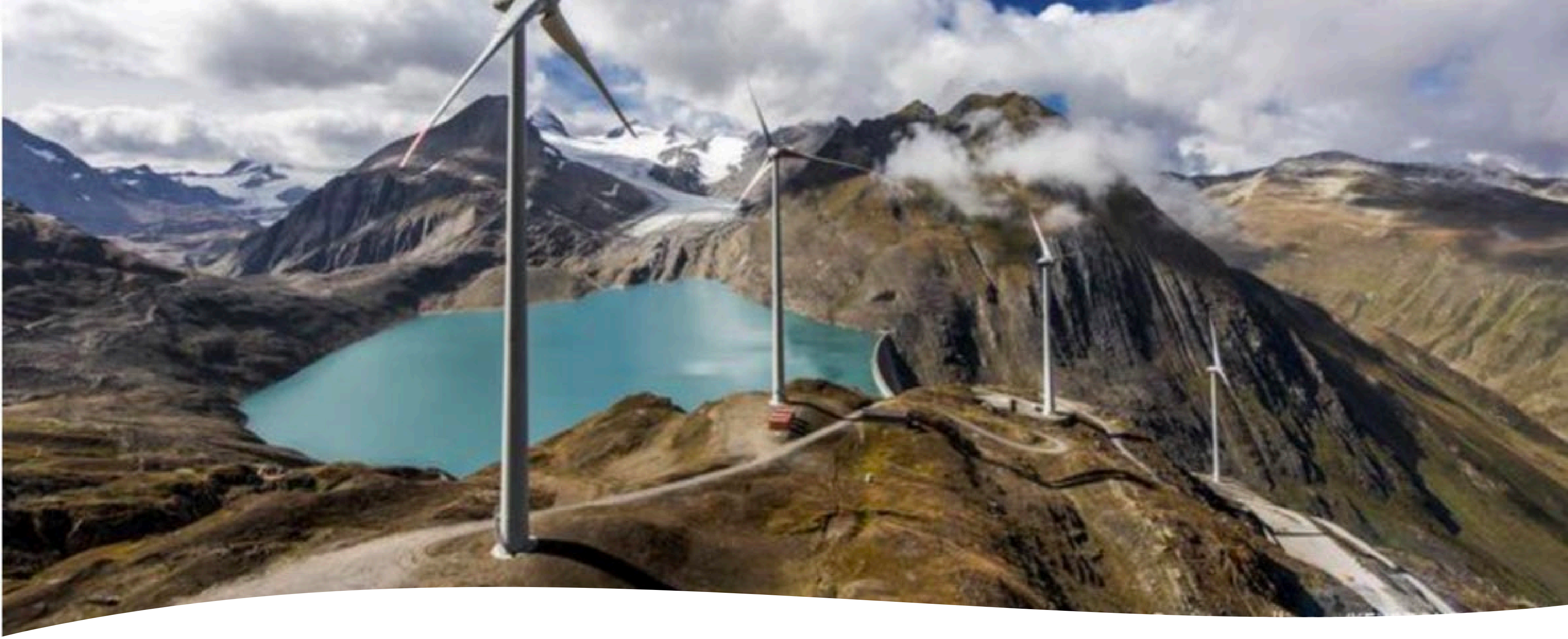


The Eklutna Battery & Beyond

Prepared for:

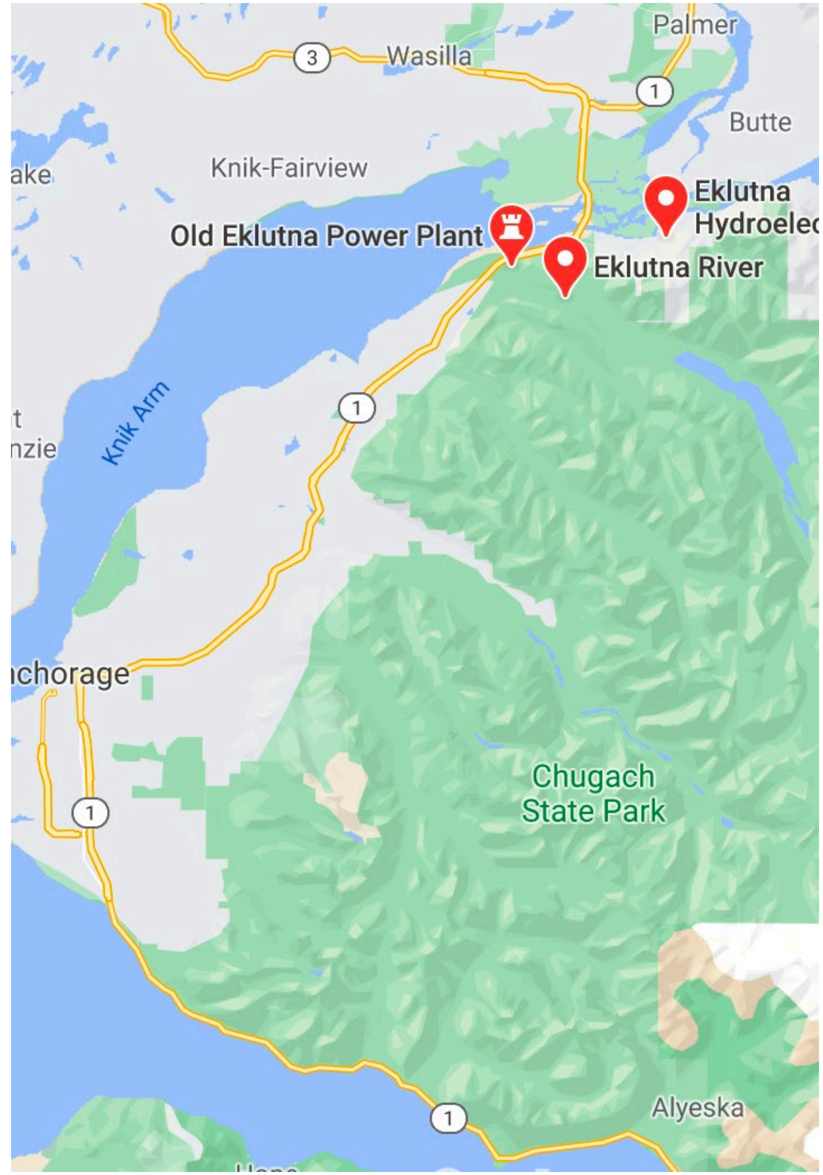
US Department of Energy
Webinar on Pumped Energy Storage in Alaska

Ceal Smith
w/Kerry Williams

November 12, 2020

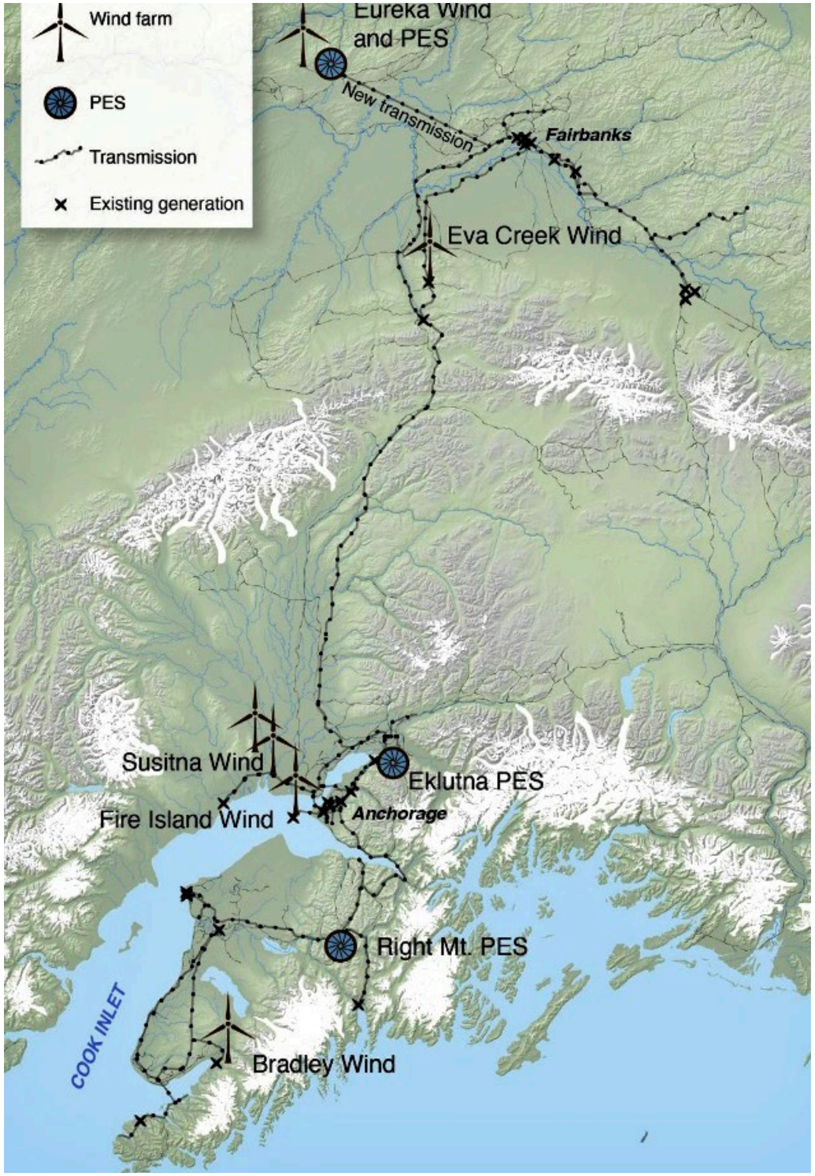
ALASKA
INSTITUTE
FOR CLIMATE
AND ENERGY

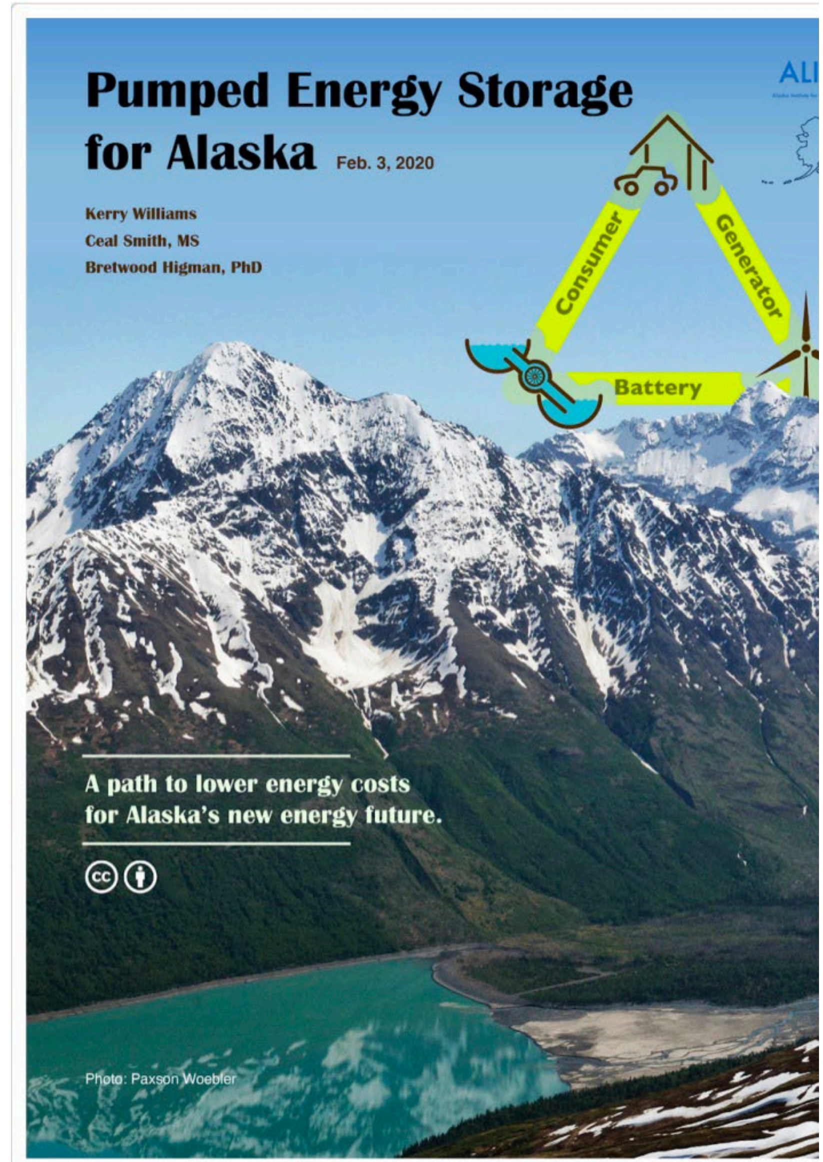

EKLUTNA POWER PLANT

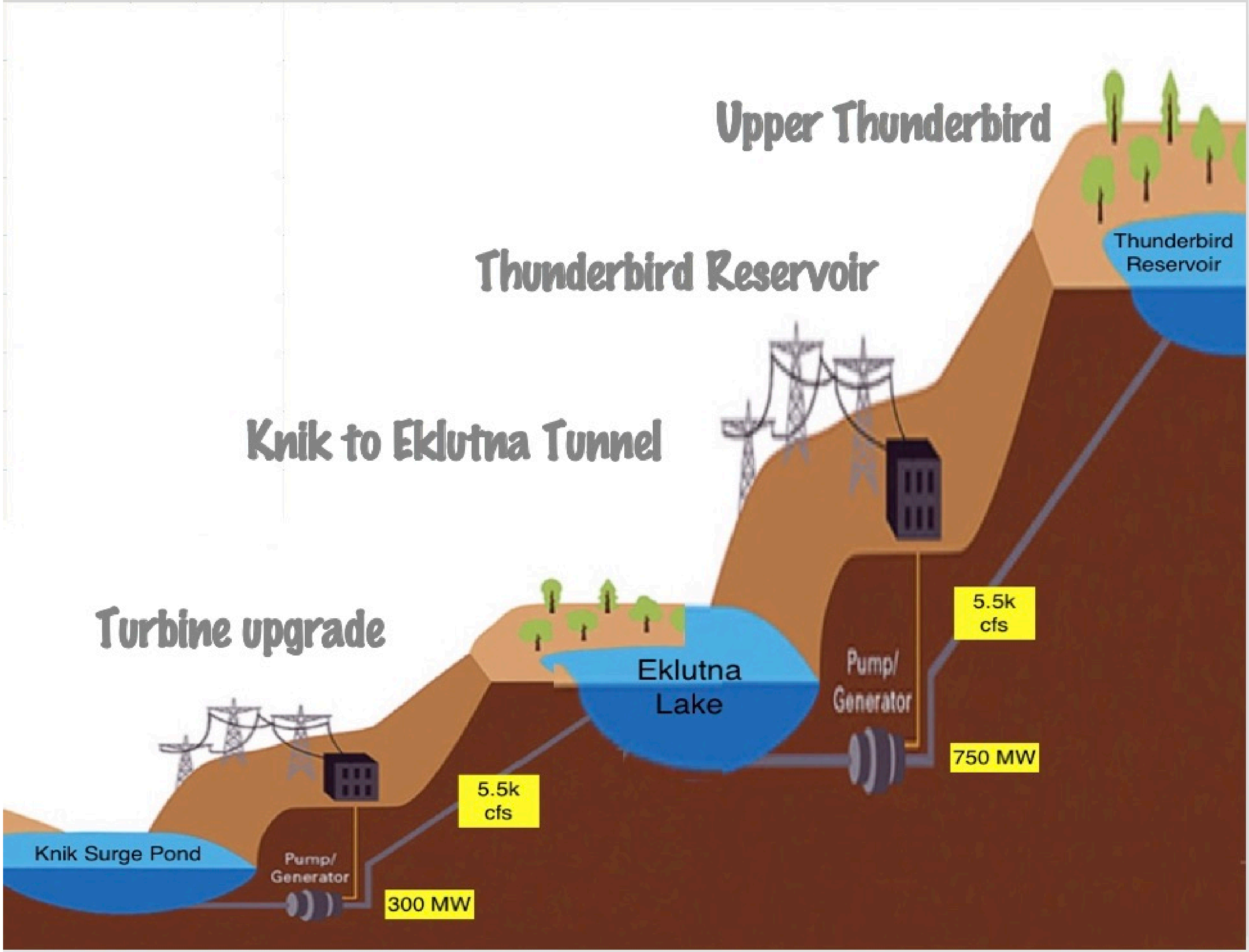

Palmer
3
Wasilla
1
Butte
Knik-Fairview
Eklutna
Old Eklutna Power Plant
Eklutna River
Knik Arm
1
Chugach
State Park
1
Alyeska
1

To meet renewable energy goals, Alaska and US need long-term storage plan

Author: Robert Seitz Updated: June 26, 2016 Published January 1, 2016


Wind farm
PES
Transmission
Existing generation
Eureka Wind
and PES
New transmission
Fairbanks
Eva Creek Wind
Susitna Wind
Eklutna PES
Fire Island Wind
Anchorage
Right Mt. PES
COOK INLET
Bradley Wind


Pumped Energy Storage
for Alaska
Feb. 3, 2020
Kerry Williams
Ceal Smith, MS
Bretwood Higman, PhD
Consumer
Generator
Battery
A path to lower energy costs
for Alaska's new energy future.
Photo: Paxson Woebler



Upper Thunderbird
Thunderbird Reservoir
Knik to Eklutna Tunnel
Turbine upgrade
Thunderbird Reservoir
Eklutna Lake
5.5k cfs
Pump/ Generator
750 MW
5.5k cfs
Knik Surge Pond
Pump/ Generator
300 MW

Eklutna Pumped Energy Storage Concept

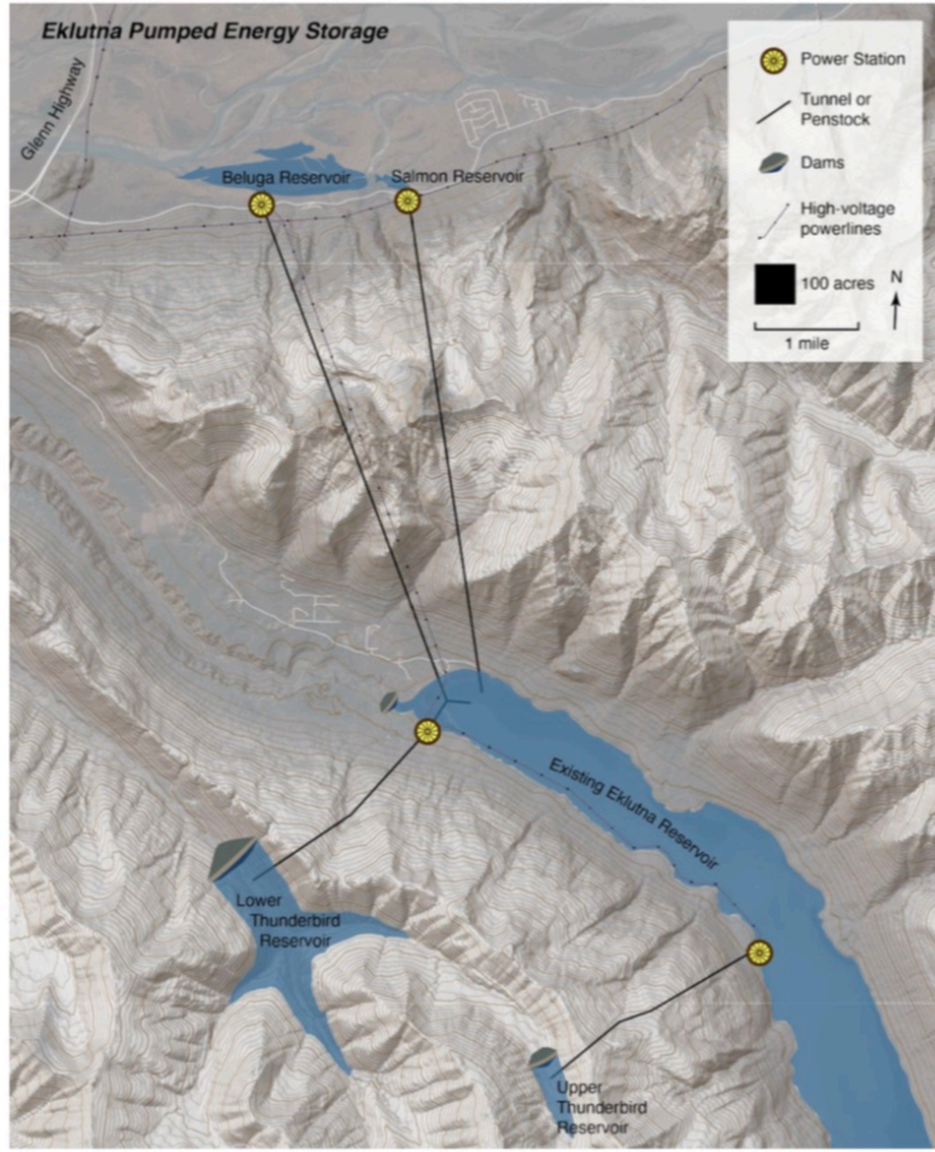


Figure 7. Eklutna Pumped Energy Storage. *This complex consists of five reservoirs, two in the Thunderbird watershed, two in the Knik River floodplain, plus Eklutna Lake.*

Pumped Energy Storage Facility	Capital Cost ($millions)	Generation Capacity (MW)	Energy Storage (GWh)
Eklutna	855	426	507
Eureka	407	210	53
Right Mt.	254	83	16
TOTAL	1,516	720	576

Table 3. Pumped Energy Storage Facilities. *Three separate PES facilities distributed across the Railbelt help ensure continued operation even if GVEA (Eureka PES Facility) or HEA (Right Mt. PES Facility) are islanded. The Right Mt. Facility doesn't need to have the high capacity and storage of other facilities because the existing Bradley Lake Hydropower Facility, and planned HEA Battery Energy Storage System help ensure reliability here even if HEA is islanded.*

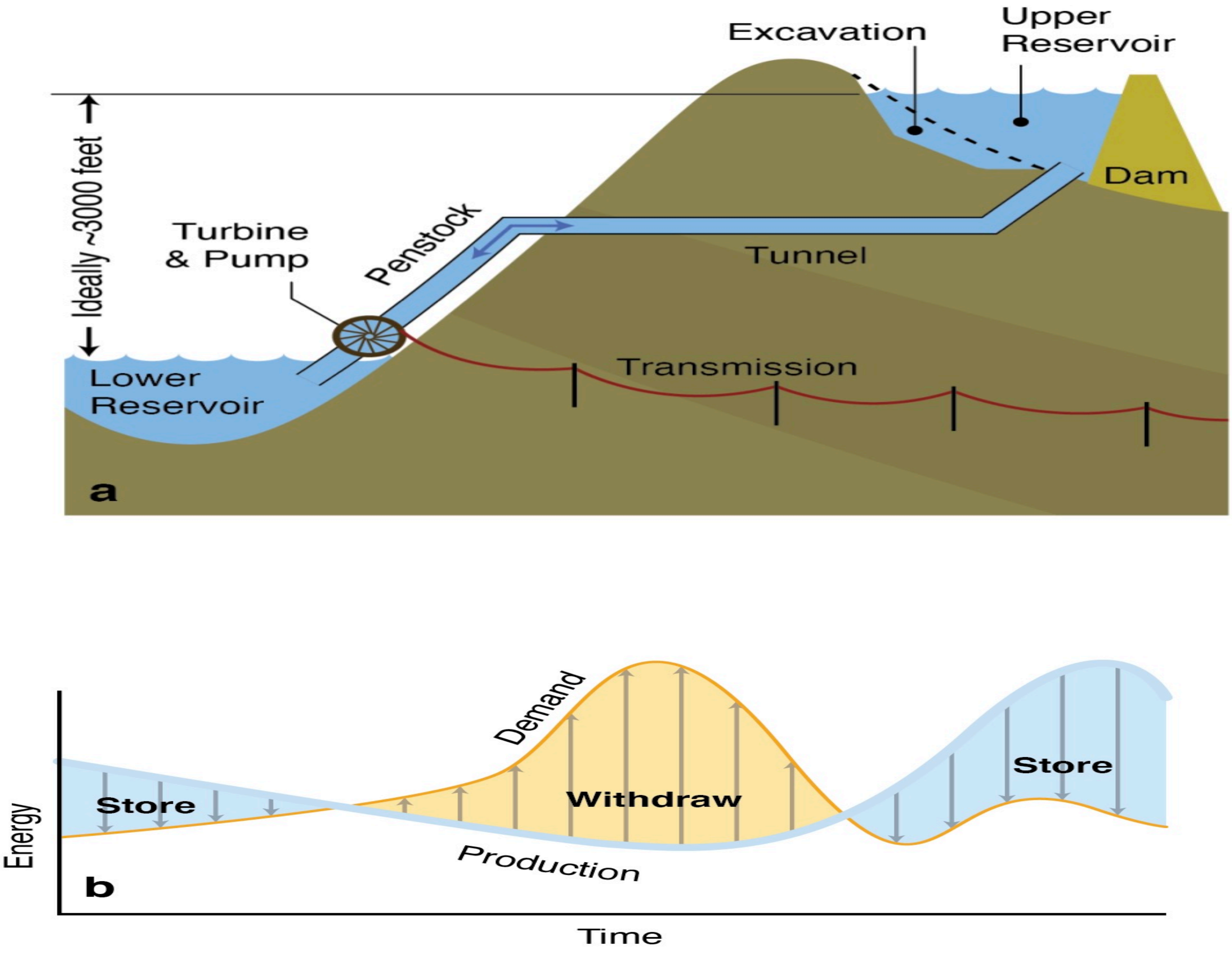
Wind Facility	Capital Cost ($millions)	Nameplate Capacity (MW)	Capacity Factor	Generation (TWh / year)
Tannana-Eureka	630	420	50%	1.8
Susitna River	387	258	50%	1.1
Right Mt.	207	138	60%	0.7
Mt. Susitna	219	146	50%	0.6
Eva Creek	268	179	50%	0.8
Fire Island	50	33	48%	0.1
TOTAL	**1,761**	**1,174**		**5.3**

Table 4. *Wind Facilities. Upgrading existing wind facilities at Fire Island and Eva Creek, plus building four new facilities would provide 5.3 TWh per year of generation for the operation of the Railbelt. This is more than needed to run the Railbelt entirely on renewable energy. Currently fossil fuels provide 4 TWh of electricity on the Railbelt Electric Grid. Capacity factors taken from the Global Wind Atlas.*

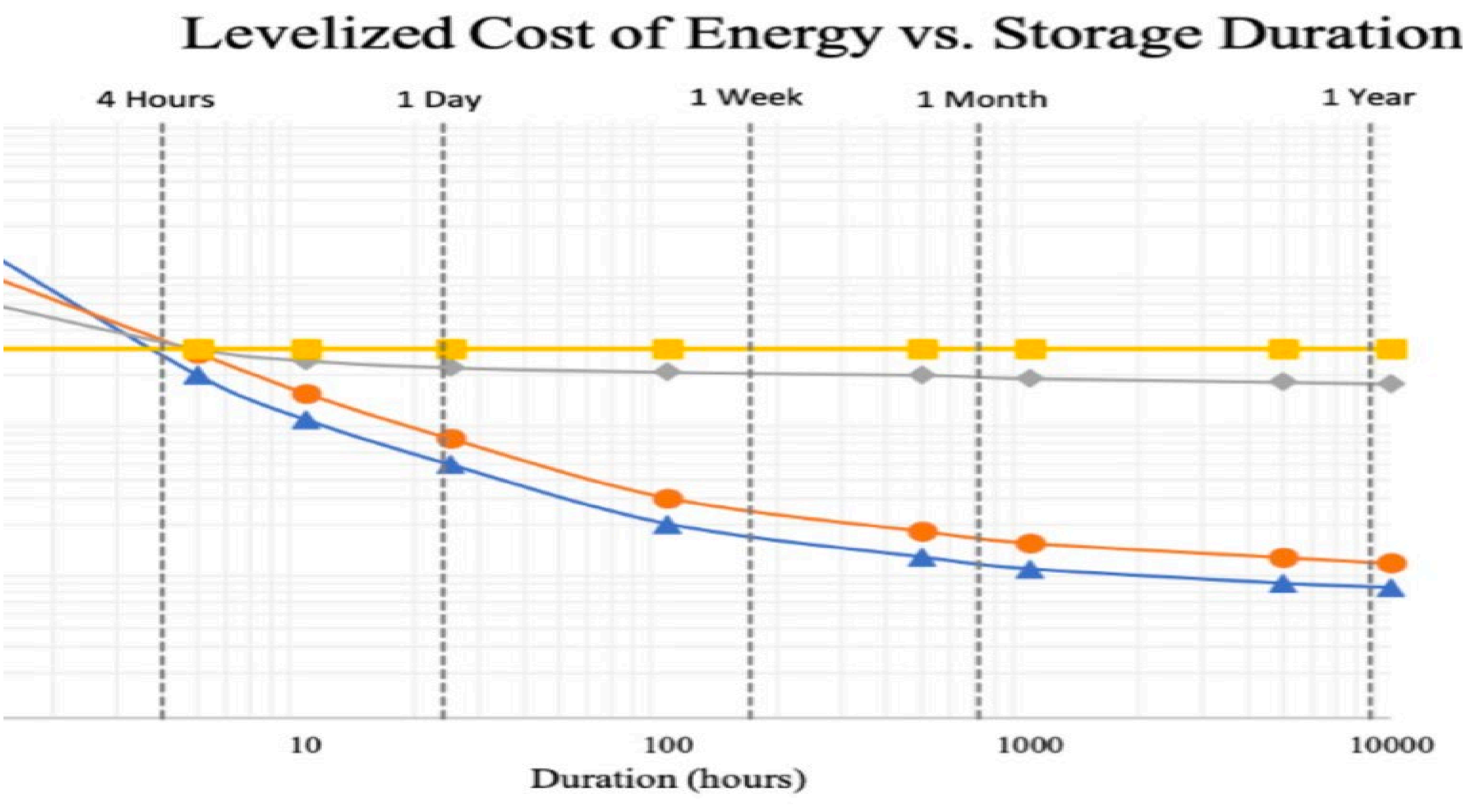
EKLUTNA PES COMPONENTS

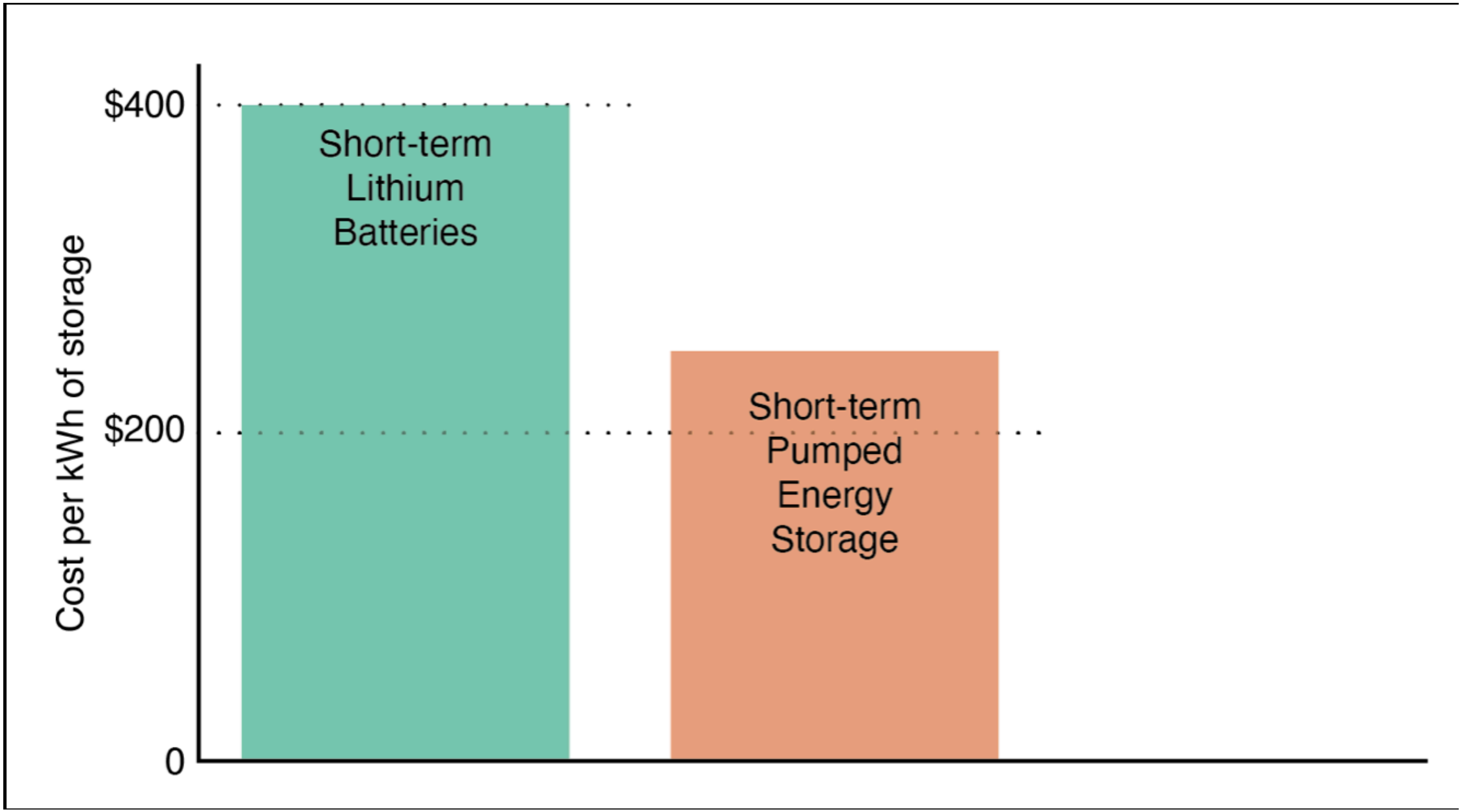
Eklutna PES Component	Capital Cost ($millions)	Generation Capacity (MW)	Energy Storage (GWh)
Convert Existing System to PES	29	39	118
Upper Thunderbird	211	143	147
Lower Thunderbird	333	159	242
Beluga Reservoir	282	85	N/A
TOTAL	855	426	507

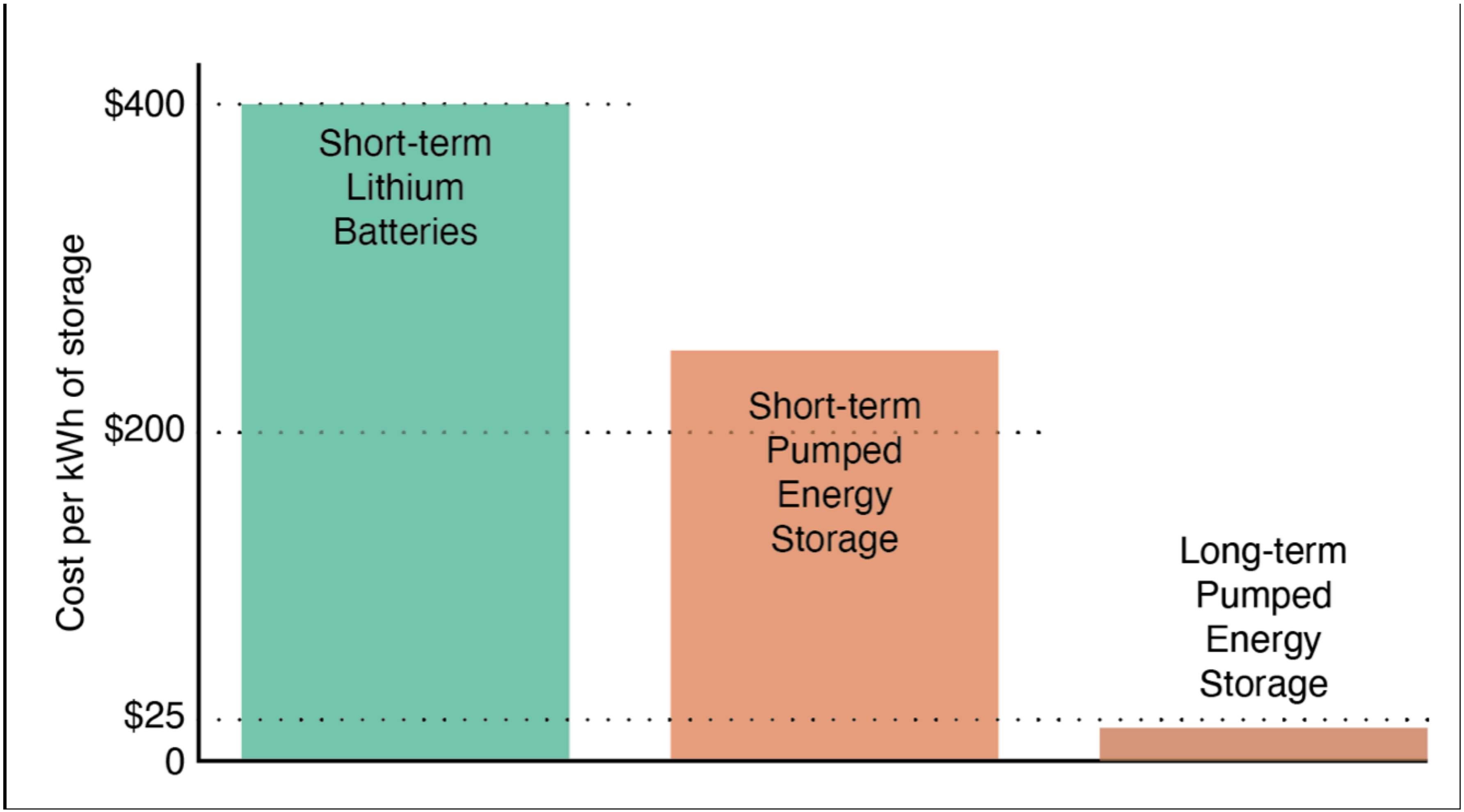
Table 2. Eklutna Pumped Energy Storage Components. *Fully upgrading Eklutna comprises the largest component of the proposed PES + wind system, and can be completed in four steps, each providing stand-alone benefits and functionality.*


Excavation
Upper Reservoir
Ideally ~3000 feet
Dam
Turbine & Pump
Penstock
Tunnel
Transmission
Lower Reservoir
a
Demand
Store
Withdraw
Store
Energy
Production
b
Time

KEY POINT: The **greater** the storage **duration**, the **lower** the per MWh **cost**.

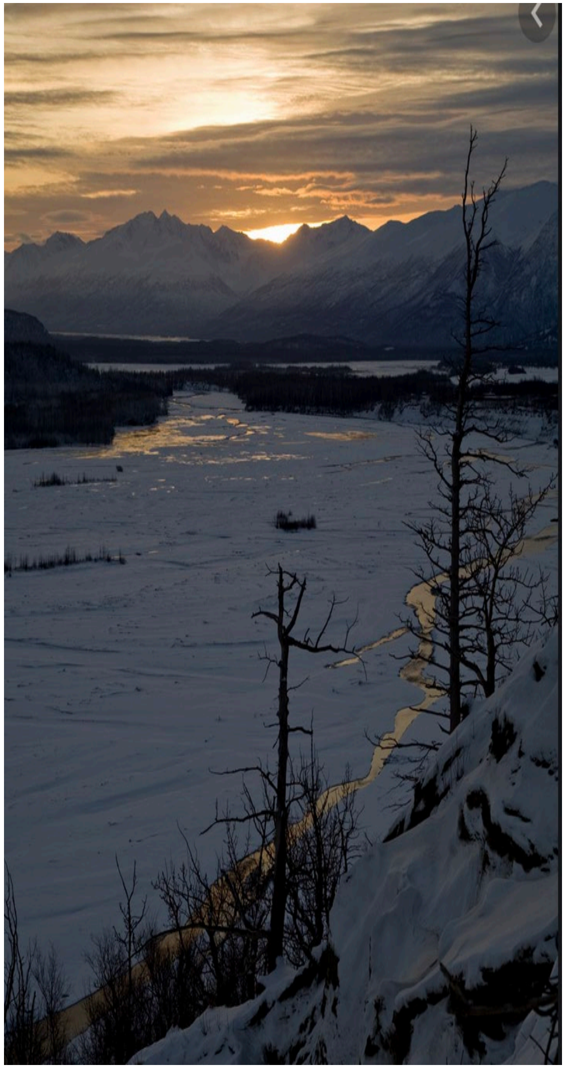



Cost per kWh of storage
$400
$200
0
Short-term Lithium Batteries
Short-term Pumped Energy Storage


Cost per kWh of storage
$400
$200
$25
0
Short-term Lithium Batteries
Short-term Pumped Energy Storage
Long-term Pumped Energy Storage

The Eklutna Battery would:

- store **507 GWh/30 days** average Railbelt demand (< 1 day max elsewhere),
- allow **rapid start-up** as either a *generator* or a *pump*
- balance **wind** output **variability,**
- offset **solar seasonality**



POTENTIAL $AVINGS

Project	Annual CO_2 Emissions (millions of metric tons)	Proportion Renewables	Capital Cost ($billions)	Fuel Price Escalation	Annual Fuel Cost in 2050 ($millions)	Payoff Time (years)
Current Railbelt Generation	2.5	15%	Already Built	2.75%	541	N/A
				4.5%	1,005	N/A
Susitna-Watana Hydropower	1.1	75%	6	2.75%	166	20
				4.5%	301	15
Pumped Energy Storage + Wind	0	100%	4.7	2.75%	0	13
				4.5%	0	10

Table 1. Comparison of Susitna-Watana Hydro with Status Quo. *All scenarios are based on a flat power use equivalent to 2018 levels, with costs increasing at the rate specified. Watana is assumed to cut fuel costs by 70%, as expected generation of 2.8TWh/yr is equivalent to 70% of current fossil fuel power. Emissions for the Watana scenario are calculated by leaving coal emissions and coal power equivalent to 2018, and assuming the remaining power is produced by a gas plant with an emissions intensity of the average 2018 gas plant on the Railbelt. Upstream emissions are not included for any scenario, but will be particularly high for natural gas. To allow comparison with PES and wind, payoff time is based on the same simple calculation of capital vs. fuel costs. More complex modeling by AEA has found greater savings for Watana, based on operations and maintenance savings and plant retirements. We expect that similar increases in savings will apply to both projects, improving the outlook for Watana and PES plus wind vs the status quo.*

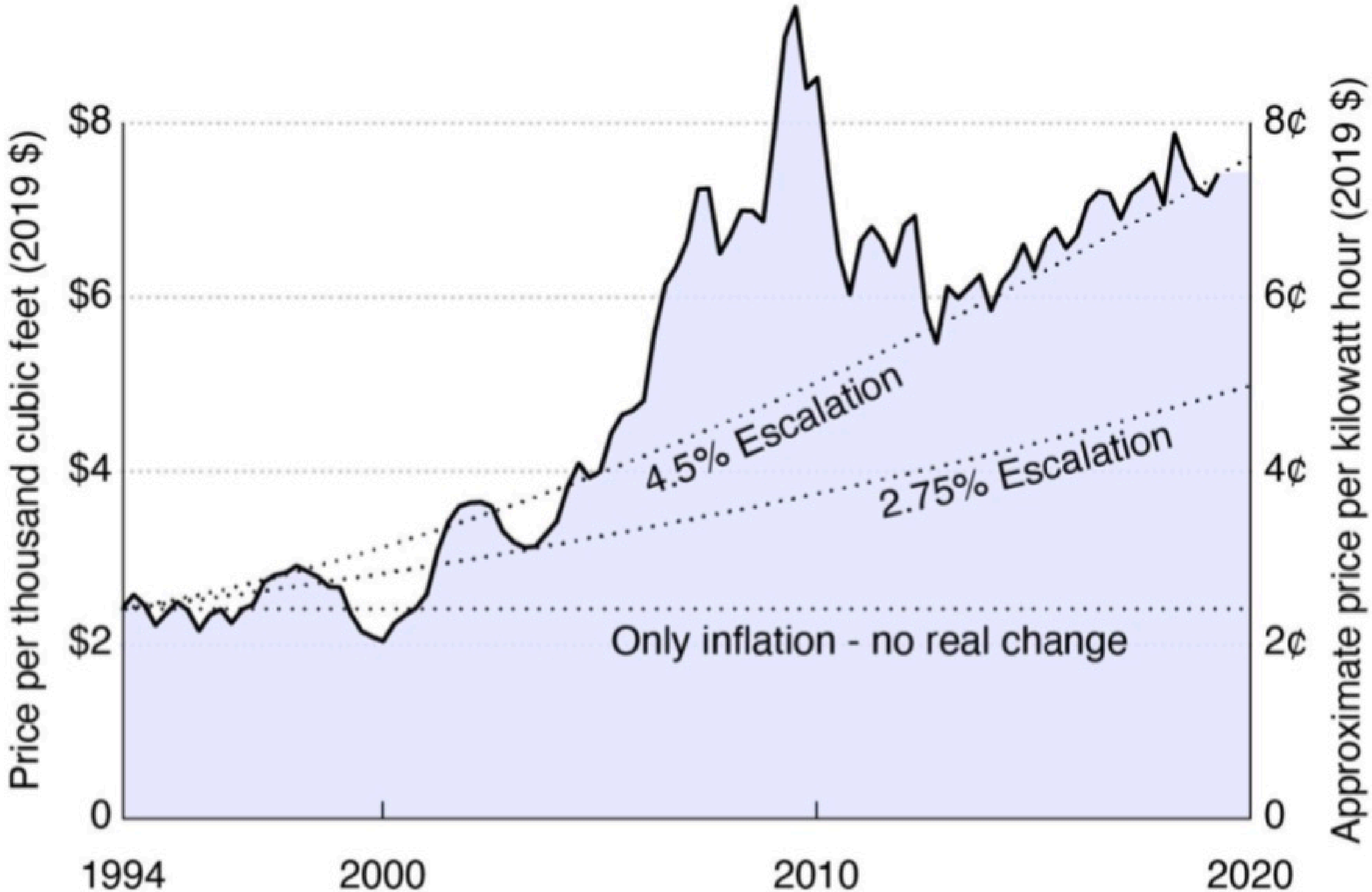
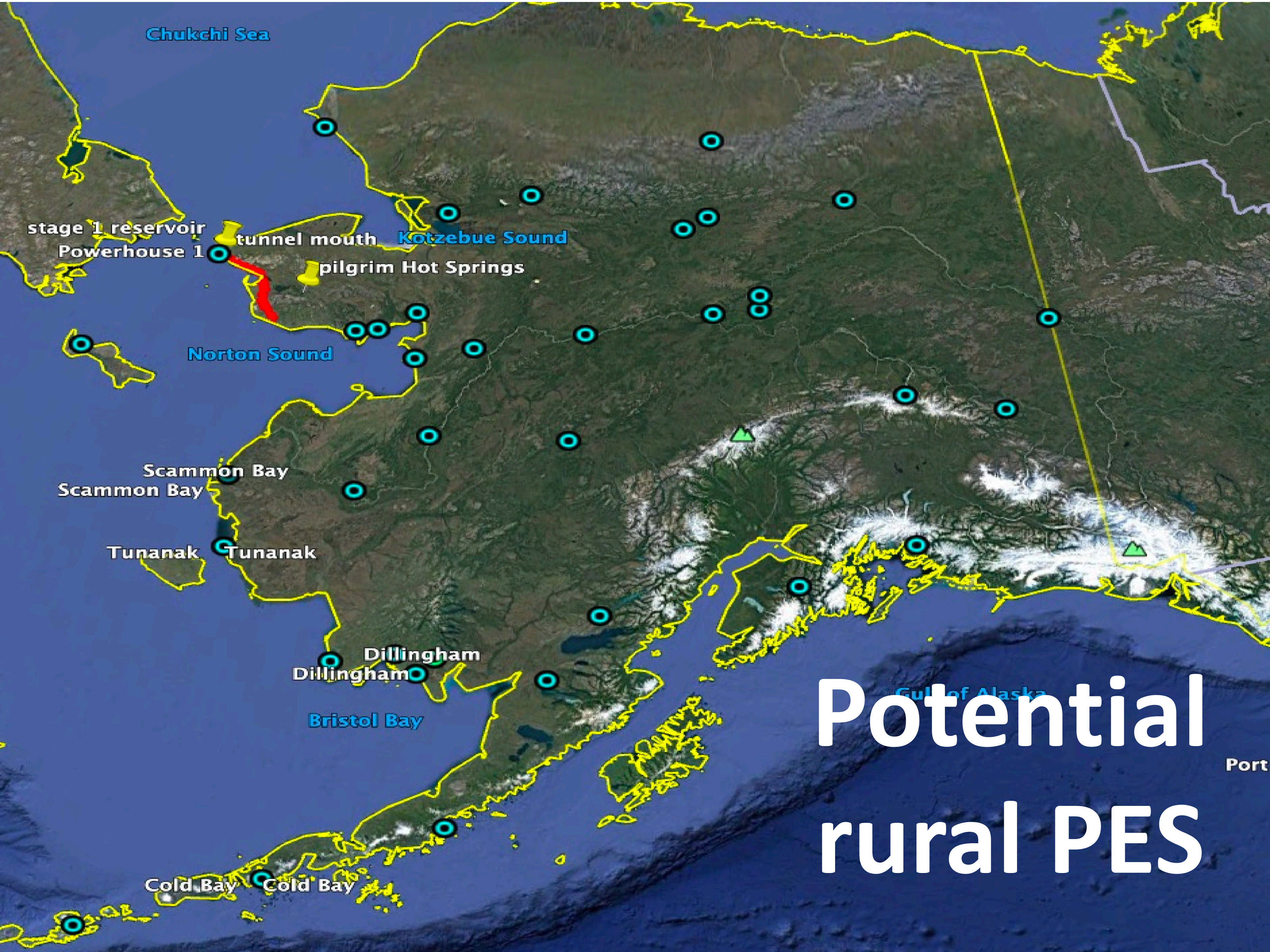


Fig 2. Natural Gas Prices. *Prevailing value (Mcf and kWh) of Cook Inlet Natural Gas, adjusted to 2019 dollars, from Alaska Dept. of Revenue quarterly reports: http://www.tax.alaska.gov/programs/oil/prevailing/cook.aspx. This prevailing price is the weighted average price of significant sales of gas to publicly regulated utilities in Cook Inlet. Values do not include the costs of state tax credits paid to oil and gas companies. 2.75% and 4.5% escalation curves are provided for reference, given those values are used elsewhere in our analysis.*


Potential rural PES
Chukchi Sea
stage 1 reservoir
tunnel mouth
Powerhouse 1
Kotzebue Sound
pilgrim Hot Springs
Norton Sound
Scammon Bay
Scammon Bay
Tunanak
Tunanak
Dillingham
Dillingham
Bristol Bay
Gulf of Alaska
Port
Cold Bay
Cold Bay

Ground Truth Alaska

Kachemak Geospatial

Our Partners

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Thank you!