Utah Winters…
Why Nuclear?

- **Massive Energy**
  - 10,000,000 times chemical
  - 1 Uranium Pellet (7 gm):
    - 3.5 barrels of oil
    - 17,000 scf natural gas
    - 1800 lbs coal
- **Reliable**
  - ~92% Capacity factor
- **Clean – No emissions!**
- **Isotopes and Element extraction**
  - Some isotopes only come from nuclear reactors!
Widespread Uses

• **Medicine**
  - 20M procedures a year in US
    - X-rays
    - Cancer Treatments
    - Diagnostics (PET, MRI, CTS)

• **Energy**
  - 20% of the US electricity
  - No emissions
  - Lowest Death Rate
  - Reliable – runs 343 days/year

• **Elements**
• **Research**
• **Manufacturing**

<table>
<thead>
<tr>
<th>Source</th>
<th>Deaths</th>
<th>US Electricity Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>161</td>
<td>39%</td>
</tr>
<tr>
<td>Oil</td>
<td>36</td>
<td>1%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>4</td>
<td>27%</td>
</tr>
<tr>
<td>Biofuel/Biomass</td>
<td>12</td>
<td>1.70%</td>
</tr>
<tr>
<td>Solar</td>
<td>0.83</td>
<td>0.40%</td>
</tr>
<tr>
<td>Wind</td>
<td>0.15</td>
<td>4.40%</td>
</tr>
<tr>
<td>Hydro</td>
<td>1.4</td>
<td>6%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.04</td>
<td>20%</td>
</tr>
</tbody>
</table>
Medical Isotopes

- 20M US procedures/yr
  - Come from fission
  - Not made in US
  - Congress mandated a domestic source by 2017
  - Current production of US supply ends 2025
Two Nuclear Pathways

• Light Water Reactor
  – Modified sub reactor
  – Requires lots of water
  – Pressurized
  – Weapons path - Pu

• Molten Salt Reactor
  – No solid fuel
  – No high pressure
  – Coolant is Fl-Li-Be
  – No Weapons
  – 5-10 years operation
Molten Salt Reactor

- Silicone chip vs. vacuum tube
- 800+ °C
- 44% efficiency
- Medical isotopes AND electricity concurrently
- Solves major nuclear problems
Safety
Waste
Challenges

- 50 years of catch-up
  - Handling
  - Processing
  - Operation
- Toxic, Rare Materials
  - Beryllium
  - Lithium
  - Fluorine gas (HF gas)
- Isotope production
  - 404 isotopes, 35 elements
- Licensing and Cost
Utah-Thorium; Perfect Fit

Lithium (Utah Salt Flats)

Beryllium – 85% Materion (Delta, UT)

Ideal Siting Conditions

Distribution (SLC Airport)
Benefits to Utah

• Become Center for MSR Technology
  – Chemical Separation
• Exciting new research (draw students)
  – Requires nuclear, chemical, mechanical, etc.
• Build STEM expertise
• New Medical and Rare Earth Elements Production Industry
  • High paying jobs
Process Heat

• 800 °C Process Heat
  – Coal Pyrolysis
  – Coal Gasification
  – Magnesium Production
  – Shale Oil
  – Electricity
  – Others

• Can produce combination of any of the above, facilitate load-following
Land Use Factors

- Utility Hookups
- Road/Rail Access
- Building Space
- Environmental Impacts
- NEPA assessments
- Reactor Site Criteria
- Security
- Zones
  - Exclusion, Low Population, Emergency Planning
Utah: Center for MSR

• Major research universities
  • BYU – Matthew Memmott
  • UofU – Mike Simpson
  • USU – Heng Ban

• Research
  • Salt handling
  • Chemical Separation
  • Isotope Separation
  • Materials

• Other Universities
  • Undergraduate Research
  • Internships
    • Policy
    • Licensing
  Industries (In/Out Utah)
Alpha Tech Research Corp

- Local Utah Company
- Commercialize MSR Technology:
  - Phase 1: Test Loop
    - At existing reactor
    - Isotope and element separation
  - Phase 2: Test Reactor
    - Utah Region
    - Isotope and element separation
  - Phase 3: Full Plant (TBD)
    - Electricity + Isotopes and elements
Idaho Research Interest

• University of Idaho – Rich Christensen
• Idaho State University – Dick Jacobsen, Larry Kerby, Jay Kunze
• Idaho National Laboratory – Piyush Sabharwall
• Submitted Joint MSR proposals with BYU to DOE NEUP
Conclusion

- MSR Technology is PROVEN
  – No waste, no weapons, no meltdown
- BUT, need to modernize, update, improve
- Utah can lead MSR tech development
- Alpha Tech Research Corp commercializing Utah University Research
- Utah/Idaho is ideal site