NET Power

Truly Clean, Cheaper Energy

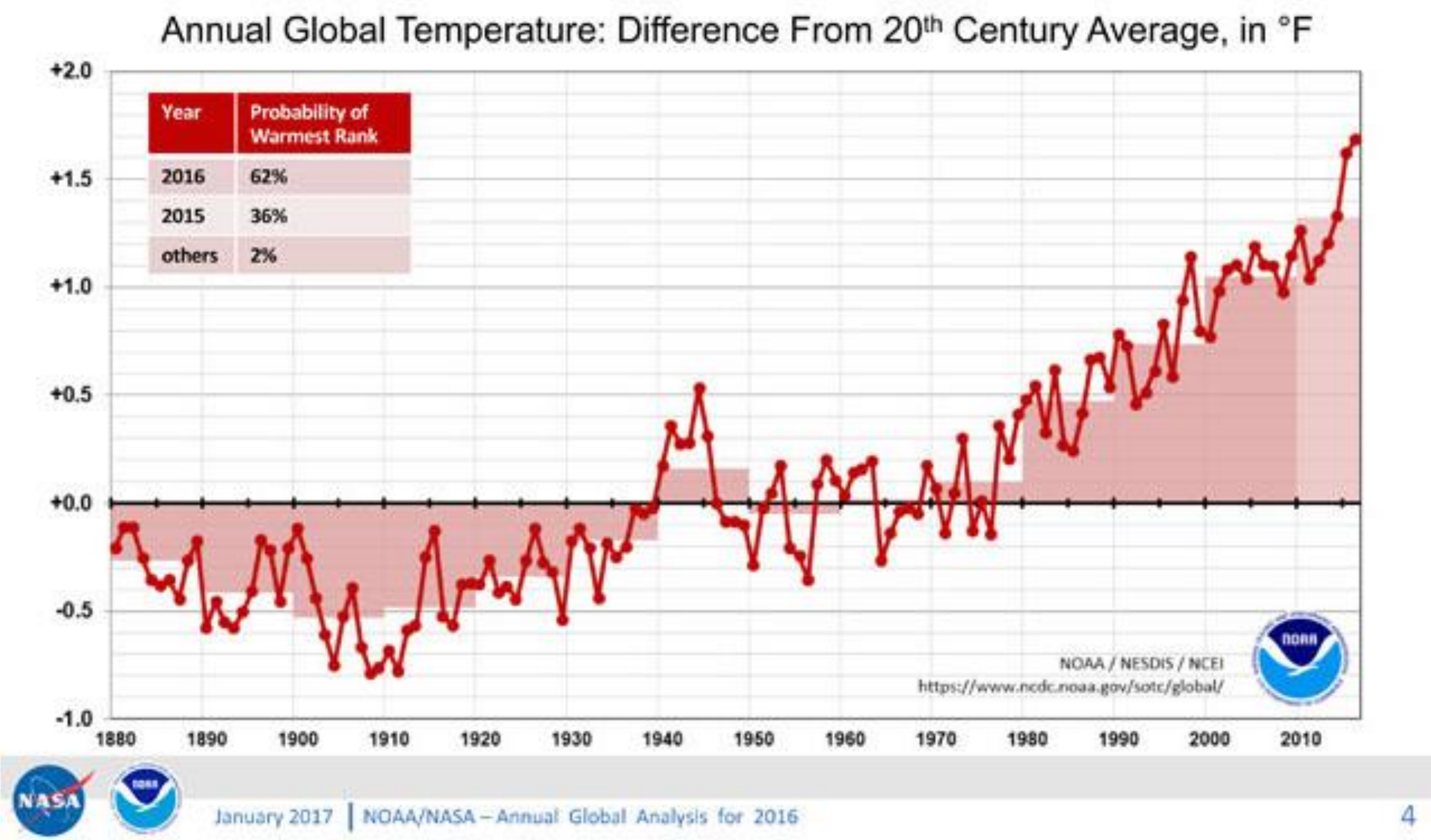
CARBON MANAGEMENT TECHNOLOGY CONFERENCE

July 19, 2017

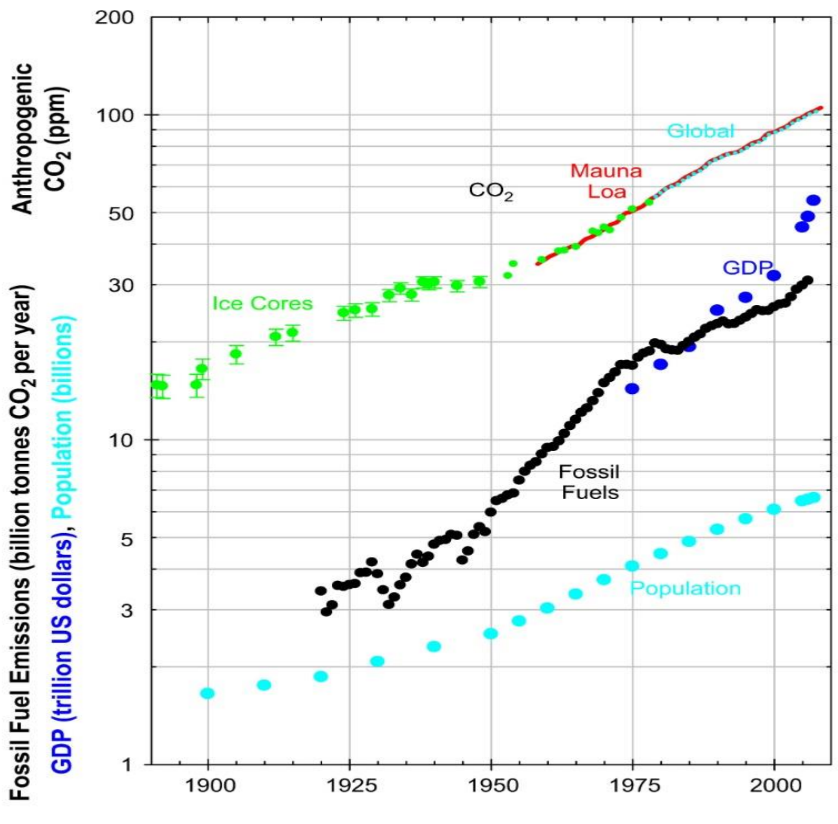
Taking Stock

Where We Are

It's Getting Hotter



Greenhouse gases are part of the problem



… and greenhouse gases are a function of

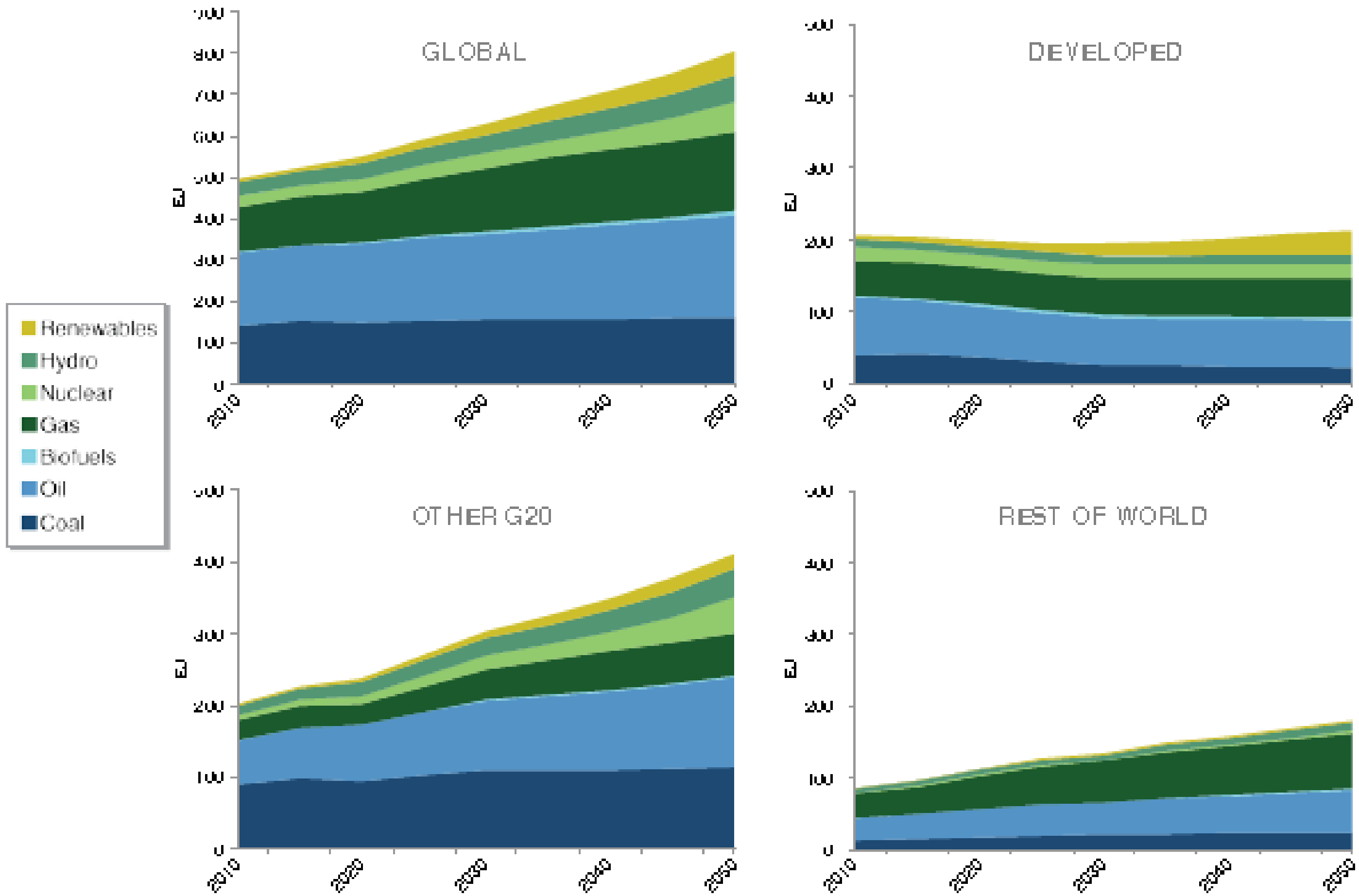
- *fugitive* carbon
- from our energy sources (among other places!)

… which, in turn, are a function of

- GDP
- Population

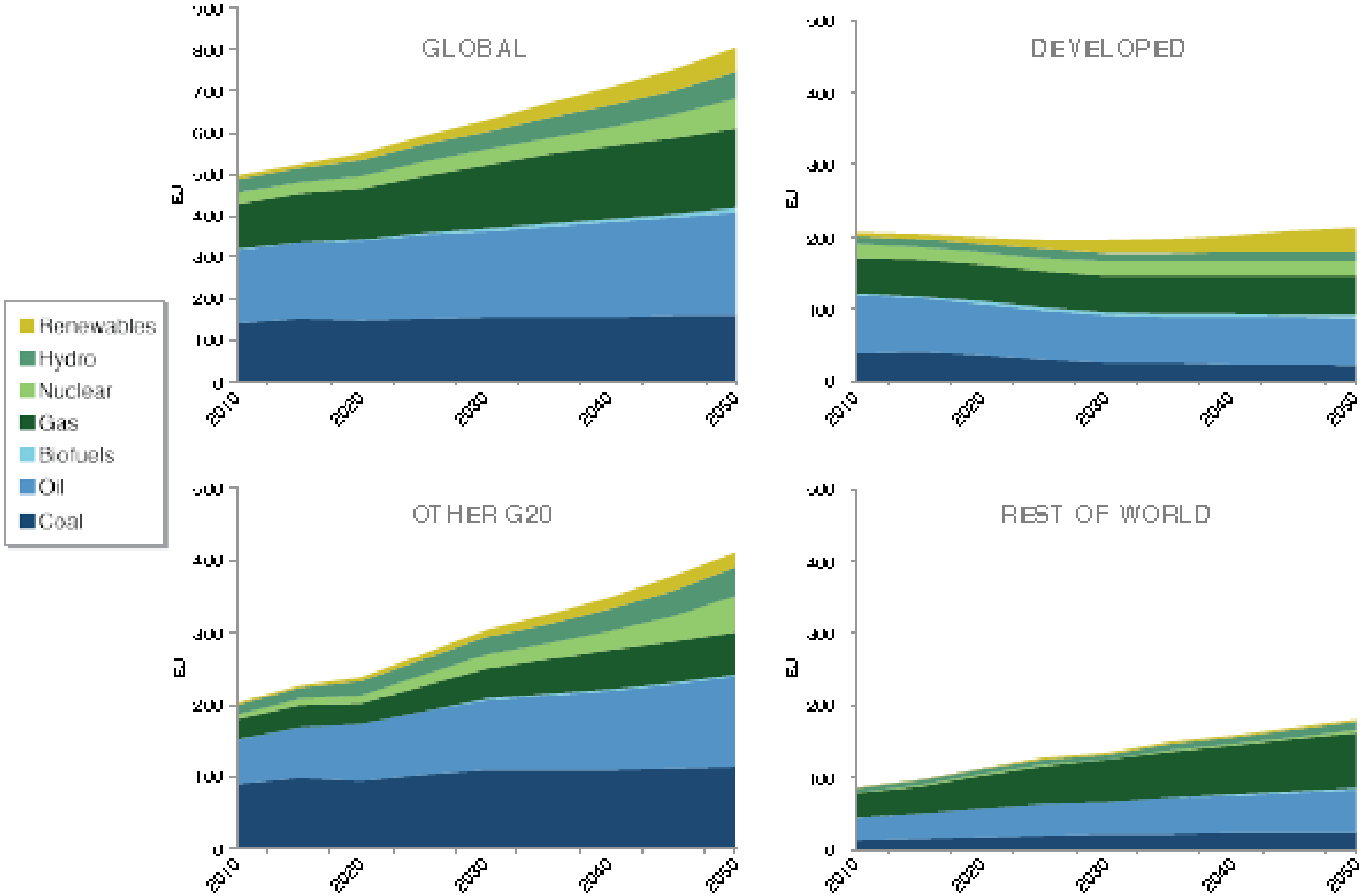
What to do?

The future as seen by some smart people



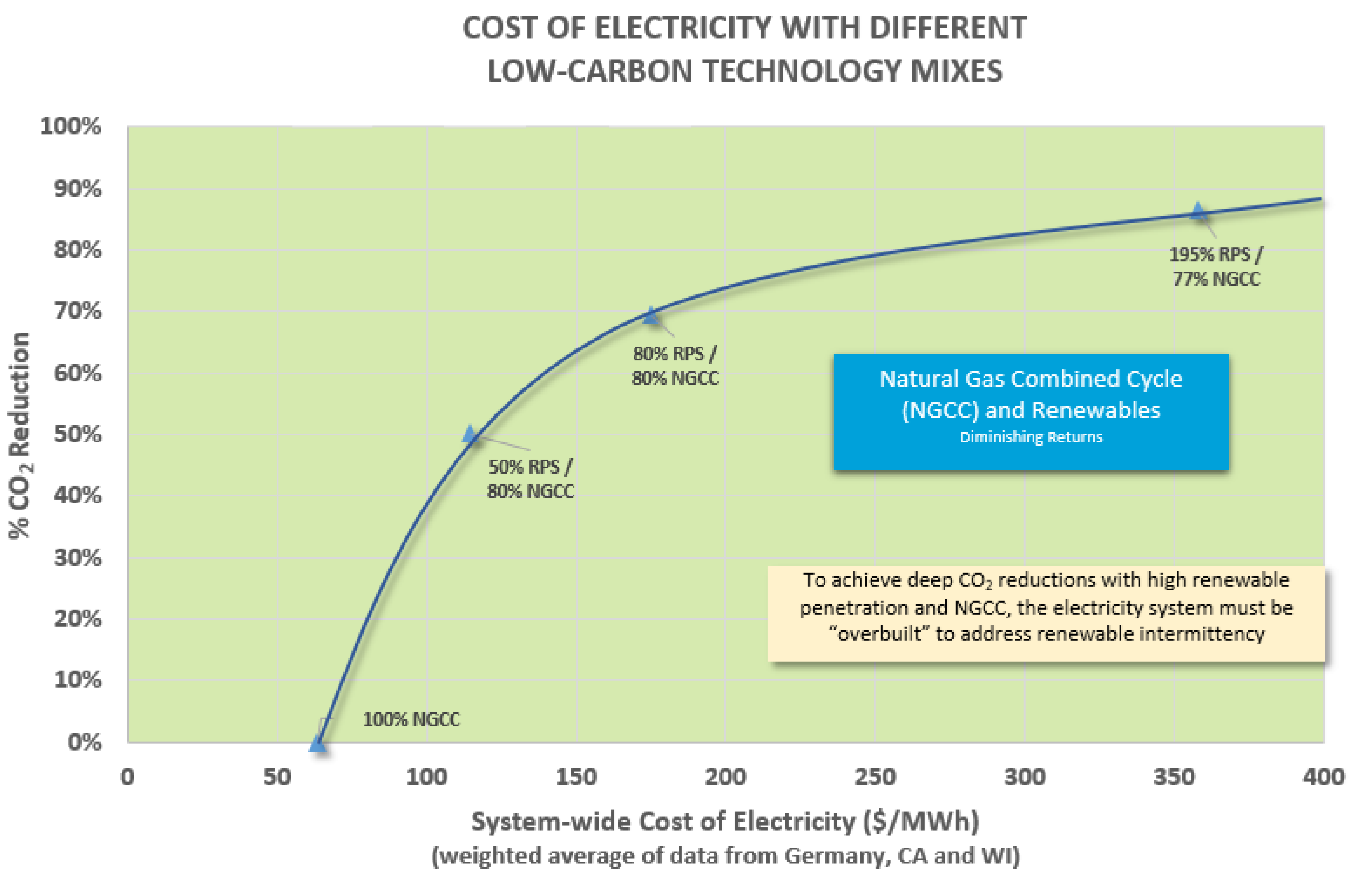
MIT Joint Program on the Science and Policy of Global Change—Food, Water, Energy, Climate—Outlook: Perspectives from 2016

Renewables are promising, but cannot do it alone



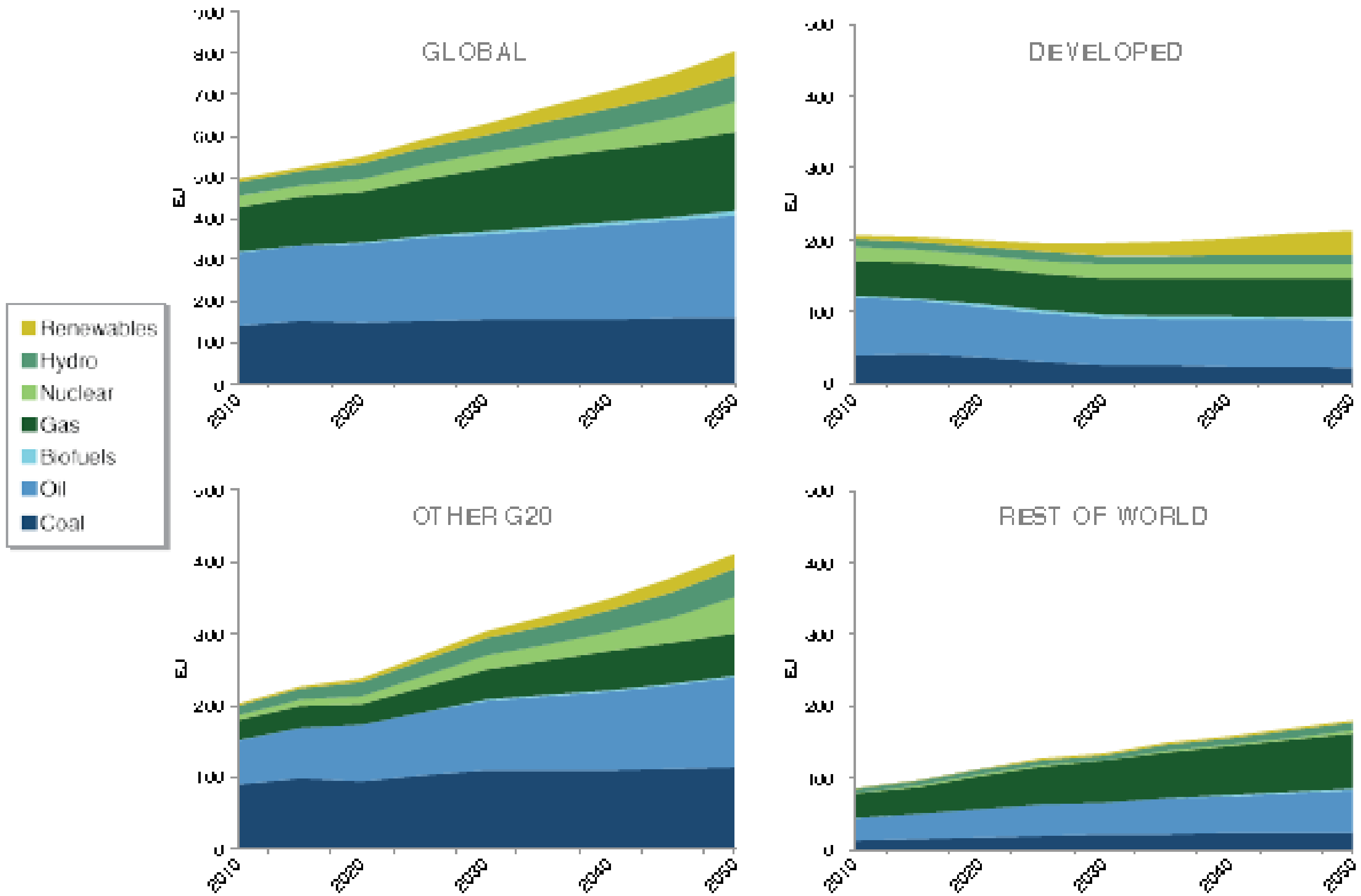
MIT Joint Program on the Science and Policy of Global Change—Food, Water, Energy, Climate—Outlook: Perspectives from 2016

Why can't renewables do it?



Data obtained from: Brick, S., and Thernstrom, S., Renewables and decarbonization: Studies of California, Wisconsin, and Germany, *The Electricity Journal,* 2016, 29, 6-12.

Nuclear is a great, but it also cannot do it alone



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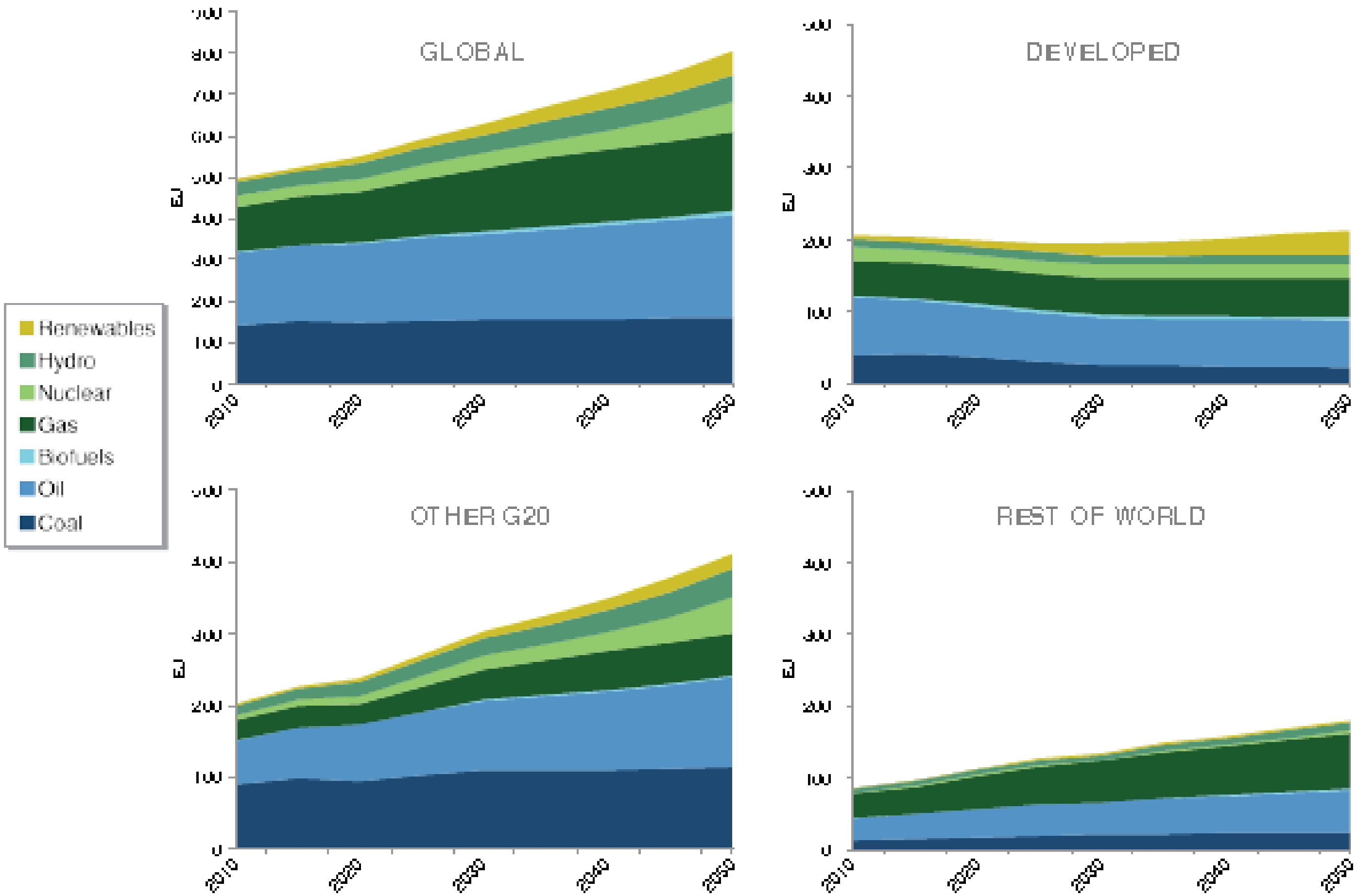
As a result, fossil fuels will be the core of the future



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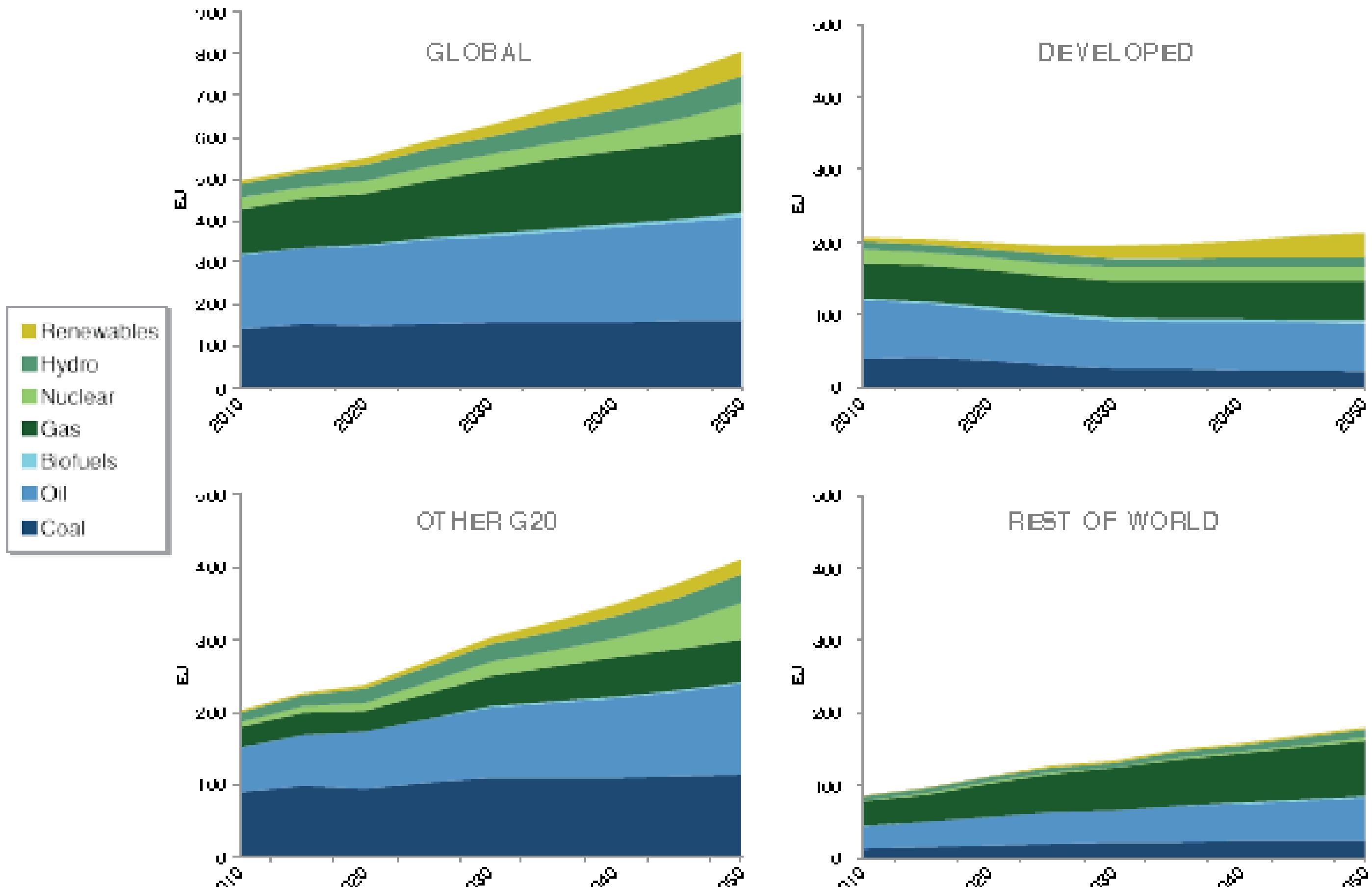
And, if we don't fix fugitive carbon, we don't solve the problem



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We Have a Strong Team

Capture

Use

Implementation, policy and research

And We Are Making Things Happen

July 19, 2017

NETPOWER


Century Project


Enid Fertilizer Project


ExxonMobil Shute Creek/LaBarge Project


Chevron Gorgon Project


Great Plains Synfuels Project


Illinois Industrial CCS Project


In Salah Project


LanzaTech Freedom Pines


NRG Petra Nova Project

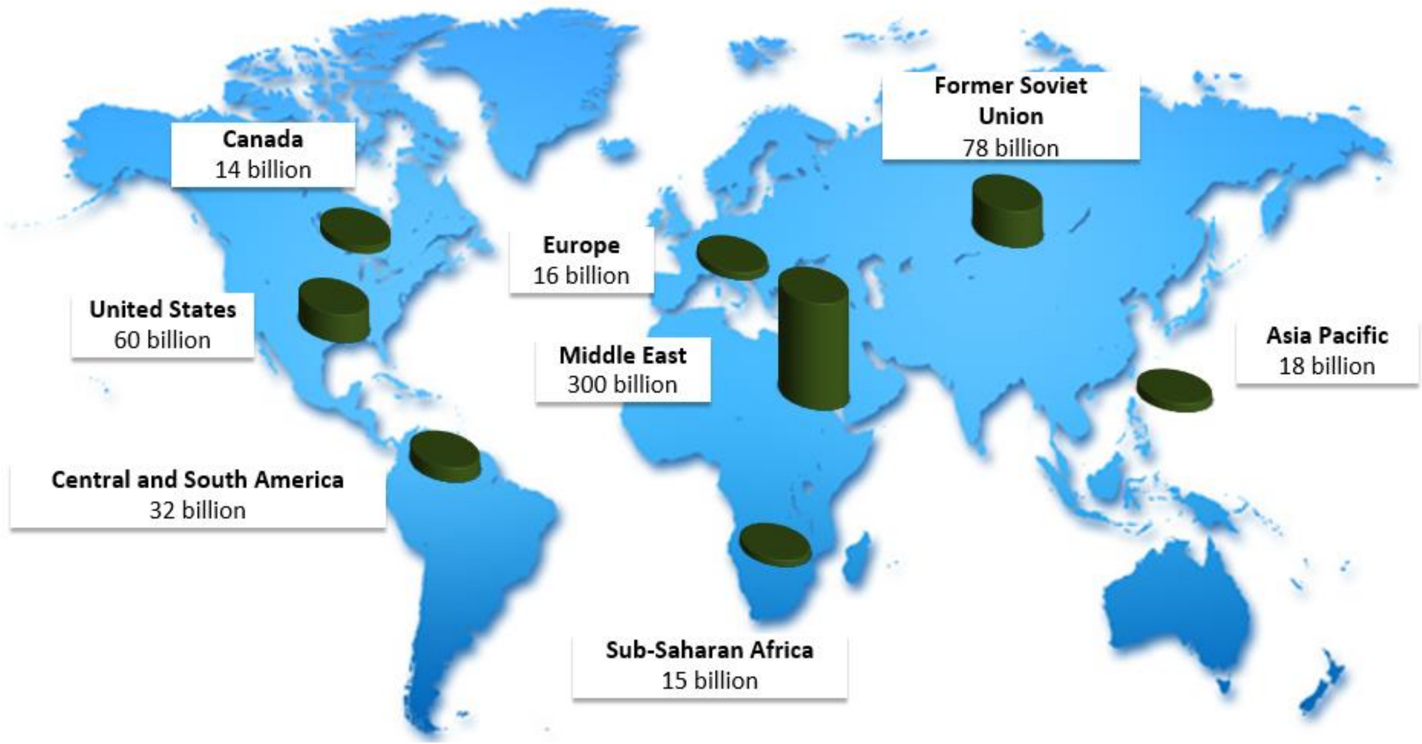

Quest


Sleipner


NET Power, Exelon, CB&I and 8 Rivers

And we know what to do with the CO_2

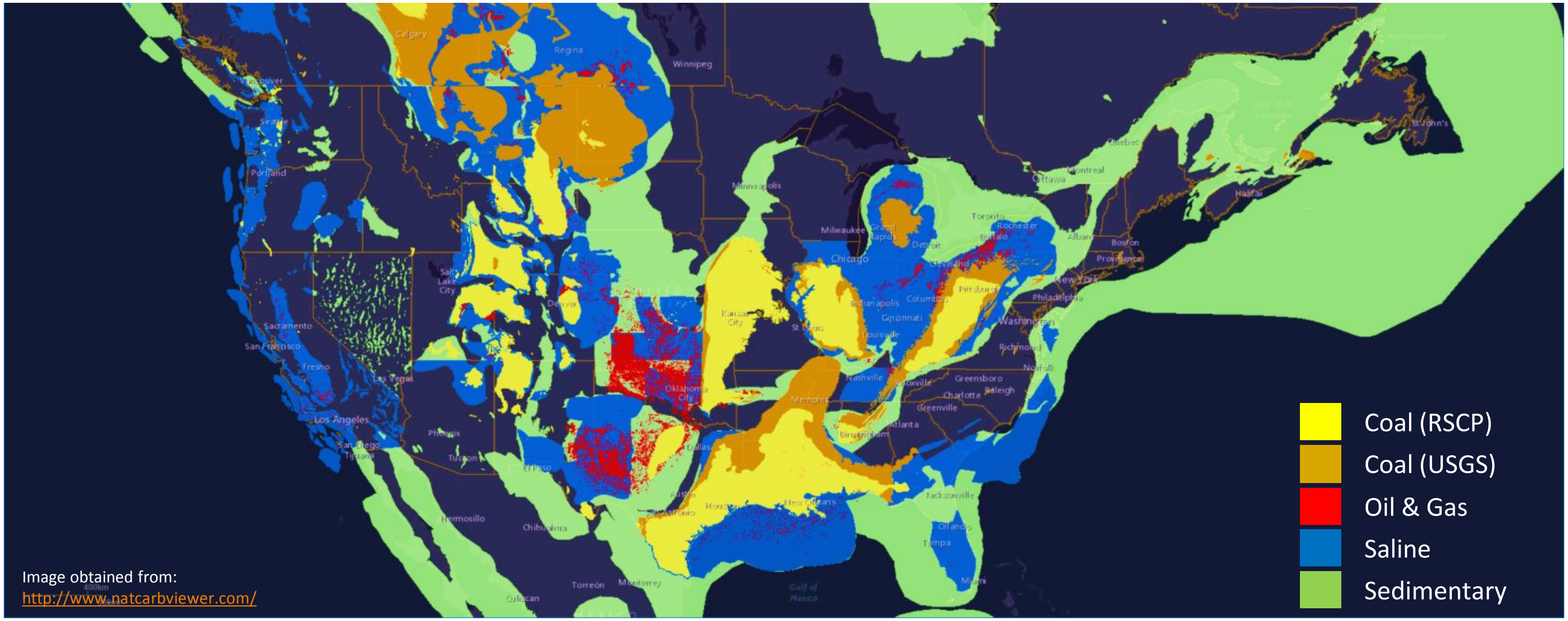
CO_2 Use: EOR, Huge Opportunity



Global perspective: 1.1B tons of CO_2 required to recover 470 billion barrels of oil

CO_2 Use: Sequestration, 2,600 billion metric tons[1]

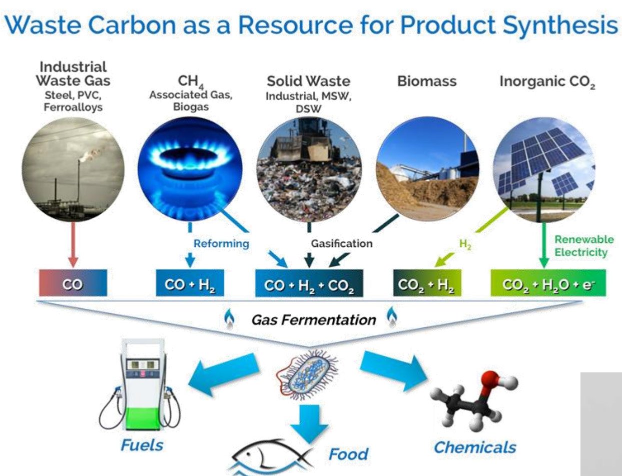
Locations with Acceptable Geology for CO_2 Sequestration in the U.S.



- **The federal 45Q tax credit puts CCS on a level playing field**
- **21 states have incentives and policies in place the provide value or preferential treatment to NET Power for capturing CO_2**

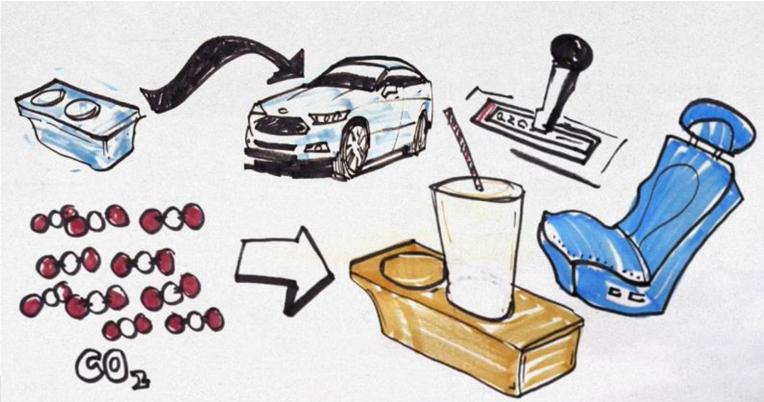
1. DOE & NETL Carbon Storage Atlas (Atlas V), 5th edition, 2015

CO_2 Use: Conversion to value added products



http://www.lanzatech.com

LanzaTech SIEMENS PETRONAS



http://www.novomer.com

NOVOMER aramco Ford

http://solidiatech.com

Solidia Technologies bp BASF We create chemistry

Wow

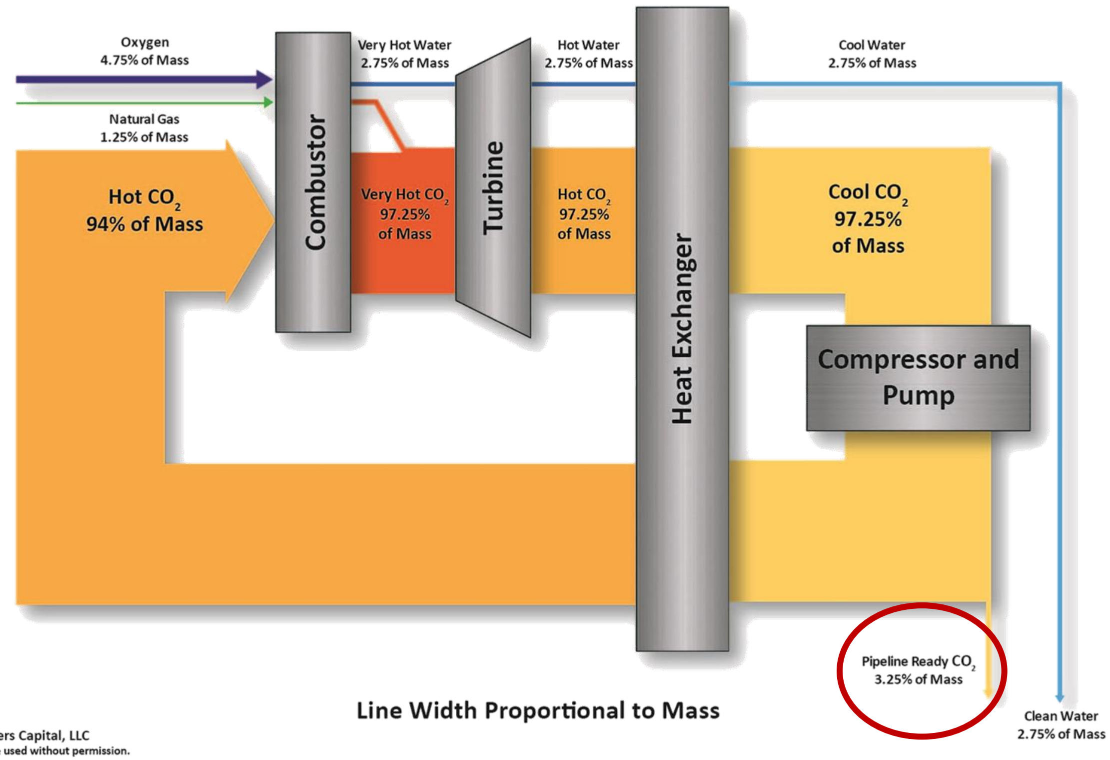
What NET Power is Doing

NET Power

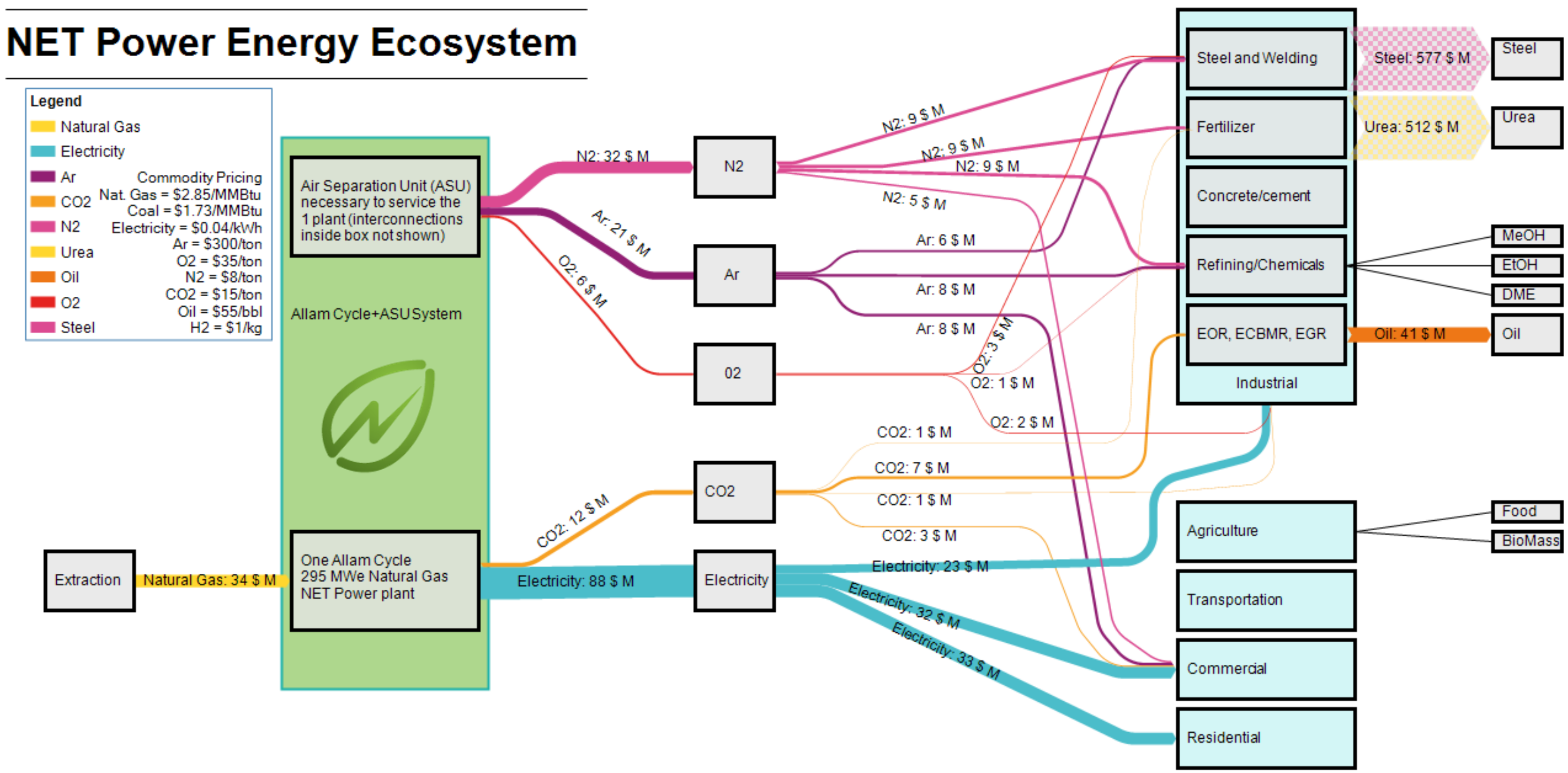
- **Electricity from natural gas**
- **Costs competitive** with existing natural gas power plants
- **Captures or eliminates** substantially all of the carbon and non-carbon atmospheric emissions *without any additional cost*
- **Water not required** (at a small reduction in efficiency)
- **Can use inexpensive fuels** such as acid gas, sour gas, associated gas, and produced gas
- **Also produces** important gases, including N_2, O_2 and Ar

The supercritical CO_2 Allam Cycle is simple

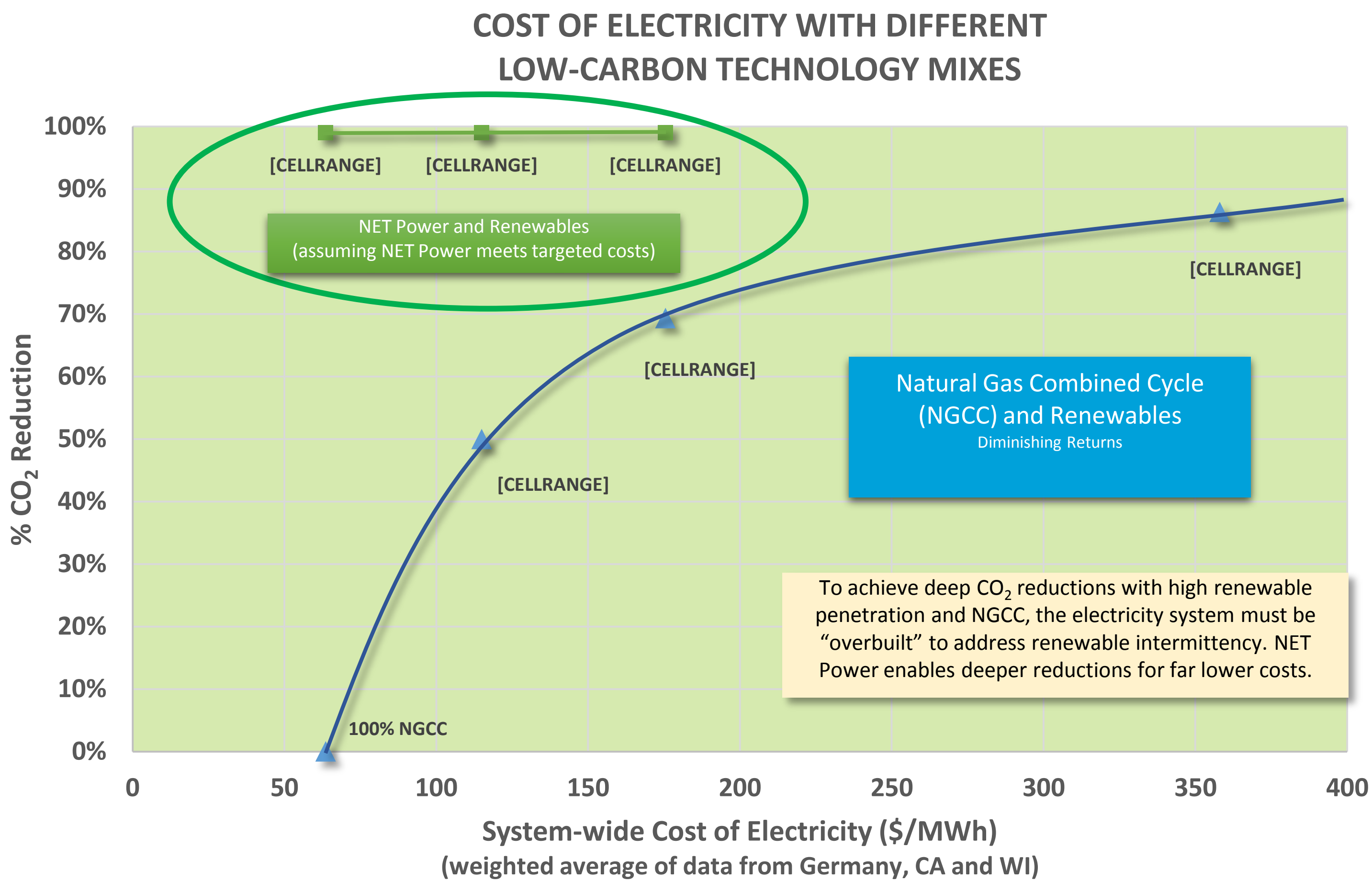
- **Historically, CO_2 capture has been expensive, whether using air to combust or oxy-combustion**
  - Air combustion
    - $\underbrace{8N_2 + 2O_2}_{air} + CH_4 \rightarrow \underbrace{8N_2 + CO_2}_{expensive\ to\ separate} + 2H_2O$
  - Oxy-combustion
    - $\underbrace{2O_2}_{expensive\ to\ produce} + CH_4 \rightarrow CO_2 + 2H_2O$
- **The Allam Cycle makes oxy-combustion economic by:**
  - Relying on a more efficient core power cycle
  - Recycling heat within the system to reduce O_2 and CH_4 consumption, and associated costs of the ASU



NET Power is about more than electricity



NET Power partners with renewables to avoid diminishing returns

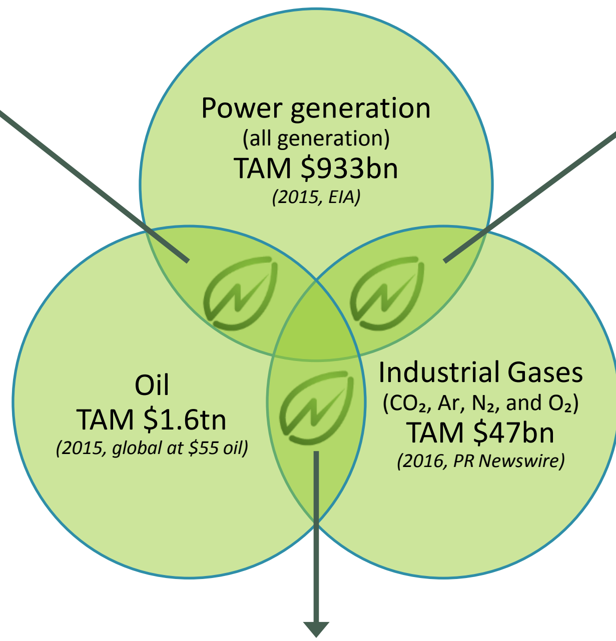


Data obtained from: Brick, S., and Thernstrom, S., Renewables and decarbonization: Studies of California, Wisconsin, and Germany, *The Electricity Journal,* 2016, 29, 6-12.

Total global addressable market: $749 billion

Petrochemicals
~$419bn
(2015, Grand View Research)

Zero-emissions power
~$303bn
(2015, EIA)



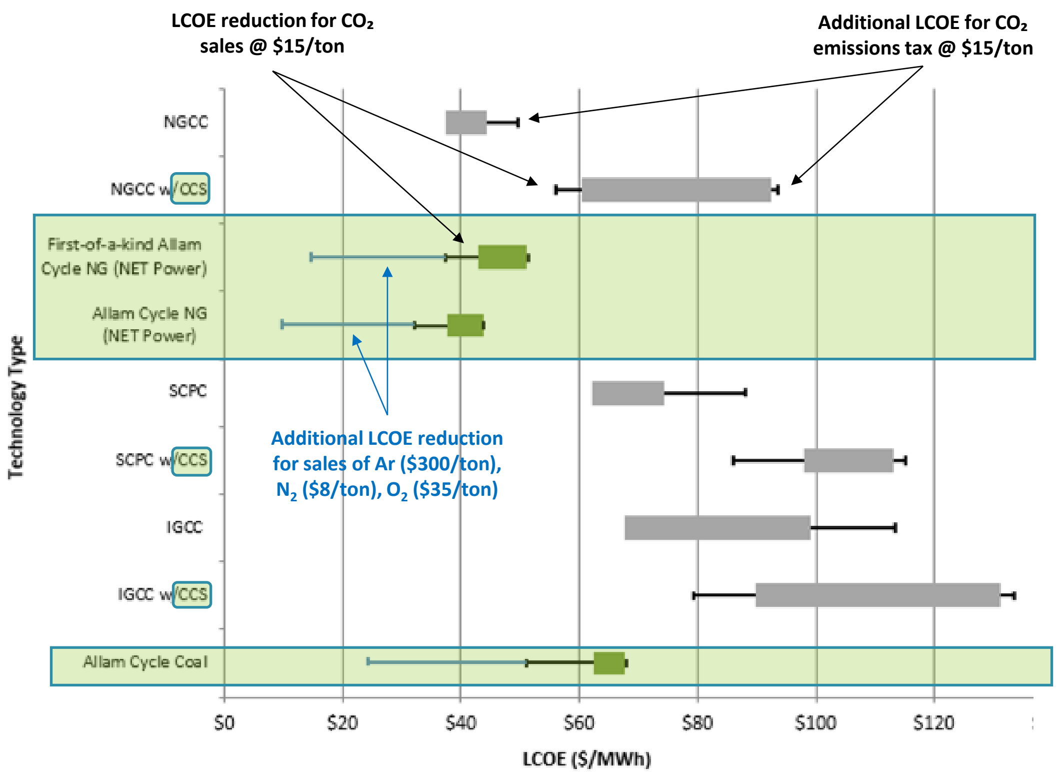
Enhanced oil recovery
*~$27.6bn (2014 global; at $55 oil) **represents only 0.04%** of total identified global EOR potential*
(2014, O&G Journal EOR Survey and 2013, Kuuskraa et.al.)

NET Power’s effective heat rate (LHV)

Price location dependent

Note: Heat rates are net of additional ASU parasitics for capture of specialty gases. Assumes gas costs are offset at $4.44/MMBtu LHV

NET Power is clean, low cost and efficient



1. LCOE calculated using EPRI methodology
2. Assumes natural gas at $2.85/MMBTU and coal at $1.73/MMBTU
3. Every move of $1 in natural gas moves LCOE $6
4. Cost ranges represent range of data combined from: EIA (2013), Parsons Brinkerhoff (2013); Black & Veatch (2012); DOE NETL (2012)

NET Power and Combined Cycle: Efficiency at ISO Conditions

Energy Components	HHV		LHV	
	F-Class US NGCC Plant (0% CC)*	NET Power NG Plant (100% CC)	F-Class US NGCC Plant (0% CC)*	NET Power NG Plant (100% CC)
Gross Turbine Output	51.06% (Compressors mechanically coupled)	74.65%	58.7% (Compressors mechanically coupled)	82.7%
CO_2 Compressor Power		-10.47%		-11.6%
Plant Parasitic Auxiliary Power	-0.86%	-11.01%	-1.2%	-12.2%
Net Efficiency	**50.20%**	**53.17%**	**57.5%**	**58.9%**

*Performance data from NETL Cost and Performance Baseline Report, 2013.

Parasitic Load Provides Opportunity for Efficiency Improvement	
ASU	91.8%
NG Compressor	8.2%

NET Power demonstration plant timeline

3/2016

Groundbreaking

12/2016

Toshiba turbine arrived on site

1/2017

Engineering 99% complete; construction over 50% complete

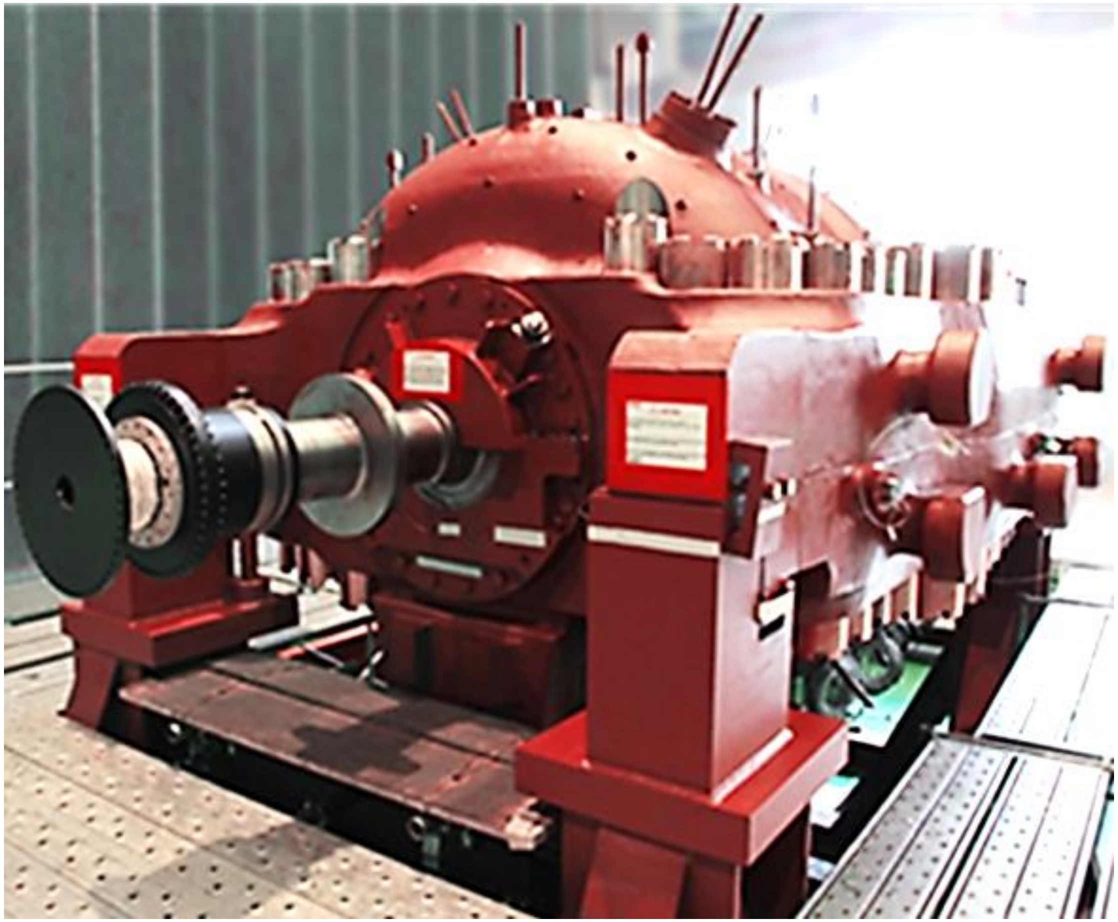
Q4 2017

Full first-fire testing full-scale combustor

Q1 2018

Connect to grid

Toshiba turbine on site



- 50MWth turbine is complete.
- Actually sized as 200 MWth, but uses only 1 combustor vs 4
- 500 MWth commercial turbine uses same technology

NET Power's demonstration plant is 95% complete

50 MWth Demonstration Plant

Commercial combustor complete with demonstration

Demonstration (50 MWth)

Commercial (500 MWth) = 10 x demonstration (50 MWth)

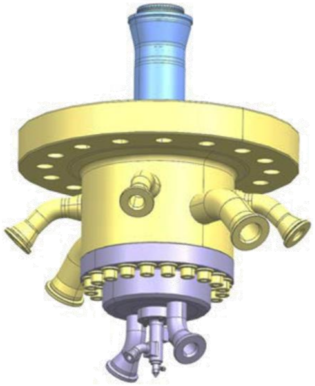
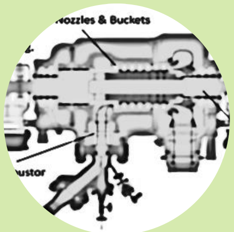


Image of Toshiba's NET Power combustor.

Image meant to be a visual aid for relative combustor-turbine configuration, not actual NET Power combustor configuration.

NET Power 1st commercial plant timeline



6/2013

Original Pre-FEED / Toshiba basic design

3/2016

Start building Demo Plant

9/2016

Pre-FEED initiated with demo lessons learned, performance optimization

1/2017

Toshiba Kick-off in Tokyo

1Q 2018

FEED for 1st commercial customer secured

2Q 2018

1st commercial plant MOU / order secured

1Q 2021

Targeting first Commercial start-up

World Class Partners

CB&I

Exelon

8 RIVERS

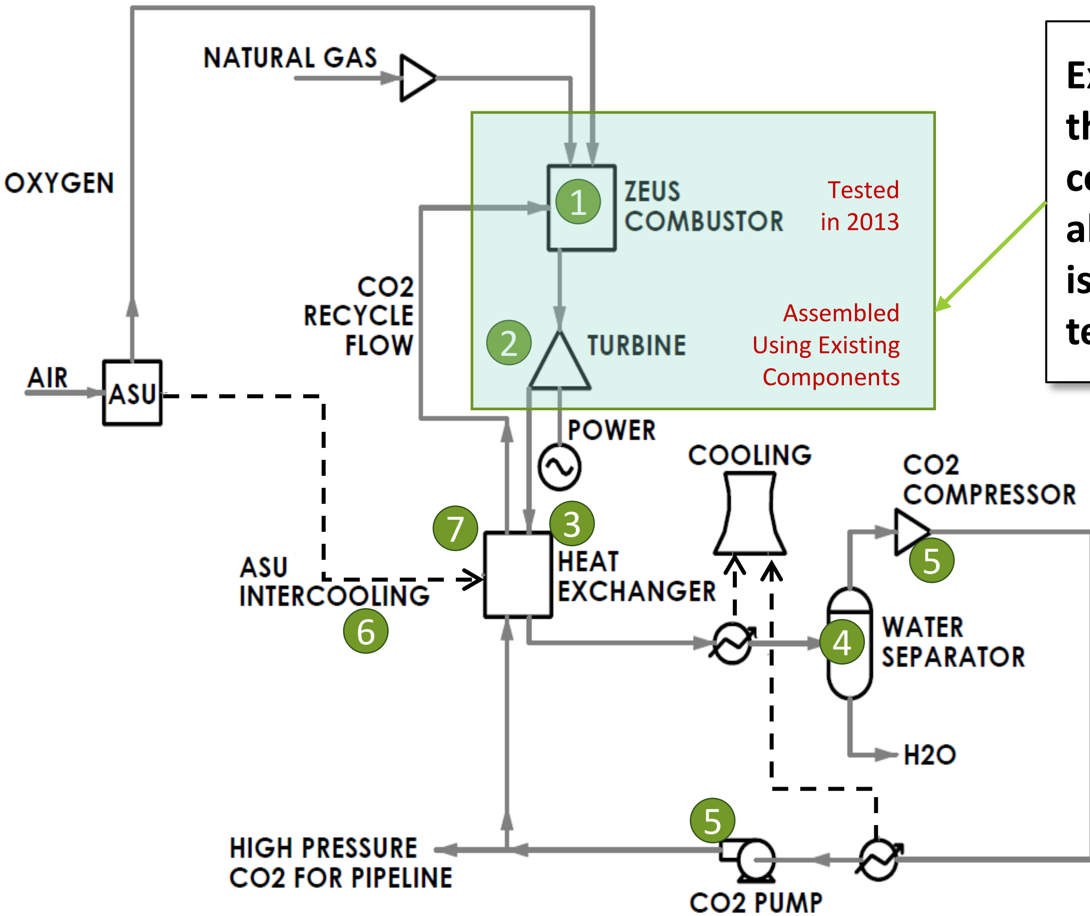
In the press

Gas Turbine World · Forbes · Science AAAS · Bloomberg Business · The New York Times · Vox · Energy Procedia ELSEVIER

Together we will solve this

Appendix

Allam Cycle Natural Gas Platform

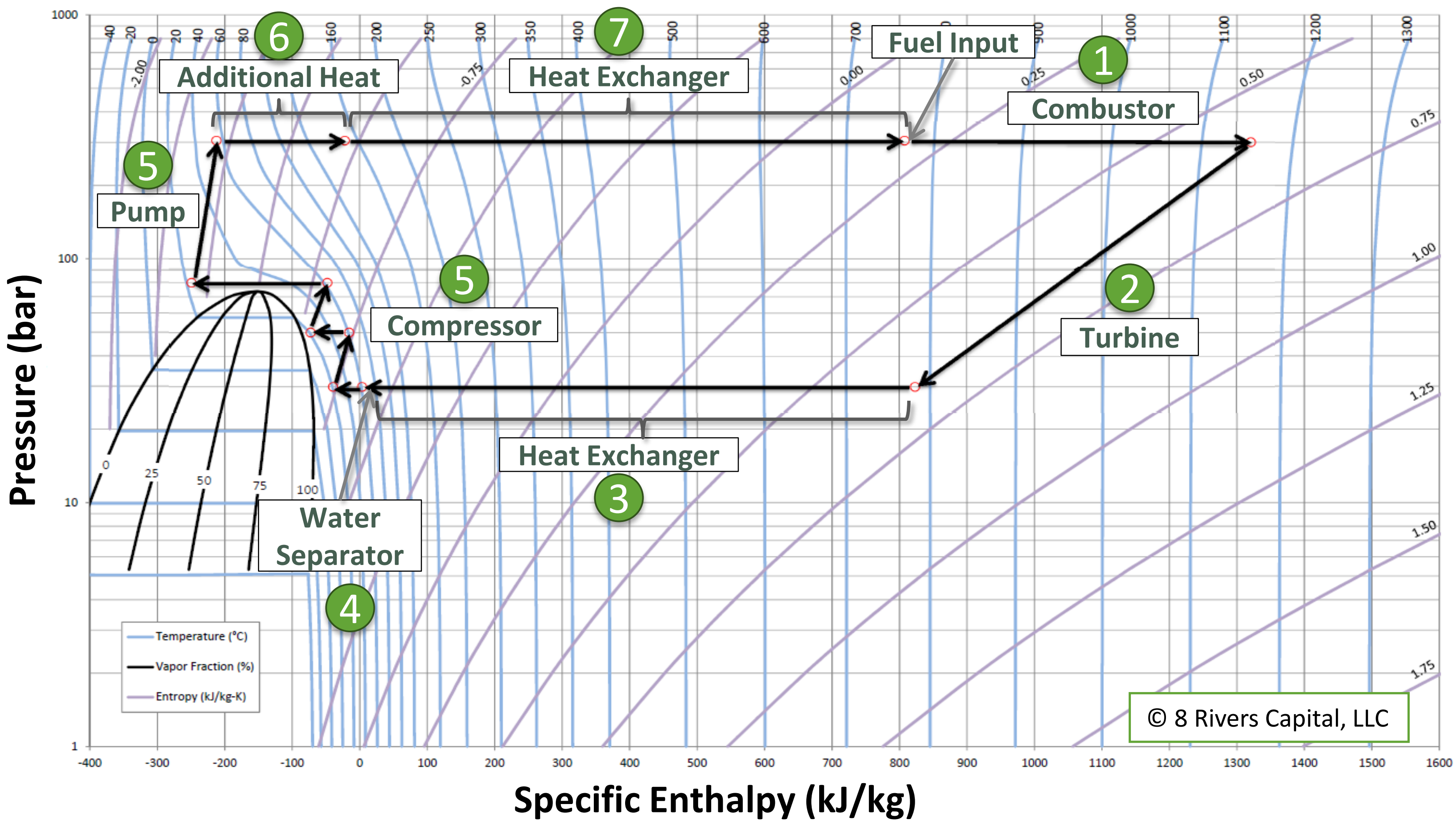


Except for these components, all equipment is mature technology

1. Fuel Combustion
2. CO_2 Turbine
3. Heat Rejection
4. Water Separation
5. Compression and Pumping
6. Additional Heat Input
7. Heat Recuperation

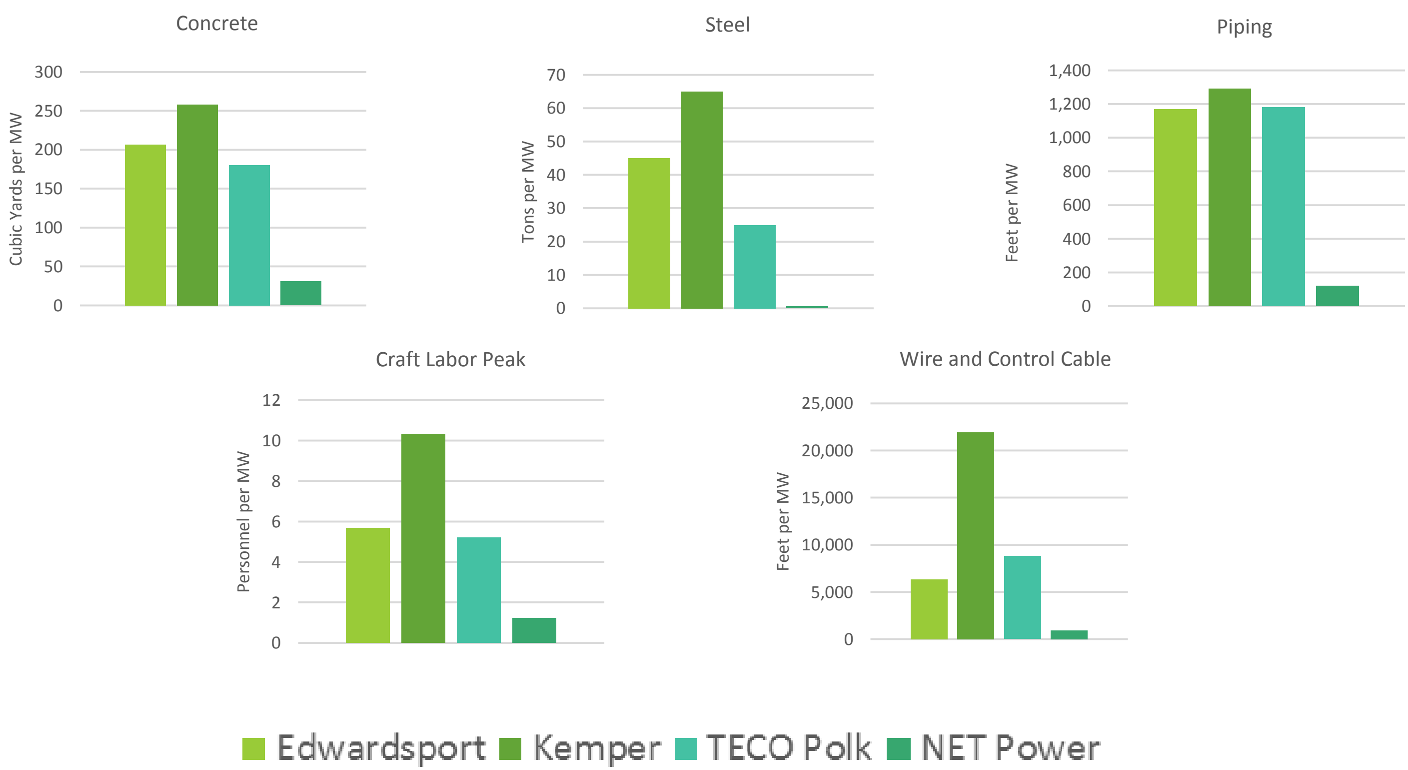
- 58.9% (LHV) net efficiency, with capture of >97% of carbon
- Oxy-fuel, closed-loop, CO_2 working fluid
- 200-400 bar; 6-12 pressure ratio
- CO_2 and water are the only byproducts
- All components, other than combustor and turbine, currently available
- 740H now in commercial use at two facilities

The NET Power Advantage - The Allam Cycle

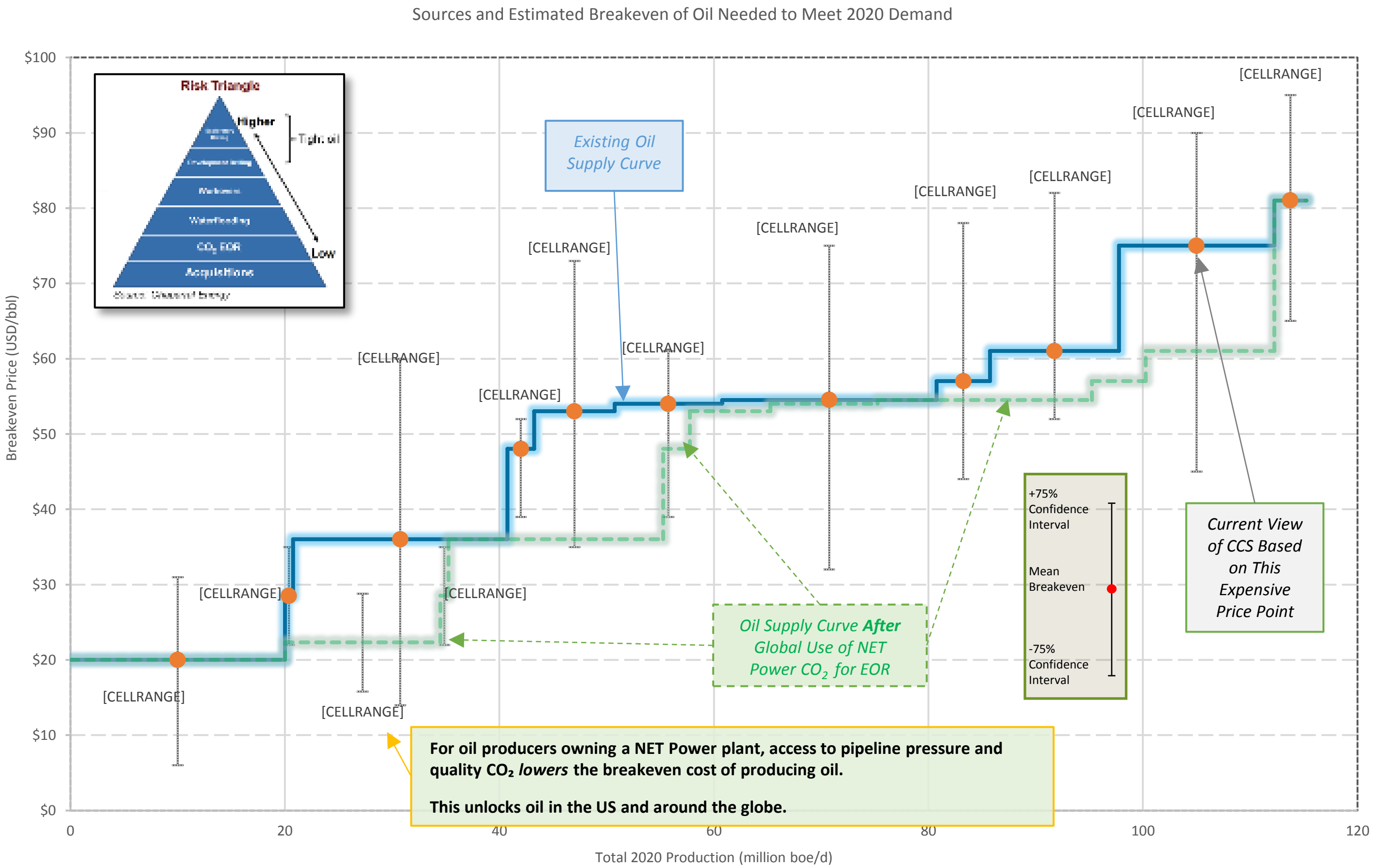


NET Power has *higher energy density* than big projects

- Compared to IGCC, bulks are small driver of costs:



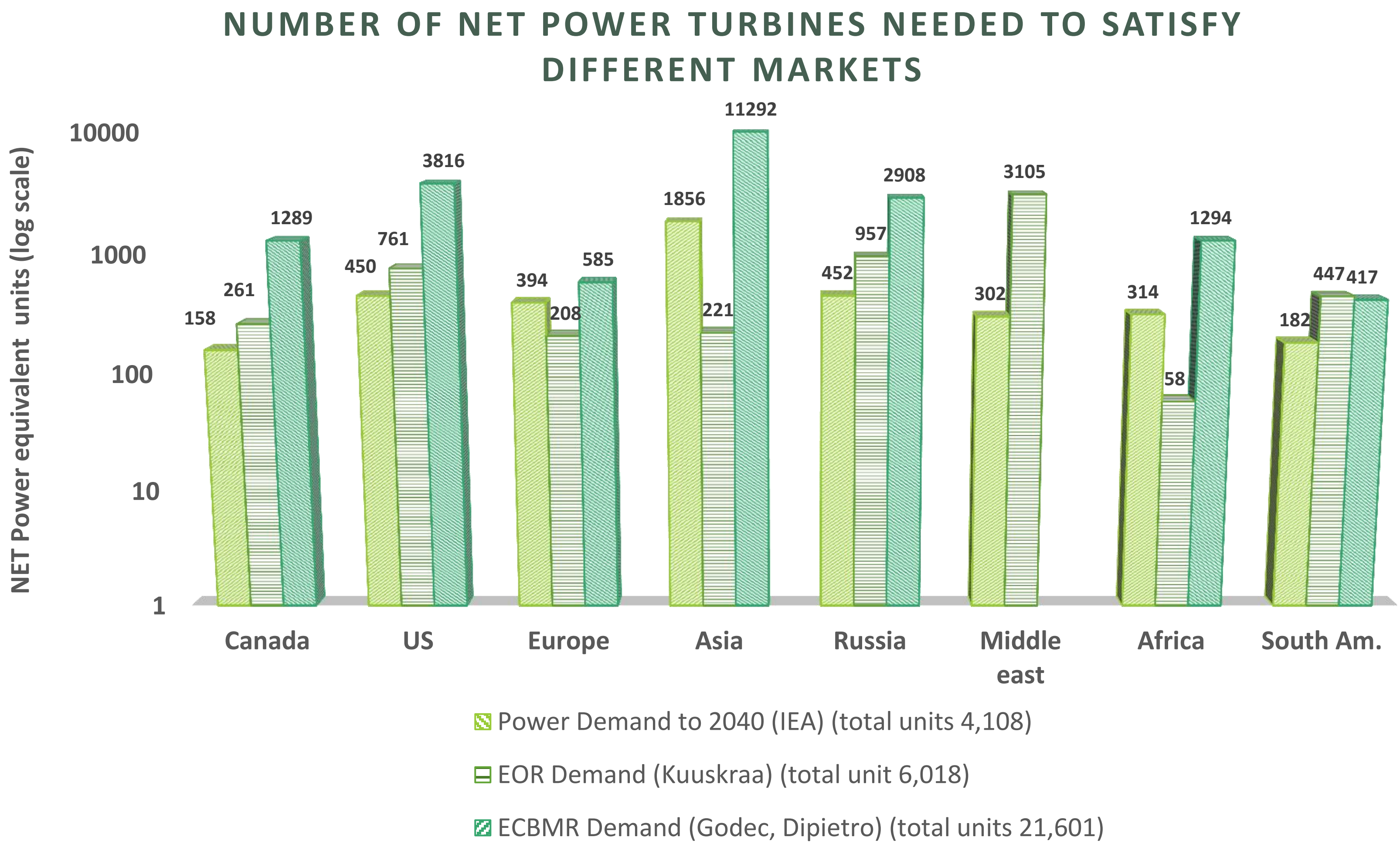
Globally, NET Power CO_2 will change the oil stack



- **Shutdown of tight oil/high cost plays highlights EOR as a low-cost opportunity for growth from existing fields**
- **NET Power further improves the economics of EOR and will significantly expand CO_2 supplies for producers**
- **NET Power solves the challenge of carbon capture adoption by achieving lower cost and higher efficiency than current non-carbon capture power generation options**

Source: Rystad Energy (2014); 8 RIvers Capital (2015)

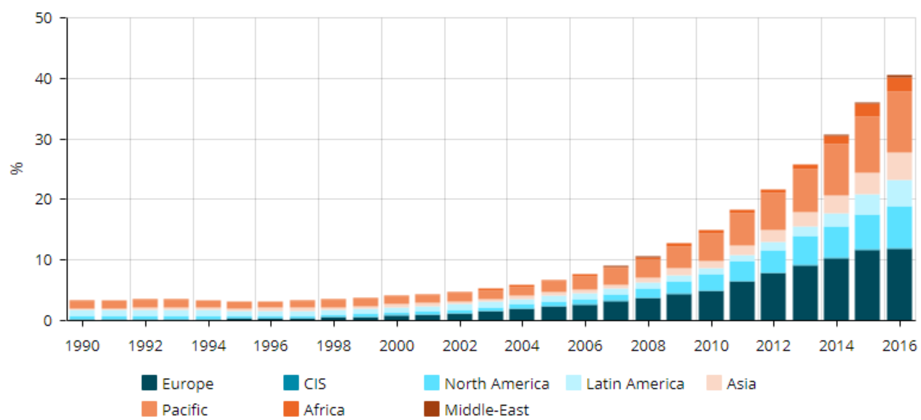
Market opportunity for NET Power turbine sales



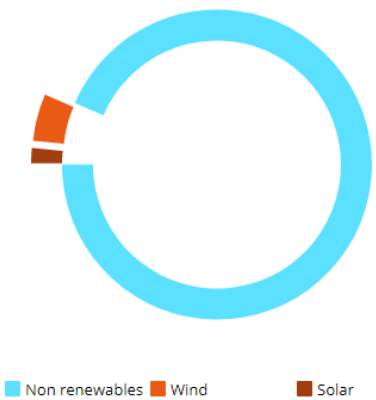
Trend over 1990 - 2016

Benchmark countries

1990 - 2016



% in electricity production (2016)



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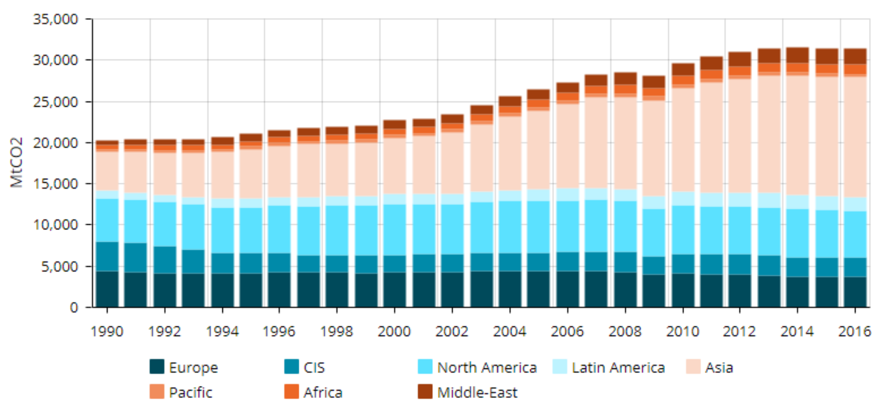
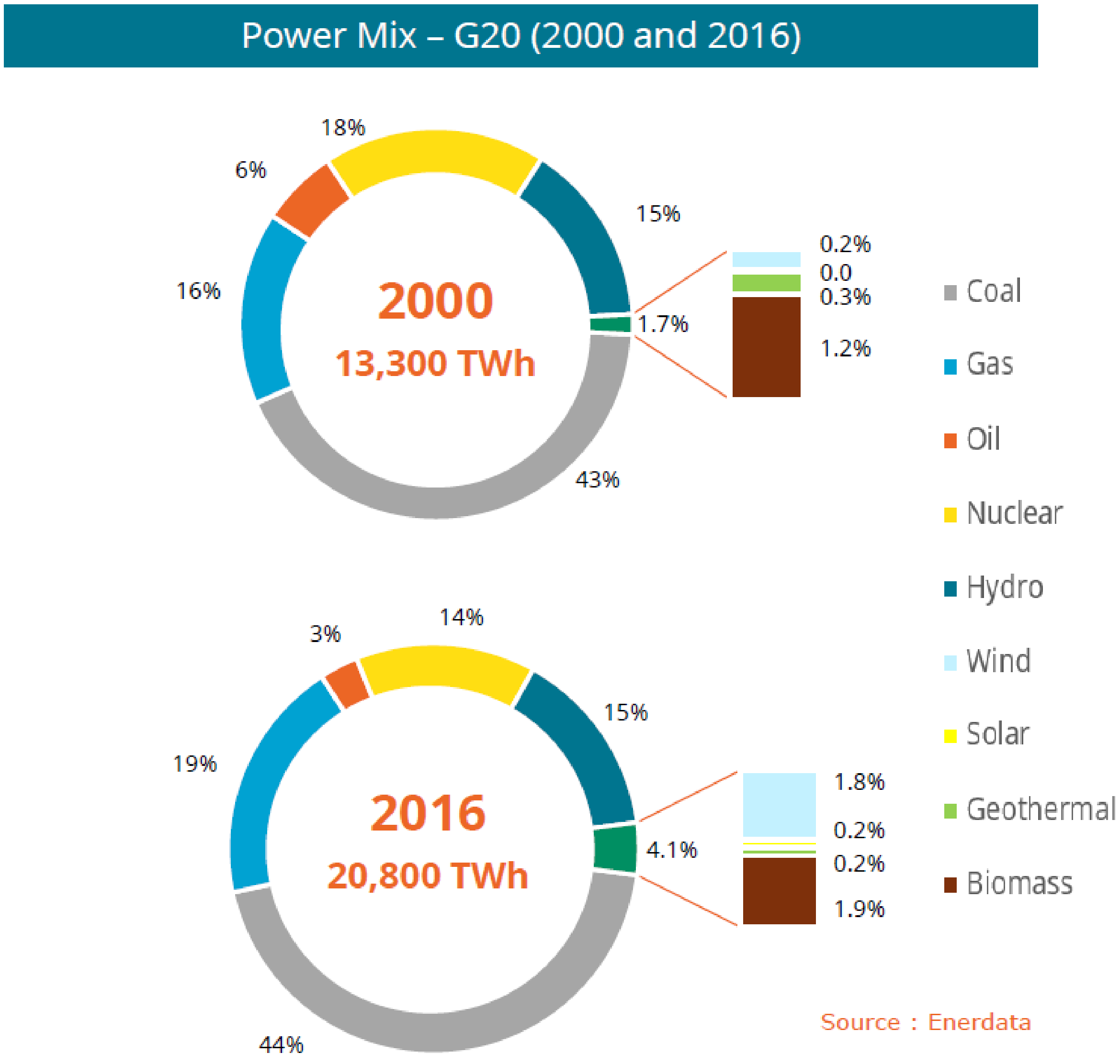


Breakdown by energy (2016)

Source: https://yearbook.enerdata.net/renewables/wind-solar-share-electricity-production.html

Even with all the huge news on renewable growth fossil still dominates and has taken a larger share of the mix!



NET Power

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