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Strategies for supporting investment decisions about large energy infrastructure in the face of regulatory and other uncertainty

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Decisions about investments in **electricity generation** are hard

- Are large & irreversible
- There are multiple alternatives to choose from
- Are long lived and have long lead times
- Have uncertain outcomes
 - Profits and costs depend on deep, irreducible uncertainties
 - Like future electricity demand, future fuel prices, or the pace of technological advancement
- Create path dependencies
 - Decisions today determine the availability of future choices

In this talk I will...

- Describe our efforts to support investment decisions made by
 - PUCs and regulated utilities
 - Partnering with NARUC:
 - training and tool development
 - Analyzing investment decisions
 - Climate-Environmental Policy Makers
 - Representing the investment decision under uncertainty
 - Using this representation to inform the design of policies to affect investment decisions
 - Design of Flexible Technology Policy with Alternative Compliance Payments (ACP)

Supporting investment decisions from PUCs (and regulated utilities)

- Common practice has been to use *Scenario Analysis*:

SCENARIO ANALYSIS

1. Identify some plausible future scenarios
2. For each scenario, identify the best strategy
3. Choose a strategy:
 - Some electric utilities (e.g Duke Energy) **qualitatively** compare the best strategies for each scenario and choose one
 - Some other utilities (e.g. Southern Company) consider minimizing the ***maximum regret***

Describing sets of assumptions regarding all the factors that affect the payoff of a decision alternative

This choice is made **without** attempting to assign probabilities to the scenarios

Main flaw of Scenario Analysis as traditionally applied in electric utilities

Scenario analysis implies beliefs about probabilities but they are **not** made explicit

- choice of scenarios implies probability judgments
- choice of strategy also implies probability judgments
- use of regret scores (for minimax) also implies probability judgments

Decision makers have probabilities in the back of their mind

- Making them explicit may produce more productive discussions
- It will make the decision process more transparent
 - **Especially beneficial for decision makers deciding on behalf of the public !!!**

We have provided extensive training to PUC commissioners and staff: 1) delivering the message that **probabilities should be formulated because they:**

- Are required for decision analysis
 - For thorough uncertainty characterization
 - For quantitative comparison of decision alternatives
 - To identify hedging investments
- Encourage discussion on likelihood of scenarios
 - Enable sensitivity analysis
- Are already in the back of the mind of those choosing strategies !!
 - It is a good idea to make EXPLICIT the subjective beliefs of decision makers

And 2) advocating for investment analysis that:

Is prospective and comprehensive

- Considers current and potential future events (e.g. regulations, technological breakthroughs, price shocks)
- Considers “all” possible investment alternatives
 - Retrofits, new plants, combinations of plants
- Represents managerial flexibility:
 - Options to delay investment, build in phases, abandon construction, or mothball

Explicitly accounts for uncertainty judgments

- Considers a wide range of future scenarios
- Considers the chances of those scenarios

Allows iteration over uncertainty characterization

- To identify robust strategies

And 3) Presenting an example and making available a tool for this

PowerOptInvest

Stochastic optimization model that determines optimal investment and operating decisions over a 30+ year horizon given user's assumptions about:

- Regulatory uncertainty
- Fuel price uncertainty
- Technology uncertainty (cost & performance)

Optimal investment and operating decisions

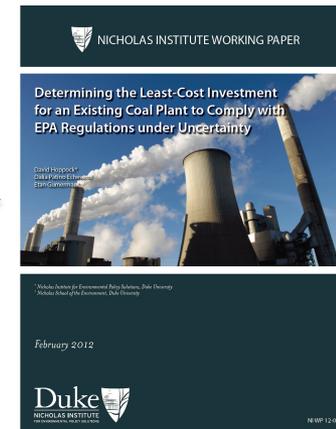
- Minimize cost/maximize profit = $f(\text{capital costs} + \text{O\&M cost} + \text{emissions})$

Used to inform LG&E Mill Creek decision



1.4 GW coal-fired power plant
In 2010 needed to decide how to
comply with CSAPR, MATS, SO₂
NAAQS

PowerOptInvest Modeling:
-CSAPR, MATS, CCR, 316b (SO₂ NAAQS)
-Fuel Price, Regulatory, Climate Policy Uncertainty





Please provide a name for this session:

Enter or select the directory into which the output file(s) will be written

Throughout this wizard, please use the same dollar year basis (example \$2010).

Planning Horizon Years (how far into the future the model looks):

Year Uncertainty is Resolved:

Total Model Projection Period (N): 39

Please enter the number of model scenarios:

Discount Rate Over Planning Horizon: Rate (%):

Variable Discount Rate (%)



Enter wholesale electricity price forecasts for each scenario (\$/MWh)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Scen 1	47.1	45.9	44.7	44.9	46.0	46.0	48.6	48.1	47.4	46.8	46.3
Scen 2	47.0	45.8	44.7	44.8	44.5	43.9	45.0	45.1	47.8	47.8	47.1
Scen 3	46.3	45.2	44.1	44.6	45.3	45.5	47.7	47.8	47.2	55.4	55.9
Scen 4	47.3	46.0	44.9	45.4	46.1	46.3	48.2	47.9	47.1	55.4	56.2
Scen 5	47.3	47.1	47.1	47.5	48.4	49.1	50.7	50.0	49.2	48.8	48.1
Scen 6	47.5	47.2	46.4	46.4	46.5	45.7	46.2	46.7	48.2	47.9	47.2

Enter delivered coal price forecasts for each scenario (\$/mmBtu)

Enter delivered natural gas price forecasts for each scenario (\$/mmBtu)

Enter SO₂ emissions allowance price forecasts for each scenario (\$/ton)

Enter NO_x emissions allowance price forecasts for each scenario (\$/ton)

Enter CO₂ emissions allowance price forecasts for each scenario (\$/ton)



Is there an existing plant to be modified?

Yes Plant Name: ExistingMillCreek

No

Plant Available In The Future?

A plant will be available one year from now. Plant Name: ExistingPlant

A plant will be available two years from now. Plant Name: ExistingPlant

Is there a minimum annual generation requirement?

Yes Minimum Annual Generation (GWh/Yr): 11328

No

Net plant capacity including pollution control technologies (MW): 1472

Plant capacity factor (%): 87.85

Plant net heat rate (Btu/KWh): 10000

Emissions Rates on Fuel Input Basis (accounting for environmental controls)

SO₂ Emission Rate (lbs/MMBtu): 0.5200

NO_x Emission Rate (lbs/MMBtu): 0.1600

CO₂ Emission Rate (lbs/MMBtu): 203.10

32 compliance options

Investment Options		Capital Costs (\$2010 M)	Investment Options		Capital Costs (\$2010 M)
1	Supercritical coal	4,532	17	13 + CCS	1,720
2	CCS retrofit on Super	1,720	18	14 + CCS	1,720
3	Super with CCS	7,273	19	15 + CCS	1,720
4	3 NGCC 2x1 F-Class CT	1,743	20	16 + CCS	1,720
5	2 NGCC 2x1 F-Class CT + 1 Advanced NGCC H class CT	1,600	21	Existing+ CSAPR + MATS + Sub D + 316b I + CCS	2,991
6	4 Advanced NGCC H class CT	1,752	22	10 + Sub C	-
7	CCS retrofit on 4 Advanced NGCC H class CT	1,526	23	Existing + CSAPR + MATS + Sub C	1,268
8	4 Advanced NGCC H class CT with CCS	3,024	24	10 + Sub C + 316b E	71
9	Existing Mill Creek	-	25	22 + 316b E	71
10	Existing + CSAPR + MATS	1,268	26	23 + 316b E	71
11	10 + Sub D	-	27	Existing+ CSAPR + MATS + Sub C + 316b E	1,339
12	Existing + CSAPR + MATS + Sub D	1,268	28	24 + CCS	1,720
13	10 + Sub D + 316b I	2	29	25 + CCS	1,720
14	11 + 316b I	2	30	26 + CCS	1,720
15	12 + 316b I	2	31	27 + CCS	1,720
16	Existing+ CSAPR + MATS + Sub D + 316b I	1,270	32	Existing+ CSAPR + MATS + Sub C + 316b E + CCS	3,059

12 scenarios considered

Scenario	Natural Gas Price	Regulation	Carbon Price
1	Baseline	Baseline	no price
2	Baseline	Less Stringent	no price
3	Baseline	More Stringent	low 2020
4	Baseline	Baseline	low 2020
5	High	Baseline	no price
6	High	Less Stringent	no price
7	High	More Stringent	mid 2020
8	High	Baseline	mid 2020
9	Extra High	Baseline	no price
10	Extra High	Less Stringent	no price
11	Extra High	More Stringent	high 2020
12	Extra High	Baseline	high 2020

All scenario had equal probability in first year... uncertainty would be reduced every year

Example Probabilities Converging Scenario 2: Mid NG, Less Strinent EPA Reg, No Carbon Price

Scenario	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
2	<i>0.083</i>	<i>0.185</i>	<i>0.287</i>	<i>0.389</i>	<i>0.491</i>	<i>0.593</i>	<i>0.694</i>	<i>0.796</i>	<i>0.898</i>	<i>1.000</i>
3	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
4	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
5	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
6	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
7	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
8	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
9	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
10	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
11	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000
12	0.083	0.074	0.065	0.056	0.046	0.037	0.028	0.019	0.009	0.000

Least Cost Investments 12 Scenarios with Carbon Price in Selected Scenarios

Scenarios	Year	1	2	3	4	5	6	7	8	9	10
1	Mid NG, Baseline EPA			MATS & Sub D & 316b I	Sub C			316b E			
2	Mid NG, Less Stringent EPA			MATS & Sub D & 316b I	Sub C			316b E			
3	Mid NG, More Stringent EPA, Low Carbon Cost			MATS & Sub D & 316b I		Sub C		316b E			
4	Mid NG, Baseline EPA, Low Carbon Cost			MATS & Sub D & 316b I							
5	High NG, Baseline EPA			MATS & Sub D & 316b I							
6	High NG, Less Stringent EPA			MATS & Sub D & 316b I							
7	High NG, More Stringent EPA, Mid Carbon Cost			MATS & Sub D & 316b I	Sub C			316b E			
8	High NG, Baseline EPA, Mid Carbon Cost			MATS & Sub D & 316b I	Sub C			316b E			
9	Extra High NG, Baseline EPA			MATS & Sub D & 316b I	Sub C			316b E			
10	Extra High NG, Less Stringent EPA			MATS & Sub D & 316b I		Sub C		316b E			
11	Extra High NG, More Str. EPA, High Carbon			MATS & Sub D & 316b I		Sub C		316b E			
12	Extra High NG, Base EPA, High Carbon			MATS & Sub D & 316b I		Sub C		316b E			
	Year	2011			2015						2020

\$940 million invested:
New WFGD and Fabric filters completed in 2014
(98% removal of SO₂, reduction of mercury and PM emissions by half)

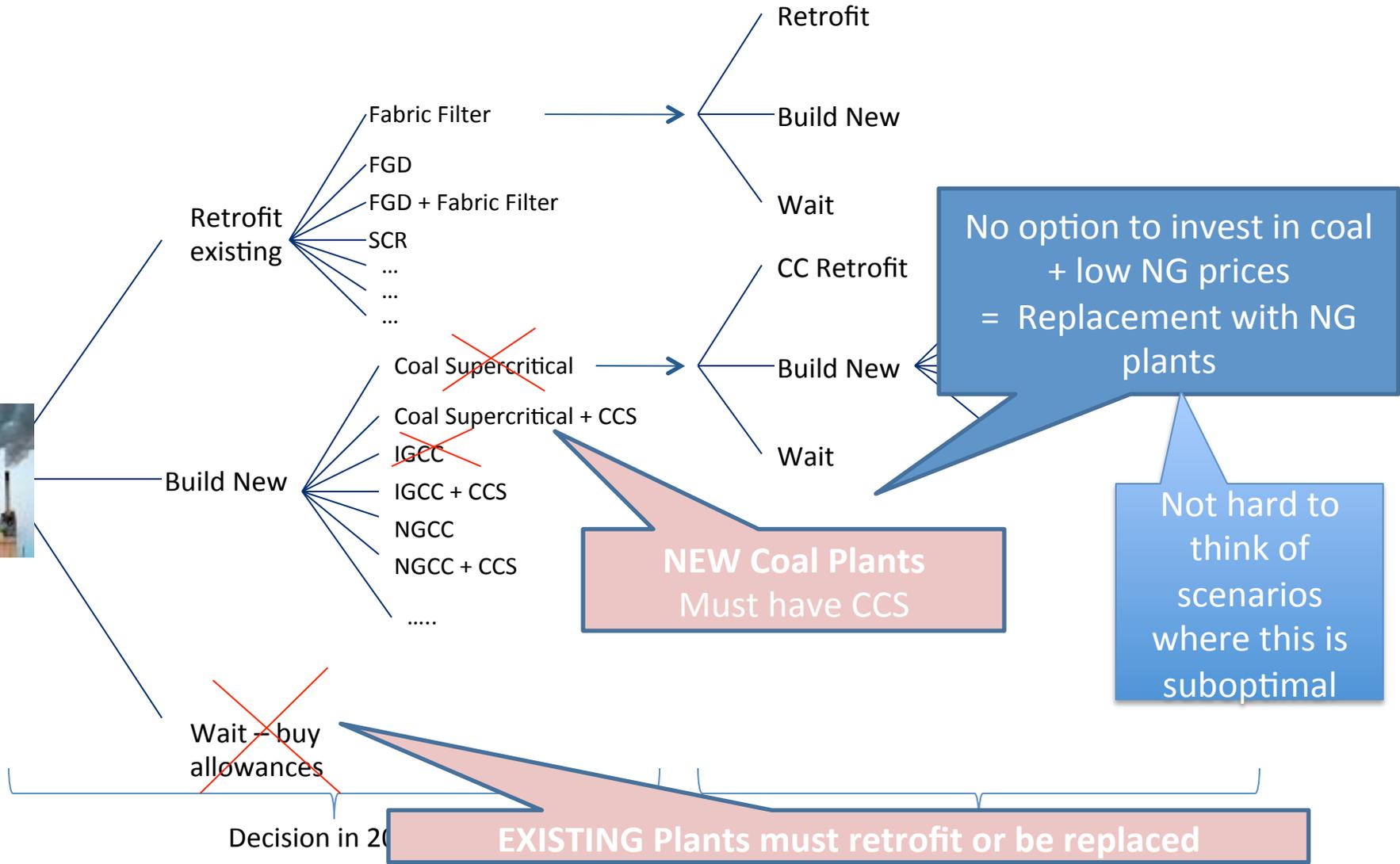


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 - Using this representation to inform the design of policies to affect investment decisions
 - Design of flexible technology policy

Analysis informing climate policy shouldn't assume investors have perfect foresight

A realistic exploration of the outcomes of policies requires representing the investment decision process under uncertainty



No option to invest in coal + low NG prices = Replacement with NG plants

NEW Coal Plants Must have CCS

Not hard to think of scenarios where this is suboptimal

EXISTING Plants must retrofit or be replaced

Is it possible to revive these options and achieve better environmental and economic outcomes ?

Reviving the options

Advantage of having today's rules:

- Most old coal plants will be replaced
- No new plants will be conventional coal plants

Disadvantage

- Since CCS is not competitive yet:
 - No investment in coal-plants
 - No learning in CCS
- **All the market for new generation is taken by conventional NGCC**
 - No time or incentives for advancing better disruptive technologies

Keep advantages and eliminate disadvantages ???

Flexible standard

Flexible CO₂ Emissions Standard for extant plants: ACP

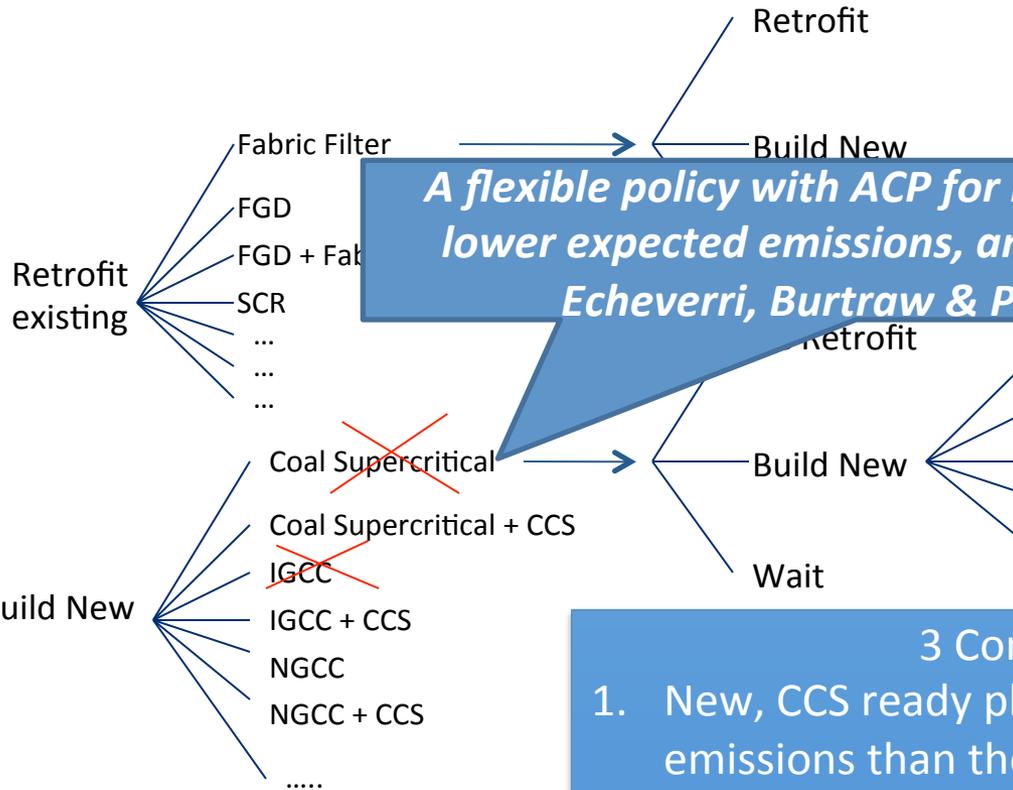
Owners pay an **Alternative Compliance Payment (ACP)** for each plant that fails to meet the maximum CO₂ emission rate standard

Policy defines:

1. The ACP in \$/ton
2. The deadline: the time when investment or closure decision has to be made

Is it legally feasible?

- ACP at the state level is not likely to face federal law obstacles
 - ACP for RPS in Massachusetts, New Jersey, Illinois
- ACP at the federal level would require legislative authorization but precedents exist under US CAA



A flexible policy with ACP for new plants can result in lower expected emissions, and lower costs: Patino-Echeverri, Burtraw & Palmer (JRE 2013)

- 3 Conditions:
1. New, CCS ready plants have lower emissions than the old plants being replaced
 2. CCS costs are decreasing
 3. CCS retrofit on CCS-ready plants should not be much higher than new installations

What is the value of keeping alive the option to wait ?

Decision in 2016

Decision in 2017

The value of allowing some plants to wait

Is it possible that in the near future (3-5 years) there will be...

1. better retrofit technologies?
2. better replacement plants?
3. more information about coal/gas prices to facilitate the choice of fuel?
4. Good arguments to limit natural-gas use?

If the answer to any of these is yes

then

A policy that allows some plants **to wait** in their decision of retrofitting or replacing may be superior than an inflexible technology policy

What are the conditions under which a flex policy with ACP would be superior (lower emissions)?

Patino-Echeverri,
UCLA Law Review –
July 2014

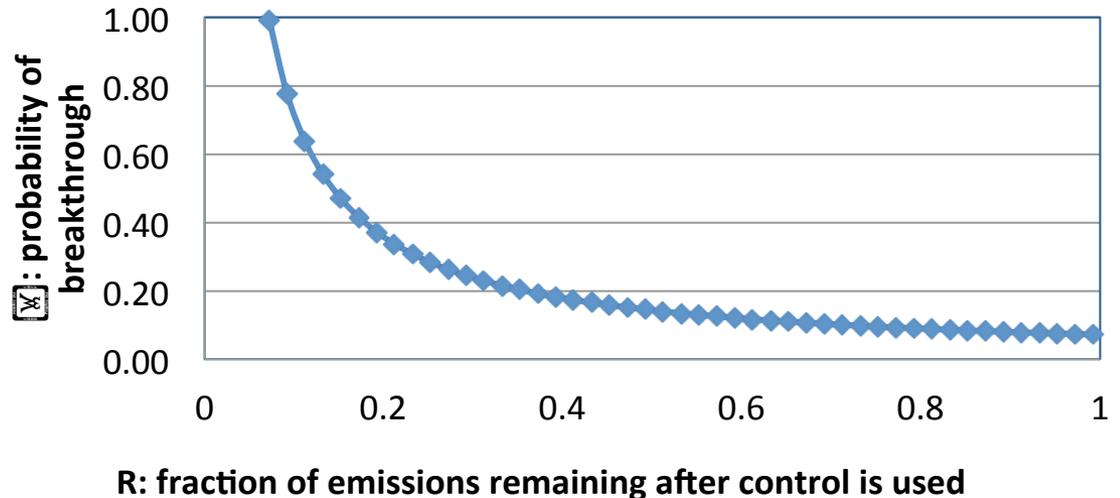
Can a Flexible Technology Standard Policy with ACP be better ?

- Lets assume there is active RD&D on a technology that will have zero emissions
- There is a probability π that it will be commercial in 3 years
- What should be π so that ACP policy is better? (lets assume lifetime of 30yrs)
- Simplest calculation:

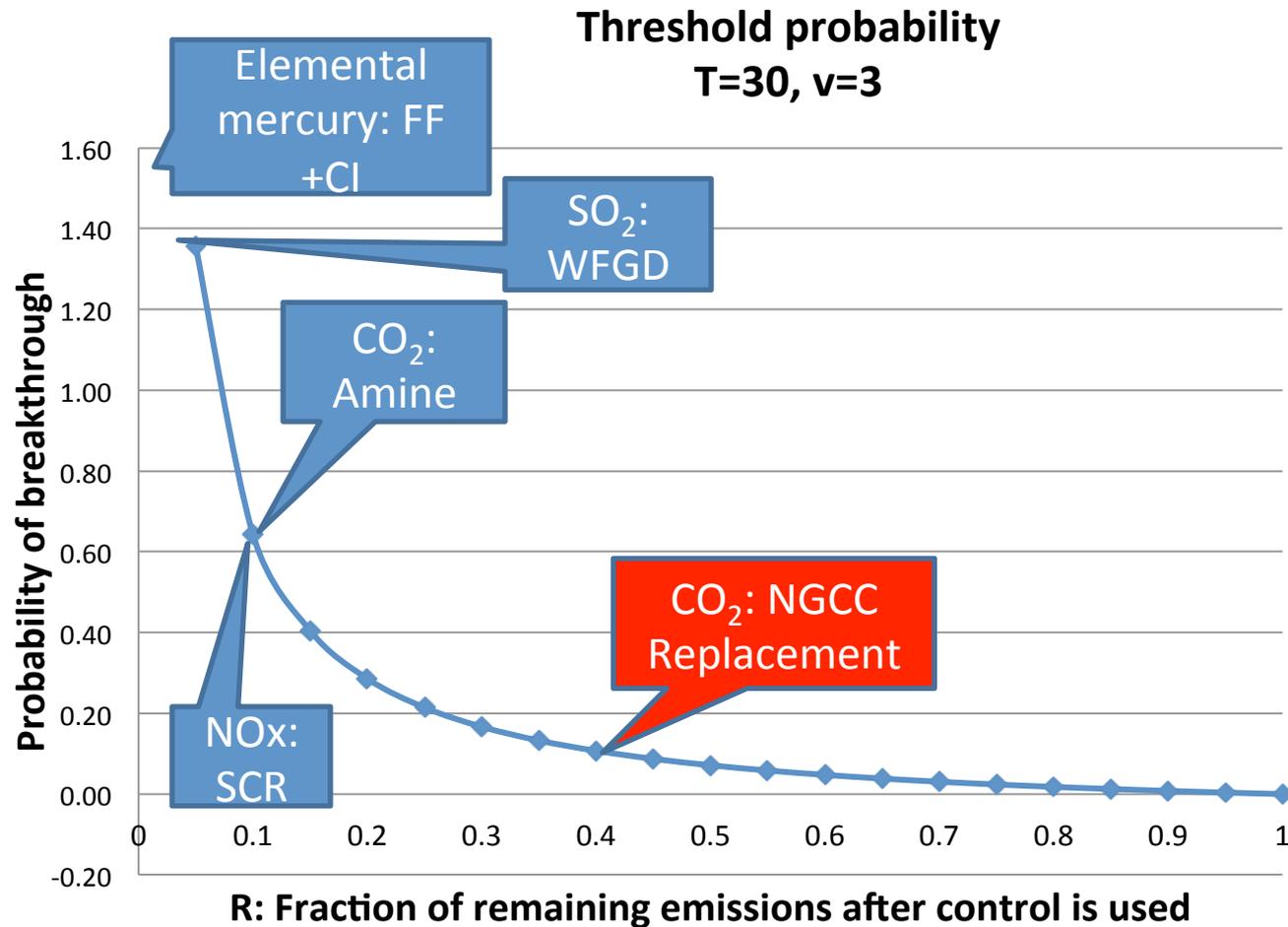
$$\underbrace{30e^{conv-control}}_{\text{Emissions of conventional}} \geq$$

Emissions of conventional

ACP is better if:
 Emissions of "Best" control are **low** enough
 And
 If π is **high** enough



What are the potential reductions for conventional retrofits of coal plants?



Can a *Flexible Technology Standard Policy with ACP* be better ?

A better policy is one that results in lower *expected* costs of compliance

ACP can be better if:

- The probability of breakthrough technology within the ACP deadline meets the condition 1

and

- The expected LCOE of breakthrough technology is lower or has lower risk (uses a fuel with lower price volatility)

and

- The ACP payment is low enough so that expected LCOE of paying ACP is lower

Are there any examples of possible future technology that would justify a policy with ACP?



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GHGT-11

High efficiency and low cost of electricity generation from fossil fuels while eliminating atmospheric emissions, including carbon dioxide

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Hideo Nomoto^b, Masao Itoh^b, Nobuo Okita^b, Charles Jones Jr.^c

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Abstract

NET Power has developed a novel, oxy-fuel thermodynamic power cycle [1] that uses hydrocarbon fuels, captures 100% of atmospheric emissions, including all carbon dioxide, and has a cost of electricity that is highly competitive with the best current systems that do not have CO₂ capture. The proprietary system achieves these results through a closed-loop, high-pressure, low-pressure-ratio recuperated Brayton cycle that uses supercritical CO₂ as the working fluid. The cycle exploits the special thermodynamic properties of carbon dioxide as a working fluid by eliminating the energy losses that steam-based cycles encounter due to the heat of vaporization and condensation. The compelling economics of the system are driven by high target efficiencies – 59% net LHV for natural gas and 51% net LHV for coal – and low projected capital and O&M costs, which are the result of utilizing only a single turbine, having a smaller plant footprint, and requiring fewer, smaller components than comparable fossil-fuel systems.

NET Power, Toshiba Corporation, Exelon Corporation, and the Shaw Power Group are partnering to commercialize this system by developing a 50MWt facility that is scheduled to begin testing in 2014. This facility will generate electricity from natural gas and capture 100% of emissions, including all CO₂. The initial design for a commercial system with an electrical output in the range of 200MWt to 500MWt is also under development. The turbine for the 50MWt plant is being designed at the 500MWt level and then scaled down for the demonstration plant to facilitate rapid development of the large-scale turbine in the future. The demonstration plant will test all components and control systems and the operability of the cycle, including 100% capture of carbon dioxide and other impurities, using a range of fuel gas compositions.

The NET Power cycle will have an important impact on the power industry's ability to control and limit greenhouse gas emissions. Driven by its competitive cost when compared to state-of-the-art technologies without CO₂ capture, the authors believe the NET Power cycle will remove economic barriers to the deployment of 100%-carbon-capture, fossil-fuel-based electricity generation technology. This will enable both the developed and developing world to produce cheap electricity that does not contribute to CO₂-based climate change.

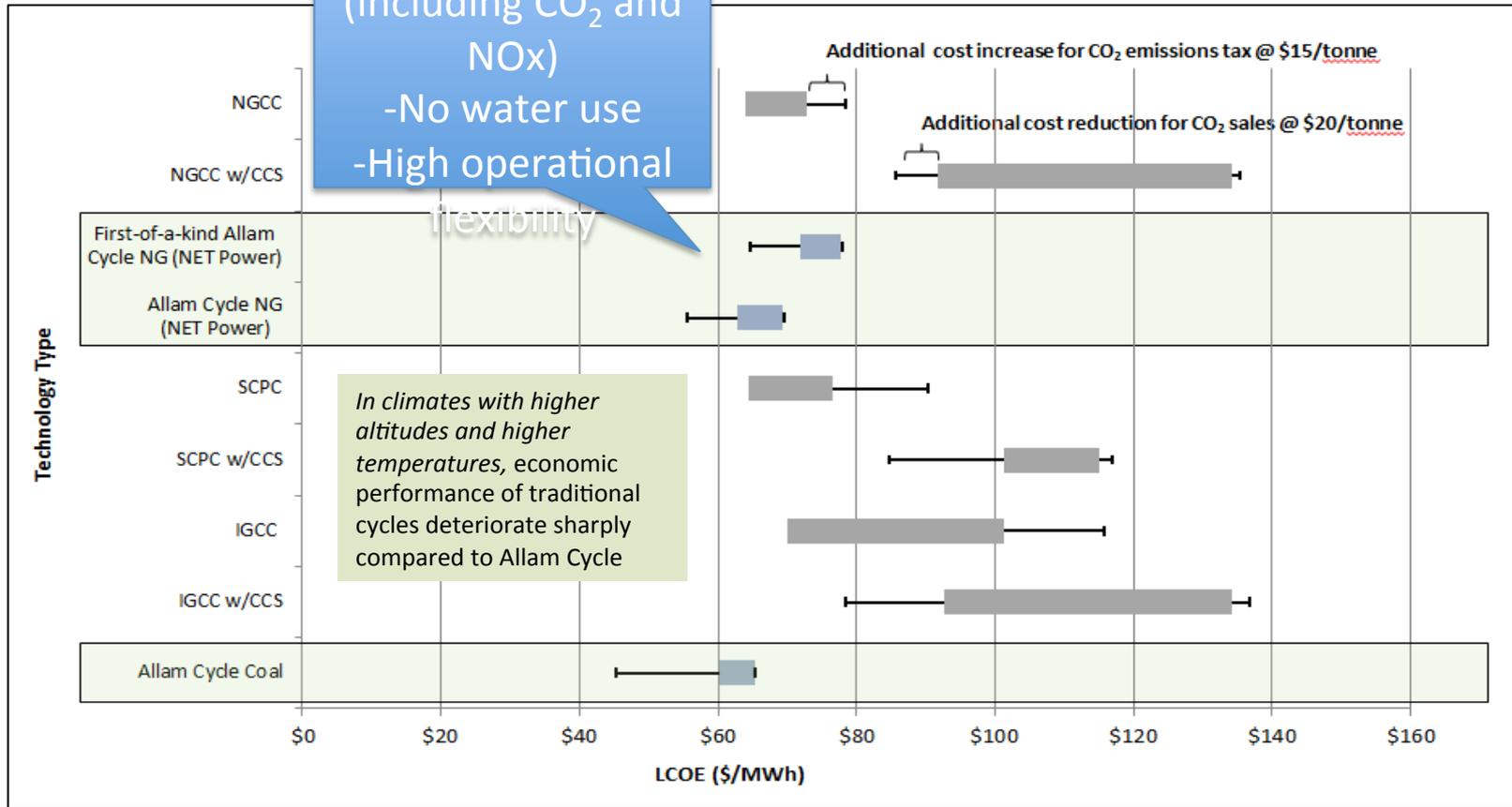
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Selection and/or peer-review under responsibility of GHGT

Keywords: CO₂ capture; carbon capture and storage; carbon capture and sequestration; supercritical carbon dioxide; carbon dioxide cycle; enhanced oil recovery; zero emissions; power generation; thermodynamic cycle; supercritical carbon dioxide; oxy-fuel

* Corresponding author. Tel.: +1-919-667-1800; fax: +1-919-681-0234.
E-mail address: Robbie.Allam@ExelonCapital.com

NET-Power: Example of possible “power generating” technology

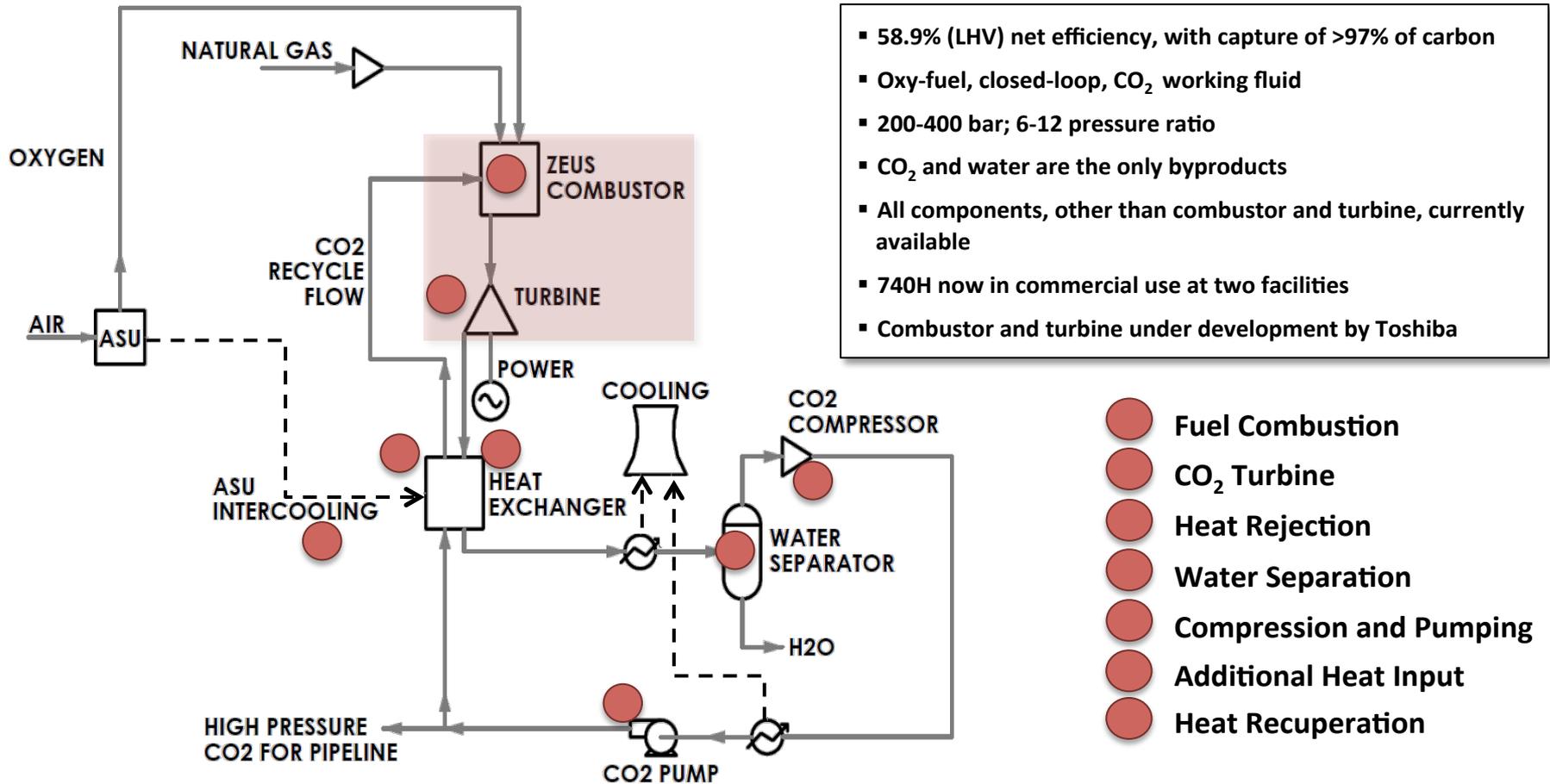
-near zero emissions (including CO₂ and NO_x)
 -No water use
 -High operational flexibility



Levelized Cost of Electricity Note:

- LCOE calculated using EPRI methodology
- Assumes \$6.50/MMBtu natural gas and \$2.00/MMBtu coal
- Cost ranges represent data from several sources: EIA (2013); Parsons Brinkerhoff (2013); NETL (2012); Black & Veatch (2012)

Every component is commercially available today, except for Toshiba combustor/turbine



- 58.9% (LHV) net efficiency, with capture of >97% of carbon
- Oxy-fuel, closed-loop, CO₂ working fluid
- 200-400 bar; 6-12 pressure ratio
- CO₂ and water are the only byproducts
- All components, other than combustor and turbine, currently available
- 740H now in commercial use at two facilities
- Combustor and turbine under development by Toshiba

NET-Power: Example of possible “path-breaking” technology

NET-POWER GAS:

Clean:

- Near-100% capture of all carbon emissions (>97%)
- No other air emissions, including NO_x
- Water usage can be eliminated with a minimal impact (2-3%) on efficiency

Economic:

- Produces electricity at a cost equal to, or less than NGCC
- No additional cost for CO₂ capture
- CO₂ supply cheaper than currently used for EOR
 - 57 commercial NET Power Allam Cycle plants could replace the entire combined CO₂ supply of the 3 largest US EOR operators (Oxy, Kinder, Denbury) at lower cost

Flexible (and hence great to integrate renewables)

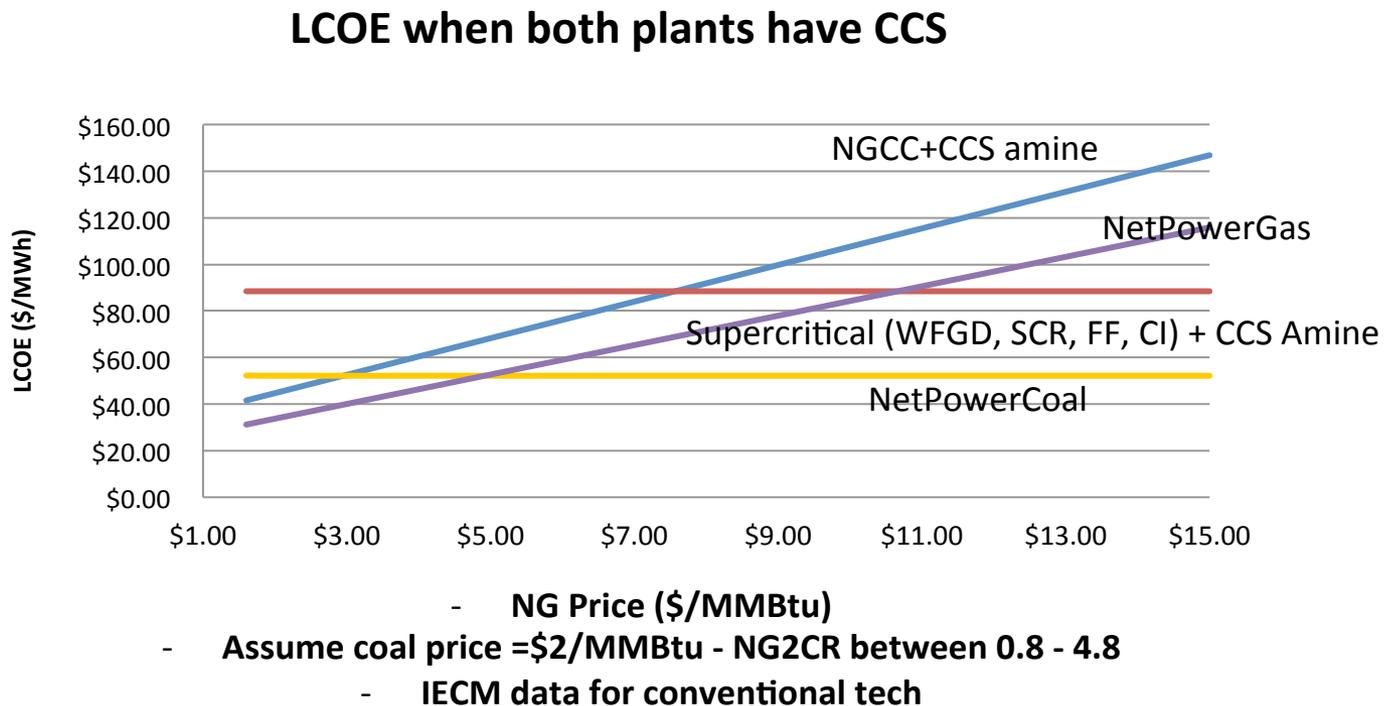
- Lower shut-down costs
 - Large parasitic load enables full electrical turndown (0% electric output to grid), burning fuel to operate plant equipment while exporting CO₂ to pipeline
- Ramp-rate expected to be 2-5% per minute from warm/hot start
- Better than NGCC plants in warm ambient or high altitude conditions

NET-POWER COAL:

Same by adding first a Coal Gasification unit

Example of possible “path-breaking” technology

Net Power, GHGT-11 Allam et al. Energy Procedia 2012



The value of waiting to invest

1. Replace one with a SC coal plant with CCS (90% capture)
(CC M\$ 1758)

Uncertainty on the relative cost of coal vs gas-fired electricity also increases the value of waiting

2. Replace 2 plants with NGCC
(CC M\$ 824)

The benefit of waiting increases with higher π

π path-breaking tech is successful



$1 - \pi$

path-breaking tech is not yet successful

3. Pay ACP and wait

The benefit of waiting decreases with ACP value

We assume deadline of ACP is 3 years ($v=3$)

Can choose 1, 2 or 3 depending on deadline of ACP policy

Three 500MW coal plants:
How to reduce emissions by 30%?

Effect of ACP value

If fees are very high:

- All investment will happen in the first period
 - even if it is very likely that a new breakthrough technology will be developed in the future

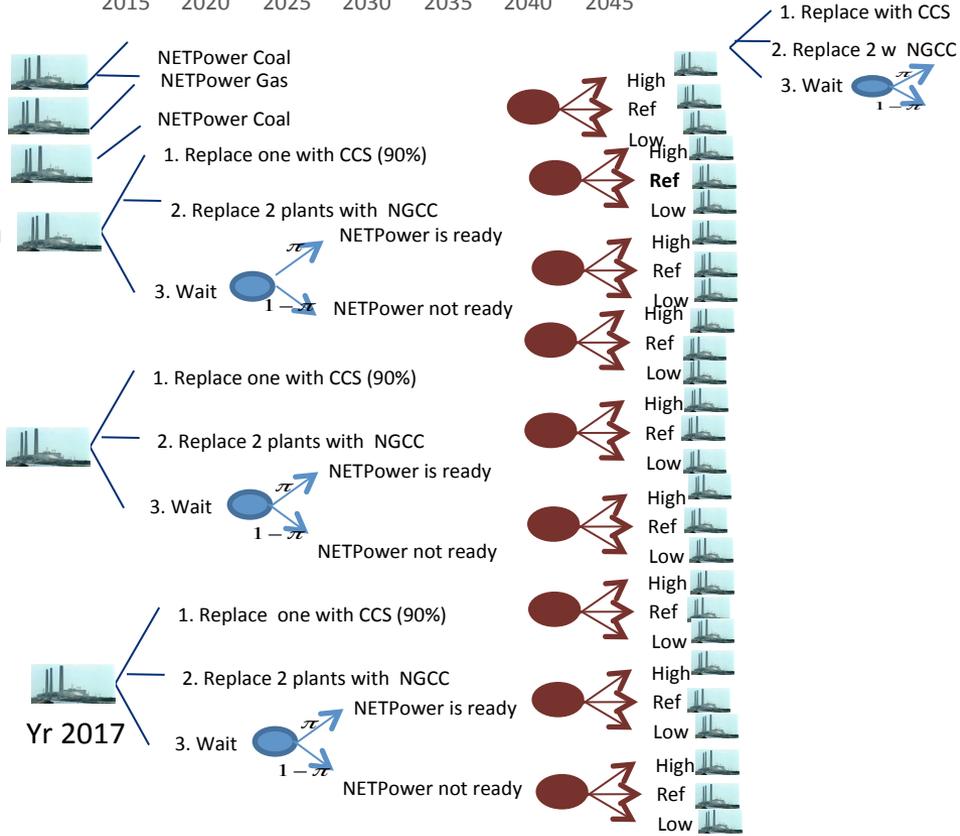
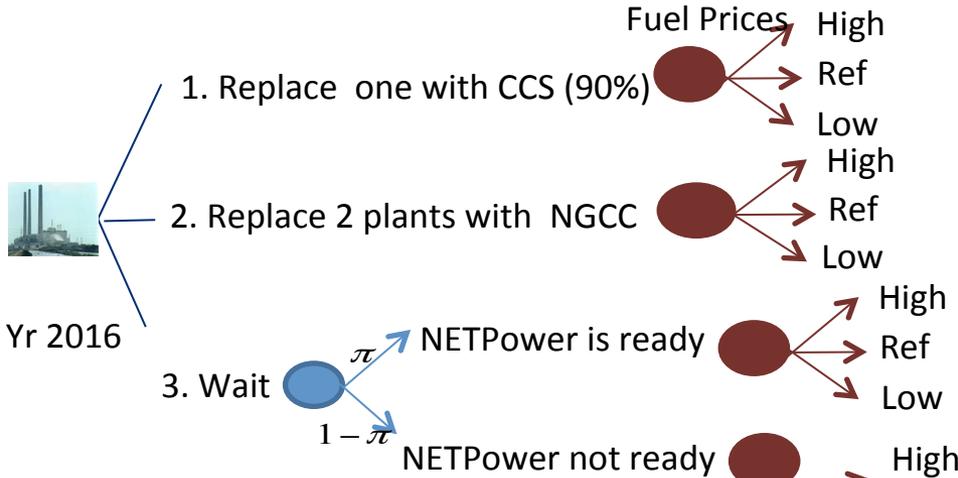
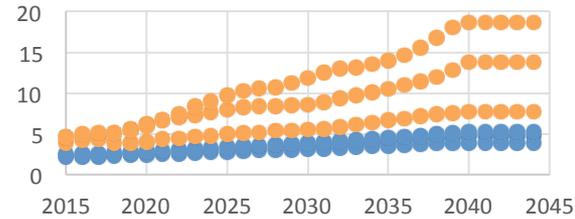
If fees are very low:

- All investment will happen at the end of the 3 years
- even if a breakthrough in technology is unlikely... its worth paying a small fee to keep the option to benefit from a remote possibility and know more about fuel prices

How to set an ACP that is just right?

Estimating the value of waiting

AEO 2015 Fuel Price Projections (\$/MMBTU)



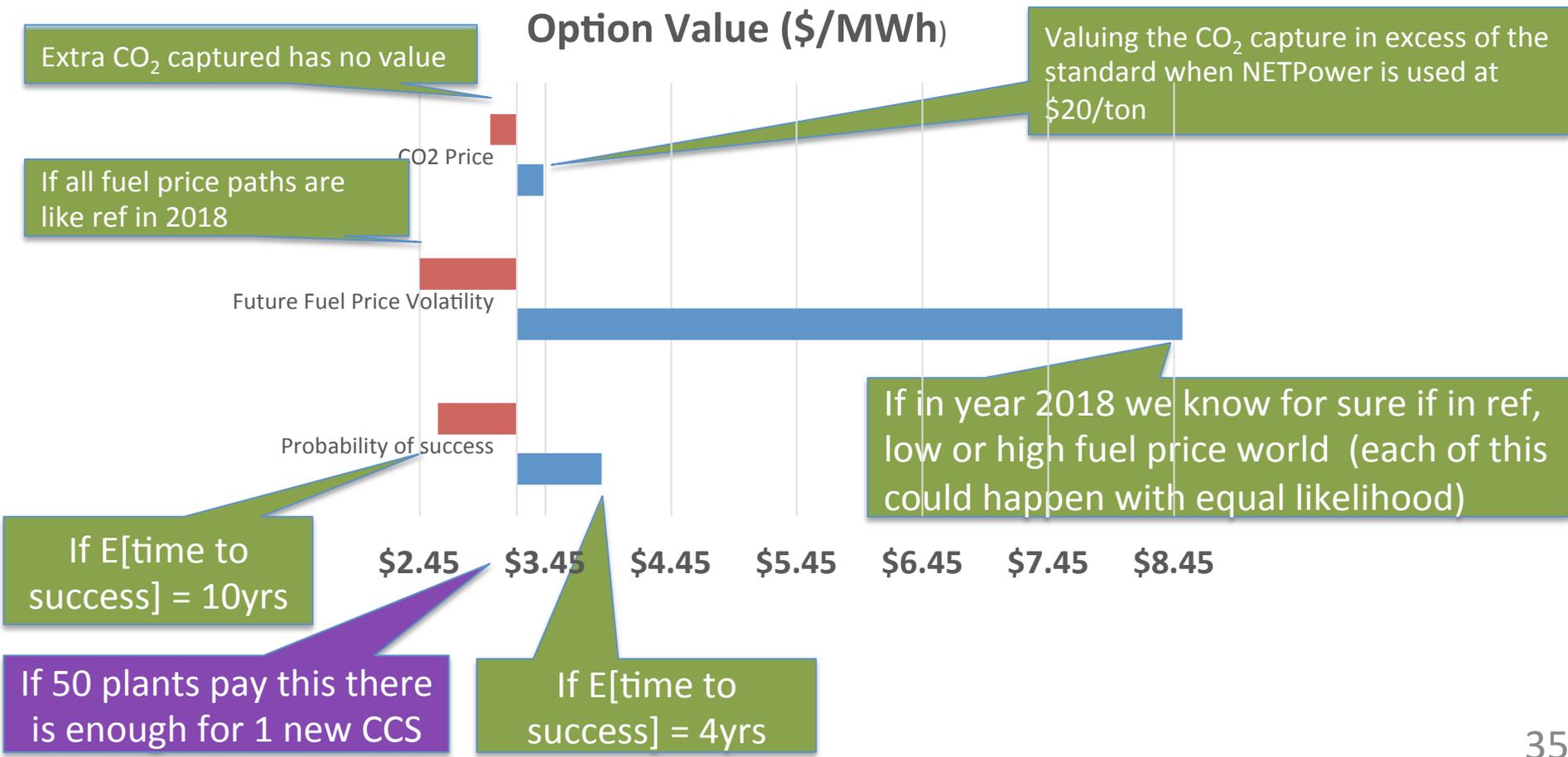
We solve multiple versions of this decision tree and compare with the NPV of a “now or never decision”

- Discrete version uses three fuel price trajectories based on AEO2015
 - Different assumptions about volatility
- Heat-rate improvement
 - Heat rate as promised (20%coal, 5.6%gas)
 - 20% higher or lower
- Valuing the CO₂ captured by NETPower plants at different prices (if it can be sold for EOR -There is demand for 57 plants)

Value of the option to wait depends

on

- a. Characterization of fuel price uncertainty
 - a. How divergent are different possible price paths
 - b. How much we will know about the likelihood of each possibility in 2018
- b. Characterization of technological uncertainty



Concluding remarks on ACP

Flexible technology policy with ACP for both new and existing paths can be designed to exceed the economic and environmental protection outcomes of inflexible traditional technology policy

For this policy to work **there needs to be a commitment to begin retrofit or replacement** installations at existing plants **by the deadline of the ACP** (e.g. 3 years) (and a credible treat to enforce this commitment. Waiting should not be used to challenge regulations in court)

More analysis is needed to estimate the power system's benefits of this policy accounting for contributions to resource adequacy and operational reliability

Summary

Consideration of the investment decision process and the many uncertainties involved allows identifying better policies but:

- More work is needed to improve public decision making on large capital investment decisions in the electricity sector
- More work is needed to represent the investment decision problem (under uncertainty) in models and tools to design and analyze policies

Thank you!

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Plan for the day

- 08:30 – 09:15 Overview of >25 years of HDGC, CDMC and CEDM – Granger Morgan
- 09:15 – 10:00 Uncertainty in energy efficiency, Part 1: technologies, strategies, behavior and policy – Inês Azevedo
- 10:00 – 10:30 Uncertainty in energy efficiency, Part 2: technologies, strategies, behavior and policy – Alex Davis
- 10:45 – 11:15 **Coffee break**
- 11:15 – 11:45 Decision support for implementing the EPA Clean Power Plan Proposed Rule – Jeff Anderson
- 11:45 – 12:30 Marginal emissions factors, health and climate change co-benefits and trade-offs - Inês Azevedo
- 12:30 – 13:30 **Lunch break**
- 13:30 – 13:55 Insights from twenty years of work on expert elicitation and projections – Granger Morgan
- 13:55 – 14:05 Transitioning to a low carbon economy, Part 1: Insights from the RenewElec Project – Granger Morgan
- 14:05 – 14:30 Transitioning to a low carbon economy, Part 2: Insights from ITC and BC's Climate Policy – Hadi Dowlatabadi
- 14:30 – 15:10 Strategies for supporting investment decisions about large energy infrastructure in the face of regulatory and other uncertainty – Dalia Patiño
- 15:10 – 15:40 **Coffee break**
- 15:40 – 16:00 Reflections on Research and Governance wrt Albedo Modification – Granger Morgan
- 16:00 – 16:45 Insights From Our Experience in Building and Using ICAMs – Hadi Dowlatabadi
- 17:45 – 17:00 Muddling through on climate policy: good, but not good enough to avoid the risk of dead ends – Granger Morgan
- 17:00 – 17:30 Discussion and round table on what investigators in CEDM might best work on in the next several years to be most useful to the IA and energy modeling communities.

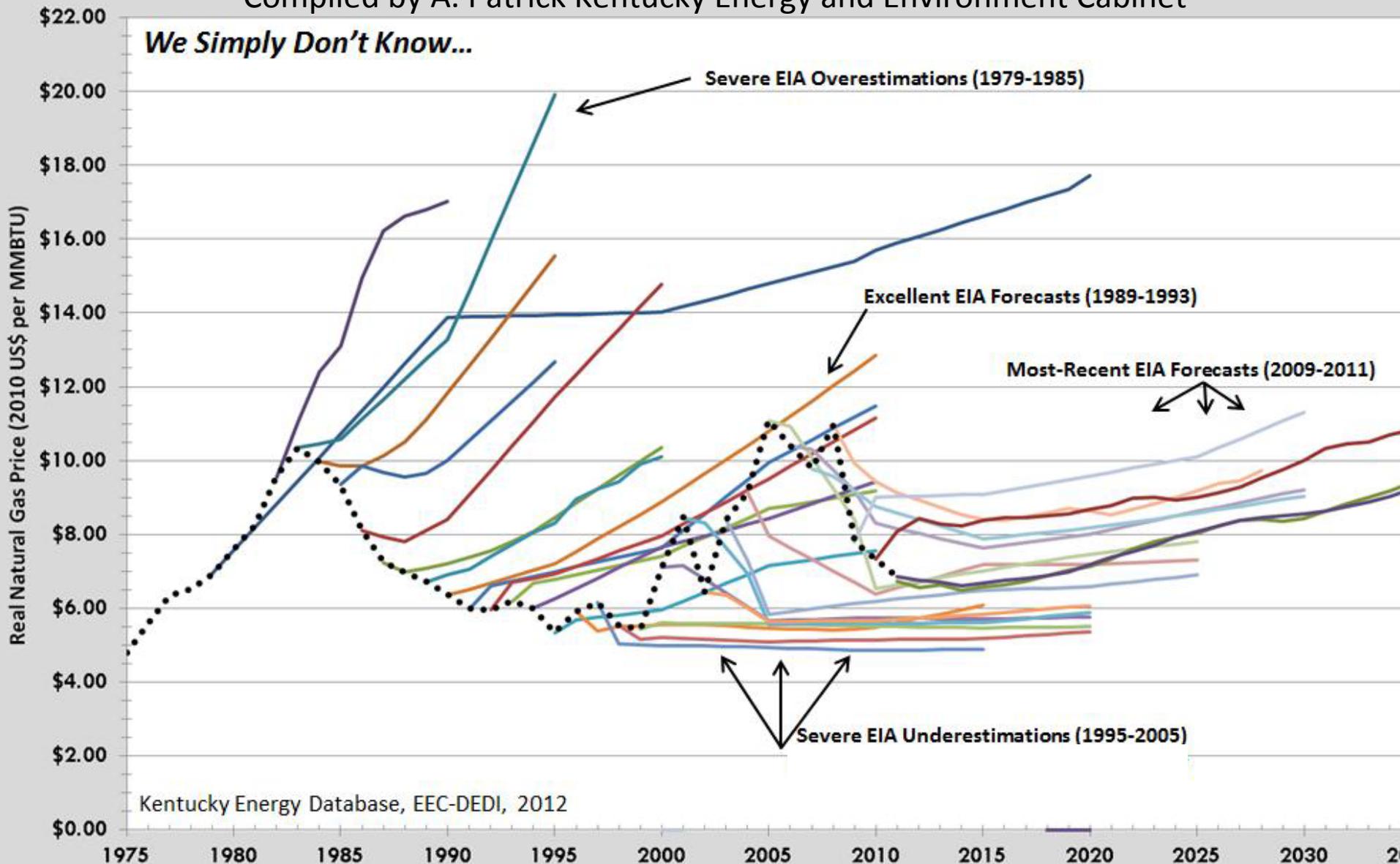
<https://www.dropbox.com/sh/9skgog59wdd3m4x/AAQzsPhamXaRmGOIOhyz7Dpa?dl=0>

EIA Natural Gas Price Forecasts, 1979-2012

Energy Information Administration - Annual Energy Outlook - Reference Case or Equivalent - Average Delivered Price - All Sectors

Compiled by A. Patrick Kentucky Energy and Environment Cabinet

We Simply Don't Know...



Kentucky Energy Database, EEC-DEDI, 2012

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| — AEO 1979 | — AEO 1980 | — AEO 1981 | — AEO 1982 | — AEO 1983 | — AEO 1984 | — AEO 1985 | — AEO 1986 | — AEO 1987 | — AEO 1988 |
| — AEO 1988 | — AEO 1989 | — AEO 1990 | — AEO 1991 | — AEO 1992 | — AEO 1993 | — AEO 1994 | — AEO 1995 | — AEO 1996 | — AEO 1997 |
| — AEO 1997 | — AEO 1998 | — AEO 1999 | — AEO 2000 | — AEO 2001 | — AEO 2002 | — AEO 2003 | — AEO 2004 | — AEO 2005 | — AEO 2006 |