Small Scale Nuclear Power an option for northern communities?

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What is Nuclear Energy?





380 million gallons of diesel (250 fuel barges)

1gallon of water = 326 petajoules (world energy use is 54 petajoules / hour)





Nuclear Fission





U-235 is an unstable isotope of U-238. A natural fission chain will end with Thorium-231, which is a stable element.

Top right: Chena Hot Spring Bottom Right: Elim Hot Springs







Nuclear Fusion



Nuclear Fusion reactions power the Sun and other stars.





Conventional Nuclear Energy



Nuclear energy produces 20% of electric power in the US, equivalent to all renewable energy resources together, including hydropower









What are Microreactors?

Microreactors are an emerging class of small advanced reactors with the following general attributes:

- Output of 1 to 10's of MWe **
- Do not require water for cooling
- Factory fabricated and transportable nearly fully assembled.
- Requires a small operational footprint.
- Employs passively safe operating and fuel designs
- Long intervals without refueling











Alaska Microreactor Legislation



NEWSROOM & MEDIA STRONG FAMILIES ADMINISTRATIVE ORDER

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Microreactor Regulations Put Alaskan Communities at Forefront of Energy Innovation

Jul 27, 2023

This month the State of Alaska adopted regulations to streamline the regulatory process for communities wanting to provide low-cost and clean energy by nuclear microreactor power generation.

The regulations stem from Senate Bill (SB) 177 which Governor Dunleavy signed into law in 2022, updating Alaska Statute (AS) 18.45.

Constructing any nuclear facility in Alaska requires both federal and state permits. The Nuclear















Level of Maturity for Microreactor and Small Modular Reactor Designs







Eielson AF Microreactor Pilot



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Eielson AFB Announced as Site for Air Force Micro-Reactor Pilot

By SAF/IEE Installation Energy / Published October 15, 2021



PHOTO DETAILS / DOWNLOAD HI-RES 1 of 1

An F-35A Lightning II assigned to the 355th Fighter Squadron (FS) takes off from Eielson Air Force Base, Alaska, July 1, 2021. Also known as the 'Fighting Falcons,' the 355th FS is one of Eielson's two combat-coded F-35A squadrons. (U.S. Air Force photo by Airman 1st Class Jose Miguel T. Tamondong)

- 2019 National Defense Authorization Act (NDAA) required the DoD to seek to develop a pilot program for the development of at least one micro-reactor by December 2027.
- Will be licensed as a commercial reactor project through a PPA with the Air Force (possibly the first in the country).





O Does the technology exist?
→ Not yet, but imminent ...
Is it safe?
Is it economic?
Is it responsible?





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Not yet, but imminent ...
Is it safe?
Is it economic?
Is it responsible?





What Does Passive Safety Mean?

Fuel/fuel configuration

New fuel configurations such as TRISO particles **cannot melt in a reactor** and can withstand extreme temperatures and stresses that are well beyond the threshold of current nuclear fuels.



Schematic illustration of TRISO fuel pellet. Inset: false-color image of TRISO fuel pellet, diameter 930 micrometers.











What Does Passive Safety Mean?



Passive Cooling

Advanced reactors do not require active systems to cool the fuel in an emergency. Instead they rely on passive safety features which require no active controls or operational intervention to

avoid accidents in the event of malfunction, and instead rely on gravity, natural convection, or resistance to high temperatures (or a combination thereof)







What Does Passive Safety Mean?



Thermosiphons for protecting foundations in the Arctic

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Question: What does TAPS have in common with micro reactor technologies?





















Life Cycle of Nuclear Energy



McArthur River uranium mine (Saskatchewan)

Elim, Alaska protest against uranium mining







Life Cycle of Nuclear Energy



?Long-term storage?

Onkalo geologic storage (above, Finland). Dry casket storage in US (Right)









Alaska factors to consider

- Alaska is a near-ideal early adopter market (high cost of energy, heat + power)
- Interest from vendors
- Risk associated with being an early adopter (economic, technological, public perception, etc)
- Opportunity for state/federal partnership
- Passive or active decision making





Why I am interested in small reactors:

- Baseload <u>heat</u> and power
- Compliment to variable renewables
- Carbon free
- Safer, Reduced risk of environmental contamination
- Competitive Pricing?
- Better long-term certainty of energy costs
- Possible complement to existing AK resource mix





Final Thoughts: Guess the Technology

XXIV. 23.-24. sem stofnað var árið 1365, og er auðug-asta, og pafnkunnasta, klaustrið á Russslitnaði ný sata, og pafnkunnasta, klaustrið á Russ-ist svo, að eigi landi, hafa ýmsir dýrir helgidómar frá fárið var eign fyrri öldunn verið geyndir, sumir eðal-Voru þeir sð mun Kubs, Dar hafs Er mögulegt að hita Rvík upp með Laugunum? Með stakasta snarræði kippti Gilbert vini sinu pert voru nú fegnir því, að þe Ringtin, sen beir hugen bera birtu i hvelfinguna, o sån ber nå dir ng har ver birtu i hvelfinguna, o sån ber nå at har ver bla höfum séð nóg", hvíslaði Gilbert, og klifraði íður úr trénu. "Við skulum fara héðan".

Svaraði hann samstundis") með bréfi i er hér fer á eptir í íslenskri þjólngu: góla, hugmynd um, hversig pað er og Frá Bretla Dingkosni i Danm I Færeyjum, sem eru kjör kosningernar enn eigi um garð gen en fara fram um mánaðamótin næ

Tresham og Barstone horfðu forviða á eptir hem "Hún veit eitthvað", mælti Tresham, í ákveðnu "En hún vill ekki segja þeð Jæja, við láta En nú skulum við," mælti Barstone, låts

mjög, og litu upp, og såu þá hr. Harley ög einbeittan: standa fyrir framan sig.

Gilbert er låtinn fara

ns og geta må nærri urðu báðir ungu mennirnir ssa, er þeir sáu hr. Harley. ann hlaut að hafa lagt af stað frá Hamborg, áður

Sidum datt i hug, ad hann hefdi enn eigi n dauða sonar síns, en á svip hans mátti þ n myndi vita, hvað gjörzt hafði.

ojó i huga. "Jeg hefi frétt, hvað eg , að þér værað í Hamborg", var forviða á hinni óvæntn

"Jeg lagði af stsð fyrir brem dögum, og er eg haf

"Engineers of our era devise many peculiar inventions. Often, these are so astonishing that tales of them appear to be sheer fabrications. Yet, people have repeatedly found themselves in situations where what was once considered utterly impossible proved to be achievable, prompting a cautious approach to dismissing the feasibility of any idea, regardless of its initial implausibility."





Downtown Reykjavik 1932











Thank you!

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When it comes to microreactors, there is a large information gap across subgroups.



| | total heard a lot/some |
|----------------------|------------------------|
| Anchorage | 29 |
| Fairbanks | 32 |
| Kenai | 21 |
| Matsu | 23 |
| Southeast | 16 |
| Rural* | 23 |
| Age 18-49 | 27 |
| Age 50+ | 24 |
| Democrat | 28 |
| Independent | 28 |
| Republican | 24 |
| Live comfortably | 33 |
| Struggling to get by | 21 |

*Small sample size

*How much, if anything, have you heard about a new type of nuclear technology called advanced microreactors?







With little to go on, support for nuclear is tepid ... after more information is provided, support grows considerably



*Based on what you know right now, do you support or oppose the idea of using nuclear energy in Alaska?

**A nuclear microreactor is a small nuclear reactor that is much smaller than conventional nuclear technology. Microreactors are essentially a small nuclear-powered battery. They vary in size based on the manufacturer, but in general would be small enough to fit inside a shipping container and produce around 10 megawatts, which could power around 7,000 homes and also provide heat. Because of their small size, microreactors use much less nuclear fuel and cannot melt down. They also do not require water for cooling. After learning more, do you support or oppose the idea of Alaska exploring the use of microreactors to supply energy to Alaskans?





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Information changes perceptions

Change in support for using nuclear energy and microreactors in Alaska

| Support | Initial | Final | Δ |
|-------------|---------|-------|-----|
| Total | 48 | 74 | +26 |
| Anchorage | 50 | 76 | +26 |
| Fairbanks | 59 | 76 | +17 |
| Kenai | 54 | 75 | +21 |
| Matsu | 49 | 77 | +28 |
| Southeast | 36 | 62 | +26 |
| Rural* | 29 | 61 | +32 |
| Age 18-49 | 53 | 78 | +25 |
| Age 50+ | 42 | 68 | +26 |
| Democrat | 42 | 76 | +34 |
| Independent | 51 | 80 | +29 |
| Republican | 56 | 72 | +16 |

| Support | Initial | Final | Δ |
|------------------------------|---------|-------|-----|
| Total | 48 | 74 | +26 |
| White | 53 | 77 | +24 |
| POC | 39 | 68 | +29 |
| Live comfortably | 57 | 79 | +22 |
| Struggling to get by | 43 | 72 | +29 |
| Affordable energy bills | 52 | 74 | +22 |
| Unaffordable energy bills | 41 | 72 | +31 |
| Heard of microreactors | 71 | 80 | +9 |
| Haven't heard | 41 | 72 | +31 |





