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Texas Advanced Nuclear Reactor Working Group

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CLEARPATH

ClearPath Mission and Vision

Mission: ClearPath's mission is to develop and advance policies that accelerate innovations to reduce and remove global energy emissions.

Vision: America leads the world in addressing climate change by developing innovative, market-competitive clean energy technologies.

ClearPath Policy Pillars

Key Technologies

Power


Nuclear


Storage


Carbon Capture

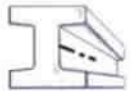

Hydro


Natural Gas


Geothermal

Industrial


Concrete


Metals


Hydrogen


Carbon Capture

Carbon Management


Direct Air Capture

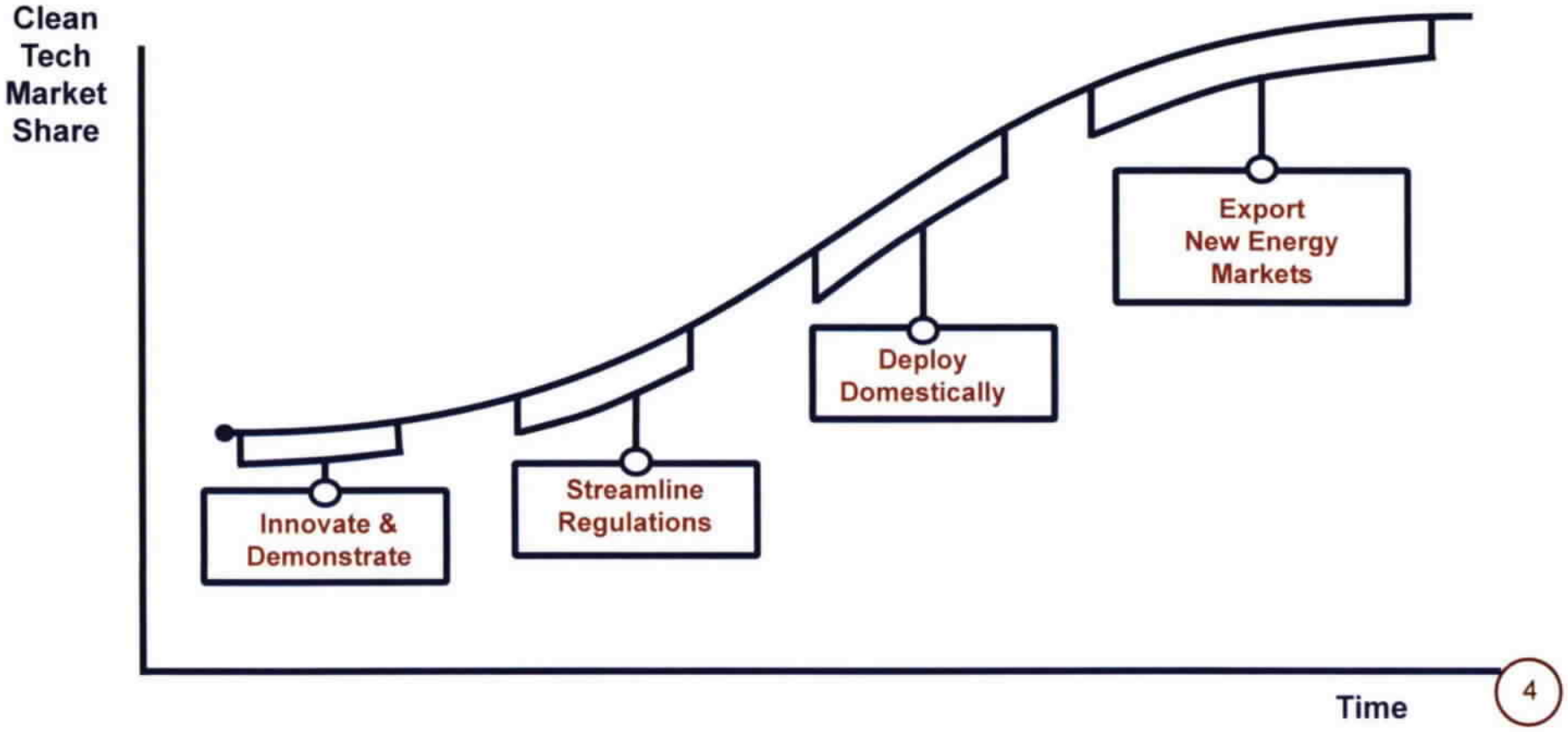
Carbon Removal


Hybrid CDR

Policy Areas

- Federal R&D (basic and applied)
- Demonstration Programs
- Deployment Incentives
- "Ecosystem" e.g. Regulatory Reform
- Technology Export and Finance

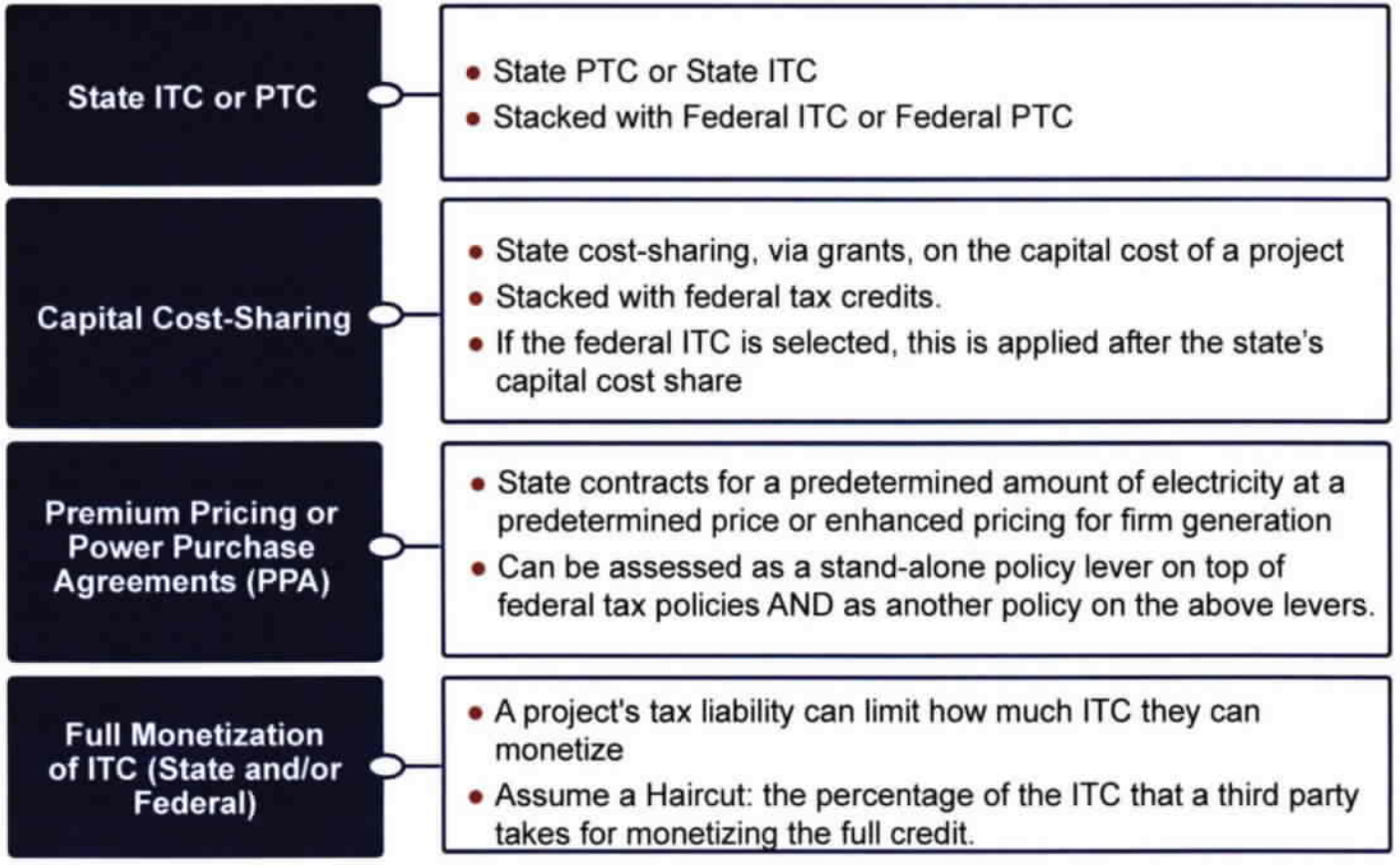
Policy can push energy technology up the "S-curve"



Net Present Value (NPV) Model to Assess Options for Deployment

Why NPV?	• Time value of money is important for long-lived assets • Facilitates decision-making when comparing projects of similar sizes • All models are wrong, some are useful
Assumptions	• First-of-a-kind capital costs of a generic project and technology • Revenue based on historic ERCOT average annual prices and/or PPAs • Analyzes whether NPV of revenue > all capital, O&M, financing costs
Existing Federal Support	• 45Y - Clean Energy Production Tax Credit (ITC) • 48E - Clean Energy Investment Tax Credit (PTC) • Loan Program Office can offer loans or loan guarantees under 1703 or 1706

Policy Options



Policy Recommendations

State ITC & Federal ITC

- Federal ITC has NPV 6-67% higher than PTC across all levels, NPV still negative
- State ITC likewise has bigger impact than State PTC with lower cost of intervention
- *Benefit:* Directly related to capital costs, which is the main cost driver for overruns
- *Downsides:* May need to be monetized if insufficient tax burden; not available until after startup

Premium Pricing/PPA

- Premium price needed for positive NPV **highly dependent** on market prices
- $148.94/MWh is breakeven for NPV (over 2x hist. Avg $/MWh), 20 yr contract for 50% of output
- *Benefit:* Higher guaranteed revenue, decreases volatility and risk
- *Downsides*: May require more than state policy, doesn't impact capital cost overruns.

State Cost-Share

- $1 million cost share had <1% improvement in NPV, still negative
- $1 billion cost share had 36% improvement in NPV, still negative
- ~$2.8 billion cost-share had positive, near 0 NPV
- *Benefits*: Early availability of funds to support project development; directly addresses main cost driver
- *Downsides*: Less efficient than State ITC in achieving a positive NPV

Model Findings & Additional Considerations

Haircuts (loss in the value) from monetizing ITC's

- Will depend on the rules and market, but stacked Federal & State ITC still best policy
- Important consideration for determining ITC level. Small haircut assumptions have large impact on the level of an ITC that achieve a positive NPV

Debt Designs

- Model allows splitting of debt into 2 Tranches
- Small improvements in overall economics

Annual Interest Rates

- Impacts the size of the loan a project takes out and must repay
- Preferential rates marginally improve economics

Overnight Capital Costs

- FOAK price and potential cost overruns are significant sources of uncertainty and cost

Fuel Cost

- Small impact, consider contracting arrangements to reduce volatility

Length of Construction

- Significant impact on NPV
- Explore insurance to projects to mitigate risk exposure to cost overruns, or
- Access to lower construction interest rates can help marginally

Wholesale Electricity Prices

- This model is limited in its representation of electricity markets.
- Premium pricing via PPA or other targeted market mechanism as stand-alone or complement to other policy levers

Using the Model: Input Dashboard

Input Categories

- Project Characteristics (Costs, Service Life, etc.)
- Revenue Inputs (Capacity Factor, Prices)
- Debt Assumptions (Interest rate, Tenor, Tranching)
- Federal Tax Incentives (ITC/PTC and adders)

Example Input Section

Category of Input	Input Name	User Inputs are Colored Cells	Input Instructions	Additional Information
Project Characteristic Inputs	Project Capacity (MW)	600	Enter value greater than 1.	On the Nuclear Plant info sheet Cells C54:C62 there is information on the size of reactor scheduled to come online in the next decade
	Overnight Capital Cost $/kW	$8,082	For a generic small modular reactor NREL ATB had overnight capital costs at 8,082 2022USD/kW	Capital expenditures excluding construction period financing. The Nuclear Plant Info Sheet contains data from NREL as well as MIT on new nuclear costs
	Fixed Operation and Maintenance Expenses ($/kW-yr)	$128	For a generic small modular reactor NREL ATB has Fixed O&M costs at 128 2022USD/kW-yr	Annual expenditures to operate and maintain equipment that are not incurred on a per-unit-energy basis. The Nuclear Plant Info Sheet contains data from NREL as well as MIT on new nuclear costs
	Variable Operation and Maintenance Expenses ($/MWh)	$3	For a generic small modular reactor NREL ATB has Variable O&M costs at 3 2022USD/MWh	Operating and maintenance costs incurred on a per-unit-energy basis. The Nuclear Plant Info Sheet contains data from NREL, MIT, and NEI on these costs. For NEI look to cells I66:I69
	Fuel Costs ($/MWh)	$7	For a generic small modular reactor NREL ATB has Fuel costs at 7 2022USD/MWh	Additional historical data on fuel costs from NEI is in the Nuclear Plant Info sheet cells I66:I79
	Project Service Life (years)	60	Maximum input is 80 years	NRC license timeframe of 40 years. Industry assumption that the plants will get the 20 year license renewal once or twice.
	Construction Length (Years)	7	Select from list. Possible values range from 1 to 20, inclusive. The median construction time for U.S. nuclear power plants is about 7 years	About half of nuclear power plant in the U.S. took 5 to 10 years to reach grid connection. Longer construction timeframes increase construction financing costs while shorter timeframes decrease these costs.

Using the Model: Input Dashboard

User-input Scenario Assumptions

- ITC Monetization Haircut Assumption
- Optional State ITC or PTC, and values associated
- Capital Cost share in $
- Premium PPA agreement details

Color-Coded Scenario Inputs Section

Scenarios 2 & 4	ITC Haircut Assumption (%)	10%	Enter a value between 0-100%. This will be the percentage of an ITC that goes to a third party with the necessary tax liability and not the project developer.	A project's tax liability can limit how much of the ITC they can monetize. It is common practice for project developers to use a third parties tax liability to access the full value of the ITC with that third party taking some share. For example, a project may qualify for a 10% ITC but only be able to access 2% of the 10% with its tax liability. The developer goes to another entity that can access the other 8% and takes a 'haircut' of 1% for itself. The project gets 9% while the third party gets 1%.
Scenario 3	State Tax Credit	State ITC	Select PTC or ITC from the List	This scenario enables the user to assess the impact of a state-level PTC or ITC on top of a federal PTC or ITC
	ITC Value (%)	10%	Enter value 0-100%	For reference the federal ITC ranges from 6 to 50% depending on whether the prevailing wage and apprenticeship requirements are met and which adders are attained.
	PTC Value ($/MWh)	$5.00	Enter positive value	For reference the federal PTC ranges from $5.5/MWh to $33/MWh depending on whether the prevailing wage and apprenticeship requirements are met and which adders are attained.
Scenario 5	Capital Cost Share from Texas ($)	$1,000,000,000	Enter Value.	This scenario enables the user to assess the impact of a Capital Cost share between the project developer and the state of Texas. This cost share is applied before the ITC (federal or state) is applied.
	Percent of project overnight capital costs from Base covered by the state	15%	Output based on cost-share amount and the total project cost	This value is generated but dividing the cost share amount and the total cost of the project prior to the cost-share being applied
Scenario 6	Power Purchase Agreement (PPA)	All	Select from list.	No will not include a PPA in any scenario and scenario 6 will be empty. All will include a PPA in Scenarios 2-6. Scenario 6 only will include a PPA in that case only.
	Length of PPA (years)	15	Max 20 years	PPA lengths are typically 10 or 20 years.
	Share of Plant Capacity Covered by PPA	23%	Enter value from 0-100%	
	PPA Value ($/MWh)	$87.00	Enter Positive Value	add something that shows relation to the market price
	PPA Premium over Ercot Market Pric	43%	This is an output showing the premium (+/-%) of the user-input PPA price and the user-input ERCOT Market Price	

Using the Model: Output Dashboard

Output Metrics

- **Is the project profitable –** Does the net present value (NPV) of all revenues and Federal + State policy support exceed all capital, operating, and financing costs?
- **Impact of policy in each scenario –** How does the return on invested capital change across policy scenarios
- **Total Cost of Policy Intervention** – what is the total value of the avoided state-level taxes, cost-share, and price premium/PPA
- **Levelized Cost of Energy (LCOE) –** metric combines the primary technology cost and performance parameters. It is one useful metric for comparing a technology cost-competitiveness but is imperfect because it does not capture other operating characteristics or attributes that provide value to the electric system broadly.
- **Total Cost of Project** – broken out by CAPEX and OPEX
- **Total Revenue** – broken out by wholesale market revenue, PPA/premium price, and state-level production tax credits.

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