



NSF NRT-InFEWS: Indigenous Food, Energy, and  
Water Security and Sovereignty  
Presents:



# Food, Energy and Water (FEWS) Learning Modules

June 2021





# Energy Storage, Environmental Impact, and Review

Presented by William Borkan



# Energy Storage



## Why is Energy Storage Important?



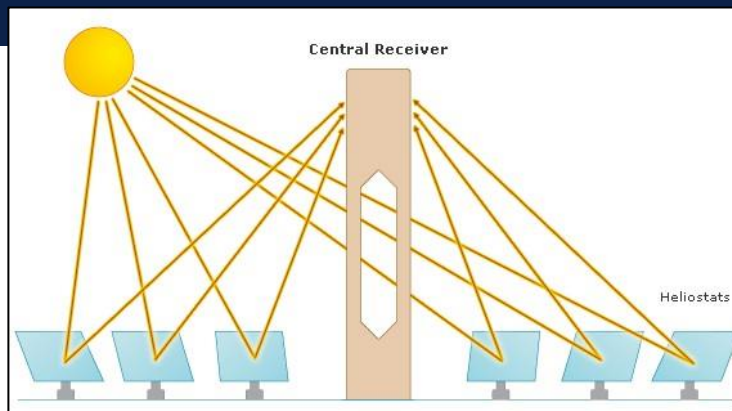
<https://departmentofgreenenergy.org/can-solar-energy-be-used-at-night/>

COLLEGE OF ENGINEERING

Electrical & Computer Engineering



# Storage – Molten Salts



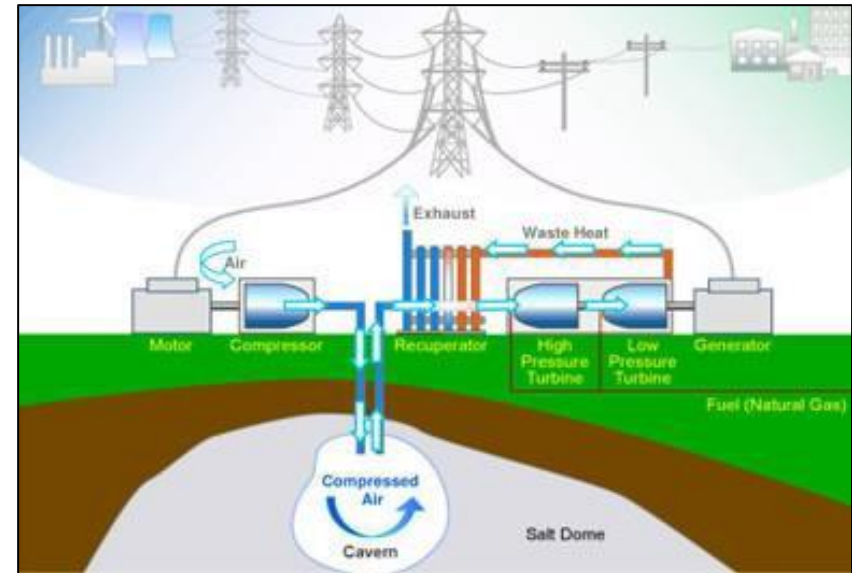
- \* Mirror array reflects light onto a central receiver containing the molten salt at the top of a tower.
- \* The ground-based mirrors, or heliostats, track the sun position.
- \* The temperatures reached in this system are around 560°C.
- \* Molten salts (60-40 sodium-potassium nitrates) are stored in insulated tanks and typically lose less than 1% of their heat overnight.
- \* The heated material powers a steam engine; can store heat for weeks/months.



# Storage – Compressed Air Energy Storage (CAES)



- \* CAES uses excess power generated by a large-scale PV system to compress air, which is then stored underground, for example in a disused mine or a salt cavern, or a natural geological feature.
- \* At night, when PV output is zero, the compressed air may be burned with natural gas, or may be expanded, to run a turbine and generate electricity.





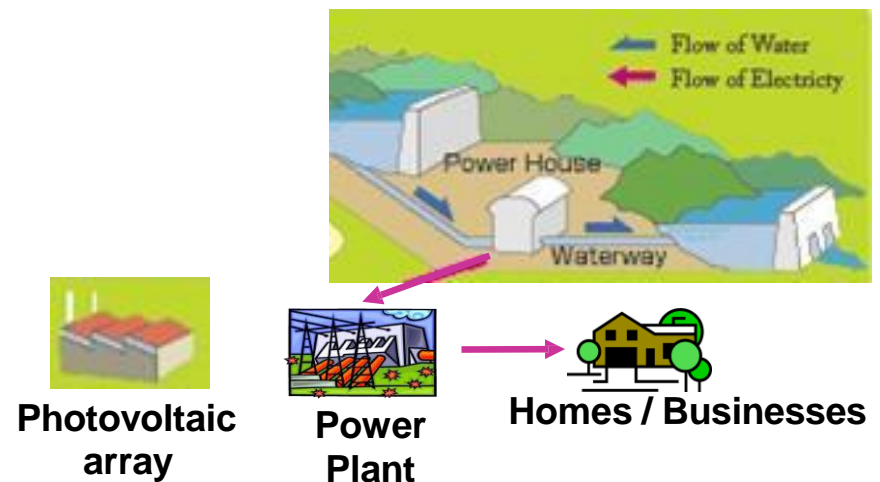
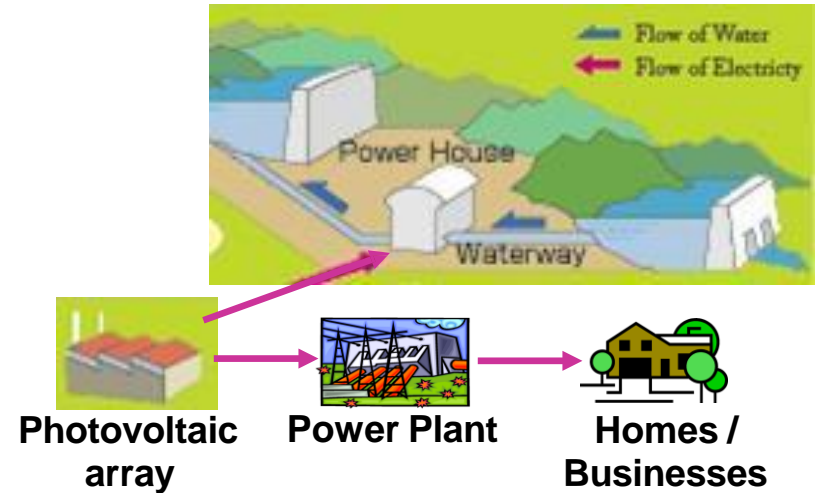
# Storage – Pumped Hydroelectric



- PV energy generation during daylight hours powers homes and businesses.
- Excess energy is stored by pumping water uphill to a pumped hydroelectric storage facility.

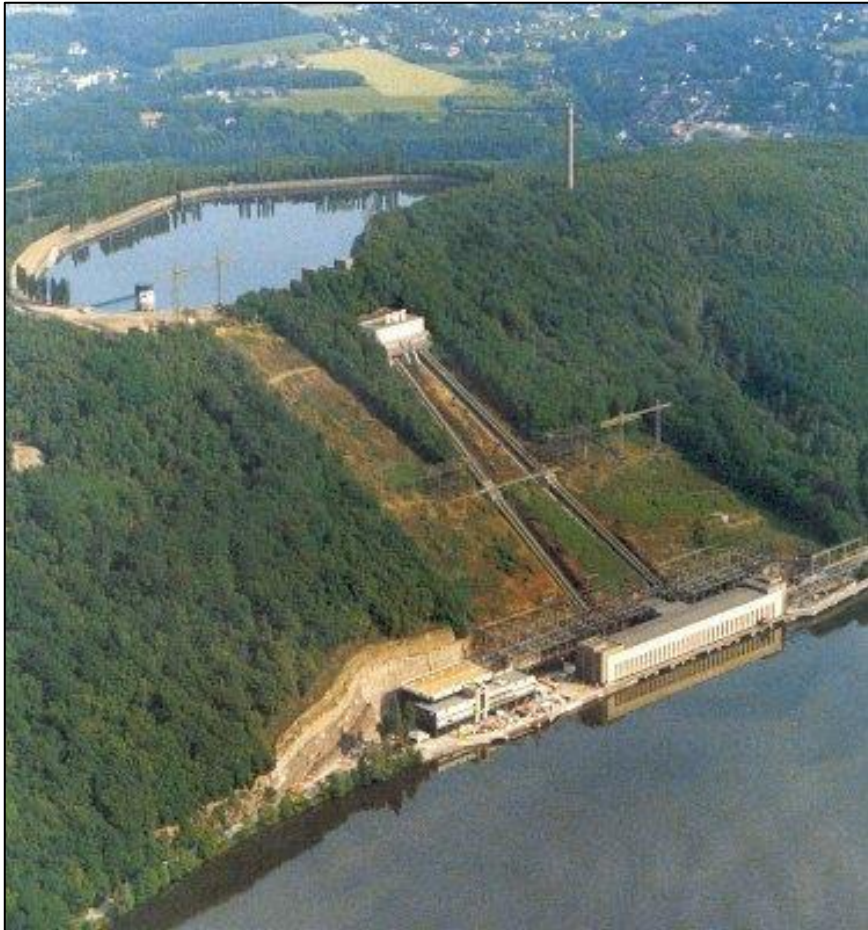


- PV energy generation ceases during nighttime hours.
- Stored energy is recovered as water flows downhill, driving turbines and generating electricity. Electricity is used to power homes and businesses.





# Storage – Pumped Hydroelectric



- European generation plant (left) - electricity is generated as water flows downhill and stored when it is pumped uphill.
- This arrangement loses somewhere between 15 and 30% of the power to friction, evaporation, and pumping losses.
- Lake Michigan Ludington Pumped Storage Facility - 1,000-acre site, generates up to 1,872 megawatts (enough electricity to serve a community of 1.4 million residential customers).

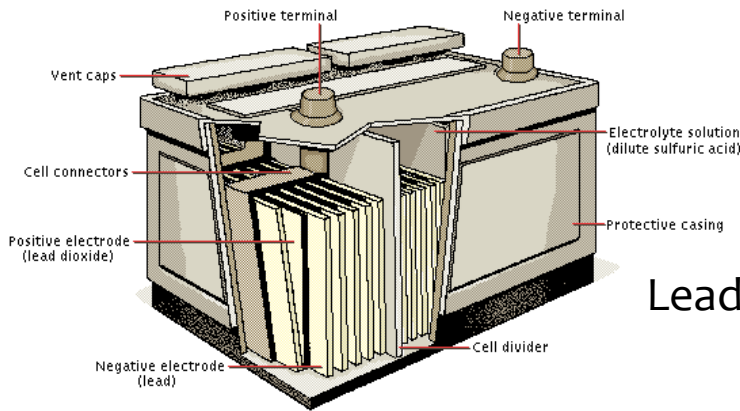
<http://home.earthlink.net/~msalsa1/images/pumped.jpg>



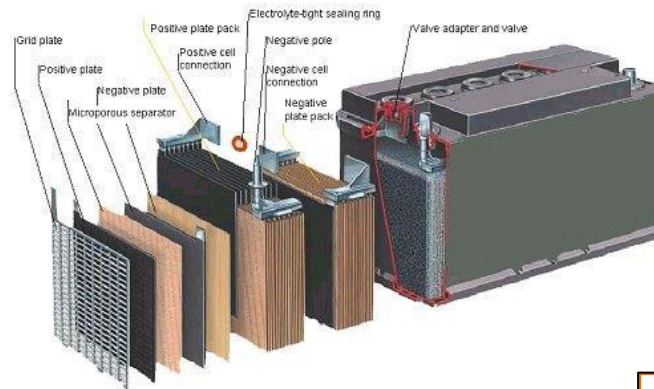
# Storage - Batteries



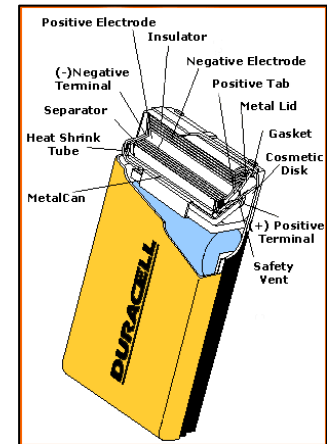
- \* Batteries are good for small scale energy storage (residential) or mid-scale (utility) energy storage.
- \* Requires environmental containment and proper venting.



Lead-acid battery



NiMH battery







# Environmental Impact



## Harnessing Solar Power Requires:

- Sustainable (yet expensive) Technologies
- Infrastructure to House Tech
- Land and Water Resources

## Storing Solar Power Requires:

- Chemicals and Processing
- Extraction and Application of Minerals

## How can we minimize the impact of Solar Power on the environment?

- Consultation
- Safe and Sustainable Construction
- Safe and Reliable Disposal



<https://time.com/5118049/donald-trump-tariff-solar-panels/>



<https://esemag.com/stormwater/lessons-learned-solar-project-present-unique-stormwater-management-challenges/>



# Environmental Impact



## Molten Salt Arrays

- \* Require vast amounts of \*undeveloped\* land
- \* Create shade on the ground
  - \* May attract animals
- \* Could affect land stability



<https://insideclimatenews.org/news/16012018/csp-concentrated-solar-molten-salt-storage-24-hour-renewable-energy-crescent-dunes-nevada/>

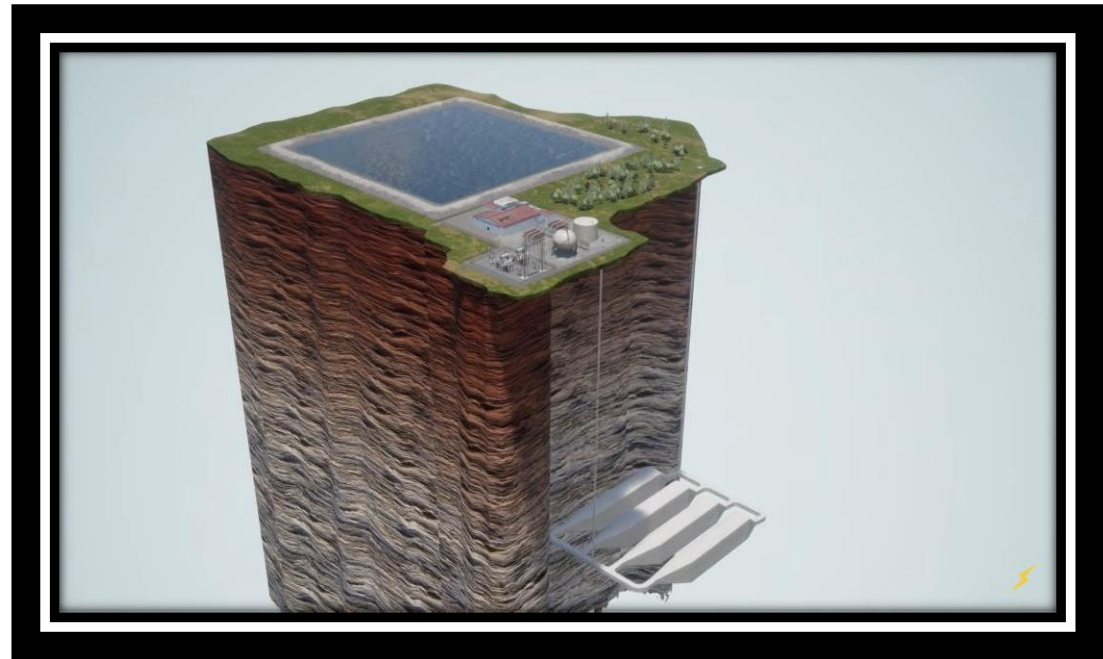


# Environmental Impact



## Compressed Air Energy Storage (CAES)

- \* Requires specific landscape features
  - \* Drilling to access them
- \* Requires water
  - \* To maintain constant pressure
- \* Mid to large-scale energy production



<https://www.popularmechanics.com/science/green-tech/a36300986/compressed-air-grid-energy-storage-system/>

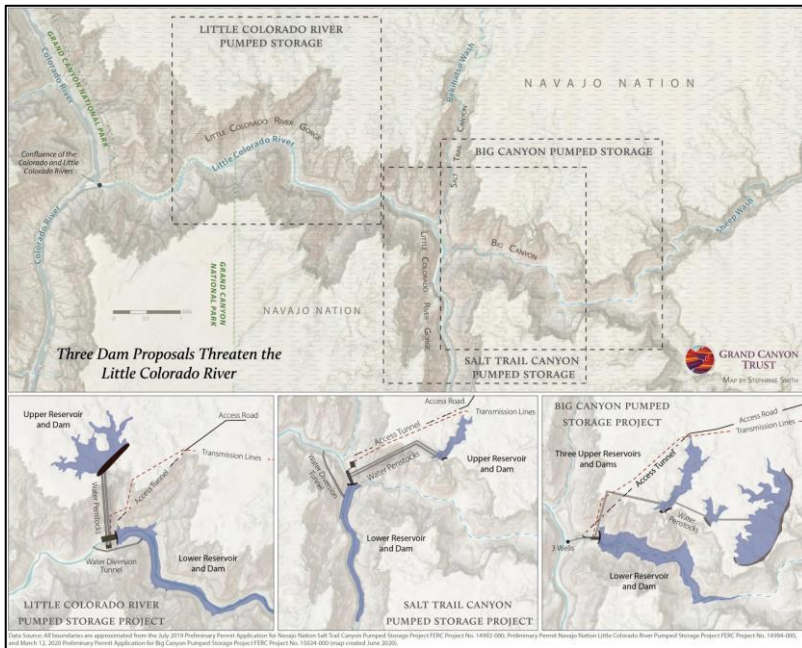


# Environmental Impact



## Pumped Hydroelectric

- \* Requires flowing water
- \* Allows for reservoirs to be created
- \* May degrade natural environments
- \* Provides cheap electricity
- \* These systems exist on the Navajo Nation



<https://www.grandcanyontrust.org/little-colorado-river-dam-proposals>



# Environmental Impact



## Batteries

- \* Effective for small (&portable) use
- \* Can be prone to leakage
- \* Need to be vented because they contain hazardous metals
- \* Commonly Lead, also Lithium
- \* Acquiring these metals is intensive
  - \* Requires mining and processing
  - \* Harsh chemicals are used for refinement



<https://extension.arizona.edu/pubs/solar-photovoltaic-pv-system-components>



# Review



## What is Solar Energy?

- Energy from sunlight
- Commonly harnessed through photovoltaic (PV) systems

## Solar Energy Systems

- Purpose Informs Design
- Scale and Size
- Type of Collection

## Connection to Food and Water Systems

- Water Purification
- Sustainable Food Production



<https://www.sltrib.com/news/environment/2021/04/19/navajo-nation-solar/>



# Considerations



## Storage Capacity Increases Potential Environmental Impacts

### Batteries

- Photovoltaic
- Small-Mid Scale

### Pumped Hydroelectric Energy Storage

- Photovoltaic
- Mid-Large Scale

### Compressed Air Energy Storage

- Photovoltaic
- Mid-Large Scale

### Molten Salt

- Thermal Energy
- Large Scale Storage



# Considerations



## Solar on the Navajo Nation

- Abundant Sunshine
- Large, Flat Landscapes

## Uses for Solar

- Greenhouses
- Nanofiltration Units
- Household Power Needs

## How does Solar Increase Food & Water Security, Sovereignty?

- Solar offers the Navajo Nation a passive electricity source
- Less need for Uranium and Fossil Fuels





# Solar on the Navajo Nation





# Agrivoltaics



<https://solarindustrymag.com/study-underscores-huge-potential-of-agrivoltaics>



<https://nsci.ca/2019/12/05/agrivoltaics-what-is-it-and-how-does-it-work/>

Shade provided by PV installations can support enhanced agricultural production:

- Food crops
- Livestock feed



# References

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- 3 Terry, Derrick, “Renewable Energy Program” PowerPoint. July 23, 2015
- 4 “Off-Grid Solar Is Filling The Void For The Power Deprived,” SEIA, 10-Feb-2016. [Online]. Available: <https://www.seia.org/blog/grid-solar-filling-void-power-deprived>.
- 5 Dieterich, Robert. (2018) *24-Hour Solar Energy: Molten Salt Makes It Possible, and Prices Are Falling Fast*. January 16, 2018. [Online]. Available: <https://insideclimatenews.org/news/16012018/csp-concentrated-solar-molten-salt-storage-24-hour-renewable-energy-crescent-dunes-nevada/>
- 6 Unbound Solar. (2020). *Lead-Acid vs Lithium Batteries: Which Are Best For Solar?* August 13, 2020. [Online]. Available: <https://unboundsolar.com/blog/lead-acid-vs-lithium-batteries>
- 7 Tingly, Lem. [2020]. *Water is Life: Bringing Farming Back to Navajo Nation*. November 25, 2020. [Online]. Available: <https://growingspaces.com/bringing-farming-back-to-navajo-nation/>



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