Institute for Energy Economics and Financial Analysis

Small Modular Reactors are too unproven, too expensive, too uncertain, and too late

Presentation for the Rumble on the River Community Forum

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What is a small modular reactor (SMR)?

- SMRs are **generally defined as reactors that are 300 megawatts (MWe) or smaller**; this compares to the 600-1135 MWe range for most current U.S. reactors
- Designs can include a **single reactor or multiple units** grouped together
  - *NuScale's reactor modules are 77 MWe each, and can be grouped in plants of up to 12 modules – not necessarily small*
  - *GE-Hitachi's reactor is a single 300 MWe unit – but also not necessarily small if grouped*
- Modular refers to the idea that **plants would be fabricated in factories, then assembled at site**
- Designs include **scaled-down versions of existing boiling and pressurized water reactors**, as well as **other proposals** for technologies that previously have been tried and failed or have never been tried at all
- ~80 SMR designs have been proposed

Key SMR Risks and Warning Signs

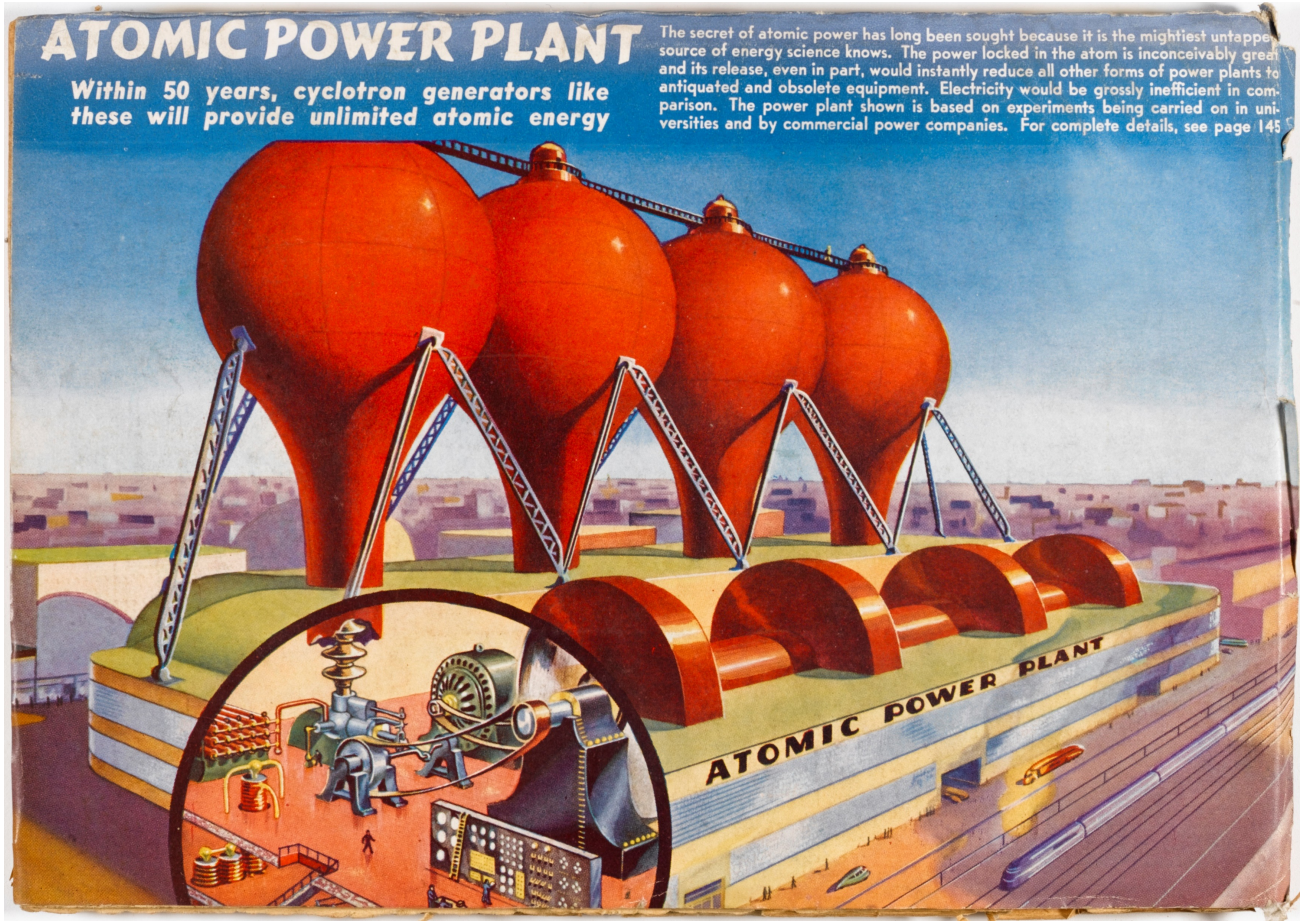
1. U.S. nuclear industry has repeatedly been unable to meet estimated costs and schedules – hundreds of billions of dollars in cost overruns and years-long schedule delays
2. None of the SMR designs currently being marketed have been built
3. None have been licensed in the U.S. or in Canada
4. Some proposals have exotic designs that have never been tried or have failed in the past
5. Not good tools for fighting climate change – too expensive, take too long to build
6. Recent cancellation of proposed first NuScale SMR and tanking of NuScale's stock price are warning signs for governments, utilities, ratepayers, and private investors
7. Key warning sign - *except for NuScale, SMR vendors and potential buyers are refusing to make estimated costs public – e.g. TerraPower, X-energy, GE-Hitachi & Westinghouse*
8. Increasing competition from declining cost renewable sources + storage

How Expensive Can SMR Power Get?

- When the NuScale SMR was cancelled in November, its target price of power was **$119 per megawatt hour (MWh)**, not including Inflation Reduction Act subsidies, & $89 per MWh *with* the subsidies
- But that's not as high as the price of power from an SMR can get
- For example, the CEO of Constellation Energy Corporation, which owns the most nuclear plants in the U.S., sees a price **of $150 to $160 per MWH for the power from a new SMR**. And wants no piece of one without a guaranteed contract that someone will pay that much for power from the plant
- The CEO of NextEra Energy has similarly expressed **skepticism about SMRs**
- "[SMRs] are **going to be very expensive**, and then you're going to be taking a bet on the technology"
- "Right now, I look at SMRs as an **opportunity to lose money in smaller batches"**
- But **$160 is not a cap** - SMR power prices could be even higher, perhaps significantly higher

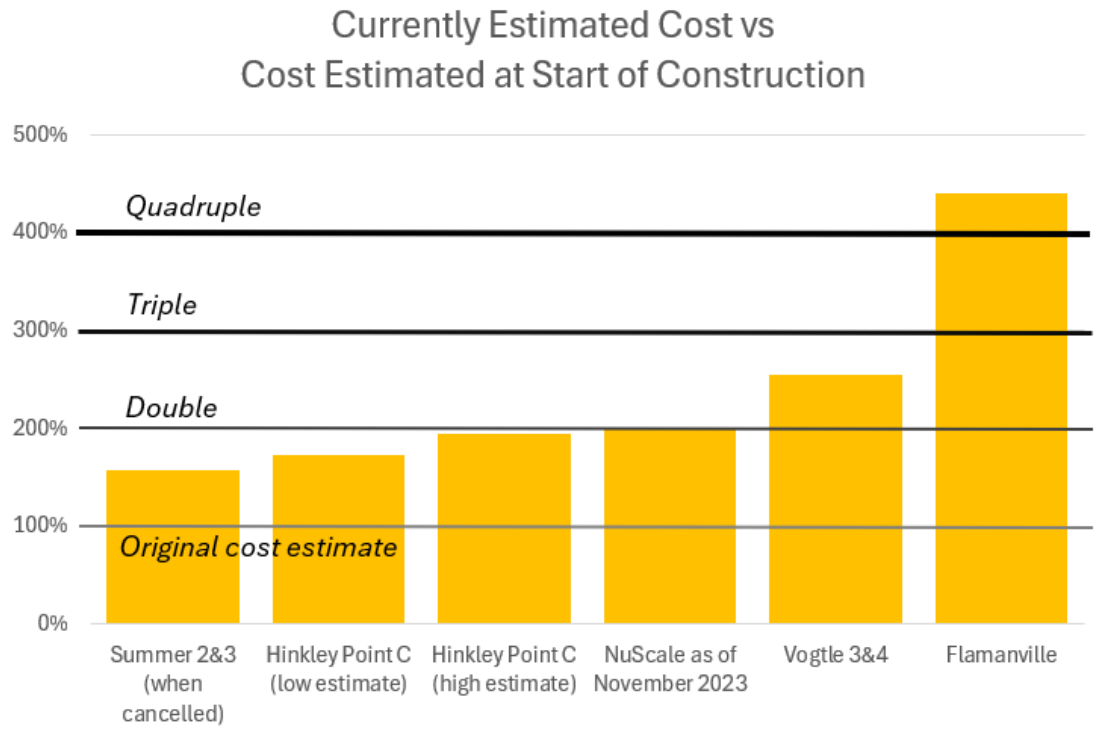
Initial Government and Industry Claim

Atomic power would be "too cheap to meter"



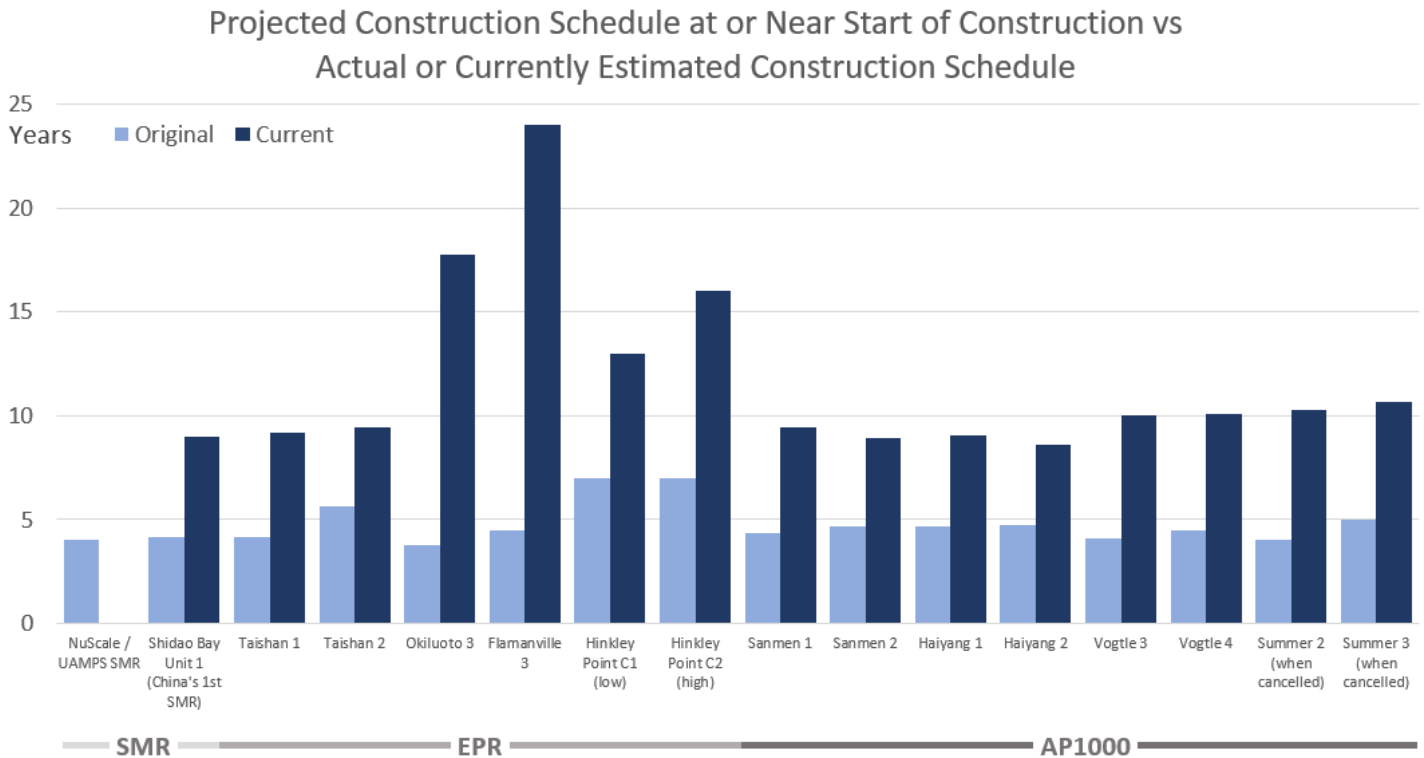
Recent Nuclear Industry Experience – Significant Cost Increases for Plants with New Designs

- NuScale/UAMPS SMR had at least 7 years of construction left when cancelled in November 2023 – which means there was plenty of time for the cost to continue to go up
- Vogtle Unit 4 and Flammanville reactors scheduled to be completed in 2024
- Completion of Hinkley Point C reactors not expected until 2031-2032 – so there is more than 7 years for the cost to continue to grow



Recent Nuclear Industry Experience – Significant Construction Delays for Plants with New Designs

- Current SMR vendors are claiming nuclear construction will be completed in about 3-4 years
- No commercial-size reactor in the U.S. has been built that fast
- All recent plants in the world with new designs have taken much longer to build than that

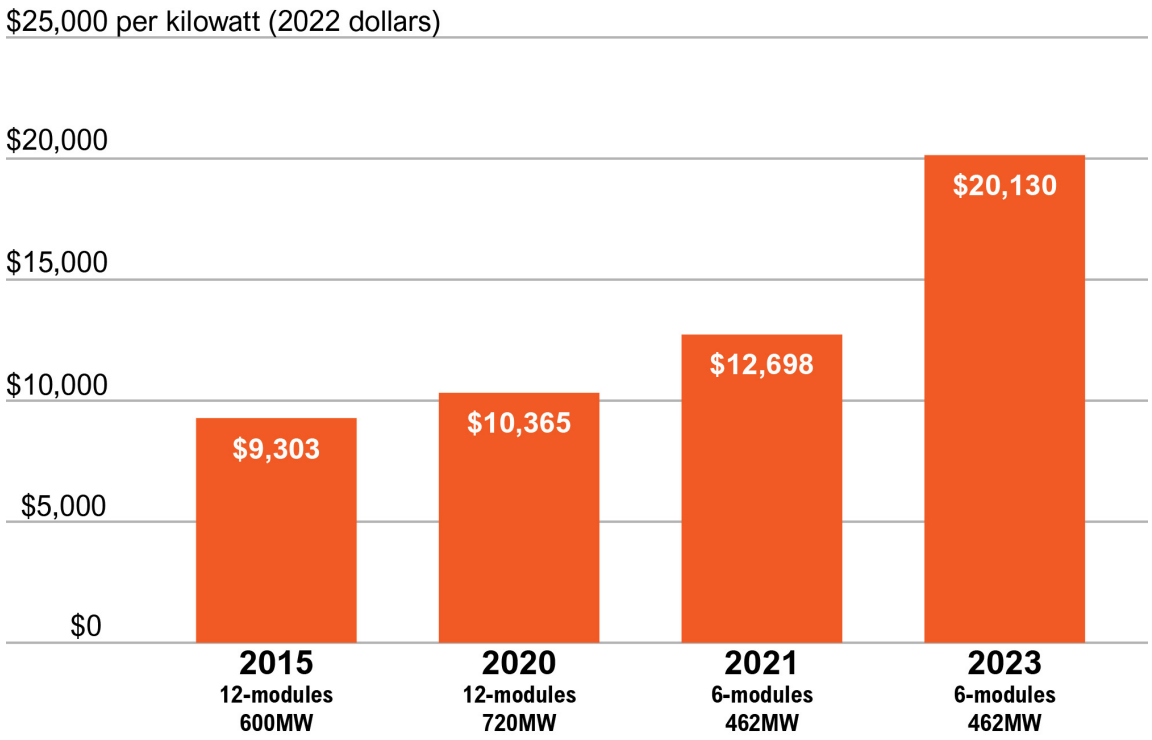


Have the Estimated Costs of Any Proposed SMRs Gone Up?

Yes.

Estimated cost of NuScale's proposed SMR for Utah more than **doubled** before it was cancelled in November 2023

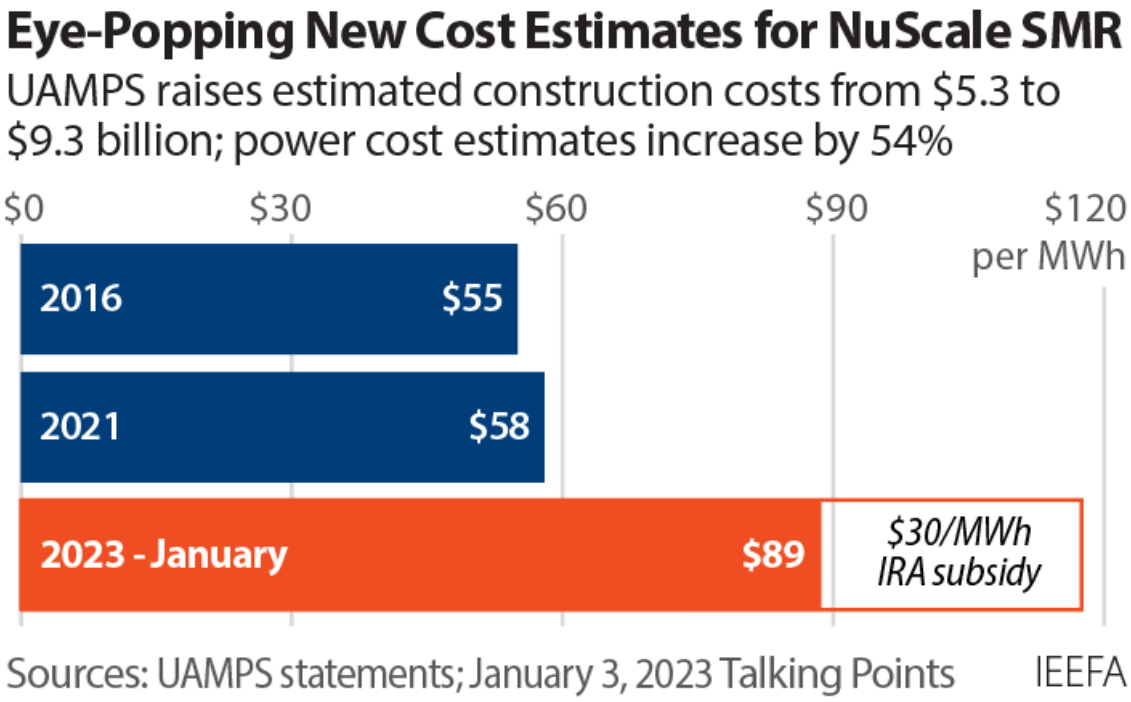
This is the only SMR whose cost has been made public



As the Estimated Cost of Building the NuScale SMR Rose, So Did Its Projected Price of Power

$119 per MWh would not have been the final price for the power from the NuScale SMR

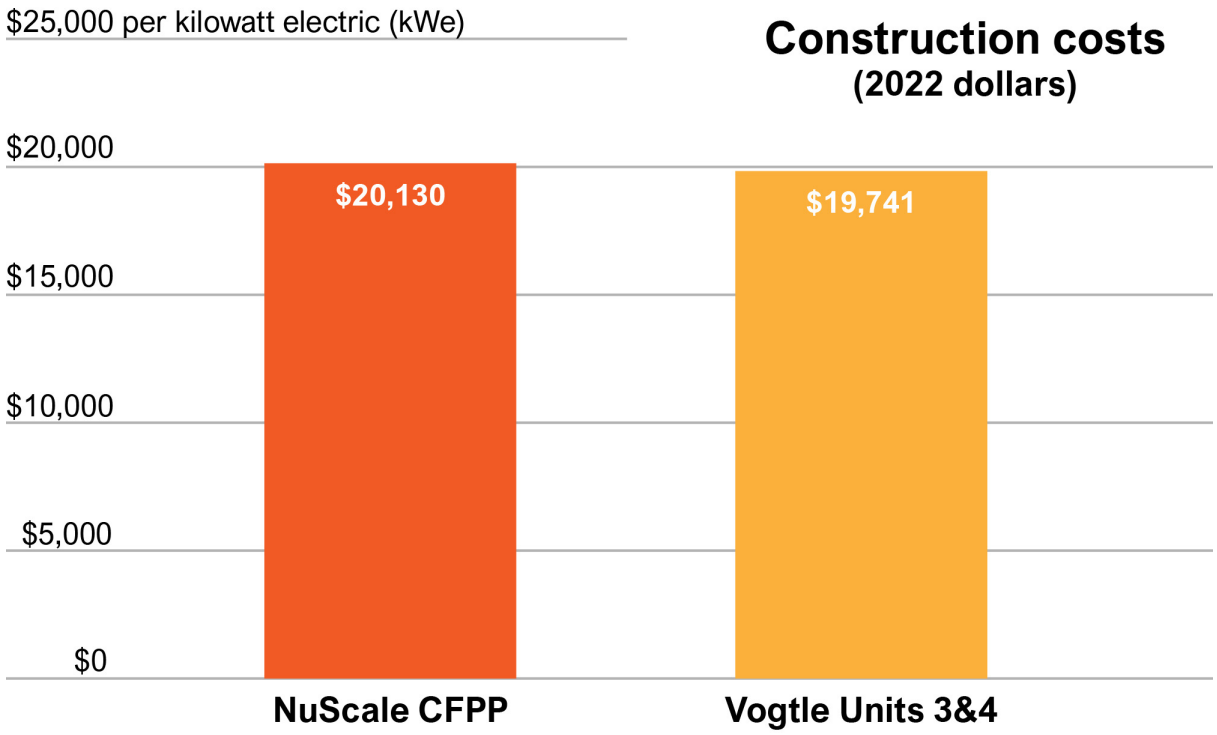
The price of power would have continued to go up had the project not been cancelled



Is There Any Evidence that SMRs Will Be Less expensive than Earlier Reactors?

No.

Despite proponents' claims, the estimated **cost of NuScale's SMR was already as high as the Vogtle project when it was cancelled** with more than 7 years left before construction is scheduled to be completed – plenty of time for the cost to go even higher.

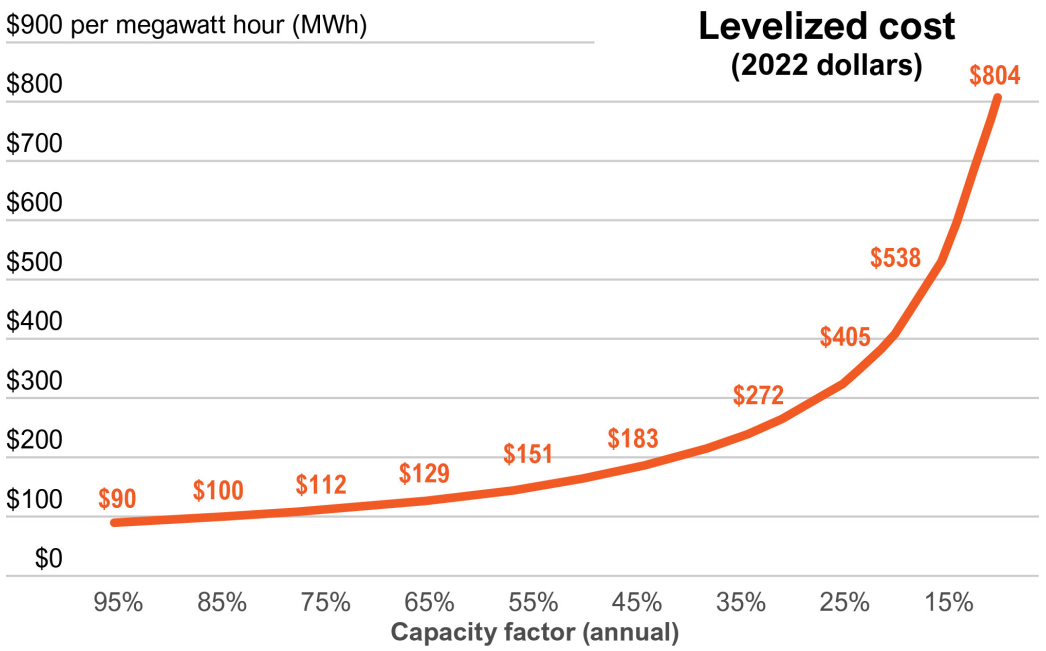


Was Concern over Rising Construction Costs and Power Prices Why the NuScale SMR Was Cancelled?

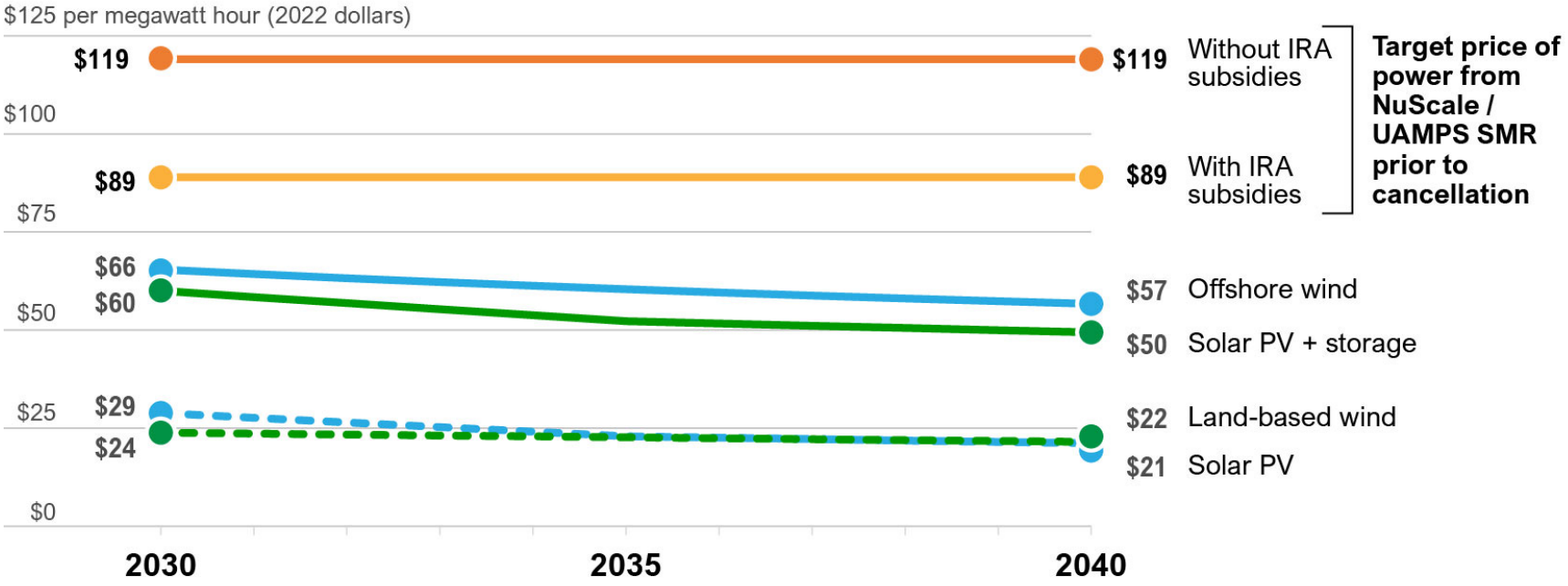
- Yes.
- Project was cancelled because NuScale and UAMPS (Utah Associated Municipal Power Systems) were **unable to find enough parties to sign contracts** to pay for the power from the SMR
- By 2023 NuScale and UAMPS were promising a target price of $89 per MWh but this was just an estimated target. Not a guaranteed price
- The contract required parties who remained in the project after a license was granted by the Nuclear Regulatory Commission to ***pay all the actual costs of the SMR even if it was not finished, never provided any power, or was damaged or destroyed***
- **New parties did not want to sign a "blank check" with no certainty as to how high the ultimate cost of the project might go**

SMRs Not Good Tools for Fighting Climate Change

- Take too long to build – faster & cheaper options can be online much sooner
- Power even more expensive if reactors cycled
- Units on the coast threatened by ocean level rise and severe storms
- Inland units threatened by storms & more severe droughts from global warming
- Will compete with renewables for space on transmission lines



Power From SMRs Will Be More Expensive than Power from Renewable Resources



Sources: NuScale Power, UAMPS and National Renewable Energy Lab's 2023 Annual Technology Baseline report.

What About the Estimated Costs of Other Proposed SMRs?

- NuScale and UAMPS cited higher interest rates and escalation of construction commodity prices as reasons why the cost of its proposed SMR increased by 75% just between 2021 & January 2023

- Reasonable to expect that the same factors will lead to similar increases in the cost of other SMRs especially those with more exotic designs

- Warning Sign - ***other SMR marketers and potential buyers have so far refused to make current project cost and schedule estimates public***

What's Going On With The Natrium Reactor?

- TerraPower refuses to provide any publicly-available cost estimate and meaningful estimated in-service date
- PacifiCorp says that it doesn't have any detailed cost estimates for Natrium in its IRP – instead it uses "proxy values that do not reflect finalized costs"
- Yet PacifiCorp refuses to reveal what those "proxy values" are
- Gates and TerraPower talk vaguely about when the TerraPower plant will be in service
- However, a recent report for large industrial users of electricity in Norway by the RystadEnergy consulting firm expresses doubt that the Natrium reactor will be in service by 2040
- Prudent resource planning by PacifiCorp and the Wyoming PSC should include complete transparency about the currently estimated costs and in-service schedule for the Natrium

Is It Reasonable to Expect That the Costs of Building SMRs Will Decline as More Are Built?

- **Proponents of SMRs assume** that there will be a "learning curve" which will make the costs of building SMRs decline over time.
- This is **just an assumption** – it certainly hasn't happened in the U.S. and credible analyses raise doubt whether it has happened elsewhere
- As noted earlier, the same prediction was made for the Vogtle Nuclear project
- Even if there is such a learning curve, it is unknown how quickly the cost of building SMRs will decline or by how much – **without offering any real evidence, SMR proponents assume steep declines**, e.g., where each successive SMR is 10% cheaper than the last
- Also, if there such a learning curve, it's slope will depend on how many SMRs of each specific design are built and whether any major flaws in that design are found during construction or operation - these are **currently unknowable especially with so many different designs being marketed**

For More Information

- Contact David Schlissel at dschlissel@IEEFA.org
- IEEFA reports on SMR risks available at www.ieefa.org/smr

  "SMRs – Too late, too expensive, too risky and too uncertain"

  "Eye-popping new cost estimates released for NuScale small modular reactor"

  "NuScale Power, the canary in the small modular reactor market"

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