# Railbelt Electricity Scenarios For 2050

Researchers at the Alaska Center for Energy and Power at UAF looked at five scenarios for Railbelt electric power supply and demand in 2050. The full report is available at https://www.uaf.edu/acep/.

## Baseline assumptions common to all scenarios

**Electricity generation in 2050** is 8,704 gigawatt-hours (GWh), about 85% higher than 2021. Peak demand equals 1,626 megawatts (MW), more than double the 2021 level. Higher loads come from population growth, electric vehicles, and heat pumps. **New baseline resources** include the Bernice-Beluga HVDC line, Kenai-Anchorage transmission upgrade to 230 kilovolts (kV), the Dixon Diversion hydro project, 30 MW of wind at Little Mount Susitna, and 228 MW of residential solar. Healy 2 is retired. Battery capacity grows to 217 MW. **Assumed 2050 Fuel costs** (2023$/mmbtu) equal: 4.19 (coal); 14 (gas); 20 (oil).

## Scenario descriptions

**Business as Usual (BAU)**. Existing power plants, plus several new fossil fuel units, provide all generation. Renewables generate 11% of required energy. 50 MW of new batteries help maintain reliability. Required investment, after 30% ITC, is $2.3 billion in 2023 dollars.

***Compared to BAU:***

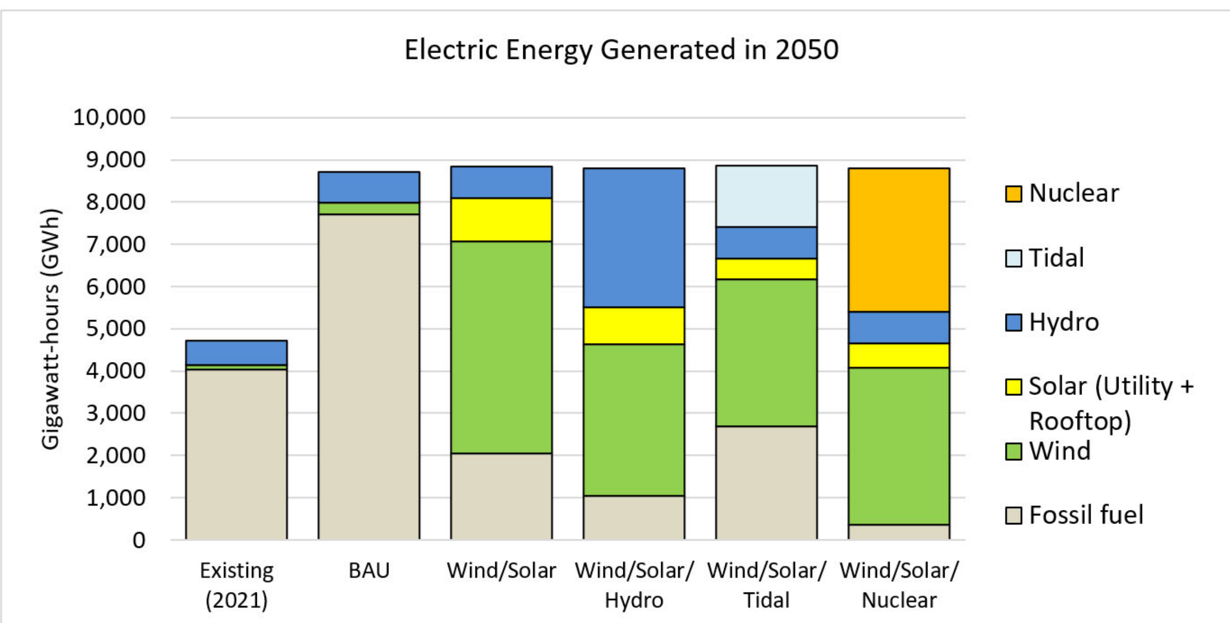
**Wind/Solar** adds 1,424 MW new wind and 547 MW new utility solar. The Alaska Intertie from Southcentral to Fairbanks is upgraded to 230 kV, which helps share energy. Renewables generate 77% of required energy.

**Wind/Solar/Hydro** adds Susitna-Watana hydro (475 MW), plus 1,022 MW wind and 472 MW utility solar. The AK Intertie is upgraded. Renewables generate 88% of required energy.

**Wind/Solar/Tidal** adds a 400 MW tidal plant in Cook Inlet plus 924 MW wind and 190 MW utility solar. The AK Intertie is upgraded. Renewables generate 70% percent of required energy.

**Wind/Solar/Nuclear** adds small modular nuclear reactors in the Northern (243 MW) and Southern (324 MW) regions, plus 1,056 MW of new wind and 328 MW of new utility solar. The AK Intertie is upgraded. Wind, solar, hydro, and nuclear generate 96% of required energy.

## Results at a glance

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| | Existing (2021) | 2050 BAU | 2050 Wind/Solar | 2050 Wind/Solar / Hydro | 2050 Wind/Solar / Tidal | 2050 Wind/Solar / Nuclear |
|---|---|---|---|---|---|---|
| **Electric energy demand GWh** | 4,725 | 8,704 | 8,704 | 8,704 | 8,704 | 8,704 |
| **Peak load MW** | 765 | 1,626 | 1,626 | 1,626 | 1,626 | 1,626 |
| **Installed capacity MW** | | | | | | |
| Fossil fuel | 1,692 | 2,086 | 1,394 | 1,332 | 1,736 | 1,332 |
| Wind | 45 | 75 | 1,498 | 1,096 | 998 | 1,130 |
| Solar (Utility + Rooftop) | 29 | 235 | 782 | 707 | 425 | 473 |
| Hydro | 179 | 179 | 184 | 659 | 184 | 184 |
| Tidal | 0 | 0 | 0 | 0 | 400 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 | 539 |
| Batteries | 87 | 267 | 1,733 | 1,460 | 967 | 1,658 |
| **Energy generated GWh** | | | | | | |
| Fossil fuel | 4,041 | 7,716 | 2,054 | 1,037 | 2,683 | 352 |
| Wind | 105 | 262 | 5,011 | 3,590 | 3,479 | 3,731 |
| Solar (Utility + Rooftop) | 2 | 12 | 1,037 | 879 | 511 | 568 |
| Hydro | 581 | 727 | 744 | 3,296 | 745 | 742 |
| Tidal | 0 | 0 | 0 | 0 | 1,440 | 0 |
| Nuclear | 0 | 0 | 0 | 0 | 0 | 3,410 |
| Batteries | (4) | (9) | (74) | (71) | (73) | (60) |
| Total energy generated | 4,725 | 8,708 | 8,773 | 8,731 | 8,785 | 8,744 |
| *% carbon-free* | *14%* | *11%* | *77%* | *88%* | *69%* | *96%* |
| **Cost** | | | | | | |
| Capital investment (post-ITC, Billion 2023$) | | 2.3 | 6.6 | 11.8 | 7.7 | 10.1 |
| Gen & Trans Avg Cost of Service 2023$/MWh: | | | | | | |
| Base case | | 119 | 124 | 134 | 128 | 128 |
| Sensitivity: Fuel cost +20% | | 137 | 131 | 136 | 135 | 129 |
| Sensitivity: Interest 6% vs 5% | | 121 | 128 | 143 | 134 | 135 |
| Sensitivity: 50% ITC (vs 30%) | | 118 | 108 | 113 | 114 | 108 |

## Takeaways

- These scenarios are illustrative. They demonstrate what is possible, not necessarily what is optimal.
- A renewables-based grid in 2050 is possible, but it will still require significant sources of firm dispatchable generation, such as fossil, hydro, or nuclear, in addition to large amounts of wind and solar.
- A renewables-based grid in 2050 would be operated very differently than it is today, with region-wide economic dispatch and extensive use of batteries and fossil fuel generators to follow load and to handle intermittent wind and solar output. Additional flexibility of natural gas supply would be needed that does not exist today.
- Interregional power flows would greatly increase as renewable generation is sited in the best places.
- Maintaining the stability and the reliability of the relatively weak Railbelt grid will be a challenge with fewer synchronous generators online to provide inertia and grid strength. That challenge can be met, but doing so will require significant resources and the use of new and emerging technologies such as grid-forming inverters. Alaska's experience operating rural microgrids should prove useful.
- The cost of electricity in the renewables-based scenarios is in the same ballpark as the cost of reliance on fossil fuels, but the cost structure would be quite different, shifting from fuel to capital and O&M.

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