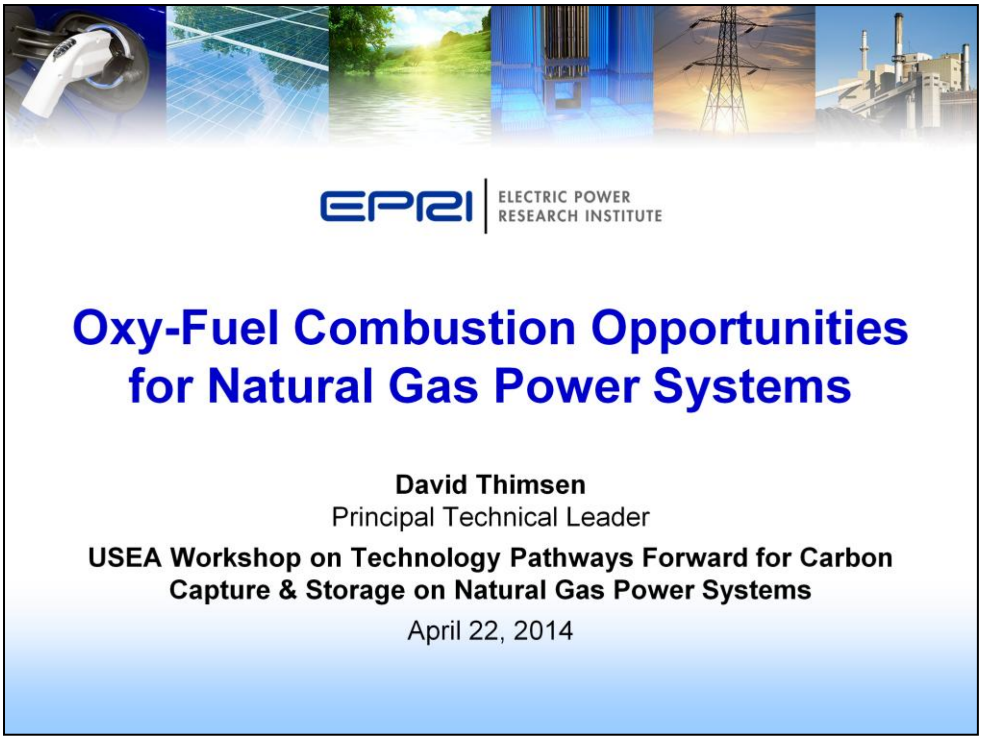
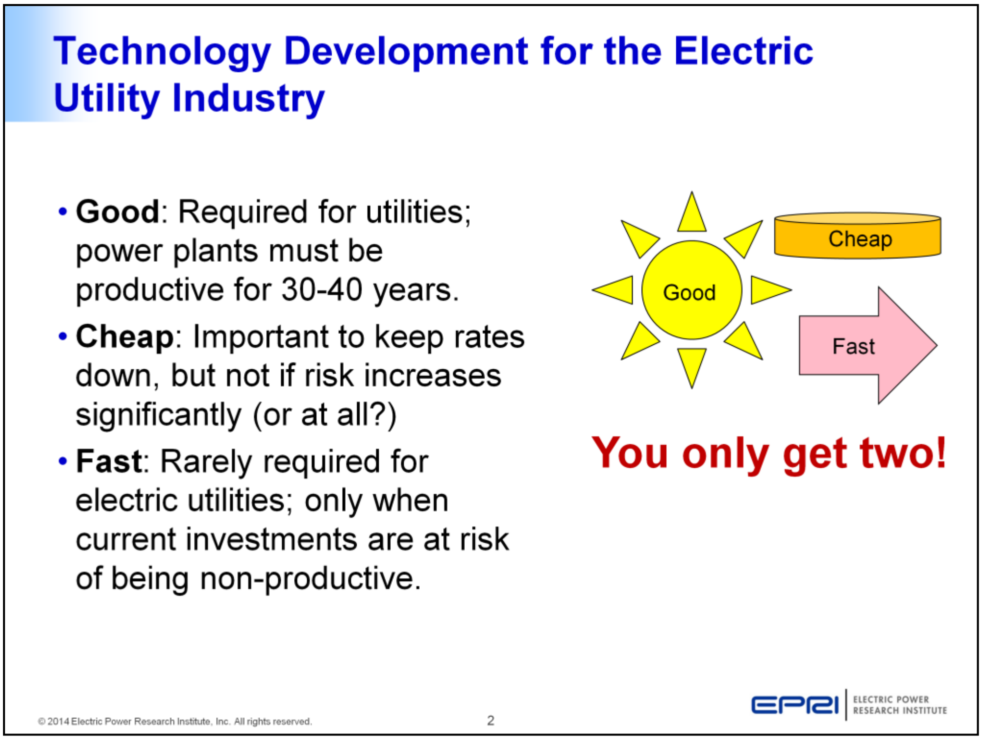



Thank you for inviting me to share some of our institute's thoughts on novel oxy-natural gas technologies for gas-fired power production with carbon dioxide capture.

I will be presenting these technologies as candidates for production of bulk electrical power for delivery to electric utility customers. Note that some of the applications being targeted by developers of these technologies are slightly different than the bulk utility power application, but the differences are unlikely to materially affect the technology development.

The gas-fired, electric power generation technologies that that I will discuss here are significantly different from technologies currently being deployed by electric utilities. For this reason, I think it will be useful to set the stage with a few comments on the general subject of technology development and specifically for development of novel power generation technologies.




Good – Cheap – Fast. An aerospace engineer in the 1960s asserted that you are only guaranteed two of these when developing technology. Cheap and fast will not necessarily lead to quality; good and fast will cost you; good and cheap will take time.

In the electric utility industry, quality technology is the first priority. The electric utility industry investments in transmission lines, distribution systems, and power plants are commonly amortized over 30-40 years or longer. This investment horizon requires technologies that are robust and will be productive over the life of the investment.

The long planning horizon means that electric utilities do generally not feel pressure to be on the cutting edge of technology development and do not feel "fast" to be a critical feature for developing new technologies. There are exceptions when the value and productivity of existing assets is threatened.

It is important to remember the #1 rule of utility economics: the rate payer pays all of the costs. Cheap is usually required by those who approve electric utility rates. As a result, utilities are generally economically efficient; they are prepared to employ technologies that will be less costly than alternatives, but are reluctant to employ lower-cost technologies that are accompanied by higher risk.

The prospective need to limit $CO_2$ emissions from fossil-fueled power plants is causing major revisions of utility long-range planning. Coal- and gas-fired power plants produce approximately 70% of the electric power in the United States. This power is generated only because $CO_2$ is produced during combustion; no $CO_2$ production, no power production. Capturing $CO_2$ from fossil-fueled power production will significantly impact the generation resource base and require development of technologies not currently in use at electric utility scale.

## Technical Achievements – Development Stages for Electric Power Generating Technologies

| Technical Readiness Level | Descriptor | Scale | Approximate Cost to Achieve | Minimum Time to Achieve |
|---|---|---|---|---|
| TRL-6 | Process Development Unit (PDU) | ~1% 2-10 MW | $5-$30 million | ~2 years + operations |
| TRL-7 | Pilot Plant | ~5% 10-30 MW | ~$30-$100 million | ~2 years + operations |
| TRL-8 | Commercial Pilot Plant | ~25% 60-150 | ~$500 million | ~3 years + 1 cycle |
| TRL-9 | 1st Commercial Plant | 100% 250-600 MW | ~$1,000 million | ~5 years + 1 cycle |

- TRL indicates achievement (not "status")
- Current achievement informs cost and schedule to achieve greater technical readiness.
- Skipping levels is likely to be higher risk/cost (Good-Cheap-Fast)

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A taxonomy of Technology Readiness, originally developed for NASA projects, has been adapted for a number of industries including off-shore oil, defense, and, more recently, the U.S. Department of Energy for major energy projects. At EPRI we have been using a taxonomy that is generally consistent with DOE's but somewhat less detailed.

The purpose of the EPRI taxonomy is communication; we use it to indicated what has actually been achieved in the field. Actual accomplishment is the metric electric utilities find most valuable. Accomplishments to date inform the cost and schedule of further technology development leading to the 1st commercial deployment.

The **process development unit** is typically the first time the technology leaves the lab and is deployed in a form that anticipates the commercial deployment. The **pilot plant** includes everything anticipated in the commercial deployment but whose operating costs must be subsidized. **Commercial pilot plants** will have revenue streams that meet or exceed operating costs but are unlikely to recover capital costs. The **1st commercial deployment** is self-explanatory. Note that the term "Demonstration plant" is not included here; we find this too vague to be of communication value.

After the "First of a Kind" deployment, plant costs can be expected to decline as the technology becomes more familiar and opportunities for cost reduction are identified.

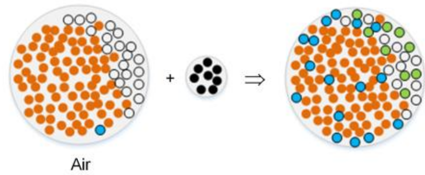
Note that costs to develop technologies for the electric power industry are very high. Until the 1st commercial deployment, these costs are not recovered. Financing new technology development for the electric power industry is a major challenge, particularly in an environment where the rate of new capacity additions is modest.

Recent experience suggests that utilities will have difficulty recovering development costs from electric ratepayers. Shareholders (utilities and private developers) and taxpayers (government grants) are the only other likely sources of development funding.

Private technology developers are likely to focus on those technologies which can find a profitable application at scales less than 250-600 MWe, exploiting this experience in lieu of sinking funds into deployments specifically dedicated to achieving TRL6-8. Interestingly enough, most of the technologies I will describe today are being developed with private funding.

## Why Oxy-Natural Gas?

Air-fired NGCC with post-combustion $CO_2$ capture




- Nitrogen
- Oxygen
- Carbon dioxide
- Water
- Natural Gas



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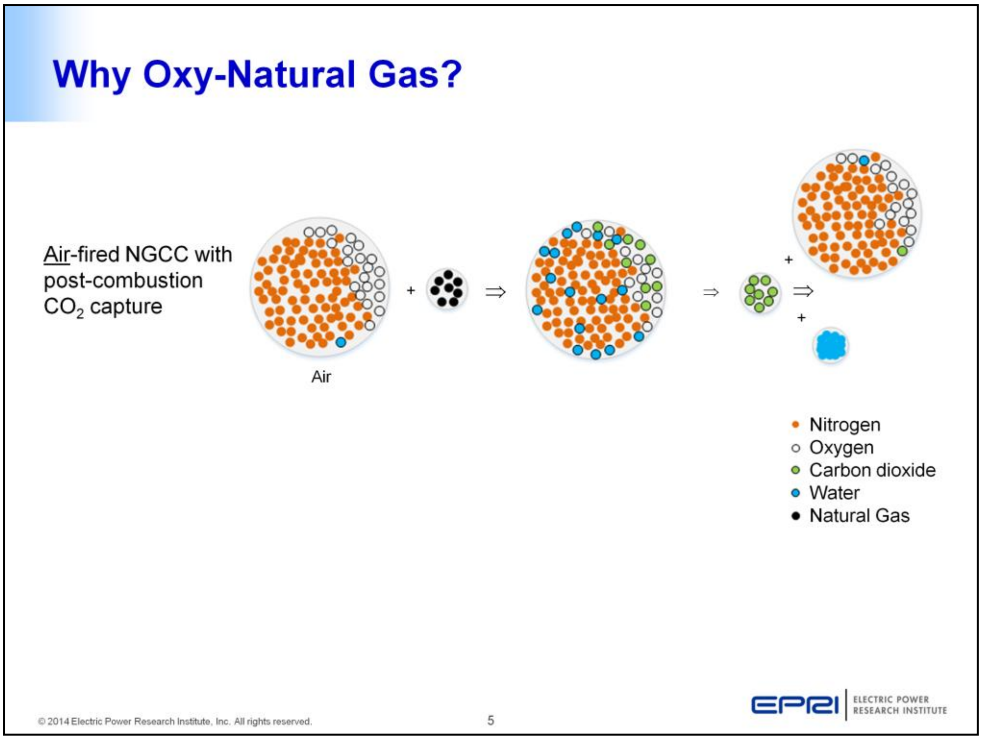
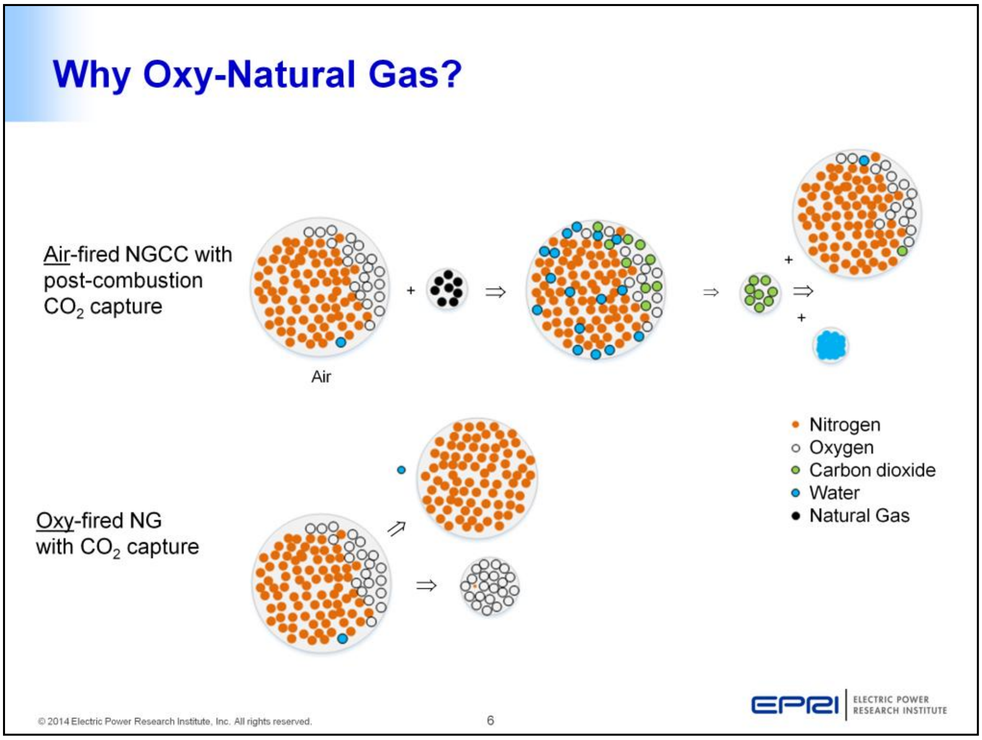
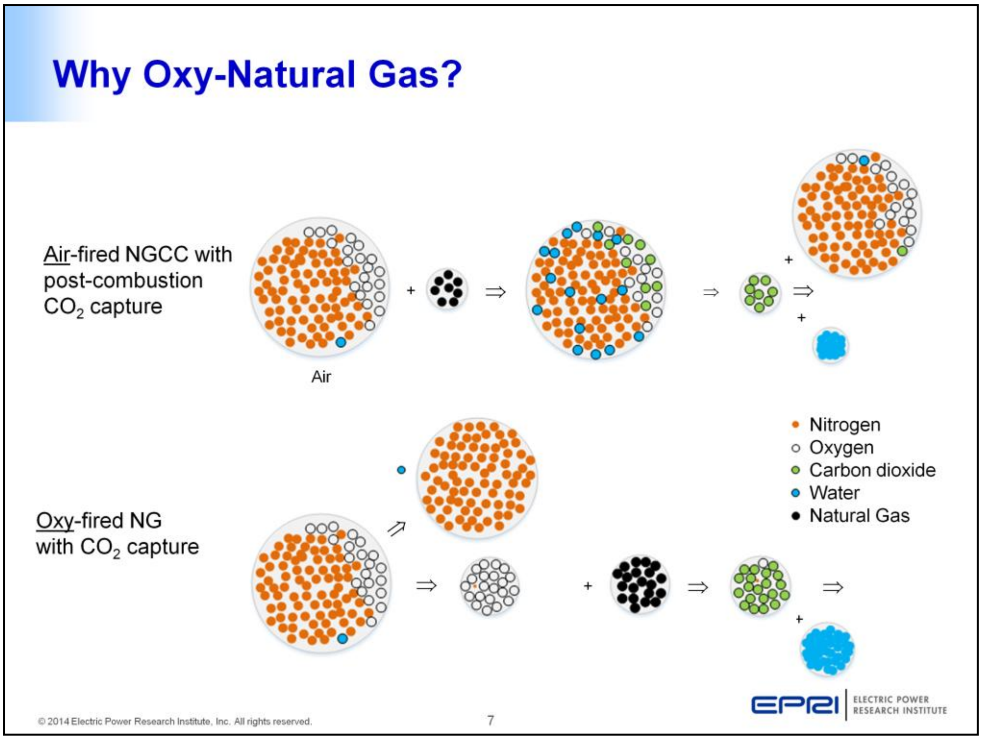
In state of the art natural gas power plants, gas is burned with a large excess of air to produce a flue gas that is relatively dilute in carbon dioxide. The primary challenge to capturing carbon dioxide produced by combustion is the large amount of relatively inert nitrogen that accompanies the oxygen used to burn the fuel as well as the oxygen not used for combustion.




Technologies that remove carbon dioxide from the products of air-fired natural gas combustion have been discussed today in previous presentations. These technologies require significant capital cost and have a significant impact on power production and efficiency.

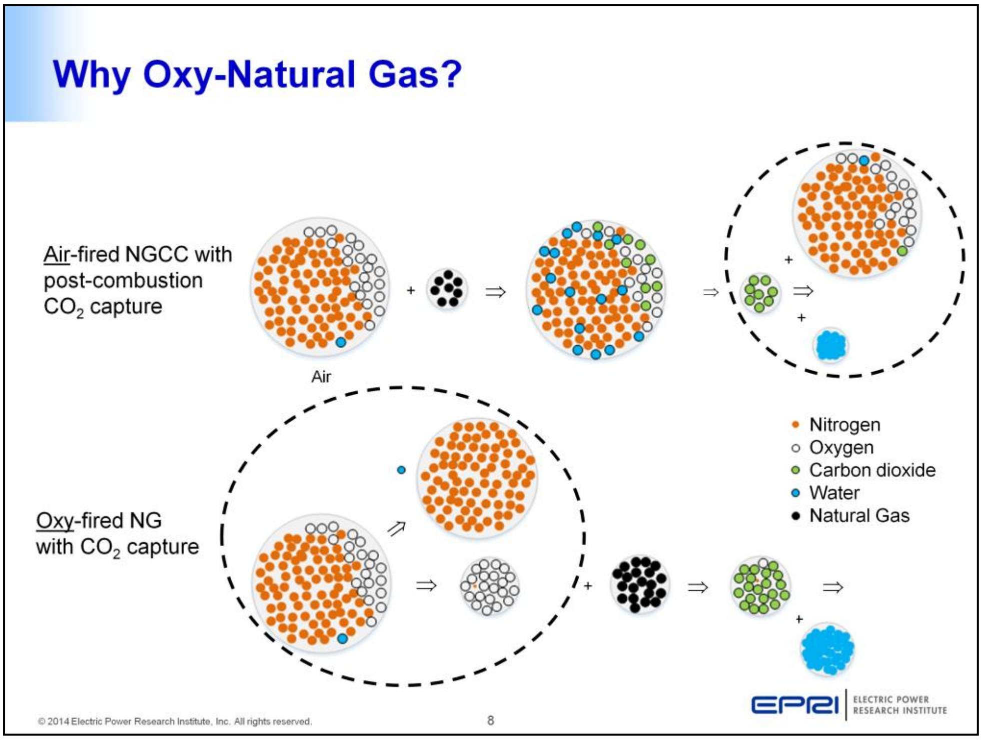



Alternatively, the large amount of nitrogen associated with providing oxygen for combustion might be removed prior to combustion.




The purified oxygen is then burned with natural gas to produce carbon dioxide and water. The water is relatively easy to remove from the carbon dioxide by condensation producing a relatively pure stream of carbon dioxide.

In general, all of the oxygen is burned in oxy-combustion processes; considerable cost was incurred to purify the oxygen; it is expensive to not make use of it.




So, the nitrogen in air may be removed at the end of an air-fired power process or at the beginning of an oxy-fired power process. Both options introduce technologies and costs not currently part of power plant design and operations.

If serious consideration is given to incurring capital and operating costs of post-combustion carbon dioxide capture, the particular advantages of a power process that incorporates oxy-fuel combustion also deserve serious consideration.

Conversely, if there is no value in capturing carbon dioxide, the capital and operating costs of the air separation unit are very difficult to justify.

## Oxy-Natural Gas Combustion Technologies

**Approaches to mitigating very high oxy-natural gas flame temperatures:**

1. Dilute the flame with carbon dioxide — *NET Power*
2. Dilute the flame with water/steam — *Clean Energy Systems*
3. Remove heat from the flame as it is produced — *Chemical Looping Combustion*
4. Bring high temperatures on! — *MHD Topping cycle*

**Bonus technology, not oxy-natural gas, but similar:**

5. Pressurized HRSG combined cycle with Post-combustion carbon dioxide capture — *Sargas/General Electric*


9
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The absence of diluting nitrogen in oxy-natural gas flames means that flame temperatures are higher than can generally be accommodated by the metals available for use in power plants. I will discuss today four classes of technologies which have different approaches to dealing with the very high flame temperatures and a fifth, air-natural gas technology with CO2 capture which is on our radar screen because it has substantial commercial backing and will compete directly with the oxy-natural gas technologies.

**Net Power** is the primary commercial developer of oxy-natural gas combustion turbine technology wherein the flame is cooled with recycled CO2.

**Clean Energy Systems** is developing an oxy-natural gas combustion turbine technology where the flame is cooled with recycled water/steam.

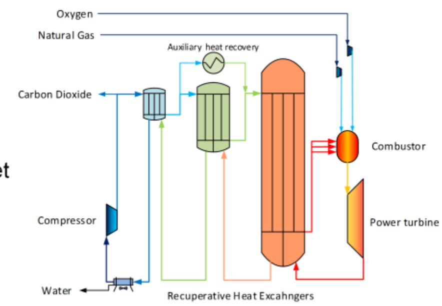
Natural gas-fueled **Chemical Looping Combustion** technology has yet to attract a private developer who will champion the technology, but has attracted public/private funding towards deploying a process development unit. In this technology, rapid heat transfer from the combustion keeps temperatures sufficiently low.

Neither has **Magneto-Hydrodynamic** technology attracted a private champion committed to taking the development to commercial deployment. It's resurrection here is due to the long history of development before 1990 and the prospects for significant cost reduction that would come from employing oxy-natural gas combustion to achieve the very high temperatures the technology requires.

The only air-fired technology reviewed here is an inverted combustion turbine combined cycle wherein heat is recovered to the bottoming steam cycle at combustor pressure followed by post combustion CO2 capture at combustor pressure, potentially reducing capital costs compared with conventional CTCC with CO2 capture at atmospheric pressure.

## 1. NET Power/Allam Cycle

- Direct-fired, semi-closed Brayton cycle
- 295 MWe commercial module conceived
- Highly recuperated, very high efficiencies possible. May compete with F-class CTCC.
- Achieved TRL-7 for combustor
- Plans to achieve TRL-7 for the entire flow sheet with 50 MWth pilot plant in 2016
- Privately funded
- Work underway to assess use in lieu of CTCC for coal syngas
- Commercial Partners:
  - NET Power Process Development
  - Toshiba Combustor/Turbomachinery
  - CB&I Engineer/Procure/Construct
  - Exelon Pilot Plant Operations




**Technical Uncertainties:**

- Combustor/turbine
- Recuperative heat exchangers
- Materials for high temperature service
- Overall performance/control




In the so-called “Allam cycle” the oxy-natural gas flame is cooled with recycled carbon dioxide. In NET Power’s implementation, temperatures in the combustor reach 1150C (2100F), not particularly aggressive by combustion turbine standards. The high temperature fluid leaving the combustor is primarily carbon dioxide with a small amount of water vapor produced during combustion of the natural gas. The carbon dioxide enters the turbine at about 300 bar (4350 psia) and expands to about 30 bar (435 psia). The carbon dioxide leaving the turbine is still very hot, near 750C (1380F) and this heat is transferred to the cold, compressed CO2 in recuperative heat exchangers. A final cooler condenses the water produced during combustion and the remaining cold carbon dioxide is compressed back up to the turbine inlet pressure before being pre-heated by turbine exhaust. The recycled carbon dioxide stream is approximately 30 times the mass flow of fuel and oxygen. The CO2 produced during combustion is removed as a high pressure, relatively pure stream.

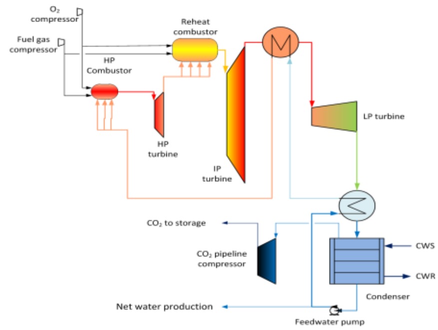
A thermodynamic analysis of the cycle indicates that, even when the power requirements of the air separation unit are included, the net cycle efficiency is competitive with F-Class CTCCs and may compete with the most modern H-class CTCCs; this while producing relatively pure CO2 at pipeline pressure. There is considerable buzz in the electric utility industry to see if a power plant can be engineered that realizes the efficiencies that the thermodynamic analysis suggests might be achieved.

Toshiba is NET Power’s partner for the combustor and turbo-machinery, CB&I has an equity stake in the technology and is engineering the balance of plant. Exelon brings plant operations experience to the partnership.

Current plans call for deployment of a privately-funded, nominal 50 MWth pilot plant in late 2015, the operation of which will inform design and construction of the full scale module envisioned at 295 MW. The particular uncertainties which require field experience at pilot scale in order to inform the full scale design focus on components not currently found in utility service: the combustor/turbine and the recuperative heat exchangers including materials for the high-temperature portion of the recuperators and the inter-connecting piping.

## 2. Clean Energy Systems (CES) Direct-Fired Steam Cycle

- **Trigen**: 200 MW and 400 MW commercial modules conceived
- Direct-fired, semi-closed steam-Rankine cycle:
- Moderate temperatures limit efficiency
- Achieved TRL-7 for combustor, IP turbine conversion. Awaiting opportunity to deploy full pilot plant to achieve TRL-7; funding sought.
- 24 Jan 2014 – Maersk announces LOU for 200 MW Trigen plant in UAE
- Oilfield applications targeted which would also include:
  - Disposal of contaminated water
  - Firing off-spec fuels
- Partners:
  - Paxton Corporation
  - SoCal Gas Company
  - Siemens
  - Paramount Resources
  - U.S. Department of Energy
  - AES Corporation
  - Maersk Oil
  - LM Alternatives




**Technical Uncertainties:**

- Combustor/turbines
- Acceptable electrical efficiency
- Acceptable materials performance
- Overall flow sheet design and performance/control

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 11

Clean Energy Systems has been developing components for use in a direct-fired, water-cooled oxy-fuel power cycle for several years. Some of the development work has been funded by U.S. DoE and California Energy Commission. The work has been oriented towards applications in the oil and gas industry served by CES.

In the oxy-natural gas combustor developed by CES, the flame is cooled with recycled water. The fluid leaving the high pressure combustor is largely water with a small amount of carbon dioxide produced during combustion. The fluid leaving the high pressure steam turbine is further used to cool the oxy-natural gas flame in a reheat combustor which exhausts into a modified combustion turbine at a temperature near 1200C (2200F). After heat recovery from the intermediate pressure turbine, the remainder of the plant is very similar to a steam power plant with low pressure turbine, condenser, feedwater pump, and feedwater heating. The CO2 produced during combustion must be evacuated from the condenser and compressed to pipeline pressure.

Achieving high electrical efficiency for this cycle technology, branded **Trigen** by CES, is constrained by the relatively modest high pressure turbine inlet temperatures currently anticipated and the need to compress the product CO2 from condenser vacuum to pipeline pressure.

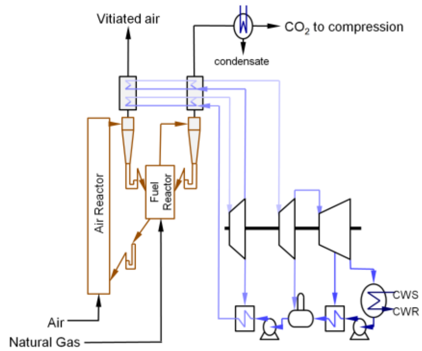
CES anticipates that suitable fuels will include ash-free off-spec fuels found in oilfield and gasfield operations. In addition, contaminated water may be cleaned by pumping into the cycle in lieu of condensate. They anticipate that contaminants will be burned to extinction in the high-temperature combustors.

The Paxton Corporation, a Canadian oil and gas equipment company, Southern California Gas Company and AES Corporation, a merchant power company, are all owners of CES. Strategic partners include Siemens for turbomachinery, Maersk Oil and Paramount Resources, both licensees of the CES technology, and LM Alternatives, a turbomachinery support company.

CES and their partners are looking for funding to deploy a pilot plant which incorporates all of the process components and which would support design of the 200 MW commercial module they envision.

## 3. Chemical Looping Combustion/Steam Cycle

- Oxy-combustion without cryogenic Air Separation Unit
- Chemical air separation by reaction with solid-supported material.
- Power to be generated by high efficiency steam cycle.
- Initial application targeted is co-production of $CO_2$ and steam for EOR.
- Achieved TRL-5 for solids flow and chemistry. Funding sought for 10 MWth process development unit to achieve TRL-6..
- Cenovus is the developing partner with major funding commitment from the Alberta CCEMC. Seeking additional funding partners.




**Technical Uncertainties:**

- Controlling solids flows
- Solids costs/attrition/safety
- Chemistry in each reactor
- Thermal integration of steam cycle


12
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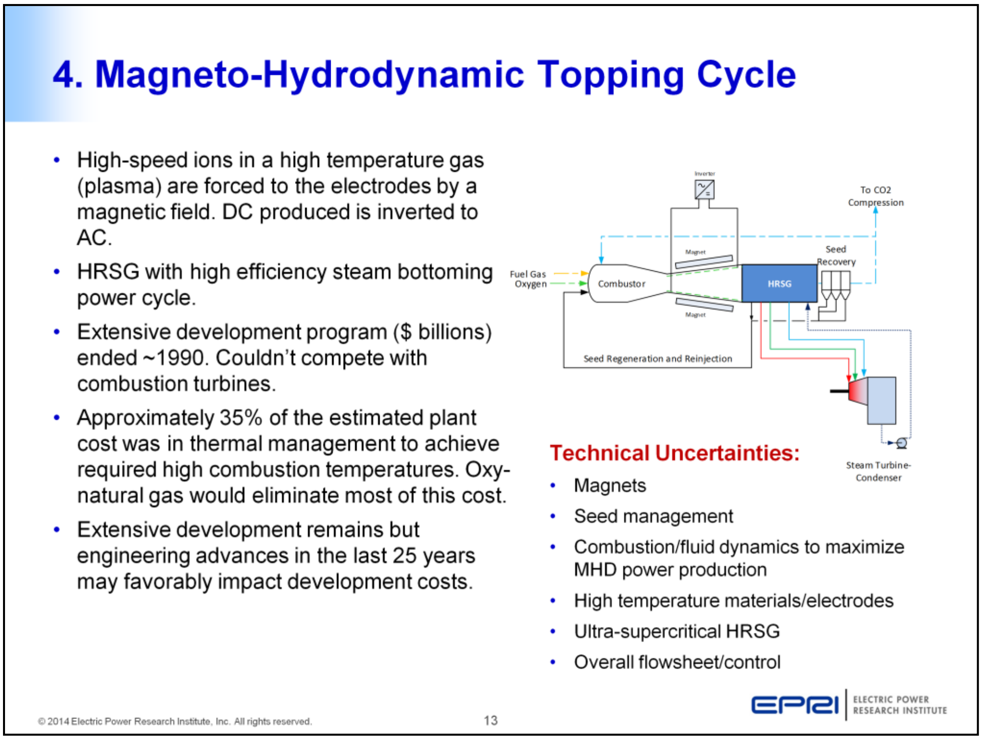
Chemical Looping Combustion refers to a technology for separating oxygen from air by chemical means, eliminating the need for a cryogenic air separation unit with it's significant auxiliary power demand. In the air reactor, oxygen is removed from the air by chemical reaction with a suitable solid. This solid is then removed from the vitiated air flow and transported to the fuel reactor where the solid gives up the oxygen to combine with and burn the fuel. The presence of the large inventory of solids in both the air reactor (where the solids are "burned" in air) and the fuel reactor (where the natural gas is "burned" by the solids) keeps temperatures in control. Solids investigated at bench scale include various metals/metal oxides and calcium sulfide.

Both the air reactor and fuel reactor are anticipated to be circulating fluidized beds or transport reactors, technologies in common industrial and utility use processing a variety of solid materials. Power would be produced using a conventional, high-efficiency steam cycle. While the overall plant electrical efficiency will be limited by the efficiency of the steam power cycle, the absence of an air separation unit will be a significant auxiliary power savings.

Cenovus, a Canadian oil and gas company, is organizing a nominal 10 MWth process development unit to test the technology with a nickel-based oxygen carrier. Their interest is in co-production of steam and CO2 for industrial uses but their results will be directly applicable to co-production of CO2 and power. They have secured a major funding commitment from the Alberta Climate Change and Emissions Management Corporation toward deployment and operation of the process development unit.

This is a less-mature technology and there remain uncertainties surrounding real-world performance of the chemistry in both the air reactor and fuel reactor as well as cost and durability of candidate solids and controlling the high-volume solids flows. Experience gained during operation of the proposed process development unit or other proposed deployments at a similar scale is required to advance this technology.




In the decades preceding 1990, $ billions were spent on developing magneto-hydrodynamic power generation technology, primarily in the U.S., Soviet Union, and Japan. This spending came to a somewhat abrupt halt for a number of reasons, not the least of which was widespread adoption of combustion turbines as topping power cycles, the same application for which MHD was being developed.

The MHD topping cycle produces DC power when a high temperature gas is seeded with materials that are easily ionized to produce a conducting plasma. This plasma is accelerated to very high speed and passes through a magnetic field. The magnetic field turns the ions and free electrons in opposite directions to collection electrodes on the sides of the flow duct. The electrons flow through the external circuit. This direct current is converted to utility-quality alternating current in an inverter, the same technology used to produce utility-quality power from photovoltaics, fuel cells, and batteries.

Typical seed materials contain potassium and this seed must be recovered and returned to the combustor. The combustion products leaving the MHD generator power a high-efficiency steam bottoming cycle.

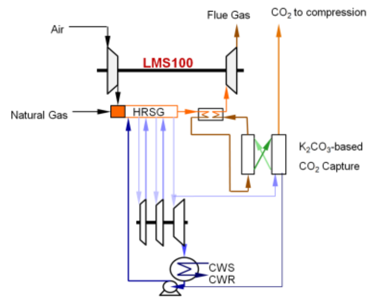
MHD development was halted for a number of reasons. Many of these were related to challenges associated with air-firing of coal to achieve the requisite plasma temperatures. The plasma temperatures can be achieved with an oxy-natural gas flame without the extensive heat recovery and thermal management required for air-fired combustion and without the sulfur oxides and ash contaminants produced by coal combustion. There is the potential for considerable cost savings in an MHD plant employing oxy-natural gas rather than air-coal.

Even with these potential cost savings, MHD power plants will have to achieve efficiencies equal to or better than alternatives to justify the added development costs that would need to be incurred to continue development of this technology. Most of the effort will need to be directed to maximizing the amount of power produced by the topping cycle. The good news is that since 1990 there have been significant advances in development of superconducting magnets, combustion/fluid dynamics modeling tools, and high temperature materials that could significantly reduce development costs.

Unlike the MHD development program undertaken in the last half of the 20th century where electric utilities were active partners, electric utilities are unlikely to be significant supporters of MHD development unless a clear path to very high efficiency and acceptable cost can be convincingly shown.

# 5. Sargas/GE Pressurized HRSG Natural Gas Combined Cycle

- **Stargate 250**: 250 MWe module envisioned.
- Natural gas/air combustion at medium pressure
- Gas pressurized HRSG allows near-complete use of oxygen in air.
- Post-combustion $CO_2$ capture at pressure and moderate $CO_2$ inlet concentration: (Lower cost than low-pressure, low-concentration NGCC.)
- Partners:
  - Sargas AS (Norway)
  - General Electric
  - DSME
  - SNC Lavalin
- Rumors of projects in the Mediterranean and Near East.




**Technical Uncertainties:**

- Redesign of theLMS100 for the specified service
- Ultra-supercritical steam cycle/pressurized HRSG design
- Recuperative heat exchanger at PCC inlet/outlet
- PCC performance
- Overall process performance

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In the decade from 1985 to 1995, a number of direct, coal-fired combustion turbine power plants were deployed in Europe, Japan, and one in the U.S. at American Electric Power's Tidd plant in Ohio. While the technology achieved some technical success, it did not emerge as a compelling commercial option for coal-fired power. Sargas AS of Norway is revisiting the technology and has teamed with General Electric to develop a gas-fired version with CO2 capture.

Branded Stargate 250, the technology being offered is based on a General Electric LMS100 combustion turbine. Air leaving the compressor is burned with natural gas in front of a gas-pressurized heat recovery steam generator. Cooling the combustion with water- and steam-cooled tubes allows essentially all of the air to be used for combustion. This results in a combustion gas CO2 content of approximately 12% rather than the 5% more commonly found in combustion turbine exhaust.

CO2 is removed (at pressure) from the combustion gases using a post-combustion CO2 capture process similar to the Benfield acid gas removal process, employing potassium carbonate as a physical capture solvent. Removing the CO2 at pressure reduces the size and cost of the PCC plant as does the higher CO2 concentration. An inlet-outlet recuperator is employed to cool the combustion gas to the CO2 capture temperature and then re-heat it prior to expansion in the gas turbine.

SNC Lavalin is the EPC partner and DSME is the equipment fabricating partner. The components of this plant not in common use in the power industry include the gas-pressurized HRSG and the flue gas recuperator in front of the CO2 capture plant. The technology also requires a redesign of the LMS100 compressed air flow path. It is likely that these systems can be produced using relatively mature engineering design tools and experience. For the bulk power application, the primary technical uncertainties are performance of the overall process and of the post combustion CO2 capture plant.

## Critical Features of Proposed Oxy-Natural Gas Technologies

**Baseline is NGCC with PCC $CO_2$ Capture**

- Proven reliability in the service.
- Low levelized cost of electricity (LCOE) requires
  - Low capital cost
  - High electrical yield (efficiency)
  - High $CO_2$ yield
- Low dispatch cost requires
  - High electrical yield
  - High value realized for $CO_2$
- Ability to readily change output: operating flexibility. Low levelized avoided cost of electricity (LACE). This depends, in part, on local electrical market pricing.



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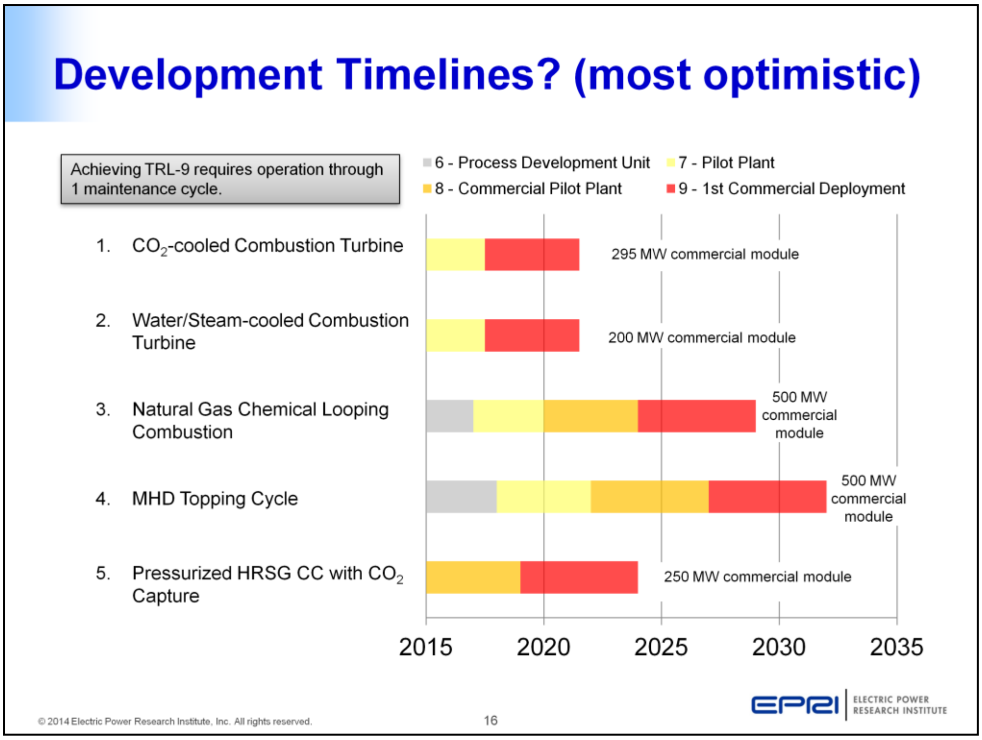
If and when capture of CO2 produced from natural gas-fired power plants is implemented, it is likely that the baseline default option for plant owners will be adding amine post-combustion CO2 capture plants on the back end of natural gas combined cycle power plants. While the prospect of capturing CO2 from the 5% CO2 flue gas produced by NGCC plants is even less appealing than capturing CO2 from the 12% CO2 flue gas produced by coal-fired power plants, the reliability and efficiency bars are set relatively high for any emerging technology that would supplant the baseline option.

I have identified here five substantially distinctly different technologies three of whose developers are risking private capital in the expectation that their technology can produce electricity while capturing CO2 at a levelized cost lower than the baseline option. In addition, there are two technologies which do not yet have commercial champions but which might also achieve the requisite levelized cost and reliability. Achieving levelized costs lower than the baseline and demonstrating reliability as good as or higher than the baseline technology will be a requirement in order for power plant owners to seriously consider embracing the alternatives.




Predictions are hard, especially when it come to the future. None the less, I'll go out on a limb a little way and lay out a very optimistic development schedule for the 5 technologies discussed here. The time lines indicated assume:

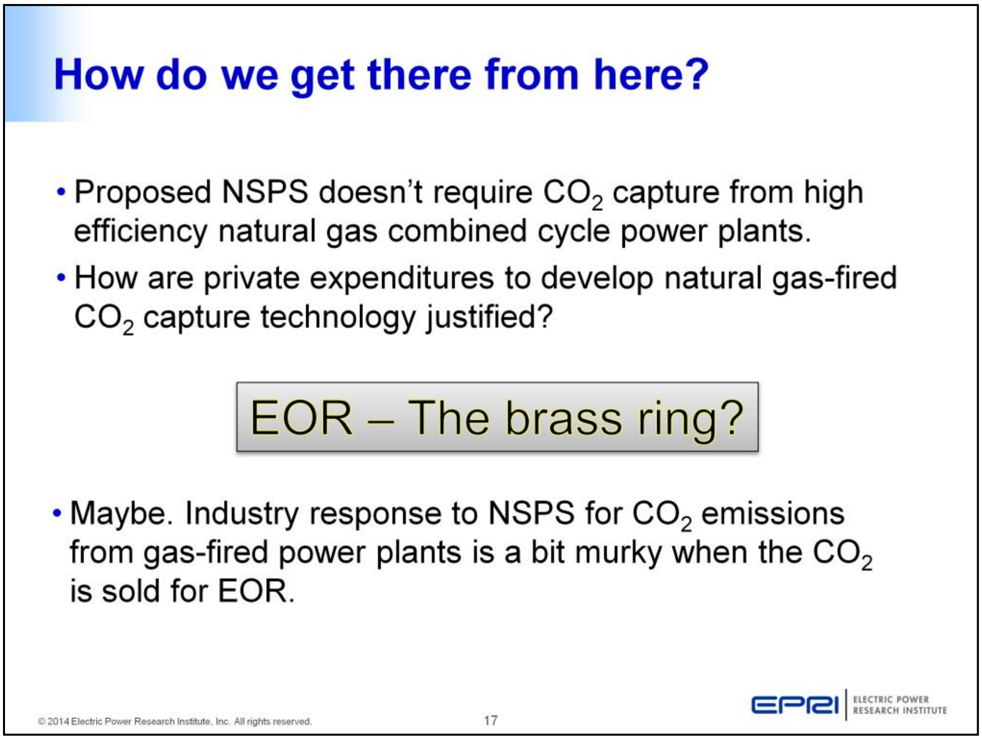
- No significant technical surprises
- Funding doesn't take extra time to secure
- Commercial outlook (LCOE) for the 1$^{st}$ commercial deployment continues to be rosy

Note that achievement of TRL-9, the 1$^{st}$ commercial deployment is accomplished only after operations through a full maintenance cycle. I've somewhat arbitrarily assigned 2 years of operations here.

The CO2-cooled and water-cooled combustion turbine technologies might go directly from pilot plant to the full commercial modules envisioned, bypassing TRL-8.

The pressurized HRSG CC with CO2 capture might go directly to the commercial pilot plant, TRL-8. Not all of the technical uncertainties can be resolved at pilot plant scale.

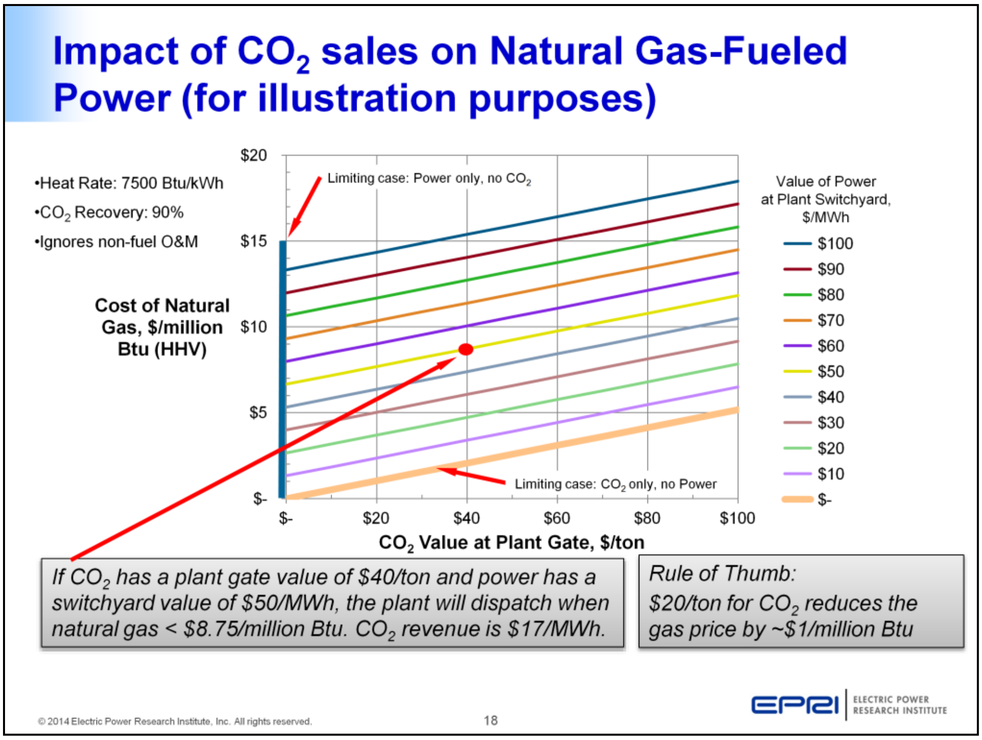
The natural gas CLC and MHD technologies are less mature and will require PDU-scale development of some of the components. The technical uncertainties in these technologies are sufficiently great, at this point, that progression through all of the TRL levels is likely to be required.




Private development of the novel gas-fired technologies identified here faces obstacles. The first is that there is no near-term regulatory requirement to capture CO2 from natural gas-fired power plants which meet a specified minimum efficiency. The utility industry is unlikely to embrace novel gas-fired technologies that do not offer the prospect of substantial cost savings over NGCC plants in the near term.

At this point the brass ring private developers are trying to grab is co-production of power and CO2 for enhance oil recovery. If oil prices continue to be sufficiently high, there will likely be a market for CO2 at a price which will justify deployment of one or more of these technologies.

A cautionary note: Initial deployments of gas-fueled co-production power plants may not be may not achieve the efficiency required to keep to keep CO2 production below proposed NSPS levels for gas-fired power plants. How would such a plant be permitted? Not clear at present.




This graphic is a little busy but it is intended to illustrate the overall value of being able to sell CO2 produced by natural gas combustion into the EOR market; the brass ring being pursued.

The x-axis is the value of CO2 at the power plant gate. Value at the oil-field must be greater than this number by the costs to transport and inject.

The y-axis is the cost of natural gas delivered to the power plant in $/million Btu.

The parameter is the value of electric power at the switchyard terminals. This is lower than the local power pool price by the cost to transmit the power to the load.

The limiting cases are shown in bold lines:

•If power has no value, a plant might still burn natural gas simply to produce CO2. This is the peach line at the bottom.

•If CO2 has no value, the situation is represented by the vertical blue line at the Y-axis.

If the plant can realize $40 per (US) ton for CO2 delivered to the plant gate and the marginal price for power is $50/MWh, the plant will dispatch whenever gas prices are less than about $8.5/million Btu. Under these conditions, the CO2 revenue is approximately one third the electric power revenue; power sales still dominate the economics but CO2 sales revenue is significant.

The rule of thumb is that realizing $20/ton for CO2 is the equivalent of reducing natural gas price by about $1/million Btu.

## Conclusions

- Capturing $CO_2$ produced by natural gas combined cycle power plants is challenging. If this is required, there may be novel natural gas-fueled power generation options less costly than NGCC with PCC.
- There are relevant gas-fired power generation technology options being privately developed. In the absence of regulatory requirements to limit $CO_2$ emissions from gas-fired power plants, these developers are targeting co-production of power and $CO_2$ for EOR.
- NSPS proposed for $CO_2$ emissions from gas-fired power plants will complicate commercial deployment of the new technologies in the U.S. Deployments opportunities outside the U.S. are being pursued.



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So, in conclusion:

Capturing $CO_2$ produced by natural gas combined cycle power plants is challenging. If this is required, there may be novel natural gas-fueled power generation options less costly than NGCC with PCC.

There are relevant gas-fired power generation technology options being privately developed. In the absence of regulatory requirements to limit $CO_2$ emissions from gas-fired power plants, these developers are targeting co-production of power and $CO_2$ for EOR.

The NSPS proposed for $CO_2$ emissions from gas-fired power plants will complicate commercial deployment of the new technologies in the U.S. Deployments opportunities outside the U.S. are being pursued.

# Together…Shaping the Future of Electricity

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