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Path to 5 GW: Financial Incentives

Summary of INL/RPT-25-89185



Key Findings

- Based on analysis assumptions:
 - BWR uprates are competitive with NGCC across all incentives
 - including no incentives
 - PWR requires incentives to compete with NGCC
 - MUR uprates are universally competitive uprates
 - PTC has highest impact on low-cost uprates
 - ITC, Milestone Payments have greatest impact for high-cost PWR uprates



Financial Incentives for Nuclear Upgrades

- Executive Order 14302, “Reinvigorating the Nuclear Industrial Base”
 - “5 GW of power upgrades to existing nuclear reactors ... by 2030”
 - New targets provide even more accelerated timelines
- Industry partners have expressed concerns over the cost of nuclear upgrades
 - Concerns that upgrades may not compete with building NGCC
- This study:
 - How do different **financial incentives** improve the **economic outlook** of nuclear plant upgrades?



Financial Incentives: Production Tax Credit

- Production Tax Credit (PTC) provides per-kWh credits for energy produced due to uprate
 - For study, assume these are active for 10 years after uprate
 - Provides funds later in project life

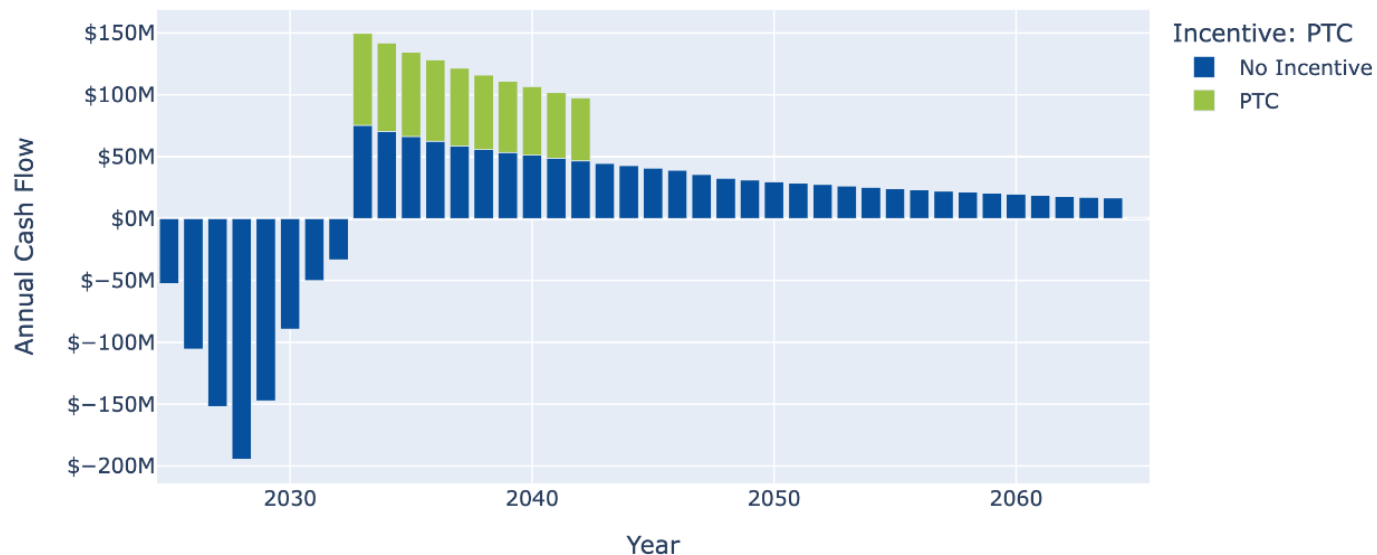


Figure 10. Annual Cashflows with PTC for BWR EPU+ in a merchant market

Financial Incentives: Investment Tax Credit

- Investment Tax Credit (ITC) a one-time credit when uprate is complete
 - Scales with cost or size of uprate
 - Provides funds once, earlier in project life

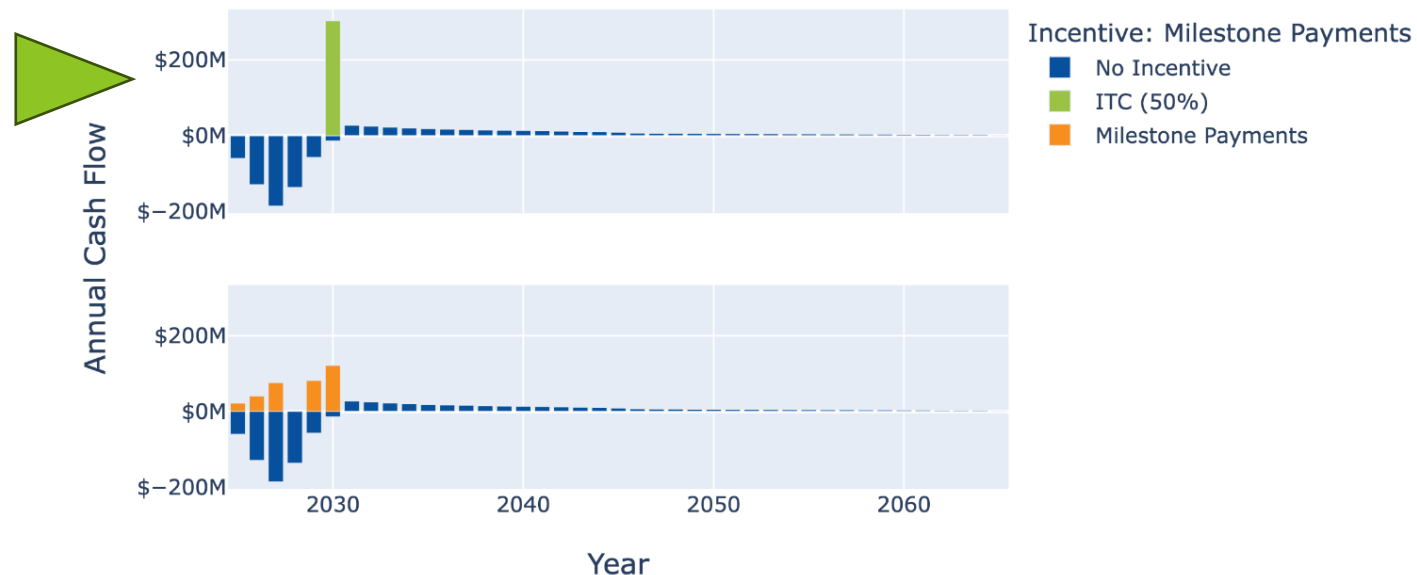


Figure 12. Annual Cashflows with ITC, milestone payments for PWR SPU/EPU in a regulated market

Financial Incentives: Milestone Payments

- Similar to ITC but credits for construction progress
- Not currently used in nuclear energy policy
 - Provides funds early in project life

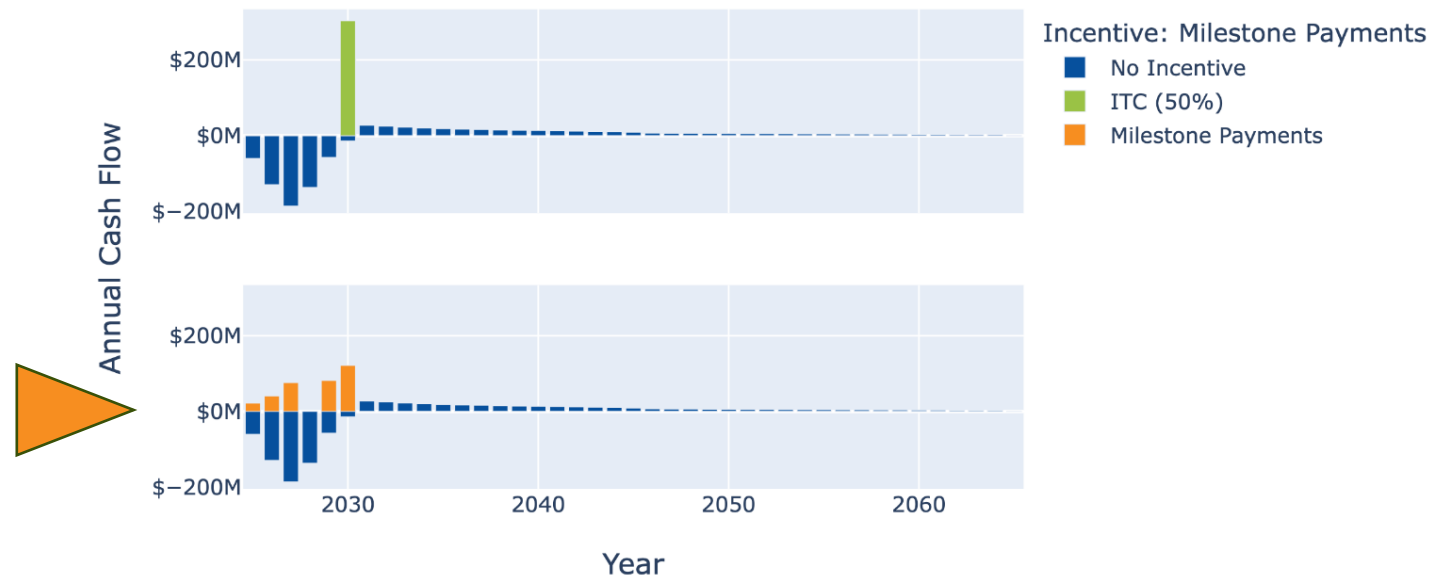


Figure 12. Annual Cashflows with ITC, milestone payments for PWR SPU/EPU in a regulated market

Financial Incentives: Interest Holiday

- Pauses accrual of interest on loan during construction period
 - Not currently used in nuclear energy policy
 - Provides relief during construction before uprate starts production
 - Supports cashflows early in project life

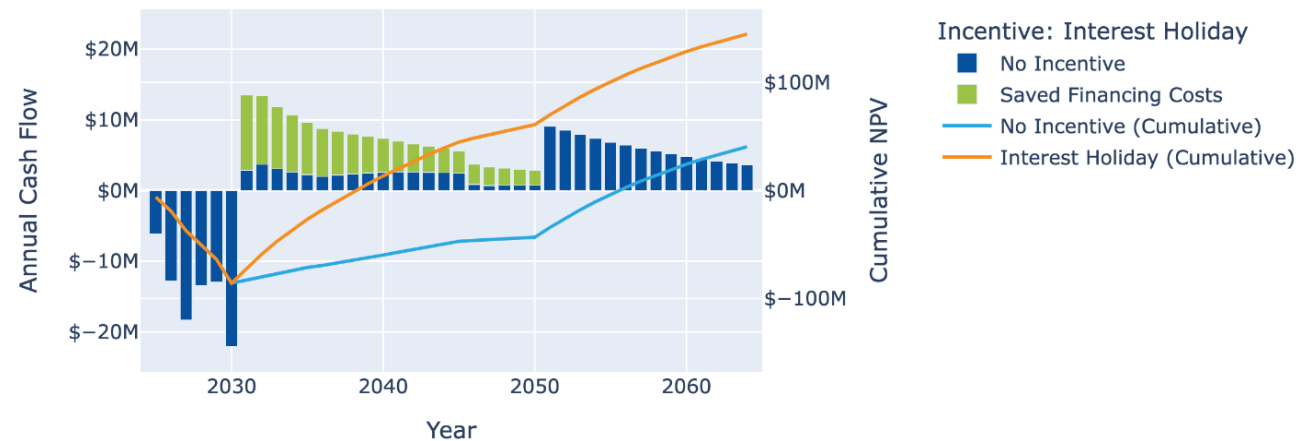


Figure 16. Interest Holiday for BWR EPU in a regulated market

Financial Incentives: Power Replacement

- Nuclear plant required to provide cost of backfill electricity during extended outage
 - This incentive partially compensates for backfill cost (50%)
 - Not currently used in nuclear energy policy
 - This incentive is very small in magnitude compared to other incentives

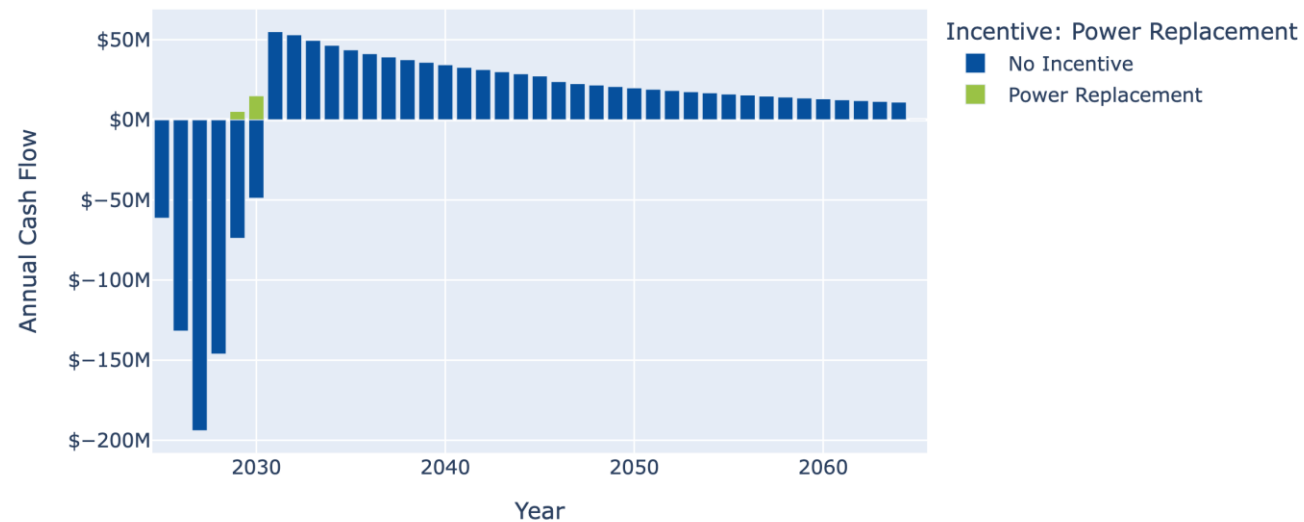


Figure 16. Power Replacement for BWR EPU in a merchant market

Inputs

Table 2. Uprate Cost and Capacity Parameters

Case	Uprate Overnight CAPEX (\$000s)	Net Electrical Capacity Added (MWe)
PWR SPU/EPU	\$635,000	80
BWR EPU	\$660,000	220
MUR	\$24,000	17
PWR EPU+	\$1,480,000	190
BWR EPU+	\$880,000	330

Table 3. Financing Case Parameters

Parameter	Merchant	Regulated
Percent Equity Finance	50%	10%
Return on Debt	5%	10%

- 5 types of uprate considered
- 2 types of markets (debt to equity ratios)
- Cost, Capacity sourced from industry collaboration

Analysis Scenario Set

- Assumptions:
 - Electricity Price: 46 \$/MWh
 - Project Life: 40 years
 - Debt Repayment: 20 years

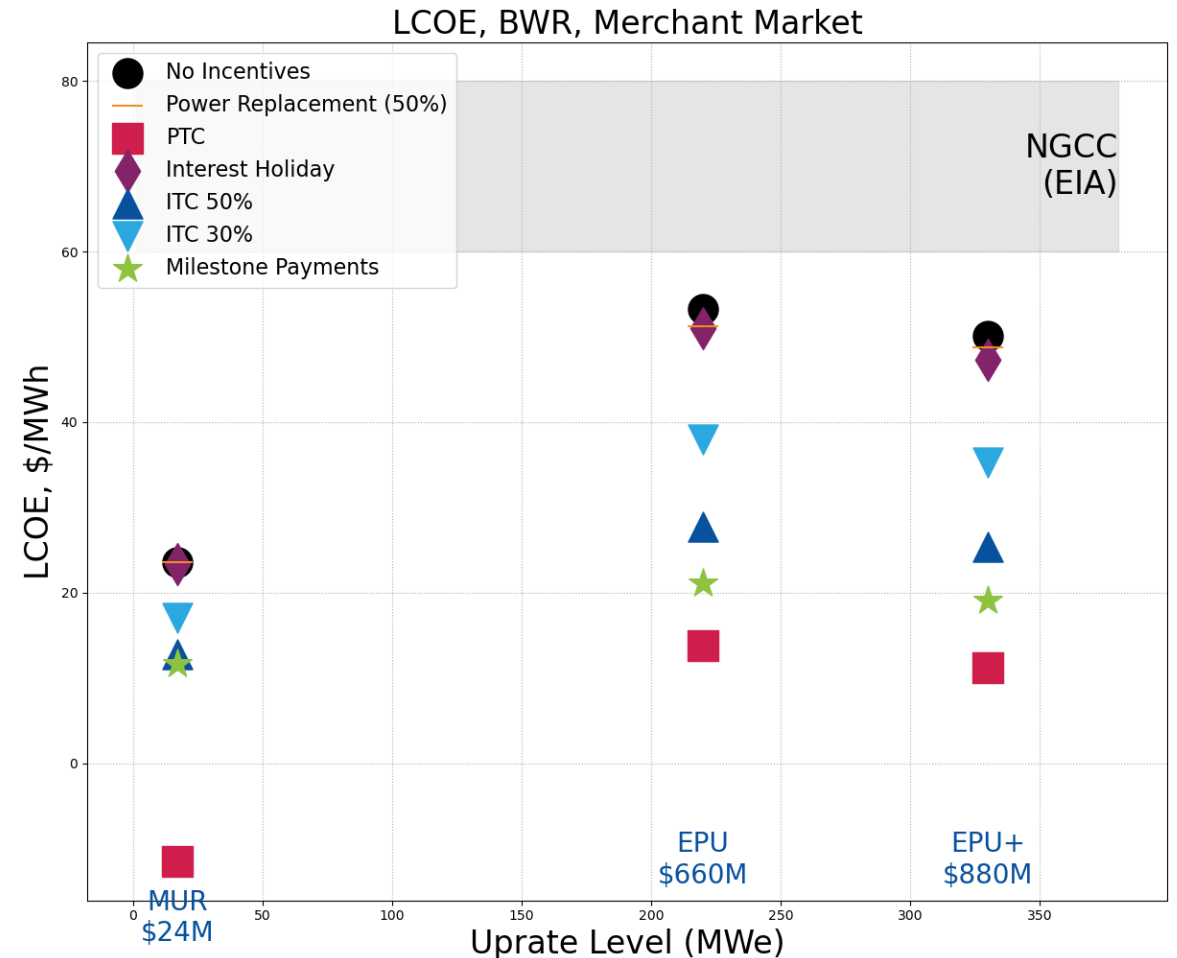
Table 1. Analysis Scenarios

Electricity Market Structure	Level of Uprate	Financial Incentive
Regulated	MUR	PTC
Merchant	BWR EPU+	ITC 30%
	BWR EPU	ITC 50%
	PWR SPU/EPU	Milestone Payments
	PWR EPU+	Interest Holiday
		Power Replacement
		No Incentive

- The analysis model is a modified version of the INL-MPR uprate model from 2023.
- Modifications allowed for additional incentives to be analyzed.
- Changes were validated by MPR for accuracy and consistency.

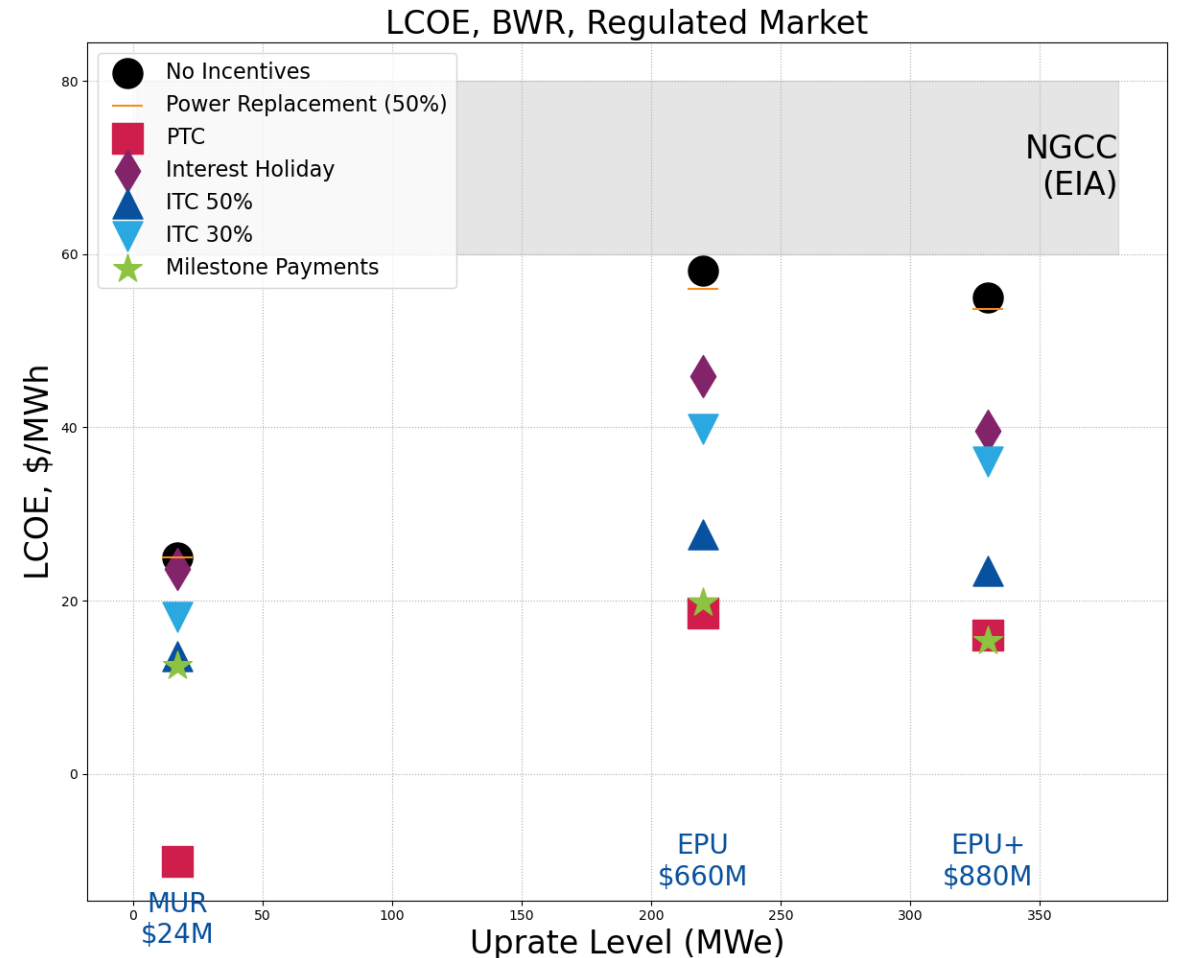
Results: LCOE, BWR, Merchant Market

- Lower LCOE is more profitable
 - Break-even cost of electricity
- NGCC shown for comparison
- PTC highly impactful incentive
 - BWR uprates are more cost-effective



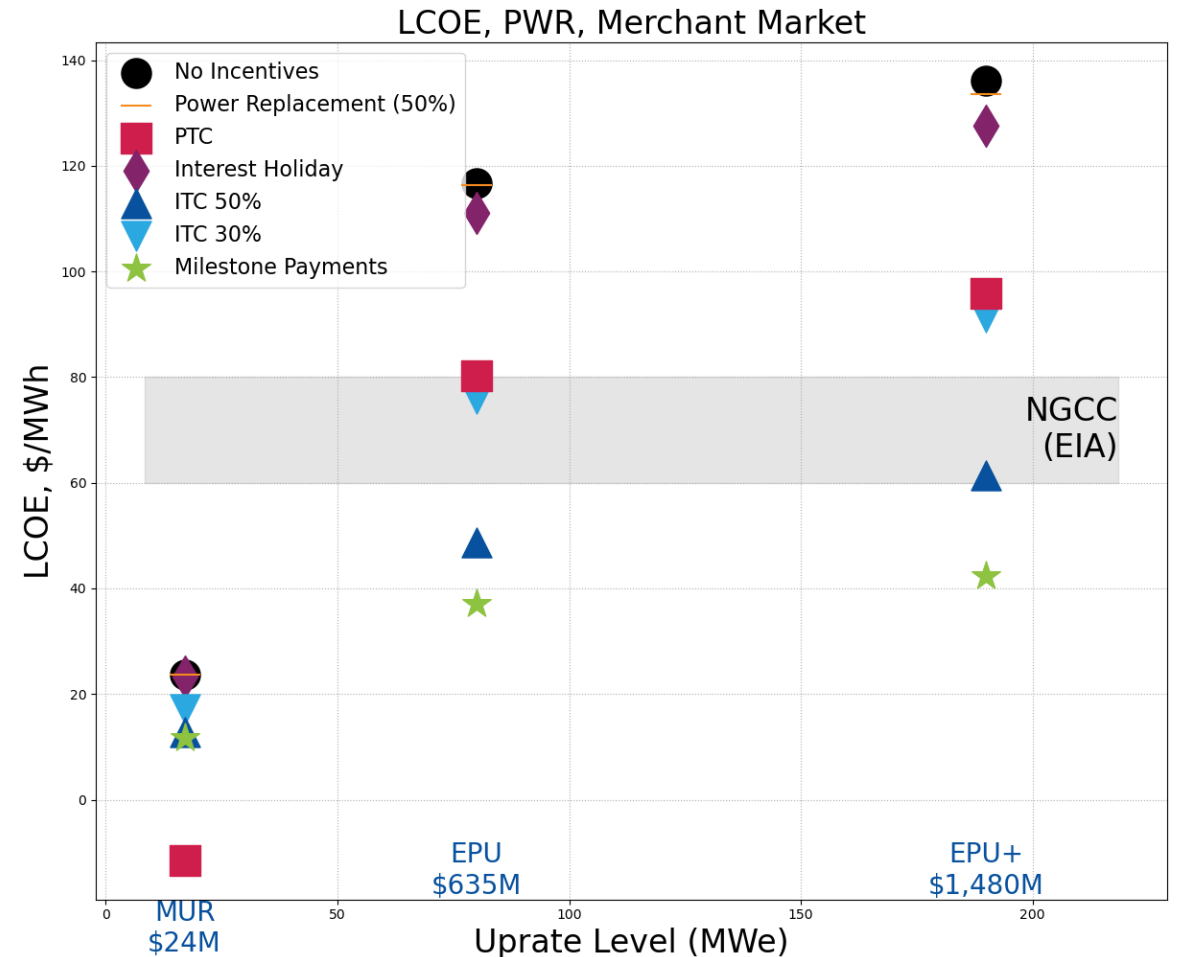
Results: LCOE, BWR, Regulated Market

- Similar results to merchant BWR
- PTC still highly effective
- Milestone Payments become competitive
- Interest Holiday has a bigger impact
 - More debt in regulated case



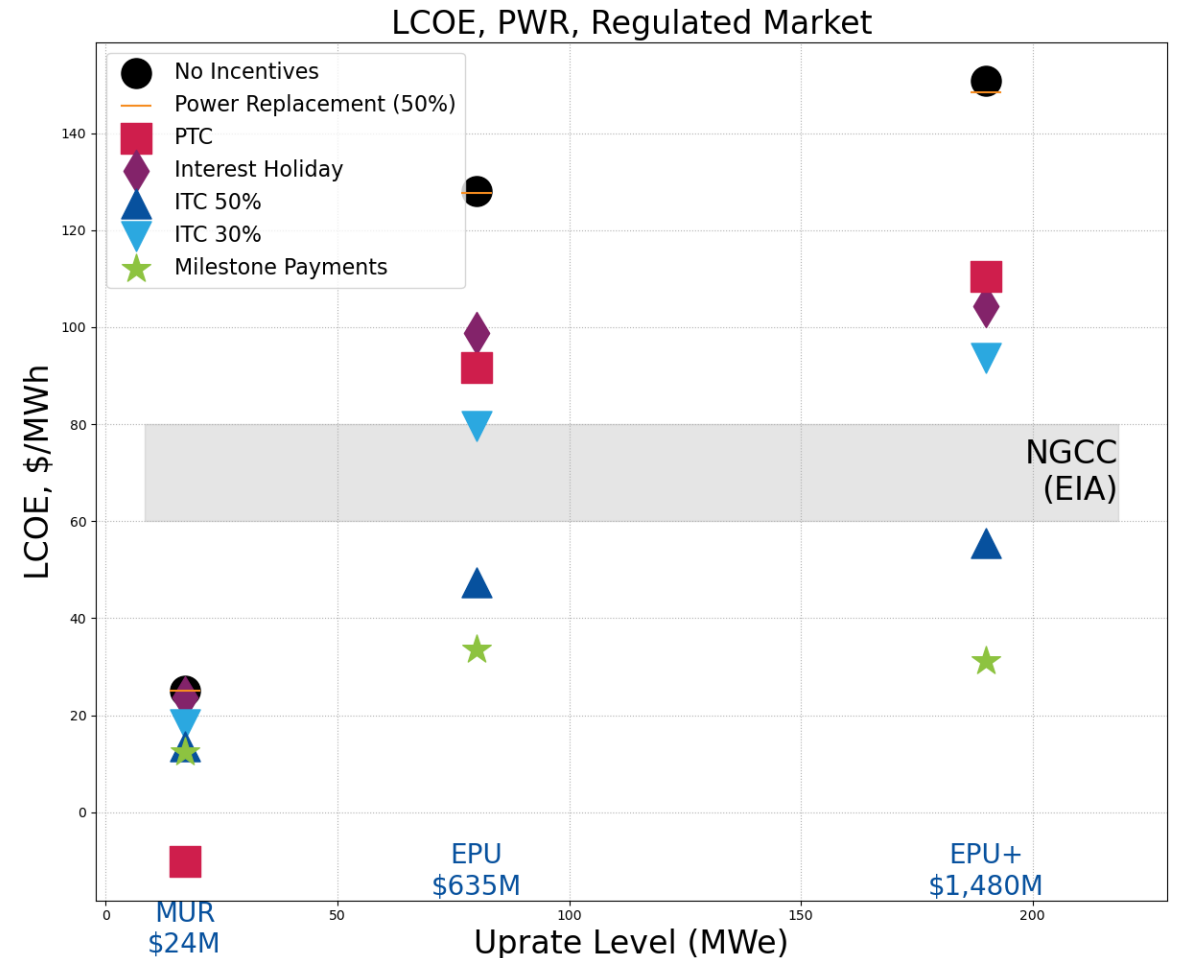
Results: LCOE, PWR, Merchant Market

- PWR uprates more costly per MW
- EPU, EPU+ not competitive with NGCC
 - Needs incentive
- Milestone payment is a strong incentive



Results: LCOE, PWR, Regulated Market

- Similar to PWR merchant market
- Interest Holiday stronger in regulated
- ITC, Milestone Payments strongest
 - Early in project life
 - Scale with cost of installation



Key Findings

- Based on analysis assumptions:
 - BWR uprates are competitive with NGCC across all incentives, including no incentives
 - PWR requires incentives to compete with NGCC
 - MUR uprates are universally competitive uprates
 - PTC has highest impact on low-cost uprates
 - ITC, Milestone Payments have greatest impact for high-cost PWR uprates
- To be impactful for utilities, need to run specific numbers or specific plants
- Many ways that novel incentives might be implemented

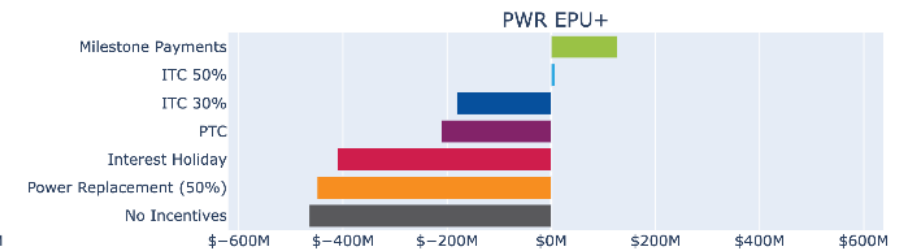
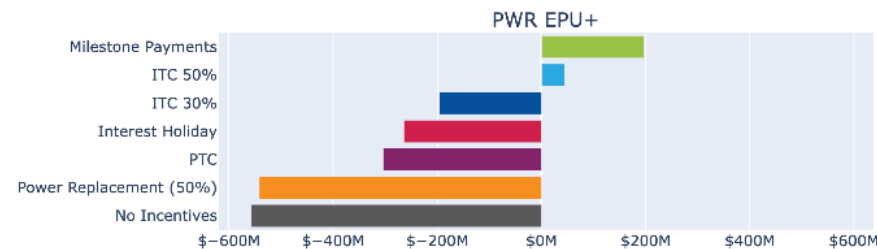
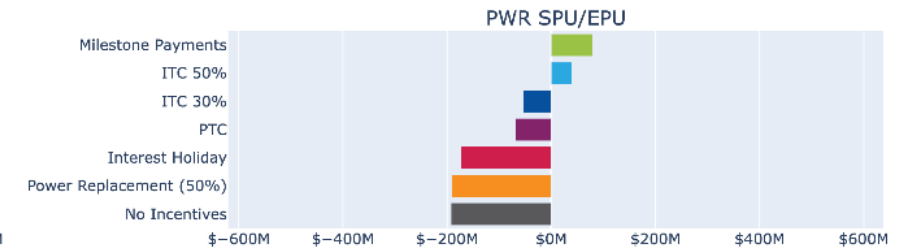
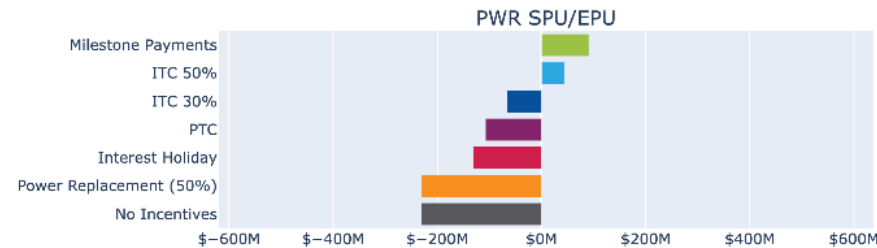
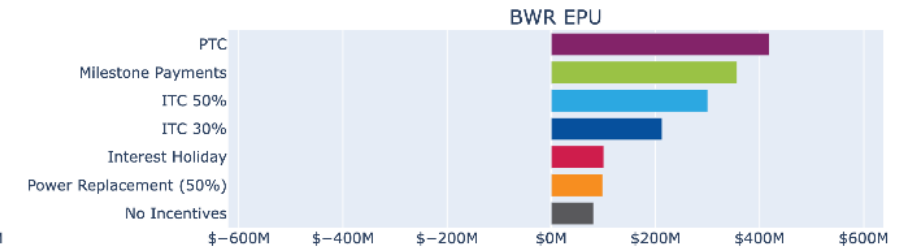
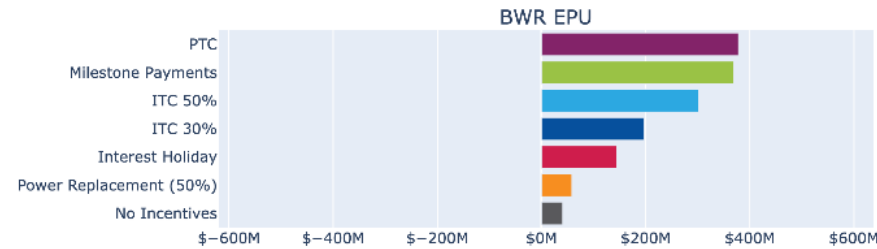
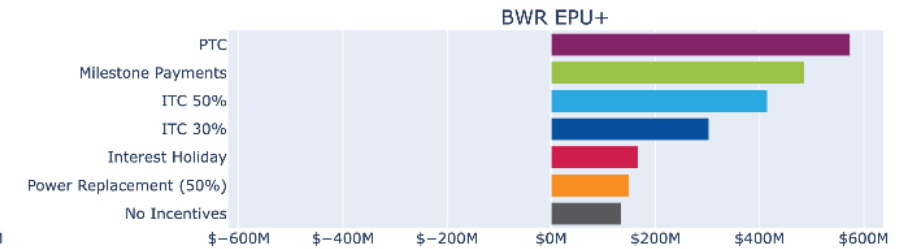
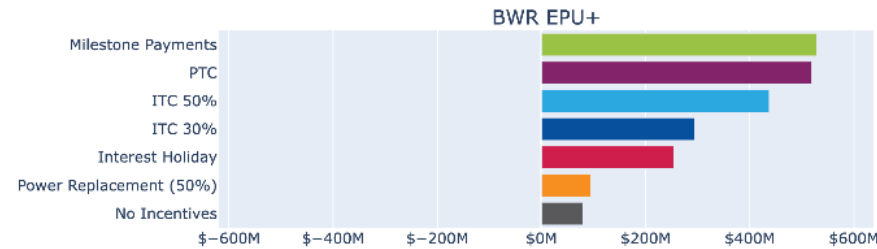
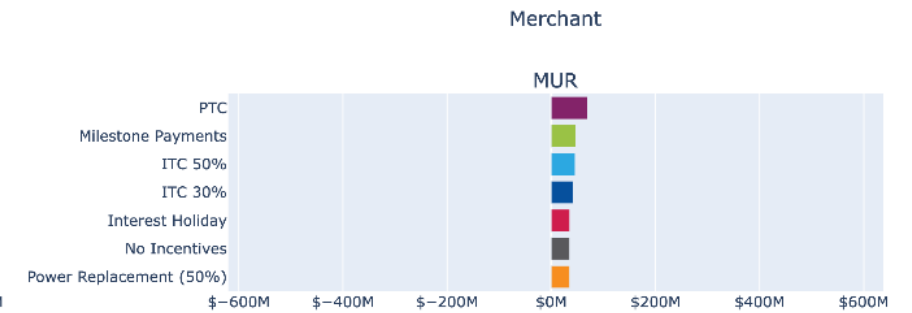
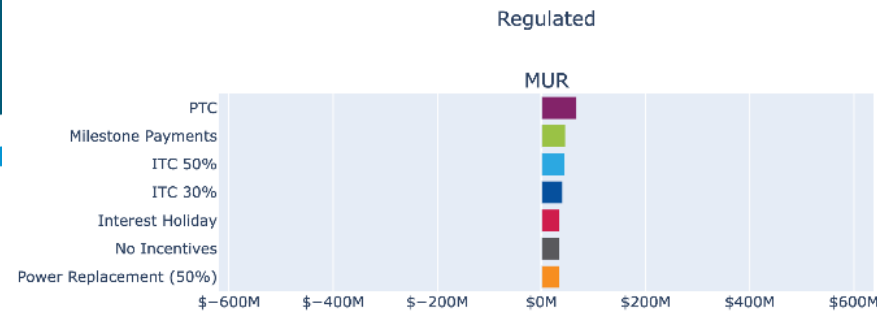


Sustaining National Nuclear Assets

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Additional Figures

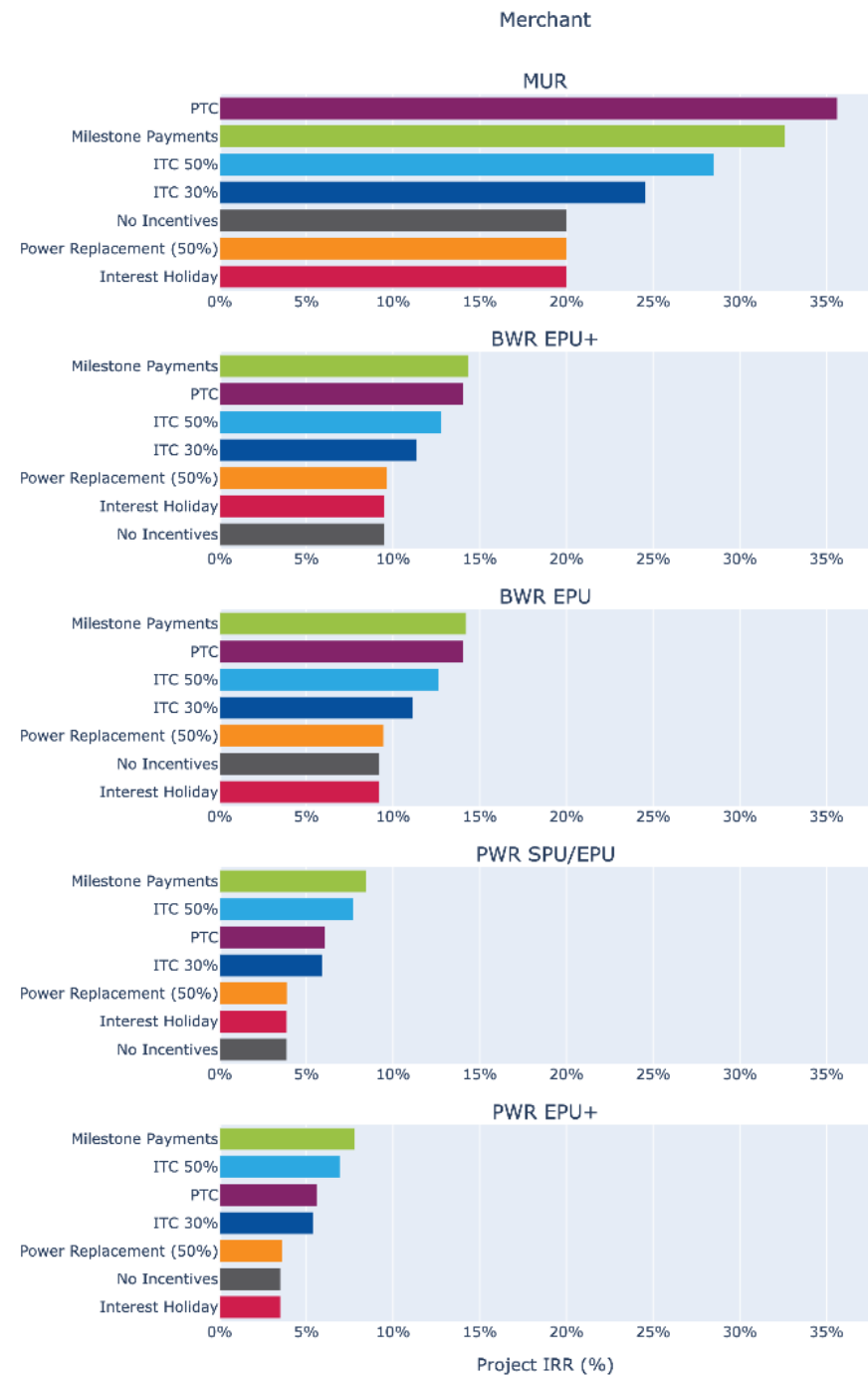
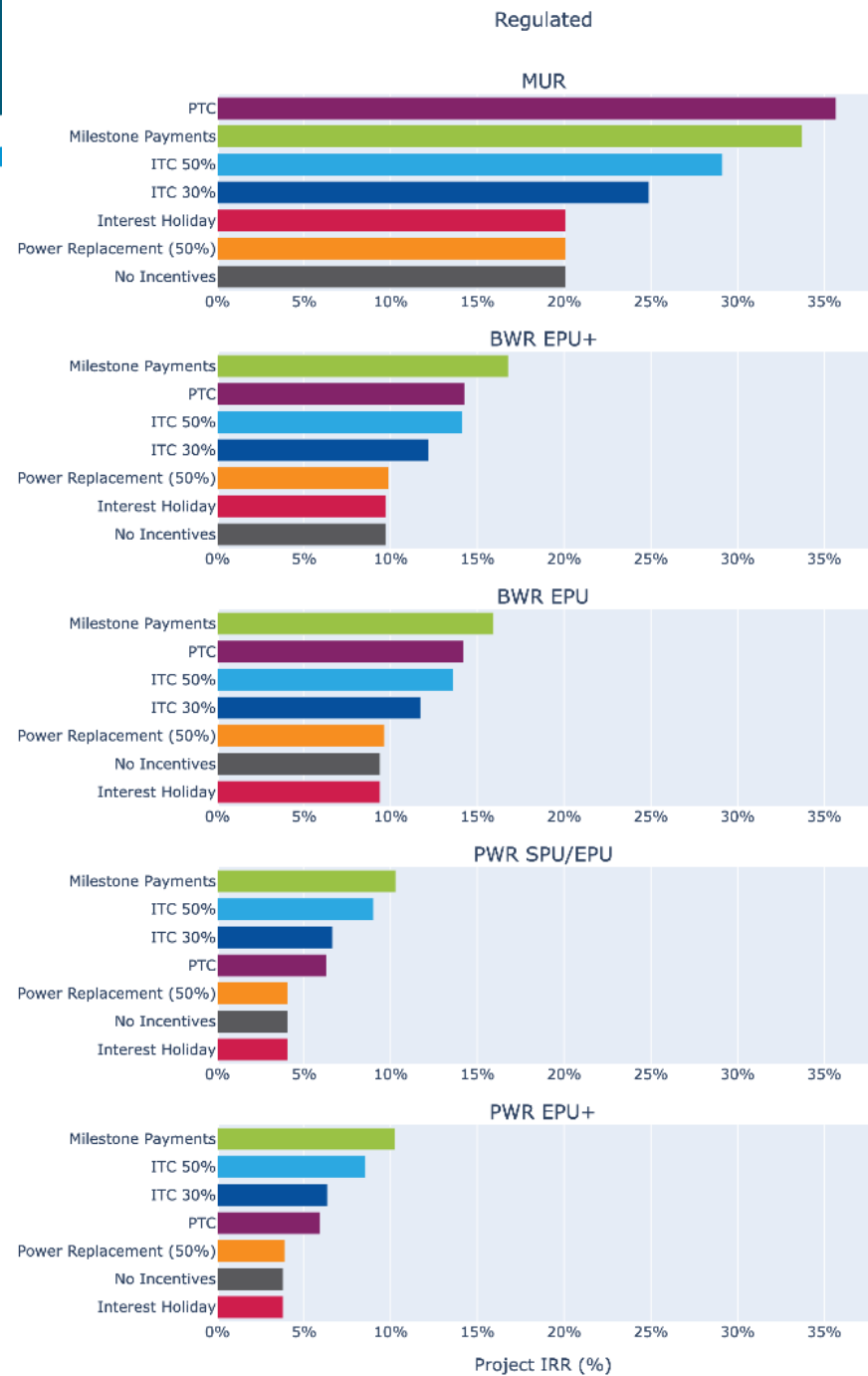
Full Results: NPV



Equity NPV (\$)

Equity NPV (\$)

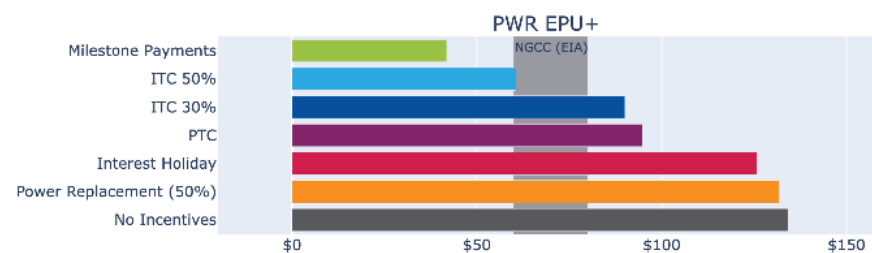
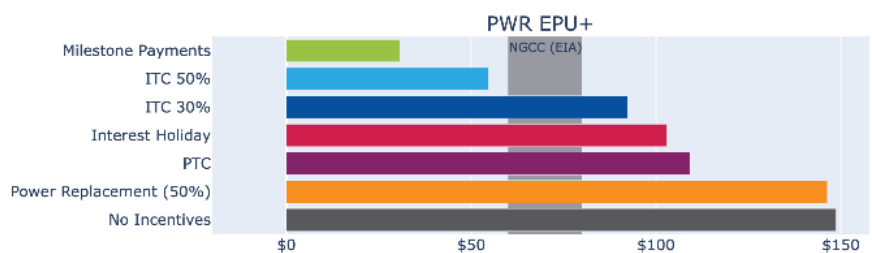
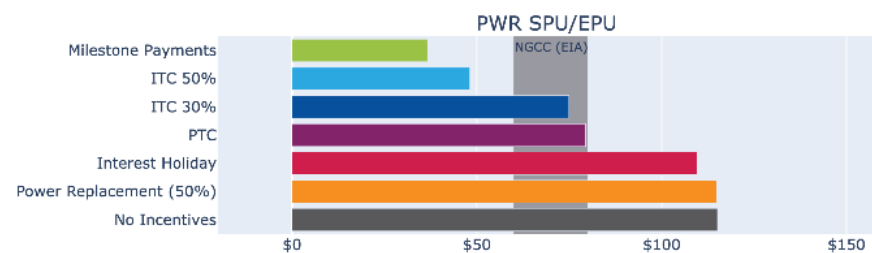
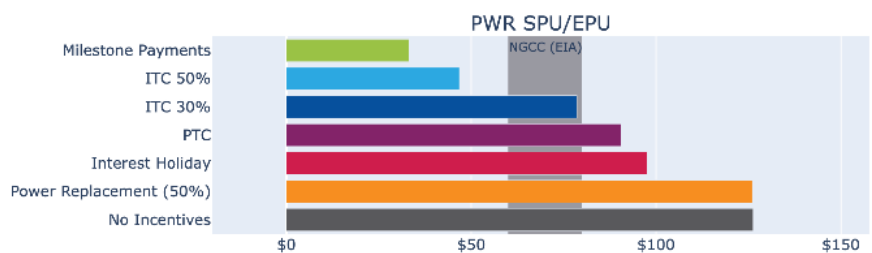
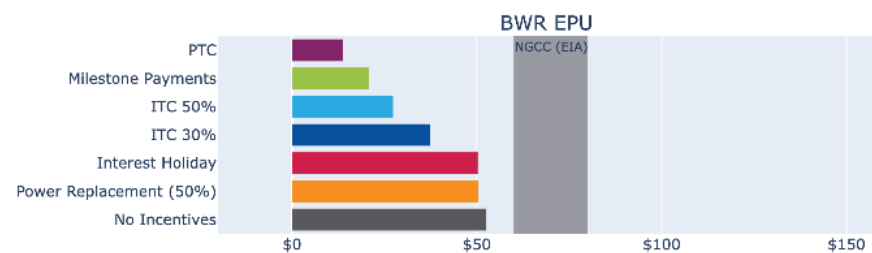
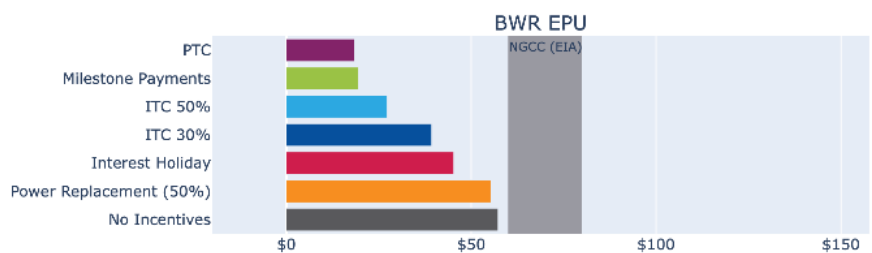
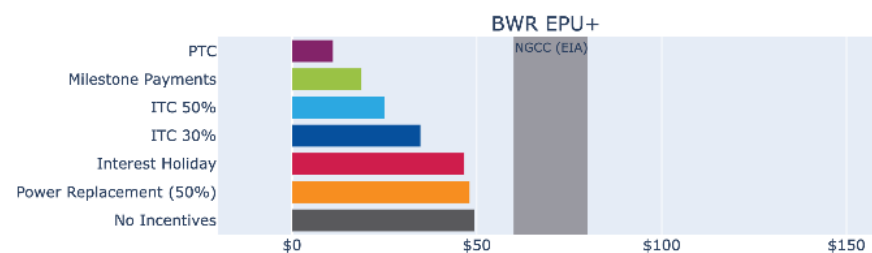
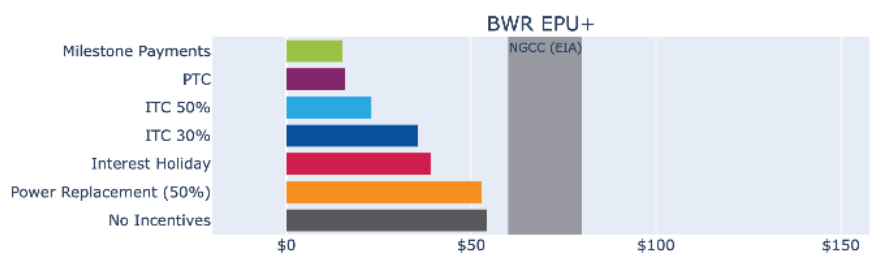
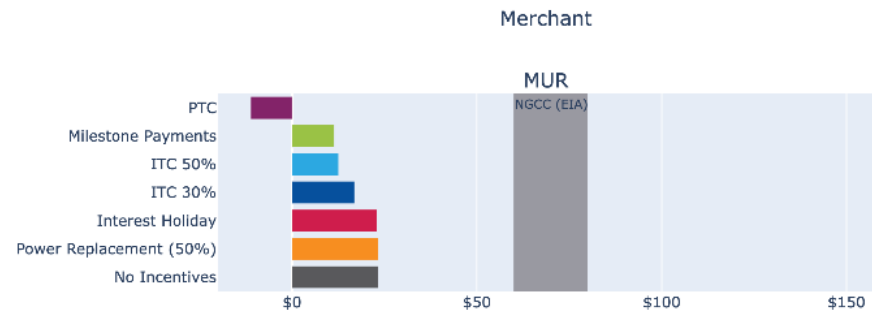
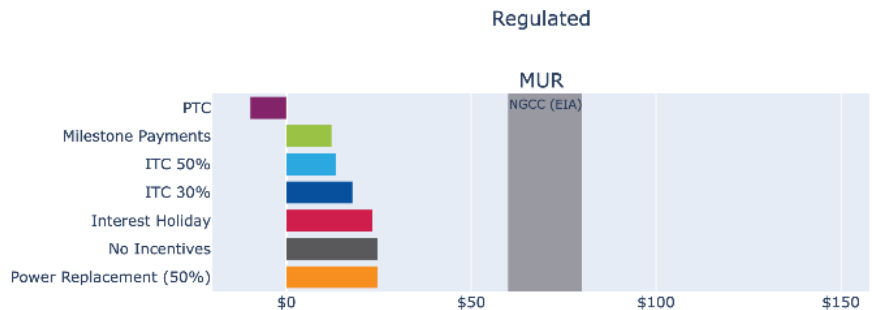
Full Results: IRR



Project IRR (%)

Project IRR (%)

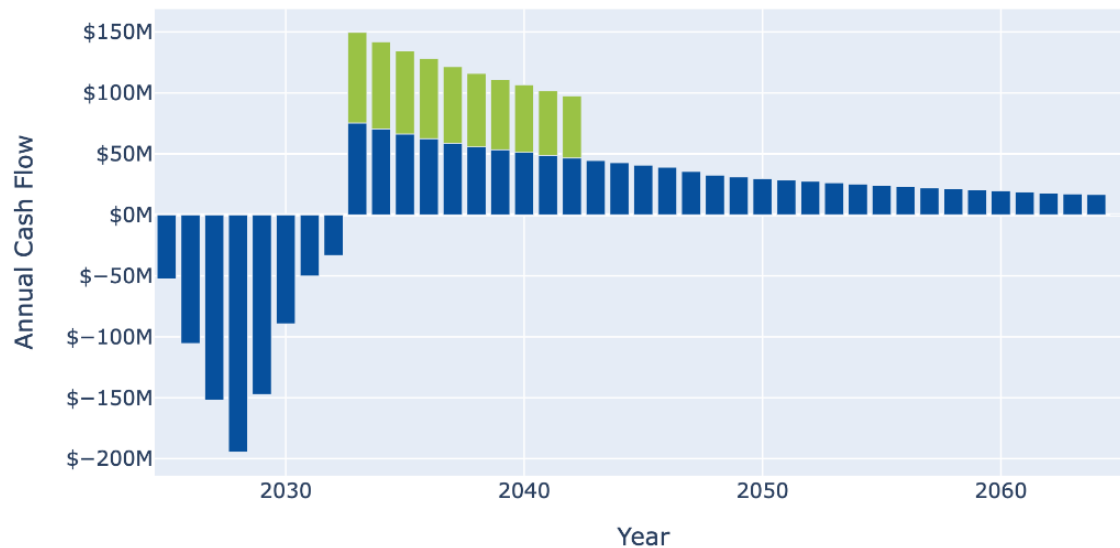
Full Results: LCOE



Equity LCOE (\$/MWh)

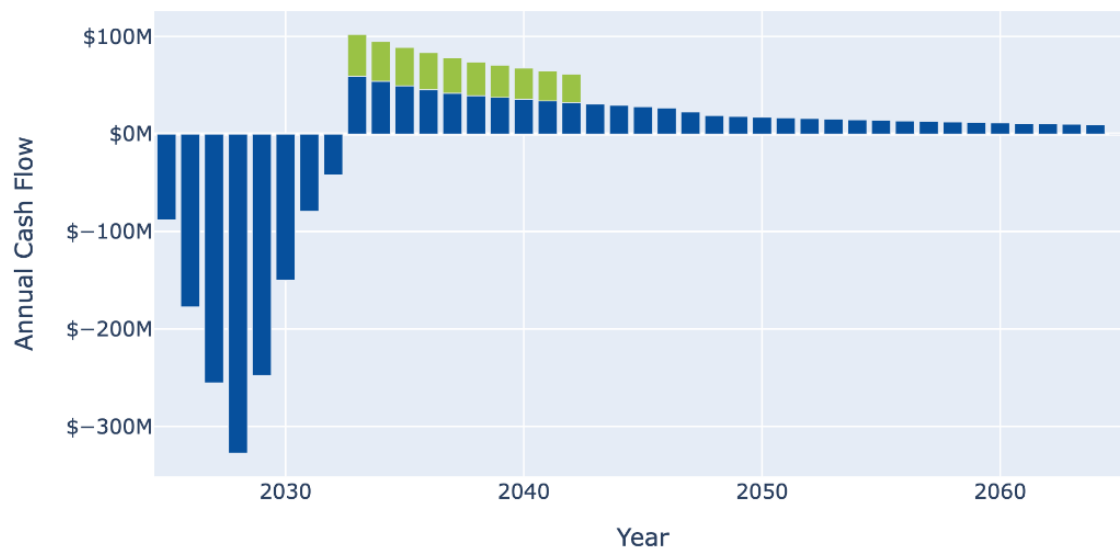
Equity LCOE (\$/MWh)

PTC



Incentive: PTC
 ■ No Incentive
 ■ PTC

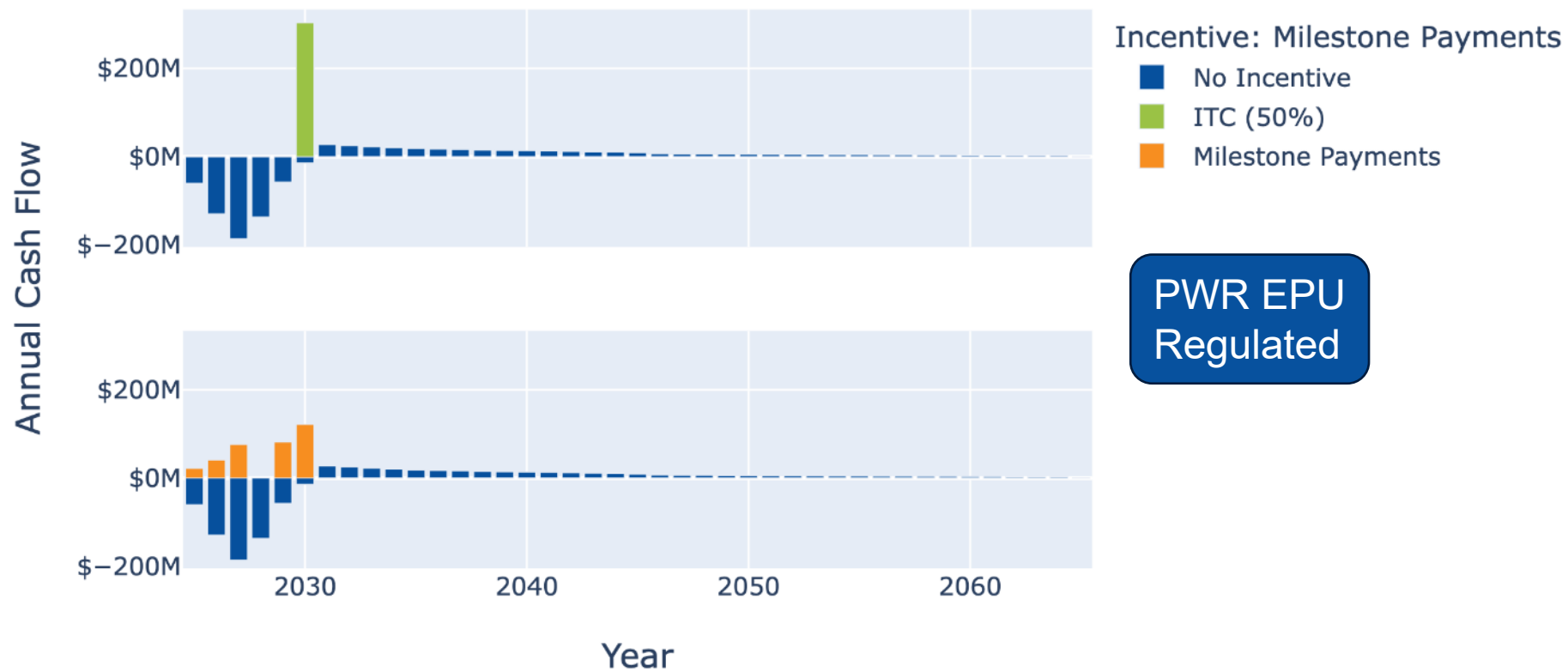
**BWR EPU+
Merchant**



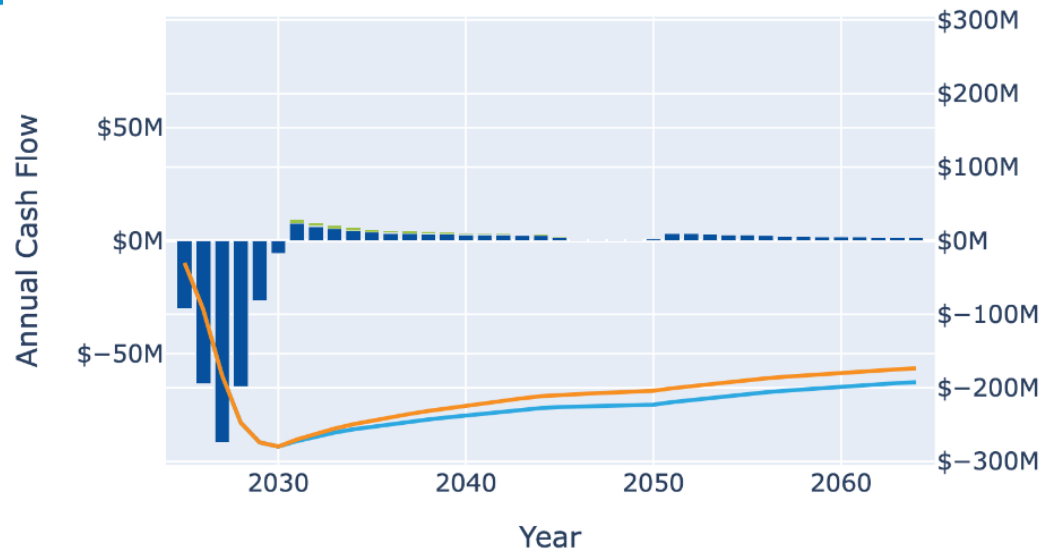
Incentive: PTC
 ■ No Incentive
 ■ PTC

**PWR EPU+
Merchant**

ITC, Milestone



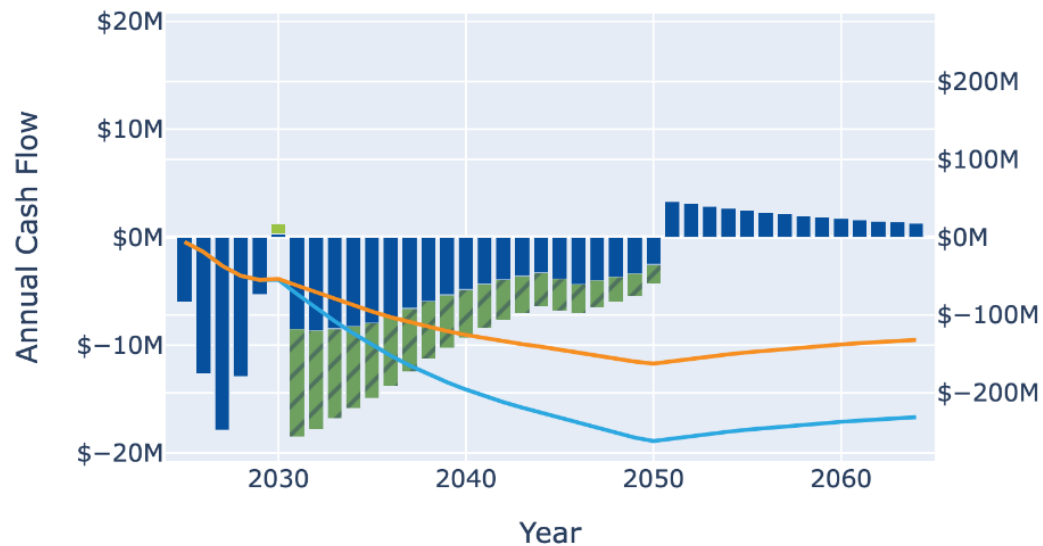
Interest Holiday (PWR)



Incentive: Interest Holiday

- No Incentive
- Saved Financing Costs
- No Incentive (Cumulative)
- Interest Holiday (Cumulative)

**PWR EPU
Merchant**



Incentive: Interest Holiday

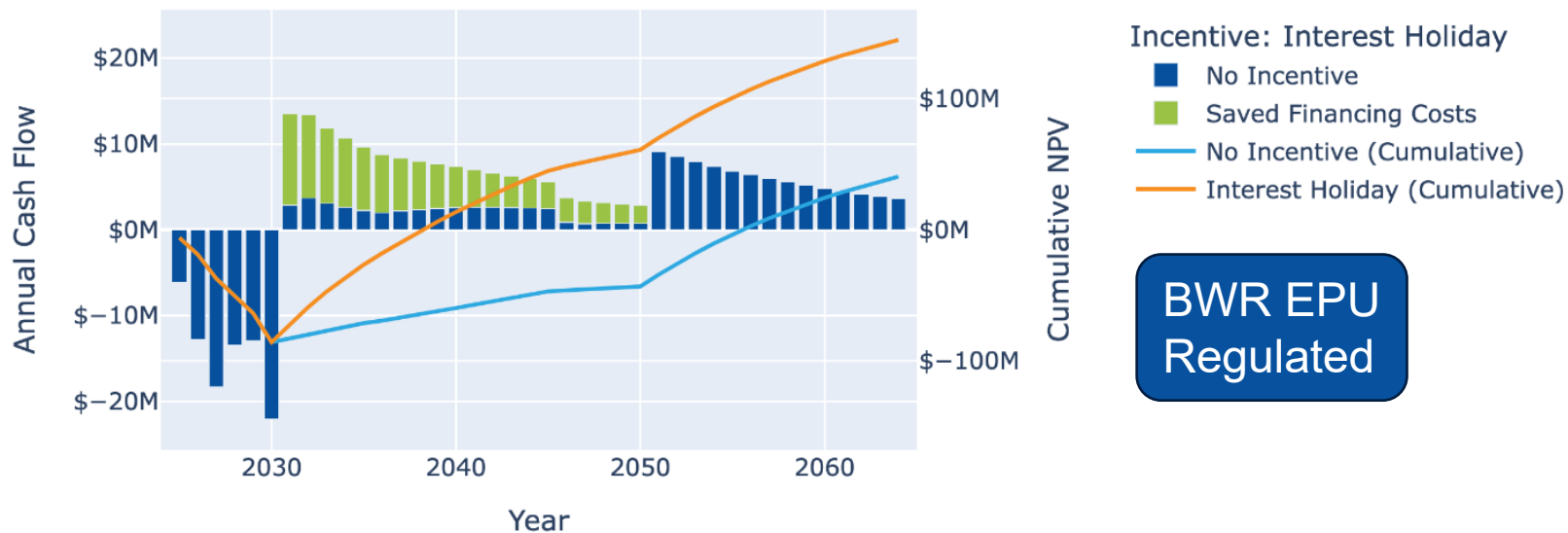
- No Incentive
- Saved Financing Costs
- No Incentive (Cumulative)
- Interest Holiday (Cumulative)

**PWR EPU
Regulated**

Interest Holiday (BWR)



**BWR EPU
Merchant**



**BWR EPU
Regulated**