

On Grid Modernization, Microgrids and Alaska as a Living Laboratory

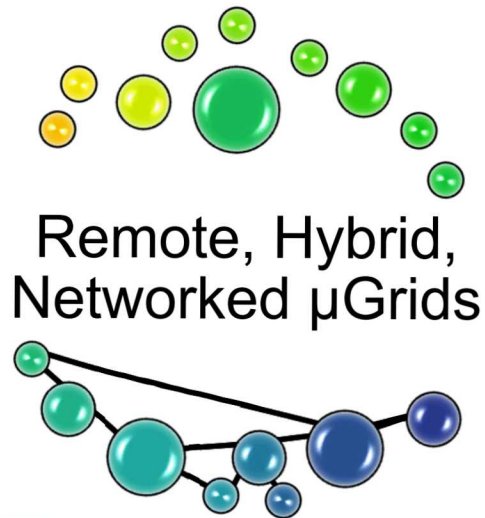
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Grid modernization is a national imperative

- Why focus on microgrids?
- Why focus on Alaska?



Validated
Technologies
at Scale

Grid of the
Future

- Safe
- Reliable
- Resilient
- Sustainable
- Affordable

Grid technologies getting a jumpstart in AK

1. Energy storage as a spinning reserve resource

» Maximize hydro generation, reduce fuel use (Cordova, AK)

2. Grid forming inverters and low inertia systems

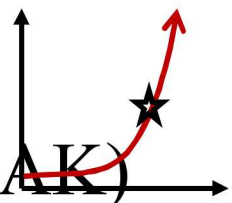
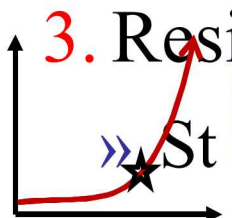
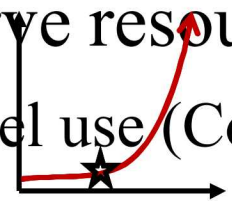
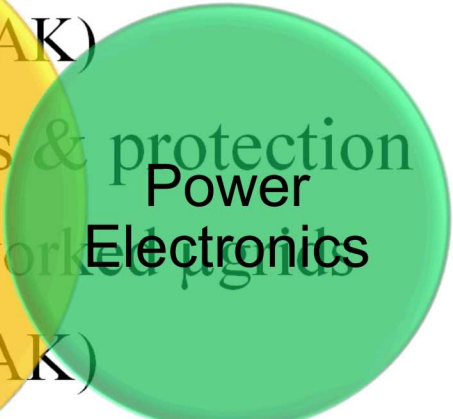
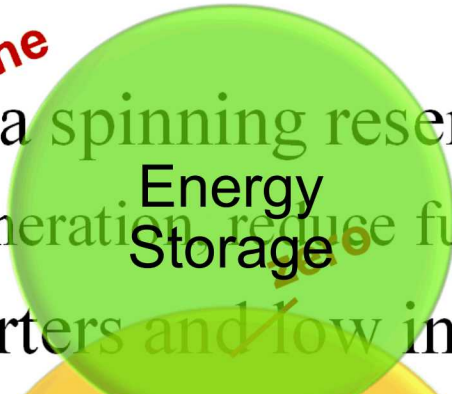
» Enable diesel-off mode (St Mary's, AK)

3. Resilient, reconfigurable systems & protection

» St Mary's Mountain Village networked grids
 » INL-led RADIANCE (Cordova, AK)

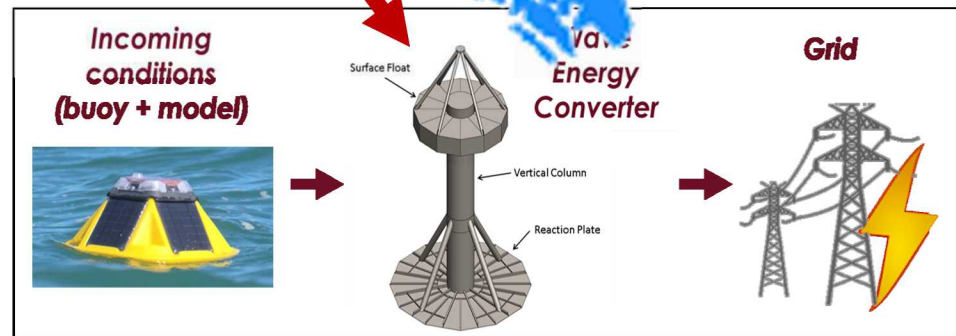
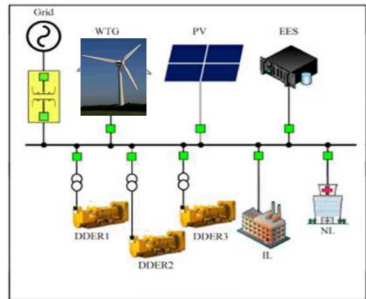
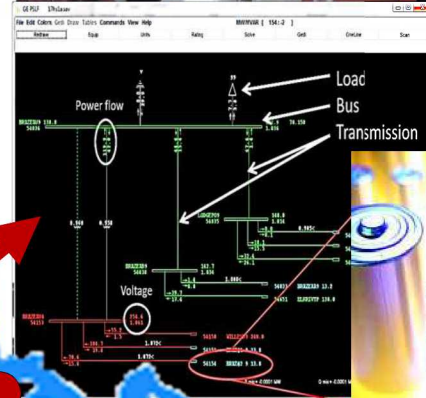
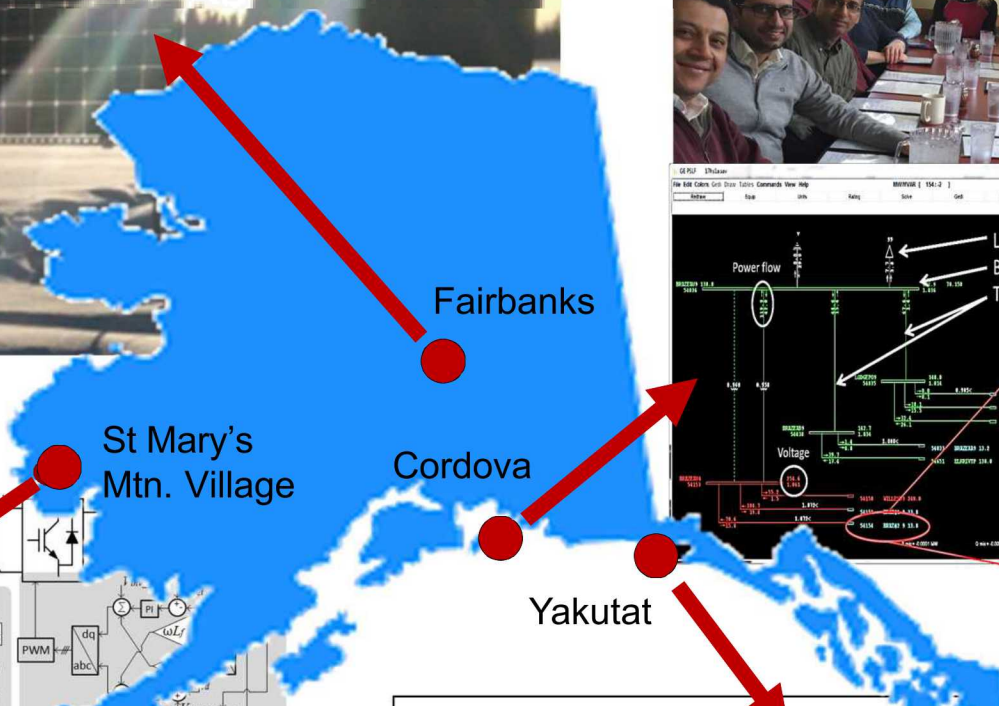
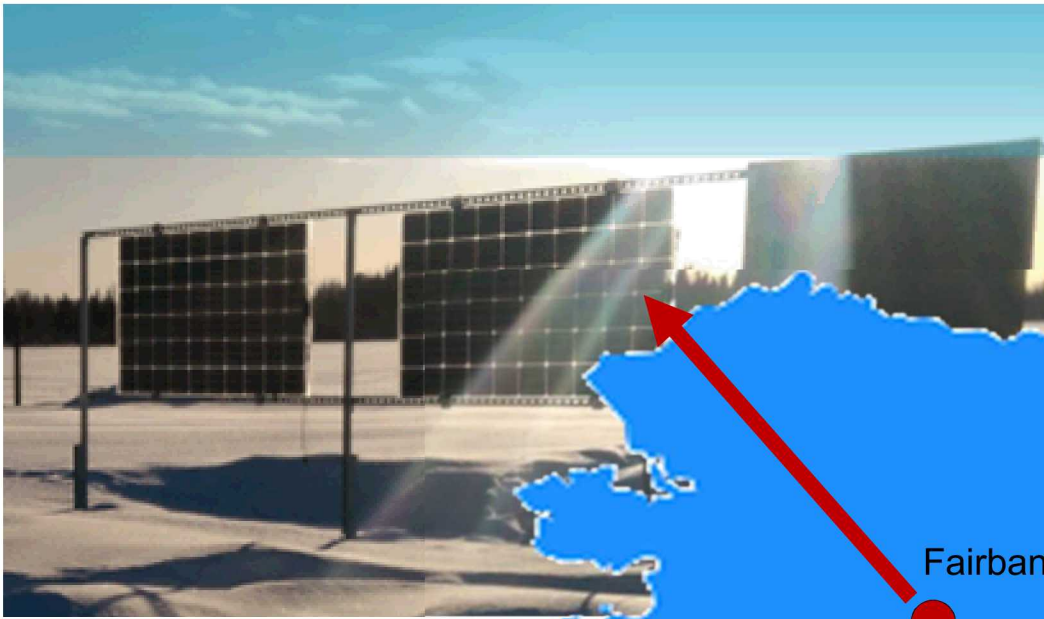
4. Renewable energy integration

» Bi-Facial PV (Fairbanks, AK)
 » MHK grid integration (Yakutat, AK)



- Communications
- Information
- Machine Learning



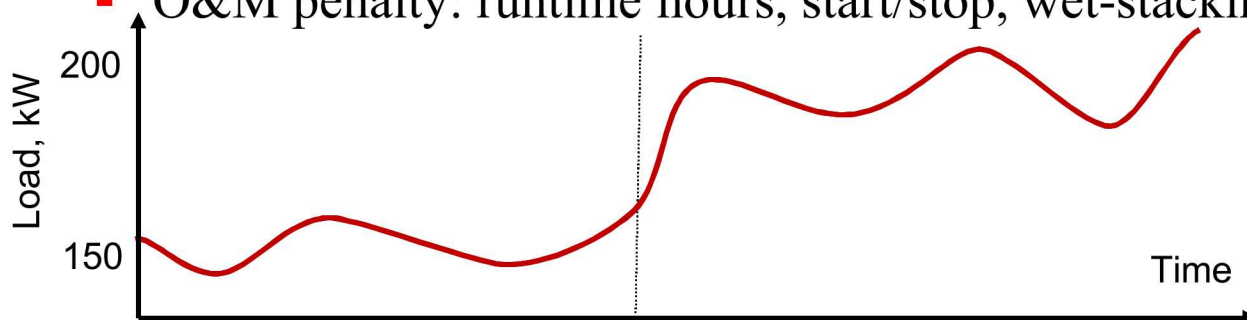


Storage Use Case #1 – Spinning Reserve

- Reducing diesel microgrid operating cost with storage spinning reserve

- Carrying reserves on diesel can be expensive
- Higher fuel use, emissions, O&M cost
- O&M penalty: runtime hours, start/stop, wet-stacking, ...

A better dispatch option for both operating periods




#1 200 kW



@ 150 kW avg. load
@ 50 kW reserve


#1 200 kW + #2 200 kW




@ <100 kW avg. load ???!
@ 50++ kW reserve



200 kW



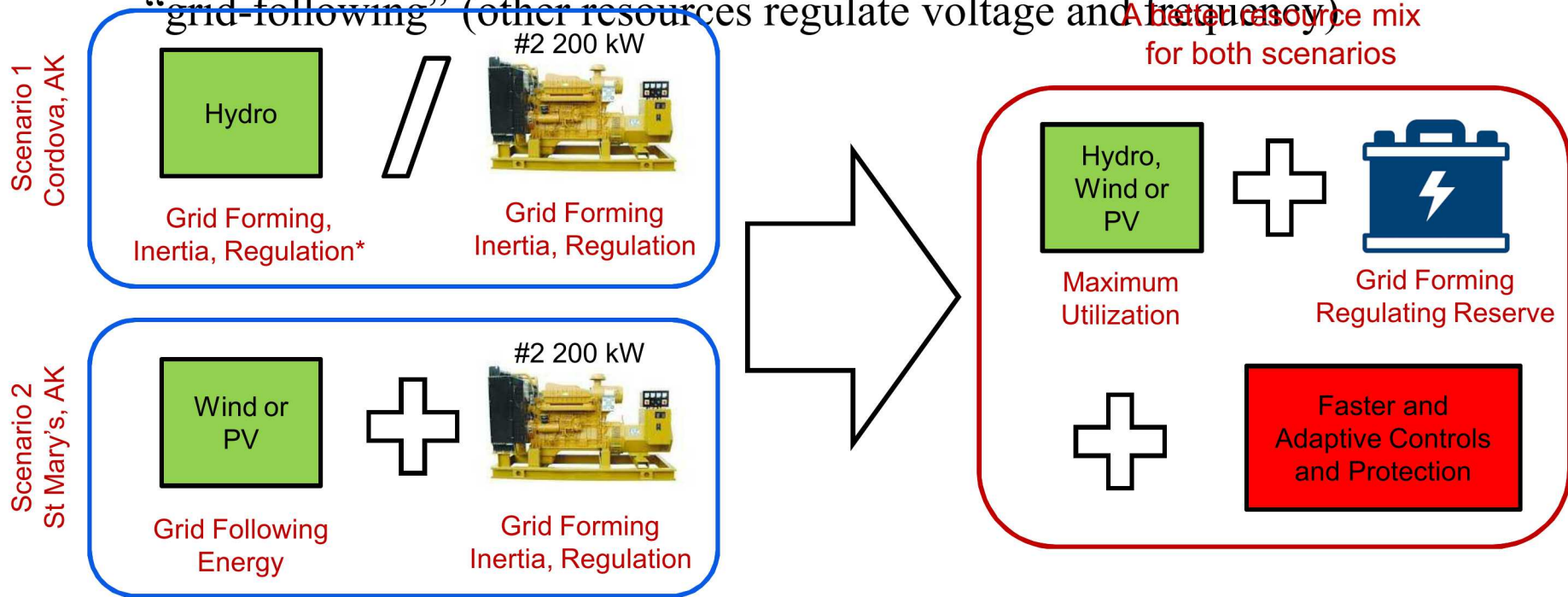
+



50 kW reserve

Storage Use Case #2 – Grid Bridging/Forming

- Enabling maximum RE utilization and diesel-off mode in AK
 - Hydro generators have inertia (helps with stability) and can regulate voltage as well as frequency if headroom capacity is reserved (spills low-cost hydro energy)
 - Inverter-based RE (e.g., wind, PV) do not have inertia and are typically “grid-following” (other resources regulate voltage and frequency)



Lessons Learned and Opportunities

- Alaska as a living laboratory
 - High energy cost, harsh climate & logistics → Innovation
 - Application to remote, island grids worldwide (e.g., PR!)
 - Incubator for Grid-of-the-Future technologies
- Technology is required, but not sufficient
 - Institutional & community factors
 - Regulatory, business case, standards
- It has to work for AK, too!
 - Partnering with AK



Questions? Comments?

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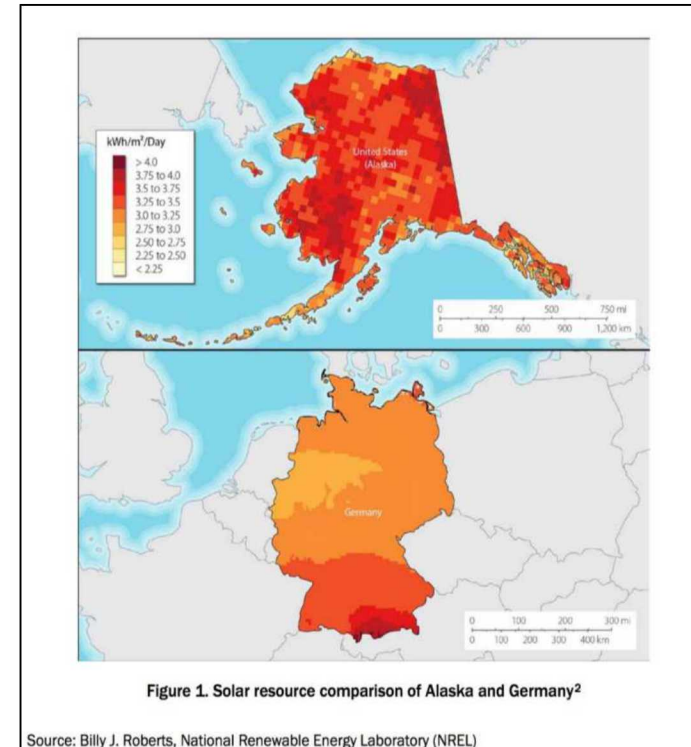
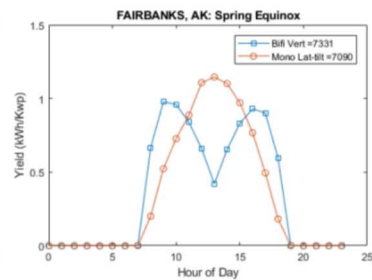
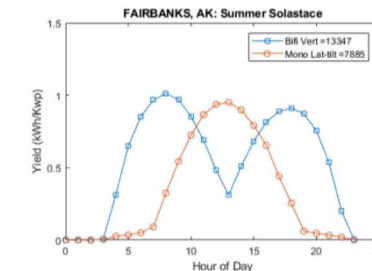
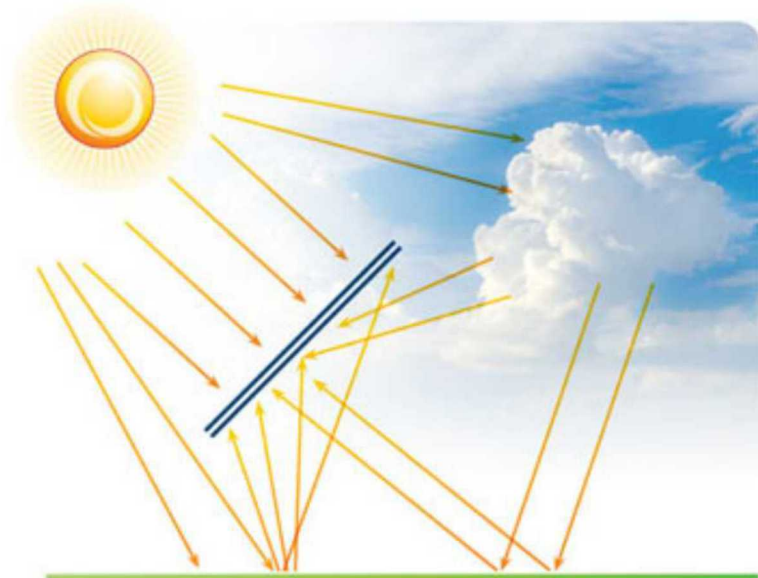
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Backup Slides

Why PV in Alaska?

- AK solar resource is ~30%-50% lower than the “lower 48”, but about equal to that of Germany...
- Bi-facial PV advantages in high latitudes
 - ~25% without snow, ~70% with snow
 - Higher energy yield in Summer months
 - Bi-modal output profile w/ vertical mounting



DOE National Laboratory Complex



The national lab complex represent the world's largest scientific research infrastructure. "Crown Jewels of Innovation"