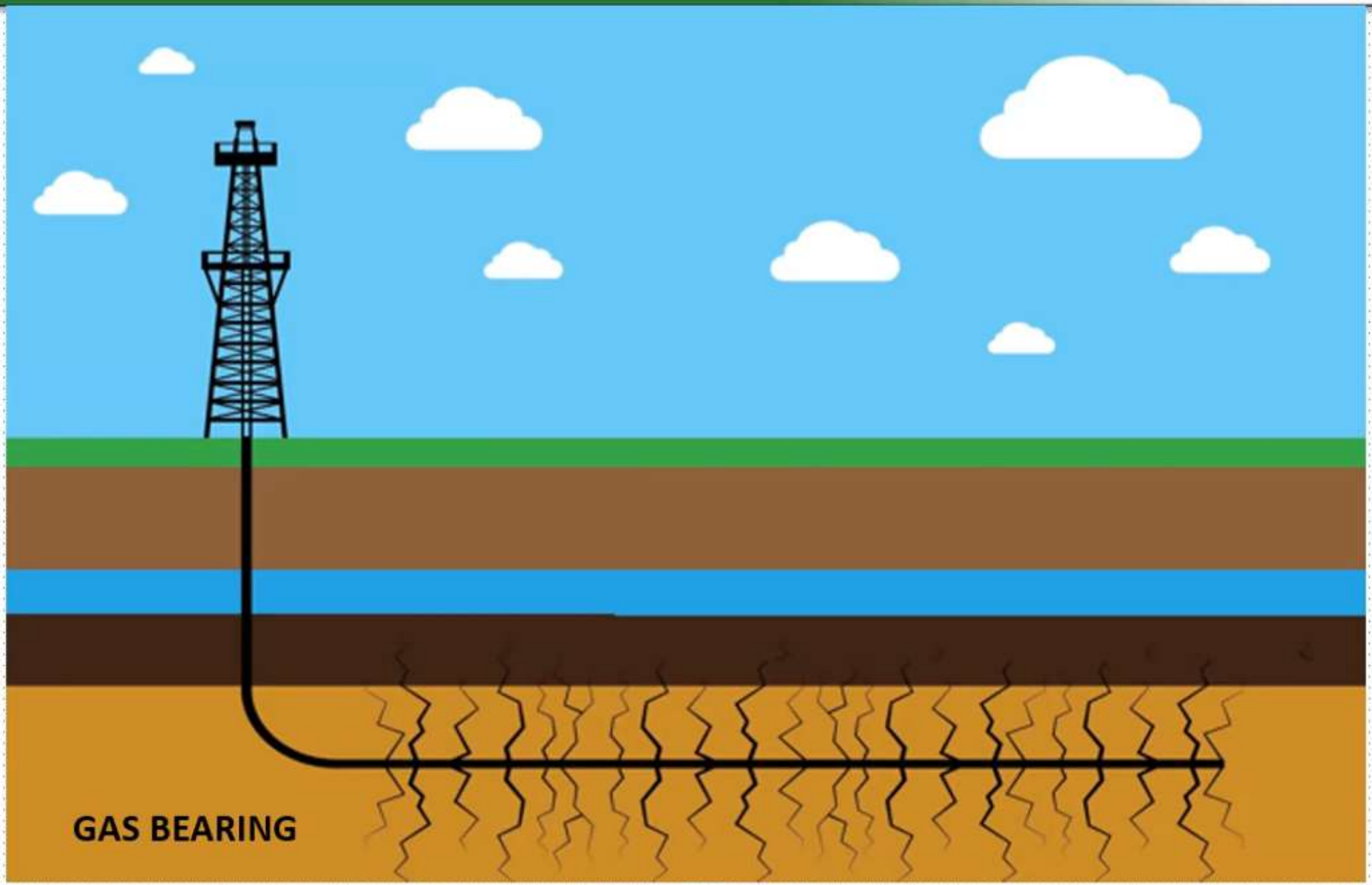
  The process of gas release and production from shale reservoirs is controlled by the combination of fractures and nano-pore network connected to micrometer pore network.

- **Very Capital Intensive-** Need Hundreds of wells

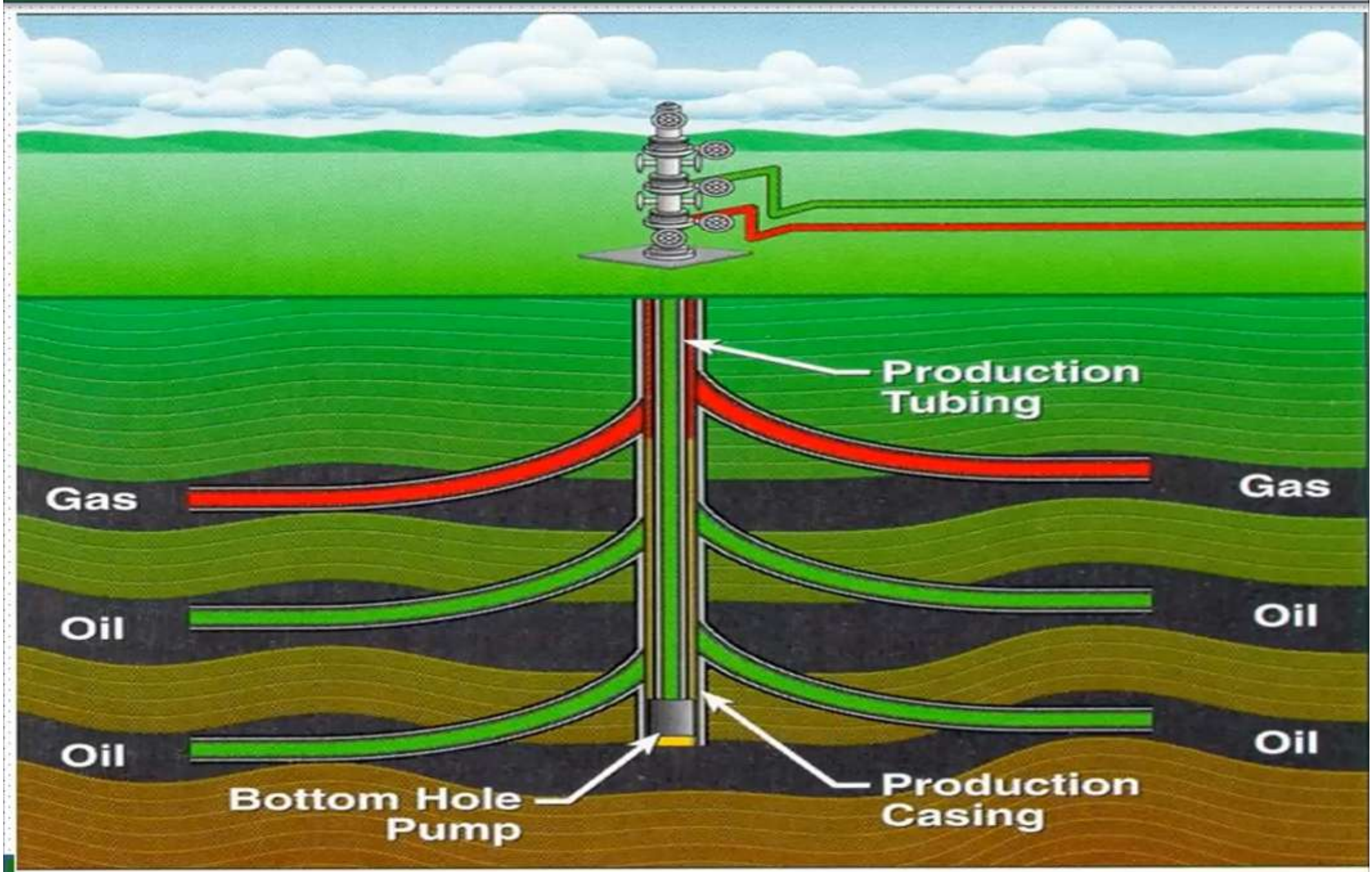
  Each Well Cost US $15 to 30 Million

- **Horizontal Well-** Drilling wells in horizontal Direction
- **Multilateral well-** Multiple well branches from Single hole
- **Hydraulic fracturing-** is the creation of network of multiple condute or fracture by introducing liquid with high pressure in the Geological rock formation

HORIZONTAL WELL WITH HYDRAULIC FRACTURE



MULTILATERAL WELLS IN DIFFERENT HORIZON



PRODUCTION CHALLANGES

- CAPITAL INTENSIVE
- LOW PRODUCTIVITY
- RAPID DEPLETION IN FIRST TWO YEAR
- LOW RATE PRODUCTION FOR LONG TIME
- CONTINUE BACK TO BAK DRILLING
- 100 TO 200 WELLS/YEAR –ABOUT 2-3 BILLION DOLLARS
- LOGISTICS ARRANAGEMENT
- PACKING OF FRACTURES
- PERIODIC STIMULATION

WAYFORWARD

- Excellent Extent of Shale Resources exist in the country.
- Shale Gas Reservoirs are Comparable with US Shale
- Need to Enhance Exploration Activities for Shale Gas
- Shale Gas Productivity Need to be Proved
- New Block May also be awarded on the basis of Shale Gas horizons
- Need to un-tap un conventional Reservoir by Consortium of the Companies
- Creation of Skilled Manpower- for un conventional Resources
- Need to Change Energy Mix to More on Renewable

WAYFORWARD

- Technology exist and can be applied in exploitation of un conventional resources
- Cost effective Exploration & Exploitation of Shale Gas Reservoir can be achieved by Generating More Volume of Work
- Research and Development Activities in the Universities for Unconventional Reservoirs
- Policy Frame work is essentially Required for the Exploration of Shale Gas
- Energy Conservation

THANK YOU