by: *Joseph S. D'Amico PE*

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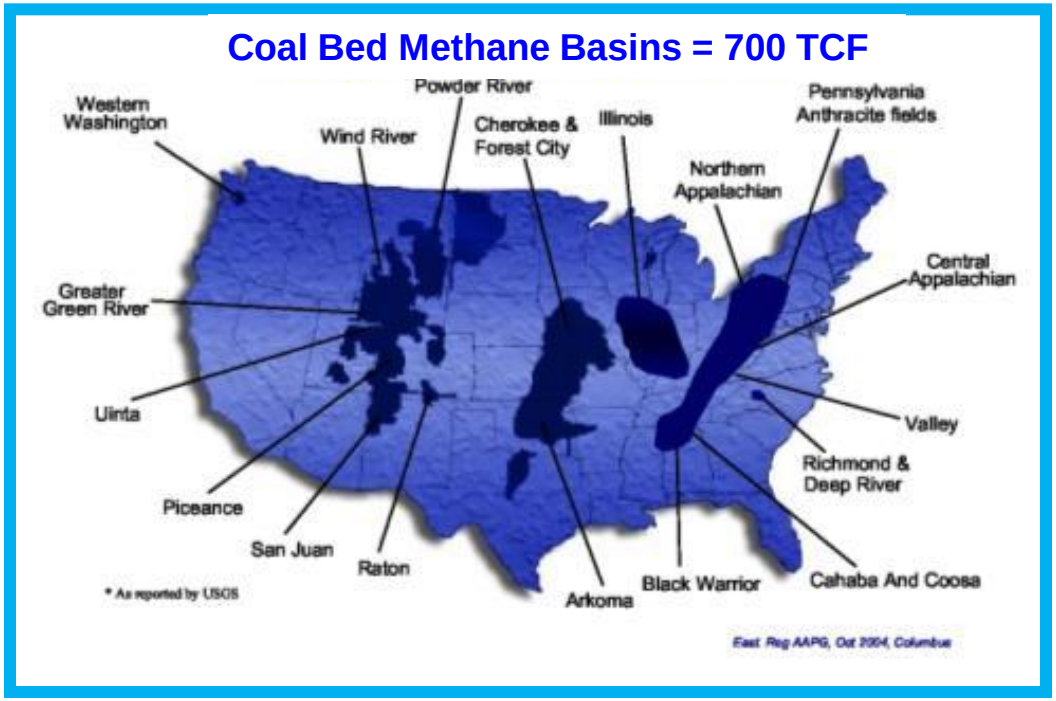
Molecular Energy by: **DTC Solutions**

CMM Recovery & Enhanced Value Utilization Amidst Low Energy Prices

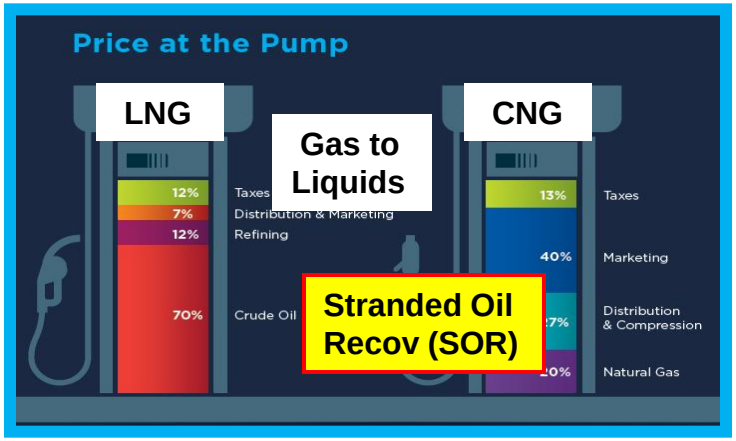


2017 International Pittsburgh Coal Conference

Sept 6, 2017

Coal Mine Methane

Enhanced Value Opport



Global Energy History of America

Molecular Energy by: DTC Solutions

Stable

Unstable

America Grows with Coal for Electricity from the 1800s to today 2017.
America Grows with Oil for Transportation, started in PA, then to TX, then to Middle East.
America Grows with Gas for Direct Use Heat & some Pwr Gen from the 1900s to 2008.
America Grows with Shale Gas for Power Gen, displacing Coal, from 2008 to today2017.

"Proven" Reserves – Coal – Oil – Gas (2016)

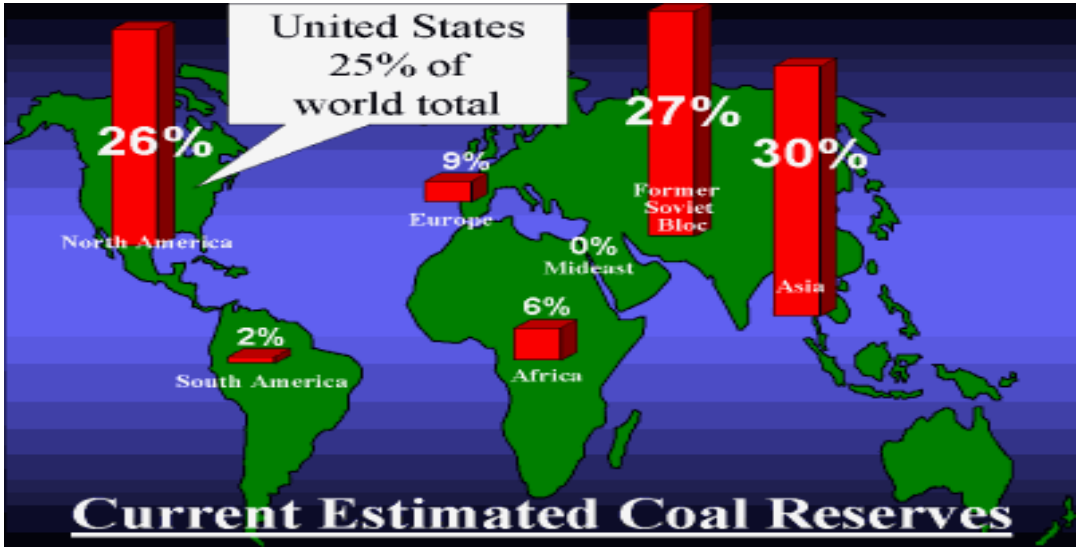
Molecular Energy by: DTC Solutions

PROVEN COAL RESERVES

TOP TEN COUNTRIES

	Million tonnes
UNITED STATES	237,295
RUSSIA	157,010
CHINA	114,500
AUSTRALIA	76,400
INDIA	60,600
GERMANY	40,548
UKRAINE	33,873
KAZAKHSTAN	33,600
SOUTH AFRICA	30,156
INDONESIA	28,017
OTHER	79,532

Source: BP Statistical review of world energy 2016



WORLD PROVEN CRUDE OIL RESERVES BY REGION

MIDDLE EAST: 48.3%	802,848,000,000 BARRELS	
L. AMERICA: 20.6%	342,757,000,000	
N. AMERICA: 12.5%	208,585,000,000	
AFRICA: 7.7%	128,049,000,000	
E. EUROPE: 7.2%	119,860,000,000	
ASIA PACIFIC: 2.9%	48,597,000,000	
W. EUROPE: 0.6%	10,064,000,000	

MIDDLE EAST COUNTRIES

*SAUDI ARABIA	16.04%
*IRAQ	8.58%
*KUWAIT	8.11%
*IRAN	9.54%
*UAE	5.89%
*QUATAR	1.52%
OMAN	0.39%
SYRIA	0.10%
OTHERS	0.19%
*OPEC MEMBERS	

OPEC MEMBERS' SHARE

REGION'S TOTAL RESERVES

Source: OPEC Annual bulletin 2016, and BP stat review 2016.

PROVEN NATURAL GAS RESERVES

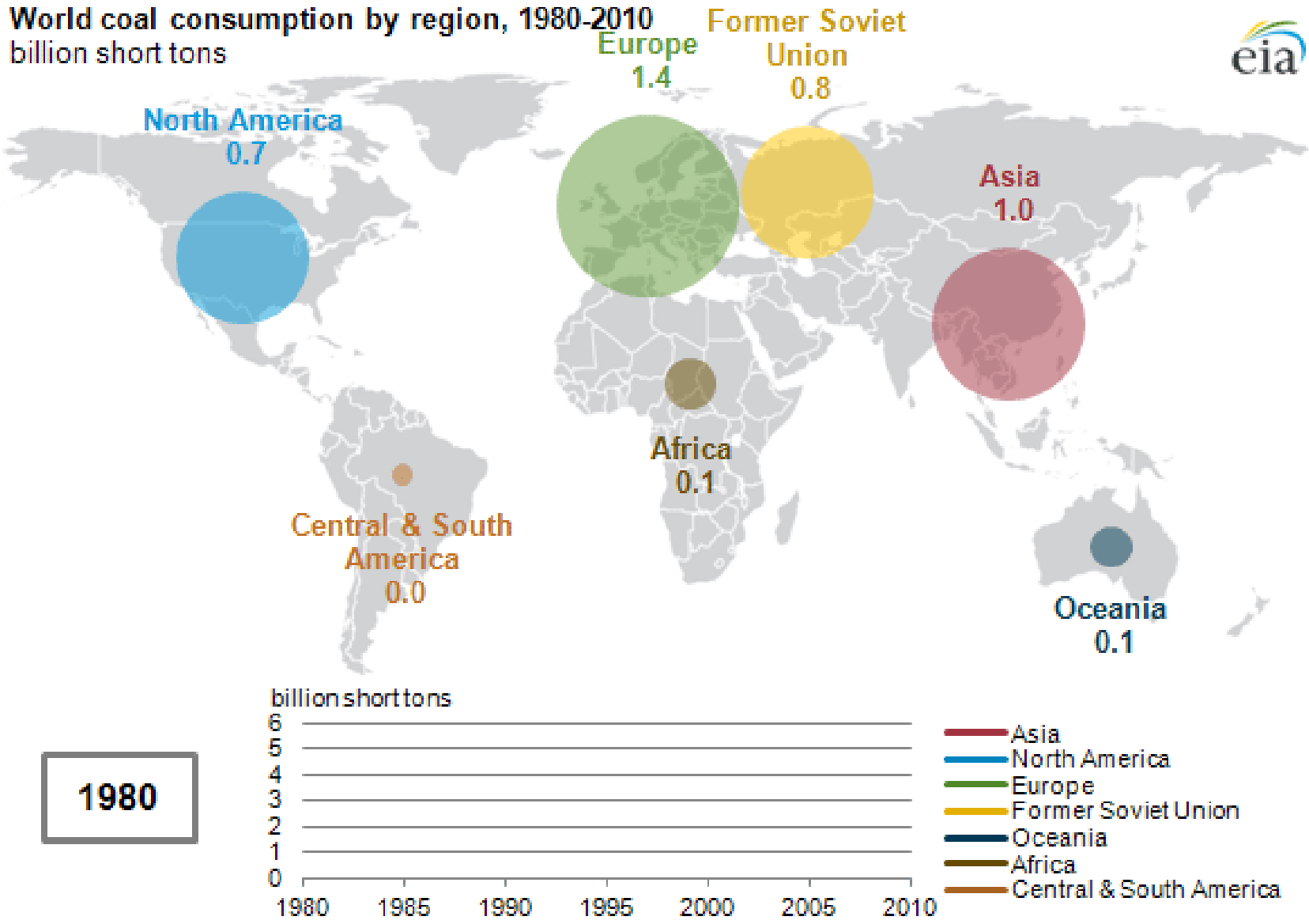
TOP TEN COUNTRIES

	Billion Cubic Meters
RUSSIA	49,541.0
IRAN, I.R.	33,500.0
QATAR	24,299.1
UNITED STATES	11,011.0
TURKMENISTAN	9,904.2
SAUDI ARABIA	8,588.2
U.A.E.	6,091.0
VENEZUELA	5,701.5
ALGERIA	5,404.0
NIGERIA	5,284.3
OTHERS	42,642.2

Source: 2016 OPEC Annual Statistical Bulletin

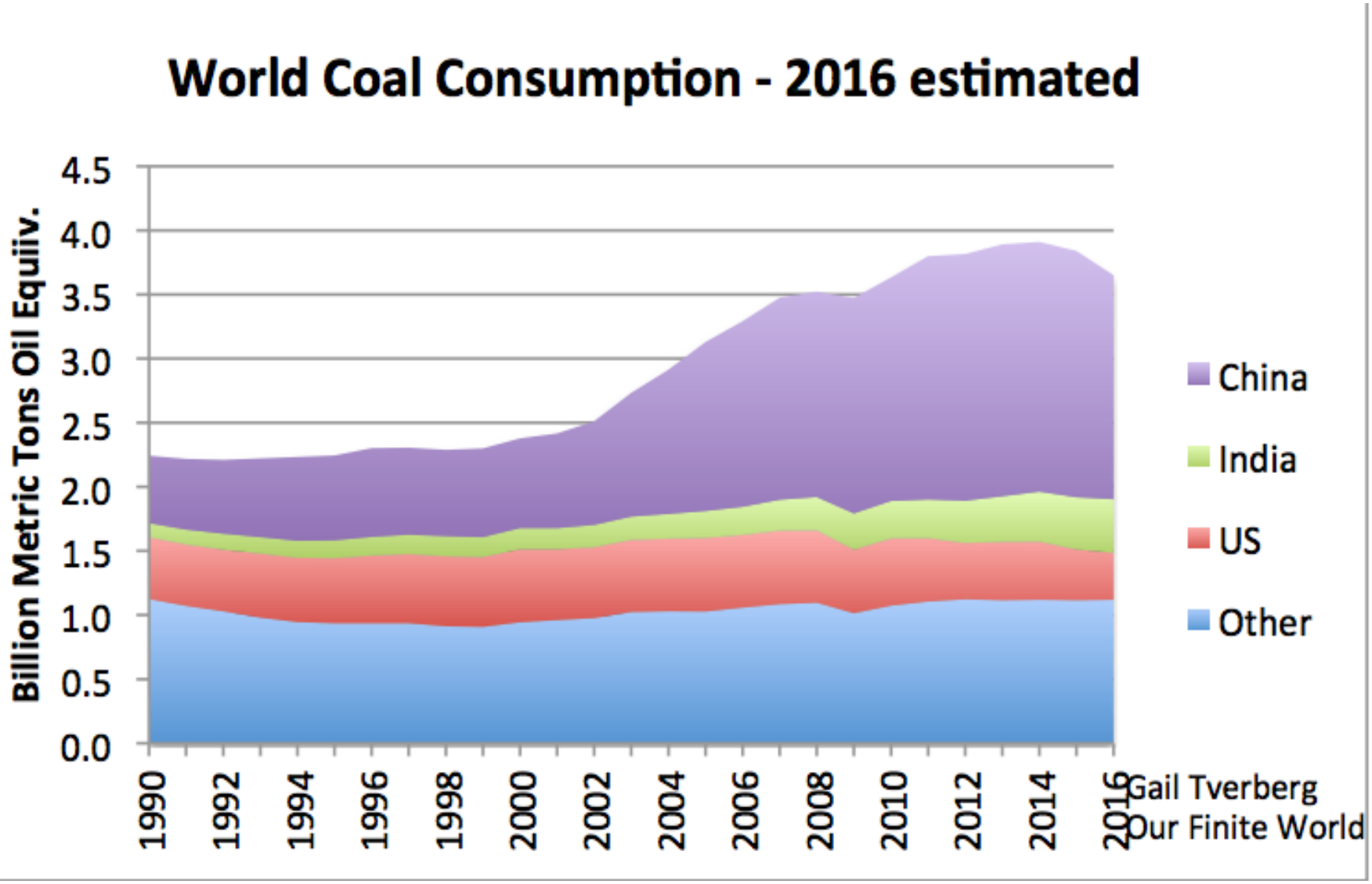
Growth of World Coal Consumption

Molecular Energy by: DTC Solutions



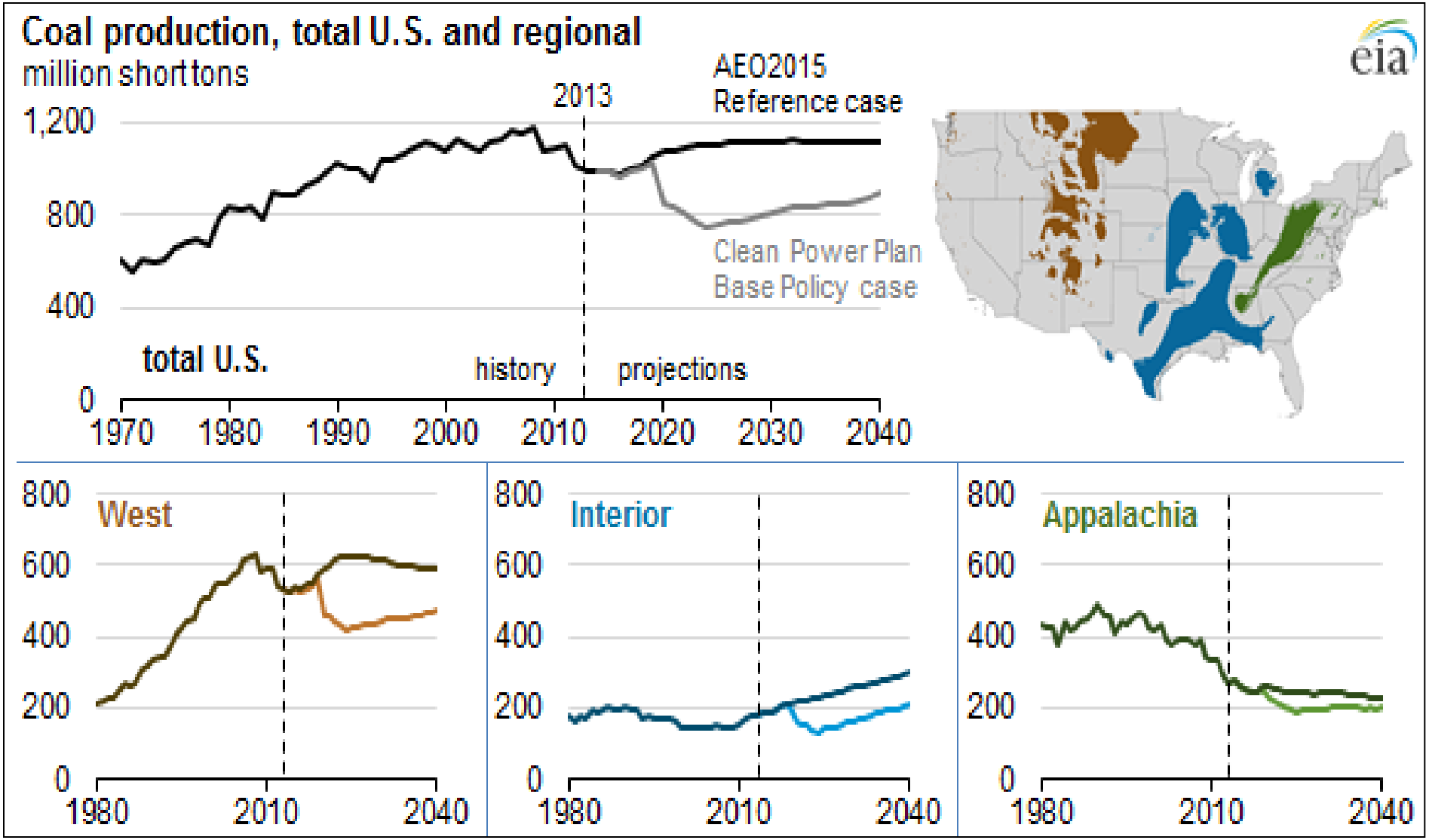
China – World's Largest Coal Consumer

Molecular Energy by: DTC Solutions



US Coal Production History

Molecular Energy by: DTC Solutions



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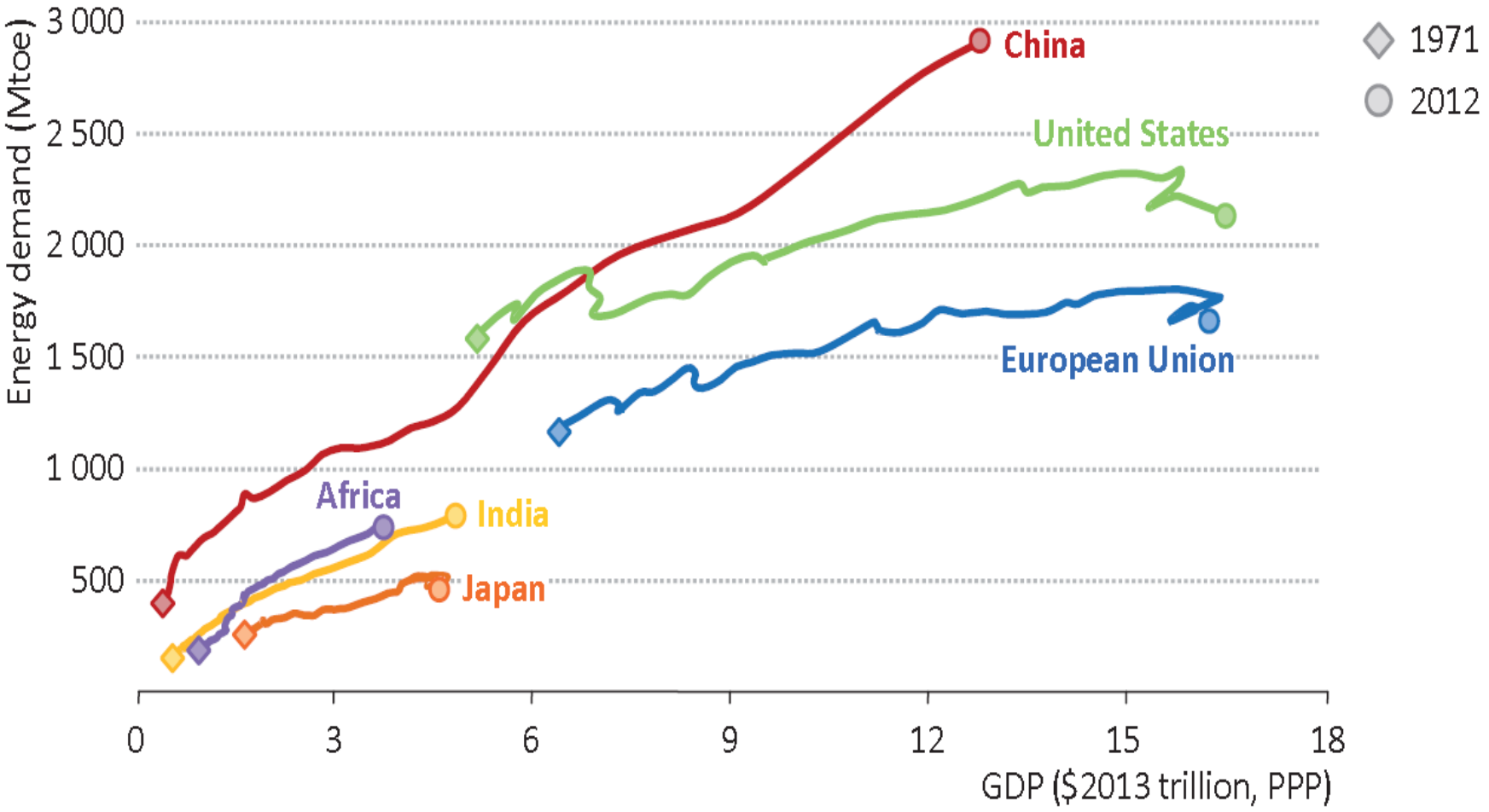
Global Energy Demand vs GDP

Molecular Energy by: DTC Solutions



Note: Mtoe = million tonnes of oil equivalent.

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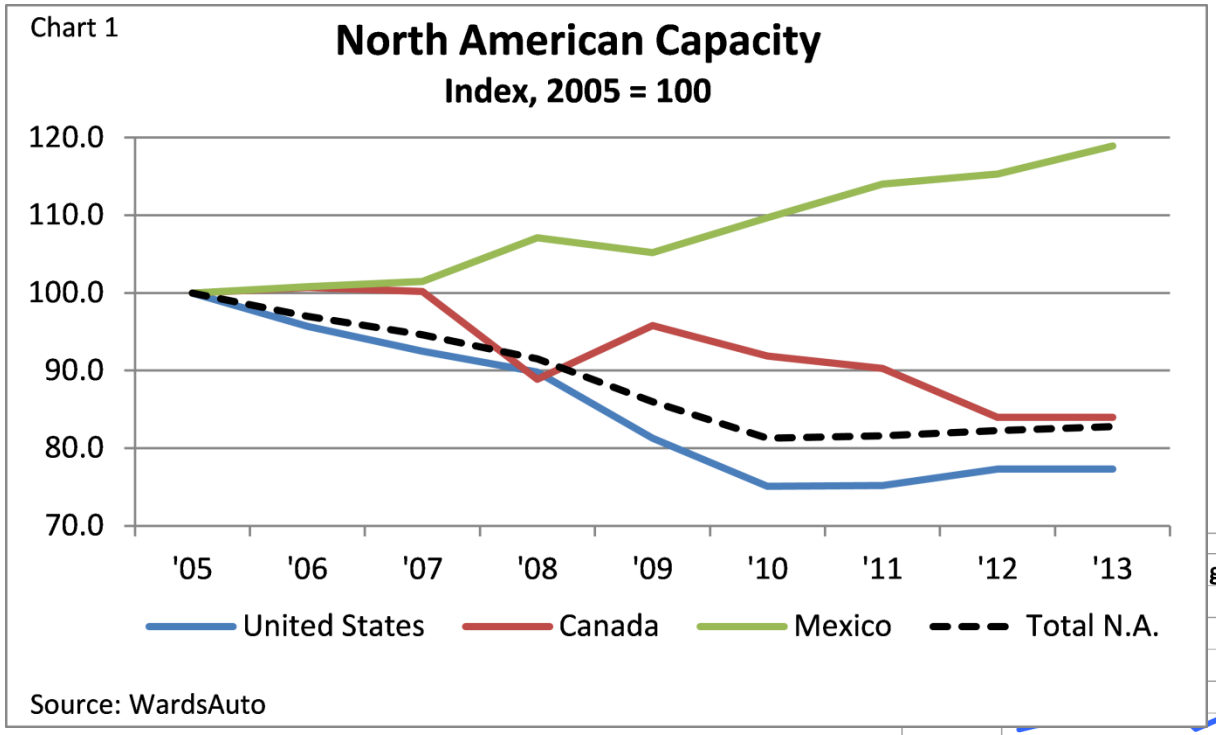
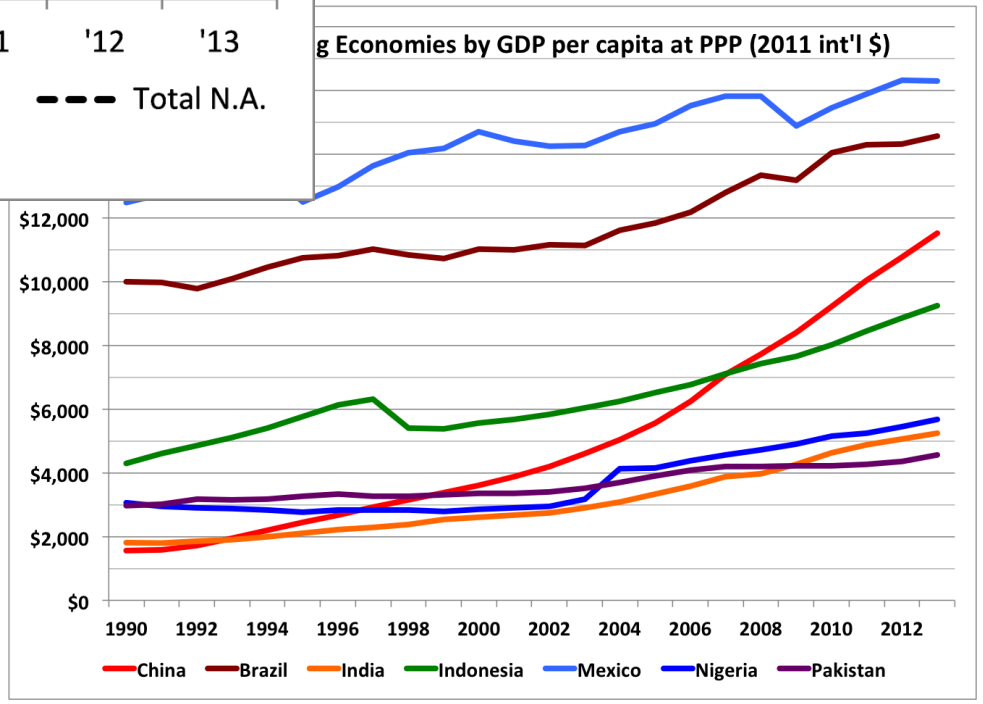
Manufacturing Capacity: Falling in N. America

Molecular Energy by: DTC Solutions

Chart 1

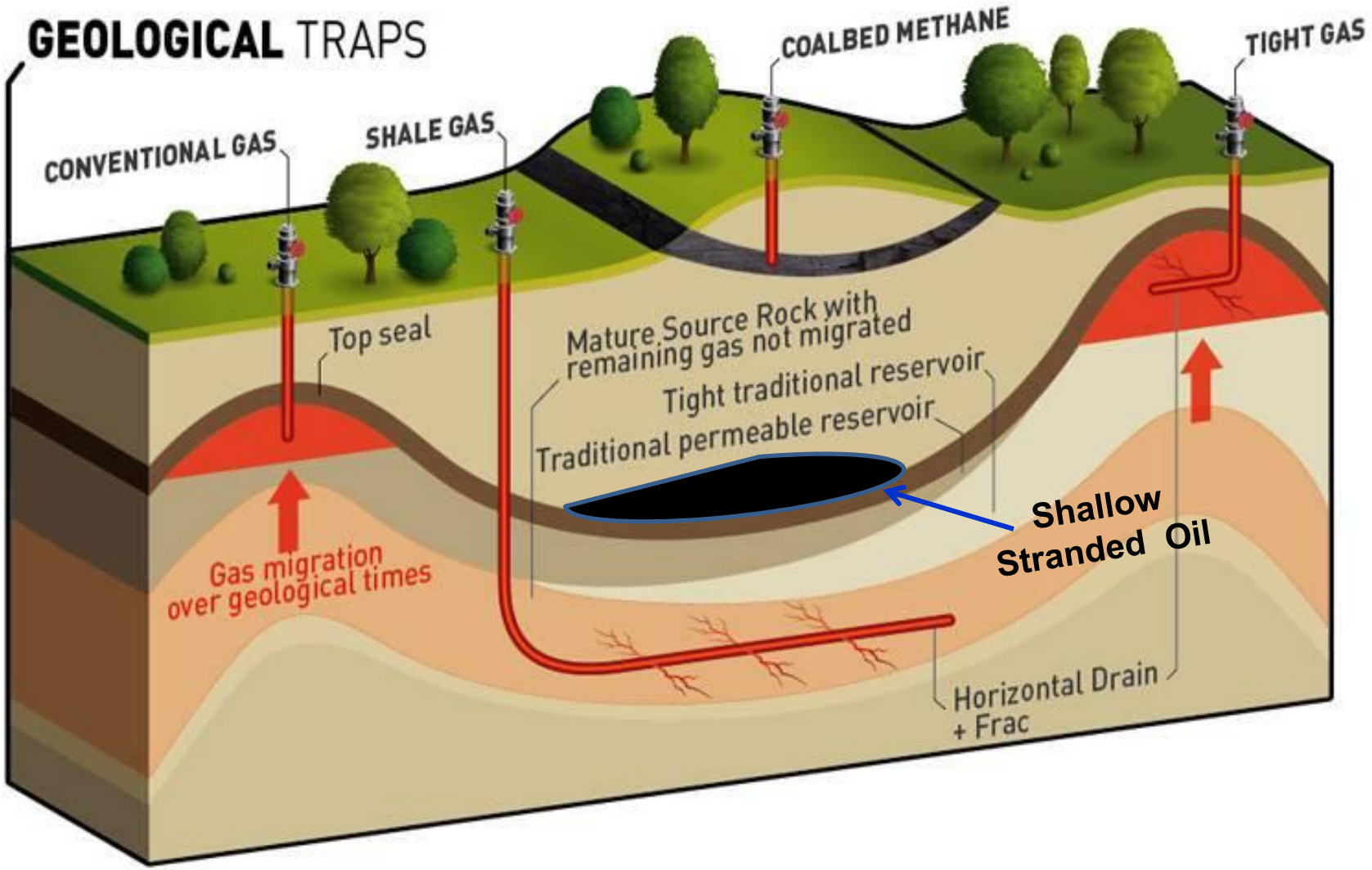


Source: WardsAuto



Sources of CBM, Shale Gas, and Stranded Oil

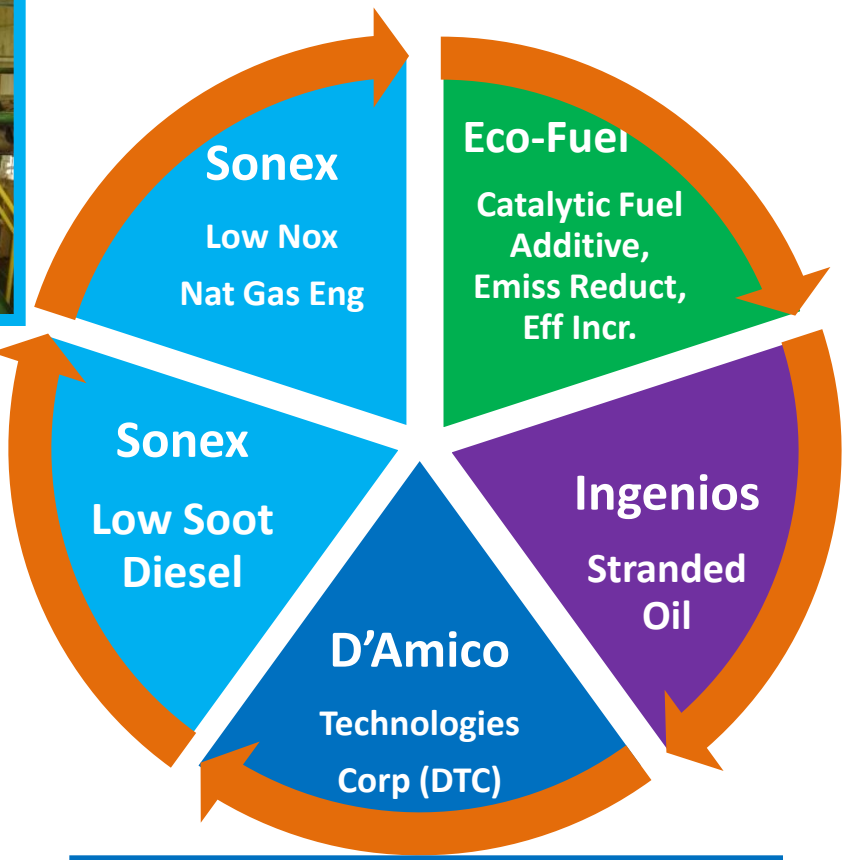
Molecular Energy by: DTC Solutions

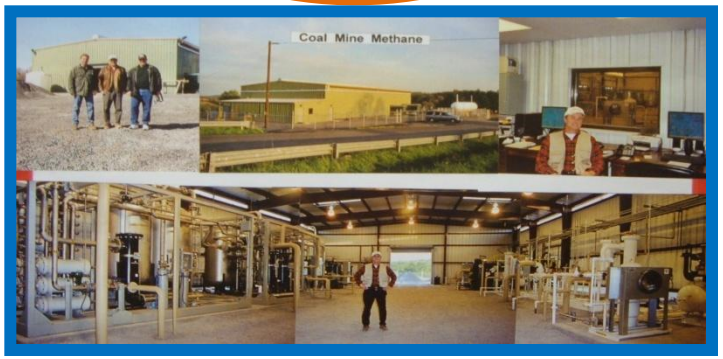


Technologies Associated with DTC

Molecular Energy by: DTC

Solutions





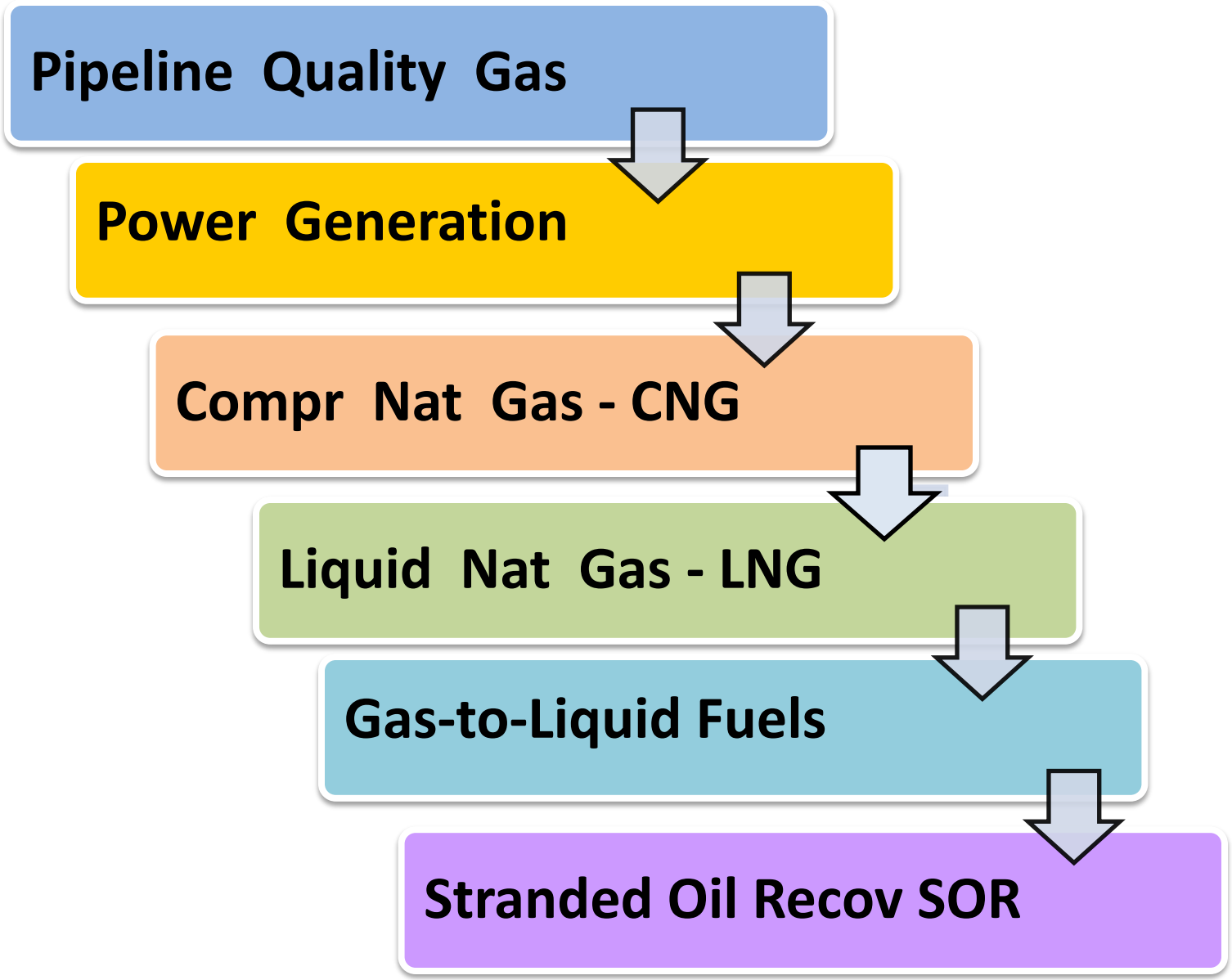
CO2
H2O
H2S
C6+
O2
Rejection & Gas Control

Chiller-Dehy
BTU Control
NGL Recovery
Hydroc DP Contr

Thermal Swing Deposition

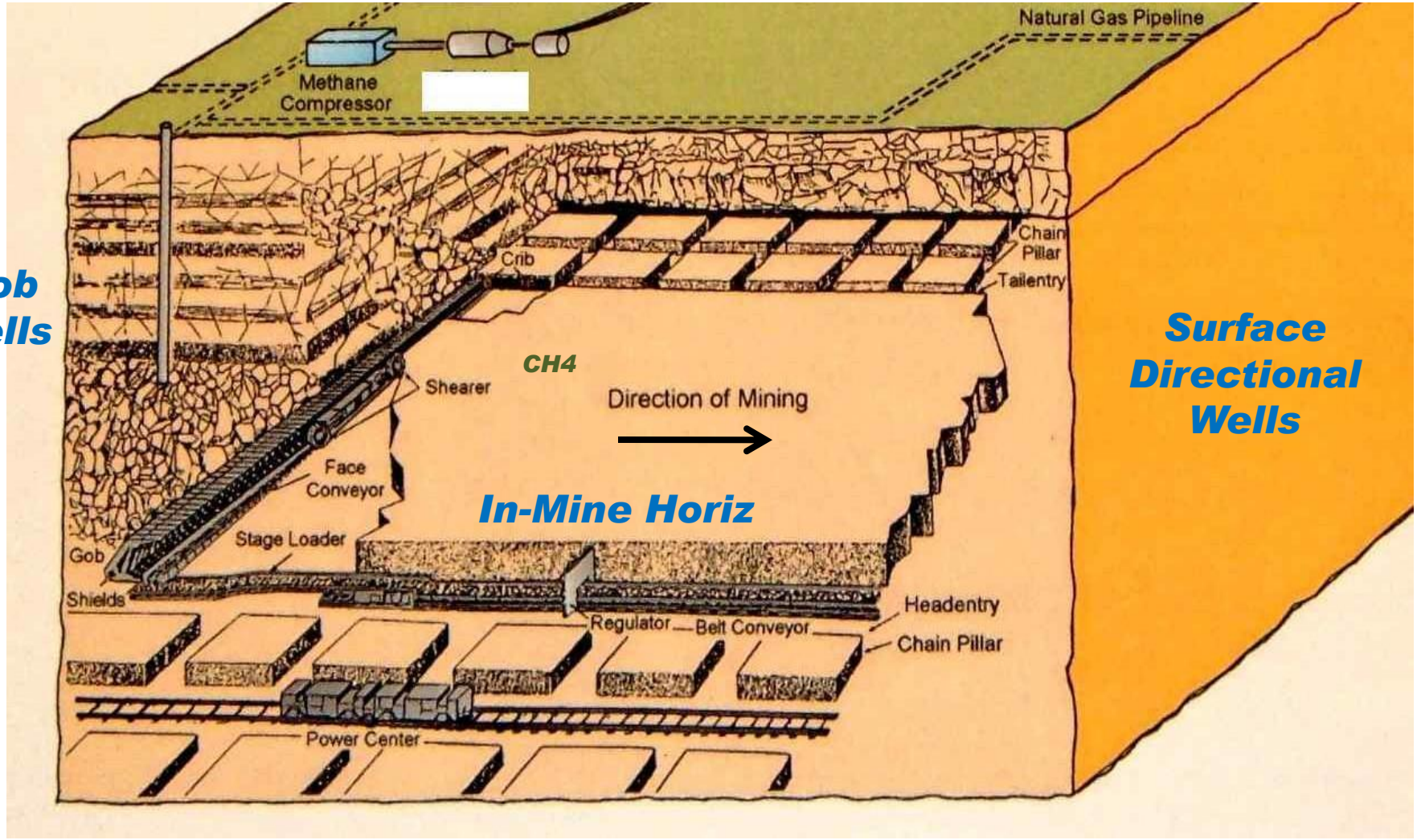
Coal Bed Methane - Utilization

Molecular Energy by: DTC Solutions



CMM Well Types

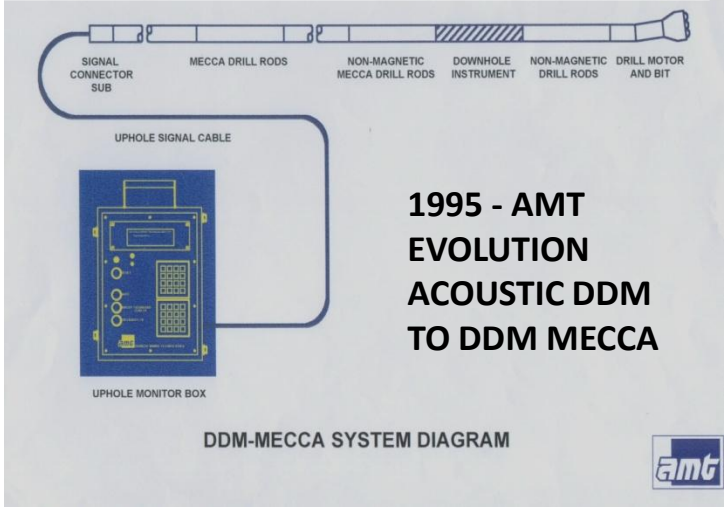
Molecular Energy by: DTC Solutions



In-Mine Horizontal Well Drilling

Molecular Energy by: DTC Solutions

TARGET DRILLING



In-mine Horizontal Wells

Molecular Energy by: DTC Solutions

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Surface Directional Well Drilling

Molecular Energy by: DTC

TWO ACCESS WELLS FOR 2 CBM HORIZONTAL WELLS TARGETING PITTSBURGH COAL BED DRILLED FROM ONE SITE

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Gas Quality – CMM Sources

Molecular Energy by: DTC Solutions

Gas Molecule	In-Mine Horiz	Gob Wells	SD – Wells	Pipeline Spec
BTU	850 – 900	840 – 1000	910 – 980	970 – 1050
CH4	84 – 93 %	73 – 95 %	89 – 95 %	~ 96+ %
CO2	7 – 15 %	2 – 7 %	5 – 18 %	< 2.5 %
N2	0.05 – 0.6 %	3 – 20 %	0.2 – 1.0 %	TL Inerts
O2	0.01 – 0.2 %	0.01 – 0.2 %	0.01 – 0.13 %	< 0.2 %
TL Inerts (N2 + CO2)	7 – 16 %	5 – 27 %	5 – 19 %	< 4 %
H2O	Saturated	Saturated	Saturated	< 7 Lb / MM
NGLs (Gal / MCF)	< 0.2 GPM	~ 1.2 GPM	< 0.2 GPM	< 0.2 GPM
Other	Carbon Dust	C6+, CL2, BTX Carbon Dust	Water	Clean & Dry

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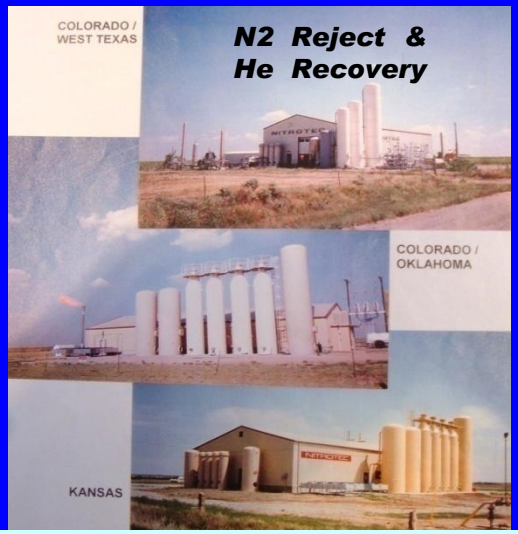
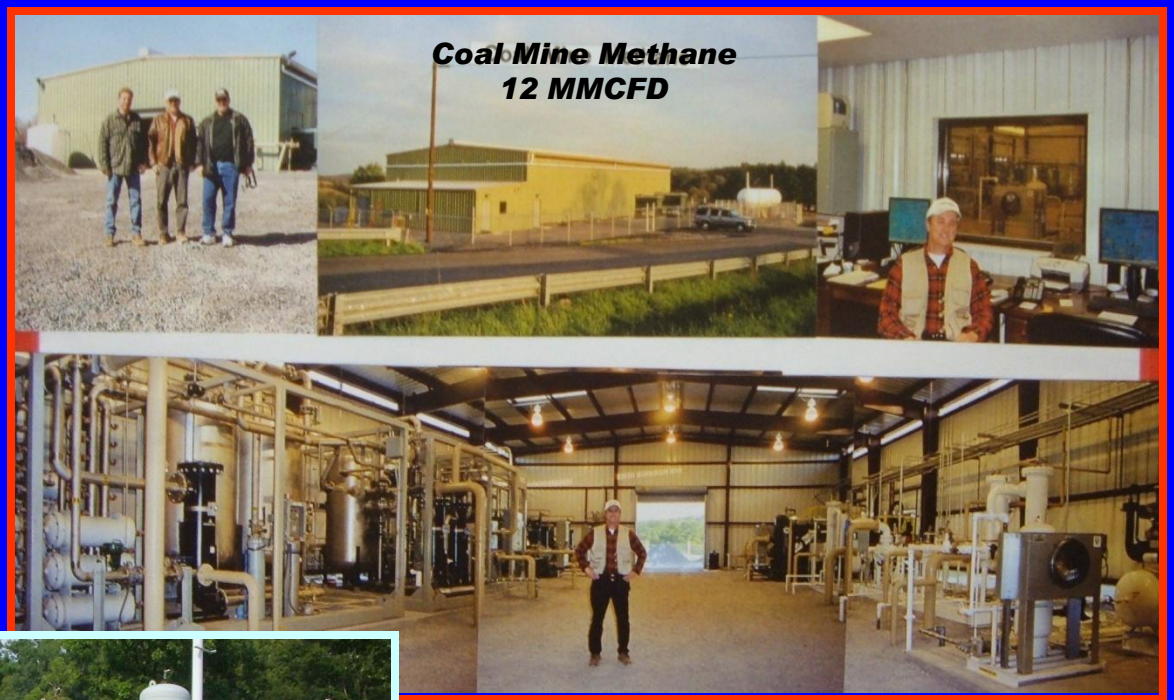
CO2
H2O
H2S
C6+
O2
Rejection &
Gas Control

D'Amico Technologies

410-859-3044

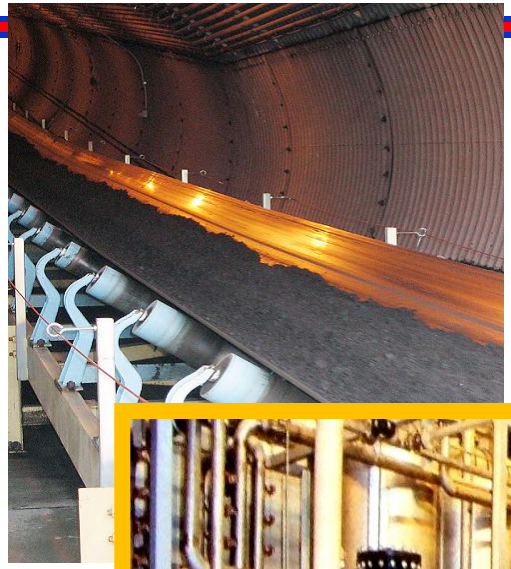




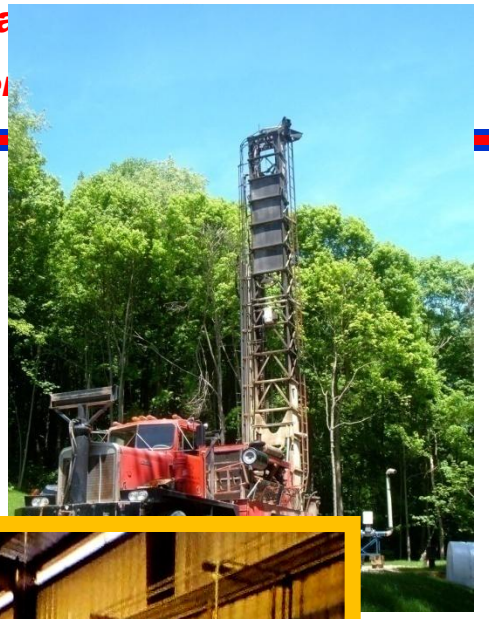
Technology & Know-how

Molecula

Ener



Mining Know-how: Coal Geology



Horizontal Drilling

Gas Processing Technology

Wellhead Gas Treatment

Relationships

Land, Permitting, Pipelines, Roads, Streams, & Gas Marketing

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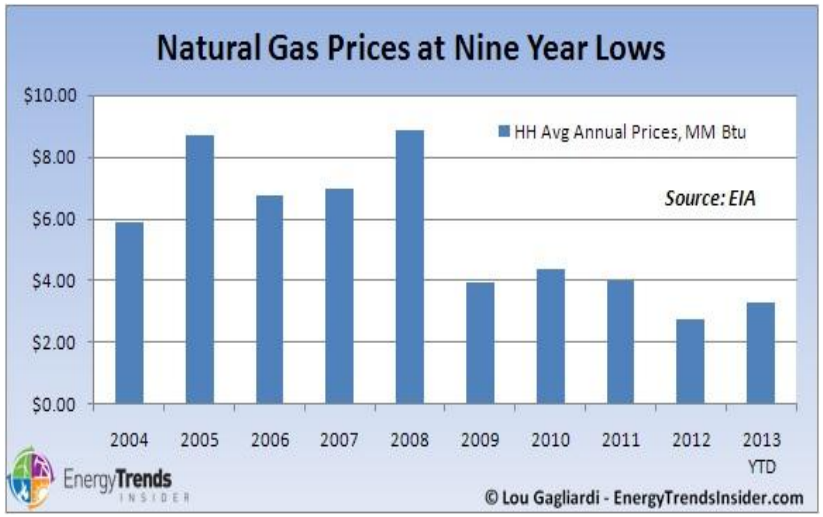
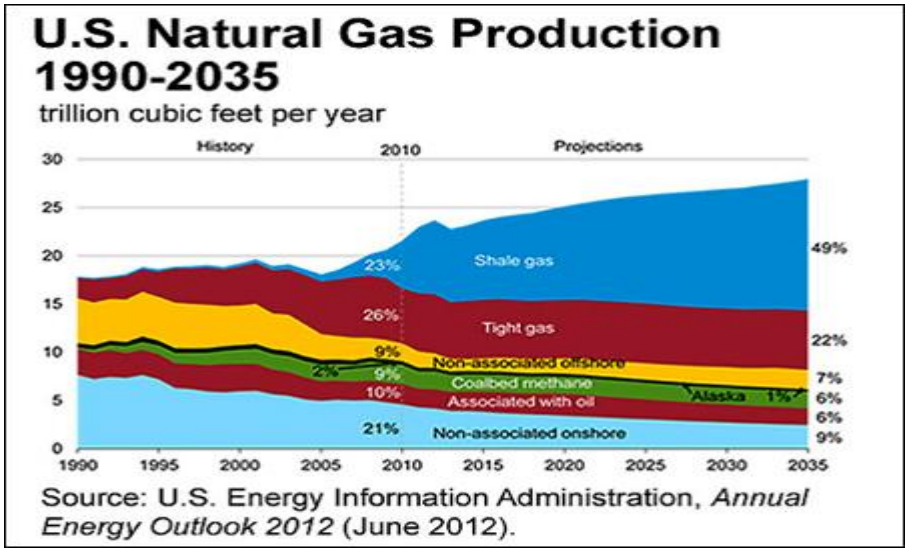
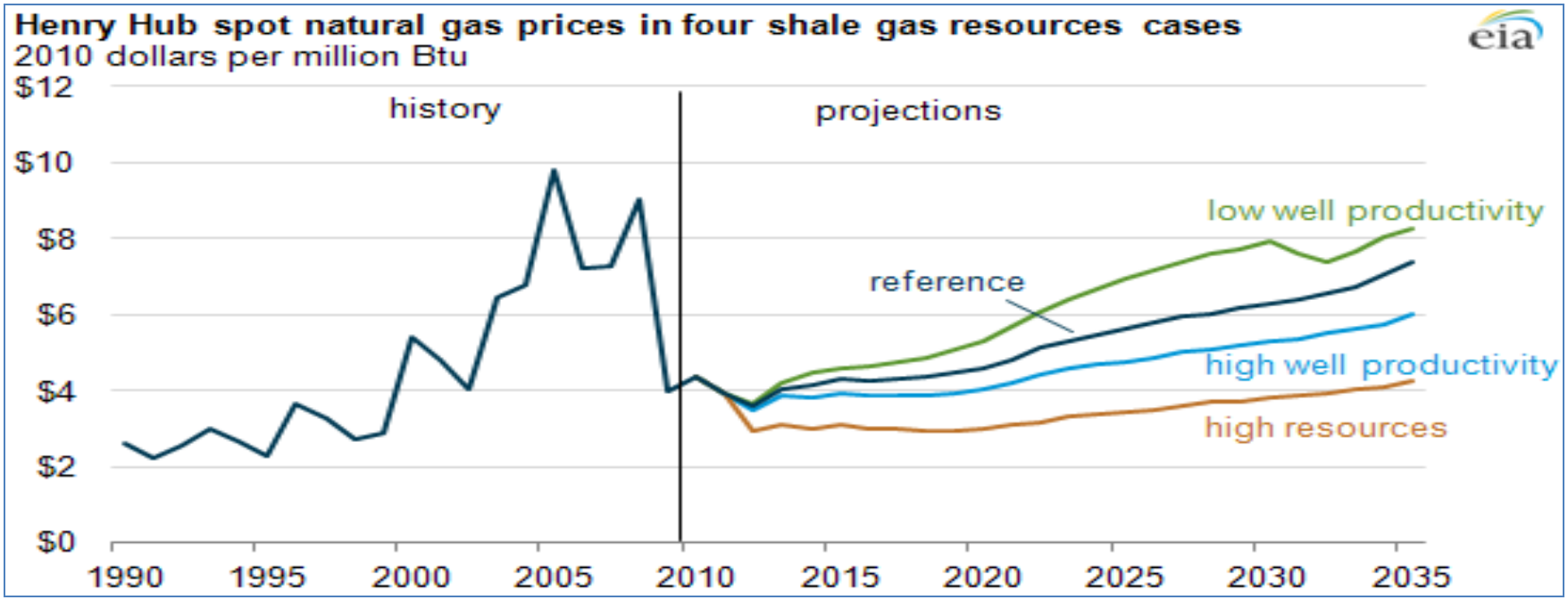
Natural Gas Prices - Past & Future

Molecular Energy by: DTC

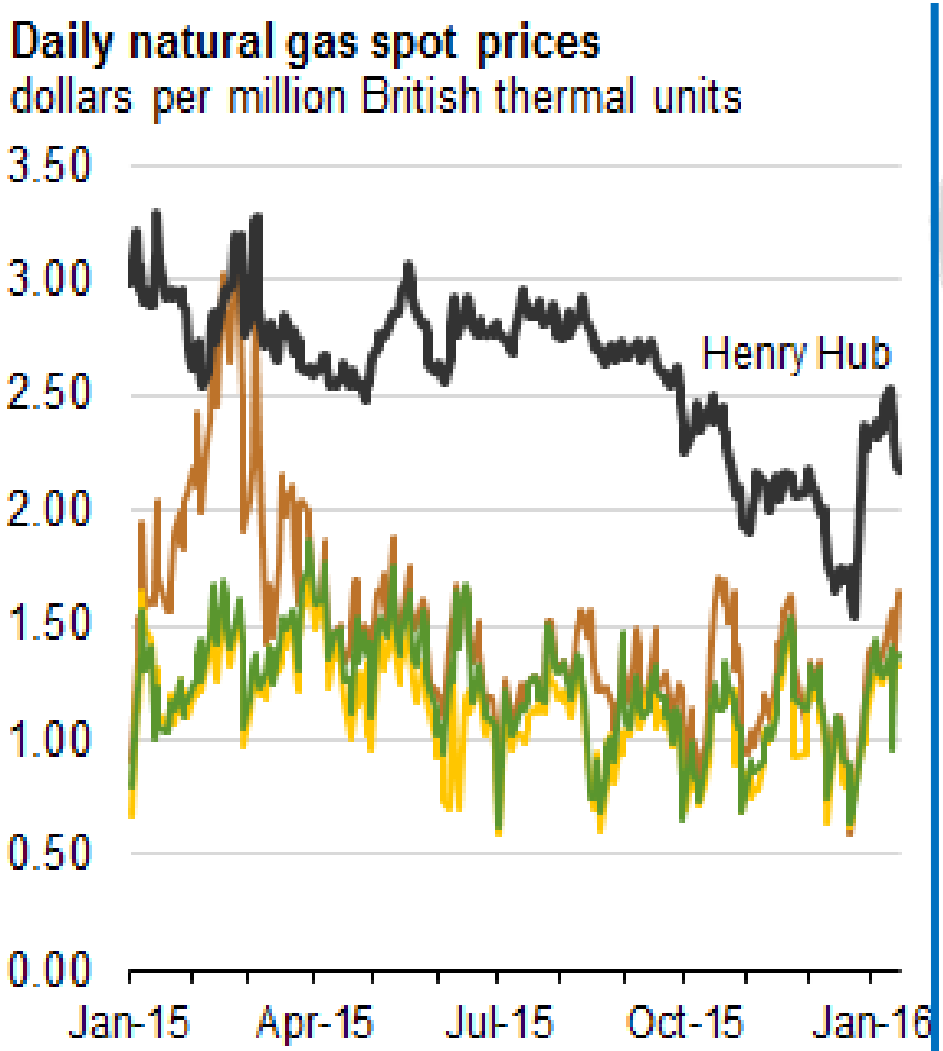


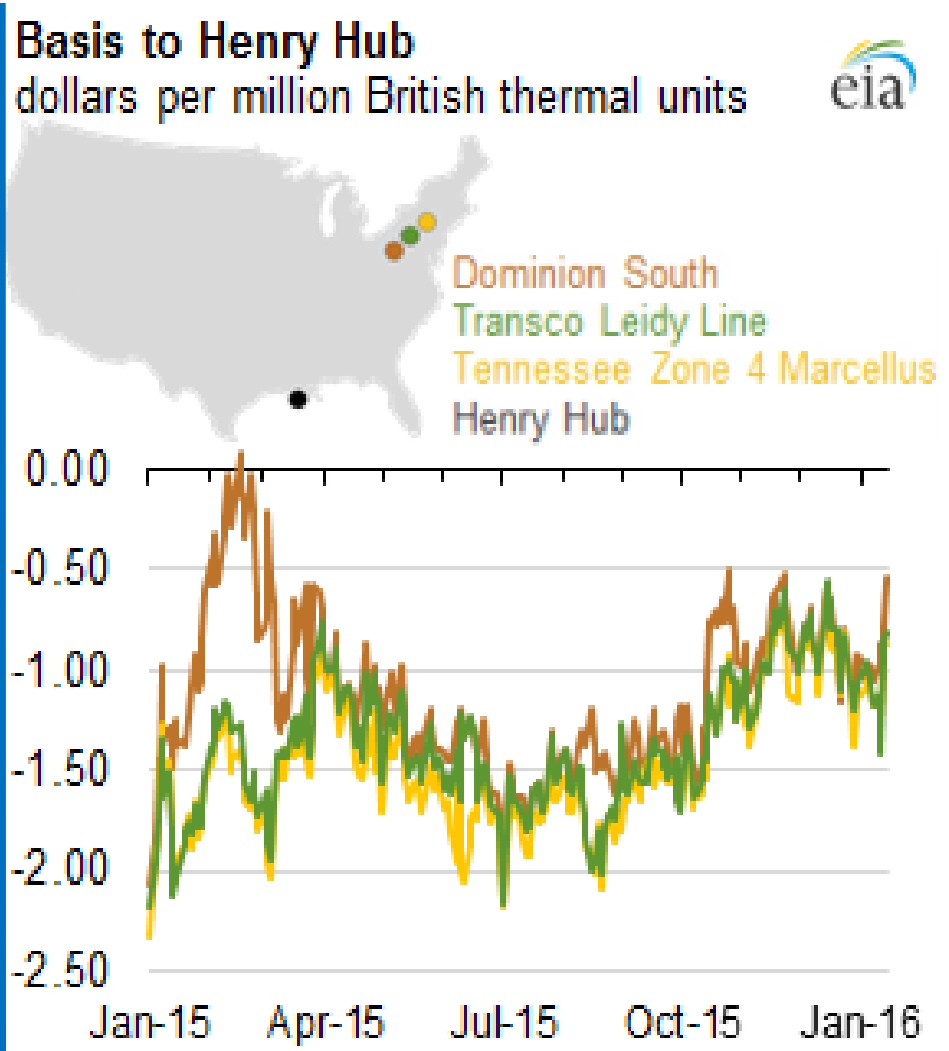




Natural Gas Prices + "Basis"

Molecular Energy by: DTC Solutions





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GHG Recovery Benefit of 10 MMCFD of CMM

Molecular Energy by: DTC Solutions

- American Source of Waste Energy.
- Displaces 250,000 bbls/yr Persian Gulf Oil
- Energy Saved = Heating 26,000 Homes / yr
- Energy Saved = Driving 160,000 Autos / yr.
- CO2 Offsets = 222,000 Acres Trees

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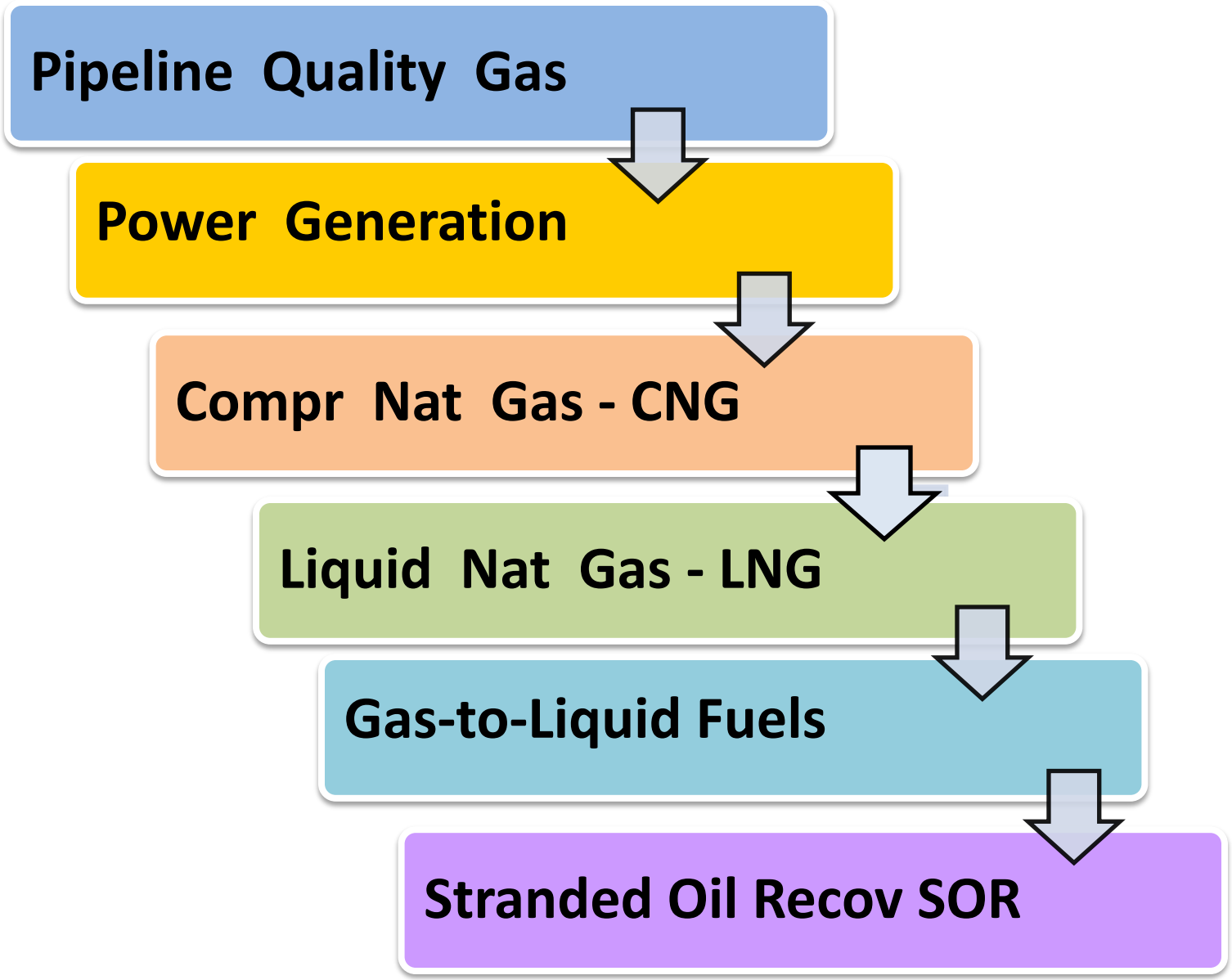
Coal Bed Methane - Utilization

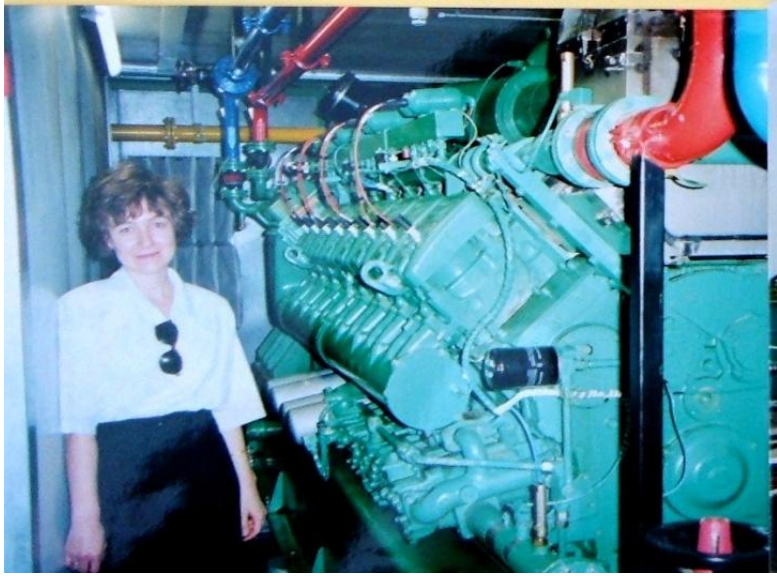
Molecular Energy by: DTC Solutions



Coal Mine Methane - Power Generation

Molecular Energy by: DTC

Solutions



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High Value Utilization of USA's Nat Gas & Coal

Molecular Energy by: DTC

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Solutions

Feedstocks

Coal

Coal Bed Methane & Natural Gas

Stranded Oil Recovery SOR

DTC Pre-Treat Adsorp-Membr

Horiz CBM Drilling

Wellhd Gas Purific

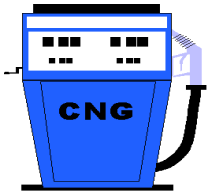
CBM Purification

Pipeline Gas Strand Oil Recov

CBM Process Plant

Power Gen

High Value Gas & Liquids

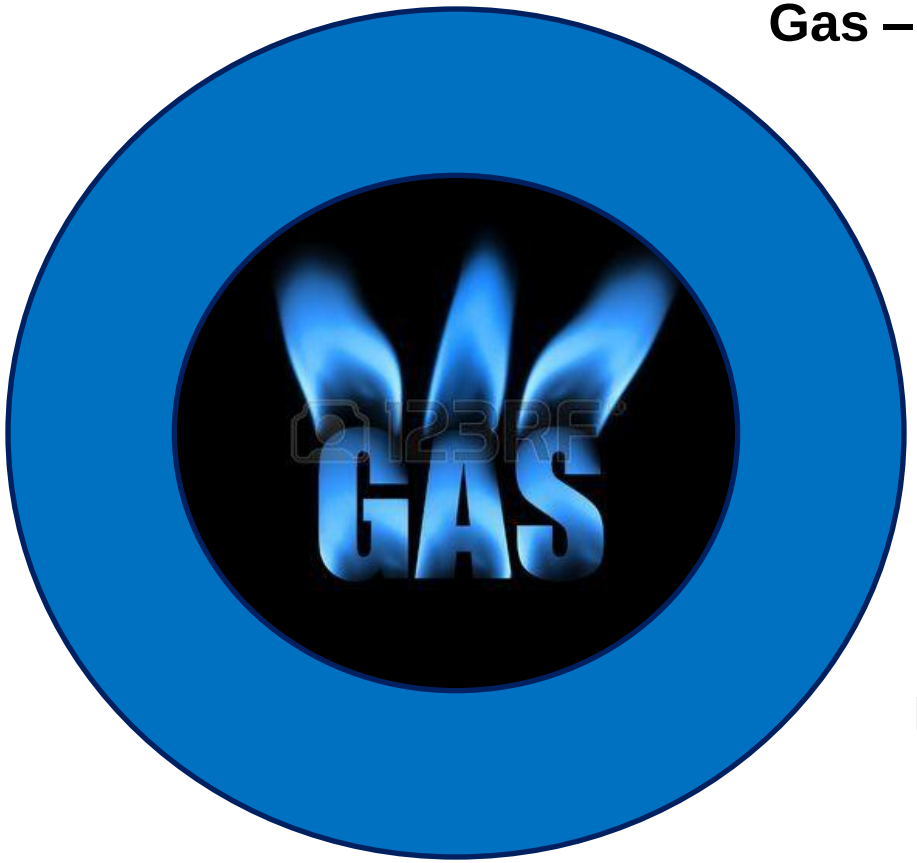


CNG $6 – 10/ mmBTU

LNG $10 – 14/ mmBTU

Methanol, Gasoline, Diesel Fuel, Jet Fuel

Gas – to – Liquids
GTL



How do we get there?

High Value Liq Fuels & Chemicals

by: *Joseph S. D'Amico PE*

North American
Coalbed Methane Forum

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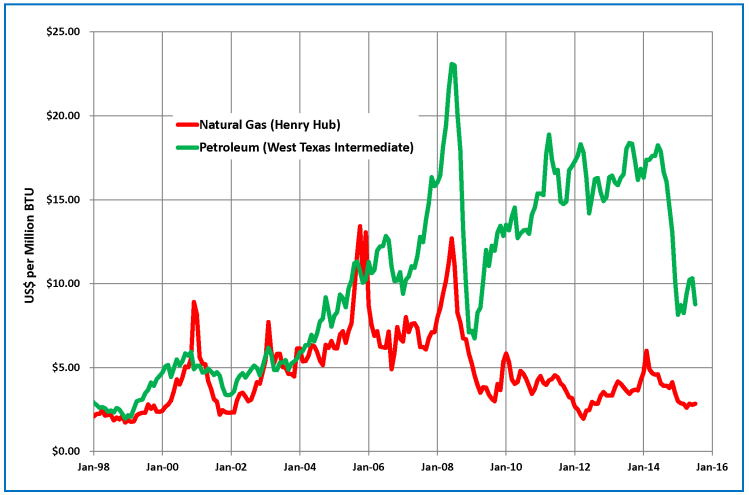
GTL Risks

Molecular Energy by: DTC Solutions

1. Technically Complicated
2. High Capital Cost
3. Volatile Oil & Gas Prices
4. Lack of Sustained Interest



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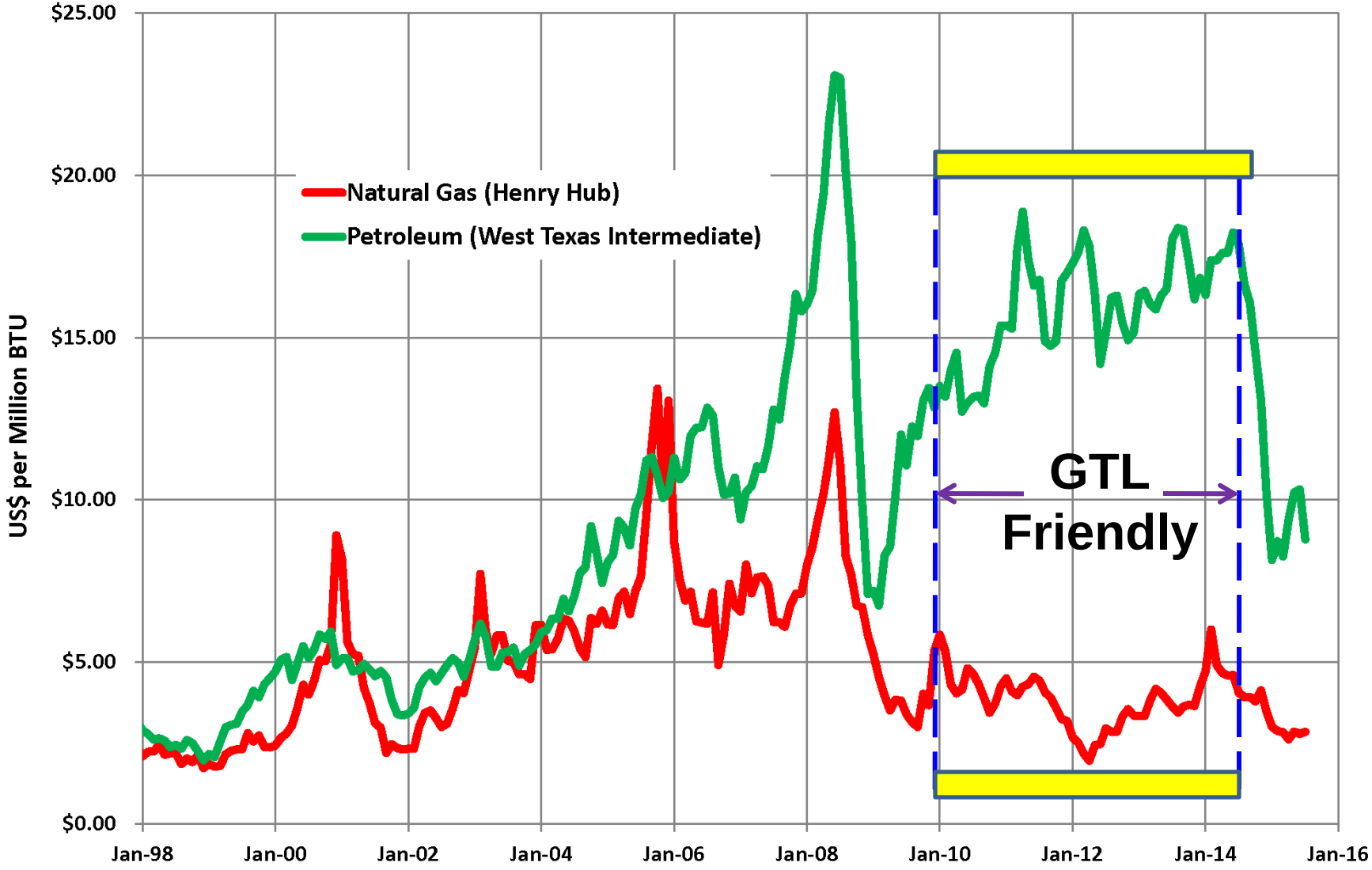
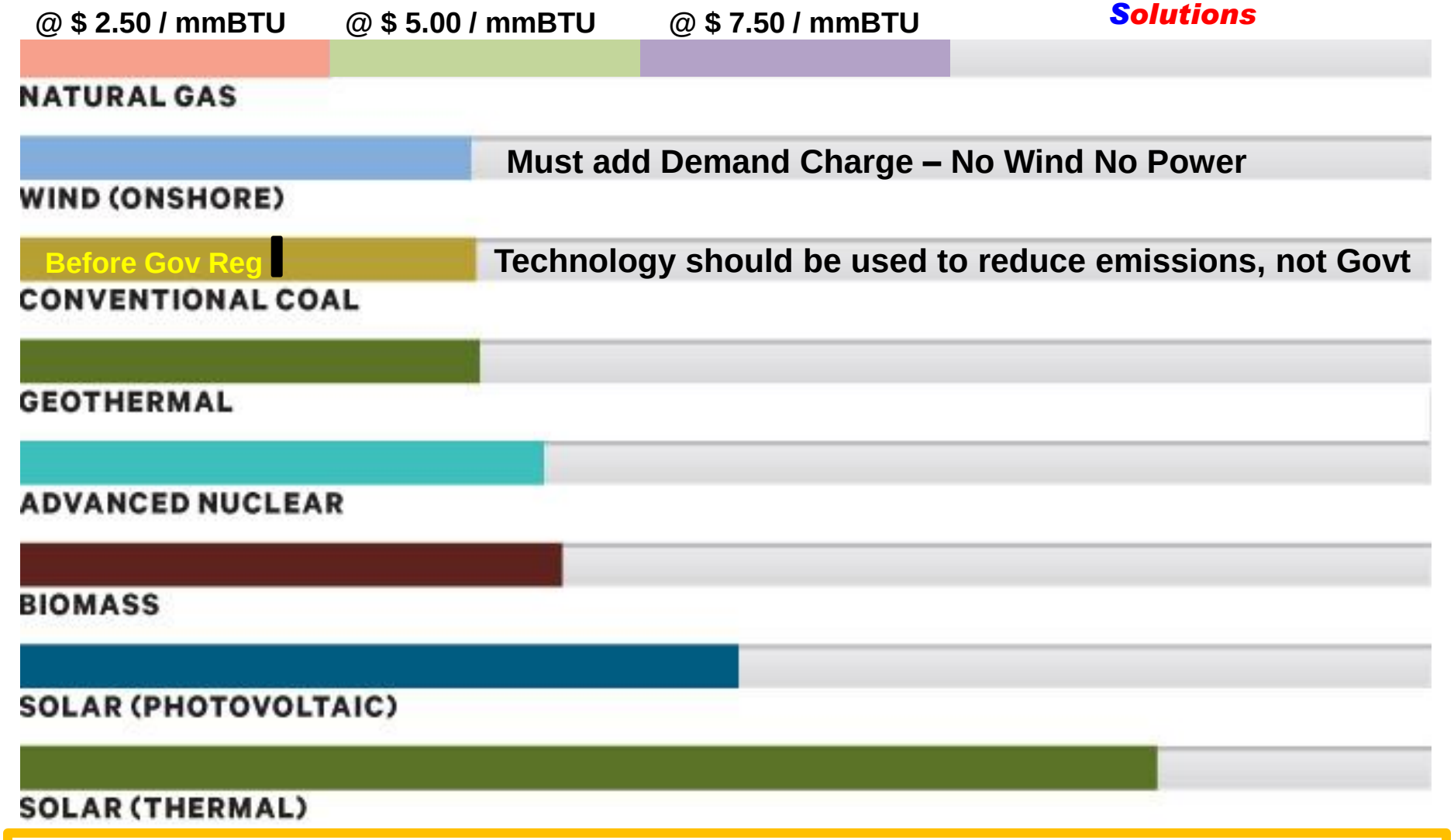
Natural Gas & Oil – Energy Spread

Molecular Energy by: DTC Solutions



US Power Gen Costs 2017

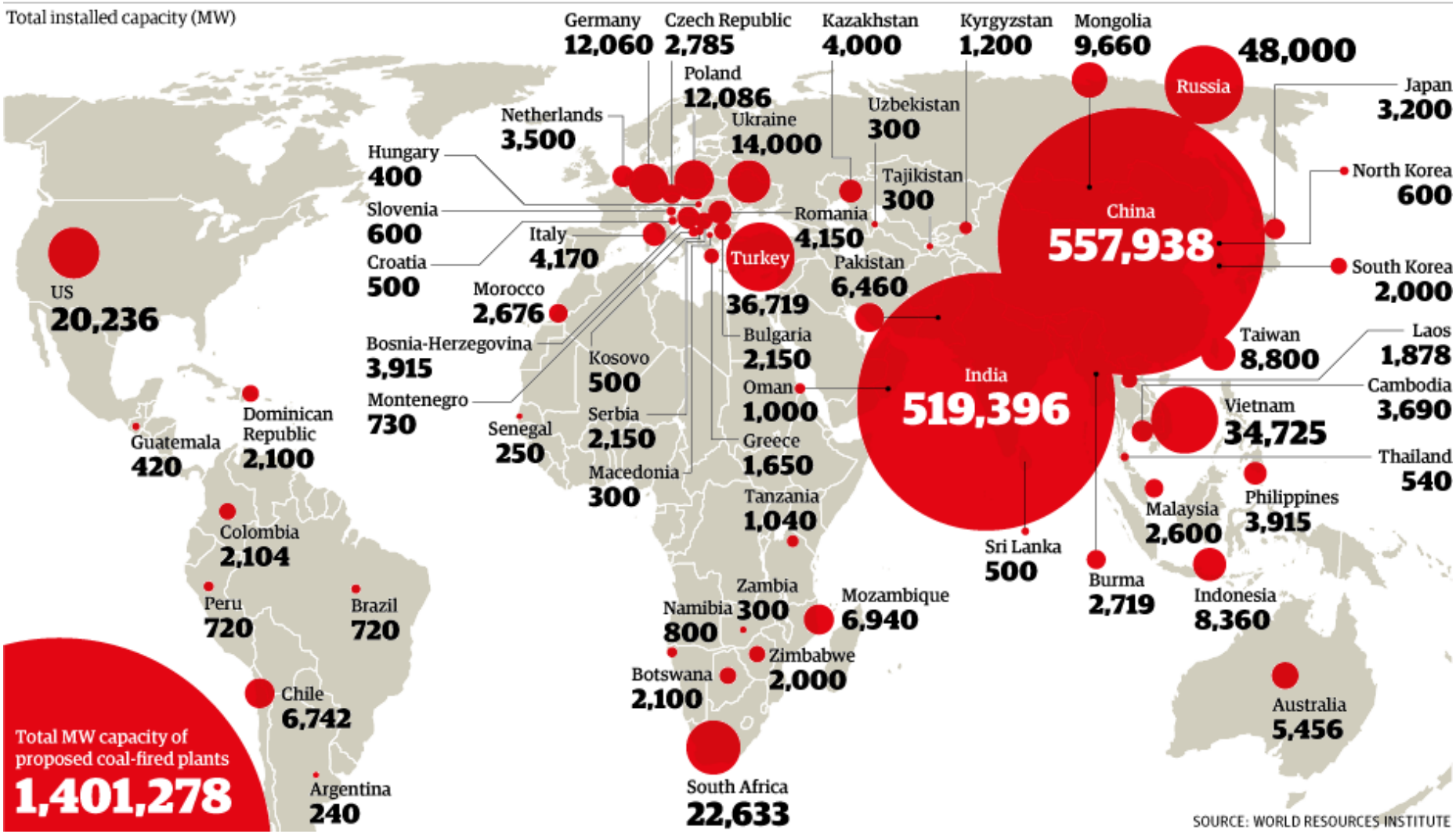
Molecular Energy by: DTC Solutions



Proposed Coal Fired Power Plants - 2014

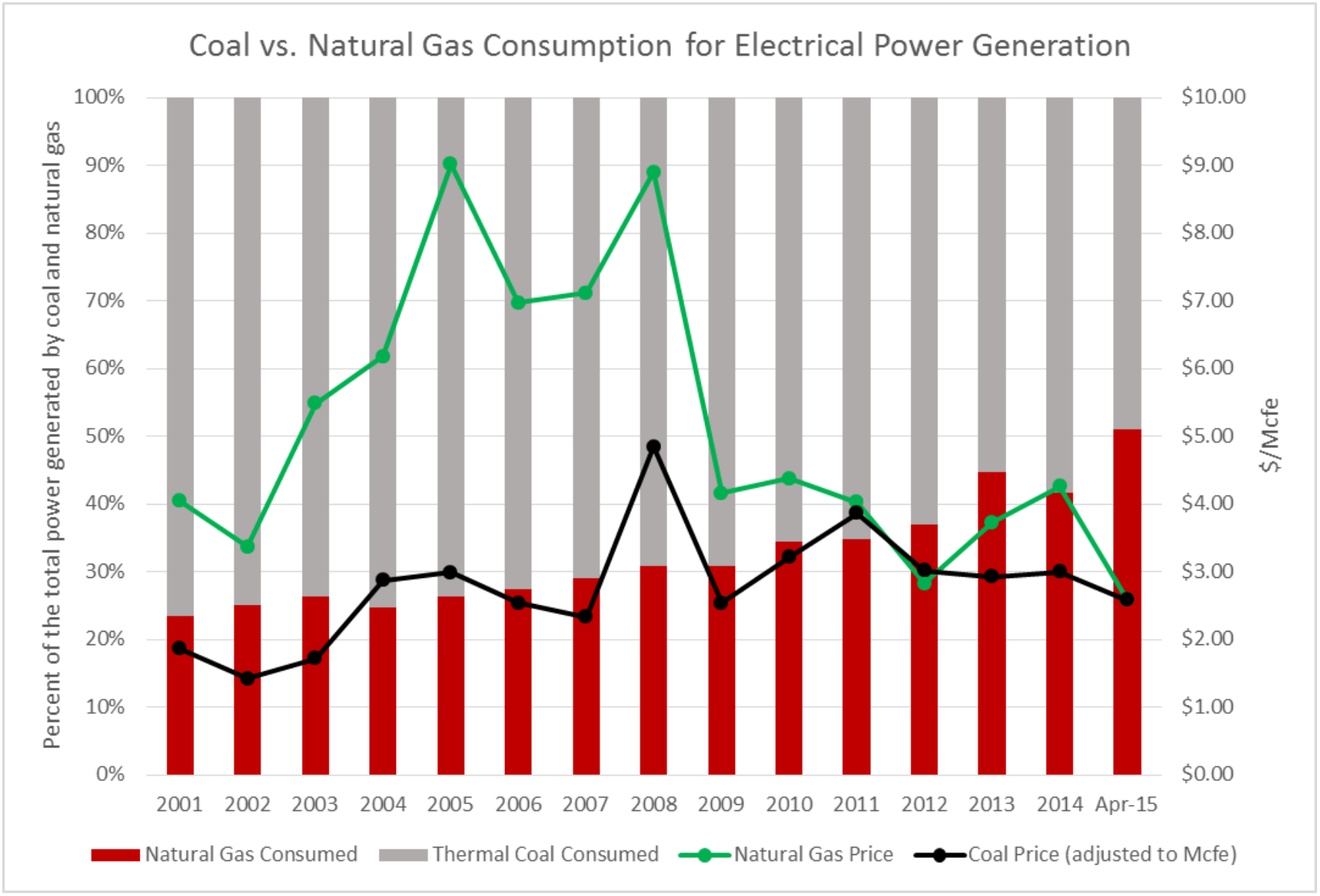
Molecular Energy by: DTC Solutions

Proposed coal-fired plants



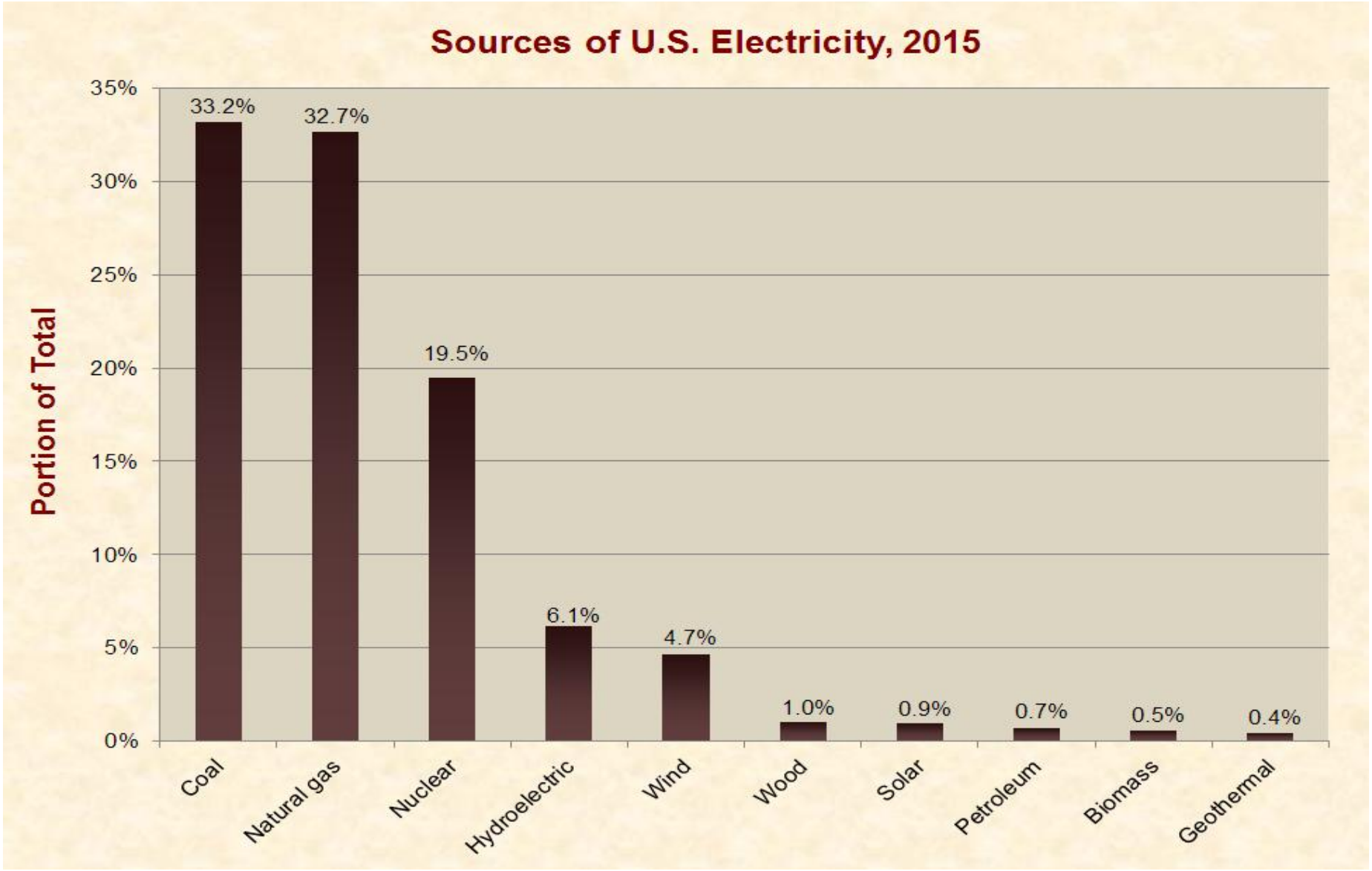
Coal & Natural Gas Price History

Molecular Energy by: DTC Solutions



US Electricity - 2015

Molecular Energy by: DTC Solutions



Nat Gas: High Eff Heat & Chemicals, Not for Electricity

Molecular Energy by: DTC Solutions

Pipeline Natural Gas

+

Distributed Heat

Thermodynamic Efficiency ____ x CH4 / BTU

= ~ 90 % Eff = 1.11x CH4/BTU

Displaces Pipeline CH4 fr Other Sources that have larger Carbon Footprint

Gas Fired Power Gen

1 MW

+

20% Line Loss (NE)

= 33 % Eff = **3x** CH4 / BTU

Requires 3 times the Methane for the same BTU

Pipeline Natural Gas

+

Chemical Products / Fertilizer Plant

= ~ 100 % Eff

Direct use Nat Gas as Feedstock for Chemical, and Fertilizer Industry

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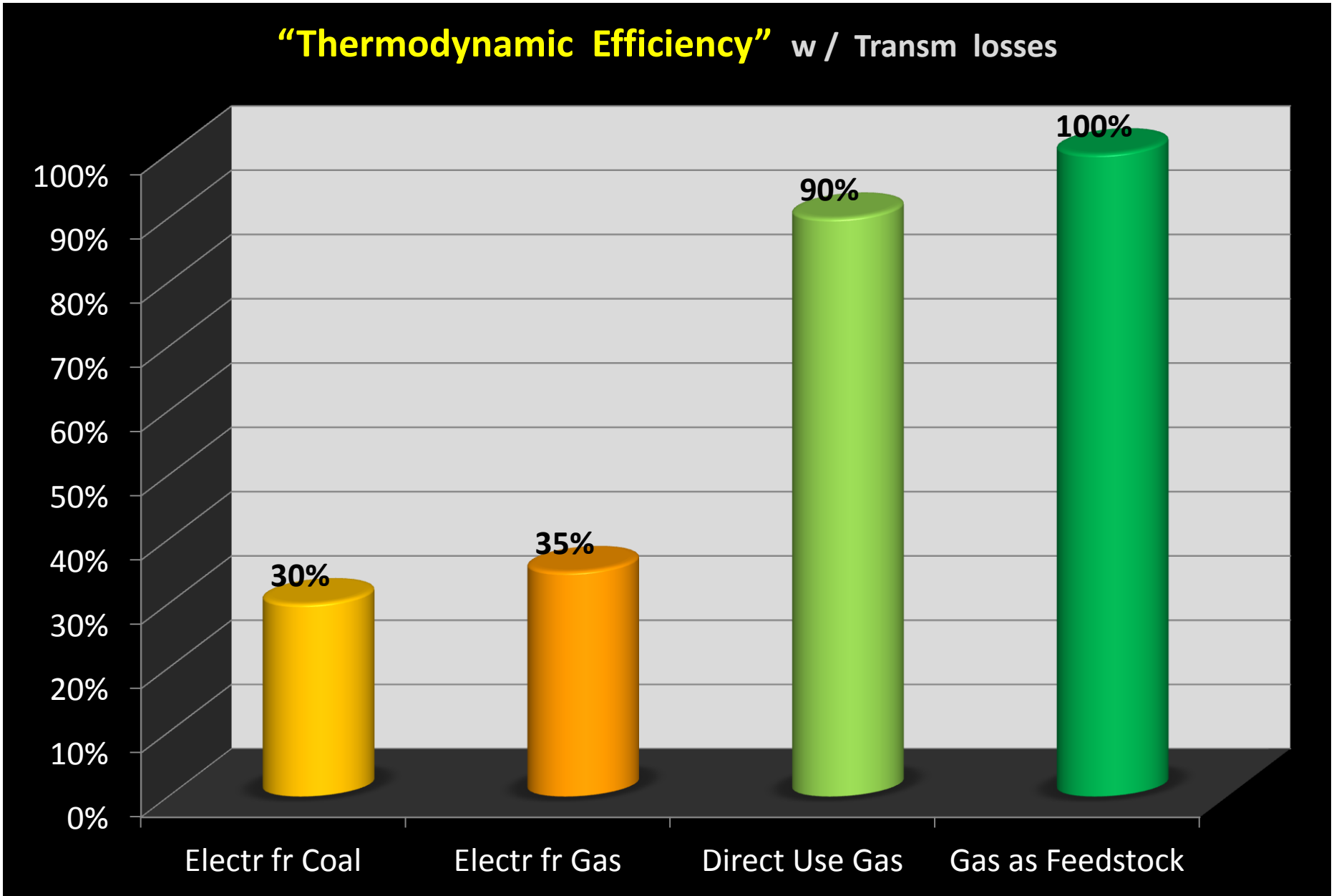
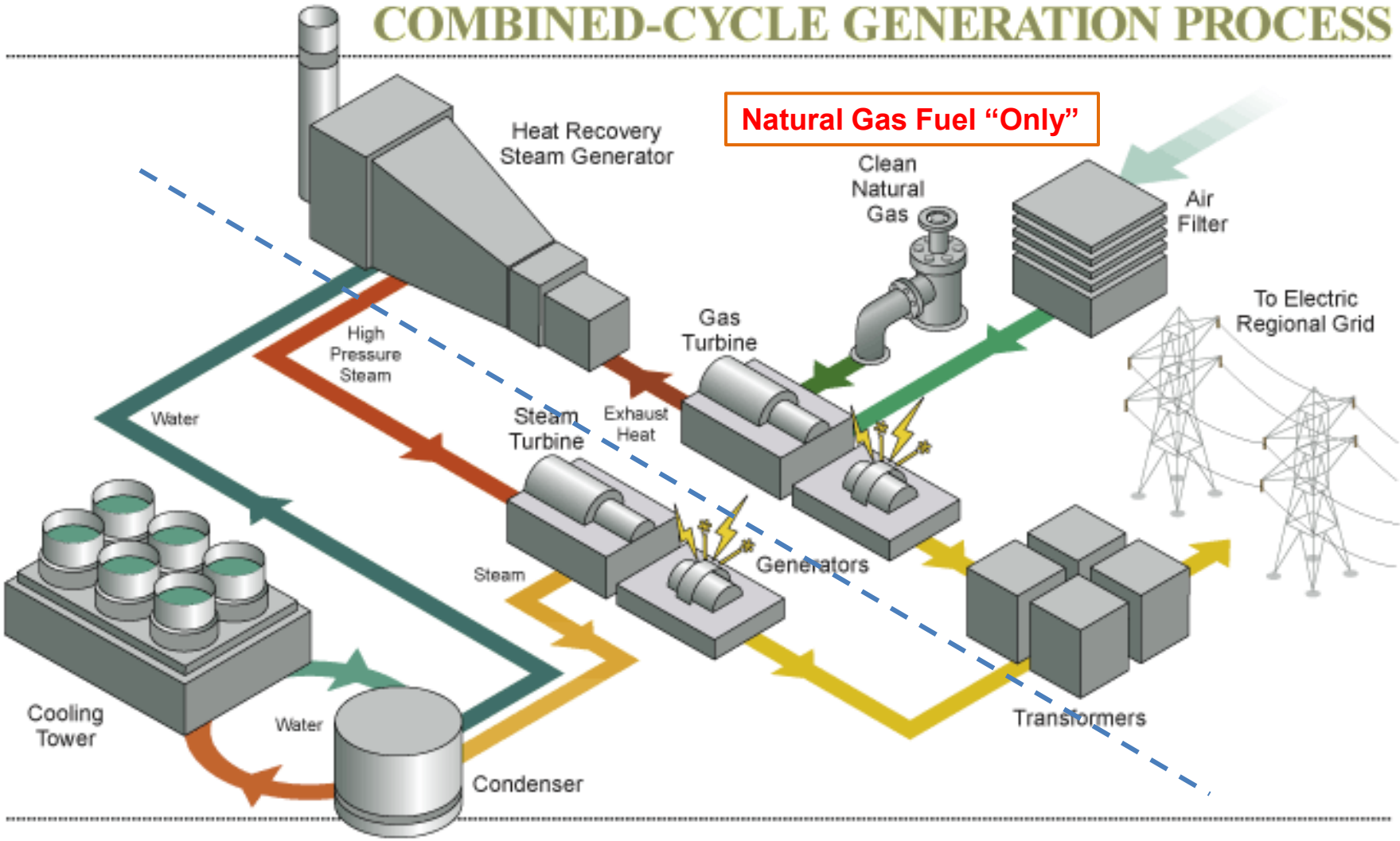
Use Methane (CH4) Wisely ?

Molecular Energy by: DTC



Gas Turbine + Steam Turbine Electr Gen.

Molecular Energy by: DTC Solutions



33 – 45% Thermodynamic Eff

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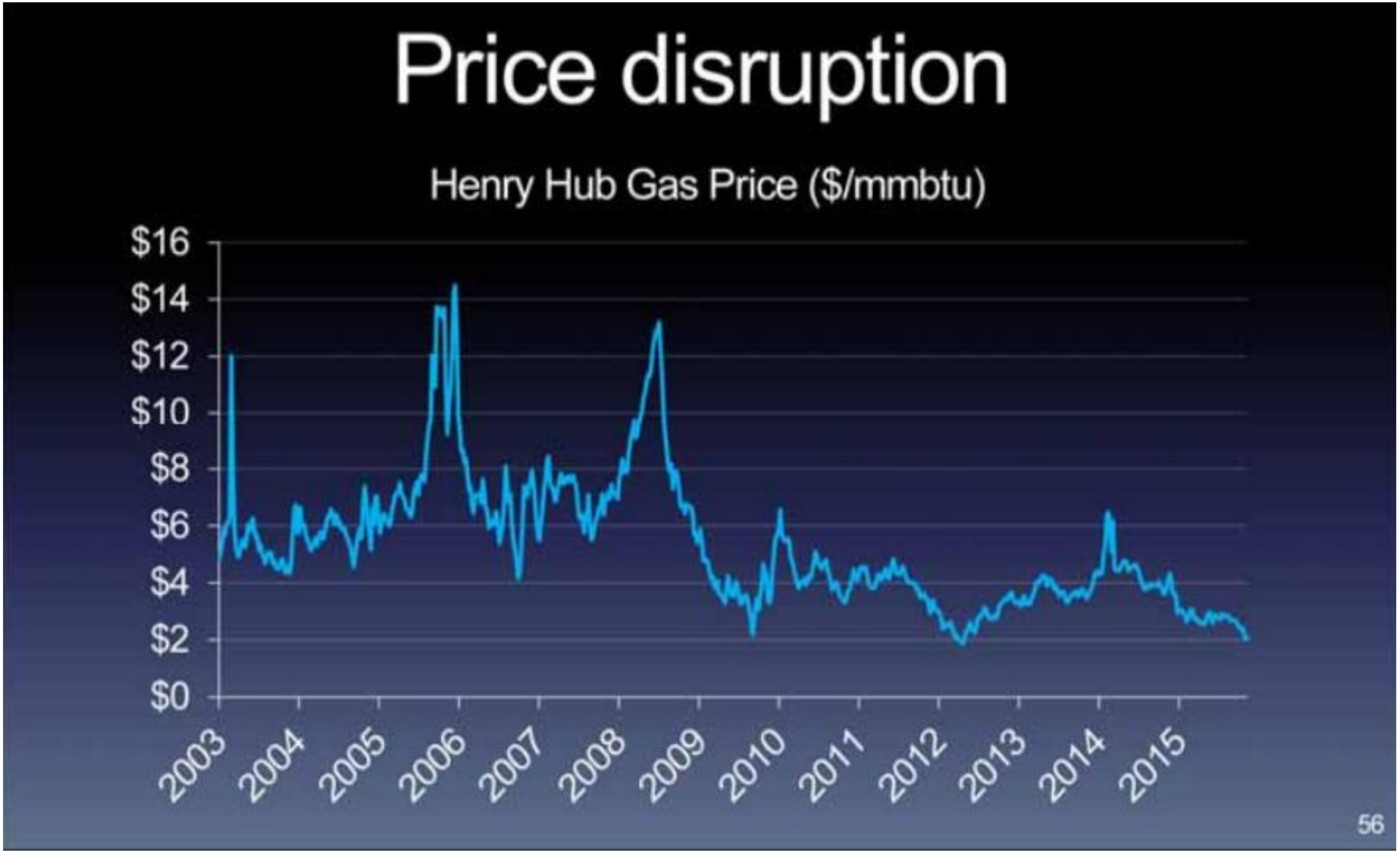
US Gas Price Volatility

Molecular Energy by: DTC Solutions



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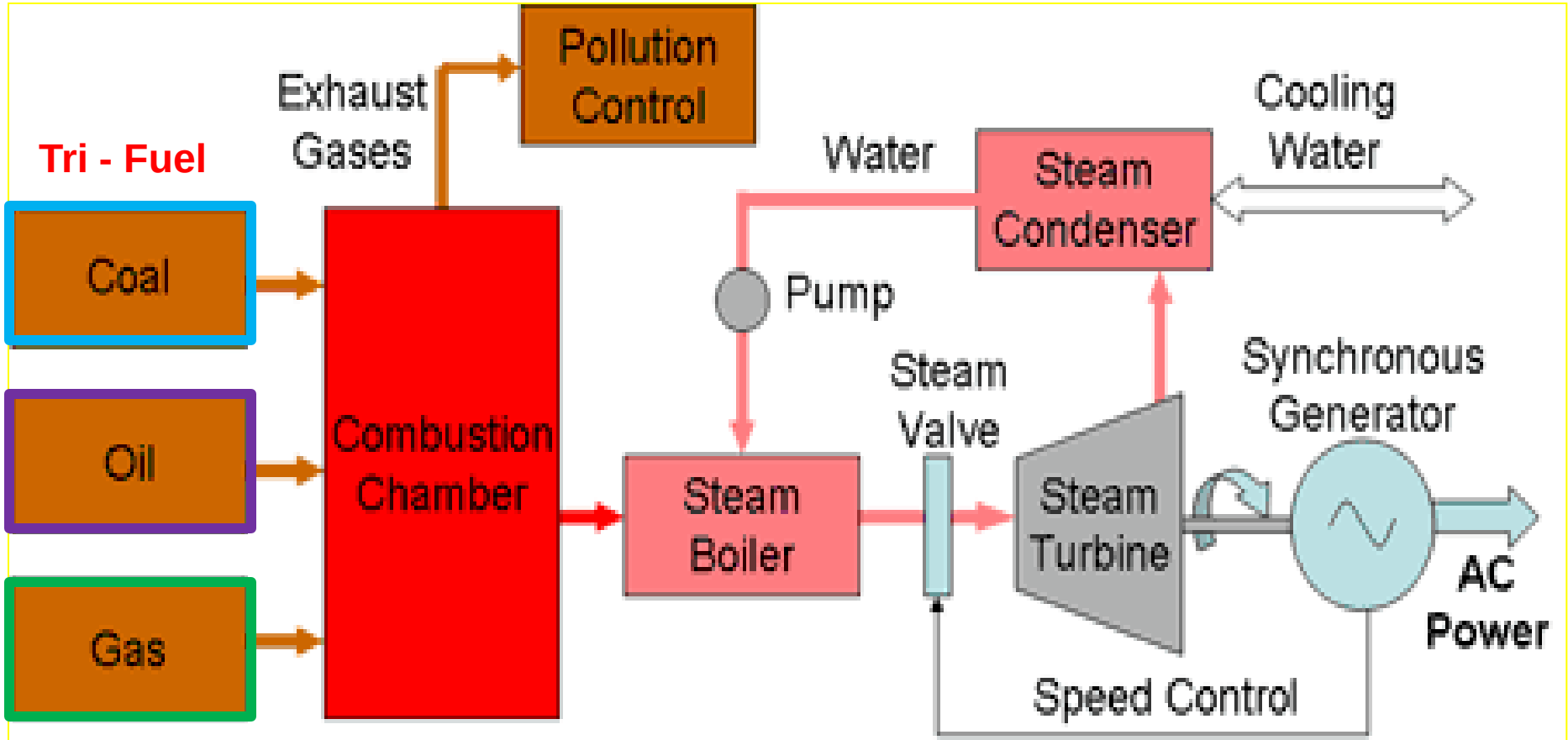
Tri-Fuel Steam Boiler Electric Generation

Molecular Energy by: DTC Solutions



Fossil Fuel Powered Steam Turbine Electricity Generation

30 – 35% Thermodynamic Eff

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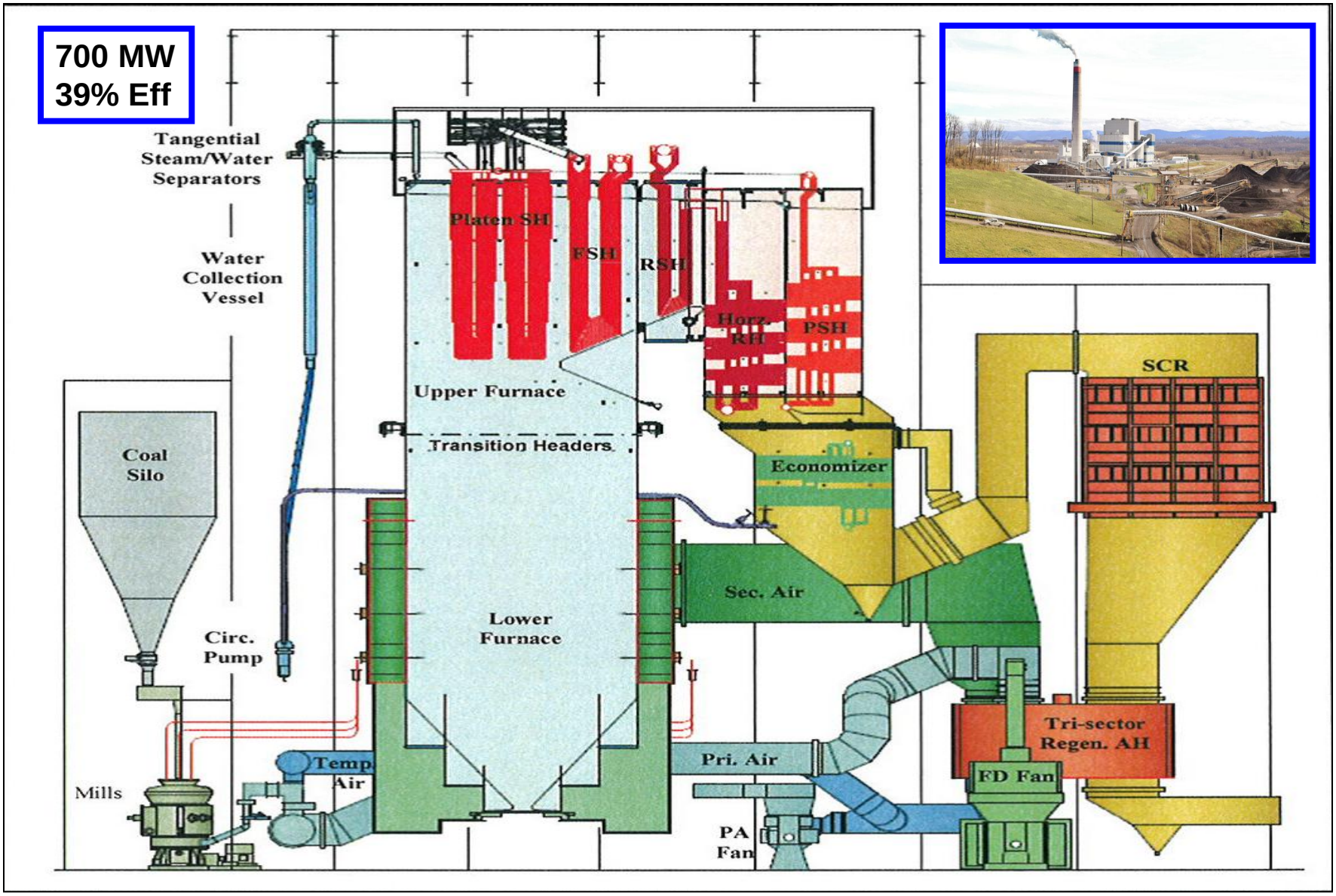
Longview Supercritical Coal-Fired Power

Molecular Energy by: DTC Solutions

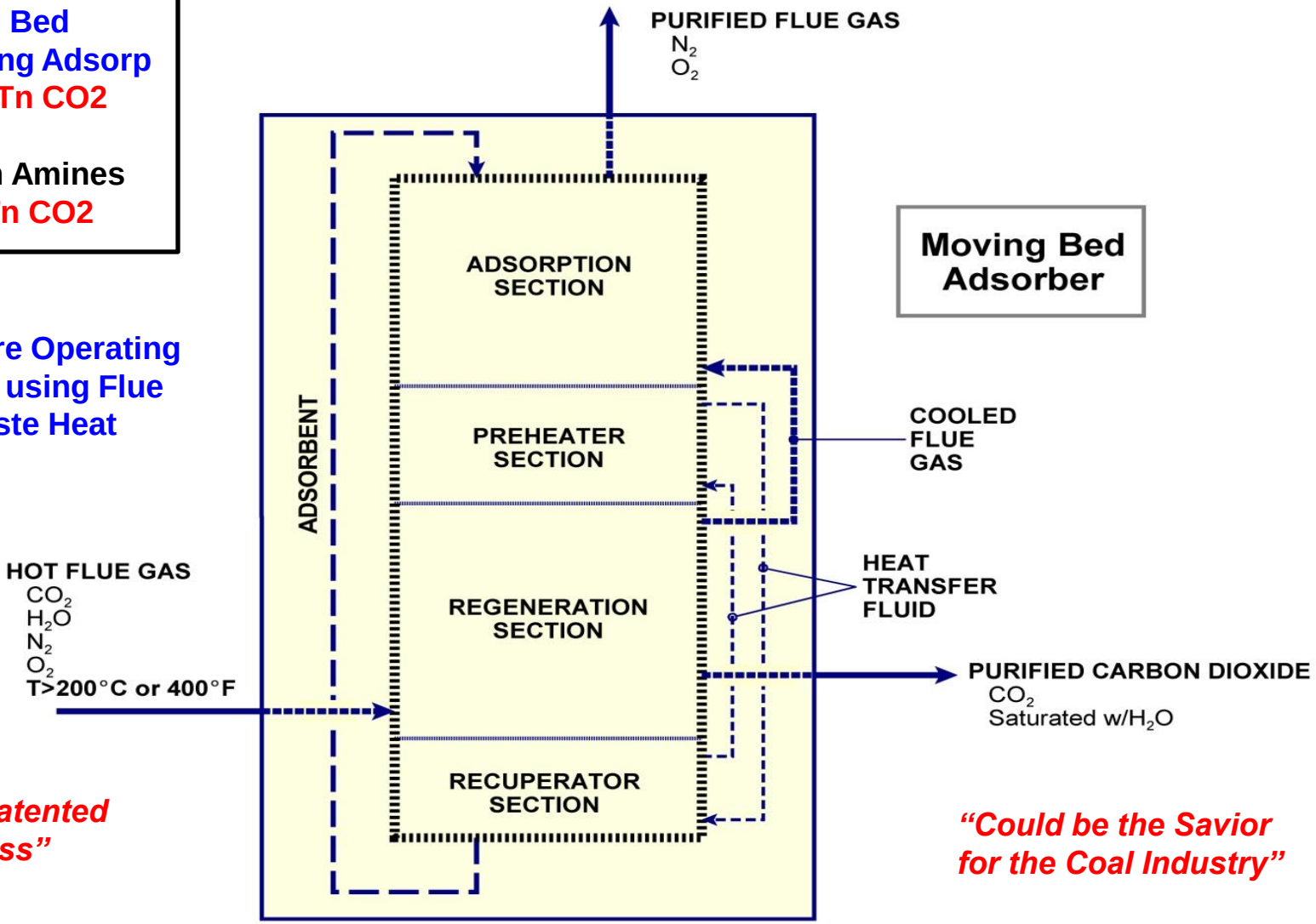


CO_2 Capture from Flue Gas via Moving Bed TSA

Molecular Energy by: DTC Solutions

Moving Bed
Thermal Swing Adsorp
= < $ 20 / Tn CO2
vs
Absorption Amines
= $ 80 / Tn CO2

Low Pressure Operating Conditions using Flue Gas Waste Heat



"Unique Patented Process"

"Could be the Savior for the Coal Industry"

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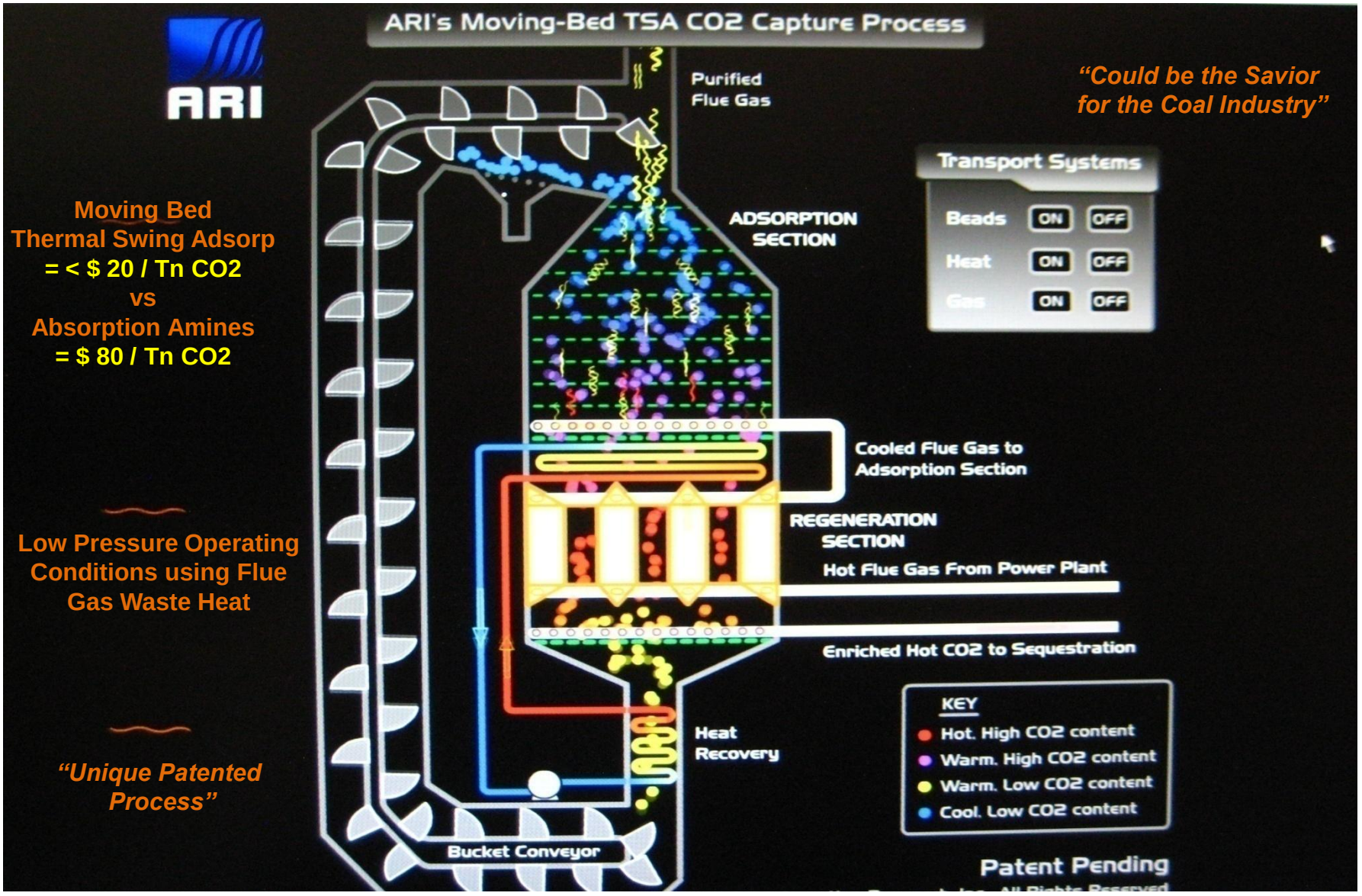
CO_2 Capture from Flue Gas via Moving Bed TSA

Molecular Energy by: DTC Solutions

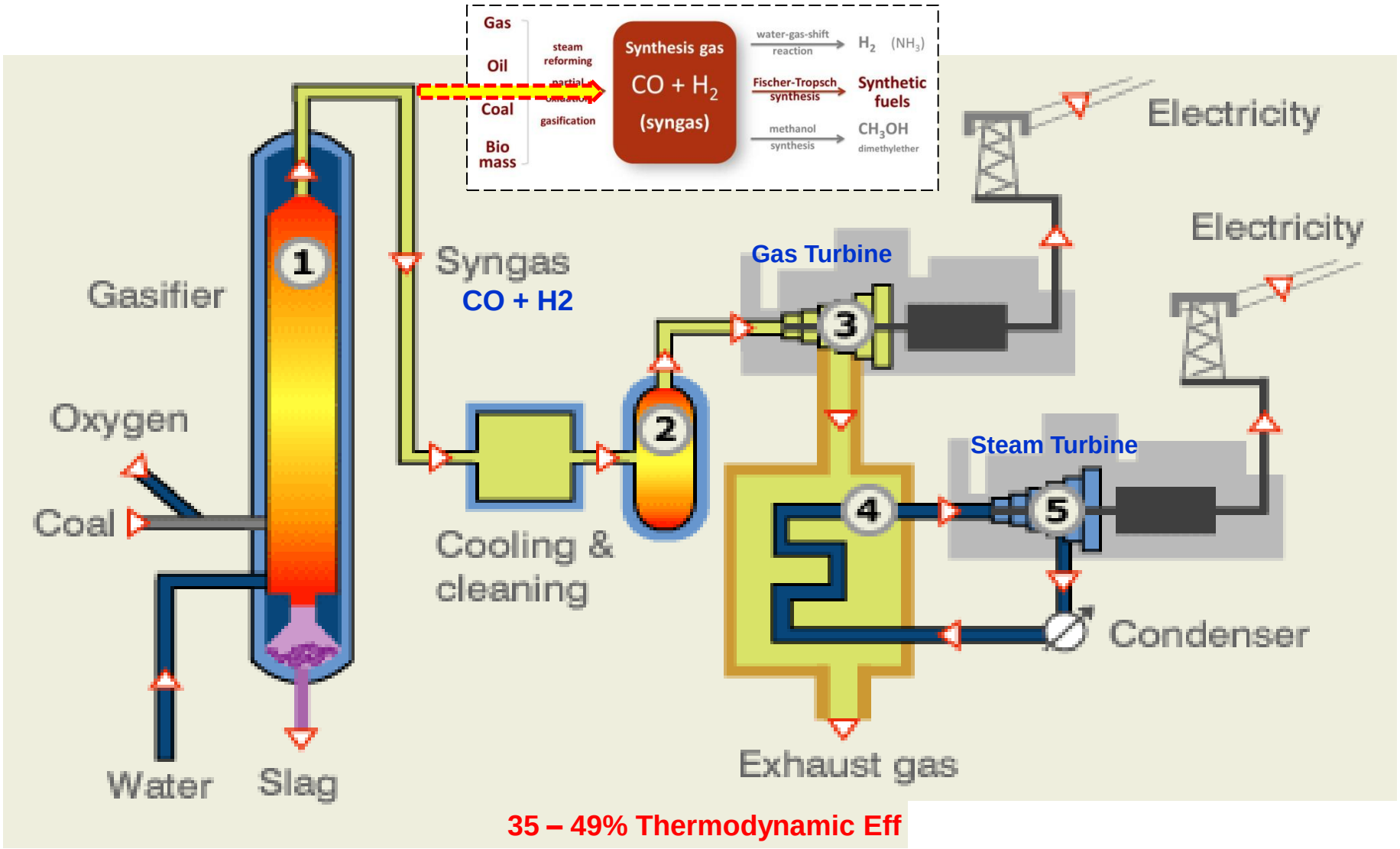


Moving Bed Thermal Swing Adsorp = < $ 20 / Tn CO2 vs Absorption Amines = $ 80 / Tn CO2

Low Pressure Operating Conditions using Flue Gas Waste Heat

"Unique Patented Process"

Integrated Gasification Combined Cycle - IGCC

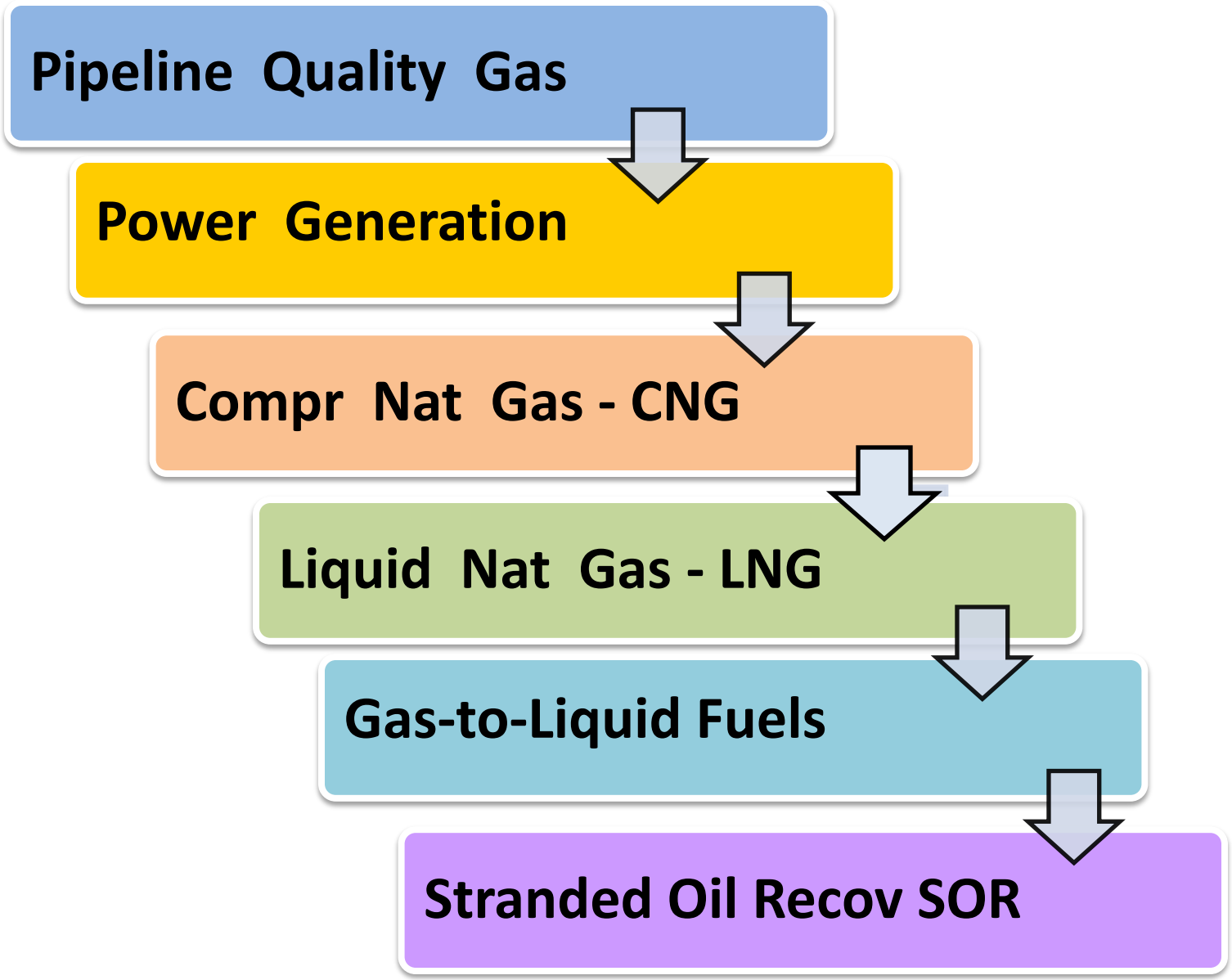


35 – 49% Thermodynamic Eff

DAMICO.CORP@VERIZON.NET

Coal Bed Methane - Utilization

Molecular Energy by: DTC Solutions



Stranded Oil Recovery

Molecular Energy by: DTC Solutions

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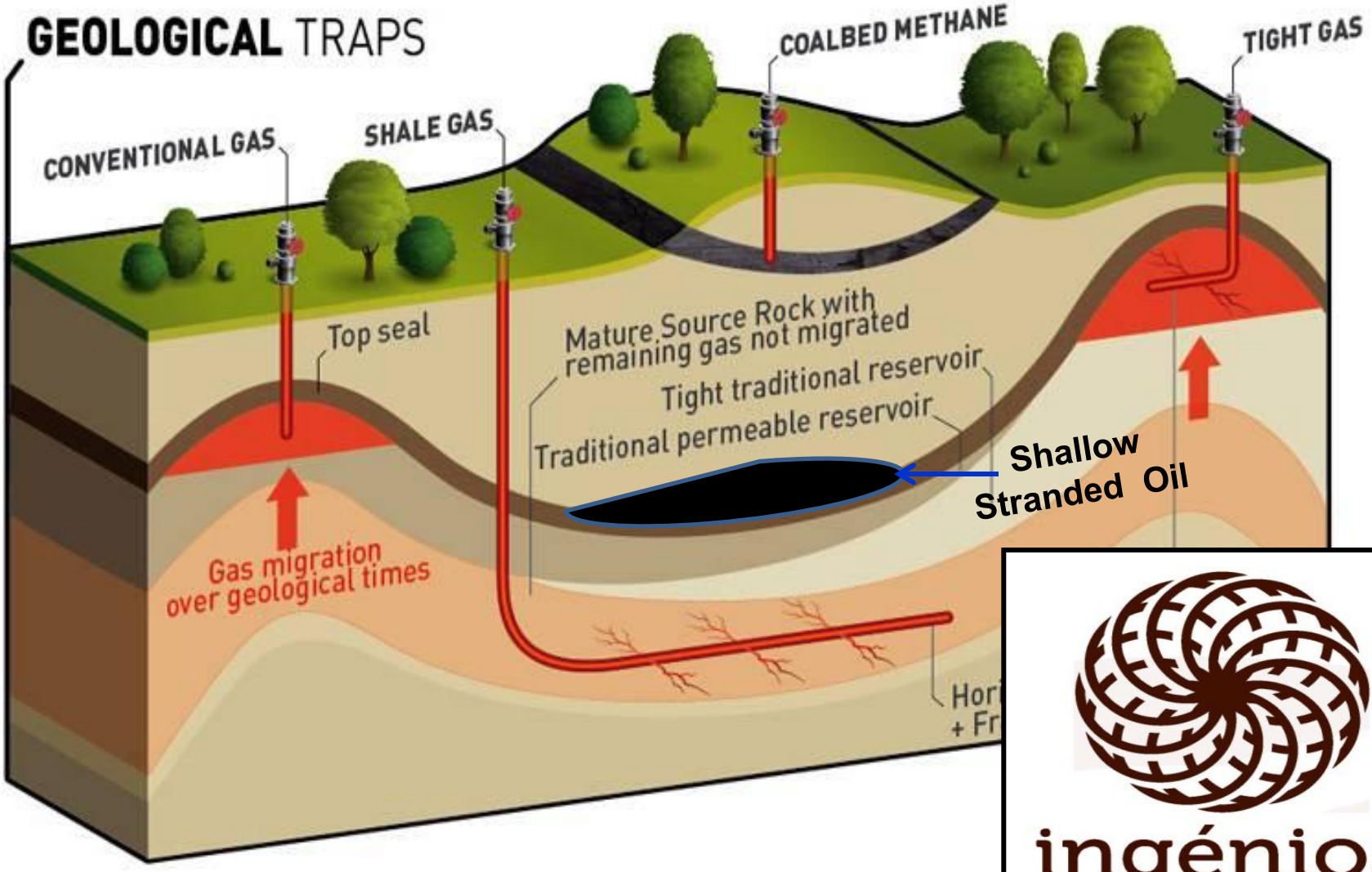
Stranded Oil Recovery with High Pressure Water Borehole Extraction

A D'Amico Technologies Group Company

Stranded Oil Recovery	From:	**Known Reservoirs**
4 Days: Start - Finish	Yields:	**Efficient & Fast Oil Recovery**
Fraction of Conventional Drilling Costs	Results:	**High Rate of Return**

Ingenios Energy Resources



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Ingenios Energy Resources

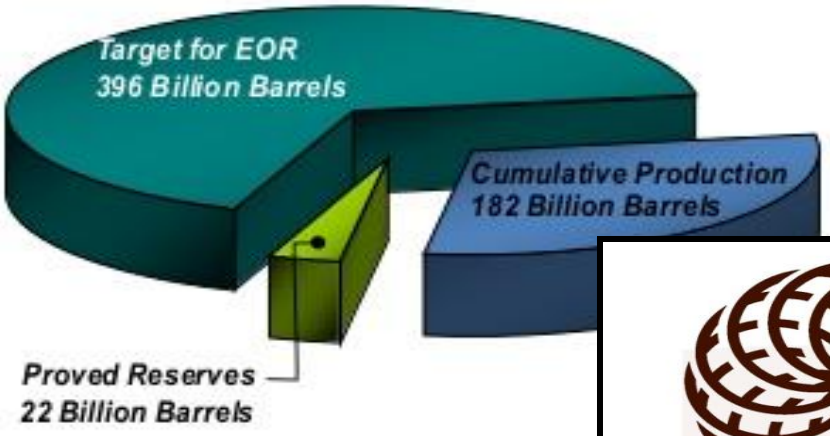
The "Size of the Prize?"

Large volumes of oil remain "stranded" in U.S. reservoirs after traditional recovery.

400 BILLION BARRELS OF OIL IN MAIN PAY ZONES.

Original Oil In-Place: 600 B Barrels

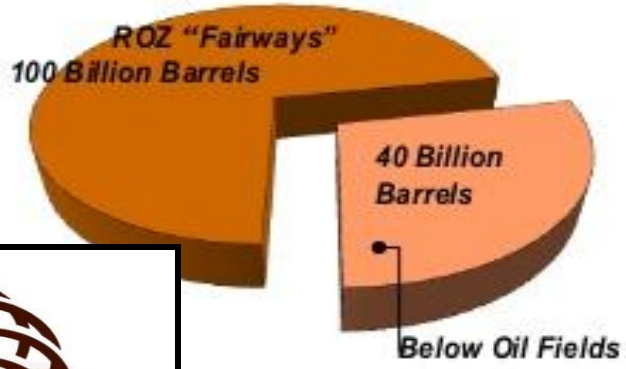
"Stranded" Oil In-Place: 396 B Barrels



Source: Advanced Resources Int'l. (2011); Melzer Consulting (2

140 BILLION BARRELS OF OIL IN RESIDUAL OIL ZONES (ROZs).

Oil In-Place: 140 B Barrels*



"Fairways" of the Permian Basin fields in 3 U.S. basins

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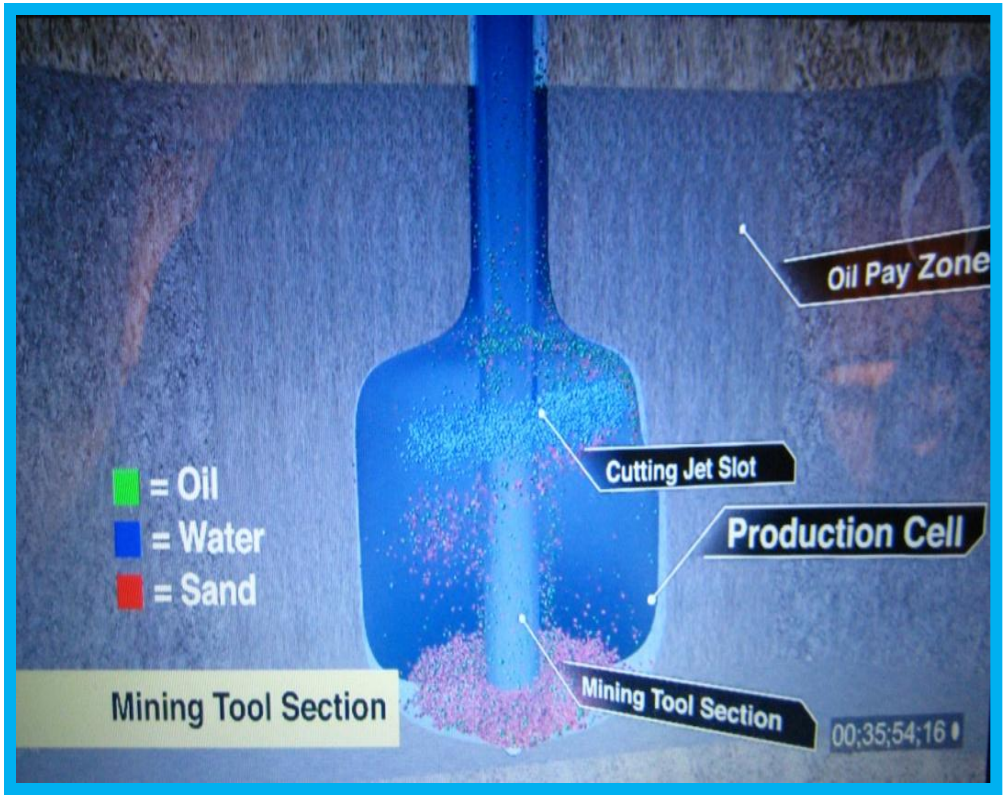
How Our System Works

"Mining for Oil"

- **Production cell stats:**
  - **Size:** 32.5' radius, 40' vertical height
  - **Time:** 4 days from start to finish
  - **Volume:** 4000 barrels of oil



Stranded Oil Recovery - USA

Molecular Energy by: DTC

Solutions

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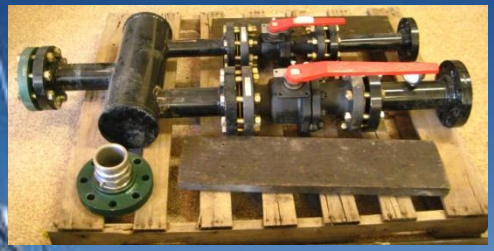
Bore Hole Extraction (BHE) Drilling Tools

BHE Wellhead Postionor



BHE Pump Manifold

BHE Cutting Tool

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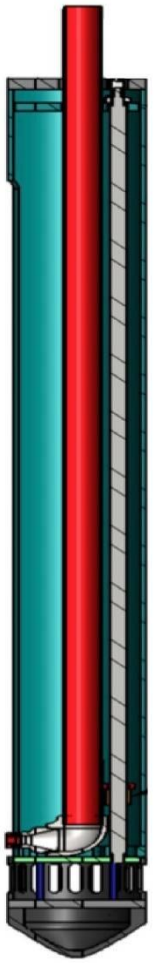
Borehole Extraction System



- **The System**
  - Disintegrates oil rich ore body
  - Makes oil when it reaches pay zone
  - Safe and environmentally protective

- **Cost Effective and Efficient**
  - No exploration costs
  - A fraction of conventional operating costs
  - Zero future administrative and operational cost

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How Our System Works

- **Production cell stats:**
  - **Size:** 32.5’ radius, 40’ vertical height
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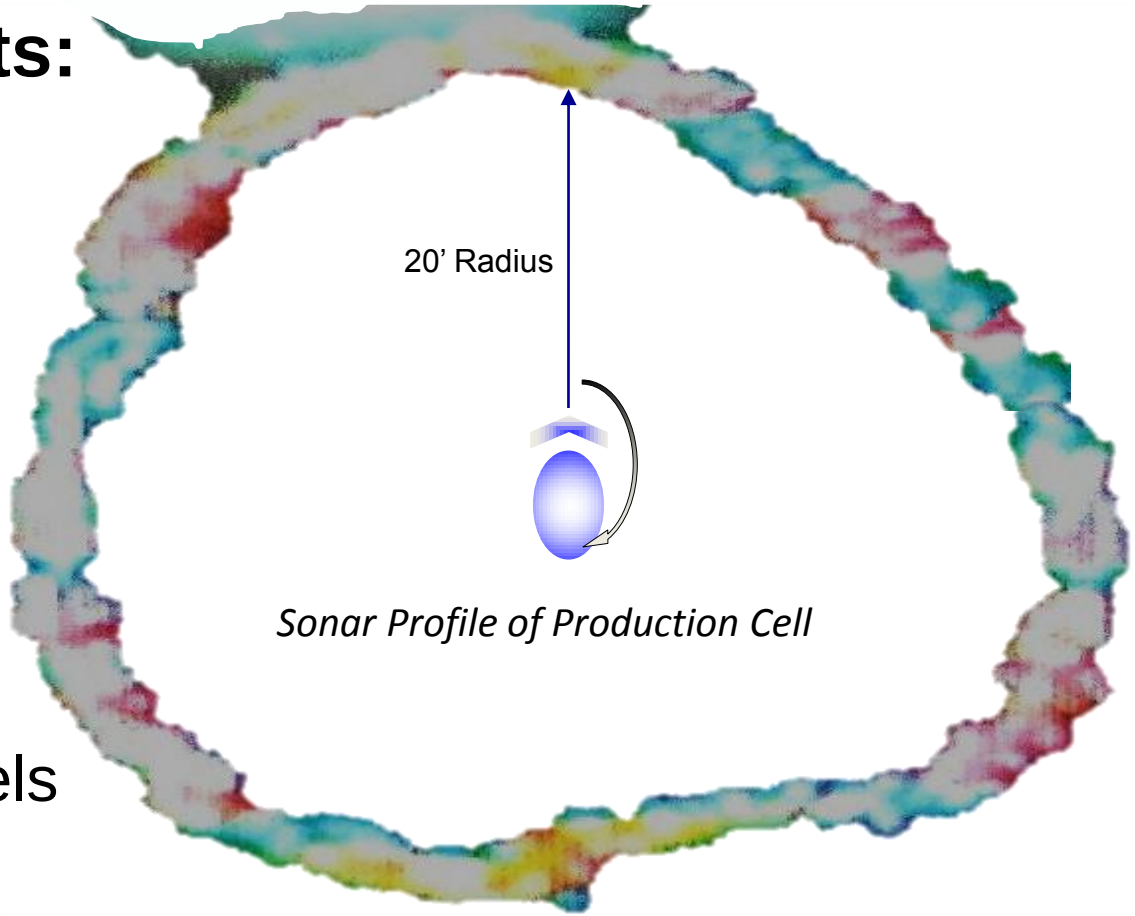

Sonar Profile of Production Cell

Use Coal & Nat Gas Wisely

Molecular Energy by: DTC Solutions

Targeted Objectives

Using the Best Technology

U.S. EPA Coalbed Methane OUTREACH PROGRAM

Let's Target Coal Mine Methane & Stranded Oil Projects Together

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