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Cyberattack on Nov. 7 poses questions about vulnerability of electric system in Colorado

A Nov. 7 cyberattack on Delta-Montrose Electric Association that left the electrical cooperative unable to operate phones, e-mail, and payment processing for several weeks has raised questions about the motive of attackers and the security of other electrical utilities.

Until Delta-Montrose reveals more about the case, little definitively can be said. The cooperative this week declined an interview. "We do not have additional details to share," said cooperative spokeswoman Becky Mashburn in an e-mail. "We are currently focused on restoring full support services to our members."

Electric service was no compromised.

The Montrose Mirror reported that Delta-Montrose, in the board of directors meeting on Nov. 30, sidestepped questions from a cooperative member about whether Delta-Montrose had been the subject of ransomware. Ransomware is a type of malicious software designed to block access to a computer system until a sum of money is paid.

Normally, once the bribe is paid, those conducting the attack deliver the data. Delta-Montrose has been rebuilding its database, however, suggesting that if a bribe was paid, the saboteurs reneged on a promise to deliver the encryption code necessary to retrieve the data.

One expert told Utility Dive that it "seemingly sounds like a ransomware attack." That expert, Ben Miller, Dragos vice president of professional service and research and development, said he expected to hear more in coming weeks on overall impact, because the electric sector has a track record of mutual assistance and sharing lessons learned.

The main takeaway from the Utility Dive article was the consensus of the experts it consulted that ransomware can just as easily target small enterprises as major ones. Delta-Montrose has 35,000 customers.

Another thought is that this may be just a simple case of sabotage. If so, the motive remains unclear.

On its website, Delta-Montrose said it had retained a team of forensic and cybersecurity experts to investigate the scope of the incident and its impacts. "That investigation is still ongoing," the website said as of Dec. 8.

Colonial Pipeline

A case in May involved a giant energy company, Colonial Pipeline, which paid $4.4 million to a Russia-linked cybercrime group known as DarkSide.

The company's systems transport roughly 2.5 million barrels of gasoline, jet fuel, and diesel from the Gulf Coast to the Eastern Seaboard, explained Bloomberg in a June 4 story. "The outage led to long lines

at gas stations, many of which ran out, and higher fuel prices," explained Bloomberg in "Hackers Breached Colonial Pipeline Using Compromised Password."

Colonial Pipeline "turned off the spigot on the fuel network out of concern that the malware that had infected its back-office functions would make it difficult to bill fuel delivered along the pipeline or even spread into the pipeline's operating system," reported the New York Times a May 14 story, "Pipeline Attack Yields Urgent Lessons About U.S. Cybersecurity."

The Times noted that government officials and industry executives for years "have run elaborate simulations of a targeted cyberattack on the power grid or gas pipelines in the United States, imaging how the country would respond."

In this case, the attacker was not a terror group or a hostile state like Russia, China, or Iran, as had been assumed in the simulations.

"Every fragility was exposed," said Dimitri Alperovitch, a co-founder of CrowdStrike, a cybersecurity firm, and now chairman of the think tank Silverado Policy Accelerator. "We learned a lot about what could go wrong. Unfortunately, so did our adversaries."

In the Montrose-Delta case, the cooperative's ability to deliver electricity was not compromised. And Alyssa Clemsen Roberts said at the Nov. 30 board meeting that they believe no customer information was accessed, according to a report in the Montrose Daily Press.

"Your address, name and things like that maybe, if it was in an e-mail or something like that. But your personal information about your address, no," she said. Ninety percent of internal network functions and "a good portion of our data" were corrupted.

Privately some knowledgeable individuals predicted that utilities will find it necessary to devote more resources to ward off such attacks. Others speculated that other, especially smaller electrical providers, are scared. Not all e-mails and phone calls for this story were returned.

Tri-State Generation and Transmission offered this statement when asked for comment:

"Tri-State places a strong focus on cyber and physical security for our critical infrastructure and systems. In addition to maintaining North American Electric Reliability Corp.'s Critical Infrastructure Protection compliance, Tri-State also maintains a dedicated Cyber Security Center focused on defending against cyber threats, utilizing an array of technologies and techniques. While we cannot further discuss the specifics of our security efforts, the recent attack is a reminder of the importance of remaining vigilant, and we remain diligent in our efforts to protect Tri-State's systems against all threats."

Denver climate tax paying $26 million for 12-plus solar projects

In November 2020, Denver voters handily approved a sales tax increase of 0.25% earmarked for a new Climate Protection Fund. The tax was projected to yield $37 million this year, rising to $45 million by 2025.

That fund is being tapped for a $26 million project that is expected to yield 12-plus solar projects at city parks and recreation centers and at least one high school campus. About 30% of electricity generated by the projects will be allocated to low-income housing and the city's public schools.

The climate fund was put before voters upon the recommendation of the city's Climate Action Task Force, which urged Denver to eliminate 100% of emissions by 2040.

The ordinance governing the fund authorizes uses in six categories, among them: 1) job creation; 2) increased investments in solar power, battery storage, and other renewable energy technology; and 3) adaptation and resilience programs to help vulnerable communities.

Ground will be broken on the solar projects beginning in spring 2022. The contract for the work is with McKinstry.

This is by far the biggest straw that has been inserted into the fund. Another 12 contracts have been awarded for a total of $7.5 million. The projects include e-cargo delivery bikes; a program designed to incentivize conversion from using steam for building heating to electricity; to e-bikes and building performance staffing.
For details of these projects, see the Climate Protection Fund Five-Year Plan.

Suncor Refinery film shown in Commerce City

A lively discussion occurred in Commerce City on the evening of Dec. 1 upon the occasion of the showing of a new documentary film called "Suncor Showdown."

The film was produced by Cultivando, Spirit of the Sun, and Womxn from the Mountain, and it tells the story of Suncor, Colorado's only oil refinery, from the perspective of community activists in Commerce City who see the refinery's operation as a classic example of the failure of environmental and social justice.

"My community has suffered through years of being poisoned and there has been no accountability to the families and children who have been harmed for decades," said Olga González, executive director of Cultivando.
"For too long, this refinery has seriously harmed our land, water, and air quality. It is my hope that this film can demonstrate the many ways in which Suncor has not been a good neighbor and build momentum for others to rally behind demanding immediate actions to stop this harm."

The Colorado Department of Public Health & Environment will decide whether to renew Suncor's lapsed permits in early 2022.

"If this refinery were located in a white neighborhood, it would have been shut down years ago," said Micaela Iron Shell-Dominguez, social and environmental empowerment coordinator at Spirit of the Sun.

"The fact that it continues to operate, trying to placate us by giving us free car washes to clean off the toxic chemicals the plant emits and other nonsensical gimmicks, illustrates how much they value our lives. It's time for Suncor to sunset."

The film can be viewed by clicking here.

The refinery is on the western edge of Commerce City, a municipality of 62,000 people. Largely agricultural until the 1930s, it became a place of industry but also more generally lower-income neighborhoods.

The refinery is located in an area where 55% of the residents live below the poverty level. This includes some neighborhoods in Denver.

After the film, long-time community members spoke as did several Commerce City Council members, both past and present.

Wonky rulemaking will make most of the difference in whether Colorado hits GHG targets

by Allen Best

Colorado has a goal for 2030 of reducing carbon emissions from its economy by 50%. Can it hit that mark?

Yes, probably, says a team of analysts from the Rocky Mountain Institute. But much depends upon how state agencies implement laws and policies adopted by state legislators.

"Having laws on the books that could put the state's 2030 goals within reach is an important achievement to celebrate, but it is not the finish line," said the RMI researchers in a blog post on Nov. 15.

Their report, "Colorado's Role as Climate Leader Hinges on its Next Steps," explains that components of recent legislation already in effect will drive down total emissions by roughly 10% by 2030 as compared to business as usual.

These concrete accomplishments will be achieved primarily in the way that electricity is generated and in the energy consumption by buildings.

Legislation alone, however, is often not sufficient, says Lainie Rowland and her co-authors, Kyle Clark-Sutton, and Olivia Ashmoore. They point to the importance of new or updated rules adopted by state agencies in closing most of the remaining gap of the 2030 goal.

"These reductions are far from guaranteed—they will require significant investment, strong rules, robust enforcement and transparent evaluation," they warn.

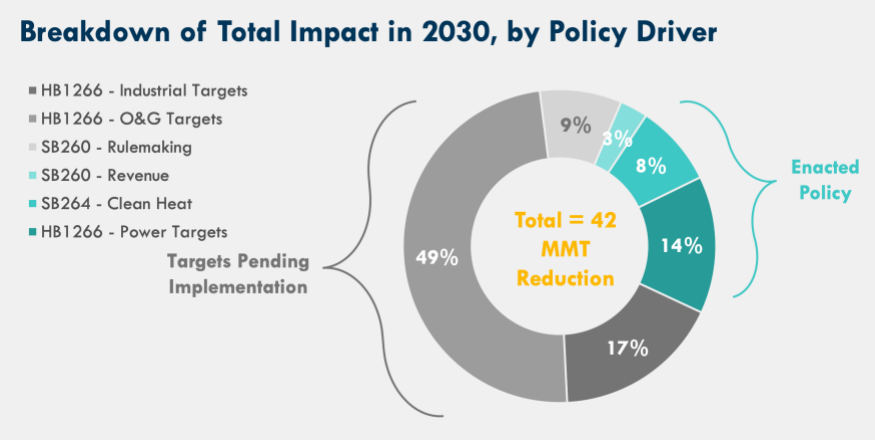
This can get tedious, as was evident in a three-hour session conducted by Megan Gilman, a member of the Colorado Public Utilities Commission, on Dec. 2. The task was to begin shaping the rules governing greenhouse gas accounting for emissions from the natural gas sector. Colorado's four gas-distribution utilities all had sat in on the video conference, as did Josh Korth, from the Air Quality Control Division, and representatives of Western Resource Advocates, Natural Resources Defense Council, and other groups.

This won't be the last such meeting. Much remains to be decided about the greenhouse gas accounting having to do with the natural gas sector.

In a sense, Colorado's aggressive decarbonization journey began with the law adopted in 2019 that established the 50% carbon reduction goal for 2030 and an even more ambitious goal for 2040.

Other laws passed in the 2019 session and then a few more in the covid-crimped 2020 session added legs to that ambition.

Then came 2021, with more than 30 bills passed into law that in various ways



seek to deliver the tools necessary to achieve the carbon reductions.

"The legislation included policies to ramp up renewable energy deployment, electrify the transportation sector, drive down emissions from buildings, and stop methane pollution at the source," the RMI team writes.

"Now it is critical that regulators take steps that enable these policies to achieve their intended goals."

RMI cited the oil-and-gas sector as a "prime example of the importance of policy implementation for driving emissions reductions." The Air Quality Control Commission in December will consider rules focused on driving down methane emissions. These rules will be crucial to Colorado getting on track toward its 2030 climate goals.

Work in oil-and-gas, transportation, and other sectors may bring Colorado very close to being on track, but additional policy will be needed, the RMI team says.

Another new board in Colorado, this to advise on transportation

Seven individuals, three from state agencies, have been appointed to a new Community Access Enterprise Board by Colorado Gov. Jared Polis.

The board will oversee the shift from internal combustion engines in Colorado's vehicles to electric ones. State officials expect the enterprise to receive $310 million to support electric vehicle charging and hydrogen fueling infrastructure during the next decade. The money will also be used for adoption of EVs and electric bicycles by those of low and moderate incomes.

This is an outcome of SB21-260, the big transportation bill passed by legislators in June.

Those appointed were:

• The Rev. Eugene Downing of the New Hope Baptist Church.

• Sarah Meirose, who works in government affairs at the Ford Motor Co.

• Alice Laird, director of the Carbondale-based Clean Energy Economy for the Region.

• Ryan Hurst, treasurer of Motiv Power Systems, Inc., a sustainable energy technology company, delivering all-electric chassis and turnkey energy systems for a wide variety of medium-duty vehicle fleets.

• Shoshana Lew, director of the Colorado Department of Transportation.

• Trisha Oeth, director of environmental policy, Colorado Department of Public Health and Environment.

• Will Toor, director of the Colorado Energy Office.

Extreme weather? Yes, and the events were interrelated

This summer it seemed that Colorado was in perdition

by Allen Best

Heat waves in June and again in July. Monster wildfires on the West Coast that made the air in Denver, Salt Lake City, and Cheyenne unhealthy. Then flash floods that produced debris flows, blocking Colorado's major east-west artery, Interstate 70 through Glenwood Canyon.

They're separate but related, said Western Water Assessment's Seth Arens in a Nov. 18 review of the year's extreme weather events in Colorado, Wyoming. and Utah. He called them a convergence of climate hazards.

"These are related; they are not independent," he said.

Arens described the concept of compound hazards, where the occurrence of one hazard can create conditions for another hazard.

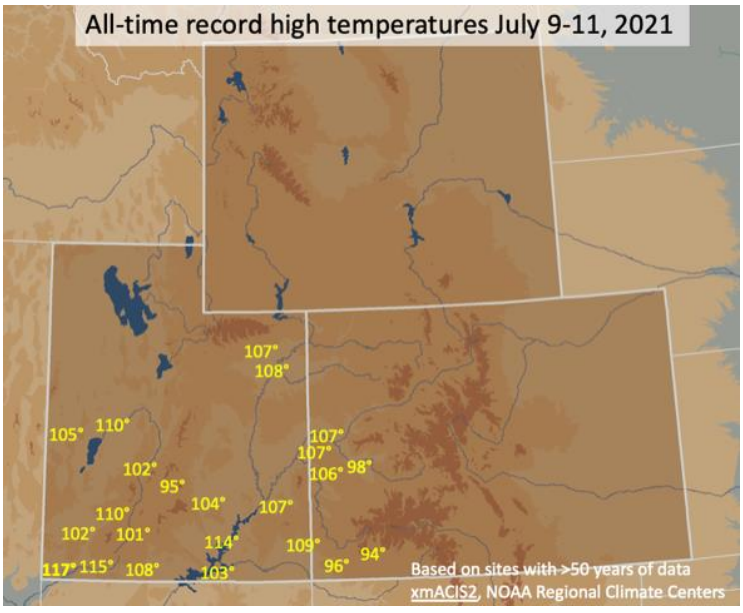
"None of these climate hazards act in isolation and many of them occur with one another," said Arens, a research scientist based in Salt Lake City.

For example, extreme temperatures and low precipitation lead to drought, which begets increased wildfire risk. The wildfires produce poor air quality. And after the fires, there's an increased risk of flash floods.

We're talking visions of Armageddon here—and, at least until the smoke disappeared in September, it seemed that Colorado had arrived in perdition.

Most of the attention about the heat dome of June focused on the West Coast, and rightfully so. Temperatures of 116 in Portland? People literally baked to death in uncooled apartments.

But it was hot in Utah, Colorado, and Wyoming, too. Arens said he narrowed his study of temperature records to places with records of at least 50 years. Even so, he found many all-time records and dozens of daily records. On just one day, June 15, Arens found that 79% of daily temperature records in Utah, 53% in Colorado, and 83% in Wyoming were broken. And so it went for two more days before the heat relented.

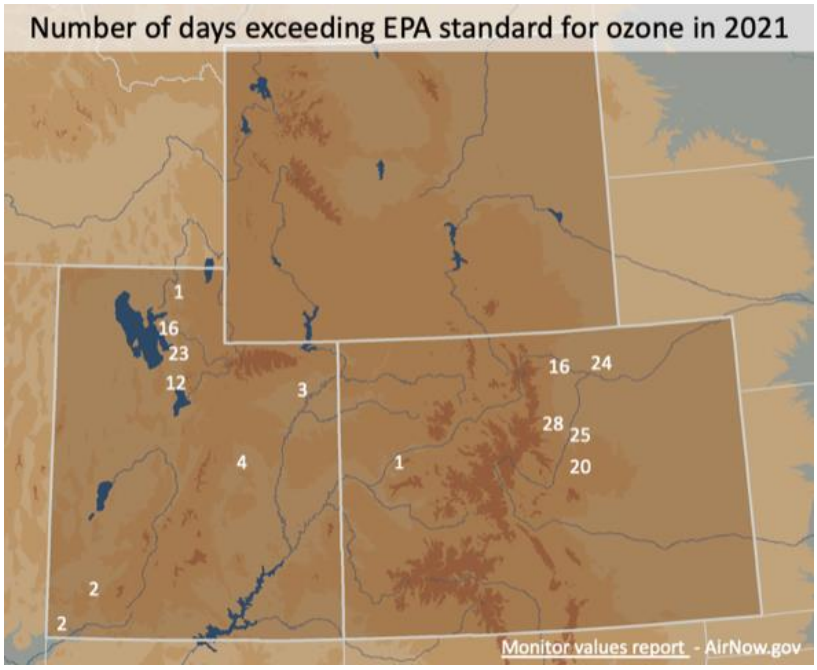


In July, more records were set, including an all-time record in Grand Junction of 107 degrees. Utah's all-time record of 117 degrees was tied at St. George. Later in July, all-time high temperatures were set in three Wyoming towns and cities, the highest being 109 degrees in Weston.

Heat devoid of precipitation equals drought. These Western states have had that. Much of the focus has been on the Colorado River Basin.

Runoff in the Colorado River during the year ending in September 2021 was 50% of average. Flows into Lake Powell were 28% of median.

In August, Powell reached the lowest elevation since it began filling after completion of the Glen Canyon Dam in 1963. It's now less than 30% of capacity. That puts it at 157 feet below full pool.



The Bureau of Reclamation, in its two-year projections, estimates the river will drop another 20 feet by spring 2022. Already, there are questions of when the reservoir level will drop below what is called minimum pool, the least amount of water needed to be able to produce electricity. That could happen by early 2023.

Might a big snow year boost water levels in Powell, averting the chain reaction of problems? Perhaps, although Arens offered little encouragement. With the La Niña weather pattern, the odds once again are for the Colorado River Basin receiving below-average snowfall.

Weather prediction has a big gap, Arens added. Weather can be predicted with some confidence beyond two weeks, and the climate can be predicted after about 9 years. But between, not much can be said with confidence.

But back to last summer. The air quality was again miserable, approaching the air quality index of 200 in Salt Lake City on July 12. In Denver it was 192. These are all levels where even healthy people are advised to stay indoors. It was marginally better that day in Cheyenne, at 119.

Along the Wasatch Front of Utah, Salt Lake City exceeded the EPA standard for ozone air quality 23 days and Ogden 16 days. In Colorado, Denver exceeded the limit 25 days, Boulder 28, and Colorado Springs 20.

Then there were the flash floods and mudslides. The torrential rains were not everywhere, but in places they sent rocks and mud rushing and tumbling down onto highways. The most notorious was in Glenwood Canyon, where the hillsides were burned last year in the 32,631-acre Grizzly Gulch fire.

These big rains had some beneficial effects, too. Soil moistures recovered, meaning the melting snow next spring will not automatically get sopped up like an absorbent paper towel.

Arens also noted that a rainstorm had a satisfying result in a Glen Canyon side canyon where the receding waters of Powell had left 18 to 20 feet of silt. The storm sent all the silt downstream, revealing parts of the canyon that David Brower had known.

Why a better handle on predicting runoff may prove valuable

by Allen Best

This story originally was published in the fall 2021 issue of Headwaters Magazine.

Runoff prediction, if much improved, remains imperfect, as managers of the Taylor Park Dam in Colorado's Gunnison County were reminded in 2018. It had been a warm winter, with rain falling around Christmas in Aspen, Vail, and other ski towns.

Traditional forecasting tools like snow telemetry (SNOTEL) monitors left water managers unaware of how much water the warm storms had left in snowpack at higher elevations. They were caught off guard when spring runoff nearly overtopped the dam. A warming, drying, and more erratic climate escalates the need for better runoff prediction.

Research launched in September at the Rocky Mountain Biological Laboratory near Crested Butte may help managers make better decisions, not just in the Gunnison Basin but in mountainous regions across the West. The $8 million Surface Atmospheric Integrated Laboratory, or SAIL, will deploy more than three dozen instruments to measure wind, rain, snow, solar radiation, and the atmospheric particles called aerosols. It's described as the world's first bedrock-to-atmosphere mountain integrated field laboratory.

Scientists hope the mountains of data gathered through June 2023 will allow them to better understand the physical processes and interactions that affect hydrology in mountainous terrain. They want greater precision in answering how, why, where, and when rain and snow will fall but also how the water flows.

Plus, they hope to better understand how dust, hot drought, and other phenomena play into this. This will improve short-term models for streamflow prediction and ideas about how the warming climate will alter water supplies.

Radar positioned on the slopes of Crested Butte Mountain Resort will be a crucial tool at SAIL for allowing a better understanding of what is going on with the weather and water. It has a resolution five to 10 times greater than a typical weather radar. Kenneth Hurst Williams of the U.S. Department of Energy's Lawrence Berkeley National Laboratory, which leads the SAIL project, says this will provide a "fantastic opportunity" to gain a sharpened understanding of the links between atmospheric and other processes that inform runoff volume.

Williams, the lead on-site researcher for Lawrence Berkeley, says availability of such a radar would have helped water managers in the Gunnison Basin better understand the high water content in the 2018 snowpack that threatened to overflow Taylor Park Dam.

SAIL will build on what was learned in two prior and overlapping projects in the Gunnison Basin. Williams in 2014 launched a separate watershed-scale effort in the Gunnison Valley and earlier, in 2009, David Gochis and others at the National Center for Atmospheric Research assessed the value and impact of radar and other technologies. That work across multiple basins also involved working with the new airborne lidar technology that uses remote sensing to better estimate water volumes in snowpacks—but lidar cannot reflect changing conditions from day to day, let alone week to week.

"Different tools and different data sets are better for some things than others," says Gochis. "At the end of the day, there is much room for improvement in all of this. But it's not 'either or;' it's 'and.'"

As for the value of all this, Gochis says it's easy. A 30% forecast error can be worth 60,000 to 80,000 acre-feet of water delivery to downstream users. "We're talking about $30 million to $40 million pretty quickly," he says.

When will low-snow or no-snow become the norm in Sierras? Or in the Rockies?

by Allen Best

In 2008, Science magazine published an essay called "Stationarity is Dead: Whither Water Management." In the essay, PCD Milly, a research hydrologist with the U.S. Geological Survey, and others, argued that climate change was upsetting all the apple carts of water management. Water management, they said, was set up for a 20th century climatic regime that had changed and would change further.

Thirteen years late, the evidence continues to accumulate in support of that thesis. The latest is a report, "A low-to-no snow future and its impacts on water resources in the western United States."

The authors, primarily from the Lawrence Berkeley National Laboratory and other University of California schools, overlap with the research team for the SAIL project in Gothic. The report has six authors from California, one from Nevada and one from Colorado, Denver Water's Laurna Kaatz.

The report published in Nature Reviews Earth & Environment provides a bold warning about the strong potential for snowless winters becoming relatively commonplace by mid-century and beyond, especially in the coastal ranges and Sierra Nevada of the West Coast.

It got significant attention from the Washington Post last week under a headline of: "Snow may vanish for years at a time in Mountain West with climate warming."

That's not exactly news. I may be low on the journalistic totem pole, but I've been writing about this for at least a decade. And no one single headline can do justice to the variations of Western topography.

In a 2016 story I wrote:

"Contrary to what some have said, those who professionally study the changing climate and its rising temperatures do not foresee an end to snow. Or winter. Or skiing.

At least not everywhere, nor in a set amount of time—the next 25 to 30 years—that matters to many North American mountain towns.

They do see, however, continued increases in both day and nighttime temperatures that might threaten the livelihood of some ski areas, especially those at lower elevations, which could have a ripple effect on the industry."

This new report delivers relatively little new information but does prominently hoist a talking point around the concept of low- and no-snow years.

The report synthesized 18 models about future precipitation and temperatures. The modeling foresees relatively little dramatic change until about mid-century. Then, changes occur abruptly.

The Sangre de Cristo Range from near the town of San Luis, Colo., remained mostly snowless on Nov. 28, 2021 Photo/Allen Best

Only 8% to 14% of years were classified as low- to no-snow over the period of 1950 to 2000.

This compares to 78% to 94% between 2050 and 2099.

The report defines a phenomenon called episodic low- to no snow as being five consecutive years in which more than 50% of the basin area experiences low-to-no snow. This emerges in the late 2040s in California, but in the 2060s for most basins.

Persistent low to no snow is defined as 10 consecutive years of greater than 5% of the basin area having low to no snow. That is predicted to occur in the late 2050s in California and as late as the end of the 2070s in the upper Colorado River Basin.

This is a broad-brush of a report. It distinguishes among the four major mountain ranges that have been studied, but provides relatively little differentiation other than to note a substantial distinction between the West Coast and the Rockies. And there is great uncertainty. "The large spread in projected changes at mid-century to end of century highlights the lack of consensus on this time to emerge of low- to no snow."

To be clear, though, the science all points in the same direction. Just how different that future will be for babies born in 2021 when they became octogenarians is revealed in this sentence: "Although not impossible, it is unlikely that a complete disappearance of snow in the Western United States will occur before the end of the 21st century, even under a high-emissions scenario."

The report bills itself as a "call to action" and warns of the "dire implications of a low- to no-snow future, given its central role in mountainous watershed behavior, ecosystem function, and ultimately, downstream water availability."

Most of us understand this so well that it seems trite to even mention it, but the water infrastructure of the 20th century was built around the idea that fallen snow —the majority of precipitation in most Western basins, including those of Colorado —builds up over winter and then somewhat leisurely melts, often far into summer.

That absence of stationarity will have huge consequences of which we are only starting to reckon.

Ceiling beams but little more remain from the lodge where Colorado River representatives in 1922 negotiated details of the compact that today governs allocations of the diminished waters. Photo Nov. 28, 2021/Allen Best

Bishop's Lodge was remade not razed. Can the Colorado River Compact also be modernized?

by Allen Best

On the Sunday following Thanksgiving I visited Bishop's Lodge, a property recently acquired by Auberge, the operator of 5-star hotels in what the company calls "extraordinary locations." It has hotels in Aspen, Park City, and Telluride as well as a few dozen other places around the world.

In New Mexico, Bishop's Lodge is found at the end of a winding, two-lane road in the foothills of the Sangre de Cristo Mountains, maybe 25 minutes from the plaza of Santa Fe. It has all the touches you'd expect of a hostelry that tonight, far from any peak season, asks $800 for a night's lodging.

But I went for another reason. Bishop's Lodge is where the Colorado River Compact was negotiated in November 1922. The compact created the platform for the population explosion of the American Southwest during the last century. Even passing students of Western history, which is how I would describe myself, are drawn to places of such pivotal transactions. Whether that seminal document survives another century is another matter entirely.

Representatives of the seven states that have land within the Colorado River Basin had met earlier in the year in Washington D.C. but had failed to reach agreement on

Lake Mead was 40% full and the surface was at 1090 feet in elevation when this photo was taken in December 2019. It was 1065 feet as of Nov. 30, 2021. The Bureau of Reclamation issued a model in September that projected a 66% chance that the reservoir level will drop below 1025 within the next 5 years. That would put the reservoir level 75 feet below what you see in this photo.

Photo/Allen Best

terms of a compact governing how waters of the Colorado would be apportioned.

The seven states had diverse motivations for wanting the compact. California needed the compact because it needed the federal government's help in taming the river's springtime floods. An effort to build a diversion canal to water the scalding hot desert in what is now called the Imperial Valley had gone awry in 1905. A portion of the river broke free of the channel and, using the new outlet, rushed downhill into a below-sea-level depression that became known as the Salton Sea.

California needed the federal government's assistance in building dams to hold back those flows so that irrigation infrastructure could be installed and the fertile but parched desert soils could be put into production.

Colorado and other upper-basins states had different reasons for wanting the compact. They were intent on specifying portions of the river's flows that they could develop when the populations of their more slowly growing states had need for the water. Colorado (and most Western states) use the doctrine of prior appropriation—first in time, first in right—in allocation of water. If this doctrine were applied to the Colorado River, California and Arizona would likely have had their straws in the river far before Colorado could get its diversions in order. This was despite the fact that roughly half of the river's waters originate in Colorado.

The Colorado River Compact emerged from the negotiations during the week before Thanksgiving. Not everybody got what they wanted, but legislators of all the states save for Arizona had approved the agreement by 1929. In approving construction of Hoover Dam the previous year, Congress had specified that the

compact would go into effect when 6 of the 7 states had ratified it. By presidential resolution, the compact went live—to use a more modern word—on June 25, 1929.

Various books have laid all of this out in great detail, perhaps none with greater detail than Norris Hundley's "Water in the West: the Colorado River Compact and the Politics of Water in the American West." I'm partial to "Science Be Dammed," a 2019 book by Eric Kuhn and John Fleck that explores in detail how the compact conceived at Bishop's Lodge was premised on faulty assumptions. The compact assumed average annual river volumes that had rarely existed. Kuhn and Fleck show that the science was available to the Colorado River delegates gathered at Bishop's Lodge that should have caused them to revise the apportionments downward. The evidence for more pared assumptions of river flows was even more persuasive in 1929, when Congress ratified the compact. (See my 2020 review of "Science be Dammed" **here.**)

In the 20th century, there was rarely as much water as the delegates assumed. In the 21st century the river flows have declined 20%. The big reservoirs, 95% full at the end of the 20th century, had declined to 32% full at the end of September 2021. Glen Canyon is emerging once again, as are the now chalky cliffs of the shrinking Lake Mead.

This may very well be part of natural climatic cycles, as had occurred in the decades, centuries, and millennia before the compact was adopted. Now comes a warming climate that is constricting river flows. There's a strong correlation with the accumulating greenhouse gases in the atmosphere. If this correlation is also causation, as many climate scientists contend, the river flows will decline even more in coming decades.

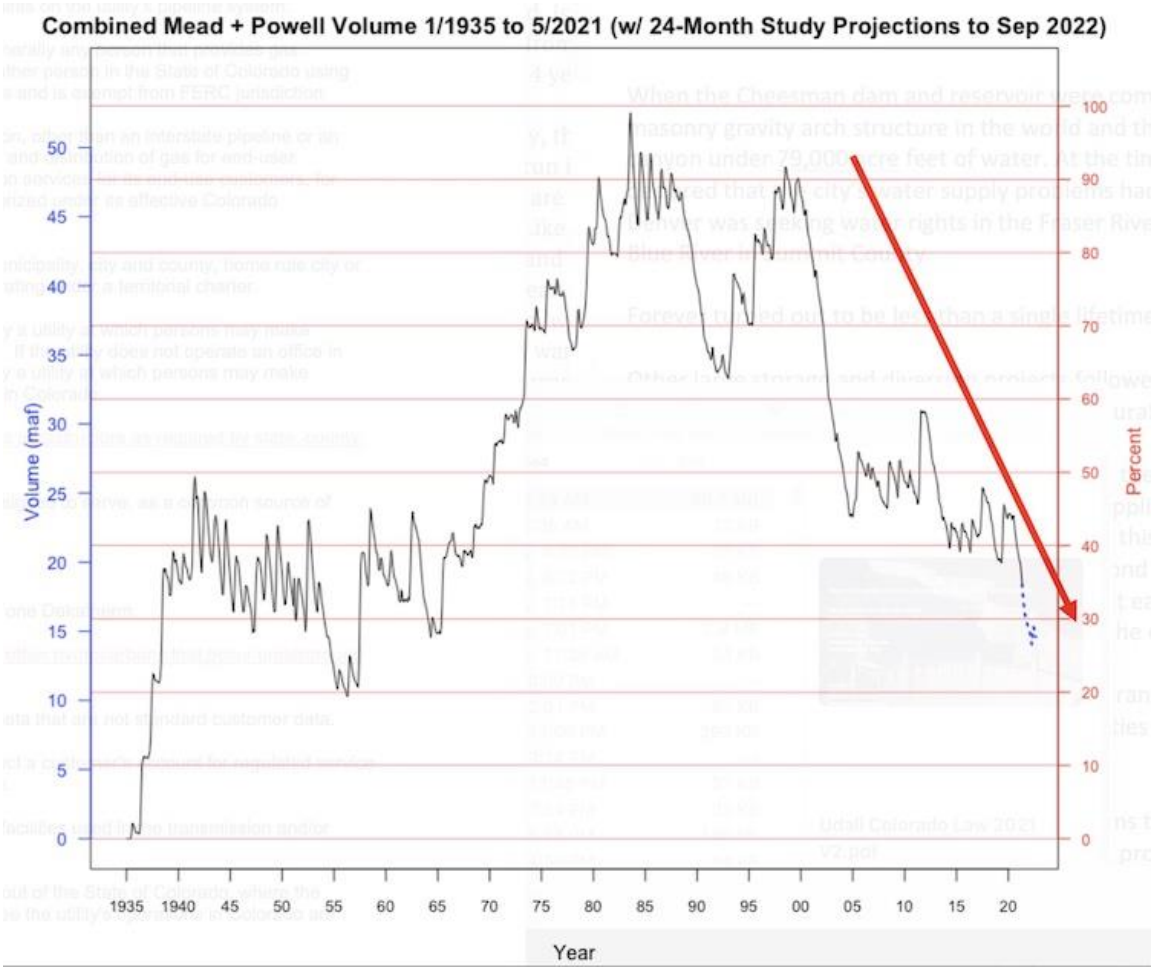
At Bishop's Lodge, I asked the professional greeters about the location of the lodge in 1922. It's still there, wooden rafters in a few interior rooms being the same as those under which the river delegates gathered nearly a century ago. The original lodge, though, now lies within a larger building, the restaurant for the resort. In front a rusted pickup tells of a time long gone, although nowhere in the building is a commemoration of the deliberations that in some way affect the water for 35 to 40 million people.

Like the original Bishop's Lodge, the Colorado River Compact remains intact but is now surrounded by additional agreements. The most recent is the Drought Contingency Plan of 2019.That mini-compact, if you will, agreed to some temporary provisions to begin removing straws or at least the vigor of the sucking. Even then, two years ago, there was agreement that the real work would be necessary for another agreement due for adoption in 2026. A few individuals said they feared that the rapidly declining flows would not abide the can being kicked that far down the road or, I guess in this case, river.

But do the worsening conditions warrant razing this compact built 99 years ago on the false premise of water abundance?

I asked that question of Kuhn several years ago, and his answer made sense. There is too much risk in trying to start from scratch, he told me. The states would not do so.

After writing the first draft of this essay, I checked with Kuhn to see if my memory of his remarks were accurate. He confirmed their accuracy, but went on to share his growing worries about the implications of the aridification of the natural flow of the river if they continue at the same rate as has occurred in the last 20 years. "I am now concerned that the states and Interior will not have the will and creativity to bend the compact enough to avoid what Doug Kenny



(formerly of the University of Colorado Law School) called a 'Dumpster fire,'" he wrote in an e-mail.

Anne Castle, in remarks to a Congressional subcommittee during October, didn't call for a remodeling of the Colorado River Compact. She did, however, suggest that the current response was laggard given the rapidly-declining reservoir levels.

In her **testimony,** Castle, the assistant secretary for water and science at the U.S. Department of the Interior from 2009 to 2014, said she doesn't see a federal imposition of a "solution" being the answer, but she does believe the federal government needs to impose a stick—as was successfully used three times in the last 20 years to hasten the pace of negotiations among the states, tribes, and other water users in the Colorado River Basin. "It is unclear," said Castle, who is now a fellow at the Getches-Wilkinson Center for Natural Resources, Energy, and the Environment at the University of Colorado Law School, "whether the river will allow the current pace to continue without devastating consequences."

Driving from New Mexico to Denver on the last Sunday in November, we saw almost no snow on the peaks of the Sangre de Cristo Range. That range does not contribute to flows in the Colorado River, of course, but it does indicate the general state of precipitation. That's not terribly uncommon for late November. Not since these big dams of the Colorado River were built in the 1930s and 1960s have the reservoir levels been so low.

Transmission lines somewhat proximate to Loveland, Colo. Photo /Allen Best

Big savings if utilities join regional electric markets. Did study understate savings?

by Allen Best

Another study, this one ordered by Colorado legislators in 2019, has delivered the now familiar news that greater participation in organized wholesale markets by the state's electrical utilities can yield savings of 4% to 5%.

A half-dozen studies in recent years have drawn the same general conclusion about massive cost savings.

"A great step forward for Colorado ratepayers," said State Sen. Chris Hansen in a Linked-In posting.

To read the report, go here.

Hansen was a prime sponsor of both the 2019 law that triggered this report and the law adopted in 2021 that creates a deadline of 2030 for Colorado utilities to join robust electricity-sharing markets.

Hansen says the report understates the likely benefits. He said he believes, based on what has happened elsewhere in the country, that participation in full markets will double the cost savings because the planning reserve margins employed by utilities can be lower.

Planning reserve margins are the extra energy generating capacity needed by utilities to ensure they are covered in case some assets cannot produce power.

Xcel Energy, for example, has a reserve margin today of a little over 16%. This is the amount of energy capacity it has over what is normally needed to supply peak demand. The current planning for new generation once more coal plants retire and new renewables are added will boost this to 20%.

In contrast, MISO, an organized market serving utilities in the upper Midwest, operates with a reserve margin of 12% or less. That difference—if realized in Colorado—could save hundreds of millions of dollars a year, said Hansen in an interview with Big Pivots. If a utility has a

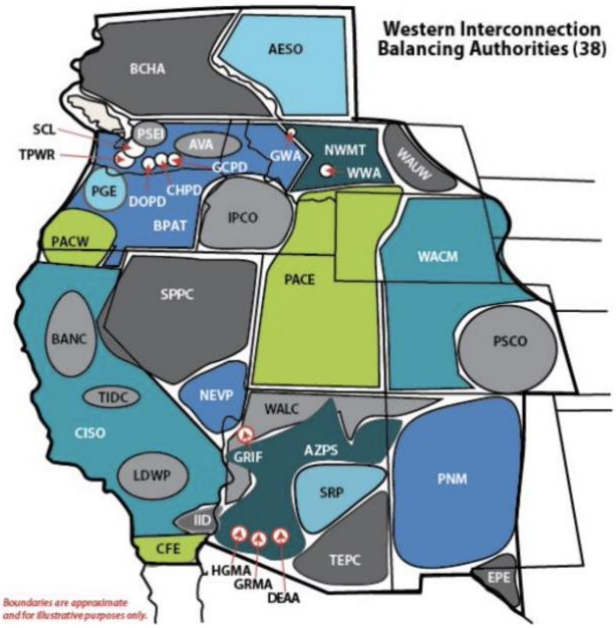
lower planning reserve margin, that's much less it needs to spend on new solar farms or keeping gas plants operating on standby.

Fully developed markets "allow you to bring reserve margins down over time," said Hansen. "I would say the 5% (cited in the study) is great but it doesn't really take into account the lower reserve margins and higher reliability."

Reserve margins can be lowered because organized markets across broad geographic areas can draw from multiple sources. The wind might not be turning turbine blades on the Peetz Table of Colorado, for example, but it might be in eastern New Mexico. Or it might be a rare cloudy day in Pueblo but nothing but blue skies in Arizona.

Why wasn't this benefit of reduced margins delivered as a takeaway by the report?

Hansen said he believes that the consulting firm Siemens, authors of the study commissioned by the Public Utilities Commission, wasn't able to quantify these benefits that he believes will come to fruition.



Knitting one step at a time

Ultimately, said Hansen, the goal will be to knit together the entire continental United States into one interconnected grid. Right now, there are three different grids. Even within the Western interconnection grid—seen in this graphic—are entities called balancing authorities, where utilities pool resources to ensure that supplies are balanced with demands.

The next, small step is creation of energy imbalance markets. They can shave costs of 1%.

One such energy imbalance market was launched in February in Colorado with several utilities and the Western Area Power Administration participating. Xcel and several others plan the launch of a different EIM next year.

The ultimate goal being pursued by Colorado is to integrate the electrical utilities in both the transmission network and the market mechanisms that will allow utilities to share their electricity across broad geographic areas with such features as day-ahead planning for resource sharing. One such market is called a regional transmission organization, or RTO.

This knitting together of supplies in order to meet demands has been hastened by the deepening penetration of renewable energy. The wind is always blowing somewhere, if not in Wyoming then in the Columbia River Gorge. Wind in those locations usually blows at different times.

Other developments have pushed along the conversation in Western states. Earlier this year, 12 investor-owned utilities announced plans to get together to study their options at integrating markets. They are banded together under the name Western Market Exploratory Group. Included are Xcel Energy and Black Hills Energy.

Hansen also points to the deepening crisis in the Colorado River Basin as an

impetus for more focus on integrating utilities into broader markets.

"I think the risk associated with hydro in the West is also directing more attention to this issue. Hydro power used to be assumed, and now with the water crisis and the low snowpacks and the long-term drought, that's not a given any more. So the entire West is going to need to do a better job of interlinking and sharing their resources."

Nancy Kelly, an Idaho-based policy advisor for Western Resource Advocates, agrees that integrating higher levels of renewables will require more electricity sharing across broader areas.

"It cannot be done without it—at least not without a lot of expenses," she said. "Battery storage has changed the equation somewhat, but battery storage can only do so much."

Will California loosen reins?

Any number of challenges exist. Have you heard of pancaking? It's sort of like the highways of old, where you had to stop every few miles to pay a toll. Except in electricity it's called a tariff. A problem, says the new PUC report. So are contracts for electricity transmission that don't correspond with how the electrons actually flow. Can existing transmission infrastructure be used more effectively?

Governance of regional markets poses a major challenge, as several studies have now documented. This new study may do the best job yet of examining that issue of governance. A bit of background:

Hansen, who has a Ph.D. in resource economics, describes Colorado having three doors to choose from. Should it join with the California's RTO, called CAISO. CAISO—it stands for California Independent System Operator—already has a footprint across much of the West, including parts of New Mexico.

An argument can also be made for the Southwest Power Pool. It operates a regional transmission organization in the wind-whipped Great Plains. Last year, several times it had in excess of 80% of its generation from renewables.

SPP has also created the energy imbalance market that debuted in Colorado and adjoining states in February. (And Colorado Springs Utilities liked this new EIM enough to jump ship from its alliance with Xcel to join it.)

A third option that has been discussed is for Colorado to create something new, perhaps with other states, such as New Mexico and Arizona.

The PUC report finds no major difference in cost benefits from one alignment over another.

CAISO has one major, likely fatal flaw, at least from Colorado's perspective. California's governor appoints the governing board. That just won't work for Colorado even if the two states currently are in general accord on many issues.

"Given this governance structure, the risk exists that CAISO could protect California's parochial interests at the expense of what is best for the region," the new report notes.

Some California legislators in 2018 attempted to revamp this. They failed. The chief executive of CAISO has reportedly suggested that another attempt will be made in the coming legislative session.

"I would hope something is figured out, either a change in California's governance or their contracts, to enable a West-wide organization," she says. She points to greater powerful potential synergies such that even Colorado could benefit from the hydroelectric and storage capabilities of British Columbia.

How about the Southwest Power Pool? The new report notes that other members might not have the same dedication to achieving carbon-free electricity as Colorado does.

And, more broadly yet, might submerging utilities into new regional

markets impair what Colorado thinks it does well already?

What Colorado does well

That concern was elucidated by Eric Blank, the chairman of the PUC, in a statement issued by the agency.

"Colorado is doing many things really well right now," he said. "We have a nationally recognized resource planning and acquisition process, where competitive bidding and third-party participation cause our utilities to access low-cost renewable energy resources with benefits directly flowing to customers in ways that some organized wholesale markets have struggled to replicate."

Blank went on to say that Colorado has no need to hurry as it figures out the best fit for the state's electrical utilities.

This report in hand, the PUC commissioners on Dec. 1 met their statutory deadline to issue a decision whether it was in the public benefit to move forward. In their decision, the commissioners decided that such participation was "generally" in the public interest "if certain governance and other concerns can be appropriately addressed."

This creates the platform for a rulemaking that the PUC plans to launch by June 1.

Hansen is confident that Colorado will move along at the appropriate pace.

"RTO's require significant, detailed negotiations to figure out the cost allocation and how state policy prerogatives will be maintained in a multi-state construct," he said. "But they have largely been answered in other parts of the country."

For Colorado, he said, the next steps will be to sharpen its pencils and move methodically through the steps. "The good news is that we have time."

A new Tri-State job: chief energy innovations officer

Tri-State Generation and Transmission has created a new position, chief energy innovations officer, to be filled by Reg Rudolph beginning in mid-January. He is currently chief executive of San Isabel Electric, a cooperative based in Pueblo West.

Rudolph will lead the development and implementation of competitive energy services that deliver value and optimize the interactions between Tri-State, the cooperative's 42 member distribution systems, and consumers.

Reg Rudolph

"Reg will lead our efforts on important issues, including beneficial electrification, distributed generation and demand side-management, that empower every part of the cooperative value chain, from the consumer to the distribution system to the G&T," said Duane Highley, chief executive of Tri-State.

Rudolph has been chief executive at San Isabel Electric for the last 13 years. There, he created Empower, an energy services program that works with its consumers to develop customized solutions that maximize economic and environmental value.

"Electrification not only drives opportunity for rural communities and economies, but is also the central driver for decarbonization," said Rudolph. "It's about delivering value as a service. Tri-State can work with its members, rooted in data and analytics, to optimize how we best utilize our energy systems, reduce costs, increase revenues and make a difference for all of our members."

The view of Boulder from a plane taking off from DIA. The city climate action plan hopes for a rapid descent of emissions in the next 8 years. ***Photo/Allen Best***

Boulder's emissions dived in '20, but can this city really hope to nail 2030 targets?

by Allen Best

Boulder's recently released greenhouse gas inventory for 2020 calls to mind a bicycle rider on a grueling uphill journey who unexpectedly finds a small downhill and a blast of tailwind.

The pandemic provided that tailwind for the city on its journey to reduce emissions 70% by 2030. Covid restrictions caused more people to more frequently work from home and travel less. This played a role in reducing emissions during 2020 by 22%, as compared against a 2018 baseline.

Taking a longer view, much uphill remains as Boulder races toward its goal of 70% reduction in emissions by 2030. That's a more challenging target even than Colorado's economy-wide goal of 50% by decade's end.

Attaining Boulder's goal will require the city's residents and workers to reduce emissions an average 5.83% per year in the next decade. Aside from this 2020 breather, the city has been shedding emissions at a rate of 1.3% per year.

Beyond that is another goal: net carbon neutrality by 2035, which was adopted by the Boulder City Council in late October as part of an updated climate action plan. That's what the United Nations in a 2020 report concluded will be necessary by 2050 for the world to keep the global temperature rise below 1.5 degrees Celsius.

Boulder wants to be a leader in upending the paradigm that put the climate in Colorado and elsewhere in the fast lane headed toward disaster. And, by 2040, the city aims to become a carbon sink, a place that absorbs more carbon than it emits.

That sort of aspiration seems audacious. It makes President John

Kennedy's goal of putting a man on the moon in the 1960s seem almost timid in comparison.

In the fast lane

Still, the city's lead architect on this decarbonization strategy sees cause for optimism. "I think we are poised to accelerate," said Jonathan Koehn, the interim director of climate initiatives, speaking of the pace of decarbonization.

Those goals, if daunting, can be achieved, according to Koehn. "It will take a substantial effort. It will take a pretty strong political will," he said. Achieving them will require a fundamental rethink, as Koehn told city council members in June, which he said has been underway for at least the last two years.

After relatively little change for many years, Koehn said the current is quickening. "We find ourselves in a different landscape today than we did just a few short years ago."

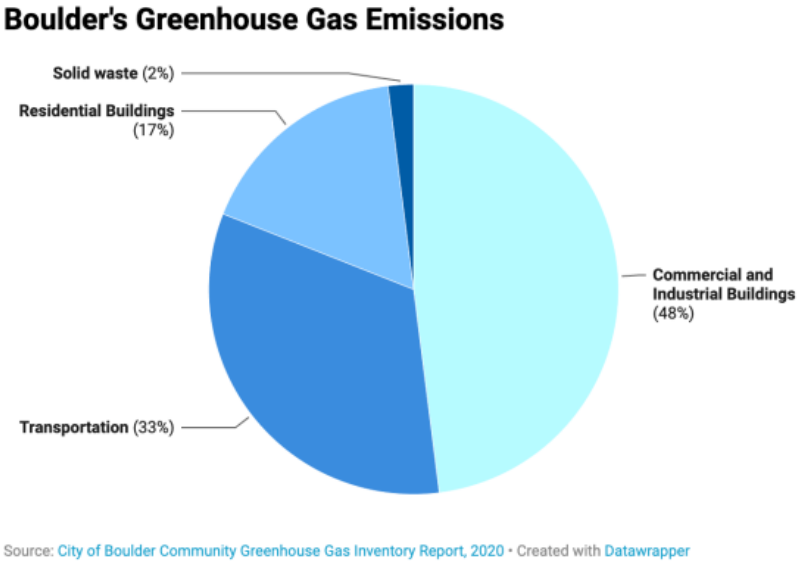
First, the short-term impact of Covid-19.

"This was an extraordinary year and may not reflect persistent progress toward the city's goals," according to the emissions report prepared by Lotus Engineering & Sustainability. "Some of the reductions seen in 2020 are durable; others are relatively unique to the circumstances of the Covid shutdowns."

Vehicle miles traveled and associated transportation emissions have been down 33% since 2018, and the first year of the pandemic provides the major explanation for that blip. Aviation travel — a significant portion, at 22% of the total travel of Boulderites — was also down. Enrollment at the University of Colorado Boulder altogether dipped, with much university instruction moving to the virtual classroom. The consumption of electricity and natural gas by the commercial and industrial sector also declined during the Covid-induced lockdown.

Of course, this greenhouse gas accounting is never simple. Residential electrical and natural gas consumption rose in 2020, as did waste-related emissions. And for that matter, there was reduced use of mass transit and more e-commerce, meaning more delivery vehicles, more takeout boxes from restaurants — and more waste.

The granular approach of sophisticated emission tracking is revealed in the report's explanation of transportation. Boulder's emissions accounting used anonymized smartphone data to track vehicle miles traveled by cars. It's not a new technology, but it's getting greater use. It has also been used to track the spread of Covid.



Boulder's emission tracking also has a breakdown on vehicle type and fuel choices, including whether diesel, ethanol, or compressed natural gas were used.

Footing the bill

A common question in such emission accounting is who gets billed for the emissions. If the trip starts in Boulder and

goes to Denver, for example, on whose sheet does it go? Boulder's new accounting now takes responsibility for all miles traveled within the city boundary while taking responsibility for 50% of miles that occur outside the boundary for trips that start or end in Boulder.

How about somebody traveling from Golden to Estes Park? That's on somebody else's carbon credit card, not on Boulder's. A trip entirely within Boulder — well, obviously, that's all on Boulder's carbon tab.

Transportation fuels altogether account for 32% of Boulder's total emissions, and even before Covid crimped travel, the city was making gains on shaving emissions, if not as much as is needed.

Through this same prism, looking at emissions by fuel source, electricity generation accounts for 41% of Boulder's emissions. Following transportation, the third-largest source is natural gas, including fugitive emissions, at 25%. Landfill, compost, and sewage treatment emissions account for less than 3%.

It's not that Boulder hasn't had successes. The city saw a 36% reduction in emissions compared to the original 2005 baseline—and this despite 10% population growth, 12% more square footage in buildings and an 87% increase in gross domestic product, or GDP.

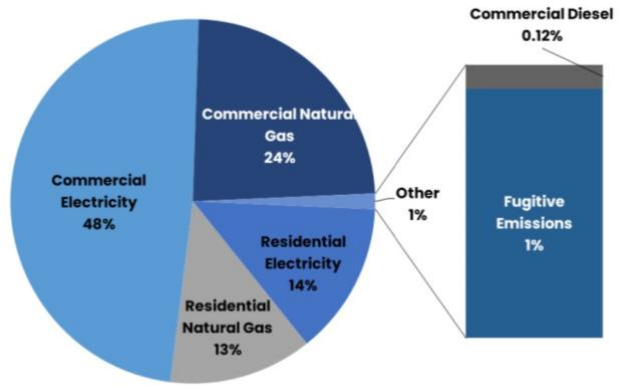
Gains in efficiency have been dramatic. One measure is in the emissions of intensity in electricity as applied against GDP. By that metric, the electricity use per gross domestic product has decreased in the commercial and industrial sector 41% since 2005 and 17% since 2018, the Lotus report notes. Again, Covid may have played a role in this reduction.

Also notable is the cleaner electricity being delivered to Boulder. The analysis by Lotus used data from Xcel Energy, the city's supplier, to calculate that the "electricity emission factor" has decreased 42% since 2005 and by 7% since 2019.

More reductions will be coming as Xcel closes four coal-burning units in Hayden and Pueblo in the next seven years and, if it gets approval of state regulators, switches another coal plant at Brush to natural gas. There is much agitation as well for closing the final unit in Xcel's fleet in Colorado, Comanche 3.

Sector by sector

A more useful way to look at Boulder's emissions as of 2021 may be through its sectors. This puts buildings into sharper focus. Commercial and industrial buildings account for 48% of emissions, primarily through electrical consumption and burning of natural gas. Residential buildings account for another 17%.



Buildings directly or indirectly are responsible for nearly two-thirds of Boulder's emissions in 2020.

If you've stuck through this story this long, you've already done the math: 65% of Boulder's total emissions come from buildings. And that's a problem, because switching out houses isn't nearly as easy as closing coal plants.

Once again, it's not that Boulder hasn't had success. Residential natural gas use has decreased per housing unit and also per capita since 2005, before flattening since 2018. However, the number of housing units has increased by 12% and the number

of residents has increased 10%. Boulder is using more, not less, natural gas. Ditto for commercial and industrial: Natural gas is used with greater efficiency, but still the demand has grown.

Buildings top the list of the city's action plan. The plan calls for developing innovative financing solutions for efficiency and electrification, along with use of low-carbon material buildings, retrofits, and so forth—all while providing increased affordability and access for residents with lower incomes.

A new series of objects, targets, and progress steps have been identified in the revised climate plan. For buildings, the city plan calls for 100% of new residential and commercial construction by 2023 to be electric-ready—able to operate without natural gas. By 2031, the plan calls for zero operational emissions in all new buildings.

In transportation, the city hopes electric propulsion will account for 30% of all vehicle miles traveled within the city by 2030. The plan calls for a completely electrified fleet of HOP buses, compared to the current four electric buses.

Nature-based climate solutions constitute a significant, if still undeveloped, component of this climate plan. Such strategies would explore ways to manage both rural and agriculture as well as urban landscapes to capture carbon and enhance urban ecosystem services.

'We have to do what we can do.'

Boulder's strategy forward can best be understood in two ways. First, it depends in part on state and federal action. That is already evident in the transportation gains, which can in large part be attributed to improved fuel efficiency standards.

Future progress will also depend on a team approach. Boulder is a joiner on climate action teams, perhaps the most important being Colorado Communities for Climate Action, a coalition of 34 towns, cities and counties that has become a reliable presence when climate and energy legislation is being reviewed at the Colorado Capitol. The city also belongs to other organizations of communities with a similar sense of urgency about climate change. One is the Urban Sustainability Directors Network. There are many others.

"We need to work more effectively outside our boundaries, and the way we do that is by influencing regulation and legislation at the state and federal levels," Koehn says.

As befits a place crawling with climate scientists, Boulder has long been at the forefront of climate activities. The city in 2002 was one of the first to sign onto the Kyoto Protocol and officially adopted carbon reduction goals in 2006. Most recently, in April, the city became one of 21 U.S. cities to join the ICLEI 150 Race to Zero campaign.

Along the way, Boulder also adopted a carbon tax. That tax will expire unless renewed next November by city voters. Koehn says one option is to expand the tax, providing more revenue for furthering the climate change programs.

Paul Culnan, a member of Empower our Future, a Boulder-based group devoted to clean energy, says funding will be important to provide incentives for the transitions identified in the report when it comes to buildings and transportation.

"You can't really force people to change out their cars, but you can incent them, and I want to see what we can come up with," he says.

Boulder has traditionally been receptive to taxes. "I don't see that changing," Culnan said. "If they said we are going from a 3% tax to a 6% tax, that might get some resistance." Those figures were for illustrative purposes.

"You have to influence the things you have influence over," he added. "We can't solve the problem ourselves, but we have to do our part. We have to do what we can do."

Who'd have thunk? Colorado is now talking about when it will close its last coal plant

by Allen Best

Something that just a decade ago would have been extraordinary, a debate about Colorado's last coal plant, is underway this week. The question is when, not if, Comanche 3 will close.

Xcel Energy, the operator and majority owner of Comanche 3, had proposed to continue operating the plant at Pueblo until 2040, if only on a part-time basis beyond 2030. Major environmental groups believe Comanche can be closed by 2030, maybe even 2027.

A proposed compromise agreement between Xcel and 15 other organizations involved in the discussions calls for the ramping down of operations beginning in 2022 and a final closure on New Year's Eve in 2034. The plan would get Xcel to 85% to 87% emissions reduction by 2030, as compared to the 2005 baseline. This is ahead of Colorado's 80% goal for 2030.

Xcel is Colorado's largest electrical utility and a supplier to many smaller utilities, including Holy Cross Energy, which serves the Vail and Aspen areas, and Yampa Valley Electric, which delivers electricity to Steamboat Springs and Craig.

Disagreements remain about how soon Comanche 3 —which is partly owned by electrical consumers in the Roaring Fork and Eagle valleys— can be retired and other topics. Western Resource Advocates contends that both energy economics and technologies are evolving so rapidly that a 2029 retirement may be possible. The other 10 parties who declined to join the settlement have various disagreements, including independent power producers who believe Xcel wants to own too much of its own generating capacity.

The Colorado Public Utilities Commission, which is hearing eight days of testimony, wrapping up on Dec. 17, will probably issue a decision in February.

What a pivot this has been. In 2004, when Comanche 3 was approved, Colorado voters approved the renewable portfolio standard of 10%. Xcel vigorously opposed

that mandate. Then wind and solar prices began declining until by 2017, they undercut coal. Utilities had also become confident they could integrate high levels of renewables without sacrificing reliability.

Eight coal units in Colorado likely will close by 2030 or, in the case of Pawnee, a plant at Brush, converted to natural gas. That will leave just Comanche 3.

Two major elements in the 32-page settlement agreement being reviewed by state regulators stem from laws approved by Colorado legislators since 2019. One is the social cost of carbon, the other just transition.

Social cost of carbon, currently set at $68 per short ton of carbon dioxide emissions, seeks to apply the true cost of atmospheric pollution from burning fossil fuel to decisions such as whether to build a new natural gas plan. The settlement agreement proposes to take this a step further, applying the social cost of carbon to decisions about whether to operate Comanche 3 beginning in the summer of 2022.

If accepted by the PUC, this likely will be the first time that social cost of carbon has been applied to operation of any fossil fuel plant in the United States. With this filter, Comanche 3 will be used less because it will be less economically to do so.

Just transition also will be a central element in retirement of Comanche 3 and also the units at Hayden. The idea, first defined in 2019 legislation, is that communities that have been providing energy will not be left behind.

Pueblo and Pueblo County both depend upon the property tax base of the coal plants. Xcel agreed to continue to pay tax money, even after Comanche 3 closes in 2034, to leave those two taxing entities whole. Xcel may be able to replace that lost tax base with new renewable energy generation, though. The landscape around Pueblo, one of the most reliably sunny places in the West, is fast becoming a sea of solar panels.

Holy Cross Energy emerges in strong position in this proposed settlement. It owns 8% of Comanche 3, but wants to be 100% renewable by 2030. Those facts seem incompatible. Bryan Hannegan, the CEO, explains that the settlement agreement would permit Holy Cross to replace electricity from Comanche 3 with new renewable generation. There will still be a gap, as cost-effective 100% renewable generation is not yet possible, but Hannegan says he believes technologies will evolve in the next few years to allow Holy Cross to achieve its 2030 goal.

As for the debt of Holy Cross on Comanche 3, the cooperative has accelerated payments. Those payments were originally scheduled to continue until 2070, but Holy Cross now expects to pay off its debt by 2042. Hannegan says the repayment schedule may be further accelerated.

Hanging over the video-conference hearing is the unsettling December weather after a hot, smoky summer. This is December in Colorado, and it's not winter yet," says Gwen Farnsworth of Western Resource Advocates. "Everyone in this proceeding is going to have that in mind."

This column was published in The Aspen Times on Thursday. Look for a longer, deeper breakdown of this plan before the PUC on the BigPivots.com website before the weekend is out.