



# **A Power Industry View – Fuel and Power Options**

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CIBO

**34<sup>th</sup> Annual Meeting**

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# Uncertainty – New Normal?



- **Regulations...**

- Legislate, Regulate, Litigate, Litigate, Litigate...

- **Markets and Finances**

- Estimated \$1.5T investment required to upgrade power sector in the future (smarter grid, different needs flexible fuels)
- > 50% for generation according to Standard and Poors
- Fuel? Gas is the answer, now what was the question?

- **Technology**

- Less expensive, flexible low-tech solutions trump high capital cost long-term (i.e., can we afford clean coal with cheap gas?)

# “U.S. Coal CO<sub>2</sub> Emissions Lowest in 20 Years” ...U.S. Energy Information Administration (EIA)

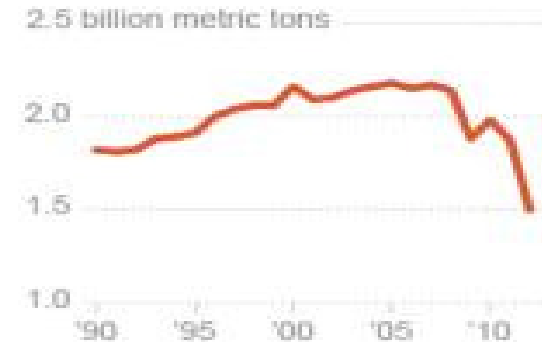
- Switch to natural gas
- Retirement of some U.S. coal (~17GW to date, >53 GW projected)
- Low generation growth

***“U.S. has cut carbon dioxide emissions more than any other country over the last six years. Peak 6 billion metric tons in 2007. Projections 2012 ~5.2 billion. 1990 ~5 billion”***

International Energy Agency (IEA)

## Emissions lower

Carbon dioxide released into the atmosphere in the U.S. from burning coal has fallen to its lowest level in 20 years. Carbon dioxide emissions from burning coal:



NOTE: 2012 is estimated

SOURCE: Energy Information Administration

# Gas Impacts Renewables and Nuclear in the USA



- Gas competes with renewables and nuclear for new units - - lower capital cost, and now low variable (dispatch) vs. coal
- If no production tax credits are available for renewables, build-out slows
- Nuclear capital cost and permit/ waste issues
- Gas (particularly peaking) is quick to build and will back up variable renewables like wind and solar, and can provide variable load and grid support for nuclear units which operate base load

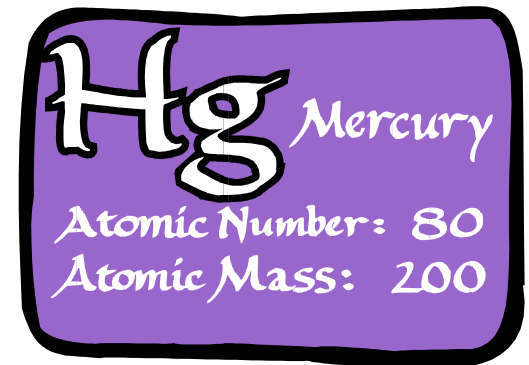
## Regulation/ Policy - CO<sub>2</sub>

- U.S. regulatory drivers are not pushing Carbon Capture and Storage
- Proposed New Source Performance Standards for CO<sub>2</sub> means *new* coal will need CCS (>40% capture based on 1000 pounds/MWh gross)
- New natural gas-fired combined-cycle may be able to meet proposed NSPS.
- Carbon tax - helpful for deficit reduction??? (Congressional Research Service)

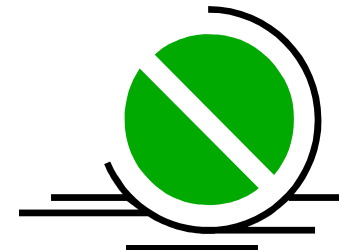


# Carbon Pollution Standard CO<sub>2</sub> Limit for Coal and Mercury and Air Toxics MATS

- CO<sub>2</sub> Standard April 2012 for new units
  - 1000Pounds/MWh -- >50% cost increase
  - Puts coal further out of the money
  - Only one unit under construction will meet it - Kemper County IGCC/CCS
- Mercury Air Toxics Standard
  - Under reconsideration for *new* units as of July 20, 2012
  - Hard for gasification
  - Impossible for Combustion?



# Cross-State Air Pollution Rule



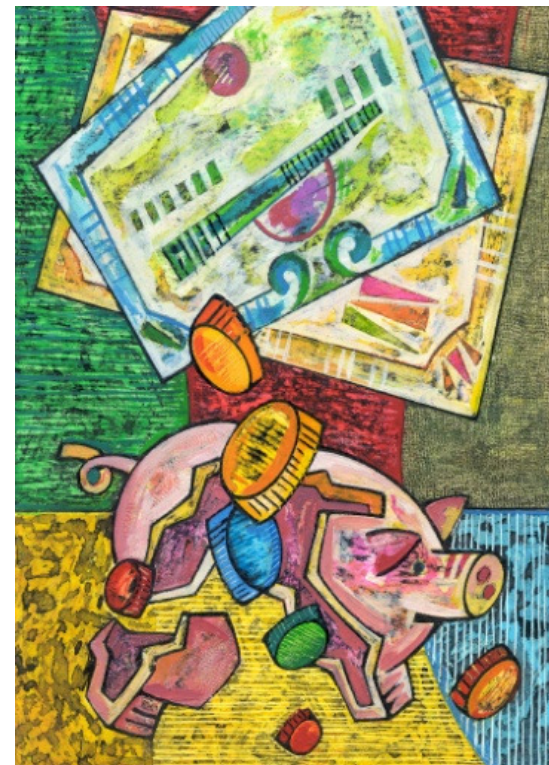
*On August 21, 2012, the Court of Appeals for the DC Circuit vacated the Cross State Air Pollution Rule.*

- The Clean Air Interstate Rule (CAIR) remains in effect
- May still be considered by the full Court or be sent to the U.S. Supreme Court for reconsideration
- This leaves the EPA to implement the old CAIR - States may sue the EPA
- Immediate impact - some delays on actions plus uncertainty. Replacement “could take years”



## Finance - What About Federal Help?

- Some large announced projects have failed to get financing
- Projects going forward often have financial backing from several sources including:
  - Grants
  - Loan guarantees
  - Enhanced oil recovery (EOR) revenues for CO<sub>2</sub>
  - Ratepayer support (if “regulated”)
  - Shareholder support
  - All or several of the above may be in play





# Coal Combustion Residuals and Water Issues

- Proposed federal regulations to govern disposal of coal ash and other coal combustion residuals (CCR)
  - not likely to be resolved in 2012
- Water – cooling and discharge issues
  - “316(b)” regulations will impact many U.S. plants
  - Power plant discharge regulations last updated in 1982 but EPA looking at changes



## Power - We Need All the Options



- There is no “silver bullet”
- Gas today, Price Tomorrow?
- > 100 units considering simple fuel switch
- Wind and solar - is the grid up to it?
- Nuclear power provides low dispatched cost of power? Issues post - Fukushima
- Existing coal is under pressure but it still is a major source of generation and new coal is not on the table now

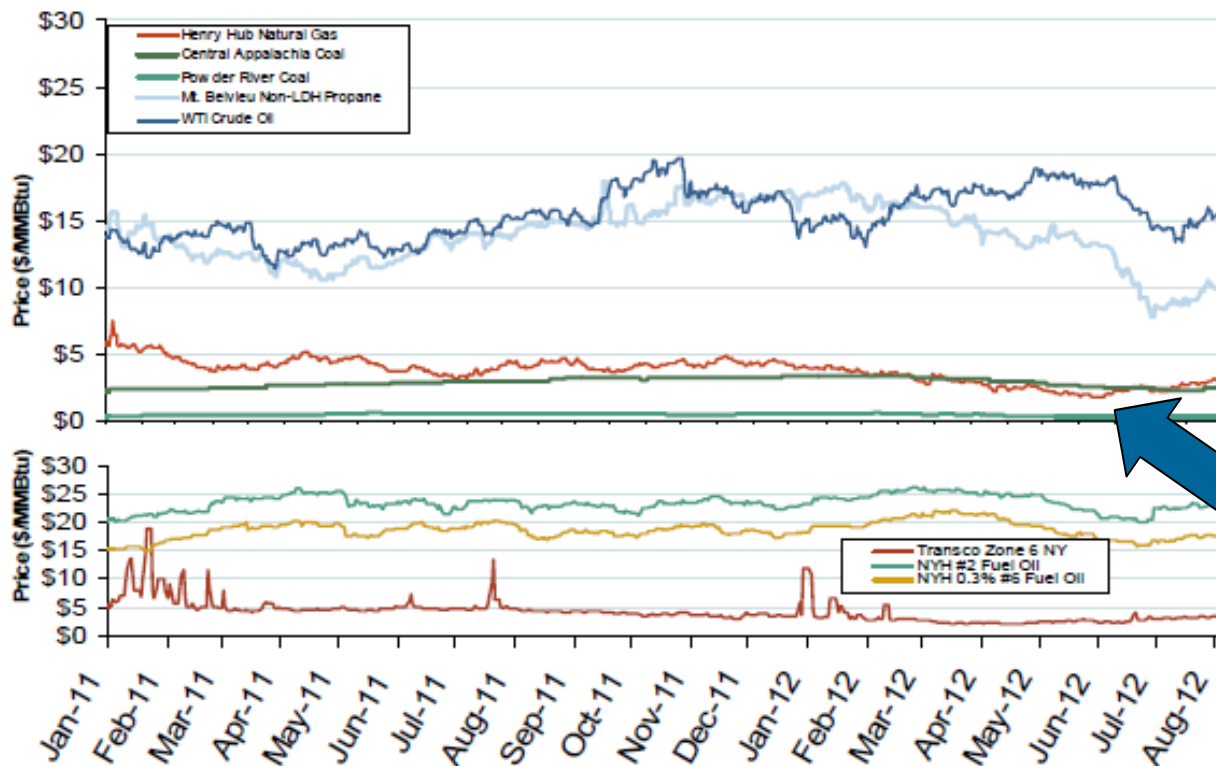
**Policy > Finance > Technology**

# Comparing Fuels (in US \$/MMBtu)

## Other Fuels Market: Fossil Fuel Prices

Federal Energy Regulatory Commission • Market Oversight • [www.ferc.gov/oversight](http://www.ferc.gov/oversight)

### Oil, Coal, Natural Gas and Propane Daily Spot Prices



Source: FERC  
Market Oversight

Gas was less expensive than Central App coal

Notes: Coal prices are quoted in \$/ton. Conversion factors to \$/MMBtu are based on contract specifications of 12,000 btus/pound for Central Appalachian coal and 8800 btus/pound for Powder River Basin coal  
Source: Derived from ICF and Bloomberg data

Updated: August 05, 2012

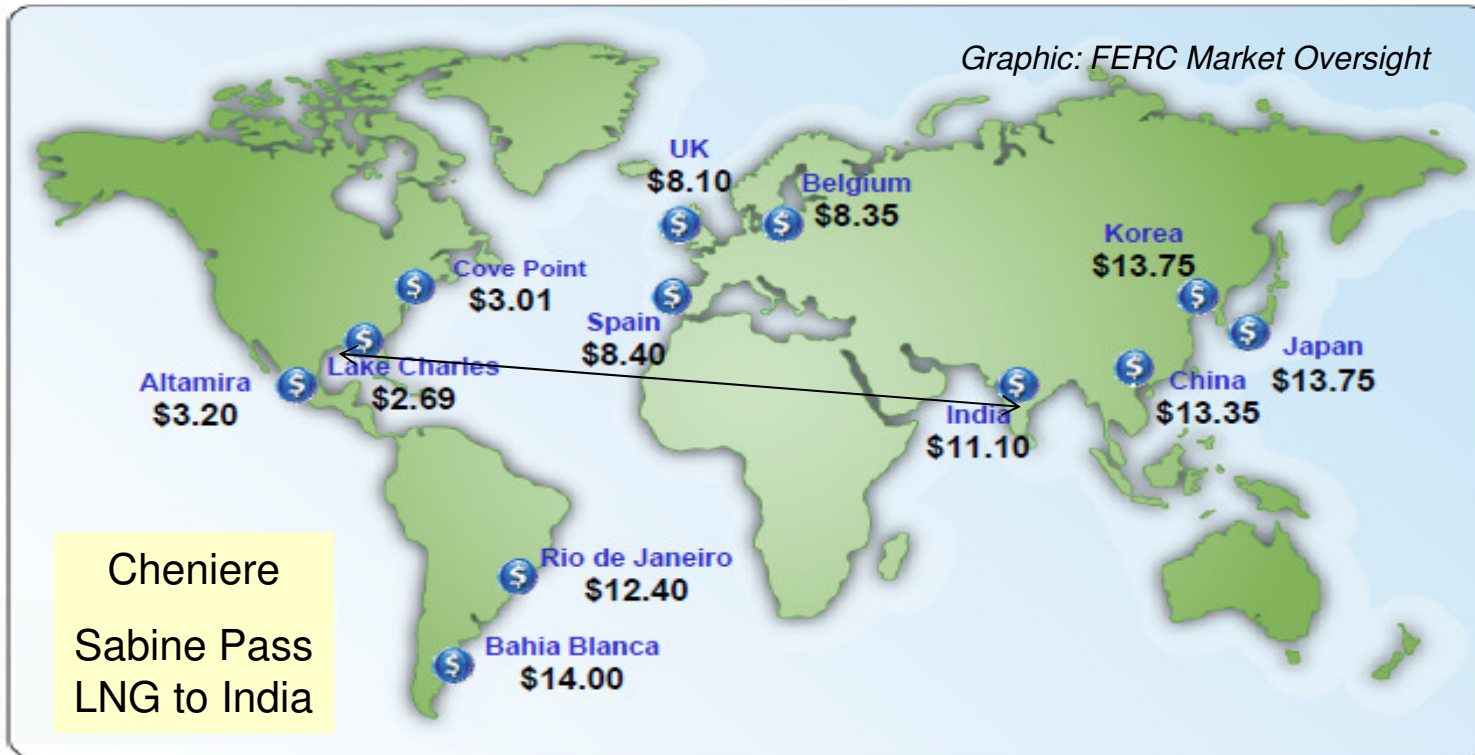
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# Global LNG “Landed Prices” (in US \$/MMBtu)

## Natural Gas Overview: World LNG Prices

Federal Energy Regulatory Commission • Market Oversight • [www.ferc.gov/oversight](http://www.ferc.gov/oversight)

### World LNG Estimated September 2012 Landed Prices



Source: Waterborne Energy, Inc. Data in US\$/MMBtu

Updated: August 8, 2012

# Tough Planning Questions Abound



- What will load look like?
  - Growth flat/ down over 4 years
- What price will we see for natural gas in the future?
- What environmental limits?
  - Air, water, solids limits for coal (MATs and mercury rule reconsideration, CSAPR, 316b, combustion products), EPA greenhouse gas limits
- Financial incentives?
  - Loan guarantees for nuclear, fossil, renewable
  - Production Tax Credits for renewable
- Cost of alternatives?

# EPRI Annual Update on Generation Options –

*Data source for later slides*

- Annual report published under EPRI's Strategic Energy Analysis work
- EPRI's public cost and performance numbers
  - Based on more detailed engineering and economic evaluations conducted at EPRI
  - Feeds into other EPRI analyses
- Overview of trends in the electricity industry
- Overview of each technology

**Current report: Program on Technology Innovation -  
Integrated Generation Technology Options #1022782**



# Cost Near-Term: 2015

Report available at [www.epri.com](http://www.epri.com) #1022782  
Update later this year (note these are *generic* costs)

# Levelized Cost of Electricity Analysis – Assumptions

- All baseload technologies 80% capacity factor, except for nuclear which has a 90% capacity factor.
- Non-dispatchable renewables assume a range of capacity factors based on a range of resource availability assumptions.
- No production or investment tax credits
- No integration costs (e.g. costs associated with additional reserves, balancing, conventional generation cycling, etc.) included for non-dispatchable technologies.

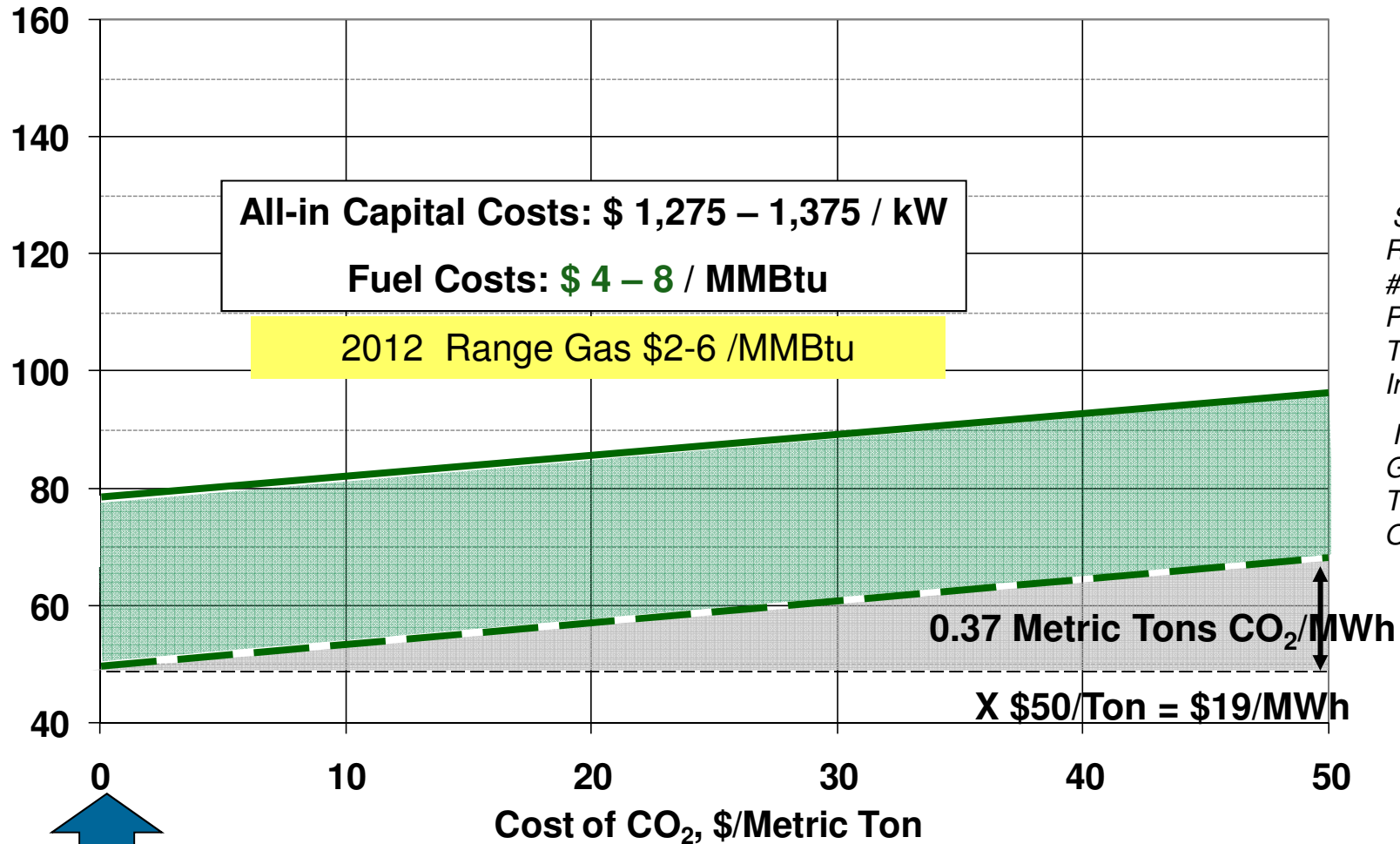


# Natural Gas Combined-Cycle (NGCC) Fuel Cost Sensitivity Comparison – 2015

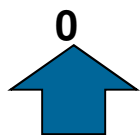


Levelized Cost of Electricity, \$/MWh

All costs are in December 2010 \$



Source Report #1022782 Program on Technology Innovation: Integrated Generation Technology Options –

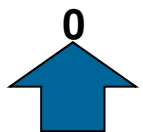
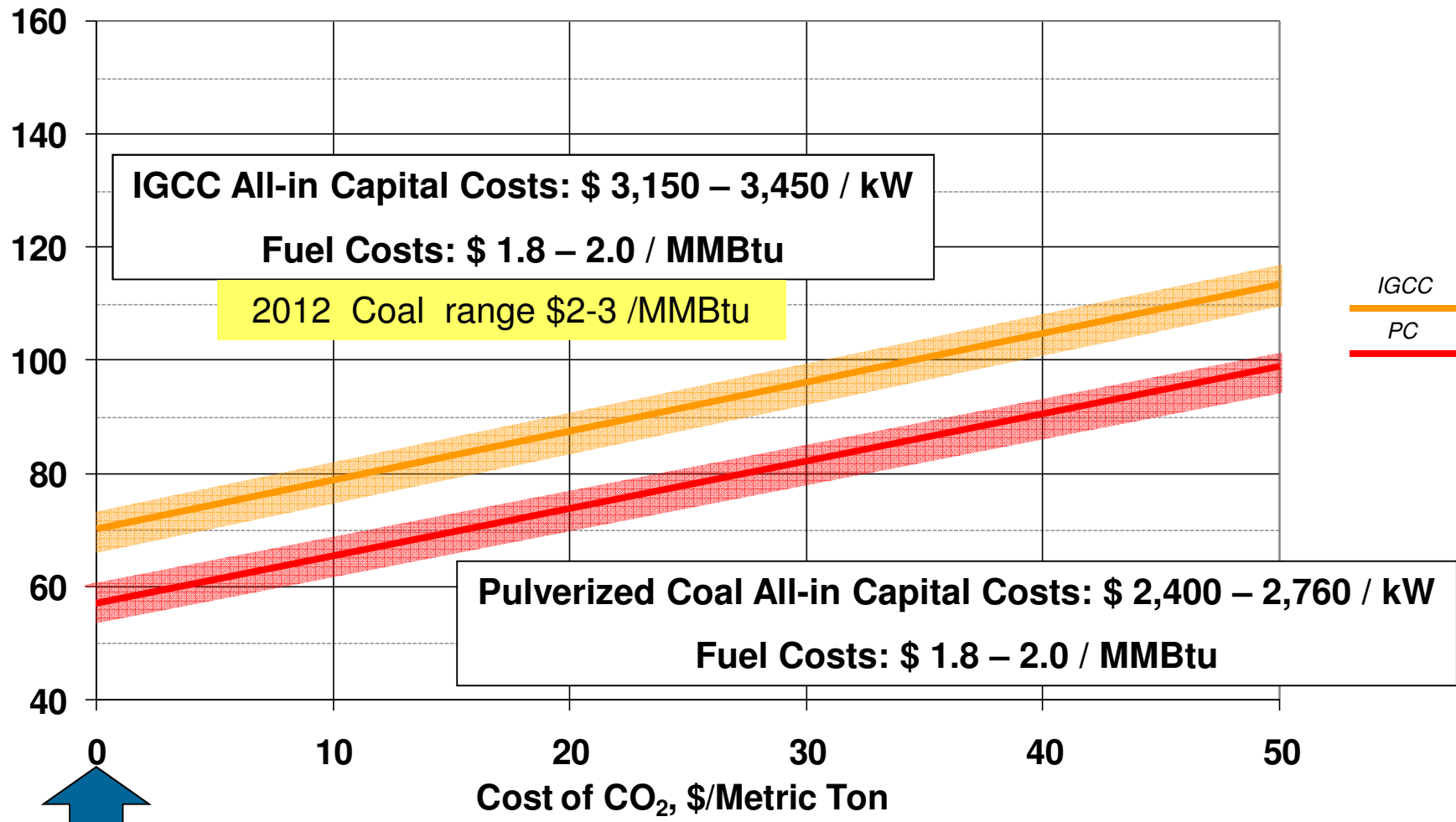


# Coal Combustion and Gasification Comparison – 2015



All costs are in December 2010 \$

Levelized Cost of Electricity, \$/MWh

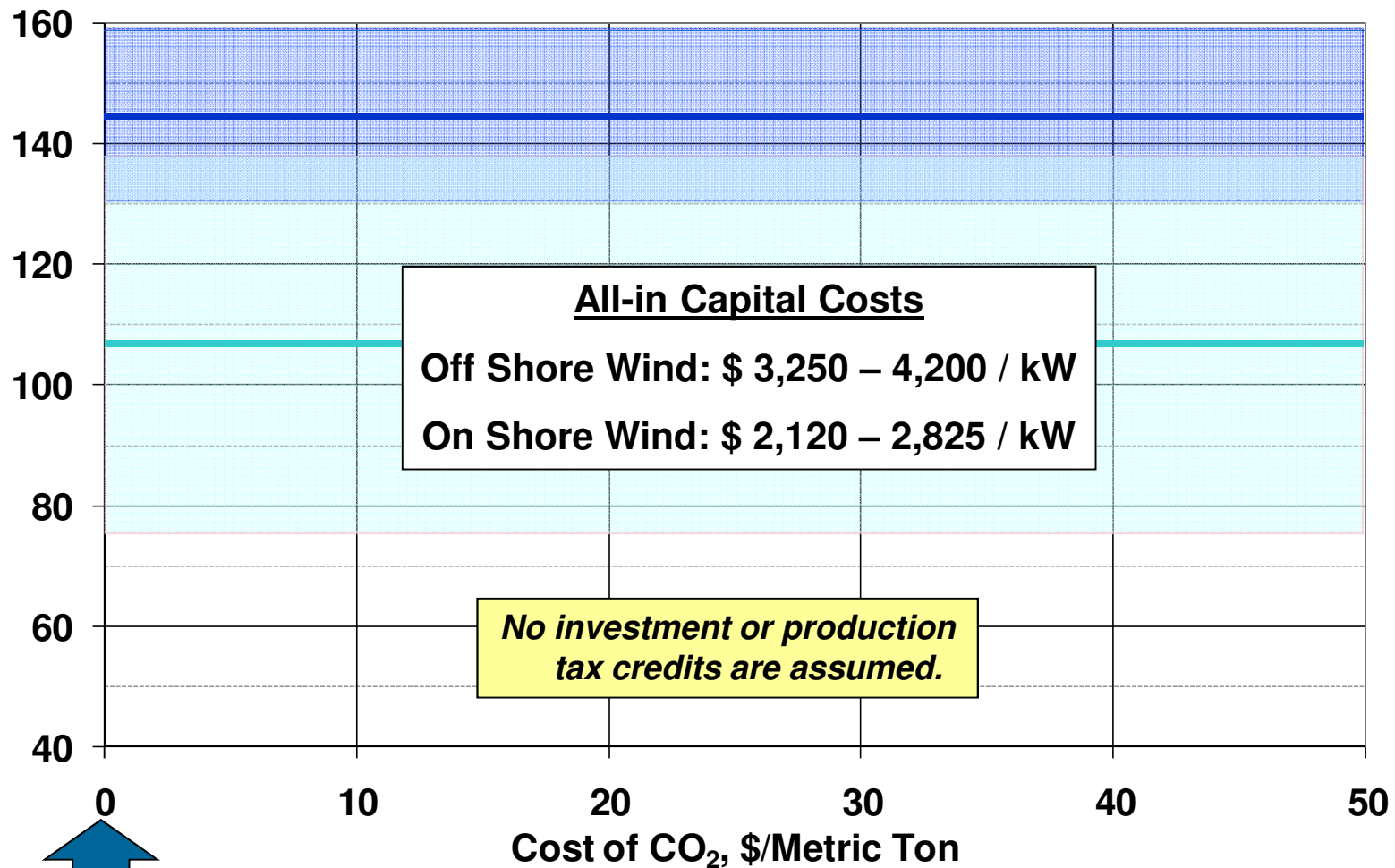


# Wind – 2015



All costs are in December 2010 \$

Levelized Cost of Electricity, \$/MWh

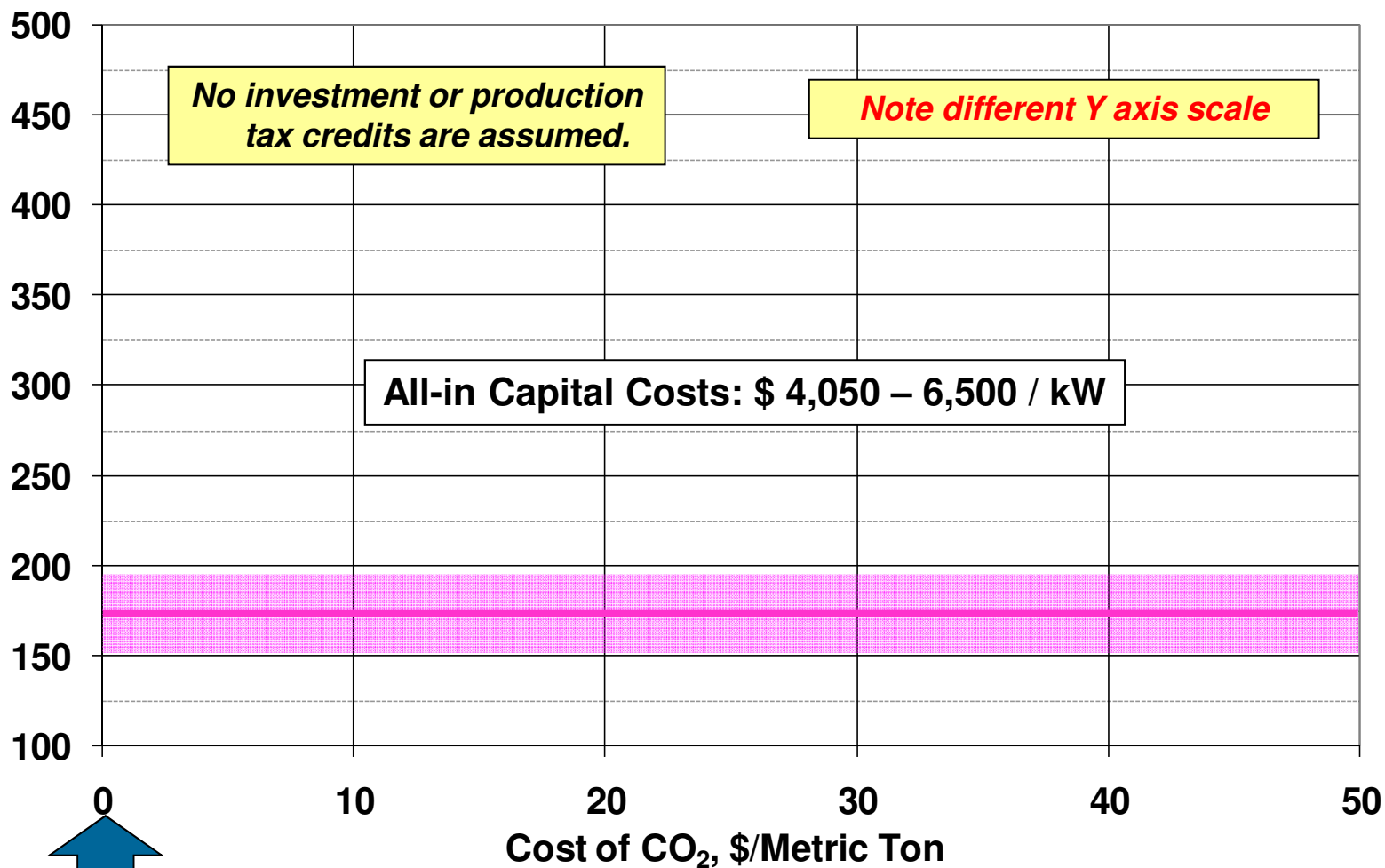


# Concentrating Solar Thermal – 2015



All costs are in December 2010 \$

Levelized Cost of Electricity, \$/MWh

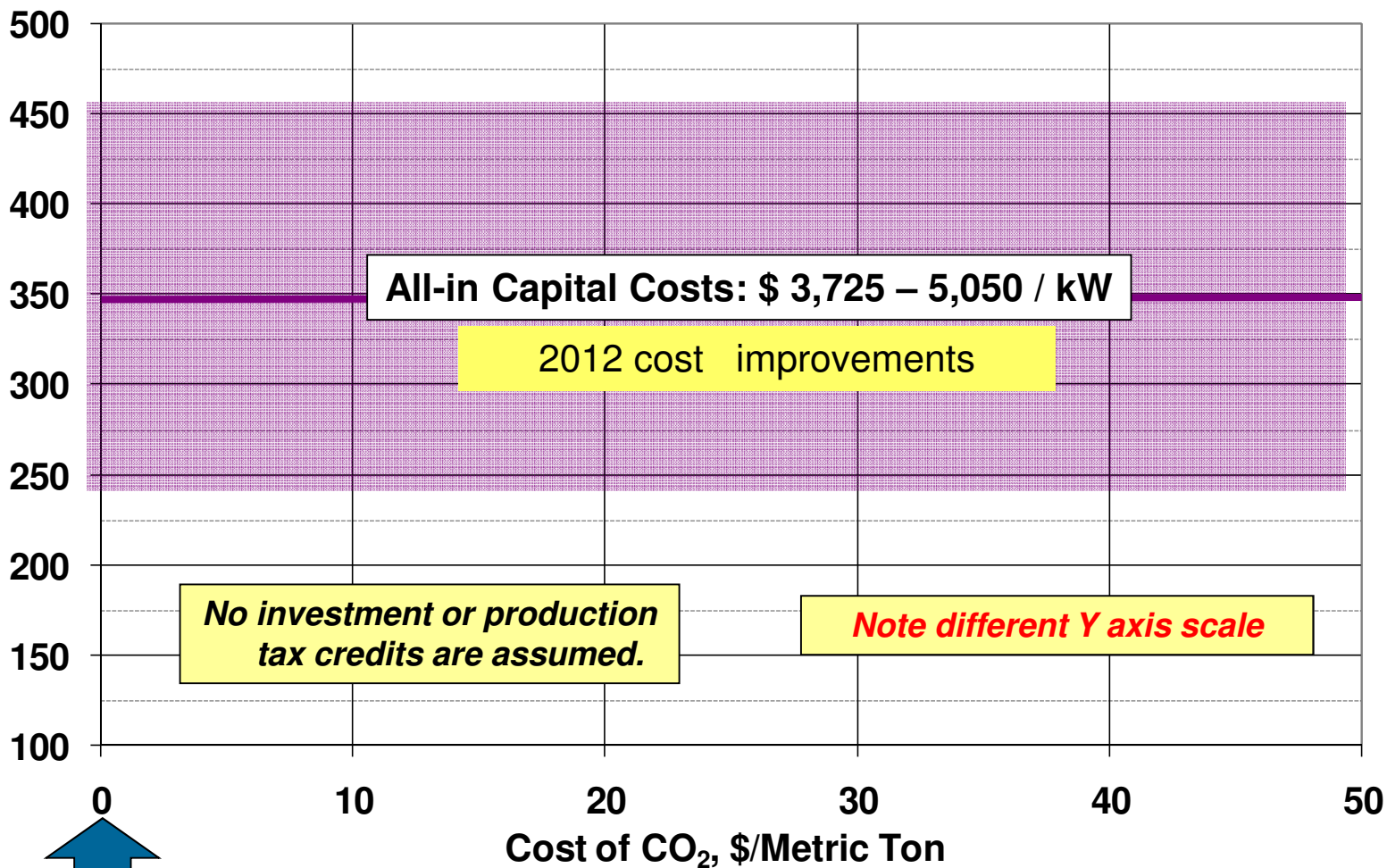


# Solar Photovoltaic – 2015



Levelized Cost of Electricity, \$/MWh

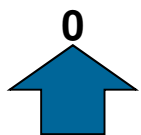
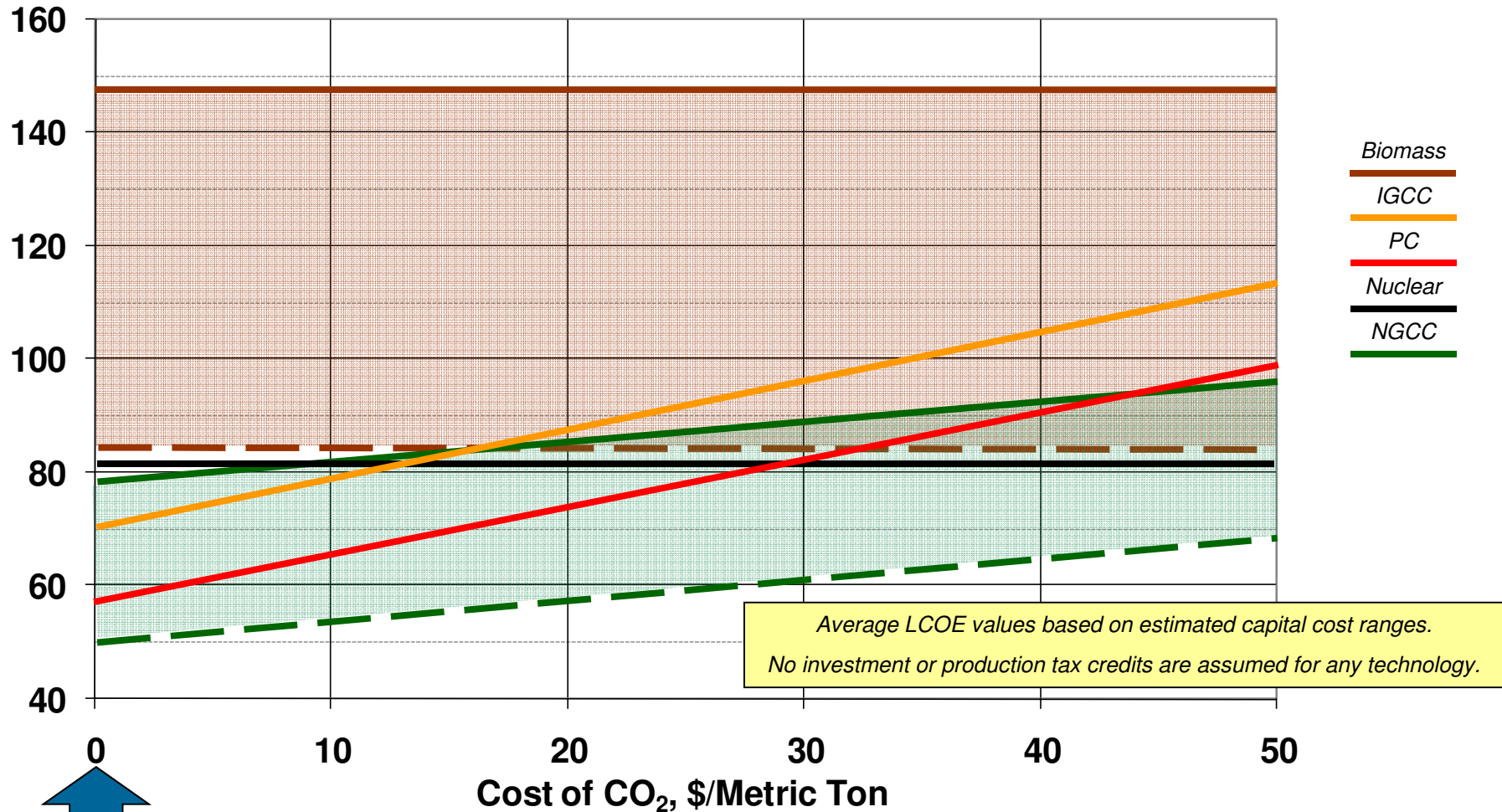
All costs are in December 2010 \$



# Comparative Levelized Costs of Electricity – 2015 – Dispatchable Technologies

Levelized Cost of Electricity, \$/MWh

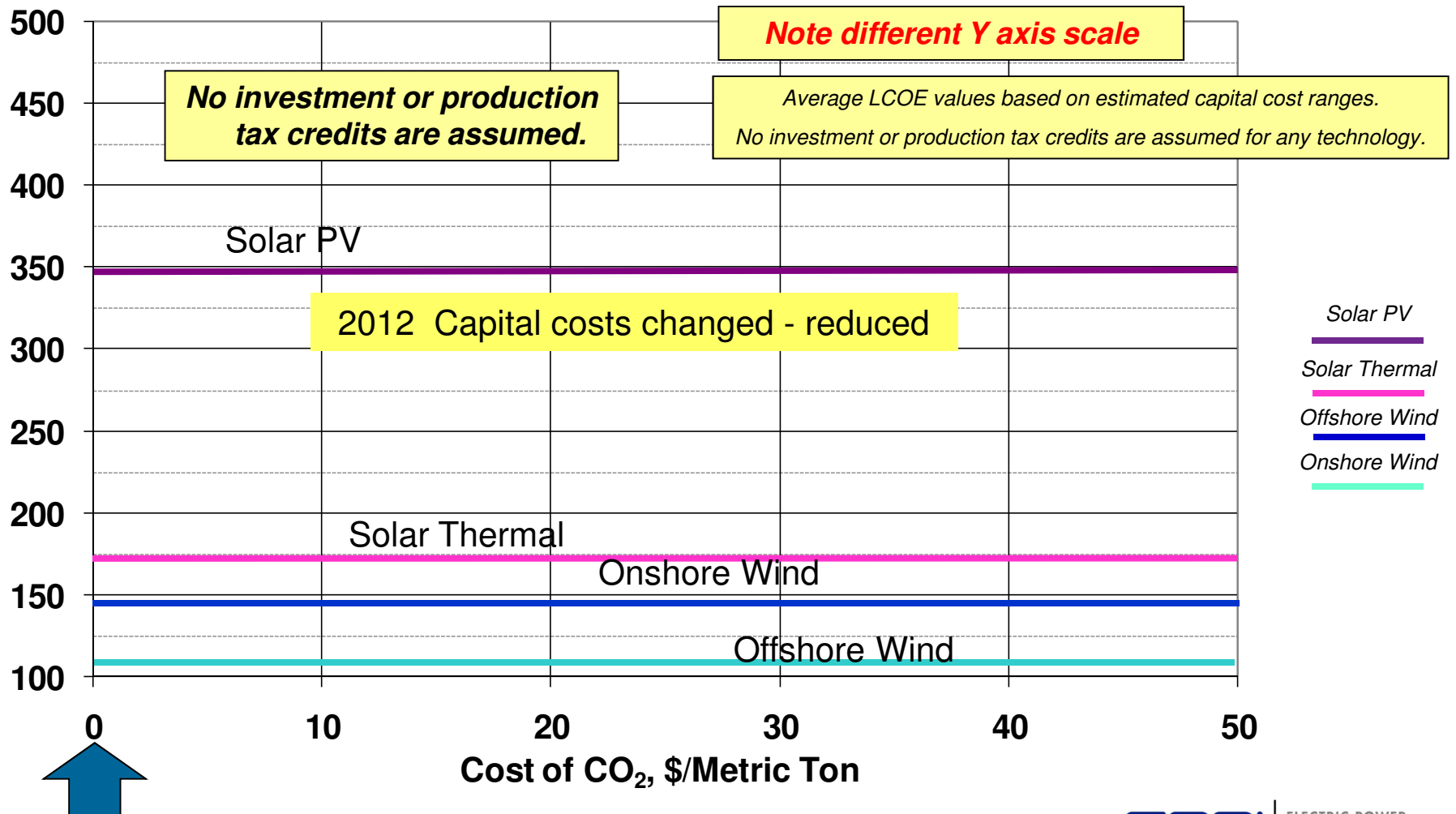
All costs are in December 2010 \$



# Comparative Levelized Costs of Electricity – 2015 – Non-Dispatchable Technologies

Levelized Cost of Electricity, \$/MWh

All costs are in December 2010 \$





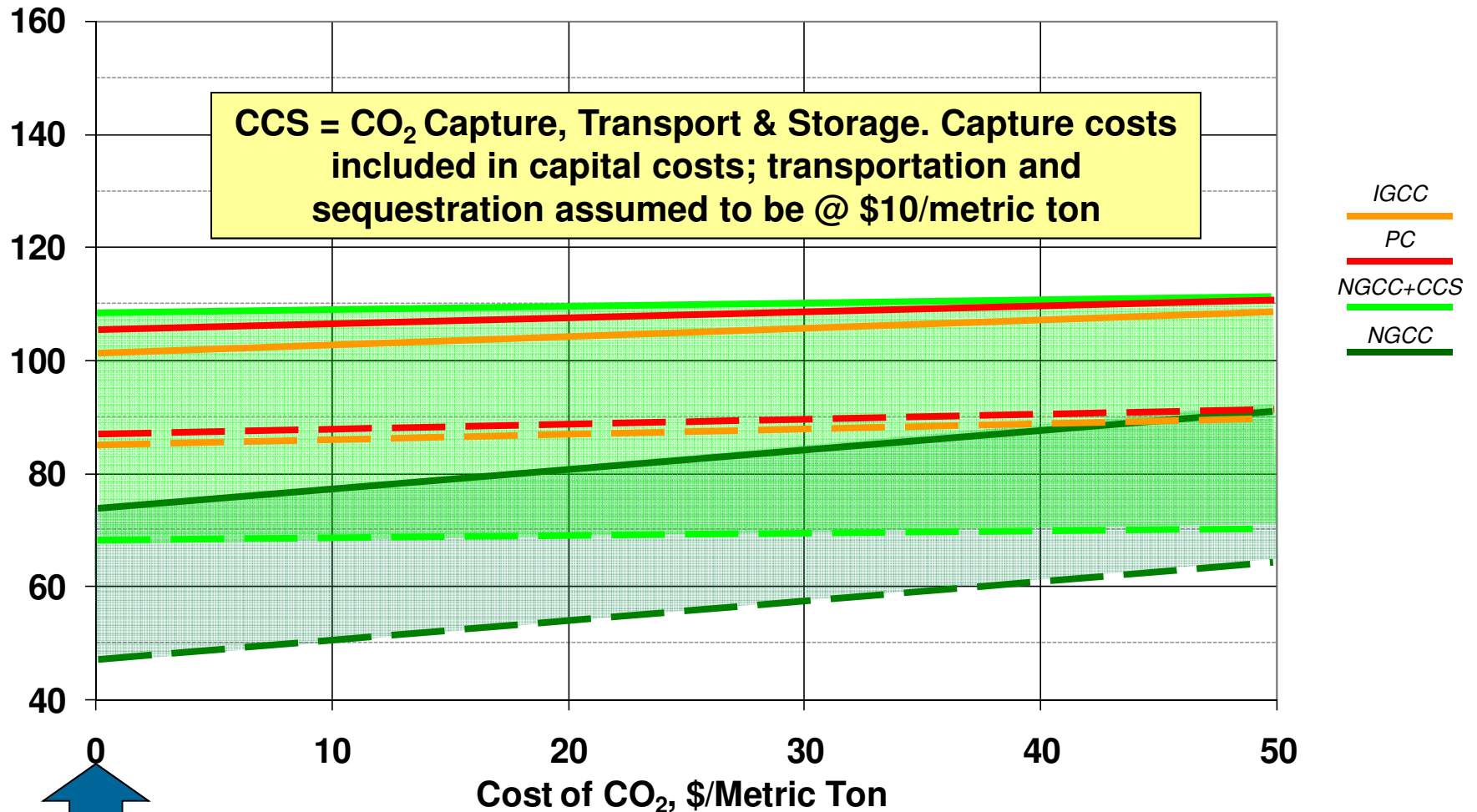
# Comparing Low-Carbon Options Longer-Term: 2025



# PC, IGCC, NGCC, 2025—Impact of CO<sub>2</sub> Removal, Transport & Storage (CCS) and Cost and Performance Improvements on Levelized Cost of Electricity

Levelized Cost of Electricity, \$/MWh

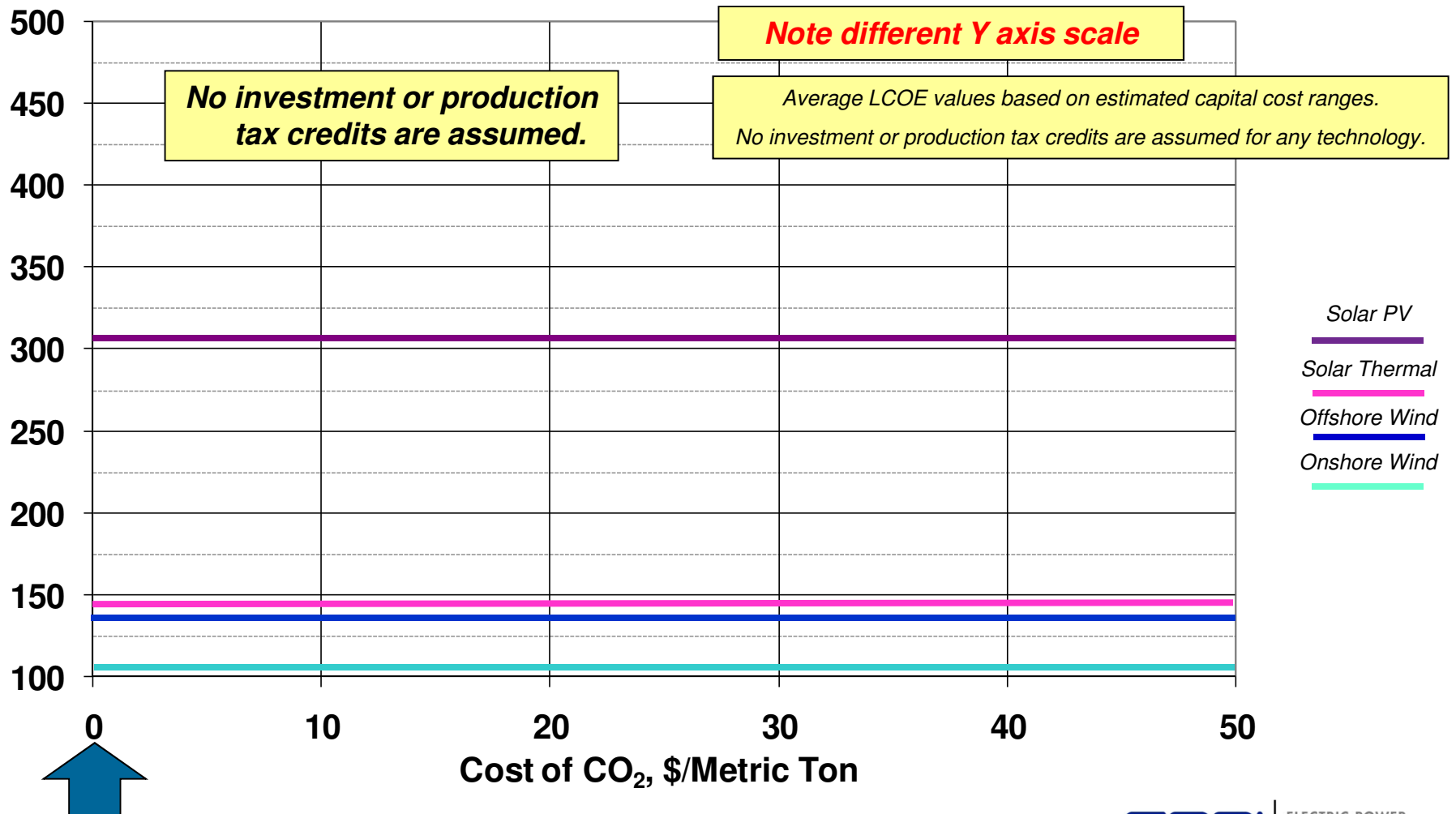
All costs are in December 2010 \$



# Comparative Levelized Costs of Electricity – 2025 – Non-Dispatchable Technologies

Levelized Cost of Electricity, \$/MWh

All costs are in December 2010 \$



## Conclusions...Options – But No Crystal Ball



- Natural Gas – great prices now – where is it going?
  - Warm winter, fracking, storage, LNG export (2016)
- Coal - MATs, CSAPR – CO<sub>2</sub> GHG - solids?
  - Hard for existing coal – loss of 10-20% of fleet? New?
- Wind – Size improves costs -Production Tax Credit fails
  - Birds, Bats, TV interference, neighbor concerns
  - Variability and “inverse correlation” with load
- Solar – PV /Solar thermal cost coming down but still high
- Nuclear power – new licenses and shared risk
  - Existing sites favored but what will build-out cost?

**Policy > Finance > Technology**

# Together...Shaping the Future of Electricity

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