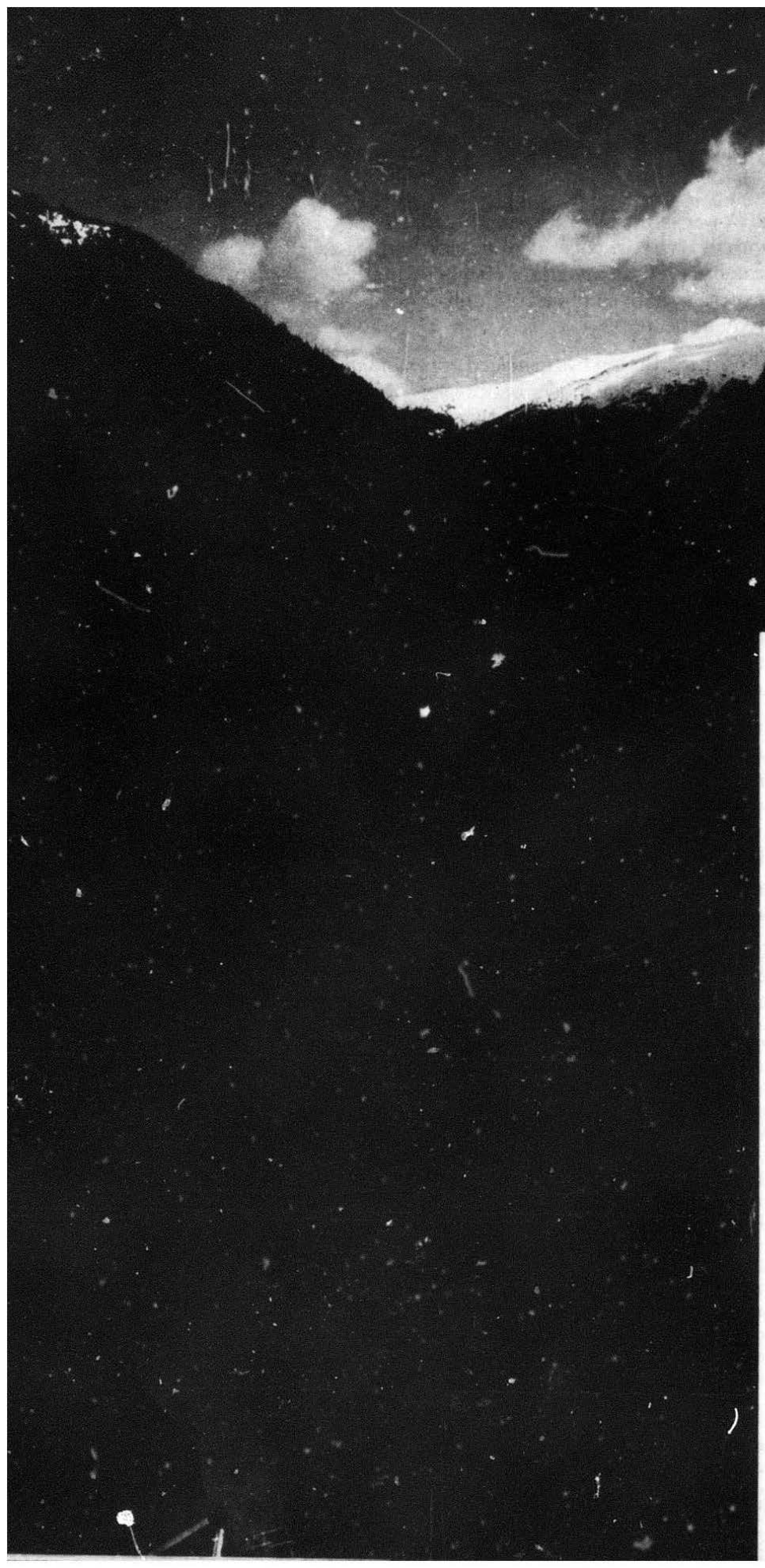


Electrifying Alaska

by VIC REINEMER
editor, PUBLIC POWER

ELECTRIFICATION IN ALASKA fits no mold familiar in the lower 48 states. Tiny private utilities serve remote areas. A municipal power system and a rural electric cooperative (REC) serve the major city, their distribution lines marching down both sides of some Anchorage streets.

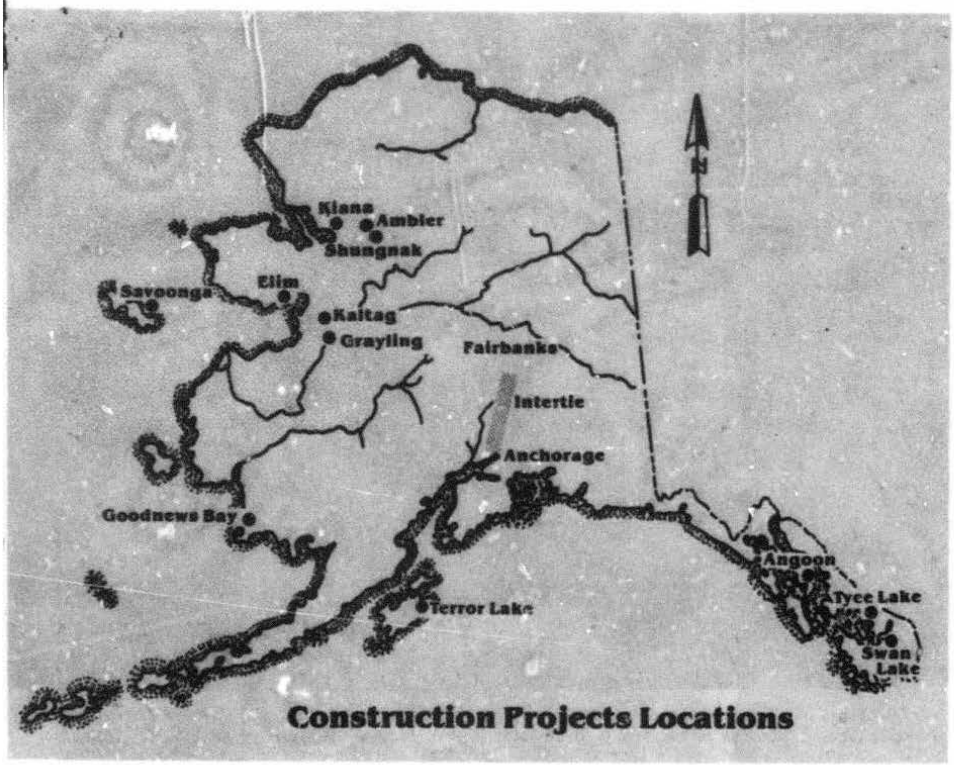
Co-ops generate 61 percent of the state's power; municipals produce 27 percent. Eight percent of Alaska utilities' electricity comes through the Alaska Power Administration, a federal power marketing agency. It sells power from two dams, the 30-MW Eklutna Project serving the Anchorage area, built by the Bureau of Reclamation in 1955, and the 47.2-MW Snettisham Project built by the Corps of Engineers in 1975.

Chief beneficiary of the federal Snettisham Project is the state's largest private utility, Alaska Electric Light & Power Co., which serves nearby Juneau, the state capital.

Only 4 percent of the state's electricity is

The Swan Lake Project in southeastern Alaska typifies the small hydro development undertaken jointly by consumer-owned electric systems and the Alaska Power Authority. To be completed by Christmas, the 22.5-MW project will replace expensive diesel generation for Ketchikan, Alaska's fifth largest city, and may be tied by a transmission line to the Tyee Project, under construction, which will serve municipal electric systems in Wrangell and Petersburg. Photo by R.W. Beck and Associates

Reinemer, Vic. 1983. Electrifying Alaska. Public Power. 41(6): 10-19.



Current construction by the Alaska Power Authority includes the Tyee Lake and Swan Lake hydro projects at lower right, the Terror Lake Hydro Project at bottom center, waste-heat recovery units in villages, and the Anchorage-Fairbanks Transmission Intertie.

Map by Alaska Power Authority

generated by private utilities, most of which are too small for the dignified title of "investor-owned utility" and only one step removed from the single diesel engine which generates electricity for one household throughout much of rural Alaska.

Electric transmission is impractical in most parts of the state because of long distance and small markets. You would have to vacate an area of Alaska as large as New England, New York state and West Virginia combined, huddle all Alaskans in what's left, to push the state's population up to one person per square mile.

Transmission Lines Rare

With minor exceptions, transmission lines operate only around Fairbanks, the second-largest city, and along Cook Inlet, from Homer to Anchorage and up to Palmer in the Matanuska Valley, whose rich soil — uncharacteristic of the state — attracted farmers and dairymen a generation before Alaska achieved statehood in 1959. More than half of Alaska's 450,000 residents live in this "Railbelt" area traversed by the 470-mile, federally owned Alaska Railroad running from Fairbanks through Anchorage to Seward.

Costs of transportation, shelter, food and clothing in Alaska generally exceed those in the lower 48, yet the average electric utility bill there, in all categories of service, is less than the U.S. average, thanks to relatively low rates in the population centers. However, 500 kilowatt-hours cost $241.35 in 48 western Alaska communities comprising the Alaska Village Electric Cooperative.

Name the energy source — except nuclear — and Alaska has it. Alaska ranks first among the states in oil production, second in natural gas potential, with most petroleum basins not fully explored. Oil and gas are used to generate three-fourths of Alaska utilities' electricity. Alaska contains about half the nation's coal reserves; coal fuels 10 percent of utility generation.

Alaska abounds with generally undeveloped energy sources — peat, biomass, geothermal power gushing from Unalaska Island in the Aleutian Chain, tides of 30 feet or more surging up the inlet where British Captain James Cook sailed in 1778 in his search for a passage to the Arctic Sea. Solar power strong enough to grow 50-pound cabbages pours in over summer. Class 7 winds, top-rated among wind engineers, with a mean speed of more than 21 miles per hour sweep almost constantly along hundreds of miles of Alaska's western and southeastern coasts.

All that, and hydro too. Hydro now provides 10 percent of Alaska's generation, seemingly a small amount in the state with nearly half the nation's undeveloped hydro potential. Most of it may stay undeveloped for the same reasons — if on a lesser scale — the once-proposed 6,732-MW Ramparts Dam on the Yukon was shelved. It would have involved major environmental change, relocation of thousands of Alaskans and long-distance transmission to power markets — unless industries requiring large amounts of electricity moved to the area.

Small hydro plants near population centers are, however, acceptable. And they are what Alaska is now developing, along with a major transmission line and waste-heat recovery projects in villages, while investigating dozens of possible projects. They include two major hydro plants, totalling 1,620 MW, on the Susitna River, which rises in the Alaska Range south of Fairbanks, meanders south, then plunges west through canyons toward the Railbelt and finally south into Cook Inlet near Anchorage.

Key Role for Power Authority

Alaska's ambitious energy construction and study program centers in the Alaska Power Authority, a state agency established by the legislature in 1976. The authority receives its capital from both legislative appropriations and tax-exempt revenue bonds. In 1981 the legislature empowered the authority to acquire or construct power projects approved by the legislature. In addition to building and investigating projects, the authority administers the state's power project loan fund, power cost assistance program, state rural electrification loan fund and other energy programs. The authority's director, until he resigned Oct. 14, was Eric Yould, an engineer with the Air Force and Corps of Engineers before becoming chief executive officer of the new agency in 1978.

The authority's construction director, Joe Perkins, started in the dam business with the Army Corps of Engineers. He oversees three hydro projects soon coming on line, the first transmission tie between the state's two large cities and waste-heat recapture in Alaskan villages as well as the Bradley Lake hydro project, on the Kenai Peninsula, which is in the preliminary engineering phase.

"We're going to rob the waste heat off the diesel generators in those villages," said Perkins. About 70 percent of the typical small diesels' energy is now lost through radiators, exhaust gases, radiated heat and friction. With jackets, pumps and pipes, the authority plans to capture half the waste heat and move it to nearby buildings. The modular systems should be operating in at least 13 villages this winter and pay for themselves in three years.

Construction Different in Alaska

Hydro construction in Alaska can be quite different than in other states. For one thing,

Perkins said, "None of the projects under construction are accessible by road. You go in by water or air."

Logistical planning is crucial in the remote north country. Delivery by boat may take weeks. High tide for unloading may rise at midnight. Snow removal and cold temperatures present problems, of course, but Perkins emphasizes the importance of experience in dealing with cold-weather construction and northern soil, which varies from peat and volcanic ash to permafrost — frozen layers of soil whose characteristics may change after disturbance.

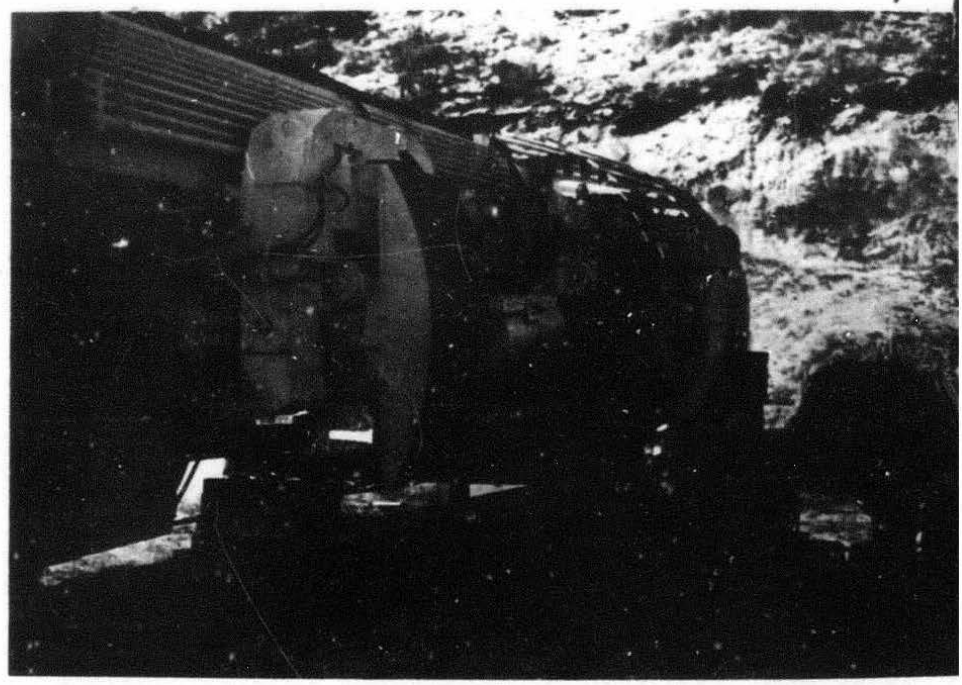
Another difference, stemming from remoteness and lack of interconnections, is that most Alaska hydro projects serve a single community, or perhaps two if they are close by.

Last year the city of Sitka in southeastern Alaska completed the 16.5-MW Green Lake project. The $65 million construction was financed by a $10 million state grant, $15 million loan from the power authority and $40 million in revenue bonds. The 12-MW Solomon Gulch project, completed last year at a cost of about $55 million, serves the Valdez and Glennallen communities east of Anchorage. The project was developed and built by the Copper Valley Electric Association, a rural electric co-op, which sold the project to the power authority. The co-op operates the project through an agreement with the authority.

The three projects now being built under authority supervision will put oil-fired generation on the reserve list for one cooperative and three municipal power systems. The 20-MW Terror Lake project will provide power for Kodiak Electric Association (KEA) and the Coast Guard station on Kodiak Island, off the Kenai Peninsula southwest of Anchorage. The 22.5-MW Swan Lake Project will serve Ketchikan, Alaska's fifth largest city, far down the southeastern Alaskan coast. The 20-MW Tyee project will serve Wrangell and Petersburg, located a few islands northwest of Ketchikan.

Hydro Replacing Kodiak Diesel

Why would the state of Alaska and local ratepayers spend $189 million on a 20-MW hydro plant on a remote island serving only 3,300 electric customers? Kodiak Electric Association Manager Dave Neese gets the answer every month — a diesel fuel bill of about half a million dollars, costing more than 90 cents a gallon. KEA has a heavy commercial load and good load factor — almost flat, said Neese — because of the fishing industry upon which the local economy depends. Processing plants work round-the-clock when the various catches come in, and the variety of salmon, crab and shrimp extend the fishing season almost year-round.



An 11-foot Robbins tunnel-boring machine, above and below, speeded tunneling through granite on Kodiak Island. Kodiak brown bears, lower right, regularly observe construction. The 20-MW Terror Lake Project on Kodiak Island involves raising the lake level 170 feet with a rock-filled concrete-face dam, facing page, left, and tunneling from the far end of the lake five miles to penstocks (being installed in July, upper right) above the powerhouse. Photo by Alaska Power Authority

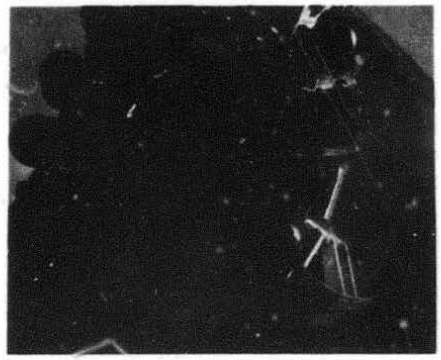


Photo by Alaska Power Authority

The first problem in developing the Terror Lake project, 25 miles southwest of the city of Kodiak, was that part of the land required lay within the Kodiak Wildlife Refuge, created in 1941 on behalf of the Kodiak brown bear. KEA, environmental organizations and state and federal agencies worked out a land swap providing the bears 27,000 acres of adjacent state land, run by the state under refuge rules. The agreement cleared the way for license approval by the Federal Energy Regulatory Commission (FERC). Bids on general construction were opened in April 1982 and construction began six weeks later.

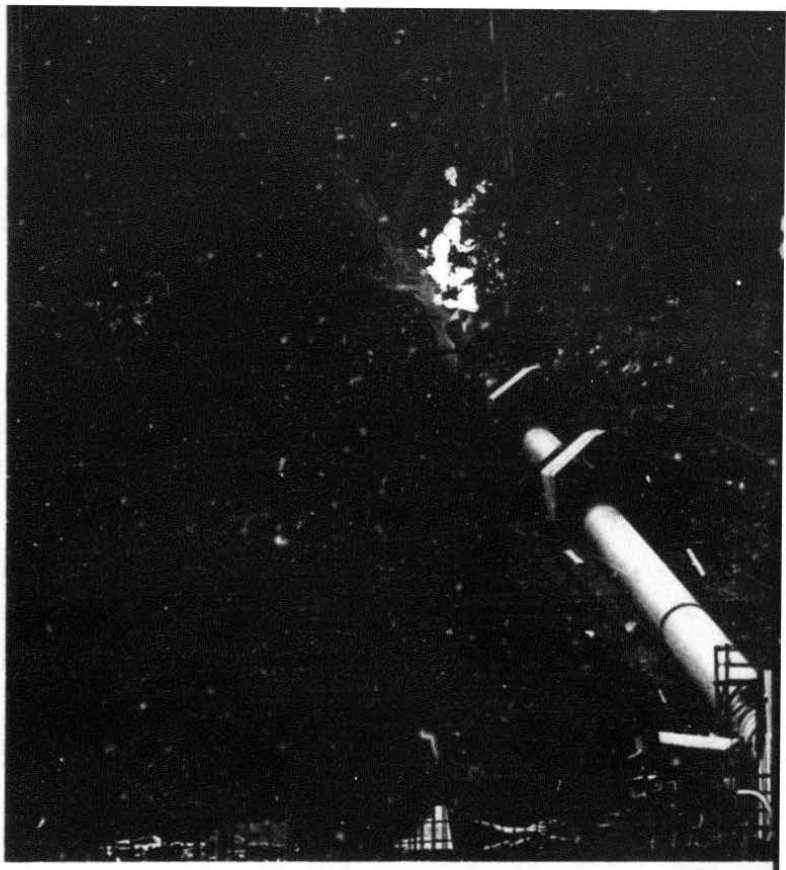
The project involves raising the level of Terror Lake 170 feet with a concrete-faced rockfill dam to increase its storage area, and tunneling from the far end of the lake five miles through a granite mountain. The 11-foot tunnel was drilled, mostly through granite, with a tunnel-boring machine — the first ever used in Alaska — which bored 100 to 110 feet in a good day according to EBASCO contract construction manager Pete Arsenault.

The tunnel goes to a 3,100-foot penstock, partially above ground, to carry the water down to the powerhouse, where two 10-MW, vertical-axis Pelton turbines are being installed. Water will be discharged into the Kizhuyak River about four miles upstream from Kizhuyak Bay, where boats and seaplanes bring in equipment and supplies. Electricity will be transmitted to the city of Kodiak and the Coast Guard station by 19 miles of 138-kV transmission line.

The plant is on schedule; Frank Bostwick, power authority project coordinator, foresees completion in November 1984. Construction has proceeded practically year-round despite rainfall averaging 74.2 inches annually, including more than 80 inches of snow, as measured at the Coast Guard station. (Bostwick believes the project site is even wetter.)

The wet and the cold can be offset on the island by the balmy 76 F summer days and long evenings fishing and catching Alaskan king crabs. Another favorite sport is watching bears watch construction. Bears and builders both usually maintain respectful distance and no bad bear incidents had been reported as construction entered its final year.

Neese said it is too early to say what effect the hydro will have on his co-op custom-



Photos by author unless otherwise credited

Photo by U.S. Fish and Wildlife Service

ers' rates, now amounting to 16.3 cents per kWh for the first 700 kWh and 13 cents per kWh on sales over 700. KEA is negotiating an operating and financial arrangement with the authority.

Lake Above Fjord Being Tapped

While the Terror Lake Project modifies a natural impoundment, raising its level to above the tunnel, the $125 million Tyee Lake Project in southeastern Alaska will simply tap a lake which nature perched in a hanging valley 1,400 feet above a glacially carved fjord similar to those in Norway. Water will flow through a 1,200-foot vertical shaft, then an 8,000-foot horizontal tunnel, 10 feet in diameter, to the powerhouse, with its two 10-MW Pelton generators and provision for a third. An open-channel tailrace will carry the water the quarter of a mile from the powerhouse to the fjord.

The project is scheduled for completion in January. Power will go from Tyee to Wrangell and Petersburg through 69 miles of overhead 138-kV transmission line, initially energized at 69 kV, and 13 miles of submarine cable, one of the largest marine-cable projects in the world.

Tyee Lake hangs about 40 miles north of the 22.5-MW Swan Lake Project, begun in August 1980 by the city of Ketchikan 22 miles southwest. Ketchikan has 28.6 MW of diesel and hydro capacity now, and swaps power with the Louisiana-Pacific pulp mill which has comparable capacity* according to John Zidalis, Ketchikan Public Utilities (KPU) electric superintendent and Swan Lake project administrator.

The Swan Lake Project features a 190-foot elliptical concrete arch dam, the first of its kind in North America. A single-circuit transmission line will take the power to Ketchikan. KPU's arrangement with the power authority provides that, in return for providing funds to complete project construction (total cost will be about $96 million) the authority will receive title to the project and provide enough power for Ketchikan's needs.

Southeastern Alaskans talk about possible future transmission ties — between Swan and Tyee lakes; to U.S. Borax Co., which has the world's largest molybdenum deposit (by the Misty Fjords National Monument about 25 miles from Swan Lake); to the Snettisham Project near Juneau now enjoyed by Alaska Electric Light & Power; or maybe with B.C. Hydro. (All southeastern Alaska is a close neighbor to Canada's British Columbia.) The municipal power system in Metlakatla, Alaska's southernmost town not far below Ketchikan, has high diesel bills too and its ratepayers would like cheaper hydro. R.W. Beck and Associates, which engineered the Swan Lake Project, is completing a transmission study which shows that the logical next step in southeastern Alaskan transmission is to tie the Swan

*Industrial generation of electricity in Alaska last year totaled 1,590 gigawatt-hours, more than 40 percent of the amount generated by utilities (3,721 gWh).

The 20-MW Tyee Lake Project, which will serve Wrangell and Petersburg, required no impoundment. Water leaving it will be diverted by tunnel to the powerhouse.

and Tyee projects with a 45-mile, 138-kV line. That would permit load-sharing among Ketchikan, Petersburg and Wrangell.

Railbelt Intertie Under Construction

But transmission construction requires load for justification and the action now is on the Anchorage-Fairbanks intertie in the Railbelt. The new 345-kV intertie, 170 miles long, will operate initially at 138 kV. Lines of that capacity already extend from Anchorage into the Matanuska Valley and from Fairbanks to the Golden Valley Electric Association's 25-MW coal-fired Healy plant near Denali National Park (which includes North America's highest peak, 20,320-foot Mt. McKinley).

Two native regional corporations own 46 miles of the intertie right-of-way. Entry agreements between them and the power authority this spring cleared the way for construction, which began this summer. Completion is scheduled for the end of 1984.

Building the big intertie will be tricky, through bog and permafrost in some places. Some of the line must be installed entirely by helicopter. But the cost-savings potential to Anchorage, Fairbanks and several interconnected RECs will be substantial. The authority estimates the $122.5-million project can reduce new generating capacity needs by 125 MW.

Both the intertie and the Terror Lake Project are being built under the management concept, adopted in 1982, of using different firms for engineering and construction, with the authority involved as decision-maker. The authority believes this organizational structure helps contain costs and maintain schedules.

Tom Stahr, general manager of Anchorage Municipal Light & Power, said his area will benefit from more reserve capacity and access in emergency to the oil pipeline from Prudhoe Bay to Valdez. Oil from the pipeline is tapped and refined a few miles east of Fairbanks. (This is the only commercial tap on the pipeline — some crude is tapped and refined along the pipeline for use in its operation.) Golden Valley Electric Association, an REC, has a 70-MW generating plant right across from the refinery, and Golden Valley is intertied with Fairbanks Municipal Utilities System.

"There's 100 MW of firm power between the co-op and the city," said Virgil M. Gillespie, general manager of the Fairbanks municipal. His system is already well-integrated, considering its position less than two degrees south of the Arctic Circle. Emergency ties exist with nearby Fort Wainwright and the University of Alaska, both of which have their own generating plants. The intertie will provide Fairbanks access to relatively low-cost gas-generated power from Anchorage.

Susitna Project Before FERC

The intertie fits into Alaska's long-range plan to build two major hydro plants on the Susitna River. The Susitna project has been intensively studied for years by Alaska agencies and is now under examination by the FERC. David Wozniak, the power authority's Susitna Project deputy manager, does not expect an FERC decision on the authority's application for a Susitna license until early 1986, even though the project is on a fast track at the commission.

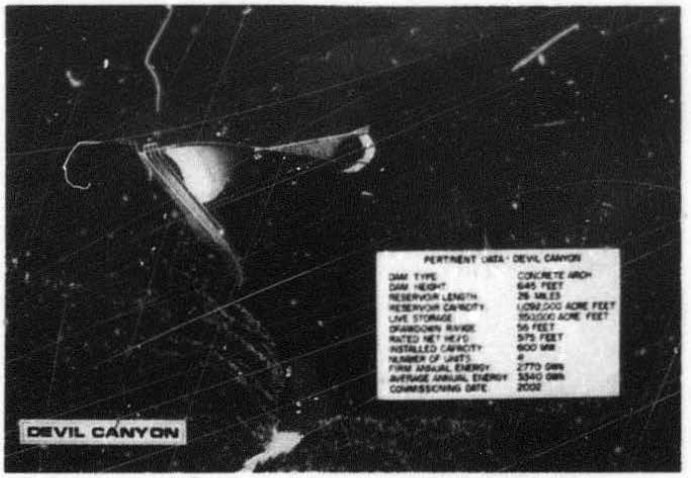
The project contemplates two high dams. Watana, upstream, would be an 885-foot earthfill structure with six 170-MW generating units in an underground powerhouse. It would be built first; if the license is granted and the timetable holds Watana would come on line in 1994. The lower project, Devil Canyon, would consist of a 645-foot double-curved concrete thin-arch dam and four 150-MW generating units underground. It would come on line in 2002. Estimated cost of the entire project is $5.6 billion.

Detailed Susitna studies by state agencies and outside experts deal with its many potential problems — environmental, fish and wildlife impact, silting, design, finance, marketing, earthquake resistance. (An earthquake registering 6.2 on the Richter scale shook the state while I was there in July. No one was hurt; fallen bottles in bars were the principal casualties. On Good Friday, 1964, the most severe North American earthquake ever recorded — 8.5 on the Richter scale — devastated parts of the state; 122 persons died in the subsequent tsunami — a great sea wave produced by submarine earth movement.)

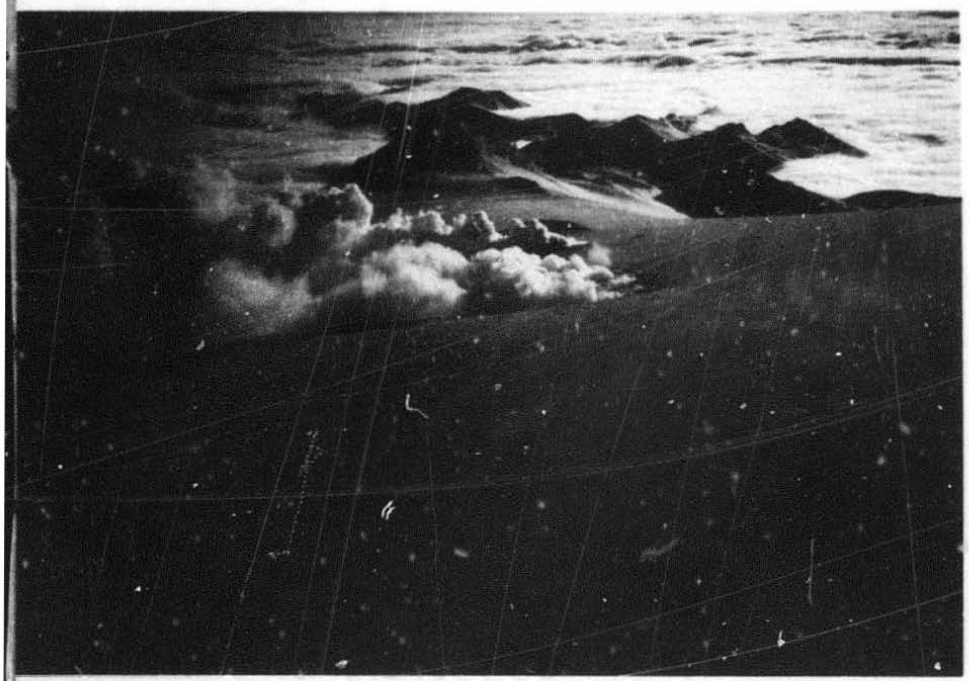
Emery C. Hill, an R.W. Beck and Associates engineer who worked on Grand Coulee Dam in the '30s, watches electricians install an earthquake-detection cable on top of Swan Lake Dam.

The late A. Starker Leopold, a nationally recognized zoologist who in the '60s helped sidetrack the proposed Ramparts Dam because of its enormous and adverse environmental consequences, was one of the outside authorities who reviewed the Susitna proposal two years ago. He called it "a very good bet," noting that the narrow impoundments would not inundate any wide alluvium or riparian zone important for many types of wildlife.

Unlike the upper Yukon, which Rampart would have flooded, no waterfowl nest in the area. Some moose and bear habitat would be lost. The new impoundments, he said, should be cleared of stripped timber so as

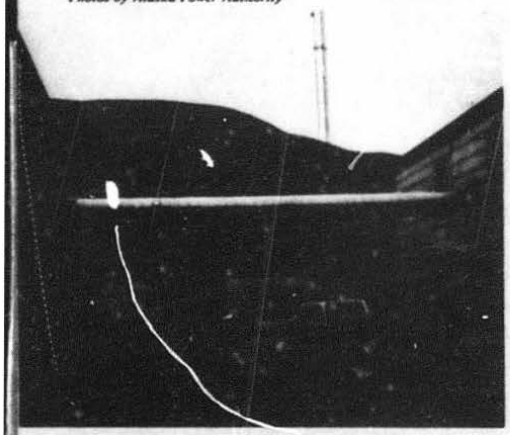


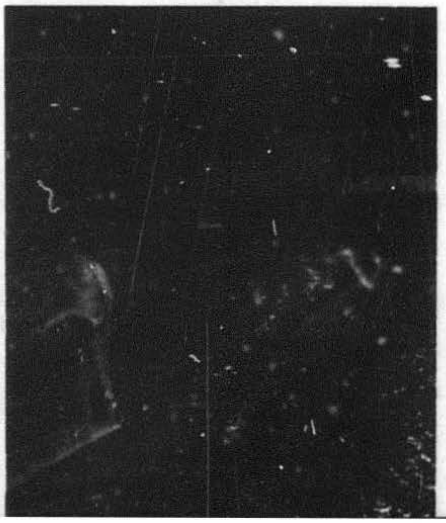
The proposed 1,620-MW Susitna Project would include two dams, Watana, left, upstream, and Devil Canyon downstream. Extensive studies on project impact, especially on fisheries, have been under way for several years. The Alaska Power Authority expects a decision in 1986 on its application to the Federal Energy Regulatory Commission for a Susitna license. Photo simulations by Alaska Power Authority



Geothermal steam is a likely energy source on Unalaska Island, in the Aleutian Chain, where waste heat is already piped between buildings and heats a swimming pool to 80 F.

Photos by Alaska Power Authority





not to trap caribou. All in all, Leopold concluded, "the upstream effect of those two dams on wildlife would be minimal."

Devil Canyon Stops Salmon

Leopold noted that — again unlike the Yukon — no salmon reach the upper part of the river. They are stopped by Devil Canyon, site of the proposed lower dam.

But what happens downstream, in flow release from the dam, would be very important. Susitna tributaries produce salmon; some of the king salmon caught in Cook Inlet, for example, come out of that area.

Make sure, said Leopold, "the flow of water coming through those dams and down the channel does not adversely affect the survival of the young salmon . . . Make sure also there is enough water downstream to flood the Susitna delta so it is maintained as waterfowl habitat. It is a very important waterfowl area."

The Arctic Environmental Information & Data Center, a unit of the University of Alaska, is conducting simulation modeling of aquatic impact downstream from the proposed Susitna project. The center is looking not only at fisheries impact, but also other possibilities such as ice and flooding. Director Dave Hickok said the answers are "a year or two away."

"On balance," said Hickok, "I think the environmental consequences of Susitna can be handled."

Alaskans treasure their fish, which provide food, employment, tourists and cash. The power authority is dealing with the fisheries issue up front, with state, federal and outside fisheries experts at construction and study sites and what may be the model of an environmental information program for an agency which builds dams.

"We've set a policy of no net loss on fisheries," said Alaska Power Authority Director Yould, who started studying the Susitna with the Army Corps of Engineers in 1974.

Tom Stahr of the Anchorage public power system said Susitna power in the early '90s would especially help his system, which generates 85 percent of its power with gas from the Kenai Peninsula.

"It will give us more power when gas gets more expensive," he said. Gas now is cheap — $2.25 per mcf. But our contracts will be running out after 1994."

He cited another reason why interest in Susitna is strong. Jobs. The bloom is off, after the pipeline construction boom. Legislators are pressing to get more jobs for Alaskans. Unemployment is above 10 percent.

Susitna sits in the lap of the gods — and the FERC. Meanwhile electrification in Alaska means tying together the electric systems within economic reach, completing small hydro plants on schedule so they can begin to pay out, investigating other potential energy sources, such as small hydro projects at Bradley Lake, Bristol Bay, Bethel and Cordova, and wrapping in waste heat from diesel plants in distant villages. Experience last summer showed the modular waste-heat recapture units can be installed quickly. The authority is ready, if the legislature approves. to capture waste heat in 35 more villages.

Municipal Service Diverse in Alaska

YOU GET A ROUGH IDEA who provides electric service in Anchorage (pop. 210,000) by looking at the height of the buildings.

"Chugach Electric Association has the area spreading horizontally," said Carolyn S. Guess, chairman of the Alaska Public Utilities Commission (PUC). "Anchorage Municipal Light & Power has the area growing vertically."

ARCO Alaska's building in midtown Anchorage rises 22 stories. Sheffield Enterprises and other investors announced plans for a 32-story downtown hotel in July.

The co-op and the muni have both served parts of the cities for years. Rivalry over which system will serve particular areas is pretty much a thing of the past, and there is serious talk about a merger of the state's largest rural electric co-op, serving some 55,000 customers, and the municipal, which serves about 19,000 customers.

In July, Anchorage Mayor Tony Knowles told the Chugach co-op's president, following meetings with her and municipal leaders, that if the co-op was interested in a merger study he would facilitate it. A merger would require formal approval by co-op members and Anchorage residents.

One impetus for the merger is the co-op's rising rates. Another is the prospect of short-term winter-peaking shortages, which might be met most cheaply by additional, municipally financed gas generation.

Anchorage Municipal Light & Power is pushing time-of-day rates, especially among its electric heating customers, now that it has new electronic meters. The 7 p.m. to 7 a.m. rate is only 2.167 cents per kWh, compared with 5.28 cents per kWh from 7 a.m. to 7 p.m.

The Alaska legislature provided for PUC regulation in Anchorage because of the dual service and territorial disputes. The municipal government manages — and the state regulates — electric, telephone and water service and waste-water treatment. The municipal government also runs the Port of Anchorage and Merrill Field, one of the largest general aviation airfields in the world, handling more than 300,000 flights last year.

Tom Stahr, general manager of Anchorage Municipal Light & Power, checks load data on one of the 26 terminals tied into the municipal's Hewlett-Packard 3000 computer. His system also has two microcomputers and a supervisory control and data acquisition system (SCADA), and is tied into the city's mainframe.

"We spend about $1 million a year on regulation, but it hasn't hurt us," said John L. Harshman, executive manager of Anchorage Municipal Utilities.

There is also co-op electric service, by Golden Valley Electric Association, within the boundaries of Fairbanks (pop. 51,000) but electric service there does not warrant regulation. The co-op serves areas annexed by the city, which provides municipal electric, telephone, water and sewer service, plus district heating.

Both Anchorage and Fairbanks discharge some waste heat into water systems to keep them from freezing. Low-grade heat (50 F to 60 F) discharged into the Tanana River at Fairbanks tends to create ice fog where engines are operating in the city when the temperature drops to -25 F or -30 F.

"It's like being in Los Angeles fog," said Fairbanks City Engineer John Phillips, "only it's frozen."

Fairbanks was the scene of one of the most innovative emergency actions in utility history. At the height of the gold rush in 1906, when the city already had a population of more than 5,000, flame from a dentist's alcohol burner (he had left his patient to talk to his wife) started a blaze which consumed one-fifth of the city. Fearful firefighters abandoned hoses which streamed uselessly, dropping the water pressure needed to fight the flames, wrote Howard Clifford in ALASKAFEST magazine.

With the town's supply of firewood exhausted, Volney Richmond — manager of the powerhouse supplying water, electricity and steam — ordered teamsters to race their horses to a warehouse and bring back the bacon. There was a ton of it, in six- to 10-pound slabs. Richmond and his crew heaved the slabs into the furnace. The hot grease roared and the water pressure at last rose. Thus was most of a city saved by its bacon and a good boilerman. VOR

Jerry Colp, above, manages Fairbanks Municipal Utilities' hot-water district-heating system which warms a school complex, library, residences and (right, background) Fairbanks Lutheran Church. The U-shaped expansion loop absorbs expansion and contraction of the piping system caused by temperature changes.