EARLY DEPLOYMENT PROGRAM FOR CLEAN COAL AND NUCLEAR TECHNOLOGIES

National Commission on Energy Policy
Clean Air Task Force

August 2009

NORTHBRIDGE

These materials summarize the results of an extension and update of a June 2008 study assessing the economics and policy options to deploy clean coal and nuclear technologies prior to the time when carbon prices are sufficient to achieve that objective.

Three topics are covered in these materials:

1. An update of the earlier analysis and extension to three partial capture technologies

June 2008 Technologies	Additional March 2009 Technologies
IGCC with 90% CCS	IGCC with 50% CCS
CCS retrofit at 90%	CCS retrofit at 50%
New PC with CCS at 90%	SNG with 90% CCS (50% from fuel)
UCG with CCS at 60%	
Nuclear	

2. An elaboration of the incentive mechanism, addressing the use of reverse auctions, tax treatment of incentive payments, and competition between merchant and regulated investors.
3. Updated estimates of the costs expected for a 30 GW deployment program reflecting in part the new technologies and current market conditions.

1. Economic Update and Extension –

   » All technologies, including both full and partial capture CCS, are expected to require carbon prices materially above those expected in the early years of carbon regulation.

   » Nuclear is expected to require a carbon price of about $35/ton ($2,000/KW), full capture CCS retrofit $50/ton ($2,800/KW), and full capture IGCC/CCS $90/ton ($2,900/KW). (1)

   » The partial capture technologies are less costly (by $800 to 900/KW) but would need capture rates of roughly 65% to achieve the emissions rate of a NGCC plant.

2. Program –

   » Deploy an average of 1 GW of each technology annually over a 10 year period (a total of 3 GW annually, or 30 GW total).

   » Use competitive process such as a reverse auction to determine incentive levels and loan guarantees. Within the limits of an annual budget, incentives awarded to the lowest bids, with the amount of capacity deployed depending on the results of the competitive process.

   » Incentives would be in the form of auction revenues and/or bonus allowance if part of a cap and trade bill; alternately in the form of a production tax credit if part of an energy bill.

3. Program costs –

   » The program is estimated to cost roughly $8.8 a year under a $12/ton carbon price case (or about $90 billion over ten years).

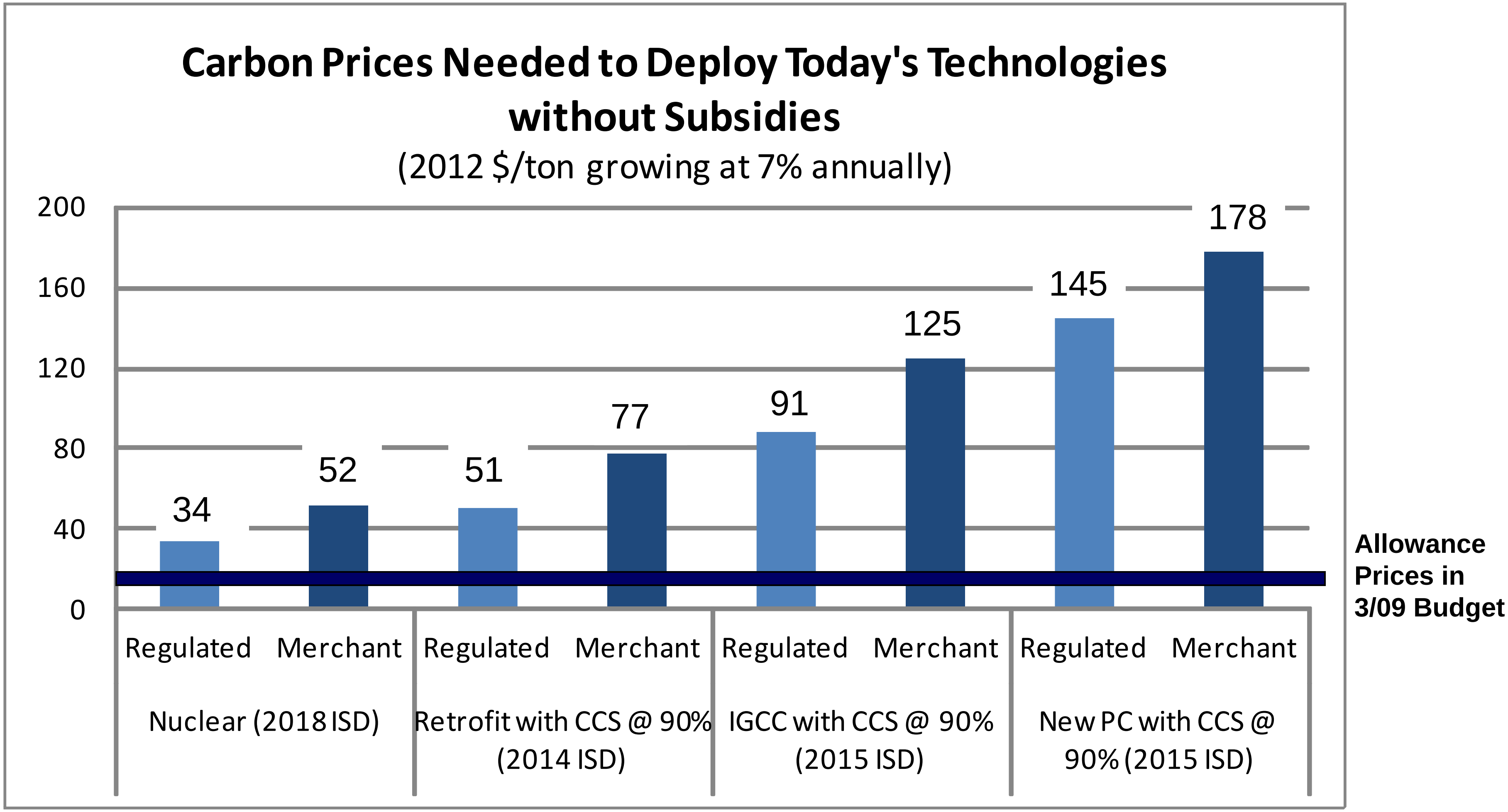
   » Without a carbon price costs would rise to $12 billion annually ($120 billion total), and with a carbon price of $25/ton decline to $4.8 billion annually (about $50 billion total).

1) 2012 $/ton escalating at 7% annually, regulated financing, baseline market conditions.

TOPICS

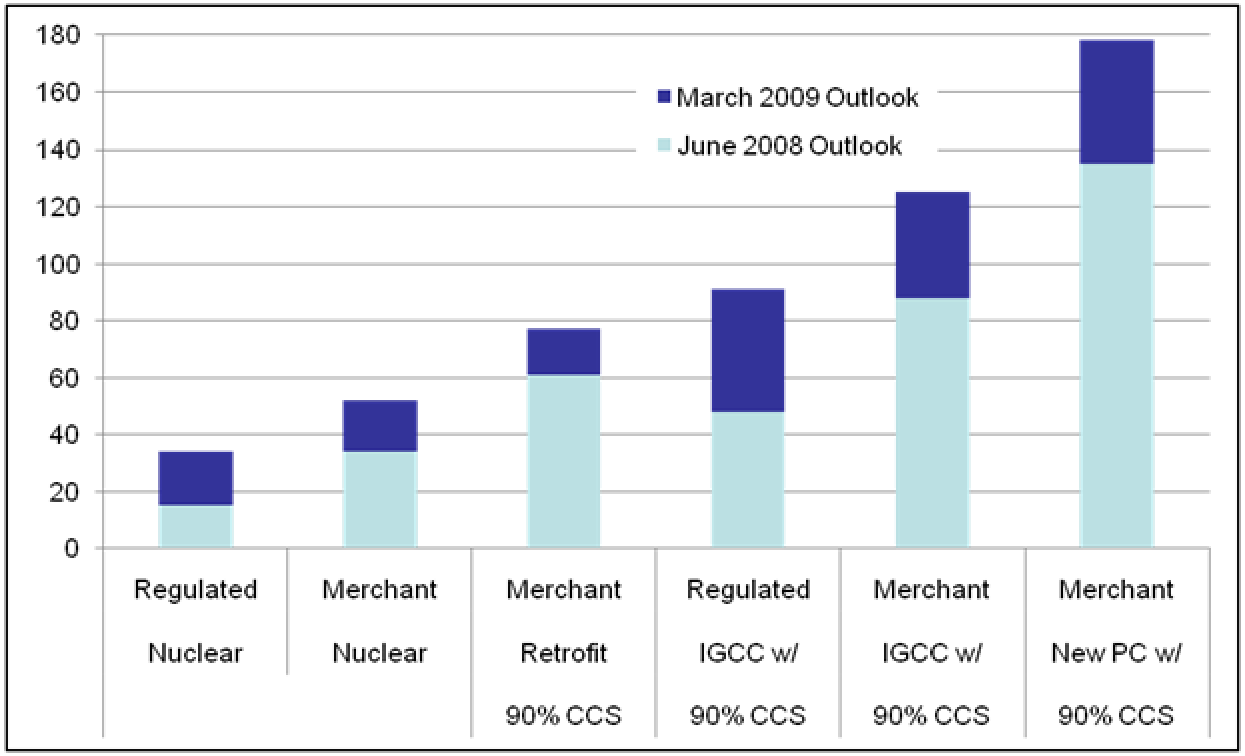
1. **ECONOMICS**
2. Program Overview
3. Program Costs

The carbon prices required to deploy new nuclear, CCS retrofits and IGCC with CCS are materially above the prices expected during the early years of carbon regulation.



The breakeven carbon prices are $20 to 40/ton higher than the June 2008 analysis due primarily to lower gas price expectations and other commodity pricing changes.

Breakeven Carbon Prices (1)

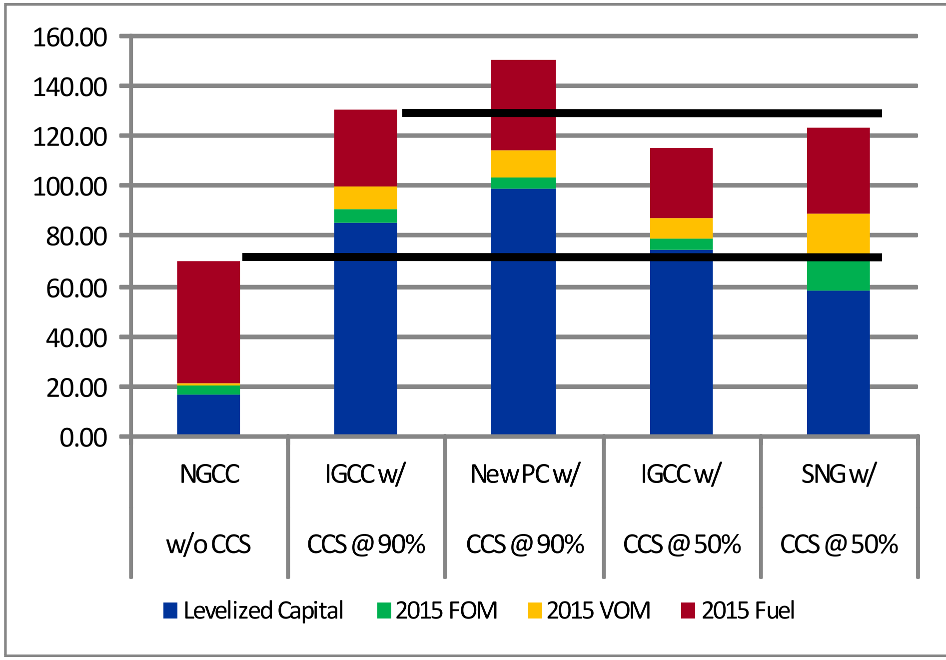


June 2008 Outlook	15	34	61	48	88	135
March 2009 Outlook	34	52	77	91	125	178

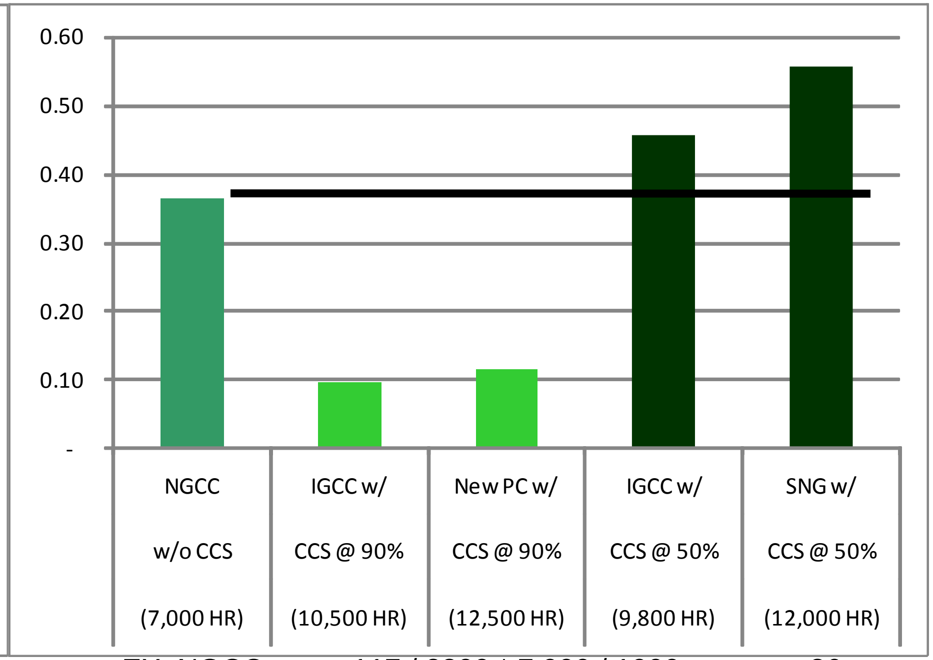
(1) 2012 $/ton rising at 7 percent annually; Results reflect a gas driven market.

The partial capture CCS technologies evaluated in this study are less expensive on a $/mWh basis than full capture, but at a 50% capture level have emission rates higher than a NGCC.

Total Costs without Carbon ($/mWh)



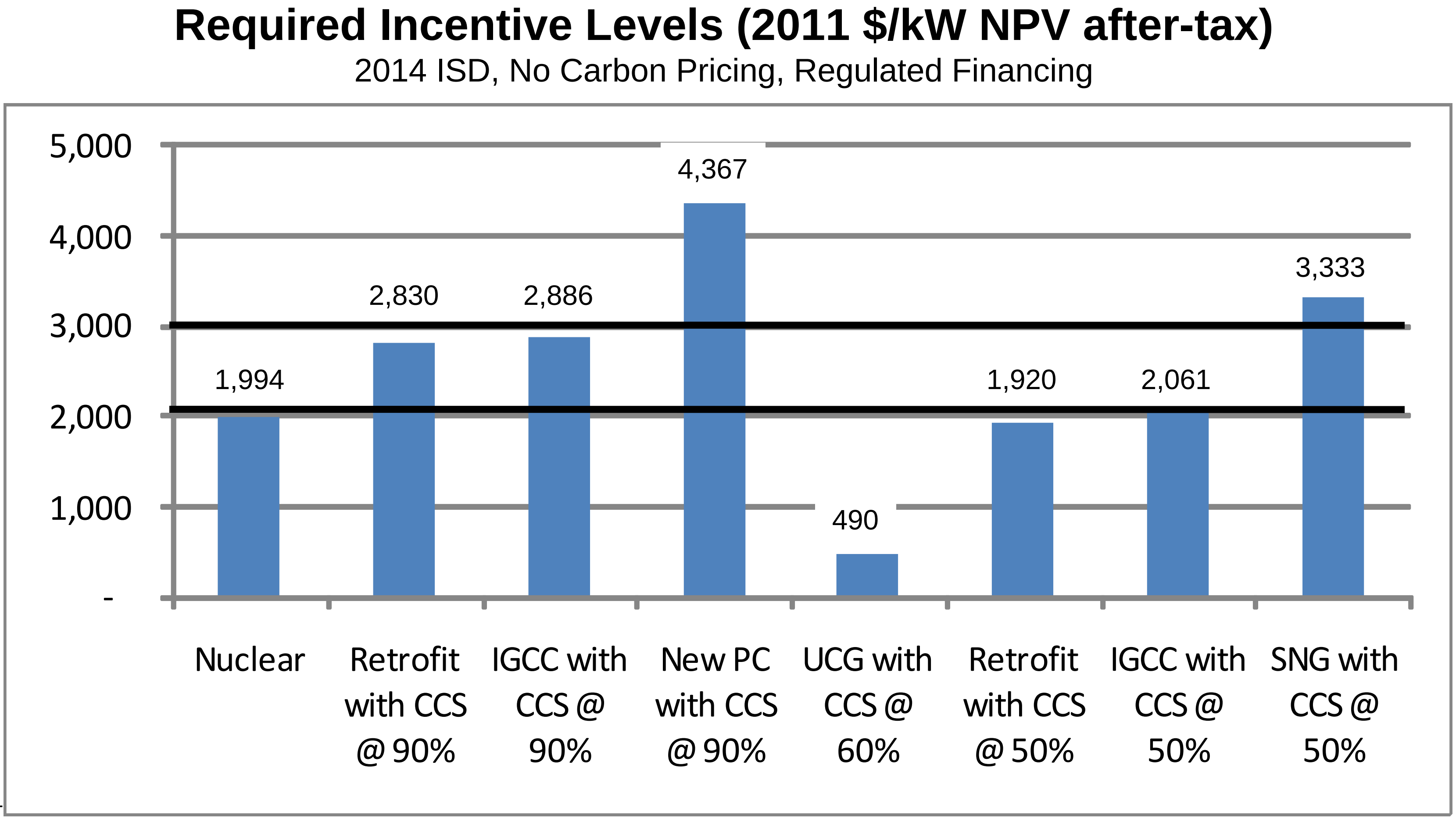
Carbon Emission Rates (Tons/mWh)



EX. NGCC: 117 / 2200 * 7,000 / 1000 = .36
IGCC/CCS: 205 / 2200 * 9,800 / 1000 * 50% = .46

A capture rate of roughly 65 percent would be needed to achieve the emissions rate of a NGCC.

On a $/kW basis, most technologies would require $2,000 to 3,000/kW to be economic, with partial capture CCS costing about $800 to 900/kW less than full capture. (1)



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TOPICS

1. Economics
2. **PROGRAM OVERVIEW**
3. Program Costs

PROGRAM

An early deployment program would encourage clean coal and nuclear projects currently in early stages of development, but which are unlikely to benefit from existing incentive programs, to complete development and go into commercial operation.

Proposed Projects				
Technologies	Nuclear (1)	CCS Retrofit (2)	IGCC (2)	SNG or Industrial (2)
Number of Projects	17 projects (26 units)	1	6	11
Amount of Capacity	Approx. 32,000	345 MW	2,545 MW	7,180 MW
Current / Possible Timing	Applications accepted by NRC 2007 - 2008	2010 Groundbreaking	2010 – 2012 Groundbreaking	2009 – 2013 Groundbreaking

(1) Source: NRC website, “Expected New Nuclear Power Plant Applications”. Updated February 4, 2009
(2) Source: Clean Air Task Force

Purpose – Deploy IGCC/CCS, CCS retrofits and nuclear technologies that would not otherwise be commercially viable*.

Initial Technology Goals – Deploy an average of 1 GW of each technology annually over a 10 year period (a total of 3 GW annually, or 30 GW total).

Funding –

- The program is estimated to cost $8.8 billion annually with a $12/ton carbon price, $12 billion without a carbon price and $4.8 billion with a $25/ton price. ** These translate to $90, $120 and $50 billion respectively over the 10 year program term. (Estimates detailed later.)
- Projects would be eligible to receive a loan guarantee for an amount up to 65% of the initial capital cost of the proposed project.

Competitive Process – Incentive awards would be made using a competitive processes such as a reverse auction. Within the limits of an annual financial budget, incentives would be awarded to the lowest priced bids. The amount of capacity deployed would depend on the results of the auction.

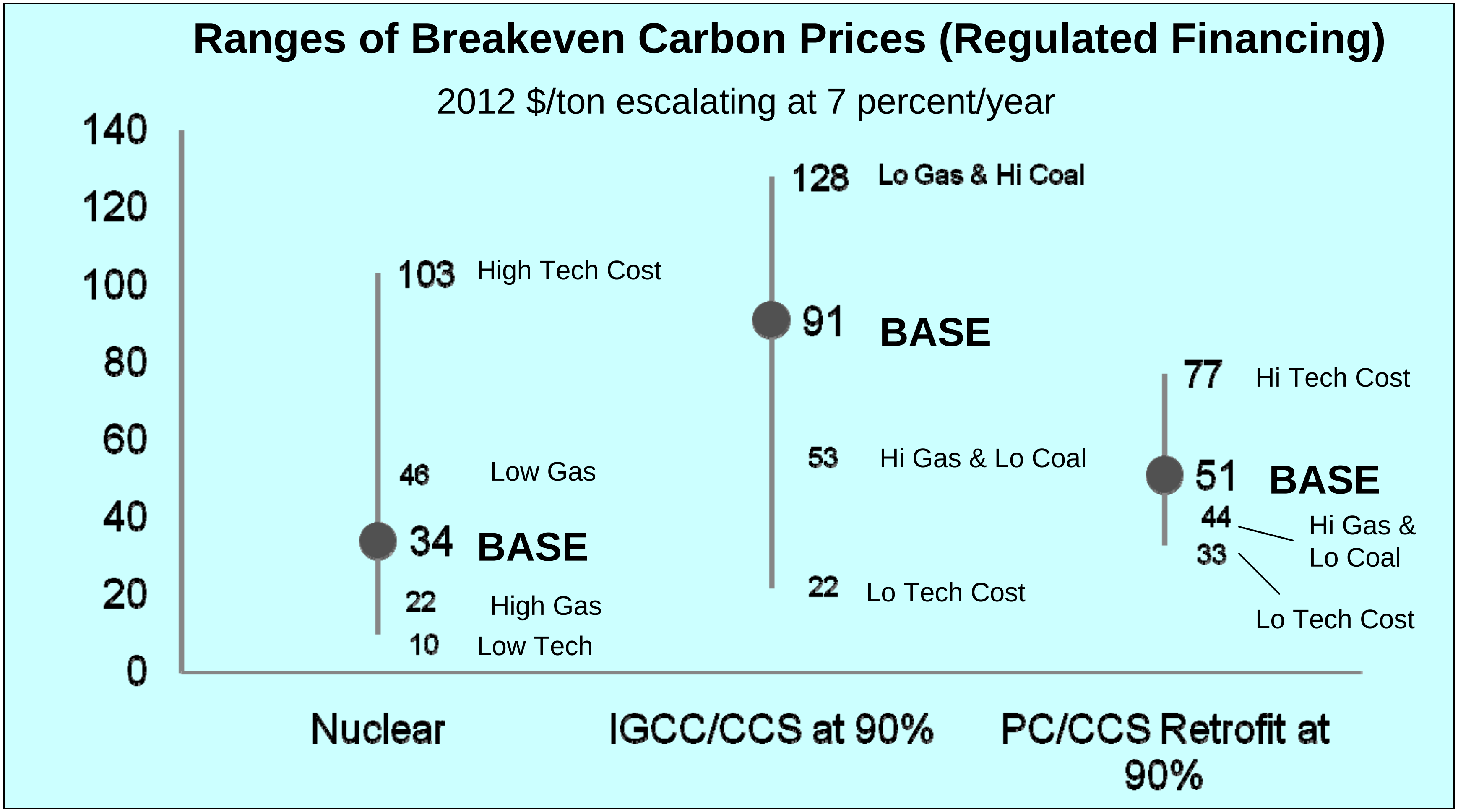
Form of Incentive -

- If part of an energy bill, the incentive would be in the form of a production tax credit .
- If part of a cap and trade bill, the incentive would be in the form of auction revenues and/or bonus allowances.

* Possibly including a range of coal types such as sub-bituminous and lignite
** Carbon prices are in 2012 dollars, escalating at 7% annually.

PROGRAM — Range Of Possible Prices

The exact level of financial support needed is uncertain due to a variety of factors including capital and commodity costs, carbon price expectations, financing costs and others.



PROGRAM — Need For Reverse Auction

Given the level of economic uncertainty, a deployment program based on a fixed level of incentives will either be ineffective or inefficient.

Illustrative Example

Incentives Expected to be Required before the start of the Program(1)

Nuclear = $50/ton avoided
IGCC/CCS = $70/ton seq.
PC/CCS = $40/ton seq.

Level of Incentives Required Given <u>Changing Market Conditions</u>

High Incentives Required
(low gas, high CO_2, high capital)

Nuclear = $80+/ton avoided
IGCC/CCS = $80+/ton seq.
PC/CCS = $80/ton seq.

Low Incentives Required
(high gas, high CO_2, low capital)

Nuclear = $10/ton avoided
IGCC/CCS = $20/ton seq.
PC/CCS = $25/ton seq.

Consequences of <u>Fixed Incentives</u>

Program is ineffective
(fixed incentives are below the level required for deployment)

Program is inefficient
(fixed incentives are above the level required for deployment:
– Program costs more than necessary, or
-- More capacity could be deployed for same funding)

(1) Level nominal amount for ten years

A reverse auction would provide the flexibility for incentives to adapt to changing market conditions, making the program both effective and efficient.

A reverse auction is a type of auction in which sellers compete to obtain business by offering to provide a product at decreasing prices until the demand of the buyer is met.

They generally work as follows:

- Some months in advance of the auction, a buyer announces its intent to conduct the auction
- The "product" to be procured is defined with sufficient specificity for potential suppliers to develop consistent proposals
- The buyer screens potential suppliers to determine whether they meet basic requirements and selects a group to participate in the auction process
- The auction takes place at a predetermined time, often over the internet, and is typically limited to an hour or two or until bids stop being submitted.

Reverse auctions are used widely in both industry and the government:

- Industry
  - Electric utilities in NJ, IL, DE use them to procure standard offer service
  - Ericsson, Target, Dell, and GE use reverse auctions to acquire commodity parts.
- Government
  - State and municipal governments in TX, CT and MA use reverse auctions procure electric supplies
  - HUD uses reverse auctions to procure the services of public housing inspectors.
  - The military has used reverse auctions to procure materials.

The loan guarantee component of the program, properly structured, serves at least two important purposes.

- It reduces the cost of the incentives required to deploy this mix of technologies, particularly for the capital intensive options, by about 20% -- under a $12/ton carbon case, from $10.6 to $8.8 billion annually.
- It also partially mitigates the concern that regulated developers may be able to propose lower-priced bids than merchant developers since they do not tend to bear fuel cost risks and therefore are able to achieve a lower cost of capital.

The structure of the loan guarantee program is important – to be effective, it will need to allow for greater leverage and lower cost debt than developers would otherwise be able to achieve.

Several tax issues have been previously identified, but based on initial discussions with energy and tax lawyers, none appear to be serious impediments:

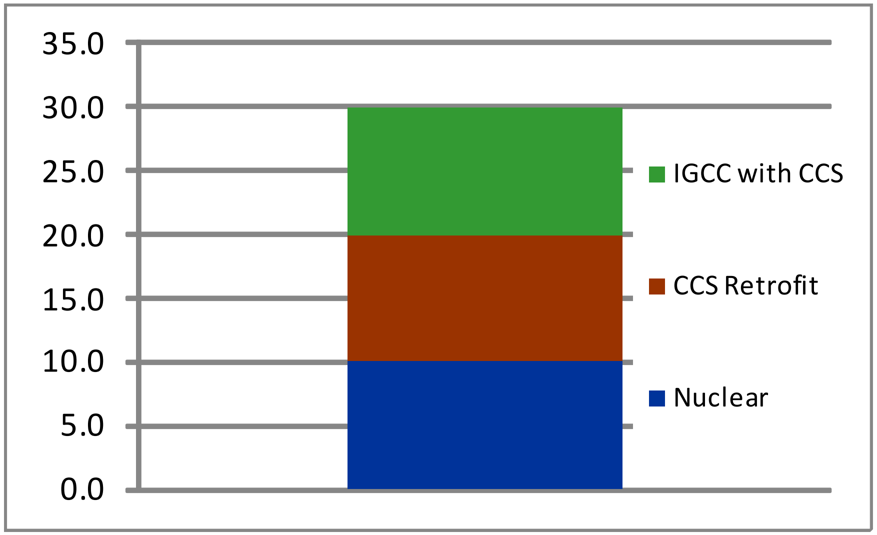
- Providing incentives to merchants and utilities on an after-tax basis
  - The mechanics depend in part on the form of the incentive -- whether it is provided as tax credit, as direct funding received from the proceeds of an allowance auction, or in the form of bonus allowances
  - In any of these cases, the incentive could be deemed by legislation to be non-taxable – this was the treatment given to allocated SO_2 allowances under the Clean Air Act; funding from allowance auctions could be provided as a form of non-taxable "cost sharing"
- In the event that the incentive is provided in the form of a tax-credit, the ability to use a reverse auction to determine the level of the tax credit
  - No known prohibition to this in current law or IRS rulings
  - Apparently at least some precedent for this in existing energy policy

TOPICS

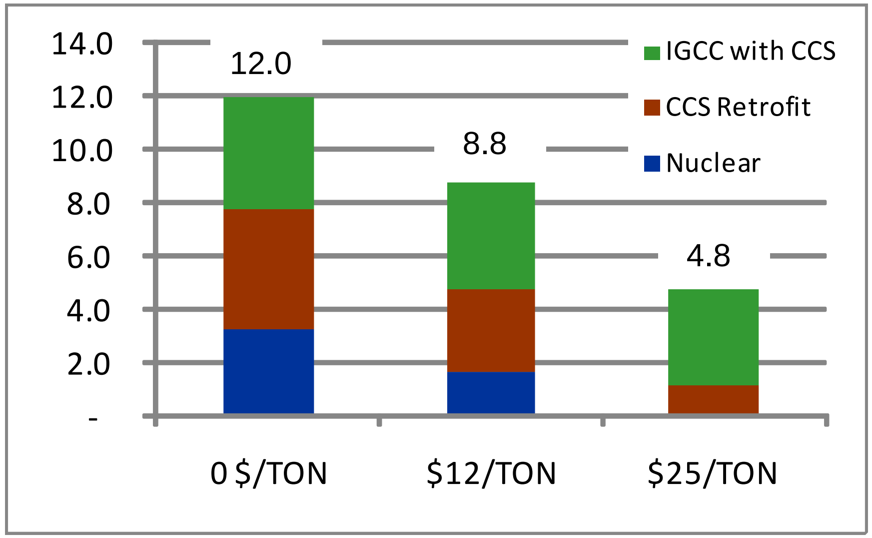
1. Economics
2. Program Overview
3. **PROGRAM COSTS**

Under expected market conditions and with a $12/ton carbon price, the program is estimated to cost $8.8 billion annually, or a total of $88 billion over the 10 year life of the program. (1)

Capacity Mix (GW)



Annualized Cost ($ B)



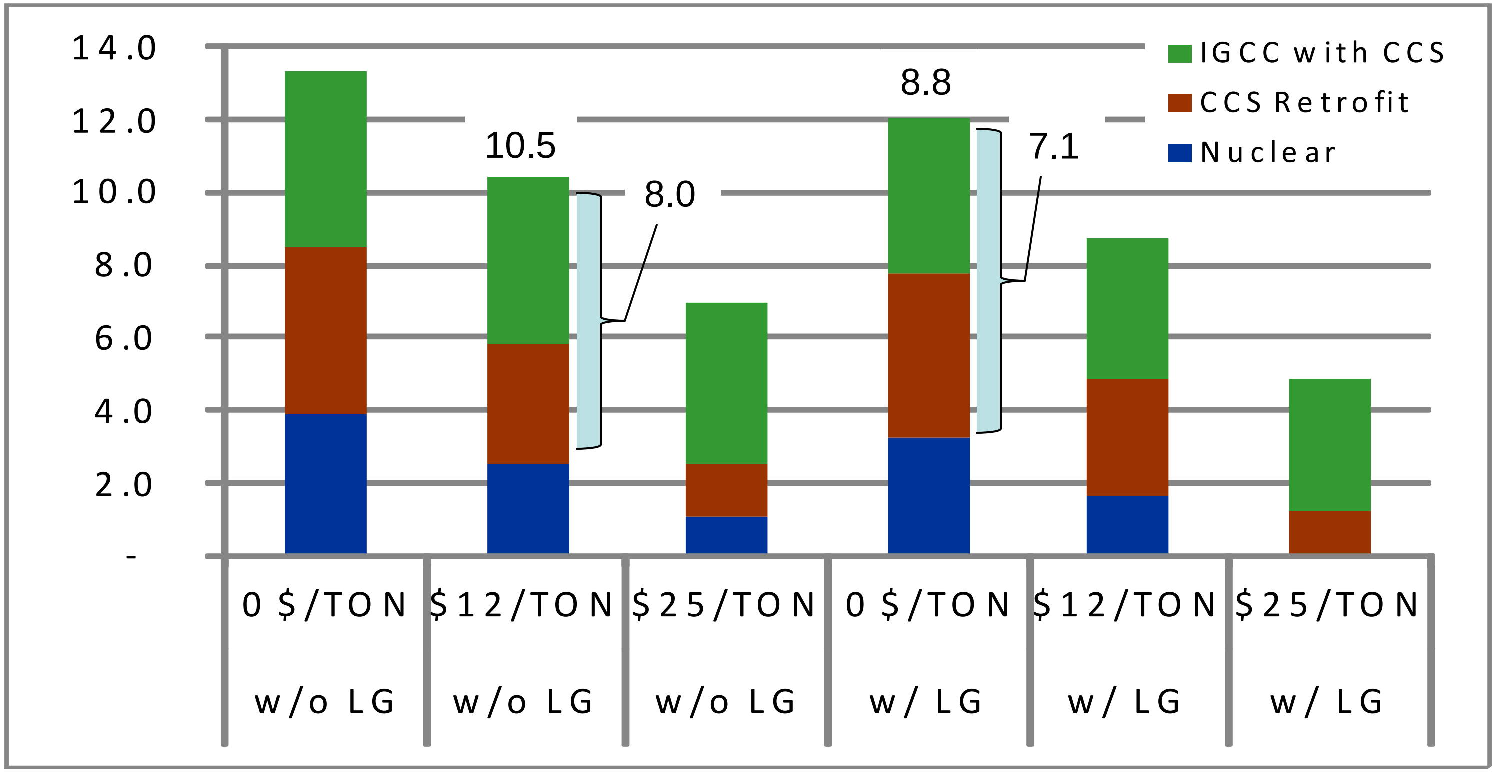
Program costs would be materially larger without a carbon price or smaller with a carbon price of $25/ton.

(1)Estimates reflect loan guarantee program.
(2)Carbon prices are 2012 $/ton escalating at 7% annually.

PROGRAM COSTS — With Loan Guarantee

Eliminating loan guarantees would increase total costs by $1.7 billion annually or 19%.

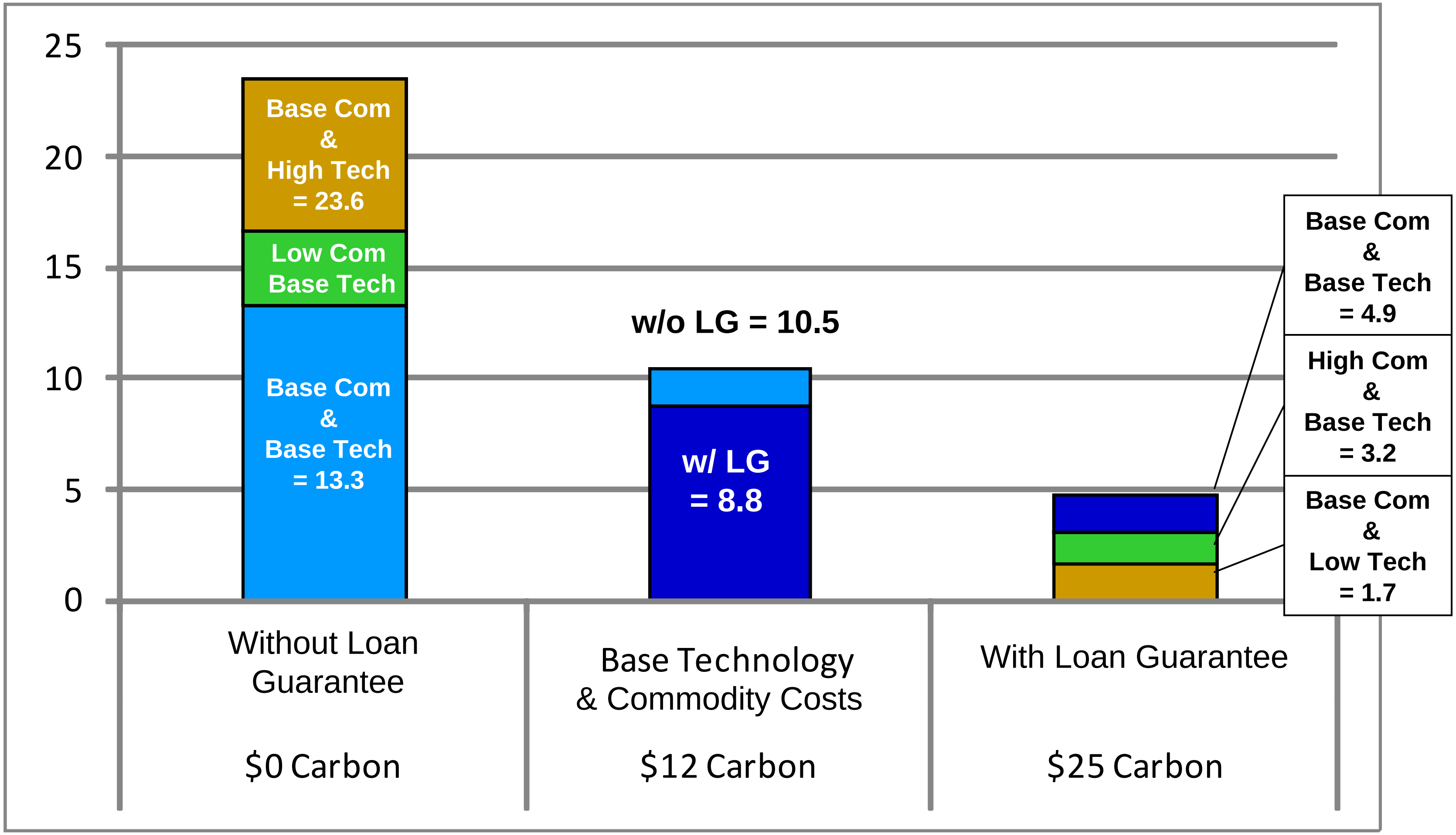
Annualized Incentive Payments ($ Billions)



2012 $/ton escalating at 7% annually.

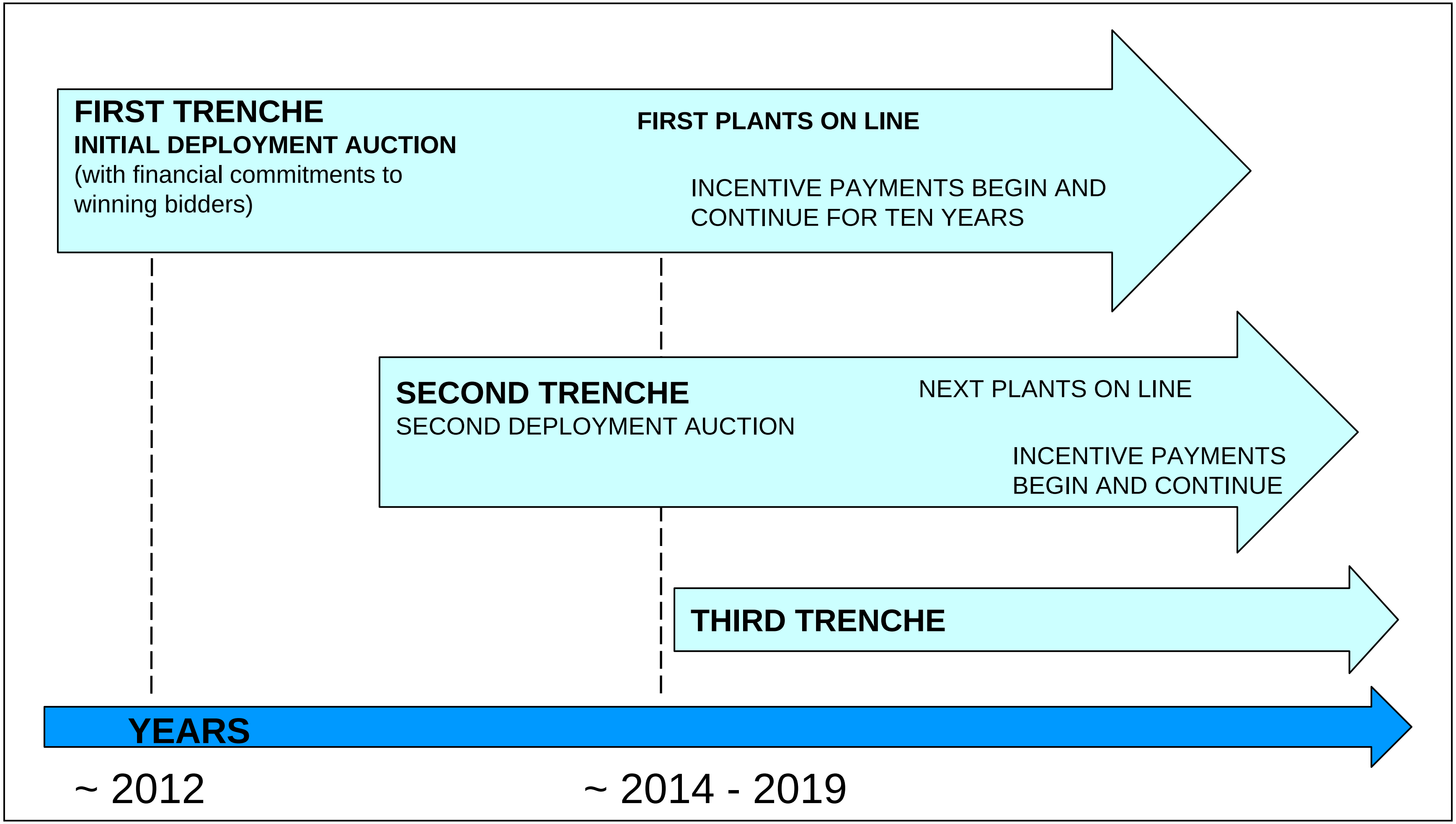
Given uncertainty around capital and commodity costs, loan guarantees and carbon prices, the annual cost to deploy 30 GW could vary widely.

Annual Cost to Deploy 30 GW ($ Billion / year)

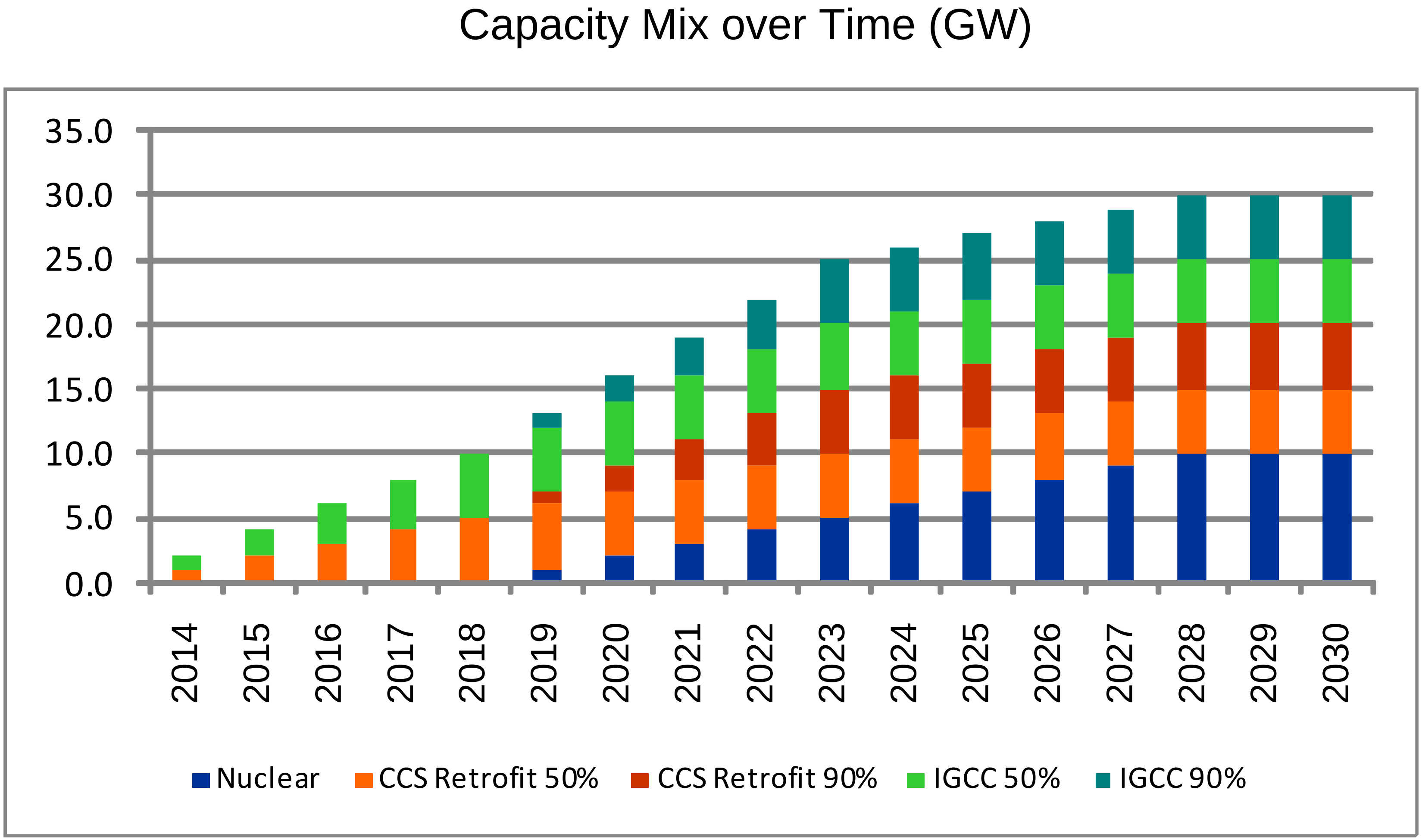


Tech = Technology Costs
Com = Commodity Costs (gas, coal, electric)
LG = Loan Guarantee

Assuming the program is part of a larger cap and trade program, the timing of auctions, financial commitments, plant development and payment of incentives could look as follows.

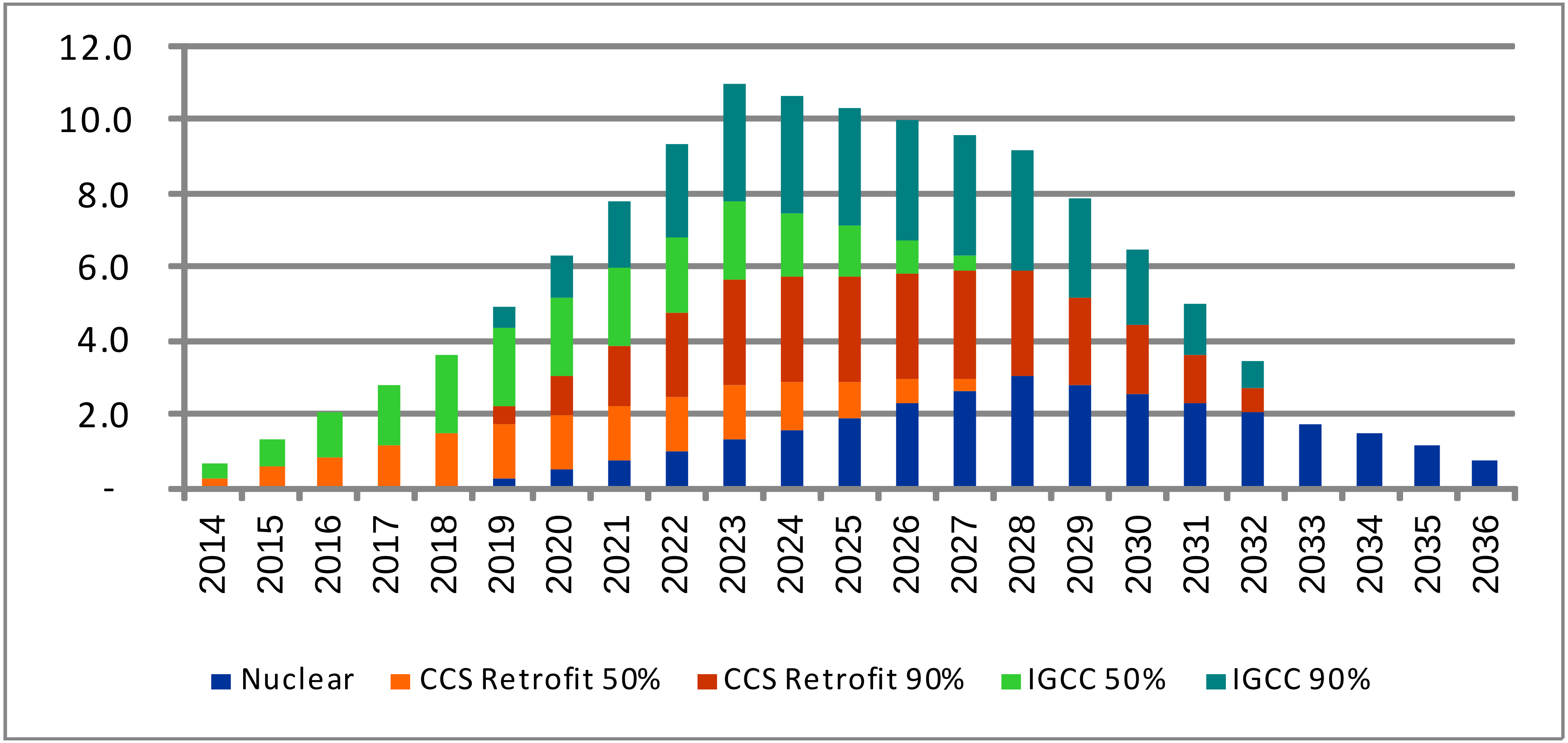


On a year by year basis, the capacity mix could look as follows.



The annual incentive payment outlays from the program would start at less than one billion annually, peak at somewhat above $10 billion around 2023 and decline over time to zero.

Cost of Incentive Payments over Time ($ Billions)



Estimates reflect loan guarantee program.