Dams:
(Grim news.)

**Brazil dam burst death toll rises to 99, with 259 unaccounted for**

By Marcelo Teixeira; Editing by Christian Plumb, Our Standards, January 30, 2019. REUTERS/Washington Alves, reuters.com

SAO PAULO (Reuters) - The death toll from a dam burst in the Brazilian town of Brumadinho rose to 99 people, with 259 still unaccounted for, according to rescuers working at the site on Wednesday. They said that 57 bodies have been identified so far in the rubble of the ruptured tailings dam, which belongs to iron ore miner Vale.
Planet Labs image of the Brumadinho tailings dam failure
By Dave Petley, 30 JANUARY 2019, blogs.agu.org

Planet Labs have captured a high resolution image of the aftermath of the Brumadinho tailings dam failure at the Córrego do Feijão Mine in Brazil. This image, which is copyright Planet Labs and used with permission, shows the tailings pond and failed dam:-

Planet Labs high resolution image of the aftermath of the Brumadinho tailings dam failure in Brazil, captured 28 January 2019. Copyright Planet Labs, used with permission. Please note that the label has now been corrected. It is worth comparing that image with the Google Earth image of the same site:-

There are a few points to note here. First, the central portion of the dam has failed catastrophically, creating a high mobility flow. In fact, very little of the dam itself is intact. Second, the compromised smaller dam to the west of the main failure can also be seen. The toe has scoured out; clearly this needs careful monitoring but the retained volume is not very large. Third, there is a substantial volume of tailings left within the pond that now has not retention in place. These tailings can mobilise in heavy rainfall, so careful management is needed.

Meanwhile the number of fatalities from the Brumadinho tailings dam failure has now reached 84 confirmed losses, of whom 42 have been identified, with a further 276 people reported missing. This would mean that the minimum final total will be 318 fatalities, making this one of the worst mining landslides in recent history. No-one was rescued alive yesterday. Five people from Vale and from a contractor, TÜV SÜD, were arrested yesterday in relation to the accident. Finally, a comment by Caner Zanbak from my earlier post on the Brumadinho tailings dam failure noted that there is an article online about the behaviour of the tailings at Dam 1 of the Córrego do Feijão Mine. This presents a detailed analysis of the liquefaction potential of the tailings. It concludes: “Considering a rapid rise of the phreatic line through the tailings deposit reaching the toes of the intermediate rising dykes, with complete saturation of tailings layers susceptible to liquefied, a post-triggering analysis indicated that the flow failure susceptibility of the Dam I is low even under a such critical loading event”. And “The conclusions of these analyses, in addition to laboratory testing program results and based on rigid management procedures adopted in field, demonstrate that Dam I constitutes a safety structure against mechanisms from liquefaction-induced failures”. Clearly these analyses did not properly characterise the behaviour of the tailings (which is not necessarily a criticism of the authors). I wonder if we know why?

Brazil’s Vale to sacrifice output for safety after deadly dam collapse
JANUARY 30, 2019, bonbonlifestylewebazine.com
Vale SA, the world’s largest iron ore miner, said it would sacrifice production for safety to avoid another tailings dam failure, after the death toll in the second dam collapse in just over three years was expected to exceed 300.

(Amazing!)
An Exclusive Look Inside Hetch Hetchy Dam’s Mountain Tunnel
January 30, 2019, sanfrancisco.cbslocal.com

SIERRA NEVADA MOUNTAINS (KPIX 5), CA — For nearly 100 years, the Mountain Tunnel has transported the water supply from the Hetch Hetchy Dam to the Bay Area. 2.7 million customers rely on the pure water that travels through the tunnel. For the first time in history, TV cameras went inside while engineers made repairs. KPIX 5 got an exclusive first look inside, using carefully inspected and equipped Quad Vehicles to travel five miles within.

An exclusive first look inside of the Mountain Tunnel. (CBS) “We are, right now, 750 feet below the surface, under the town of Groveland,” said Steve Ritchie, Assistant General Manager for Water at the San Francisco Public Utilities Commission. Engineers needed to know how the old tunnel is doing. “We were concerned that the tunnel, at some point, could collapse, or some portions could collapse, but what we found was the liner was in better shape than we thought!” explained Ritchie The tunnel is 19 miles long. Engineers say they are surprised that little erosion damage happened in the last century, but some areas need critical attention. Holes and cracks are being filled, repairs that are designed to last for the next hundred years. “Every customer that we serve receives its water from this tunnel. Yes! Right here where we are standing!” said Mountain Tunnel Project Manager Dave Tsztoo. Two hundred million gallons–or three hundred Olympic swimming pools–flow past the tunnel each day. The project is scheduled to be completed by March.

(Everyone wants to put their fingers in the pie. Is this even legal?)
Washington state to regulate federal dams to cool hot water
By Associated Press, January 31, 2019, columbia om

SEATTLE, WA — A new draft analysis by the U.S. Environmental Protection Agency says dams and climate change are the leading cause of high temperatures in the Columbia and Snake rivers that are killing salmon. Now, the state wants to get involved. The Seattle Times reports the state Department of Ecology on Wednesday initiated a public comment period on proposed new regulations on federal dam operations. The department’s goal is to for the first time initiate work toward meeting state water-quality standards, including temperature, at federal dams on the Columbia and Snake rivers.
Washington has long had an uppermost temperature limit of 68 degrees (20 degrees Celsius) in state waters, but it’s never been enforced at federal dams. Temperatures have become so high, sometimes exceeding 70 degrees (21 degrees Celsius), that they kill migrating salmon.

(Another step towards dam removal.)
Harbor to discuss dam removal
Following a presentation from Pacific Power representatives Tuesday, Crescent City Harbor commissioners will weigh in on efforts to remove four dams on the Klamath River. Monte Mendenhall, Pacific Power’s business manager and Bob Gravely, the utility’s public information officer, will speak on the status of the dam removal process. Harbor commissioners will then vote on a letter of support for the project to the State Water Resources Control Board.

The State Water Resources Control Board is currently collecting public input on a draft environmental impact report that addresses, among other things, the level of sediment that will be released into the river after the J.C. Boyle, Copco No. 1 and Iron Gate dams are removed. The draft EIR is in response to the Klamath River Renewal Corporation’s request for a final Clean Water Act Section 401 permit for the removal of the Copco No. 1 and No. 2 and Iron Gate dams. “The beneficial results of the dam removal project include positively affecting the water quality of the Klamath River and by doing so, taking an historic step toward restoring traditional salmon runs,” according to the harbor district’s proposed letter, “Dam removal is crucial to restoring the natural ecosystem that existed before construction of the dams.”

The Crescent City Harbor District’s proposed letter comes after Commissioners James Ramsey and Rick Shepherd along with harbor staff and commercial fisherman George Bradshaw on Jan. 24 sat through an overview of the project from KRRC Community Liaison Dave Meurer and Glen Spain, northwest regional director of the Pacific Coast Federation of Fishermen’s Associations. During their presentation, Meurer and Spain sought to allay concerns about potential impacts to the harbor from sediment behind the dams, noting the draft EIR predicts about 5-9 million cubic yards of sediment is expected to travel downstream after they're removed. Much of that material is expected to settle on the riverbank and revegetate it following dam removal, according to Meurer. An estimated 85 percent is expected to consist of fine silt and clay, while 15 percent is expected to be sand and gravel. Meurer pointed to a section in the draft EIR stating the material is much less than what the Klamath transports during a wet year and greater than is transported during a dry year.

Very little to no sediment is expected to wind up in the harbor, Spain said during the presentation. Also on Tuesday’s agenda, Crescent City Harbor commissioners will revisit a discussion about the port’s strategic plan, potentially creating an ad-hoc committee to discuss a permanent color palette for a “Harbor Vision & Design Guidelines” booklet for its tenants. The ad-hoc committee would also address placement and content of informational signs located in various areas of the harbor pointing the way to businesses and services. The committee will also contact Crescent City staff about its directional signs. Crescent City Harbor board meets at 5:30 p.m. Tuesday at 101 Citizens Dock Road, Crescent City. For more information or to view an agenda, visit www.ccharbor.com.

Brazil Dam Catastrophe Sounds Alarm for U.S. Waste Ponds
Feb. 4, 2019, bloombergenvironment.com

• Some engineers say U.S. not immune to issues like Brazil disaster
• But U.S. mining industry says key differences make U.S. safer

(The eye is on tailings dams. What we know is that we already have an inventory of dams. What we don’t know is whether the current inventory includes all of the tailings dams. Remember the Buffalo Cr disaster in West Virginia.)
A mining dam failure similar to the one that killed more than 100 people in Brazil could happen in the U.S., according to a mine engineer who consults with the government.

At the root of the risk is a quilt of differing state regulations, sloppy dam construction, lax maintenance, neglect of decades-old dams that are wrongly assumed to be stable, and stronger storms dumping water into dams that weren’t designed to handle the weight, said James Kuipers, who consults with the Environmental Protection Agency and state governments on tailings dams, which hold mining waste.

"It can happen here," Kuipers told Bloomberg Environment. But the industry says tailings dams in the U.S. are safer than they've ever been, thanks to advances in technology and design. Rigorous oversight also ensures that dams don't break, said Ashley Burke, a spokeswoman with the National Mining Association. "The U.S. mining industry is one of the most heavily regulated industries in the world," Burke said. And in the event of a dam break, the risk to human life is lower in the U.S. than in some other parts of the world, including Brazil, because "a lot of our mining, especially metals mining, takes place in areas with low population density," said David Chambers, a mine engineer and president of the Center for Science in Public Participation, a nonprofit that focuses on mining pollution.

But Kuipers says: "Something could always happen, even where we have the highest level of confidence. There are so many places in the U.S. where we have populations downstream. There are locations that could kill hundreds of people easily."

Wall of Mud

On Jan. 25, a dam holding back 3 billion gallons of sludgy mine waste burst in southeastern Brazil, killing more than 100 people. A wall of mud quickly engulfed a busy cafeteria full of workers employed by iron ore giant Vale SA, which owned the dam. The deluge then charged through the nearby town of Brumadinho. Investigators haven’t yet pinned down what caused the dam failure, but another Vale dam failed in a similar, deadly environmental disaster in Brazil late in 2015. In the U.S., environmental group Earthworks found in 2012 that 28 percent of all U.S. copper mine waste dams had failed at some point. The biggest potential problem spots in the U.S. are in states like Alaska and Minnesota, which tend to have heavy rains, said Kuipers, principal consulting engineer at Kuipers and Associates LLC. A downpour can rapidly increase the weight of the material inside the dam and liquefy relatively dry mine waste that can then spill out, overwhelming and drowning people in its path, he said.

Earthquake-prone regions like Nevada, Washington, and Wyoming are also worrisome, Kuipers said. For example, the planned Pebble Mine in Alaska would be built close to partly unmapped fault lines that could cross directly through the mine, said Bretwood Higman, executive director of environmental advocacy group Ground Truth Trekking. “If you have an earthquake, there might be impacts to the mine facility, and liquefaction can lead to failure of the dam or motion of the flow of the tailings,” Higman said. Pebble’s owner, Northern Dynasty Minerals, has said its facilities will withstand the greatest possible seismic activity predicted by science.

‘Risk Goes on Permanently’

The Bruno Creek tailings pond still in use in the Salmon River Mountains of Idaho, is potentially problematic, Kuipers said. Perched high above the Salmon River, the dam currently holds back about 100 million tons of mineral waste, which could plunge at high velocity downstream. "If they don’t figure out how to close it properly, that risk goes on permanently," said Kuipers, referring to the Thompson Creek Mining Co.
Suzanne Budge, a Thompson Creek spokeswoman, said the tailings facility “has been closely monitored for decades [and] is managed regularly for stability, material control, water management, and several other technical issues material to the stability of the tailings facility.” The environmental group Appalachian Voices has raised concern about the massive Brushy Fork pond 40 miles south of Charleston, W.Va., which features a 950-foot dam built to hold back 8 billion gallons of black water that was once used to wash coal. Should the dam fail, a monstrous surge of water dense with mercury, arsenic, lead, and cadmium could immediately overwhelm local residents and flow into the Coal River, which ultimately joins the Mississippi River, said Erin Savage, a campaign coordinator at Appalachian Voices. “If a dam in Central Appalachia broke, people would almost certainly die,” Savage said. Alpha Natural Resources, which owns dam operator Marfork Coal Co., didn’t respond to a request for comment.

State-by-State Regulation
Each state has its own regulatory scheme. But even states that do a good job of overseeing the design, operation, and closure of a mine—such as Montana, Alaska, and Nevada—still rely mostly on mining companies to police themselves, Kuipers said. Tailings facilities don’t generate profits, and dam safety tends to become a low priority for companies, according to Kuipers. But Burke, from the mining industry group, said the state-by-state system works because it allows for flexibility.

“While various agencies provide guidance in terms of how tailings dams should be constructed and maintained, there is universal agreement that specific construction determinations are made on a case-by-case basis, taking into consideration foundation location and stability issues, potential environmental impacts, and the type of material to be stored,” Burke said. “There is no simple solution to prevent every incident, but the combination of constant vigilance of industry and the thorough regulation governing it in the U.S. work together to minimize the potential for accidents,” she said.

Inventory of Dams Called For
Developing a complete list of dams across the U.S., then assessing them one by one, is the first step to mitigating any risk, said Bonnie Gestring, Earthworks’ Northwest program director. That initial assessment is especially crucial for old dams on private lands that are no longer owned by anyone, she said. Congress and federal regulators also should mandate the technical recommendations that came out of the 2014 Mount Polley dam failure in British Columbia, Gestring said. And mining companies should be required to post surety bonds to cover the costs of a dam failure, according to Chambers. While companies do have to bond the cleanup of their mines, those IOUs don’t cover dam failures because federal and state agencies don’t consider them to be reasonably foreseeable events. A mandatory bond would give mining companies a financial incentive to make sure their dams are safe, Chambers said. “Tailings dams have to last forever,” Gestring said. “They’re in the landscape in perpetuity.”

(Again breach the dams expert.)

Letter: Breaching dam is best solution for killer whales
whidbeynewstimes.com, February 5, 2019

Editor,

"Urgent warning: Elected officials, if breaching does not begin this winter, you are killing the last hope for southern resident killer whales and our fisheries," reported the Center for Whale Research in December 2018. And, actually a lot more. The equation is simple. Without breaching the four Lower Snake River, dams the Puget Sound’s orca, aka southern resident killer whales, and the salmon that use that river are doomed to extinction. That’s the opinion of 34 fisheries scientists. There are 5,500 miles of climate change resistant, salmon spawning streams blocked by these purposeless and costly dams.
The Army Corps of Engineers’ own assessment is that breaching is the best solution. The dams exist primarily to make Lewiston, Idaho a seaport so private grain growers can use barges instead of trains, which taxpayers subsidize. The dams are a proven liability for the Bonneville Power Administration, costing it millions of dollars per year. They produce electricity at the time of year it is not needed.

BPA will spend an estimated $1 billion to maintain these obsolete structures. The Corps spent millions on ineffectual, energy intensive salmon strategies. The dams don’t have to be dismantled, a simple rerouting of the river at a cost of only $2-3 million per dam, which could be done in two to three months, will suffice. The governor’s $1.1 billion dollar plan will be a waste of money. Why? The Chinook that use the Snake/Columbia River system feed the killer whales in the winter off the coast. Banning tour boats and improving water quality in the Puget Sound will have no effect.

We don’t need more studies. Chinook returns have been diminishing dramatically every year. This is a taxpayer/rate payer rip-off and a racial injustice as well! These dams came at severe cost to tribes, like the Nez Perce, whose lives have been dependent on salmon for millennia. Ultimately, the Army Corps and BPA will be responsible for the extinction of these species unless a massive upwelling of public sentiment and our federal officials can encourage them to act. Lt. Gen. Todd Semonite must issue a “Record of Decision” to direct the Walla Walla District of the Corps of Engineers to select Alternative #4 of its 2002 Environmental Impact Statement. Please contact the BPA at 800-622-4519, The Army Corps at 202-761-7690, Gov. Jay Inslee at 360-902-4111, senators Murray, 206-553-5545, and Cantwell, 206-220-6400, and demand the dams be breached. With your help we can “Free the Snake.” Gary Piazzon, Coupeville

Hydro project uses power to create power
2/6/19, heraldandnews.com

The Swan Lake Hydro Project may have long-term consequences that haven't been publicized. This project is designed to produce enough electricity to power 600,000 homes every year for 45 years or more. The fuel used to produce this electricity will be enough electricity to power 750,000 homes every year for 45 years or more. In order to recoup their billion dollar investment and beat the regeneration inefficiency, the developers are planning to operate every day, rain or shine.

Assuming that 3 people would live in each home, when the project is switched on, it will be as if a new city of over 2 million people instantly entered our region's power market every day. Usually rapid growth in demand for a product increases its price. There has been no analysis of this project's effect on electrical rates over an extended period of time. Since the electrical grid does not segregate green renewable power from fossil energy, it is likely that some of the Swan Lake Hydro fuel will come from coal-fired plants especially during the night and on dark or windless days. I believe that in the ensuing 45 years, technology will enable everyone to personally use renewable energy without wasting 25 percent to production inefficiency. I hope that such a large block of power as required by the Swan Lake Hydro Project will not be tied up for 45 years by a foreign company trying to recoup their investment. Dave Wirth Klamath Falls, OR

Hydro: (A non-believer.)
The dark side of hydroelectric power
31st January 2019, scitecheuropa.eu
Dr Peter Harrop, Chairman, IDTechEx, discusses the dark side of hydroelectric power and why solar power is now overtaking it as the primary energy efficient source. The new report from IDTechEx addresses the success if hydroelectric power, along with the dark side of the environmental and socioeconomic disadvantages of hydroelectric power. Dr Harrop states: “Hydroelectric power is by far the most successful form of so-called zero-emission production of electricity but it has a dark side. Large hydro schemes drown huge areas of vegetation that emit methane for 100 years, far more damaging than carbon dioxide in global warming. Concrete causes 8% of carbon dioxide emissions. Dams have collapsed in Brazil, Cambodia and Vietnam recently killing many people. Expensive dams are on some rivers that are drying up. This brings new meaning to the term, ‘stranded assets’.”

The socioeconomic impact of hydroelectric power
Referring to the socioeconomic issues, he wrote: “The biggest hit is economic. The cost of hydroelectric power is not dropping by much whereas solar costs are plummeting so solar is overtaking it as the primary zero-emission energy source. Solar has problems of ugliness and grabbing huge areas of real estate. It is badly intermittent due to night time and bad weather. Compensating with batteries brings inefficiency and large costs and can involve poisons and flammability.”

What is the solution?
Harrop adds: “Fortunately, three new zero-emission options are easily relocated (no stranded assets: lower financial risk). They are minimally intermittent, often to the point of using fit-and-forget supercapacitors and no battery. There are few malign side effects. None have massive concrete and steel of offshore wind, hydro or tidal barrages: all are plug-and-play. Enter airborne wind energy, wave power and – in both rivers and the sea – new tidal power. Fly a tethered drone where the wind is strong and often continuous, launch a buoy tethered to a generator or fix rotating blades under a moored boat.”

He concluded: “Silent, virtually invisible and operational in hours, they make electricity at about twice the cost of solar initially, if you ignore the extra battery size and real estate cost of solar. They are already part of the reason why Orkney makes 140% of its energy needs, all zero emission. Ghana has ordered a 100MW wave farm and Bali a 10MW wave farm and a farmer in Norway already deploys the drones. For more see the IDTechEx Research reports, “Airborne Wind Energy 2019-2039” and “Wave, Tidal and Hydro Power 1W-10MW 2018-2038”. Indeed, there are now two routes to non-flammable 100kW/kg supercapacitors – where lithium-ion batteries were in 2012 – and they have many superior parameters. See the IDTechEx Research report, “Supercapacitor Materials and Technology Roadmap 2019-2039”.

(And, then there’s this guy’s opinion.)

Clean Energy: A future for hydropower?
By Bob Sack, January 31, 2019, pamplinmedia.com

The Pacific Northwest has led the way in hydropower electricity generation.
Editor’s note: This is the third in an occasional series of articles about what Lake Oswego resident Bob Sack calls “underappreciated, carbon-free sources of energy that are under development right here in Oregon.” Sack’s first “snapshot,” about geothermal energy, appeared in the Dec. 13 issue of The Review; “Blowin in the (offshore) wind” was featured in the Jan. 3 issue. Today’s installment: hydropower.

Did you know that Lake Oswego has its own hydroelectric power plant? If you walk across the bridge on Highway 43
and look down to the east, you will see a large pipe where overflow from the Oswego Lake dam courses to a small powerhouse in George Rogers Park. It is one of the oldest hydro generators on the West Coast, in operation since 1909, producing enough power for about 400 homes. The Pacific Northwest has led the way in hydropower electricity generation. In 1889, electricity began to flow from the Sullivan Plant at Willamette Falls in Oregon City to the streetlights of Portland, 14 miles away; the plant is still in operation today. Currently, 40 percent of all U.S. hydropower generation comes from the Columbia River basin.

But nowadays, there is much more enthusiasm for getting rid of dams than for building any new ones. Beginning in 2021, the largest dam removal project in U.S. history, costing about $400 million, will begin on the Klamath River in Siskiyou County. The hope is to restore the river’s iconic salmon runs. Two major dams on the Elwha River in the Olympic National Park have already been removed, and the salmon have returned. So is there a potential for getting more clean electricity from hydropower? In July 2016, the U.S. Department of Energy published “Hydropower Vision; A New Chapter in America's 1st Renewable Electricity Source.” The report foresees a 50 percent increase in the nation’s hydropower capacity by 2050; it does not, however, propose building new dams on free-flowing rivers. So where would all this extra hydropower come from?

The report says there are three potential sources:

Upgrade existing hydroelectric plants: For example, many existing dams along the Columbia are over 50 years old and could be upgraded with investments in new designs and technologies, yielding substantially more electricity. Add power generation to some of the existing dams or canals originally built for other purposes such as flood control, etc.: Only 3 percent of the more than 87,000 existing dams in the U.S. currently produce electricity. Even in Oregon, there are places where power generation could be added to existing resources. Although some of these projects might be small. Every little bit counts.

PGE has added micro-turbines to its century-old system along the Clackamas and Willamette rivers to take advantage of downhill flows that weren't previously being used for power generation. In central Oregon, upgrading leaky irrigation canals with a liner or pipe saves water, but in addition, it can provide an opportunity for hydropower. For example, the Juniper Ridge Project in central Oregon installed a generator, in conjunction with a 2.5-mile-long canal lining project, that produces enough electricity for 3,300 homes. In yet another example of small-scale hydropower, the City of Portland has been partnering with Lucid Energy, a Portland-based startup, to install electricity-generating turbines in its large gravity-fed water pipes, turning drinking water into electricity. Wow!

Develop Pumped Storage Hydropower: When wind (or solar) power is plentiful or even overflowing, water can be pumped uphill so that it can be stored and then released when needed, to flow downhill to turn turbines that make electricity. Such a system would be, in essence, a gigantic hydroelectric battery. The huge increase in wind generation along the Columbia River in the last decade sometimes produces a surplus of power that could be stored on the surrounding hills for use on days when the wind doesn't blow.

Last year, the U.S. Department of Energy awarded a $1.5 million grant to study a proposed pumped-storage reservoir on the Washington side of the Columbia near the John Day Dam. (A similar project has been proposed for pumped storage behind Hoover Dam.) In this era of excitement about alternative renewable energy, old-fashioned green hydropower is sometimes neglected. Let’s not forget about it. For more information, see: “Hoover Dam was a public works project likened to the pyramids. Now, after channeling a river, what if it could tap the power of the sun and wind,” New York Times, July 24, 2018. Bob Sack is a member of the Lake Oswego Sustainability Advisory Board (appointed by the City Council) and is on the board of the Lake Oswego Sustainability Network, a citizens’ group. The views expressed in these articles are his own, and do not necessarily represent the views of the organizations with whom he is associated.

Copy obtained from the National Performance of Dams Program: http://npdp.stanford.edu
The Snake River dams fill a power gap. Lawmakers need to know that

BY THE TRI-CITY HERALD EDITORIAL BOARD, JANUARY 30, 2019, tri-cityherald.com

Saying we don’t need the four lower Snake River dams because they generate just a small percentage of the region’s electricity is a bit like saying the Seattle Mariners don’t need relief pitchers who are in the game for only an inning or two. The dams, like a closing pitcher, are needed for their reliability and to fill in during critical times. As lawmakers consider Gov. Jay Inslee’s proposal to make Washington 100 percent carbon free, we hope they grasp the role hydropower plays in providing clean, renewable, low-cost power to the region. We also hope they come to understand the essential role the Snake River dams play in the power-generating system.

Hydro: An Old Generating Dog Can Offer New Tricks
02/01/2019 | By Kennedy Maize, powermag.com

Hydroelectric power doesn’t get much attention in today’s discussions of how to generate electricity, particularly in a world looking to boost renewable technologies such as wind and solar. But the oldest form of electricity generation—the original renewable—has plenty of life.

Hydroelectric generation—using water to turn turbines—is the Rodney Dangerfield of renewable energy. The late American comedian had a well-known catchphrase: “I don’t get no respect.” But what some have viewed as a politically incorrect form of electric generation—due to its environmental impacts—is the dominant source of low-carbon dioxide renewable energy on the planet, as well as the oldest source of power. According to the International Energy Agency (IEA), “Hydropower is the largest source of renewable electricity in the world, producing around 16% of the world’s electricity from over 1,200 GW of installed capacity.”

The International Hydropower Association (IHA) this year said China leads the world with 341 GW of installed hydro capacity, followed by the U.S. with 103 GW, Brazil with 100 GW, and Canada with 81 GW (Figure 1). Hydro’s position in the U.S. mirrors the IEA world assessment. The U.S. Department of Energy’s (DOE’s) Energy Information Administration (EIA) says that “conventional hydroelectric” generation—high-head dams—totaled 300.353 TWh of generation in 2017, compared to 254.303 TWh for wind, 50.017 TWh for solar photovoltaic, 41.152 TWh for wood and wood-derived fuels, and 15.927 TWh from geothermal. Wind and solar have boomed, but they started from a smaller base. An analysis from the anti-hydro group Rivers without Boundaries noted that worldwide in 2017, solar added 98 GW of nameplate capacity, wind 52 GW, coal 35 GW, natural gas 38 GW, large hydro 19 GW, and nuclear 11 GW. IEA’s 2018 hydro assessment says, “Annual net capacity growth has slowed in recent years, due to fewer large projects being developed in China and Brazil. However, cumulative capacity is still expected to increase by an additional 125 GW by 2023.” By 2050, according to a 2012 IEA analysis, hydro could double its generation to more than 7,000 TWh, and “prevent annual emissions of up to 3 billion tonnes of CO2 from fossil fuel plants.” It appears that this old generating dog has new tricks.

A Deep History of Water Power
Hydroelectricity dates to the 19th century, when both Pelton and Francis turbines were invented, based on water wheels that ground grain for 2,000 years (see sidebar).
Legendary British scientist Michael Faraday in 1831 demonstrated the basis of hydropower: electromagnetic induction.

**Hydro Turbine Technologies**
Hydro turbines generally come in two types: impulse turbines and reaction turbines. According to the U.S. Department of Energy (DOE), “The type of hydropower turbine selected for a project is based on the height of the standing water—referred to as the ‘head’—and the flow, or volume of water at the site. Other deciding factors include how deep the turbine must be set, efficiency, and cost.”

**Impulse Turbines.** According to the DOE, “The impulse turbine uses the velocity of the water to move the runner and discharges to atmospheric pressure. The water stream hits each bucket on the runner. There is no suction on the down side of the turbine, and the water flows out the bottom of the turbine housing after hitting the runner. An impulse turbine is generally suitable for high-head, low-flow applications.”

An example is the Pelton turbine used in the Bieudron Hydroelectric Power Station in the Swiss Alps, which went into service in 1998. The plant features three Pelton turbines rated at 423 MW each. The Pelton turbine was originally developed and refined in the 1870s. Another impulse technology is the cross-flow turbine, also known as a Banki turbine. These designs are suited for small projects, such as run-of-river or conduit projects that capture energy from larger water flows and lower heads.

**Reaction Turbines.** These machines generate power from both the pressure and the energy from moving water. According to the DOE, “The runner is placed directly in the water stream flowing over the blades rather than striking each individually. Reaction turbines are generally used for sites with lower head and higher flows than the impulse turbines.”

The Francis turbine, according to the DOE, “has a runner with fixed buckets (vanes), usually nine or more. Water is introduced just above the runner and all around it and then falls through,
causing it to spin.” Invented in the 1850s, the Francis turbine is suited for applications ranging from several kW up to several GW. They are the most common hydro turbines. The Grand Coulee Dam on the Columbia River in Washington state, with two powerhouses developed in the 1930s and a third in 1974, employs Francis turbines with a total capacity of 6.8 GW.

In 1881, a dynamo at Niagara Falls, New York, generated electricity for nearby street lighting, the first commercial hydroelectric generation. By 1886, 50 hydro plants were online or under construction in the U.S. and Canada. By the turn of the 20th century, hydro was rapidly becoming the source of most U.S. electricity. The 1902 Reclamation Act gave the federal government’s Interior Department authority to develop large-scale hydro on public land.

The 1930s saw hydropower take off, with the Boulder (renamed Hoover) Dam (Figure 2) on the Colorado River, the creation of the Power Authority of the State of New York and its Niagara River generation, the establishment of the Tennessee Valley Authority and its major hydro program, and the construction of the Grand Coulee and Bonneville dams in the Pacific Northwest.

By the 1960s, hydro galvanized a nascent environmental movement. Opponents began challenging the lakes created by high dams, as the water inundated enormous amounts of land, sometimes destroying unique ecosystems and beautiful natural features. That was the case with the 1960s-era, 710-foot-high Interior Department Glen Canyon Dam (Figure 3) on the Colorado River in Arizona. It created Lake Powell, with a 161,000-acre surface area. That project energized the Sierra Club, then mostly a California-based hiking group. It turned environmental activist, the late David Brower, into an icon of environmentalism. Brower later founded Friends of the Earth, which cut its political teeth on opposition to hydro.

Today, hydro is evolving away from the conventional big dams with high water heads. In the U.S., sites for large-scale hydro now appear limited, except perhaps in Alaska. But newer hydro technologies may have a bigger role in keeping water power in the generating mix. These include run-of-river hydroelectricity; smaller low-head projects of 10 MW or less, often with no manmade reservoirs; conduit and canal generation; wave and tidal power; and, perhaps most important, pumped storage. Hydro has tangible virtues. Able to provide baseload power, hydro can also follow load, so it can be dispatched economically. Hydro also offers spinning reserves, reactive power and voltage support, and black-start capability. Hydro can provide power storage, an increasingly valuable service as intermittent generation from wind and solar begins to capture much new generation in a world looking for low- and zero-carbon dioxide generating sources.

A Pumped-Storage Future?

Pumped storage dates to the 1930s. It may be the most attractive future hydro application. According to the EIA, 97% of installed electric storage capacity in the U.S. today is pumped storage. The concept is simple: Surplus electricity from conventional generation pumps water uphill. Then operators release the water to generate power when the grid needs more electricity. The development of nuclear power gave impetus to pumped storage. By federal regulation—and U.S. plant designs—U.S. nuclear plants don’t follow load. They operate 24 hours a day, every day of the year, in the ultimate definition of “baseload.” But often—particularly in the dead of night—the power nuclear plants generate can’t be used. It is dumped, a wasted resource. Generating utilities saw pumped storage as a way to store that formerly unwanted power for when it was needed, helping to recover costs.
The U.S. has more than 13 GW of pumped-storage capacity in projects greater than 1,000 MW. The Federal Energy Regulatory Commission (FERC), which licenses hydroelectric projects, said, “Most of these projects were authorized more than 30 years ago.” As nuclear power faded and the connection linking pumped storage to nuclear plants weakened, utility interest in the technology waned. The rise of intermittent power generation, particularly from wind and solar, has revitalized interest in pumped-storage technology. Worldwide, according to IEA data, pumped-storage capacity today is about 150 GW, with about another 75 GW in the development pipeline. The National Hydropower Association (NHA), the Washington, D.C., lobby for the domestic hydro industry, said in a 2018 report on pumped storage: “A technology exists that has been providing grid-scale energy storage at highly affordable prices for decades: pumped storage hydropower. While batteries, compressed air, flywheels and other emerging technologies often capture the headlines, pumped storage hydropower has continued to advance its capabilities as the leading grid storage solution allowing for even more optionality in the effort to integrate intermittent renewable energy in a reliable and cost-effective manner.”

Given new opportunities for energy storage, pumped-storage purveyors have upped their game. The NHA noted that pumped storage “has continued to advance its technology in recent years, including the capability for very fast response to grid signals, and an increased flexibility for development in broader, less traditional geographies with the application of ‘closed loop’ systems.” According to FERC, closed-loop pumped-storage systems “are not continuously connected to a naturally flowing water feature.” That reduces their environmental impact. There are no closed-loop systems currently operating in the U.S.

The DOE in December said it had picked two proposed pumped-storage projects for analysis of their “long-term value”: GridAmerica Holdings’ conventional 1,200-MW Goldendale project on the Washington-Oregon border, and Absaroka Energy’s 400-MW closed-loop, Gordon Butte project (Figure 4) in Montana. DOE said that while pumped-storage hydro was “initially built to balance the electricity system between periods of high demand during the day and low demand at night, increases in variable renewable generation have changed how plants are operated and the value they provide to the grid.”

POWER magazine in May 2017, citing the IHA, reported that “about 6.4 GW of pumped storage systems were installed worldwide in 2016—more than twice the 2.5 GW installed in 2015. The surge in pumped storage system installations is in tandem with soaring interest in energy storage technologies to support the integration of variable generation and support grid stability.” While often dismissed, hydro has not run out of steam (or water). As a DOE analysis recently concluded, “Even after a century of proven experience with the reliable renewable resource, significant opportunities exist to expand the nation’s hydropower resources through non-powered dams, water conveyance systems, pumped storage hydropower, and site —Kennedy Maize is a long-time energy journalist and frequent contributor to POWER.

(Wind power people are greedy, they don’t want hydro competing with them.)

Dennis Carr: Gov. Polis needs to rethink 100 percent renewable plan
By Dennis Carr, 02/04/2019, reporterherald.com

Opinion: Colorado going 100 percent renewable energy by 2030 disturbs me. Renewable energy is solar- and wind-generated. Coal, oil, gas and nuclear are not considered renewable. It is not clear to me if Gov. Polis and environmentalists include hydro generation as renewable. Some environmentalists would like to
Before such commitments are made, one must consider the consequences of shutting down all forms of non-renewable energy generation. The law of diminishing returns must also be considered. Renewable energy sources are unpredictable. Light energy is spherically radiated from the sun. A very small cone of light strikes that part of earth facing the sun. Solar cells can only generate electrical energy when enough sunlight strikes them. Maximum energy is when the solar cell is perpendicular to the sun rays and is dependent on the season and location on the globe. To obtain maximum energy the cell must move with the sun, which consumes electrical energy. Cells produce no energy in darkness. Cloudy days lower their electrical output. Wind generators produce no energy when the wind speed is low and when their vanes are feathered during high winds. Environmentalists and those concerned about birds have impacted the installation and use of renewable energy sources.

Hydro generation is already restricted by environmentalists, those concerned about birds that make nests on sandbars, concerns of fish being able to spawn, those who use water for boating, fishing and hunting, those downstream and upstream concerned about flooding, commitments under contract to deliver energy to customers, Corps of Engineers requirements and more. Consideration will need to be given to energy storage systems should excess energy (in excess of load demand) be generated so it can be used to supplement lean times. These storage systems may use batteries composed of environmentally dangerous chemicals or of water pumped behind dams so the water can flow downhill through generators, which will take away more land.

Electrical vehicles are becoming more numerous and will increase the consumption of electrical power. To “feed” these electrical vehicles like gas vehicles are today (consider out-of-towners), there needs to be commercial charging stations as numerous as gas stations are today. Eventually the electrical vehicle will be capable of being charged as quickly as a gas tank can be filled today. That will require high-voltage power being delivered to each charging station. How much land for renewable sources can we take away from farmers and ranchers currently being used for growing food and raising cattle before we impact our food chain? If I remember correctly, energy cannot be created or destroyed; it can only be converted from one form to another form. So any light energy converted to electrical energy will not be available to heat the earth.

Considering all this, especially during hot summers and cold winters, I sincerely believe that if Colorado prohibits the production of non-renewable energies by 2030, Colorado will have to import energy from out of state, if any is available! Once non-renewables are gone, they will not come back quickly, for many reasons. Gov. Polis needs to rethink this plan. It is foolhardy. Colorado should not put its “life” in the hands of other states! Dennis Carr is a Loveland, CO resident.

Environment:
(Someday it’ll happen.)
Firm abandons plan to help endangered salmon in Maine river
BY PATRICK WHITTLE, ASSOCIATED PRESS, JANUARY 31, 2019

PORTLAND, MAINE
A plan to test the use of a new technology to help endangered salmon in a Maine river that is critical to their existence has been abandoned, at least for now. Atlantic salmon return to very few rivers in the United States, and the most important of those is the Penobscot River in Maine, which is more than 100 miles (160 kilometers) long and runs inland from the state's mid-coast
As the salmon return to rivers from the sea, they are faced with hazards, including manmade structures such as dams. Fish passages, such as ladder-like structures, are used around the world to help fish around difficult spots so they can eventually spawn. Brookfield Renewable of Toronto had planned to evaluate the performance of a new type of fish passage that might help Maine’s salmon navigate a hydroelectric facility the company operates on the Penobscot in Milford, some 140 miles (225 kilometers) north of Portland.

The U.S. Department of Energy awarded the project an $800,000 grant and issued a statement in April signaling its support of the project. But Brookfield spokesman Andy Davis told The Associated Press that the firm has withdrawn from the project, and it’s not scheduled to go forward. He said the project's architects discovered a "significant risk" to species other than salmon, such as river herring, from installing the system. "We found concern about non-targeted species," Davis said. "We're always looking at innovative types of fish passage, and we're hoping that something like this can be implemented on a broad basis." Davis said the federal money for the project will not be sent due to the cancellation. A U.S. Department of Energy spokesperson confirmed the project isn't moving forward.

The fish passage on the Penobscot was to be a system designed by Whooshh Innovations, a Seattle company. The system would have been designed to use pieces of flexible tube to propel the fish around potential obstacles. Davis said Brookfield is still hoping to use it, and has plans to test it out on alewives at a different location on the Saco River in southern Maine. Vince Bryan, chief executive officer of Whooshh, said his company is interested in making the Saco River project happen, and he still believes the system could have potential on the Penobscot in the future. He said the system has the ability to more efficiently move salmon and other fish through dangerous areas than older model solutions such as fish ladders and lifts. "Brookfield was concerned the work would be dangerous. So it would be more expensive than the grant allowed," Bryan said. "What we're trying to organize is a study with alewives." Alewives are a species of herring. The Penobscot River is a closely watched body of water in conservation circles because it's the most productive river for the salmon in the U.S. Maine's also the only U.S. state left with native Atlantic salmon populations. Less than 850 of the salmon returned to the Penobscot in 2017, though the numbers tend to rise and fall from year to year. The number was above 1,000 per year in the late 2000s and early 2010s. The fish are on the U.S.'s endangered species list.

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