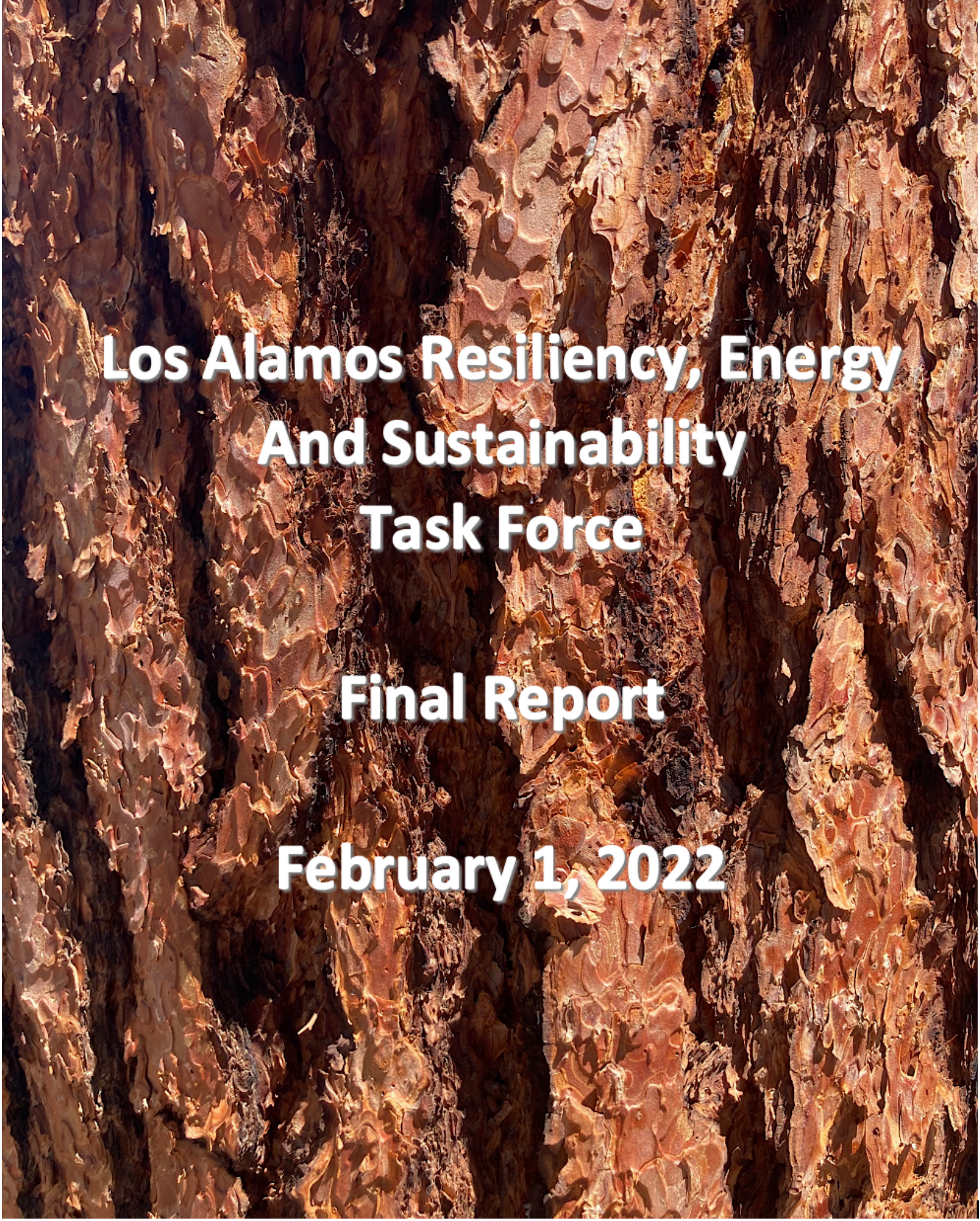

Los Alamos Resiliency, Energy And Sustainability Task Force

Final Report

February 1, 2022

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Executive Summary

A. Overview

Climate change represents an existential threat to our community and the world, with impacts becoming evident at an accelerating rate: hotter temperatures, reduced precipitation, increasing intensity and frequency of wildfires, and more animals seeking food near our homes.

In December 2020, a group of concerned residents submitted a petition to County Council requesting action on climate change. This was the basis for the formation of the Los Alamos Resiliency, Energy and Sustainability Task Force (LARES), charged with creating greenhouse gas (GHG) reduction and climate change resiliency recommendations to Council. The Task Force had one year to accomplish this task. The recommendations presented here offer Los Alamos County (LAC) a place to start.

This report contains six focus areas: General Recommendations; Natural Gas Reduction; Electricity; Transportation & Mobility; Waste, Consumption & Natural Resources; and Community Planning, all aiming to reduce our carbon footprint and enhance sustainability. The recommendations themselves are listed later in this summary. Each is then detailed in the sections that follow.

The Task Force's recommendations are intended to assist the community as a whole (exclusive of Los Alamos National Laboratory [LANL]) in reaching its carbon-reduction goals. The County government can and should assist residents as they seek ways to reduce their own carbon footprints. Of course, County government should lead by example through its own operations.

Carbon dioxide (CO_2) and other GHGs are primarily produced when hydrocarbon ("fossil") fuels are burned, whether physically within Los Alamos or remotely for our benefit. Burning natural gas (NG) and petroleum motor vehicle fuels produce CO_2 directly. Much of our electrical power presently comes from burning coal or NG. Construction materials, food, and a myriad of everyday household and industrial products involve production of CO_2 in their manufacture and transport to us. All are major contributors.

The very first thing to do is to establish a long-term goal of achieving net-zero greenhouse gas emissions. We must then create a climate action plan and follow it. To create this plan, we will need to perform a baseline GHG emissions study from which the County can set reduction targets and timelines. Providing updated information in a yearly mailer, much like the Department of Public Utilities' (DPU) Annual Water Quality Report, will make residents aware of progress and changes. Hiring additional LA County government staff to support sustainability efforts will be critical to success, as will partnering with LANL and Los Alamos Public Schools (LAPS). Providing information, education, and advocacy in leading the community effort to reach "net-zero," along with integrating sustainability practices into all County government operations (including purchasing and contract work) will speed change.

One of the largest challenges will be reducing (and eventually eliminating) natural gas (NG) usage. Virtually the entire Los Alamos community is heated by combustion of NG. Residential space heating is more than three-fourths of that demand. NG is primarily methane. When it burns, it produces CO_2, and when escapes unburned into the atmosphere, it is a powerful GHG. The Board of Public Utilities (BPU) has adopted a strategic goal to phase out NG use in Los Alamos by 2070. No single "silver bullet" will accomplish that. Technology, economics, and regulatory factors will evolve to ease this difficult task.

Technically and economically viable approaches to new construction, current homes, and other buildings already exist. New buildings can be designed to utilize our abundant sunshine and to reduce heat loss, and new building codes can provide guidance. Old or new, heat loss can be reduced by better insulation, including doors and windows. NG-fired furnaces and water boilers can be replaced by modern air-sourced electric heat pumps, which also provide cooling (air conditioning). Water heating, cooking, and NG pilot lights can also be replaced by more efficient electrical means. Electrical demand may exceed present electrical supply system capacity. Distributed ("rooftop") solar photovoltaic (PV) generation and storage may be necessary.

Weaning our community from NG will increase demand for electricity, as will electric vehicle (EV) charging. New sources of renewable electricity will be needed, and they should be carbon-free as much as possible. Candidates include solar, wind, and nuclear. Solar and wind are fairly inexpensive, but require storage to overcome their intermittency. Strategies to manage those intermittencies must also be developed. These could include, but are not limited to demand management, generation curtailment, and time-of-use metering. Transmission and distribution systems must also be upgraded for the heavier loads.

In 2013, the BPU made the original commitment to become a "net-zero electricity provider by 2040." Formalizing and accelerating that timeline to 2035 would align with state goals. LAC has a long-standing power pooling relationship with LANL which currently expires in 2025. We must develop a strategy to achieve net-zero in electrical supply independent of the post-2025 LAC/LANL power generation relationship.

A 2017 Integrated Resource Plan for LA's electric utility recommended greatly increasing our solar generation and storage capacity. Siting options for solar installations have changed and should be broadened to include anywhere within LAC's balancing area.

Residential ("rooftop") photovoltaic (PV) installations with associated storage batteries are an alternative to more utility-scale solar power. We should continue to support and incentivize adoption of residential PC installation while establishing a program to enable homeowners to purchase or lease residential storage batteries.

GHG emissions caused by transportation make up a large part of overall emissions, and single-occupant vehicles are a major contributor. Encouraging and incentivizing the use of local and regional public transportation and carpooling, as well as commuting on bicycles (and just plain walking), are important ways to reduce GHG emissions. Encouraging the purchase of EVs by County government, other institutions, and residents is another key way to reduce

transportation-based GHG emissions. Adequate EV charging infrastructure to support this transition from gas-powered vehicles is necessary. Installing shaded parking and implementing a "no idling" policy will reduce unnecessary emissions from vehicles. Eventually all gas-powered equipment (lawn/garden, golf carts, etc.) will need to be powered by carbon-free sources.

In order to comprehensively address Los Alamos County's GHG emissions, it is necessary to consider all of the activities and resources of the community. Numerous studies of cities around the US have shown that waste, consumption and natural resources management are a major portion of a community's GHG footprint. Everything we use and consume plays a role in GHG emissions: consumption of goods, food, and services; waste management; refrigerants; water and wastewater; soil and land use. As we plan for resiliency and sustainability in the face of climate change, we cannot ignore any contributor to GHG emissions.

Addressing areas of waste and consumption largely involves educating residents and businesses on their own personal choices and how they can reduce their carbon footprints. It also includes waste reduction strategies to help us eliminate what we send to the landfill and reducing any waste of our natural resources, specifically water. Drought, reduced precipitation, and lower water table levels, and increased wildfire danger all present threats to our community. Our precious natural resources not only provide us with our "habitat," they also present opportunities for increased health and quality of life. Updating our water and forest management plans will be critical to living in Los Alamos in the long-term.

Natural gas reduction, electrical supply and demand adjustments, reduction in transportation-based emissions, reducing waste, and managing our natural resources will go a long way to achieving net-zero. Updated building codes and community planning will help us cross the finish line.

Between building operations and embodied carbon (i.e., construction materials), buildings generate a large portion of total GHG emissions. Adopting the most current building codes for new construction, both residential and commercial, will ensure new buildings are as "green" as possible. Educating property owners about the large difference in energy efficiency (and utility bills) that adding insulation, replacing old windows, and other improvements can make, will help save them money, reduce energy usage, and lower emissions. Given that the County is close to being "built out" in terms of new housing, an incentive program would help greatly to speed voluntary GHG reduction changes in existing buildings. To that end, the County should consider advocating for an interpretation in the NM State Constitution's "Anti-Donation Clause" to help develop an interest-bearing loan program for energy-related retrofits for those whose incomes exceed the low-income threshold served by the Los Alamos Housing Authority.

Finally, community outreach will be critical to educate LAC employees and residents about reducing their carbon footprints and encourage them to make GHG-reducing lifestyle choices. Many residents and businesses would like to make changes but do not know where to start or do not have enough information to make informed decisions. Others are worried about the financial impact. Los Alamos County can help provide community members with the information they need to choose a path forward that works for their individual situations, whether that be home

energy audits, information about property retrofits or appliance replacement, electric vehicle charging infrastructure, how best to reduce their utility bills, or how changes to the bus system will help them commute without a car. Community outreach and education will help inform residents and business owners about what Los Alamos County is doing about climate change, how they can take action, and how they can benefit from it.

B. Specific Recommendations

The consolidated lists of recommendations below are given one or more of the following timelines:

- Immediate (3 months-1 year)
- Short-Term (1-2 years)
- Medium-Term (3-5 years)
- Long-Term (6-10+ years)
- Ongoing (already started and continuing)

We begin with General Recommendations (GR) which are presented in order of priority and action: Recommendations GR-3 through GR-9 will depend on Recommendations GR-1 and GR-2 being put into place. Further recommendations divided into categories follow these General Recommendations.

General Recommendations (GR)	Immediate	Short-Term	Med-Term	Long-Term	Ongoing
GR-1: Establish net-zero greenhouse gas emissions as a long-term goal for Los Alamos, both the community (exclusive of LANL) and its government.	●				
GR-2: Perform a comprehensive baseline greenhouse gas emissions study from which to set reduction targets (and other goals) and against which to measure progress.	●	●			●
GR-3: Create and adopt a strategic climate action plan for Los Alamos County which includes baseline data, greenhouse gas reduction targets, and climate mitigation strategies, to be utilized and updated regularly.	●	●			●
GR-4: Create and fund a senior staff position (e.g., "sustainability coordinator") to lead and coordinate the work of all County departments, including the Department of Public Utilities, to meet the County's net-zero and other resiliency and sustainability goals.	●				
GR-5: Provide recurring funding to invest in and integrate the goal of net-zero greenhouse gas emissions and other sustainability practices into all County government operations, including modeling new green technologies for residents.	●	●			●

GR-6: Create an on-going body of (largely citizen) collaborative stakeholders to advise Council, Department and Board of Public Utilities, and other relevant County bodies on implementing the goals and strategies recommended in the climate action plan and monitor progress.	●	●			●
GR-7: Form a partnership with LANL and the Los Alamos Public Schools with the specific intention of collaboration on greenhouse gas reduction.	●				●
GR-8: Invest in consistent, ongoing community outreach and education promoting the reduction of our individual and collective greenhouse gas emissions, including an "Educational Specialist" position.	●	●			●
GR-9: Produce an annual climate action report to be presented to County Council and shared with the community.			●		●

Below is a consolidated list of recommendations by category. For further detail (background information, data, examples in other communities, figures, etc.), please refer to that category's section.

Recommendations: Natural Gas Reduction (NG)	Immediate	Short-Term	Med-Term	Long-Term	Ongoing
NG-1: Set a community goal to reduce natural gas use by at least 2% per year.	●				
NG-2: Encourage compact architectures in new construction.		●			●
NG-3: Require new construction to have solar access, if feasible.		●			●
NG-4: Require new construction to derive a significant portion of its heating energy from the sun.			●		●
NG-5: Adopt the 2021 International Energy Conservation Codes (IECC) as the standard for new construction and guidelines for remodeling, and continue to adopt new IECCs as they are issued.	●				●
NG-6: Set a cut-off date for new natural gas hook-ups and new electric resistance heating installations, effectively requiring electric heat pumps. Encourage substitution of heat pumps when gas-fired furnaces and boilers are replaced.		●	●		●
NG-7: Encourage substitution of solar thermal, heat pump, tankless, or point-of-use water heaters when traditional hot water heaters are replaced.					●
NG-8: Encourage substitution of electric induction ranges when traditional electric or natural gas ranges are replaced.					●
NG-9: Discourage or prohibit pilot lights in new or replacement gas appliances.		●			●

NG-10: Include heating demand in electrical utility generation, transmission, and distribution supply planning.		●			●
NG-11: Make energy audits and other relevant information available to property owners through County government.	●				●

Recommendations: Electricity (E)	Immediate	Short-Term	Med-Term	Long-Term	Ongoing
E-1: Formalize the BPU/DPU and Los Alamos County Council goal to be a net-zero carbon electricity supplier by 2035.	●				
E-2: Develop a strategy that achieves LAC's net-zero carbon goals regardless of the nature of any future LAC/LANL power generation relationship.	●				
E-3: Develop an "Intermittency Management Strategy'' including but not limited to demand management, curtailment of generation, and time-of-use metering.		●			
E-4: Implement the recommendations of the 2017 Integrated Resource Plan (IRP) and expected IRP recommendations in 2022.	●	●			●
E-5: Investigate periodically the feasibility of restricting market purchases of electricity to carbon-free sources.			●		
E-6: Continue to pursue the feasibility of small modular reactor technologies.	●				●
E-7: Study distributed ("rooftop") electric generation and storage as potentially an integral part of LA's power supply.		●	●		
E-8: Initiate a pilot program to support the addition of residential storage batteries to homes with and without rooftop solar.	●				●

Recommendations: Transportation & Mobility (TM)	Immediate	Short-Term	Med-Term	Long-Term	Ongoing
TM-1: Increase and incentivize public transportation ridership.		●			●
TM-2: Improve bicycle and walking infrastructure to promote safe and convenient carbon-free transportation.		●	●		
TM-3: Increase publicly accessible electric vehicle charging infrastructure.			●		●
TM-4: Increase the number of electric vehicles in the County fleet by at least two per year, eventually making 100% of light duty (passenger cars and trucks) plug-in electric.	●				●

TM-5: Revise and implement a County-wide "no idling" policy with shaded parking options.			●		
TM-6: Launch a municipal bike share program.			●		
TM-7: Encourage private electric vehicle purchase and charging during non-peak hours.		●			●
TM-8: Increase the number of solar-powered flashing light crosswalks.		●			●
TM-9: Convert municipal small engines, lawn/garden equipment, and golf carts, to be fossil fuel free within ten years.		●			●

Recommendations: Waste, Consumption & Natural Resources (WCNR)	Immediate	Short-Term	Med-Term	Long-Term	Ongoing
WCNR-1: Set a goal to eliminate municipal solid waste through reduction, reuse, recycling and composting (by e.g., 2035) following "Zero Waste" principles.	●			●	
WCNR-2: Reduce consumption-associated greenhouse gas emissions through sustainable purchasing and consumption/disposal of food, goods, and services.	●			●	
WCNR-3: Develop and adopt a comprehensive water conservation and watershed stewardship plan to maintain and enhance the quality and quantity of LAC's water supply.	●				●
WCNR-4: Develop and implement a plan to capture stormwater runoff and reduce contamination through green infrastructure approaches.	●				●
WCNR-5: Manage natural and community landscapes for climate mitigation, resiliency, community, cultural and wildlife values, and carbon sequestration.	●				●

Recommendations: Community Planning (CP)	Immediate	Short-Term	Med-Term	Long-Term	Ongoing
CP-1: Adopt a local overlay code that incorporates additional locally-specific greenhouse gas reduction provisions.		●	●		
CP-2: Advocate for change or clarification of the NM Anti-Donation Clause to allow local governments to provide incentives for energy-reduction projects.			●		

CP-3: Educate property owners on potential energy-saving renovations to their buildings.		●			●
CP-4: Strengthen the County's environmental purchasing policy.		●	●		
CP-5: Add commercial zoning within each area of town, such as each mesa and within White Rock.			●		

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I. Los Alamos Resiliency, Energy and Sustainability (LARES) Task Force Charter as Adopted by County Council December 15, 2020

I. Purpose

The Los Alamos Resiliency, Energy and Sustainability Task Force ("Task Force") was initiated through an action of the County Council on December 15, 2020, when the Council formally accepted the Citizen Petition requesting action. The Task Force will serve as an advisory body to the County Council for the purpose of recommending ways for the County as a whole, including government, businesses, and residents, to achieve net-zero greenhouse gas emissions and advance other sustainable practices in the face of climate change. This will be a working committee; members will be responsible for collaborating with each other and Los Alamos County stakeholders.

II. Scope of Work

The Task Force will build a comprehensive resiliency, energy, and sustainability "white paper" or strategic plan. This plan will present specific, measurable, achievable, and timely recommendations for how Los Alamos can achieve or exceed the goals set forward by our governor in the New Mexico Climate change Executive Order 2019 which complies with the 2015 Paris Agreement. We expect this comprehensive plan to include Los Alamos community recommendations while incorporating the goals and work that is being undertaken in other cities in New Mexico that are seriously tackling these issues. The subjects addressed by the report will include, but is not limited to, the following:

- Consolidate current global, federal, state, and local greenhouse gas (GHG) goals, mandates, and recommendations.
- Review, validate, and expand as necessary existing data and analyses of GHG emissions associated with primary fuels (coal, natural gas, and petroleum).
- Study and recommend County government policy and other steps to phase out use of natural gas consistent with Department of Public Utilities conservation goals.
- Study and recommend practices to reduce energy use.
- Study and recommend practices for other sectors (e.g., building design and planning) as time permits and information is available.
- Study and quantify economic impacts of the adoption of recommended practices and policies in terms of initial investment and costs over time.
- Make recommendations to apply to all of the above to the County as a whole.

The Task Force will present an interim report of their findings and recommendations by August 1, 2021, with final recommendations, including public commentary and input, by February 1, 2022.

III. Task Force Representation

The Task Force will be composed of volunteers and is open to all County residents and County staff who are interested in producing a comprehensive "white paper" for the County. The ideal representation will include at-large community members and current or former representatives or liaisons from the following boards: Environmental Sustainability Board, the Board of Public Utilities, the Planning and Zoning Commission, and the Transportation Board. One member of the County

Council and the Los Alamos County Manager or designee will serve as liaisons to the Task Force. The total number of members shall not exceed nine (9) persons. Task Force members will be individually appointed by the County Council after having submitted letters of interest.

IV. Charter and Member Term

The term of this Charter shall be for shall be for THREE HUNDRED AND NINETY (390) days from the date this Charter is adopted, and the term of each member shall run until the term of the Charter expires. If during the term of the Charter a member resigns or is otherwise unable to serve, Council shall appoint a new member to fill that member's remaining term.

V. Quorum

A quorum of the Task Force is defined as a simple majority of the appointed Task Force members. Task Force actions can be taken and considered valid only if a quorum has been established at the meeting. Information can be shared during a meeting even if a quorum is not established.

VI. Resources

The County will provide a staff project manager responsible for coordinating the Task Force in its exploration and development of implementation actions including meeting logistics and other needs. Other County staff will be available based upon identified needs or specific topics of discussion but all staff members will be non-voting members of the Task Force.

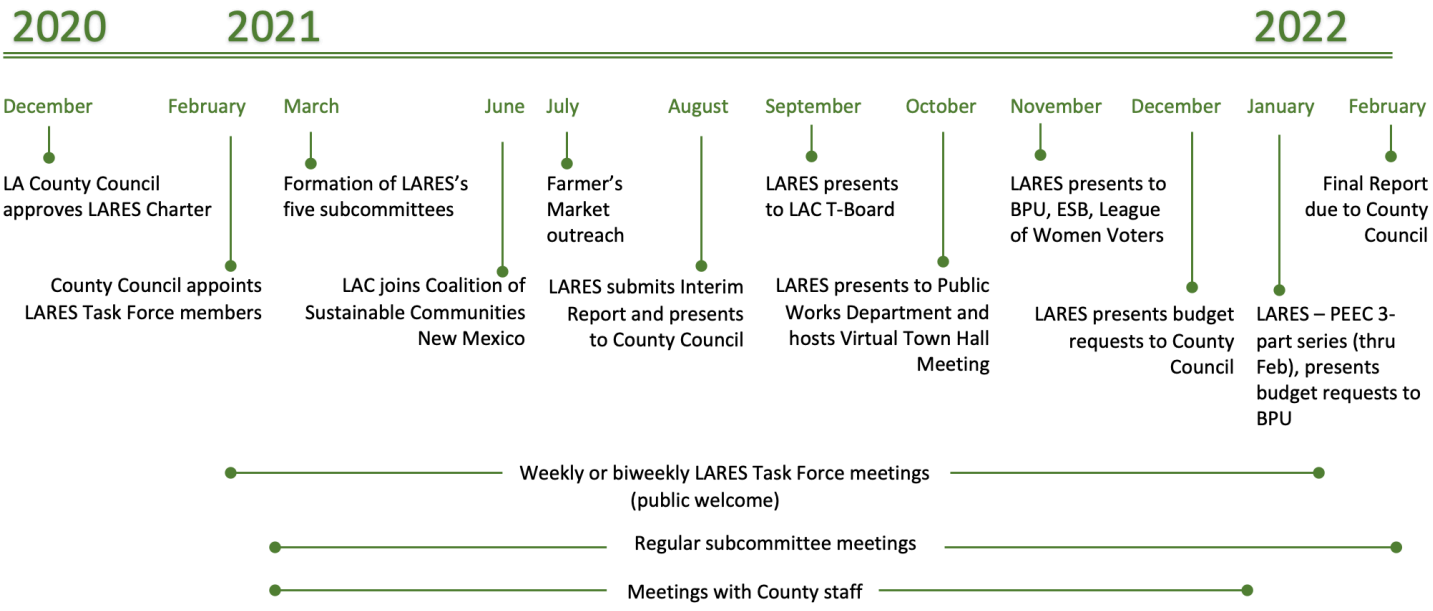
VII. Meetings

Meeting dates and frequency will be established by the Task Force and County staff. A Chair and Vice Chair shall also be appointed at the first meeting. Action minutes shall be made and kept for each meeting of the Task Force. The public shall be given notice of any meeting of the Task Force at least 72 hours in advance of any meeting through coordination with the County's Public Information Officer. All meetings may be attended by the public, who will be permitted and encouraged to comment.

VIII. Subcommittees

The Task Force may form subcommittees as needed. These may include content experts and interested parties. Subcommittee reports will be available to the public and presented to the full Task Force. All recommendations to the County Council should be that of the full Task Force, as indicated by a majority vote of Task Force members. The subcommittees may include persons not otherwise identified as a member of the Task Force. However, subcommittee membership does not convey an ability to vote on any recommendations. Subcommittee formation may be for the purpose of research, education, and outreach.

II. Timeline of LARES Task Force Activities & Recommendation Development



III. Introduction

Communities all around the world, large and small, are creating action plans to address climate change. The recommendations outlined in this report are based on research and discussions with County staff and other stakeholders, and include recommendations and policies based on the success of other nations, cities, and towns.

The Task Force presents this report to you as a place to start.

The Task Force has taken into account Los Alamos's unique location and population: a high-altitude, mountainous desert environment with a fairly stable population (in terms of numbers). The major employer for most residents is Los Alamos National Laboratory (LANL or "The Lab"). While we recognize that the County has no jurisdiction over LANL, we have considered its impact on our community and our recommendations, as well as opportunities for collaboration.

In 2021 under the direction of President Biden, the US Department of Energy (DOE) released its 2021 Climate Adaptation and Resilience Plan, an aggressive agenda to adopt agency-wide strategies to manage the short- and long-term effects of climate change in DOE's operations. In addition to prioritizing achieving net-zero emissions at the Department's 17 national laboratories, including LANL, DOE is planning to take the following actions:

- Advance Deployment of Emerging Climate Resilient Technologies
- Assess Vulnerabilities and Implement Resilience Solutions at DOE Sites
- Enhance Climate Adaptation and Mitigation Co-benefits at DOE Sites
- Institutionalize Climate Adaptation and Resilience Across DOE Activities

President Joe Biden has also called for major change on a short time scale. On April 22, 2021, President Biden set **new target reduction goals** at 50-52% (from 2005) by 2030, as well as reaching net-zero-carbon emissions by 2050. This goal includes reaching 100% carbon pollution-free electricity by 2035. This means everyone, government, industry, residents, consumers, communities large and small, urban and rural, will need to make major changes and cutbacks to their GHG emissions.

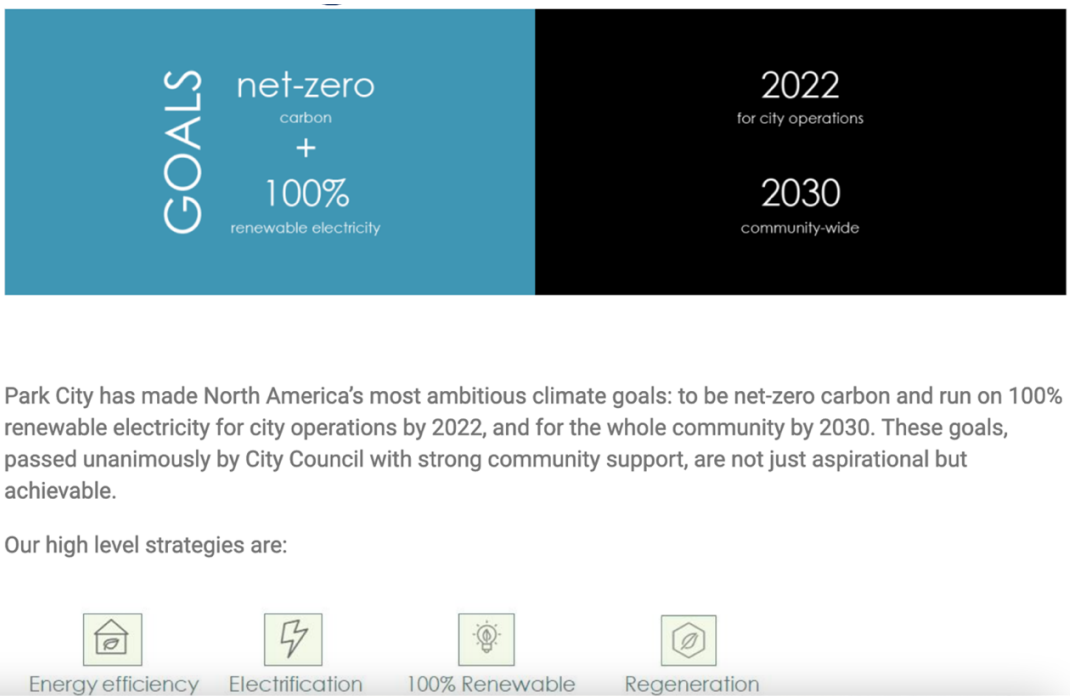
The Task Force's intention in submitting these recommendations is for the County and its employees and residents to take action, slow climate change, and create a plan to address how our natural environment will change over the coming decades. We do not wish for any future crisis to ruin lives or our beautiful natural surroundings and the wildlife within them.

New Mexico Governor Michelle Lujan Grisham also acknowledges that climate change is happening, is human-caused, and has set ambitious climate change action goals in Executive Order 2019-003:

- Supporting the Paris Agreement Goals
- Reducing New Mexico GHG emissions by 45% by 2030 (as compared to 2005 levels)

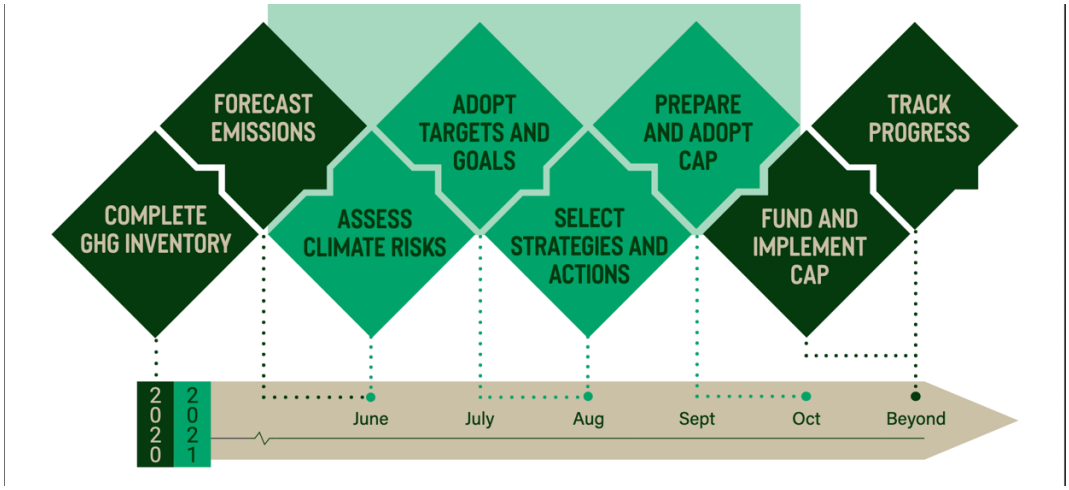
- Creating a New Mexico Climate Change Task Force
- Increasing energy efficiency standards for electric utilities
- Creating a New Mexico Climate Strategy document

Similar communities to ours, such as Park City, UT, have very ambitious climate goals:



Park City, UT Sustainability Website

Telluride, CO, while smaller than Los Alamos, has completed a baseline GHG inventory and will soon be starting the process of setting climate mitigation targets through a Climate Action Plan (CAP):



Town of Telluride, CO Sustainability Website

Los Alamos County has already taken some action to address climate change in several ways:

 40% of total County facilities over 5,000 sq. feet meets at least LEED Silver certification, and LAC Facilities department is switching out toxic chemicals to environmentally preferable products.	 Atomic City Transit provides free public transportation and LAC has started to invest in electric vehicles for its fleet.	 The DPU and BPU have increased our renewable electricity sources and hope to be a carbon neutral electricity provider by 2040.
 DPU and Environmental Services compost bio solids and yard waste. Free curbside recycling is available County-wide.	 The BPU plans to phase out Natural Gas by 2070.	 The ESB has a Sustainability Plan, and the DPU has an Energy and Water Conservation Plan.

We applaud these efforts. Since its founding, Los Alamos has been an innovator, a leader, and a hub of scientific research. We must continue to lead the way by addressing climate change and creating a sustainable future for generations to come. We, too, must create a climate change action plan to help us be resilient as things change so that our children, grandchildren, and their children and grandchildren will be able to thrive as we have. Making significant progress against climate change will take every stakeholder in our community: the County, the Lab, the Schools, local businesses, and residents. As the saying goes, we need to "think globally, act locally."

A Word on "Net-Zero"

In this document, most of the recommendations refer to reducing GHG emissions, carbon emissions, our carbon footprint, being net-zero carbon, or some other reference to *carbon*. Carbon dioxide (CO_2) is the primary GHG emitted by humans (roughly 80%) and is often the reference point for comparing the potency (effectiveness of heat trapping in Earth's atmosphere) of other GHGs; this is called the Global Warming Potential (GWP). Methane (CH_4), for example, has a GWP of at least 28 times that of CO2. Nitrous oxide (N_2O) is at least 265 times as powerful, and sulfur hexafluoride (SF_6) and halocarbons (chlorofluorocarbons [CFCs], hydrofluorocarbons [HFCs] and perfluorocarbons [PFCs]) are thousands or tens of thousands more heat-trapping (called high-GWP gases). These numbers are widely accepted throughout the scientific community and by governments, though you can find references on the US EPA's webpage as well as on the website for the Intergovernmental Panel on Climate Change (IPCC). Ozone (O_3) and water vapor (H_2O) are also considered GHGs.

The IPCC's Glossary (p. 555) helps us define what net-zero means and how we can achieve this:

> "Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).

Notes: Net zero and net-zero are used interchangeably. CO_2e (carbon dioxide equivalents) is sometimes used to refer to GHG emissions.

A Word on Equity

The LARES Task Force is concerned about potentially disproportionate risks to socially vulnerable groups (e.g., income, race/ethnicity, educational attainment, and age). Historically marginalized groups, including low-income and people of color, have been adversely impacted by the inequities of public policies and practices. Research suggests that climate change most affects those that are least able to anticipate, cope with, and recover from its effects. Thus, we emphasize that centering equity is an essential foundation for all of our recommendations, and that a climate change plan should include considerations for the risks to socially vulnerable groups in Los Alamos. This is at the heart of co-creating, protecting, and sustaining healthy and resilient social-ecological systems.

Beyond the official local jurisdiction of Los Alamos County, it is imperative that regional-scale resilience planning and actions be coordinated with neighboring institutions, communities, and other partners. Indeed, the recently drafted 2022 NM Climate Bill also has specific language around communities disproportionally impacted by climate change and mitigation strategies.

Most communities' climate action plans include something called the "Triple Bottom Line," which is a way to prioritize recommendations based on three things: economic impact, environmental sustainability, and social justice. We strongly suggest incorporating this into LAC's future climate plan.

A Word on Resiliency

While interrelated, sustainability and resiliency are not the same. Sustainability is being able to maintain a way of life moving forward, whereas resiliency is being able to bounce back from challenges and adapt to change. It is preparedness when facing vulnerability. Hazards such as extreme heat, wildfire, flash flooding, drought, winter storms, and forest habitat loss are already happening in Los Alamos and northern New Mexico.

> "Enhanced resilience allows better anticipation of disasters and better planning to reduce disaster losses — rather than waiting for an event to

occur and paying for it afterward." National Academies of Sciences, Engineering, and Medicine

While aspects of resiliency are discussed in the Waste, Consumption & Natural Resources section, LARES has largely focused on sustainability and reducing our community's carbon footprint. In preparing for a changing climate, we may do well to consider both a climate action plan and a regional resiliency plan. The latter would likely focus more on inherently regional resource management issues (forests, water, etc.), disaster preparedness and prevention, and community capacity building to respond to the challenges that climate change will present over the next decades. The LARES Task Force encourages the County Council and LAC leadership to incorporate resiliency planning into all aspects of County and community services.

Ponderosa pines in our surrounding forests

IV. General Recommendations

The General Recommendations are presented *in order of priority and action*: Recommendations GR-3 through GR-9 will depend on Recommendations GR-1 and GR-2 being put into place.

Recommendation GR-1: Establish net-zero greenhouse gas emissions as a long-term goal for Los Alamos, both the community (exclusive of LANL) and its government.

Time Frame: Immediate

Background

The Intergovernmental Panel on Climate Change (IPCC) has recommended that we achieve net-zero GHG emissions as quickly as possible in order to avoid the most catastrophic outcomes from anthropogenic climate change. In addition to contributing to the greenhouse effect, air pollutants contribute significantly to human health problems. In order for our community to have the best possible outcomes, we need to cut emissions as quickly as possible.

Outcome

Establishing net-zero GHG emissions as a specific and measurable long-term goal for the County will help policy makers and program leadership collaborate and prioritize needed components of LAC operations and development. It will also show our community that this is an important issue that is not being ignored. Setting a goal puts us on the path to lowering our GHG emissions, which is our responsibility in the state, national and global efforts against climate change. It will also improve our local environment.

Strategy

LAC departments, possibly working with consultants, should provide extensive analysis of current and planned programs to reduce GHG emissions. Together with public comment, the County Council should evaluate this and set a reasonable and responsible target date for achieving net-zero GHG emissions.

Examples in Other Communities

Please see section XIV (Other Communities' Climate Action Plans) for a list of other places which are also taking this action, though this list is by no means exhaustive.

Economic Impact

- **Costs:**
    - Staff time to evaluate current and projected GHG emissions and plans to reduce.

- The act of establishing a net-zero GHG emissions goal will not cost any money. The actions and infrastructure needed to accomplish these goals *will* take money. These are listed in other sections of the report.

Benefits Other than CO_2 Reduction

- Jobs created to support sustainability
- Opportunity to exemplify Los Alamos as a "green" community, committed to acting on climate change. This may help to attract new residents and LANL hires (especially younger adults), as well as inspire other communities in NM and nationwide.

Recommendation GR-2: Perform a comprehensive baseline greenhouse gas emissions study from which to set reduction targets (and other goals) and against which to measure progress.

Time Frame: Immediate to short-term and ongoing

Background

It is impossible to evaluate the efficacy of actions intended to reduce GHG emissions unless there is a known starting point and continued measurement. There are multiple methodology options for a GHG emissions inventory, and it makes sense to follow a proven method unless there are compelling reasons to do otherwise. The most commonly used protocol is the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) which divide emissions into five sectors: Stationary Energy; Transportation; Waste; Industrial Processes and Product Use; Agriculture, Forestry and Other Land Use. Furthermore, it is divided into three categories:

- Scope 1 (direct emissions)
- Scope 2 (indirect emissions, generated or purchased energy)
- Scope 3 (other indirect emissions, often post-consumer) (see figure on next page)

The GPC GHG inventory is more simplistic and less precise if only Scope 1 emissions are included. Additional precision, complexity, accountability are obtained by adding Scope 2 and Scope 3 emissions. The Task Force recommends a comprehensive GHG inventory, which includes Scopes 1, 2 & 3.

Existing LAC estimates account for GHG emissions from electricity production, natural gas use, transportation fuel and solid waste (R. Gibson, 2021 report). For Los Alamos in 2019, this was estimated to be 11.9 metric tons/year per person. The total LAC community GHG footprint, which includes the above plus emissions associated with goods, food and services consumed by a community, is likely to be considerably higher (based on results from GHG inventories of middle-high income communities in North America and Europe). One study, performed for each zip code in the US using consumption data, calculates LAC per capita GHG emissions to be 24 metric tons/capita/yr (Jones & Kammen, 2014), about twice the current estimate.

While this study could potentially be done in-house through the LAC DPU (and other departments), we recommend hiring a consulting firm to gather baseline data, create accountability metrics, and generate strategy recommendations (as well as a Climate Action Plan). Consulting firms do this professionally; they are set up for performing exactly these types of analyses and they have experience, tools, and information they need at-hand. Because of this, hiring a consultant to do this for the County may be the most cost-effective way of getting these data. In addition, we do not wish to over-burden already very busy County employees with this extra duty.

The GHG emissions study should be conducted as soon as possible after Task Force's submission of final recommendations.

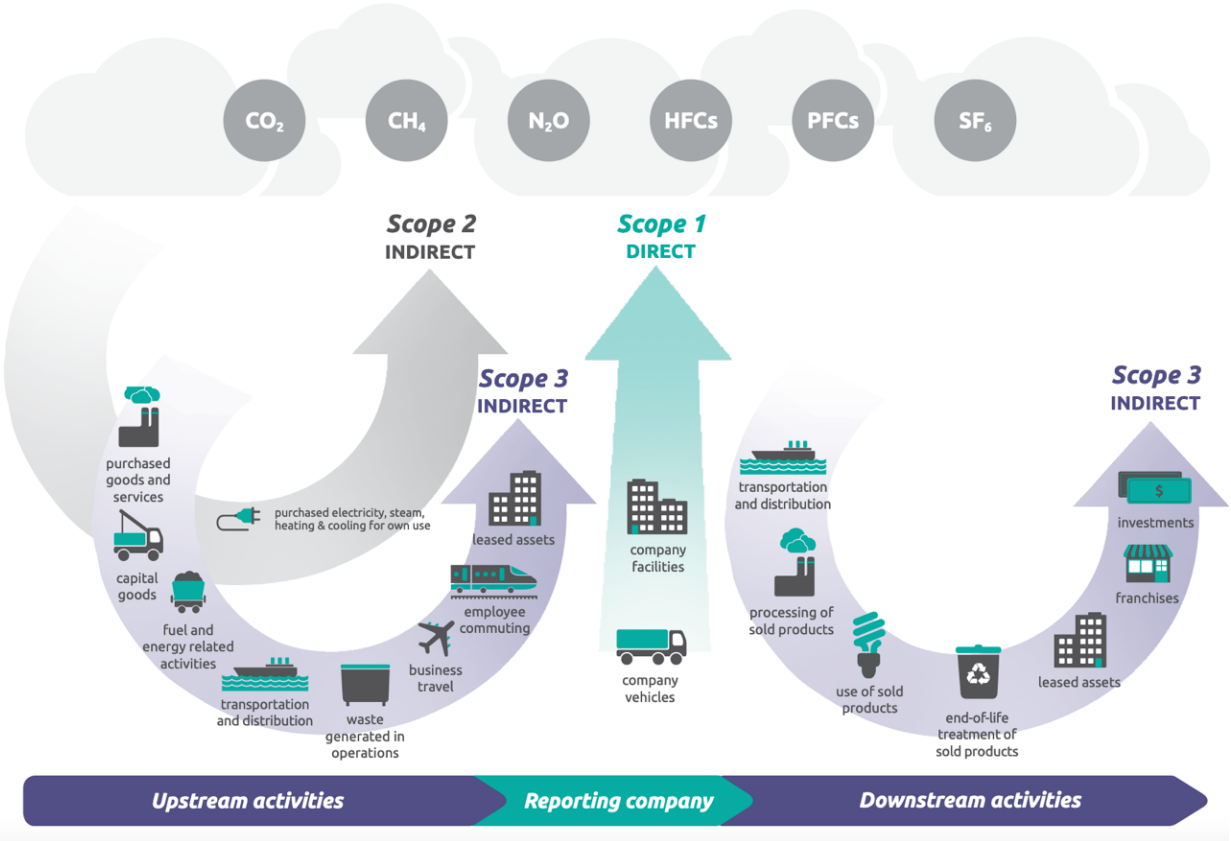
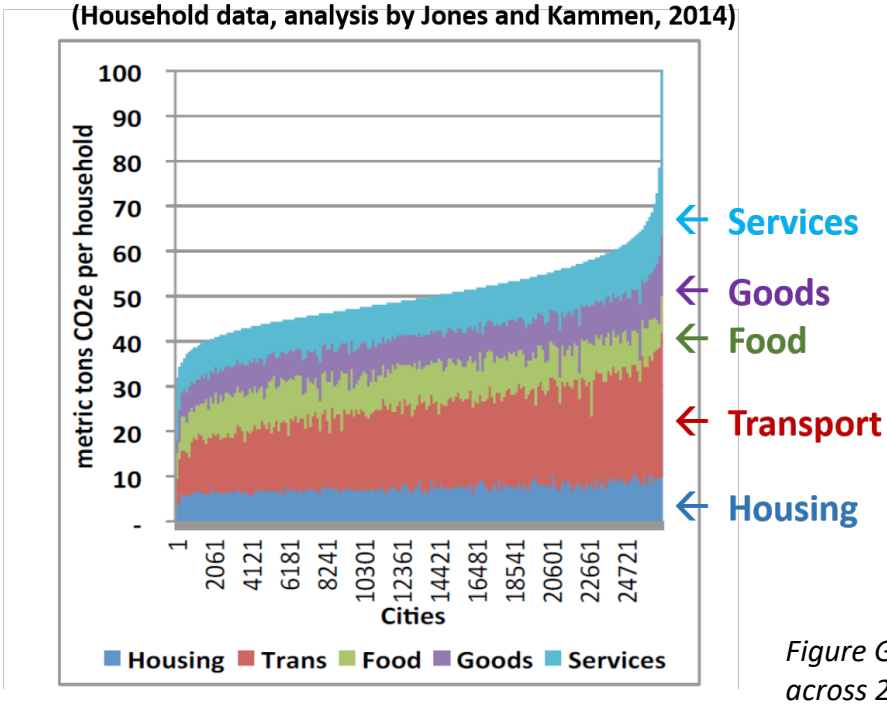


Figure GR-1. Scopes 2 & 3 emissions from p. 5 of the [Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard.]

Carbon footprints by category across 26,697 US cities

(Household data, analysis by Jones and Kammen, 2014)



In addition to emissions from electricity, natural gas and vehicle fuel, households are responsible for the carbon footprint of goods, food and services they purchase. These emissions are substantial and occur in all communities.

Figure GR-2. Carbon footprints by category across 26,697 US Cities.

Outcome

A total GHG emissions analysis will provide a more comprehensive understanding of total CO_2e than a standard Scope 1 & 2 analysis, which only includes direct and indirect emissions from electricity, NG, transportation, and waste. This will provide baseline data for goal setting and ongoing monitoring that aligns with state and national data, and allows for comparison as well as estimated benefits by sectors.

This type of GHG inventory will identify the most timely, urgent and in some cases, easy activities to target in efforts to reduce GHG emissions. It will also help ensure equitable actions for GHG reduction initiatives; not everyone can put up rooftop solar or purchase an electric vehicle, but most people can compost food scraps, recycle, and reduce how much they drive a car.

This study will provide impetus and support for individuals and entities to undertake carbon footprint analyses and adjust patterns of consumption of goods, food and services (see recommendations below).

Strategy

1. Determine specific scope of analysis.
2. Determine if analysis should be done by LAC Staff and/or external consultant and perform analysis.
3. Provide results to County Council, LAC Boards and staff, LAPS, and residents, together with strategies that target GHG sources identified in analysis.
4. Monitor changes to GHG emissions through ongoing and periodic analyses.

Examples in Other Communities

- Eugene, OR found that consumption-based emissions were more than 2.5 times greater than previously estimated local emissions.
- King County, WA performed a consumption-based GHG analysis, and found that 63% of emissions were due to goods, food, services and construction.
- Edmonton, AB, Canada performed a consumption-based GHG analysis in 2016 because it "provides cities with a better understanding of their consumption choices, which can lead to the implementation of policies that mitigate associated, but generally unregulated GHG emissions." (From the Executive Summary of their GHG analysis report, link below).
- Multnomah County, OR: A consumption-based analysis found that 53% of GHG emissions resulted from food, goods and services consumed in the county.
- Denver, CO is in the process of updating its GHG inventory, setting a new baseline using consumption-based estimates.
- Lake Oswego, OR: A consumption-based analysis found that 46% of GHG emissions were due to production, transport and disposal of goods, food and services.

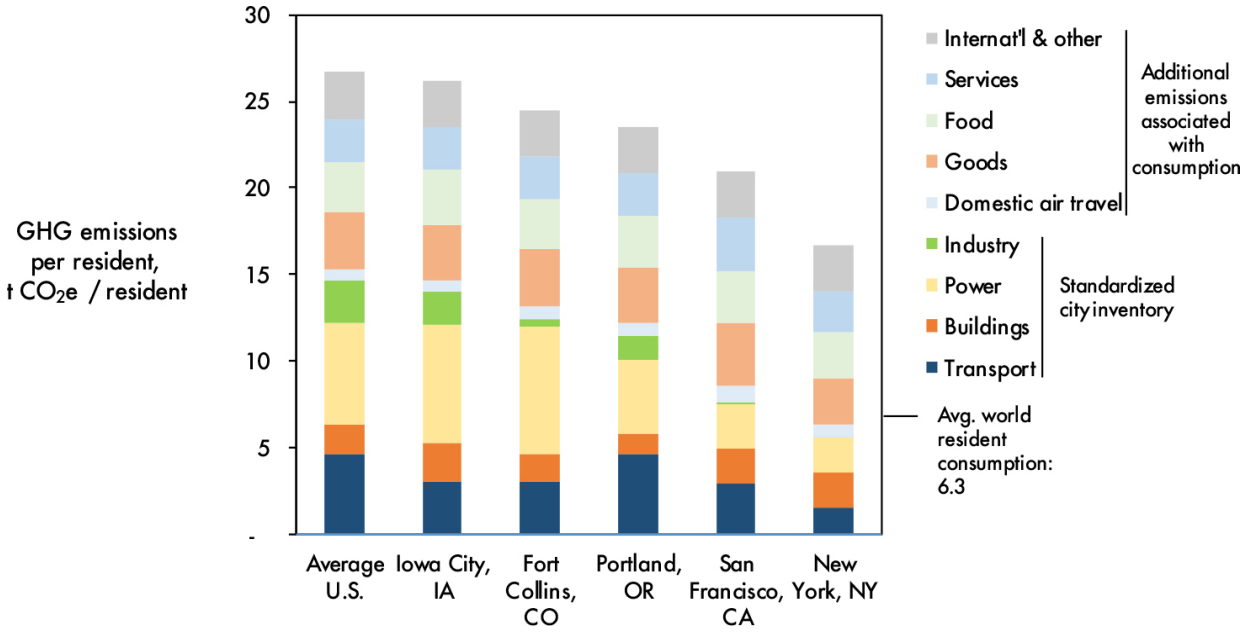


Figure GR-3. Estimated GHG emissions inventories for selected U.S. cities.
Source: [Stockholm Environment Institute](#).

Economic Impact

- **Costs:**
  - LAC Staff time to prepare RFP (if using a consultant), hire and work with a consultant.
  - LAC Staff time to gather relevant data for analysis.
    - Possible additional cost to purchase economic data and/or conduct spending surveys of our community.
  - Estimates are $30-80k for a standalone GHG inventory by a consultant (if used), estimate of $100-125k for both a GHG inventory and climate action plan creation.
  - Funds for education/outreach to community regarding results and GHG mitigation actions ($25k annually, included in Community Outreach & Education request 12/14/21)
- **Savings:**
  - There may be cost-saving measures available after analysis is performed and Climate Action Plan is produced.

Benefits Other than CO_2 Reduction

- A comprehensive emissions study is a relatively complete accounting of GHG sources, and fundamentally important for any subsequent climate action plan and recommendations.
- Economic/spending data obtained should also be useful to economic development and local businesses.
- Potential for greater equity in actions recommended (and taken) to lower GHG emissions (lower-income households (HHs) typically have lower GHG emissions, and from different sources, than more affluent HHs).
- Opportunity to educate the community on full environmental impacts of lifestyle.
- Allows community and County leadership to take a critical look at LAC GHGe and assess anticipated reduction by mitigation strategy (aid in prioritization of strategies).

Challenges & Anticipated Barriers

- More economics/spending data for analysis may need to be gathered.
- Consumption-based measures can be difficult to use for ongoing monitoring of GHG reductions. Research into alternative methods for tracking changes in consumption-related GHG emissions going forward is warranted.

References & Resources

Carbon Trust website information on "Scope 3" emissions

CBEI Guidebook-- by the Stockholm Environment Institute provides advice for local governments seeking to measure and manage their carbon footprint using consumption-based emissions inventories (CBEIs).

Christopher M. Jones and Daniel M. Kammen, Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density. *Environ. Sci. Technol*., 2014, dx.doi.org/10.1021/es4034364

City of Albuquerque Greenhouse Gas Inventory

City of Edmonton, Alberta, Canada Consumption Based Inventory

City of Lake Oswego, OR Greenhouse Gas Inventory

Compilation of Climate Action Plans, West Coast Climate Management Forum

Estimating consumption-based greenhouse gas emissions at the city scale (2019) SEI report. Stockholm Environment Institute, U.S. Center, Seattle, WA.

Eugene, OR Climate Action Plan 2.0 (2020)

Greenhouse Gas Protocol Reporting Standards

King County, WA Greenhouse Gas Inventory

PAS 2070: 2013 Specification for the Assessment of Greenhouse Gas Emissions of a City *(PAS 2070)* Direct plus supply chain and consumption-based methodologies

Santa Fe County Greenhouse Gas Inventory

Under-reporting of greenhouse gas emissions in U.S. cities. NATURE COMMUNICATIONS | (2021) 12:553

Recommendation GR-3: Create and adopt a strategic climate action plan for Los Alamos County which includes baseline data, greenhouse gas reduction targets, and climate mitigation strategies, to be utilized and updated regularly.

Time Frame: Immediate to short-term and ongoing

Background

We should develop a climate action plan (CAP) that includes a baseline GHG inventory as an action, with recognition that the CAP shall be revised as soon as there is a GHG inventory that can inform specific actions and priorities.

Outcome

Creating an official plan will help keep LAC on target to reduce GHG emissions on a yearly and continuing basis.

Strategy

1. Perform baseline GHG emissions study, the results of which will be provided to the County Council, LAC Boards and staff, and residents. If this is done by a consulting firm, determine whether they will also be creating the CAP.
2. If necessary, send out an RFP to get bids on a Climate Action Plan creation from consulting firms (unnecessary if GHG study includes a plan) with strategies that target GHG sources identified in analysis.
3. Adopt and implement CAP.
4. Monitor changes to GHG emissions through ongoing and periodic analyses, updating the CAP every 5 years or when necessary.

Examples in Other Communities

Section XIV lists numerous examples of Climate Action Plans from cities and towns across the United States.

Economic Impact

- **Costs:**
    - Cost to hire a consultant to create CAP. Estimates range depending on whether the same consulting firm is doing the GHG inventory. Ballpark figures look like $50-80k for GHG inventory, $100-125 with GHG inventory and CAP.
    - There will be costs associated with the recommendations in the CAP.

- **Savings:**
    - There are likely to be cost-saving measures outlined in the CAP.

Benefits Other than CO_2 Reduction

- Creating a CAP will give the County and residents actionable items to reduce our carbon footprints. This will be a sigh of relief to most residents, particularly young people, who are worried about climate change.
- There are likely to be recommendations that improve air quality, access to nature, personal health and fitness, and quality of life here in Los Alamos.

References & Resources

Section XIV lists numerous examples of Climate Action Plans that were helpful for this section.

Brendle Group

Good Company Consulting

Recommendation GR-4: Create and fund a senior staff position (e.g., "sustainability coordinator") to lead and coordinate the work of all County departments, including the Department of Public Utilities, to meet the County's net-zero and other resiliency and sustainability goals.

Time Frame: Immediate

Background

Coordinating a Climate Action Plan and its components requires time and effort, and "Sustainability Coordinator/Manager/Officer" positions are becoming more and more ubiquitous. Many cities, counties, universities, public school districts, and private businesses are all seeking someone to do this important job.

Supporting sustainability work in a community cannot be another task piled onto an already full-time employee; it must be its own job. This position must work across many departments and coordinate work being done in addition to its own unique tasks.

In addition to developing the GHG reduction plan, this position will be responsible for maintaining sustainability and resiliency issues, and facilitating community education and outreach. This employee will report directly to the County manager and the County Council quarterly with progress on the plan and identify any obstacles inhibiting attainment of the goals. This position should be supported by an "Education Coordinator" responsible for community education and outreach.

Outcome

Hiring a Sustainability Coordinator for Los Alamos County will ensure that the work and goals set out in this plan are accomplished. This person will help launch these new initiatives and coordinate all necessary moving parts.

Strategy

This position needs to be strategically designed in collaboration with LAC staff and leadership to augment and connect the existing work that is happening.

Examples in Other Communities

Hundreds of municipalities and other entities around the country have a Sustainability Coordinator. Right here in New Mexico, Santa Fe, Albuquerque, and Las Cruces all support this position (Sustainability "Officer" in some cases). Albuquerque and Las Cruces each support 2.0 FTE, and Santa Fe is hoping to return to 2.0. The Santa Fe Public Schools have more than one Sustainability Coordinator for the district.

Economic Impact

- **Costs:**
    - As we have looked through these jobs around the country, the salaries range from the mid $50k to $130k. We recognize that LAC staff is best suited to establishing the salary/benefit package. This is a ballpark figure.
    - Developing a sustainability program will also require funds so the program can be successful.

Challenges & Anticipated Barriers

- Communication and positionality are important challenges that need to be considered. We hope the County Council will work across sectors to design the position in a way that increases communication and involvement across all sectors. This position will need to have jurisdiction and funding in order to help LAC achieve the established net-zero GHG goals.

Benefits Other than CO_2 Reduction

- LAC will be able to make great strides in its sustainability goals because there will be a person to help get these tasks accomplished.
- This position will facilitate coordination between County departments.
- Job creation.

References & Resources

City of Albuquerque Sustainability Office

City of Las Cruces Sustainability Office

City of Santa Fe Sustainability Plan

Coalition of Sustainable Communities New Mexico

Glass Door

LinkedIn

ZipRecruiter

Recommendation GR-5: Provide recurring funding to invest in and integrate the goal of net-zero greenhouse gas emissions and other sustainability practices into all County government operations, including modeling new green technologies for residents.

Time Frame: Immediate to short-term and ongoing

Background

Los Alamos County should lead by example in the fight against climate change. This should happen in both large and small ways, from purchasing or generating renewable energy to buying 100% recycled content paper.

Outcome

Integrating net-zero, zero waste, and sustainable practices into daily habits, lifestyles and business practices, will reduce the community's carbon footprint. This may also result in cost savings or reduced purchasing for the County. It could also encourage contractors competing for work to be more thoughtful in how they do business and the CO_2 emissions involved in their work.

Strategy

1. Allocate yearly funding for "green" initiatives.
2. Any remodeling or appliance replacement within County property should begin with net-zero in mind.
3. Create a document with CO_2 comparisons for purchasing.
4. Invite residents to view the County's green technology improvements to encourage them to do the same in their properties.

Examples in Other Communities

Section XIV lists numerous examples of Climate Action Plans from cities and towns across the United States. These CAPs give detailed strategies for how to integrate net-zero into everything a community does. Any community with a CAP is doing what we are suggesting in this recommendation.

The 2022 NM Climate Bill includes language proposing funding a "climate fund," also called a "green bank" or "green fund" in other places. Communities, school districts, and businesses are starting to set aside monies in these green funds to prepare for climate change initiatives, and to ensure progress can be made and maintained in the future. Los Alamos County should consider the same.

Economic Impact

Costs and savings tend to go hand-in-hand for this. While some products may cost more (for example, compostable trash bags cost more than plastic trash can liners), the costs could be mitigated by product use reduction (i.e., emptying trash cans into a larger trash bag but keeping the liner in until it is no longer usable). Buying in bulk can eliminate major cost differences.

Benefits Other than CO_2 Reduction

- Reduction in other environmental toxins.
- More thoughtful purchasing.
- Reduction of purchasing in some cases.
- Encouraging private contractors to be the lowest carbon footprint entity bidding for a job.

Challenges & Anticipated Barriers

- Some lower CO_2e products cost more (EVs, for example, generally cost more than gas-powered cars).
- There may be some readjustment for purchasing department practices.

References & Resources

Coalition of Sustainable Communities New Mexico

Mark Hayden, State of NM Purchasing Director, Mark.Hayden@state.nm.us**,** 505.827.2331

Recommendation GR-6: Create an on-going body of (largely citizen) collaborative stakeholders to advise Council, Department and Board of Public Utilities, and other relevant County bodies on implementing the goals and strategies recommended in the climate action plan and monitor progress.

Time Frame: Immediate to short-term and ongoing

Background

A citizen body is necessary to work with the County Council, Department of Public Utilities, Board of Public Utilities, and the County Sustainability Coordinator to oversee implementation of the CAP, monitor its progress and update when necessary, and help produce an annual report for citizens. It is also important that the community can engage in and inform this work. Stakeholder representation from the BPU, the DPU, the County Council, the Chamber of Commerce, the Schools, Bandelier, and other key community positions should contribute.

This body could be, e.g., a continuation of the current LARES Task Force in some form, a new standing advisory board, or a broadening of the charter of the existing Environmental Sustainability Board, ensuring all aspects of County operations and community education support the mission.

This citizen body will provide information, recommendations, and education to the County and to the community. Point(s) of contact for the community and other LAC boards and departments should be established and clear.

Outcome

Accountability for reducing our carbon footprint will help make it a reality. A citizen body gives residents the opportunity to be involved in the process.

Strategy

1. Determine what shape the future accountability citizen body will take and the associated responsibilities that this group will have.
2. Recruit applicants for this citizen body.
3. Review and appoint members to the body.

Economic Impact

- **Costs:**
    - Citizen boards are voluntary, but it does take time from a County staff liaison to coordinate, run/attend meetings, do printing and community outreach.
- **Savings:**

- Volunteer positions on a board save the County money from not having to hire more staff.

Benefits Other than CO_2 Reduction

- Creating a citizen body helps Increase opportunity for citizen engagement and allows for multiple perspectives to inform the work.

Challenges & Anticipated Barriers

- As with all community boards, communication, clear expectations, and scope of work needs to be established and organized.

References & Resources

City of Albuquerque Sustainability website

City of Las Cruces Sustainability Office website

City of Santa Fe Sustainability website

Town of Eagle, CO Climate Action Collaborative

Recommendation GR-7: Form a partnership with LANL and the Los Alamos Public with the specific intention of collaboration on greenhouse gas reduction.

Time Frame: Immediate and ongoing

Background

While LANL's GHG emissions are specifically not in the purview of the LARES Task Force, LANL and its carbon footprint within the community cannot be ignored.

Both LANL and LAPS are important communities within our County, and a collaboration with the County will be beneficial for all parties. This partnership may help share the load in such things as budgets for specific projects and/or community outreach and education. It may also influence the creation of a Climate Action Plan (CAP) and the setting of GHG reduction targets and strategies.

Outcome

Collaboration between the three "major players" in Los Alamos County will facilitate change and provide opportunities for accomplishing tasks that one entity could not perhaps do alone.

Strategy

This partnership needs to be sustainable. The Task Force asks that the responsibility for partnerships with LANL and LAPS be incorporated into LAC staff and leadership positions as indicated and necessary. The expectations for these partnerships and the communication on the progress of the collaborations needs to be a regular component of the LAC strategic CAP.

Economic Impact

- **Savings:**
    - A partnership between LAC, LANL and LAPS provides cost-sharing opportunities for all parties.

Benefits Other than CO_2 Reduction

- Greater sense of community through collaboration.
- Collaboration and information sharing reduces uncertainty as to what others may or may not be doing about climate change and GHG reduction.

Challenges & Anticipated Barriers

- LANL is a Department of Energy (DOE) facility and thus may not have the freedom to make decisions on their own without going through a lengthy chain of command.

Recommendation GR-8: Invest in consistent, ongoing community outreach and education promoting the reduction of our individual and collective greenhouse gas emissions, including an "Educational Specialist" position.

Time Frame: Immediate to short-term and ongoing

Background

Communication and information are extremely important as we adopt new policies, practices, services and technology that help us assess our own individual and our collective impacts on the environment and our GHG emissions. Having an educational specialist whose responsibility it is to bring information and education to our community and the LAC leadership is extremely important.

There will need to be extensive outreach and education to promote home energy audits, a "homeowner's checklist" for reducing GHG emissions and improving home efficiency (including lowering of utility bills), updated public transportation information, rooftop solar opportunities, improved water collection/recycling information, personal greenhouse gas reduction, and much more.

Outcome

A more-informed citizenry helps us all work together toward a common goal. Residents are interested in reducing their carbon footprints, reducing utility bills, and retrofitting their homes in energy-reducing ways. Knowing how to access information is just as important as acting on it.

Education and outreach will result in a community that better understands both its individual and collective impacts on the environment and has the education and access to information and services necessary to contribute to the work ahead.

Strategy

1. An Educational Specialist would ideally be responsible for collaborating across LAC and community sectors (including LAPS and UNM-LA) to assess the information needs of the community. They should collaborate with educational specialists from other communities to share resources and insights.

2. Develop a carbon-reduction guide website.

3. The Waste, Consumption & Natural Resources section provides detailed community outreach and education tools and ideas, some of which are already in effect in LAC.

Examples in Other Communities

- Community Works Institute: Educating for Sustainable Communities
- United Nations Educational, Scientific, and Cultural Organization (UNESCO)
- US Department of Education "Green Strides" website

Economic Impact

- **Costs:**
    - Funding for the position and time from other departments (and leadership) for collaboration and information sharing.

Benefits Other than CO_2 Reduction

- More engaged and closer community through collective civic engagement.
- Better education and understanding that reaches multiple sectors and populations with diverse information needs.
- Raise awareness of the impact of climate change.
- Role model for other communities.

Challenges & Anticipated Barriers

- As with every position, it is important that education initiatives are meaningful, collaborative and that the person in this position is accountable for making sure that multiple ways of learning and multiple information needs are met.
- In addition, recent research has cited that youth are experiencing more anxiety and grief over the environment than any other demographic. It would be extremely important that the person in this position partner with the youth in our community to increase their knowledge (and advocacy) of policies and practices that are necessary to address the climate crisis in our community.

References & Resources

Coalition of Sustainable Communities New Mexico

The Lancet: Climate anxiety in children and young people and their beliefs about government responses to climate change: global survey

Recommendation GR-9: Produce an annual climate action report to be presented to County Council and shared with the community.

Time Frame: Medium-term and ongoing

Background

Publicity of the climate action report (CAP) and outreach to residents so they are aware of its contents will be important, as will an annual update on progress made. A condensed version (1-2 page) of the report should be made available to all residents, much like the County furnishes residents with an Annual Water Quality Report.

Outcome

An annual CAP will serve to inform residents and businesses about action being taken to reduce GHG emissions (as well as other things like water conservation, renewable energy sources, etc.). A more informed and engaged populace increases investment in a project and cooperation with changes.

Strategy

The CAP annual summary needs to contain information on current GHG emissions and the associated sectors, policy, and practice recommendations to further reduce GHG emissions. This is also an opportunity to highlight community and business contributions to achieving net-zero.

Economic Impact

- **Costs:**
  - Cost of staff time (Sustainability Coordinator) to develop
  - Cost of printing & distribution (also online via LAC website)

Benefits Other than CO_2 Reduction

- Residents and businesses will be aware of actions being taken by LAC to mitigate climate change and will know how/where to ask questions.

References & Resources

LAC Annual Water Quality Report

V. Natural Gas Reduction

Introduction

Natural gas (NG) is a major contributor to global climate change. Its principal component is methane, CH_4. When methane is burned, it combines with atmospheric oxygen to form carbon dioxide, CO_2, and harmless water vapor. CO_2 remains in the atmosphere for hundreds of years, forming a heat-trapping blanket that helps raise the temperature of the planet, hence the term "greenhouse gas." Unburned methane is also a greenhouse gas. It can be released during exploration, drilling, extraction, transmission, distribution, or incomplete combustion of NG. Compared to CO_2, it has a much greater global warming potential but lasts "only" decades in the atmosphere. It, too, is a significant contributor to climate change.

In October, 2020, the Board of Public Utilities (BPU) adopted a strategic goal to "support elimination of natural gas usage by 2070." The exact date is not important today. Starting towards "elimination" is.

Background

Almost all buildings in Los Alamos County (LAC), including White Rock, are heated with NG. The Department of Public Utilities (DPU) supplies gas to approximately 7700 meters. In a typical year, the citizens of Los Alamos County, exclusive of the Laboratory, use a total of about 8,600,000 therms,* resulting in emission into the atmosphere of 60,000 metric tons of CO_2 and its equivalent in methane. Small quantities of other toxic pollutants, e.g., nitrous oxide, carbon monoxide, and formaldehyde, are also emitted.

Roughly sixty homes in the La Senda area of White Rock are heated with commercially-supplied propane, C_3H_8. When burned, C_3H_8 also produces CO_2. Its use also needs to be phased out using the same approaches as for NG.

NG use closely follows ambient air temperatures, as expected. County-wide use typically peaks at about 1,500,000 therms/mo. in December and January. Minimum usage is around 200,000 therms/mo. in June, July, and August (2010-2019 averages). Summer use indicates how much gas is used for purposes other than space heating. These secondary purposes include water heating, cooking, pilot lights and decorative fireplaces. Secondary uses are undoubtedly greater in colder weather when more water heating is necessary, more cooking is done, and fireplaces are used, but they cannot be separated in the data. If 200,000 therms/mo. year-round is assumed, 28% of NG is used for secondary purposes. The real percentage is higher. This work assumes an average of 70% of NG use is for space heating and 30% for secondary uses. Percentage will vary with construction types.

At least 75% of NG goes to residential customers. About 4% is used by LA Public Schools. Close to 5% is used by County government. About 16% of use is classified by DPU as "commercial." A significant part of the "commercial" space in town is occupied by the Laboratory or its

subcontractors and should not be attributed to LA citizens. Some “commercial” use is actually residential, therefore the actual percentage of NG that goes to residences is higher than 75%.

Clearly, residential space heating is by far the single largest use for NG in Los Alamos. It is also the most challenging to reduce. Hence, NG reduction efforts should focus on residential use while recognizing that secondary and non-residential are significant, too.

This report outlines one general path to phasing out NG that is technically and economically viable today. Technical, economic, and regulatory environments will evolve. Other paths may open. However it is done, it will take decades. We need to start with the tools at hand.

References & Resources

The County Assessor’s office kindly supplied reports on all taxed properties in the County. These data include: year originally constructed, occupied square footage, basic architectural type, type of heat, and whether or not the space is air-conditioned. DPU supplied usage data for all NG meters in the County for every month in calendar year 2018. That year was chosen as the most representative year in the past decade. 2020 data are available, but it is uncertain how COVID-related issues may have affected usage patterns. All information is public and obtained either directly or through Inspection of Public Records Act (IPRA) requests. The two datasets were correlated, to the extent possible, through street addresses. 2021 data are not yet available as this report is written.

“Energy Use and Greenhouse Gas Emissions in Los Alamos County: 2000-2020,” R. B. Gibson.

* Usage is an average for 2010-2019. One therm = 100,000 British Thermal Units (BTUs). LA gas customers are billed by therms used. The average household uses about 860 therms in a typical year.

Recommendation NG-1: Set a community goal to reduce natural gas use by at least 2% per year.

Time Frame: Immediate

Background

BPU has a goal to "support elimination of natural gas usage by 2070." Progress towards this goal will not be linear, but intermediate milestones can help maintain focus and reduce the tendency to "kick the can down the road" for too much of that time.

NG use fluctuates more than +/- 10% from one year to the next, primarily following variations in temperatures. A baseline derived from average consumption over at least a decade would "smooth out" those annual variations. For the decade 2010 – 2019, average annual use was 8,566,000 therms.

Normalization of annual NG use to heating degree days* could remove variations resulting from annual temperature fluctuations. If desired, use could also be normalized to population.

Outcome

A clear, easily understood goal (e.g., "put a man on the moon…") and an easily measurable metric of progress help establish and maintain focus and are keys to public understanding and "buy in."

Strategy

- Consideration of this goal, presumably in the form of a Council resolution or other formal action, would provide a focal point for discussion and action. If this, or something like it, is adopted, the other recommendations become implementing steps, the basis for which should be less controversial.

Economic Impact

- **Costs:**
  - Setting a goal costs nothing.
  - Achieving the milestones and ultimate goal has significant "up-front" costs for every property owner, a portion of which will be recouped in reduced utility costs. The other recommendations in this section provide more specific information.

Benefits Other than CO_2 Reduction

- Other combustion by-products would also be reduced, creating a healthier environment inside buildings.
- Rallying around a shared goal is one way to build a sense of community.

Challenges & Anticipated Barriers

- The pace of NG phase-out may not be fast enough to satisfy some. It may not reach future federal or state mandates. It can always be adjusted. The key today is to get started.
- Political opposition by those who do not accept the premise that climate change is caused by human activity, principally combustion of hydrocarbons, can be expected.
- Architects and builders may object to having to change established designs. However, the State of New Mexico's adoption of the 2021 IECC which goes into effect in March 2022 has given ample time to address the heightened standards in their respective practices.

References & Resources

* "Heating Degree Day" is the standard measure of potential heating demand. The number of heating degrees in a day is the difference between the mean temperature for that day and 65°F. (Cooling degree days are similarly defined by mean temperature above 65°F.)

Recommendation NG-2: Encourage compact architectures in new construction.

Time Frame: Short-term (code amendments) and ongoing (actual construction)

Background

Heat energy is lost from buildings through external surfaces – outside walls, roofs, crawl spaces (where applicable), and through windows and doors. The less exterior surface area for each square foot of usable internal area, the more thermally efficient the building can be. Single-family, single-story, detached (ranch style) homes are the least energy-efficient. Multi-story, multi-family units are significantly more efficient. The same is true for institutional buildings.

In hot weather, heat is conducted into buildings through the same external surfaces. Reducing their area reduces cooling needs, although much summer heat comes from direct solar radiation rather than through conduction from outside air.

Los Alamos housing is already being forced to more compact buildings by limits on available land.

Outcome

External envelope heat conduction per square foot of residential or commercial floor area can be decreased significantly, lowering the need for heating (and cooling) energy.

Examples

Heat loss is proportional to surface area, among other factors. Three simple examples demonstrate the advantage of compact architecture:

- Significantly more heat is typically lost through roofs than walls. A two-story building has half the roof area of a single-story building with the same living area, although it does have more wall area.
- A rectangular duplex has 75% of the wall area of two detached homes with the same living area.
- A quad of rectangular units has 62% of the wall area of detached homes for the same living area.

The average NG usage for all residences in LA is 0.41 therms/SF/yr. (one therm = 100,000 BTU; SF = square foot; yr. = year.) The average usage (in the same units) for several “newer” compact developments is:

- Los Arboles: 0.28
- Short Drive: 0.33
- Canyon View: 0.36
- Timber Ridge: 0.37

These reductions of 10-32% in total gas use correspond to roughly 14-45% lower use for space heating, i.e., heat loading. These numbers are consistent with the very simple roof and wall area arguments of the previous bullet. A reasonable estimate is that compact housing would use at least 25% less NG per square foot for space heating as the average LA home.

Strategy

- Amend the zoning code or map to allow multifamily homes in more residential areas of town.
- Encourage construction of attached and low-rise multi-story buildings for both residential and commercial applications.

Economic Impact

- **Savings:**
    - Since less structure and land are required, compact architectures are less expensive to construct, reducing capital costs per square foot for builders and owners.

Benefits Other than CO_2 Reduction

- More compact architectures allow the option of higher overall housing density and hence the ability to house more people on LA's limited land area. While not everyone would regard this as a benefit, higher density contributes to a more vibrant city core.
- Vertical residential development within downtown could increase foot traffic to local merchants.
- Higher housing density in downtown or near any future shopping area(s) may increase foot traffic to local businesses, reduce motor vehicle trips for some services, and increase walking in general.

Challenges & Anticipated Barriers

- Compact housing architectures may not be as desirable to suburb-oriented residents, but is often preferred by younger professionals more focused on work and adventure.
- There may be fear that low-rise "multi-story" will turn into "high-rise," a concept historically unpopular in LA.

References & Resources

NG usage (in therms/yr.) for each property from DPU databases is normalized to living area by correlating to data from the County Assessor's Office. While 2020 data are available, that was an unusual year because of COVID-19. 2018 data are used as total NG use was almost exactly equal to the 2010-19 average.

Recommendation NG-3: Require new construction to have solar access, if feasible.

Time Frame: Short-term (code amendments) and ongoing (implementation)

Background

Solar thermal heating and "rooftop" photovoltaic (PV) electric power generation only work if sunlight hits the building. Adjacent buildings and trees can block solar radiation.

Outcome

All newly constructed buildings should "see" the sun. Both the roof and the south face of the building should experience direct solar radiation most, if not all, of the day, particularly during the colder months. (Roofs and other overhangs may be designed to shield walls from solar radiation during the warm months.)

Examples in Other Communities

A "solar fence" is one type of solar access requirement. An example is in Boulder, CO.* This concept prohibits structures that cast shadows more than would a solid fence of certain heights around a protected property.

A "solar setback" achieves a similar result by limiting how close to a protected property a structure may be erected for a given orientation, sun angles, etc. Eugene, OR, uses this approach.**

As is typical, both of these examples address structures, not trees.

Strategy

- Development plans should require solar access to all occupied buildings, if feasible.
- Special consideration and further study are warranted for trees with respect to solar access.
- Site plans should encourage or require building orientation to take maximum use of solar energy for heating and PV electric generation where possible.

Economic Impact

- **Costs:**
    - Requiring solar access could result in more challenges and iterations in new construction planning, with attendant costs in time and money.

Challenges & Anticipated Barriers

- Solar access creates an additional planning/design/permitting constraint on new construction which may reduce utilization of some of LA's unusual land parcel shapes.
- Reduced shade from trees and other buildings increases undesired heating and potential cooling loads in warm weather.

References & Resources

*Boulder Municipal Code, Sec. 9-9-17

**Eugene Code, Sec. 9.2795.

Recommendation NG-4: Require new construction to derive a significant portion of its heating energy from the sun.

Time Frame: Medium-term (code amendments) and ongoing (implementation)

Background

Our southwest climate provides abundant sunshine which can and does heat buildings. In this region, roughly ten percent of the winter heat for most homes actually comes from sunshine pouring through windows and heating interior floors, walls, furniture, and other contents. These masses store that thermal energy and release it later when the sun is no longer shining.

Buildings can be designed to derive a much greater portion of their heating needs from the sun, either directly or indirectly. Direct solar heating allows sunlight to warm the interior of the building directly. Indirect solar heating uses rooftop photovoltaic (PV) solar panels to generate electricity to power a heat pump. Discussion associated with this recommendation focuses primarily on direct solar heating. For more discussion of indirect heating, see Recommendations NG-6, and NG-10.

Outcome

At least 30% of the heating energy requirement of newly constructed buildings can and should be derived from solar energy.

Examples

Effective solar heating is primarily dependent on two things, the amount of south-facing window glass (glazing) and the amount of interior thermal mass directly heated by the sun.

The amount of solar heating energy that gets into a building is roughly proportional to the amount of south-facing window glass. As a rule-of-thumb, south facing window area that exceeds about 7% of the building's floor area may cause overheating during the day, possibly even in winter, unless additional thermal mass (stone, brick, concrete, or other materials with high heat content) is incorporated inside the building to absorb and store some of the solar energy. With added thermal mass, south-facing window area up to about 12% of the floor area is beneficial.

With the minimal 7% south-facing window area of an otherwise conventional home, approximately 30% of the building's heating needs can be derived from the sun. More windows, thermal mass, and more sophisticated steps can increase the fraction of its heat needs supplied by the sun to 60% or more. For present purposes, it appears 30% is easily and economically attainable and can be used as a minimum expectation for new construction.

With no other improvements, 30% solar heating would reduce NG use in the average LA home by 190 therms/yr.

Many other factors affect how efficient solar heating can be, e.g., shade, overhangs, breezes, lowered window shades at night, etc. Floor plans that place rooms for which heating and good light is most important on the south side are helpful. So is minimizing north-facing window area, which allows no solar energy into the house but is a pathway for heat loss. Each of these factors also affects how much undesired solar heating occurs in the summer.

Strategy

- Consider codifying solar heating standards. The City of Santa Fe has one such code that may be used as an example.*

Economic Impact

- **Costs:**
  - The only significant increased expense to construct a new home with increased south window area is the cost of the windows themselves. For a 2000 SF home, that would represent about a half dozen additional windows at around $1000 each or $6,000. Even that cost could be partially offset with fewer windows on other sides of the house.
- **Savings:**
  - Higher solar heating fractions will come at a higher initial price but correspondingly larger reductions in heating bills.

Benefits Other than CO_2 Reduction

- Increased south-facing window area also increases the light in the home, with the attendant psychological benefits.

Challenges and Anticipated Barriers

- To take advantage of solar energy, buildings should have a wall that faces south or within +/- 15 degrees of south. Given the unusual lots throughout LA, it could be difficult for even some new detached homes to be sited to meet that criterion.
- Multi-family homes have fewer outside walls. Orienting them so each unit has a south facing wall is a greater constraint on development plans. In these cases, indirect solar heating utilizing rooftop PV with storage could provide additional power for a larger heat pump to make up for the lack of direct solar heating.
- The magnificent views enjoyed in many areas of LA are generally best looking at the mountains east or west. Those aesthetic considerations may favor those directions for large window areas.
- Institutional buildings are less likely than homes to be conveniently oriented for direct solar heating. They may also need fewer windows. For them, indirect solar heating with rooftop PV and storage providing some of the electrical energy for a heat pump is an alternative.

References & Resources

"Passive Solar Design Strategies: Guidelines for Home Building," Passive Solar Industries Council and National Renewable Energy Laboratory.

*Santa Fe City Code, Sec. 7-4.2, "Residential Green Building Code," Exhibit A, Sec. 704.3.

Community is important in Los Alamos

Recommendation NG-5: Adopt the 2021 International Energy Conservation Codes (IECC) as the standard for new construction and guidelines for remodeling, and continue to adopt new IECCs as they are issued.

Time Frame: Immediate and ongoing

Background

After basic structural style, heat loss can be minimized through adequate insulation and modern window and doors. Some fresh outside air does need to be admitted into any occupied building. It should be in a controllable fashion (e.g., open windows) not just through random leaks, i.e., infiltration.

Owners of existing buildings don't have the luxury of orienting their buildings or optimizing their structure for the most favorable solar thermal heating. Solar access may be limited. Every structure will be different. They will likely have to rely more, or exclusively, on upgraded insulation, reduced infiltration, and artificial heat.

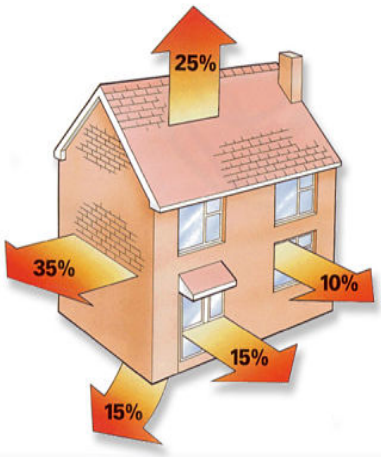


Figure NG-1: Typical residential heat loss paths, from My Green Home Blog.

Many LA homes originated as government-built housing in the late 1940s and 1950s. These were generally well built, but energy efficiency was not a consideration. Insulation was sparse and single-pane windows were standard. Virtually all government housing has been upgraded to varied extent in many different ways. Regardless of upgrades, annual NG use of government housing averages about 0.55 therms/SF/yr. Significant numbers of those buildings use more than 0.75 therms/SF/yr., but significant numbers use 0.40 therms/SF/yr. or less, demonstrating that energy-efficient upgrading is possible. Figure NG-1 shows NG energy use for every LA home vs. year constructed.

Private construction of homes began about 1960. The average home originally built in the 1960s uses around 0.42 therms/SF/yr. For homes built around 1980, annual NG use drops to around 0.37 therms/SF/yr., where it remains. Many of these newer homes are more compact, as discussed under Recommendation NG-2. More and better insulation, double-pane and coated windows, more efficient furnaces and boilers, and transition from forced air to hydronic heat have also contributed to this improvement.

Formal energy conservation standards began with the Model Energy Code in 1983. It was superseded by the International Energy Conservation Codes (IECC) starting in about 2000. The latter are revised every three years. Figure NG-2 shows an estimate of the improvements in energy efficiency for buildings conforming to successive versions of the codes, compared to pre-code years.

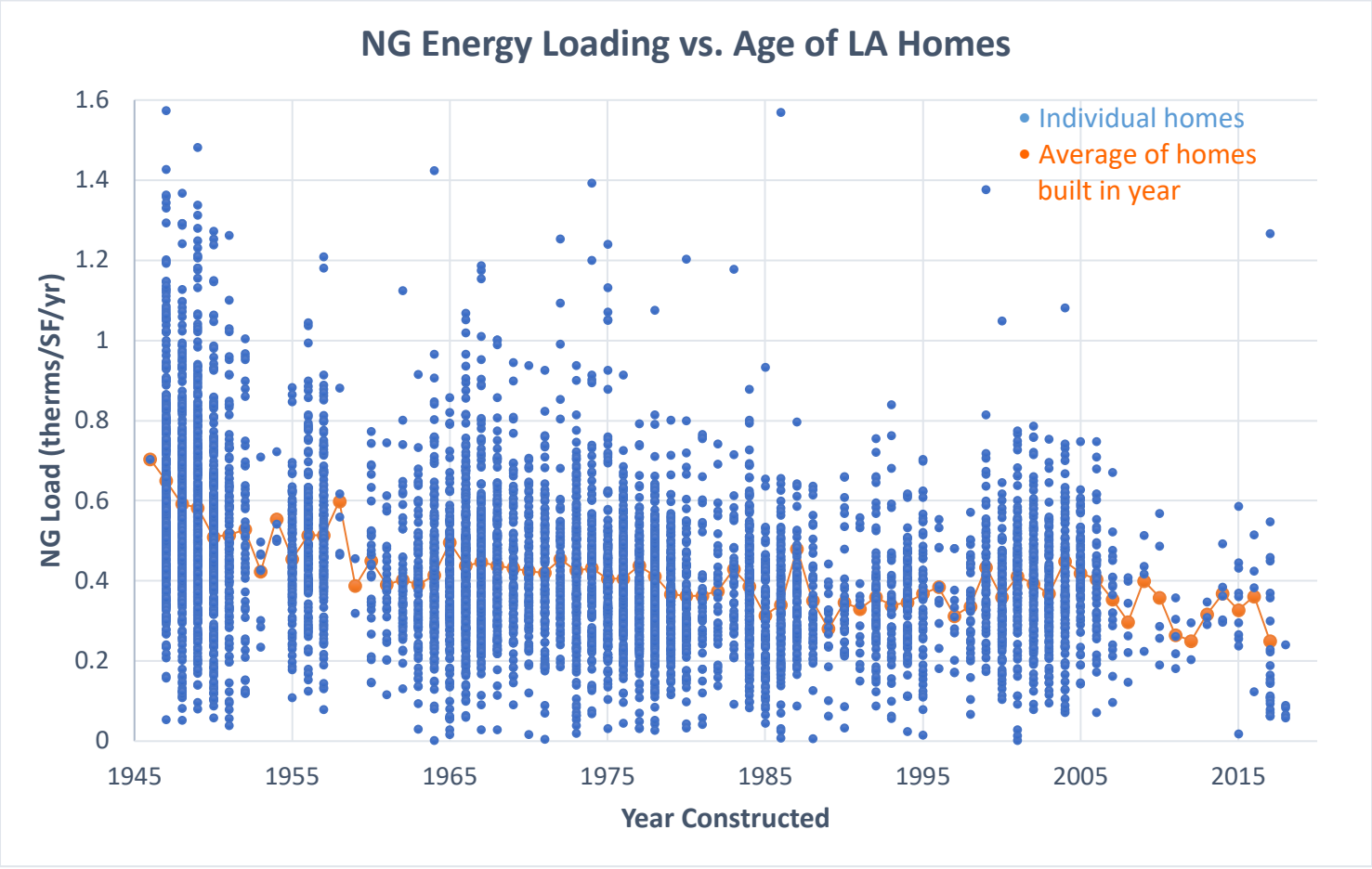


Figure NG-1. NG energy loading vs. age of LA homes

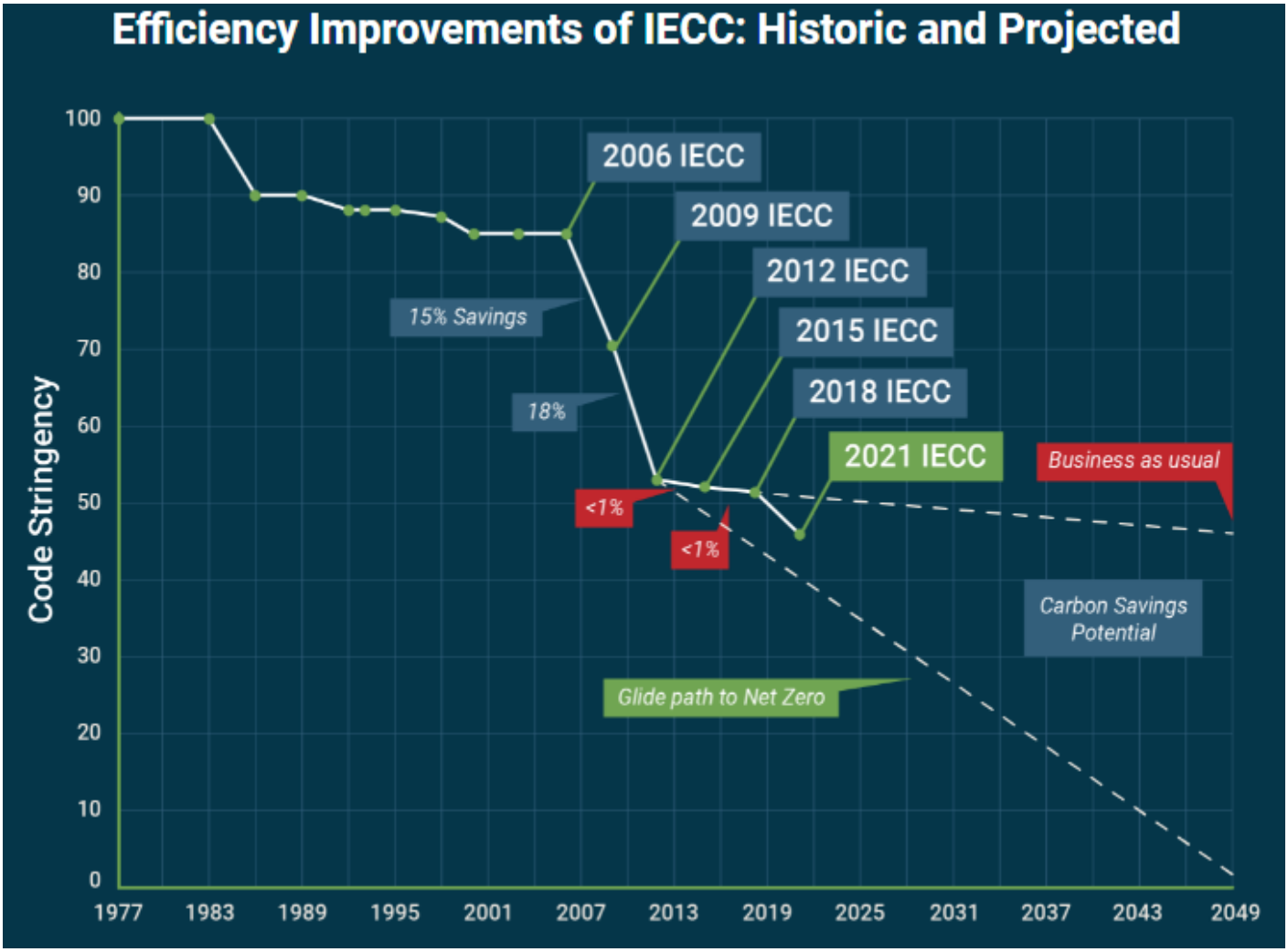


Figure NG-2. Energy efficiency improvements vs. time for IECC

New Mexico relies primarily on the 2015 International Energy Conservation Code (2015 IECC) in the NM Residential and Commercial Energy Codes. The State did not adopt the 2018 IECC, which includes greater insulation requirements, but is jumping directly to the 2021 IECC, which is expected to be adopted either this year or in 2023. Typically, these codes are revised every three years, but it can be many years for the state to adopt them. Energy savings are lost during the delay, thus increasing greenhouse gas emissions. These codes apply to new construction and to modifications substantial enough to require permits. Where code provisions are not binding, they are still useful as guidance for property upgrades. Until the state adopts 2021 IECC, Los Alamos could adopt it as a local overlay code. See Recommendation CP-1.

The County should evaluate new IECCs as they are issued and consider adopting sections of any new energy codes it determines to have greater energy efficiency before the State adopts them. When the State adopts the code, the local code is unnecessary, but energy savings would have been achieved in the interim. Homes constructed to 2021 IECC standards should use less than 50% of the heating energy of buildings built prior to the early 1980s, which is 70% of LA's homes.

The newer 2021 IECC requires residential ceiling insulation of at least R-60, wall insulation of at least R-25, and windows to have a U-factor (reciprocal of R-factor) of no more than 0.30. Foundations and crawl spaces also have enhanced insulation requirements. For comparison, the current 2018 IECC requires ceilings and walls to have R-48 and R-20, respectively. Window requirements are unchanged. IECC codes cover more than just residential building thermal envelopes (Sec. R402), but that is their primary relevance. IECC estimates, and DOE evaluations confirm, residences built to the 2021 code would be about 9% more energy efficient than those built to the 2018 code.

Few existing homes will be completely remodeled to the new (or subsequent) IECC standards or even close. Those standards can still serve as a guide for remodeling, a roadmap for the property owner to reduce heating energy needs and costs and reduce greenhouse gas emissions.

Windows represent a major pathway for heat loss in most home envelopes. Their heat loss is rated in "U-Factor," (BTU/hr•SF•deg F). Single-pane windows typically have a U-Factor around 1. Double-pane windows can vary from about 0.8 to 0.3 depending on frame and what gas is between the panes. Triple-pane windows may have U-factors as low as 0.15. For rough comparison, the more familiar R-value of a window is the reciprocal of the U-Factor. Even a window with a U-Factor of 0.3 has an R-value of only 3.3, much less than walls should be. How much heat is lost through windows depends both on the U-Factor of the windows and the total window area. Doors can be similarly large heat loss points.

Many older LA homes have air leakage (infiltration) rates of at least one complete air change per hour which typically accounts for one third of a home's heat loss. The 2021 IECC requires air leakage be tested to be no greater than one-half an air change per hour. New windows and continuous exterior insulation can significantly reduce air leakage, and there are many things a "do it yourself" (DIY) homeowner can do for a quick return on investment.

Outcome

Updated building codes will result in a faster reduction of greenhouse gas emissions.

Overall, annual energy loading of existing LA housing averages 0.41 therms/SF/yr, of which an average of 74%, 30 therms/SF/yr., is for space heating. Clearly, there is opportunity to reduce the need for heat energy, with the highest leverage being in the older government housing. A reasonable overall goal over the next decades would be to reduce that average loading to no more than 0.30 therms/SF/yr. with no more than 18 therms/SF/yr. for space heating. That would be a reduction of 40% in average heating energy needs.

Strategy

- Adoption of 2021 IECC would force newly constructed or renovated buildings to meet the most current standards for insulation and infiltration.

- While there is no requirement to bring existing buildings up to new energy code standards, the IECC standards can serve as a guideline to property owners for planned upgrades.
- External energy audits of buildings are relatively easy, inexpensive, and non-intrusive. They could help property owners understand where their heat is being lost and how much. They can also easily detect heat leaks due to gaps, failed caulking, etc. Leaks are often relatively easy to fix. See Recommendation NG-11.

Examples in Our Community

With no other improvements, an average LA home built or retrofitted to 2021 IECC standards would reduce its NG use by 320 therms/yr.

Costs for remodeling vary wildly and are affected by many factors. However, the base recommendations of the most cost-effective improvements have remained consistent over a long period of time with some exceptions. Blown-in attic insulation at roughly $1.75/SF for R-38 is one of the most cost-effective improvements and is often easily added in homes with attic space. Flat-roofed homes will need to be addressed differently. The majority of residential energy loss is through windows and doors especially if the existing windows are single glazed. Replacement for energy considerations alone is usually cost-effective only for single-glazed windows. Ballpark cost of replacement and installation of windows is $1,000/window unit. Doors similarly can be thermal underperformers, but are expensive to replace at $1,200+/door. Adding exterior insulation to existing walls finished with new siding or stucco can improve the walls' thermal performance by 50% or more at a cost of $7.50+/SF.

Case studies on existing LA homes built in the 50s and 60s yield return-on-investment (ROI) times for insulation upgrades as follows:

- Attic Insulation 10-15 yrs.
- Single Pane Window Replacement 10-15 yrs.
- Older Dual Pane Window Replacement 20-25 yrs.
- Ext. Wall Continuous Insulation Upgrades 20-25 yrs.

Examples in Other Communities

- Updated IECC adoption in Maryland
- Updated IECC adoption in Richland, WA
- Texas: Home rule cities choose the applicable codes

Economic Impact

- **Costs:**
    - It is easiest and most economical, of course, to incorporate low-loss insulation, windows, and doors into a building when first constructed. Doing so adds little to the cost of a new building.

- Some infiltration losses in existing homes may be very easy and inexpensive to reduce or eliminate, e.g., with caulking or weatherstripping, once they are identified.
- Depending on the individual existing home, the next easiest improvement is likely from adding insulation in the attic if the home has one. Insulation can also be added to walls. Cost effectiveness (ROI) will vary greatly.
- While window and door replacements are typically not cost-effective for purely energy use reduction, upgrading during remodeling may add little cost while significantly reducing heat loading.
- Staff time required to update codes should be fairly minimal as there are many examples to follow. Procedures for implementation, education of constructors, and enforcement protocols would need to be developed. In areas where the state provides the inspector, memoranda of understanding would need to be formalized.

Benefits Other than CO_2 Reduction

- Well-insulated homes tend to have more uniform interior temperatures, which most people find more comfortable. Drafts not related to forced-air systems are essentially eliminated.
- Some code requirements, such as basement egress windows, enhance home safety.
- Fire-resistant finishes can be incorporated into the new wall finish to reduce the wildfire threat to the building.

Challenges & Anticipated Barriers

- Cost and inertia are the major impediments to any remodeling.
- Any time new requirements are added that cost additional funds there will be pushback. Education before implementation will be key. No homeowner renovating their home desires to have the costs increased. New home construction companies are generally more accepting of additional requirements.
- Additional code requirements and associated expense can discourage some property owners from making otherwise-desirable renovations.

References & Resources

2021 IECC

"2021 IECC Residential Cost Effectiveness Analysis," National Association of Home Builders Rpt. CR1391_06112021 (June, 2021)

Build With Rise: Avoiding Home Heat Loss

Image of heat loss percentages from My Green Home Blog

The US Department of Energy Guide for Reducing Air Infiltration

Recommendation NG-6: Set a cut-off date for new natural gas hook-ups and new electric resistance heating installations, effectively requiring electric heat pumps. Encourage substitution of heat pumps when gas-fired furnaces and boilers are replaced.

Time Frame: Short-term (code amendment adoption for new construction), medium-term (for an effective date), and ongoing (implementation in existing buildings)

Background

Buildings constructed today will (hopefully) exist for many decades, typically 50-100 years or more for residences, less for institutional structures. It is much easier to build a new building that does not use NG than to retrofit one after it is built.

Most new buildings with some solar heat and all existing buildings will require artificial heat. Today's sources are NG-fired furnaces (for air) and boilers (for water). (Despite the name, boilers do not heat water nearly to boiling temperature). A few places may use electric resistance and/or some wood fireplace heat. There are no known sources or uses of geothermal heat on the east side of the Jemez mountains.

Traditional electric resistance heat has a well-deserved reputation as being very expensive. At current Los Alamos rates, electricity costs over four times as much as NG for the same amount of heat energy.*

Heat pumps are a well-established technology that makes far more efficient use of electricity for heating than resistance heating. Heat pumps are not new. Refrigeration in its many forms (e.g., refrigerators, freezers, and refrigerated air conditioners) uses heat pumps. Utilizing phase changes in a working fluid, they essentially extract heat energy from a cold source and "pump" it "uphill" into warmer air or water.

Heat pumps can be configured to work both directions, to heat or cool the inside of a building. A valve in the heat pump system reverses the direction of heat flow. See Figure NG-3.

Heat pumps can substitute for a furnace or central air conditioner to heat or cool air in a forced air system. They can also substitute for a boiler, heating water in a hydronic system, either baseboard or in-floor. Hydronic air conditioning gets more complicated, because some air movement is necessary to prevent condensation. Chilled water pipes near ceilings are one approach, more applicable in institutional buildings. Another is to create some airflow through indoor evaporator coils. The popular "mini-splits" use this technique. Either way, one heat pump can both heat and cool a home.

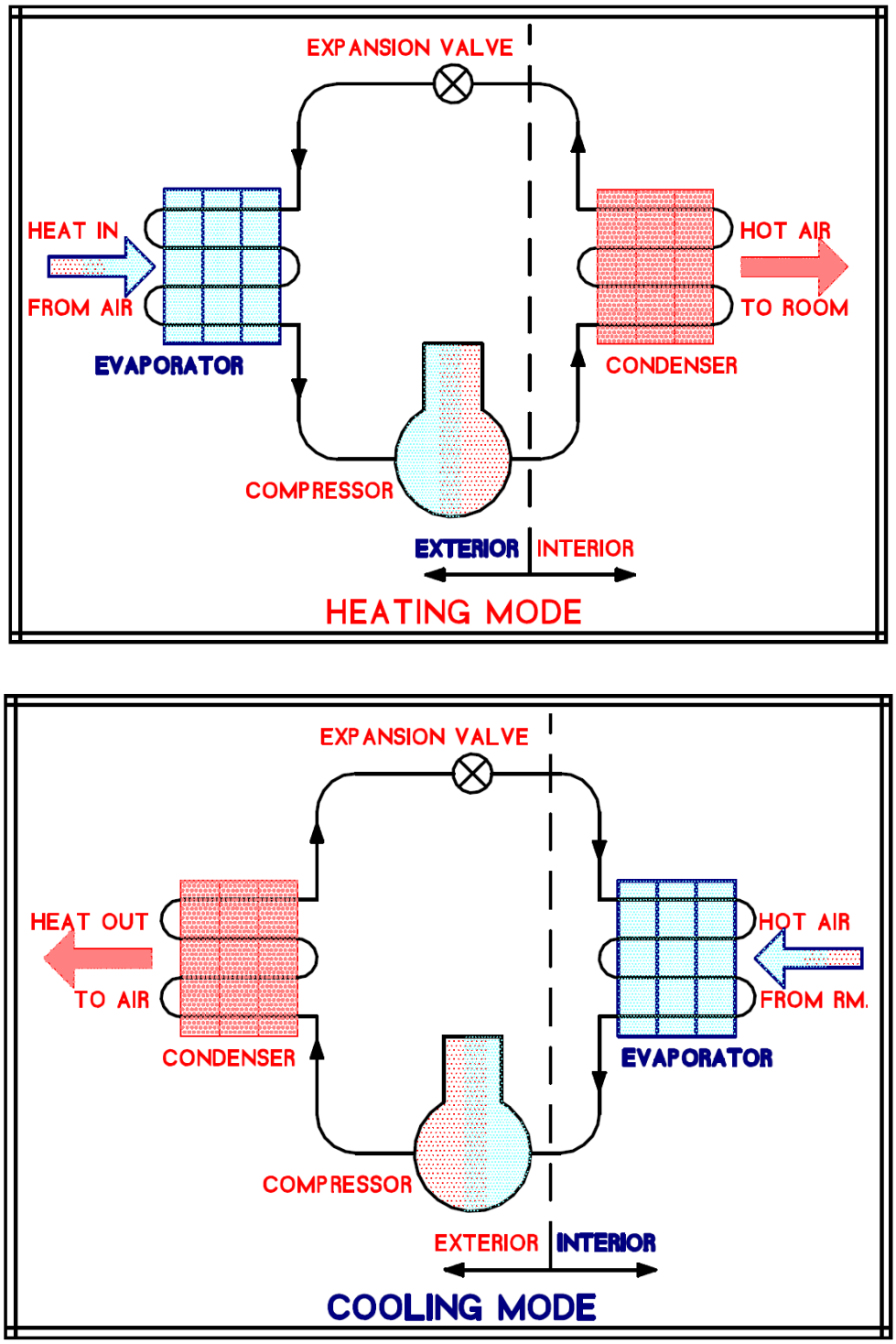


Figure NG-3. Heat pump basics. (Top) pumps heat into building from (even cold) outside air. (Bottom) is conventional air conditioning.

In a heat pump, electricity is not turned into heat. It only runs the pump (and controls). The colder the source, the more work the pump has to do – and the more electricity is required – to pump heat energy "uphill." Heat pump efficiency is characterized by a "Coefficient of Performance" (COP). COP is basically the ratio of heat energy transferred to the energy content of the electricity required to affect that transfer. It might be considered the "gain" of a heat pump relative to straight resistance heating. Resistance heating has a COP of 1.0. A typical heat pump might have a COP of 4.0 if the source temperature is around 50° F, a COP of 3.5 if the source temperature is 30° F, and a COP of 3.0 if the source temperature is 5°F.

The warmer the source, the less work heat pumps have to do and the higher the COP. The source of heat can be the ground, water, or ambient air. 20 ft. or more below the surface, our ground temperature is around 50° F all year round. When heat energy is extracted from soil by a heat pump, the soil temperature drops unless the energy is replaced. Water is a good conductor of heat. Ground-source heat pumps work best in wet soil. A lake or pond is even better. Our volcanic soil is dry and contains a lot of air, a thermal insulator. It is a poor thermal conductor and not suitable as a source for heat pumps. Air-source heat pumps are the practical choice in Los Alamos.

Heat pumps can be augmented by so-called "reverse cycle chillers." ("Chiller" is a misnomer, since they can both heat and cool.) In a reverse cycle system, the heat pump actually heats or cools a well-insulated reservoir tank of water, usually built underground. That water then heats or cools the building. The overall system is more efficient, but also more complex and costly to install, than a heat pump by itself.

Examples in Our Community

Early in the past century, most buildings in the U.S. were heated with wood or coal. Conversion of both new and existing buildings to other heat sources (NG, propane, oil, electricity, or central steam) occurred over only a few decades, largely without government mandate or subsidy. It can be done.

In Los Alamos, many buildings in the western part of downtown (Medical Center, High School, Gold St. apartments, Central Shopping Center, etc.) were heated with steam from the DOE steam plant on 35th St. In the mid-1980s, DOE decided to close that plant. It gave affected entities notice (which was extended). They all came up with alternate sources of heat and "the plug was pulled" on the DOE steam plant. There was grumbling, of course, but it was done.

Simply converting the average LA home from an NG furnace or boiler to a heat pump, with no other improvements, would eliminate the 635 therms/yr. of NG used for space heating, but require 5300 kWh additional electricity. If insulation upgrades are installed at the same time as the new heat pumps, the kWh loads could be significantly reduced. Quantitative estimates are in Table NG-1.

Strategy

- Discourage new hookups, starting very soon. Buildings already in design or permitted should not be forced to change course.
- Set a date, perhaps two or so years away, after which new NG hookups will not be permitted, with few exceptions.

Outcome

Eventually, all NG-fired heaters should be replaced by heat pumps.

Furnaces and boilers require replacement every several decades. Replacing them with heat pumps would eliminate the single largest use of NG in each home. Details, including physical layout, of replacement installation would vary for each building. Older furnaces and boilers could be retained for back-up as long as NG service remains.

NG should eventually no longer be needed for space heating, although the NG supply and distribution system will need to be maintained operational for several decades until conversion is complete.

It is not possible to predict or plan the "end game" for terminating NG service. The energy world will be a different place then. Fixed costs to maintain and operate DPU's NG utility will not drop proportionately to the number of customers. Redistribution of fixed costs over the remaining customers will cause those fixed monthly costs to rise, providing an increasing economic incentive to customers to convert away from NG. This will take several decades; it will not be abrupt. How costs for the last few customers will be managed is a policy decision that does not have to be considered for decades.

Economic Impact

- **Costs:**
    - The initial cost to install a heat pump is substantially higher than the cost to replace an existing NG-fired furnace or boiler, typically two to three times as much today. Since a large part of the cost is in the installation itself, not the unit, there will be great variations for different installations.
    - NG prices are near historic lows. They are unlikely to drop much lower. Normal market fluctuations are large, a factor of several, even with the buffering provided to LA retail customers by DPU's long-term contracts. Government actions to discourage use of carbon-based products (e.g., a "carbon tax") may drive prices higher, also. In November 2021, the LA residential rate was $0.76/therm. At that NG rate and the current residential electricity rate of $0.1152/kWh, assuming an average heat pump COP of 3.5, and assuming an average NG furnace efficiency of 85%, the commodity cost for electricity to run a heat pump is about 7% more than cost of gas for the same amount of heat, an inconsequential difference considering the range of NG and electricity price variations.

- **Savings:**
    - Eventually, the NG utility can be shut down, saving its annual operating cost, currently about $4M/yr. (more than $500/yr. for each customer), not including capital investments. That, too, is decades away and cannot be considered until adequate confidence in NG-free heat and back-up plans is established.

Benefits Other Than CO_2 Reduction

- Heat pumps work both directions, providing cooling (air conditioning) as well as heating. As the climate warms, LA summers are getting hotter for longer. Summer cooling will become increasingly desirable.
- The small, but real, risk of fires or even explosions from gas leaks would be eliminated.
- Indoor air quality would be improved by elimination of the trace nitrous oxide, carbon monoxide, formaldehyde, and other NG combustion products.
- Gas valve stations will no longer be needed.
- While electrical outages are more frequent than NG outages, they are generally of short duration, seconds or minutes. Thermal energy stored in structures limits the rate at which a structure without a heat source cools. While NG may seem more reliable than electric heat, NG heating systems use electric controls that do not operate during power outages. Purely electric systems would actually be more reliable than those that require both NG and electricity.
- An NG outage requires DPU crews to manually relight pilot lights. This could take weeks for a widespread outage. An NG outage can be more than a short-term inconvenience. This potential would eventually be eliminated.

Challenges & Anticipated Barriers

- Heat pumps are not a direct or “drop-in” replacement for furnaces or boilers in existing buildings. Replacement will take some time and planning.
- Installation cost will be significant, often more than the cost of the hardware itself. This will compound the usual resistance to change.
- Most homes are likely to need 3-6 ton heat pumps (1 ton = 12,000 BTU/hr. or 0.12 therms/hr.) with the larger size needed only for the largest or most poorly-insulated. Heat pumps typically draw about 1.1 kW/ton. At 230 VAC, that is approx. 5 Amperes (A)/ton. If all of that power is drawn from the utility service line, some older homes with 100 A service may have to upgrade to the more modern 200 A service. Charging of electric vehicles may also push service upgrades. Alternatively, heat pumps can be powered by stored electricity from rooftop PV.
- Developers and builders may complain, asserting that costs will skyrocket. They may threaten not to do business in LA. The reality is that this will require change what they build, and change is hard. Some developers are already building with heat pumps in LA.

References & Resources

*In November 2021, residential NG costs $0.76/therm. Electricity costs $0.1152/kWh. The energy in a therm is equal to that in 29.2 kWh of electricity. Thus, a "therm" of electricity costs 29.2 x $0.1152 = $3.36 or 4.4 times as much as that same energy in NG.

"LARES Committee: Heat Pumps – 21st Century Heating & Air Conditioning" LA Reporter, October 22, 2021, and "County LARES Task Force Discusses Electric Heat Pumps," LA Daily Post, October 23, 2021.

Recommendation NG-7: Encourage substitution of solar thermal, heat pump, tankless, or point-of-use water heaters when traditional hot water heaters are replaced.

Time Frame: Ongoing

Background

Whether electric or gas, hot water heating is a major secondary use of energy in homes.

Domestic hot water is needed for personal hygiene, dish washing, clothes washing, and ancillary uses. It is almost always provided by a "hot water heater" for which the primary energy source may be electric power, NG, or heated water from the hydronic boiler that also supplies space heating. Heat losses from hot water are large. The water heater itself, no matter how well-insulated, is losing heat 24/7. Any time hot water is flowing through pipes to points of use in the house, the pipes (usually uninsulated) are losing heat. If a tap has not been used in a while, hot water must flow all the way from the heater to the tap. Water not used then sits in the pipe and cools towards room temperature, wasting heat energy. In winter, much of the wasted heat in hot water systems contributes to heating the house. In warm weather, it adds to the cooling load.

Traditional storage-type (tank) electric hot water heaters typically draw about 4 kW when heating and do this for 2-4 hours/day. That is 3000-6000 kWh/yr. NG-fired tank hot water heats are only about two-thirds as efficient. They typically use 150-300 therms/yr., not counting a pilot light, if so equipped.

Alternatives include:

- Solar "rooftop" heating of water during the day with subsequent storage, similar to – but larger than – current hot water heater tanks.
- A "stand-alone" heat pump dedicated to heating water.
- Heating water with the same heat pump system that provides space heating in hydronic systems. The water heater is simply a heat exchanger on another loop in the house heating system. This is already done in some hydronically-heated houses.

Example of rooftop solar water heater from Clean Energy Summit

- Electrically heated "tankless" hot water heaters. These are centrally located, like storage-type heaters, but heat water only "on demand." They avoid the "standby" losses from keeping a tank full of water hot all the time, but require very high electric power, typ. 10-

30 kW, when operating. Tankless hot water heaters tend to last longer than traditional tank types.

- Use of electrically-heated "point-of-use" hot water heaters. These are also tankless. Located near the tap or other point of use, these provide "on-demand" hot water, avoiding all the standby losses inherent in stored hot water systems. In new construction, traditional hot water piping is no longer needed.

Outcome

Newly constructed buildings should use the sun, heat pumps, or tankless water heating. Existing buildings should move in those directions to the extent practical. Individual property owners should have information to help them evaluate the best options for their homes.

Examples in Our Community

The number of electric vs. NG hot water heaters in Los Alamos is not known. For an example, we assume 50% each. We also assume average heat demand toward the lower end of the national range, 4000 kWh/yr. or 200 therms/yr.

Of course, solar hot water heating consumes no artificial energy.

Heat pumps have an average cold weather COP of more than 4.0 in LA's climate. Year-round, the COP would be higher, since the average outside air temperature would be higher. To be conservative, we use a COP of 4.0. Thus, a heat pump, whether separate or combined with the space heating system, to provide the same amount of hot water would consume about 1000 kWh/yr. for a typical home.

Additional energy savings may be possible with "on-demand" systems that reduce or eliminate standby heat losses.

Economic Impact

- At current (November 2021) rates ($0.115/kWh and $0.76/therm), the average water heater costs $460 for electricity or $152 for NG each year.
- Hardware and Installation costs for any alternative type of water heating system will depend on individual property characteristics and vary widely.

Benefits other than CO_2 Reduction

- Point-of-use systems reduce wait time and the water wasted while hot water is flowing from a central source to a tap.
- As with other NG appliances, elimination improves indoor air quality.

Challenges and Other Barriers

- Solar water heating systems require a larger storage tank than traditional hot water heaters and are not amenable to tankless or point-of-use systems.
- For existing buildings, it is always easier to simply replace like-with-like than design, acquire, and install something quite different. The most likely time to upgrade a hot water heating system is when the existing heater fails. Absent advance planning, the strong temptation is to do what takes the least time. That is usually to replace a traditional water heater with another.

Recommendation NG-8: Encourage substitution of electric induction ranges when traditional electric or natural gas ranges are replaced.

Time Frame: Ongoing

Background

Electric induction ranges are steadily gaining in popularity. Instead of using electrical (resistance) heating elements or NG flames to heat cookware, they induce an electric current directly in the cookware. Only the cookware and its contents get hot, not the burner. No heat energy is lost in the transfer.

Available data on average monthly or annual energy use by ranges varies widely due to the large number of variables in any test. There is general agreement that induction ranges are roughly 10% more energy efficient than conventional electric ranges, which are much more energy efficient (by a factor of two or more) than NG ranges. (Since NG is presently so much less expensive than electricity for the same energy, NG ranges cost less to operate.)

Outcome

Ranges, NG or conventional electric, tend to be replaced every 20-30 years. Thus, most NG use for cooking could be eliminated within thirty years.

Examples

The typical NG range consumes about 20 therms/yr. Replacing it with an electric induction range would replace that gas use with ~350 kWh/yr. of electricity use, similar to what a conventional electric range uses.

Strategy

- Replacement of functional ranges simply for NG elimination or energy efficiency should not be mandated.
- Education is the preferred mechanism to start the transition.
- Induction ranges are generally well-liked by those who have them. It can reasonably be assumed that “word-of-mouth” will motivate conversion, some even before replacement is necessary.
- If new NG hook-ups are still allowed, kitchens should at least be required to have outlets for electric ranges, whether conventional or induction.

Economic Impact

- **Costs:**
    - Purchase prices for induction ranges are still higher than traditional electric or natural gas ranges, but are dropping steadily as they become more common.

Ranges tend to be replaced every few decades, so the incremental cost of an induction range is small and may well disappear in a few years.

- Induction ranges use slightly less energy than resistance ranges. Electricity costs will be similar, although they would remain higher than for NG ranges at current utility rates.

Benefits Other Than CO_2 Reduction

- Induction ranges heat faster than NG ranges and much faster than traditional electric ranges. Temperature can be controlled more precisely, especially at low heat.
- When cookware is removed, the smooth surface of the range itself is cool, reducing the risk of burns or fires. There is no gas to leak into the house if an un-lit burner is left on.
- Without trace NG combustion products, indoor air quality is improved.

Challenges & Anticipated Barriers

- Today's induction cooktops require cookware containing iron. Cast iron or stainless-steel cookware both work; aluminum, glass, or ceramic do not. Smooth surfaces facilitate energy transfer. Hence, some households may need new cookware. Further technology development is likely to expand the range of cookware that can be used with induction ranges.
- Kitchens with NG ranges may need to be rewired for electric induction stoves.

References & Resources

U.S. Department of Energy (DOE). 2009. Technical Support Document: Energy: Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Dishwashers, Dehumidifiers, and Cooking Products, and Commercial Clothes Washers, Chapter 6: Energy Use Determination. EERE-2006-STD-0127. Washington, DC.

Induction Cooking Technology Design and Assessment, Micah Sweeney, Jeff Dols, Brian Fortenbery, and Frank Sharp, Electric Power Research Institute (EPRI), Table 3, p. 9-375. (2014)

Recommendation NG-9: Discourage or prohibit pilot lights in new or replacement gas appliances.

Time Frame: Short-term and ongoing

Background

Pilot lights burn 24/7/365 to provide ignition in some NG furnaces, boilers, water heaters, ranges, and fireplaces. Electric spark ignition has largely replaced pilot lights in newer appliances. Electric energy consumption by intermittent spark ignition is negligible. It could replace most pilot lights even if the unit itself continues to use NG. Retrofit kits are available for pilot lights in some existing units.

The American National Standards Institute (ANSI) has just banned pilot lights in fireplaces. That is likely the start of a national movement towards banning pilot lights more broadly.

Outcome

No new pilot lights should be installed. To the extent possible, existing pilot lights would be replaced by electric ignition ASAP.

Examples in Our Community

It is not known how many pilot lights are in LA. If we assume two associated with each meter, average annual NG consumption per meter is then 106 therms. That is roughly one-eighth of our total NG use.

Strategy

- As NG appliances are phased out, the need for pilot lights will disappear. There is no reason to wait that long. Installation of appliances with pilot lights should be discouraged or outright banned.

- Surveys could ask residents how many pilot lights they have burning in their homes. That would provide some statistical basis with which to refine the above total use estimate.

Economic Impact

- **Costs:**
  - At $0.76/therm, NG for each pilot light costs about $40/yr. to operate.
  - Kits to replace NG pilot lights with electric ignition run ~$200 plus the cost of installation.

- **Savings:**

- The cost of the replacement is returned in 5-10 years (depending on installation cost). There is no significant difference in cost when a new furnace or other appliance is purchased with electric ignition.

Benefits Other Than CO_2 Reduction

- Although usually well protected, pilot lights are an ignition source for flammable items, e.g., curtains, spilled liquids, etc. This modest hazard would be eliminated.
- If the NG supply is interrupted, utility crews would no longer have to visit every building with gas service to relight pilot lights. This can take weeks or months, depending on the extent of the outage. During cold weather, affected areas would have to be evacuated.

Challenges and Other Barriers

- Replacement electric ignitors are not available for some older furnaces, water heaters or other appliances.

Recommendation NG-10: Include heating demand in electrical utility generation, transmission, and distribution supply planning.

Time Frame: Short-term and ongoing

Background

Heat pumps will increase overall demand on the electric supply and distribution system. Normal annual electrical energy use in LA is around 120,000 MWh. Peak instantaneous power demand is typically 8-20 MW, with occasional peaks in the low 20s. The daily peak is typically in evenings. Lowest demand currently occurs overnight.

Peak County-wide NG use in recent years was 5060 therms/hr. on the single-digits morning of February 8, 2019. Simply replacing all NG-fired furnaces and boilers with heat pumps with a COP of 3.0 at that air temperature would require approx. 50 MW of electric power. That would substantially exceed generation, transmission, and distribution capacity of our current power supply system.

The approaches outlined in other recommendations will significantly reduce that potential increase in demand for electric power.

In any case, there will be additional demands placed on the electric power system. These will peak during the coldest temperatures which usually occur at night when other electrical demand is lowest. This will increase the base load on the system. Sources that can support 24/7 base loads, such as the Carbon-Free Power Project, will become even more important than they are presently. See Recommendation E-6.

The basic approaches outlined for residential space heating are also applicable to institutions. More compact envelopes reduce heat loss for the same floor area. Some types of institutions (e.g., most retail stores, manufacturing) require little window area with attendant heat losses. For others (e.g., offices, schools) the bright, open, airy indoors areas enabled by extensive use of glass exterior walls may be a luxury that should be tempered by heat loss considerations. Good ceiling and wall insulation is as vital to reducing heat loss in institutional buildings as in residential.

Heat pumps can replace NG-fired furnaces and boilers. Larger, more complex buildings (e.g., large offices, schools) often have very different heating and cooling needs in different areas. More complex heat pumps, such as Variable Refrigerant Flow (VRF) systems, can move heat from warm parts of a building, such as the south side near windows, to cooler parts, reducing greatly the need to “pump” heat energy out of much colder outside air.

Most institutional buildings are largely unoccupied at night. They can tolerate reduced nighttime temperatures. Unlike residences, a well-insulated building may need little artificial heat at night. Nighttime temperature setbacks are already common.

Institutional distributed generation and storage is likely to be much more dispatchable (i.e., controllable by electric utility system dispatchers) than residential.

Outcome

- The electrical utility system has to be capable of meeting the increased demands imposed by converting NG space heating and appliances to electric power.

Examples in Our Community

- There are many variables involved in converting NG space heating and supplemental appliances to electricity. A very crude model has been developed to help estimate the magnitude of the added electrical loads. It is based on percentage of conversion, not on unpredictable dates. While the model appears to show all aspects of the conversion occurring at the same rate, that is extremely unlikely. It still gives a rough idea.
- The model depends on many assumptions outlined below:

    - The number of housing units remains constant at 7220. (This is the sum of current residential NG meters and 60 La Senda homes heated with propane.) Increases due to increases in population or changes in average household size would have to be considered separately.
    - The average LA home uses 860 therms/yr. of NG. Of that, 635 therms/yr. is associated with space heating and 225 therms/yr. with secondary uses.
    - Half of new homes will have approximately the same exterior envelope area as current homes. Half will be “compact” with 25% less exterior envelope area.
    - All new homes will be insulated to 2021 IECC standards, which should reduce their heat loss through their exterior envelope by 50%. (2021 IECC actually would reduce heat loss by slightly more, 55%.)
    - Existing homes that are upgraded will reduce their heat loss by half of the 2021 IECC standard, or 25%.
    - New homes will derive an average of 30% of their space heating needs directly from solar irradiance.
    - There will be no new NG hookups or electric resistance space heating installations. Thus, all new homes will be built with heat pumps for artificial space heating. Existing homes will convert to heat pumps as indicated (25%, 50%, 75%, 100%).
    - Averaged over a heating season, heat pumps will have a COP at LA’s altitude of 3.5, which is a typical value for a modern heat pump at 30°F. At 5°F, they will have an average COP of 3.0. Temperatures well below that were more frequent in the past but have become rare.
    - Absent any better information, it is assumed 50% of homes use electric hot water heaters and 50% use NG water heaters. Similarly, it is assumed 50% use electric ranges and 50% use NG ranges.
    - Peak heating use is likely to occur in the early morning hours when hot water is also in demand (showers, etc.) and ranges are being used (breakfast). It is assumed

20% of storage-type water heaters are actually heating water and 20% of ranges are in operation at any one time.
    - It is assumed conventional hot water heaters will be replaced by tank-type storage units heated by heat pumps. No solar or electric tankless hot water heaters are assumed.
    - Absent any better information, it is assumed the average home today contains two continuously-burning pilot lights.
    - Almost all NG consumed by institutions is for space heating. Institutions use much less for water heating, cooking, and pilot lights than residences.
    - Institutional buildings tend to have a shorter life span than residences. Most will be replaced within 50 years. For simplicity, the model assumes institutional buildings are replaced, rather than upgraded, and will meet 2021 IECC standards.
    - Effects of night-time heating setbacks and dispatchability of distributed generation and storage assets are not included.

- Outputs from the model are shown Table NG-1 and Figure NG-4.
- This is not the only path to conversion from NG to electricity. It is only representative.

Strategy

Average annual electric energy demand would increase by 25,000 - 53,000 MWh or 21-44% over its current average of 120,000 MWh/yr. If supplied entirely by the utility, this would require increases in sources of supply, transmission capacity, and distribution capacity. Additional electric energy demand for electric vehicles (EV's) would add to this.

Peak electrical power demand would increase by 19-41 MW, a doubling or tripling of current peak loads of 20-25 MW. These new peak loads are largely for space heating. They can be expected to occur at the coldest times of the day, the early morning hours, when other electrical loads are at their lowest. In any case, increased capacity would be required of the distribution system.

In both cases, the lowest increases are associated with virtually all LA homes being replaced in the next several decades, which is extremely unlikely. The higher energy and power scenarios are more realistic.

Demands on the utility could be reduced with more distributed generation ("rooftop PV") and storage. The latter is essential in that much of the heating need is overnight, when the sun does not shine and wind power tends to be low, also. See Recommendations E-7 and E-8.

With very good insulation (2021 IECC standard), hot water heating requires almost as much peak power as space heating. Solar heating of hot water, which is not considered in this model, could reduce peak electric power needs by up to 7 MW.

Economic Impact

- Cost to DPU (hence, to all utility customers) to increase capacity of the electric distribution system, and perhaps the transmission system into LA, are beyond the scope of this work to estimate. Some of this cost will ultimately be recouped through elimination of the NG distribution system.

Benefits Other than CO_2 Reduction

- Upgrades to the electric power distribution system to increase capacity may also present opportunity to further underground parts of the system.

Challenges & Anticipated Barriers

- Redesigning and upgrading the electric distribution system for increased capacity and/or increased distributed generation is a massive job.

References & Resources

Figure captions:

Table NG-1 (on following page). Changes in residential NG and electricity requirements as NG uses are converted to electric. Conversion is shown as a percentage of residences. No dates are forecast.

Figure NG-4 (on second page following). Total residential NG and electricity use for heating (space, water, ranges, and pilot lights) as conversion progresses. Conversion is shown as a percentage of residences; no dates are forecast. (a) shows the decline in NG use. (b) shows the evolution of annual electric energy use. (c) shows the evolution of peak electric use. In (b) and (c), solid lines are total heating usage; dashed lines are space heating only.

Changes in NG and Electricity Requirements as NG Uses are Converted to Electric

		Conversion Progress				
Percentage of Units Affected (Conversion Rate)		0%	25%	50%	75%	100%
Number of Housing Units Affected		0	1805	3610	5415	7220
Residential Space Heating						
NG Use for Space Heating						
Annual w/ No Conversion to Heat Pumps	(k therms/yr)	4,585	4,585	4,585	4,585	4,585
Annual w/ % Conversion to Heat Pumps	(k therms/hr)	4,585	3,439	2,292	1,146	0
Peak Hourly w/ % Conv. To Heat Pumps	(therms/hr)	3,249	2,437	1,625	812	0
Convert NG to Heat Pumps w/ No Insulation Upgrades						
Annual Electric Use	(MWh)	0	9,595	19,190	28,785	38,380
Peak Electric Use	(MW)	0.0	7.9	15.9	23.8	31.7
Convert NG to Heat Pumps w/ Insulation Upgrades						
Annual Electric Use	(MWh)	0	6,297	12,594	18,890	25,187
Peak Electric Use	(MW)	0.0	5.9	11.9	17.8	23.8
Replace Existing Housing w/ New						
Annual Electric Use	(MWh)	0	2,571	5,142	7,714	10,285
Peak Electric Use	(MW)	0.0	2.4	4.9	7.3	9.7
Residential Secondary Uses						
Convert Conventional Water Heaters to Heat Pumps						
Annual NG Use	(k therms/yr)	722	542	361	181	0
Peak Hourly NG Use	(therms/hr)	289	217	144	72	0
Annual Electric Use	(MWh)	14,440	12,635	10,830	9,025	7,220
Peak Electric Use	(MW)	2.9	2.5	2.2	1.8	1.4
Eliminate Pilot Lights						
Annual NG Use	(k therms/yr)	765	574	383	191	0
Peak Hourly NG Use	(therms/hr)	72	54	36	18	0
Replace Tradional Ranges with Induction						
Annual NG Use	(k therms/yr)	72	54	36	18	0
Peak Hourly NG Use	(therms/hr)	325	244	162	81	0
Annual Electric Use	(MWh)	1,264	1,579	1,895	2,211	2,527
Peak Electric Use	(MW)	2.2	2.7	3.2	3.8	4.3
Total for All Secondary Uses						
Annual NG Use	(k therms/yr)	1,560	1,170	780	390	0
Peak Hourly NG Use	(therms/hr)	686	514	343	171	0
Annual Electric Use	(MWh)	15,704	14,214	12,725	11,236	9,747
Peak Electric Use	(MW)	5.1	5.2	5.4	5.6	5.8
Institutional Use (primarily Space Heating)						
Annual NG Use	(k therms/yr)	2,445	1,834	1,222	611	0
Peak Hourly NG Use	(therms/hr)	1316	987	658	329	0
Annual Electric Use	(MWh)	0	1,371	2,742	4,113	5,484
Peak Electric Use	(MW)	0	1.0	2.0	3.0	3.9
County-wide Total						
Total for Space Heating + Secondary						
Annual w/ No Conversion to Heat Pumps	(k therms/yr)	8,589	7,588	6,587	5,586	**4,585**
Annual w/ % Conversion to Heat Pumps	(k therms/yr)	8,589	6,442	4,294	2,147	**0**
Peak Hourly w/ % Conv. To Heat Pumps	(therms/hr)	5,251	3,938	2,625	1,313	**0**
Convert NG to Heat Pumps w/ No Insulation Upgrades						
Annual Electric Use	(MWh)	15,704	25,181	34,658	44,135	**53,612**
Peak Electric Use	(MW)	5.1	14.2	23.2	32.3	**41.4**
Convert NG to Heat Pumps w/ Insulation Upgrades						
Annual Electric Use	(MWh)	15,704	21,882	28,061	34,240	**40,418**
Peak Electric Use	(MW)	5.1	12.2	19.3	26.4	**33.5**
Replace Existing Housing w/ New						
Annual Electric Use	(MWh)	15,704	18,157	20,610	23,063	**25,516**
Peak Electric Use	(MW)	5.1	8.6	12.2	15.8	**19.4**

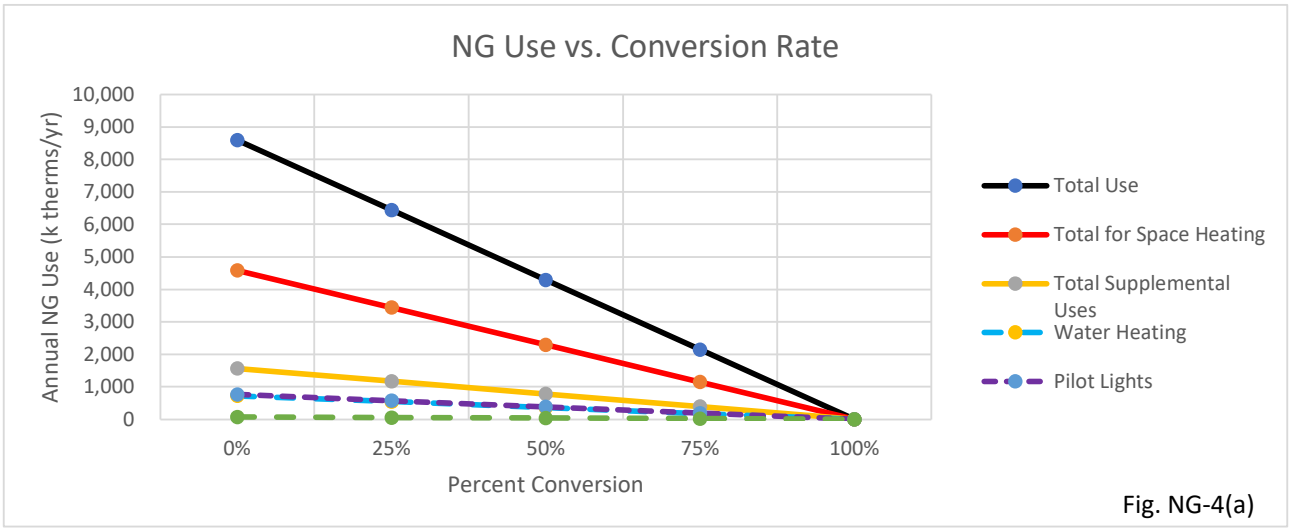


Fig. NG-4(a)

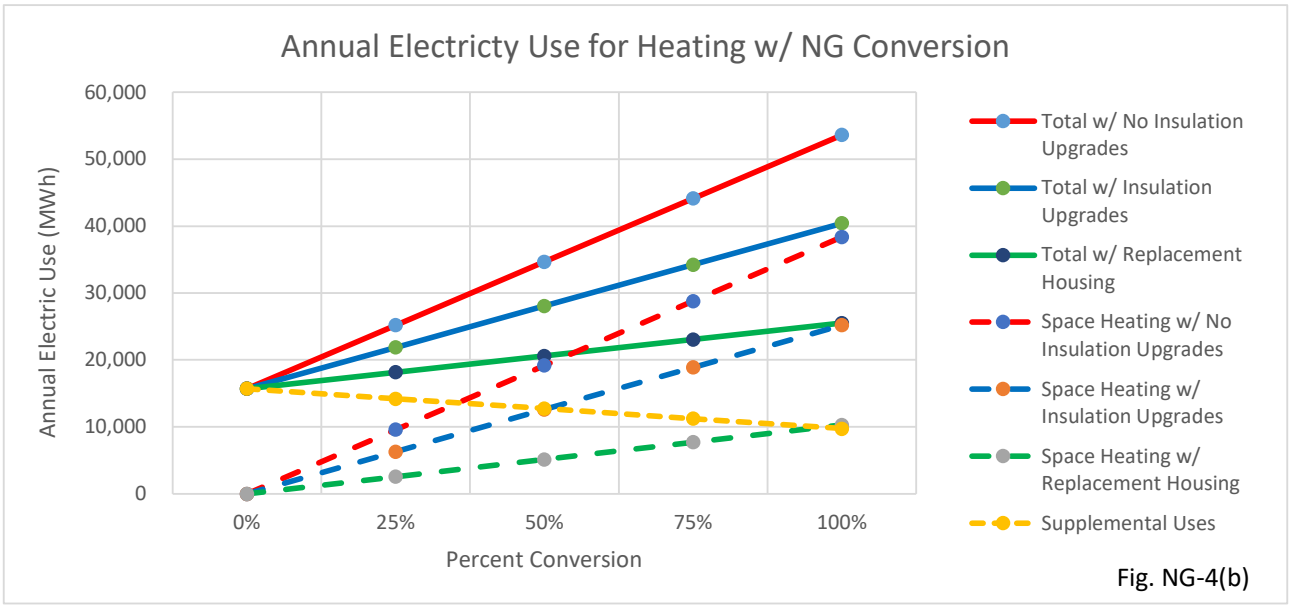


Fig. NG-4(b)

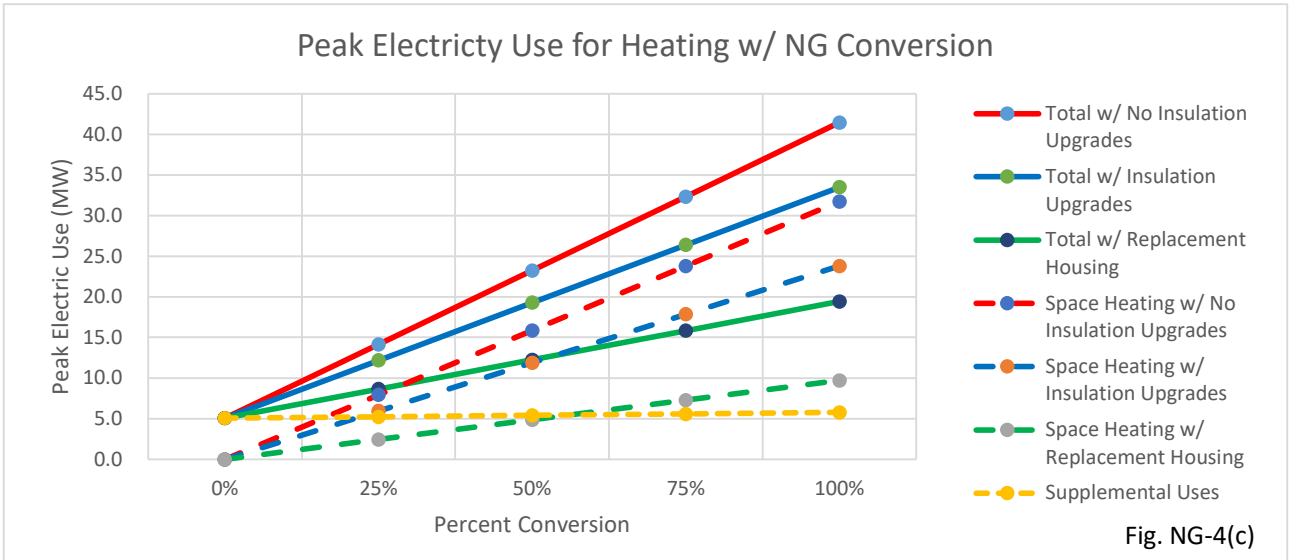


Fig. NG-4(c)

Recommendation NG-11: Make energy audits and other relevant information available to property owners through County government.

Time Frame: Immediate and ongoing

Background

The NM Constitution prohibits, in Art. IX, Sec. 14, government financial support of private entities. (This is the so-called "Anti-Donation Clause.") However, government can provide less tangible assistance in the form of information and advice.

For many property owners, a major part of the challenge of phasing out NG lies in knowing what can be done to their specific property. The intent of this recommendation is to provide property owners with "a place to start." All services would be voluntary.

Outcome

An office would be established in DPU, Community Development, or both that would provide services and information to property owners contemplating conversion away from NG.

This office would also become a repository of local experience in the subject.

Individual property owners would have a "one stop shop" to at least start their unique conversion from NG.

By establishing relationships with area suppliers and installers, this office may be able to reduce the "Los Alamos Factor" that frequently results in much higher prices in Los Alamos than surrounding areas.

Strategy

- Examples of Information to individual property owners:
  - Energy audits
  - Individualized recommendations to reduce heat loss
  - Individualized recommendations on planning for replacement space heating systems and supplemental appliances BEFORE the need arises.

- Examples of Information for the broader community:
  - General information, through various media, on conversion options. These might well be different for different neighborhoods, age and type of construction, etc.
  - Lists of vetted equipment suppliers and installers

Economic Impact

- **Costs:**

- A very rough guess is that this effort would require two County FTE's. With salary, benefits, office space, telecommunications access, etc., that might cost the County (which is, of course, the citizens of the community) of order $250,000 per year.

- **Savings:**
  - "Up-front" costs of conversion away from NG will cost individual property owners many thousands of dollars each. If more informed decisions save each property owner $2000, citizens of LA would save approximately $15M. That is a good return on community investment.

Benefits Other than CO_2 Reduction

- More important than the potential cost saving to citizens, people are likely to start (and finish) phasing out NG sooner if they have "a place to start" instead of being entirely on their own.

Challenges & Anticipated Barriers

- In accordance with the Inspection of Public Records Act, energy audits and other matters related to specific properties would be public records.

VI. Electricity

Introduction

Note: This document presupposes a continued relationship with LANL and a sharing of resources.

The major motivation for transitioning to carbon-free energy within the county is the imminent threat of climate change. Climate change models of the southwestern United States predict a higher probability of droughts and high temperature events. Lower precipitation will directly impact Los Alamos County's ability to generate power from hydroelectric resources. The current models predict that Los Alamos will experience > 100°F heat waves within the next 20 years, and even hotter ones after that. Given these predictions we anticipate the partial desertification of the County.

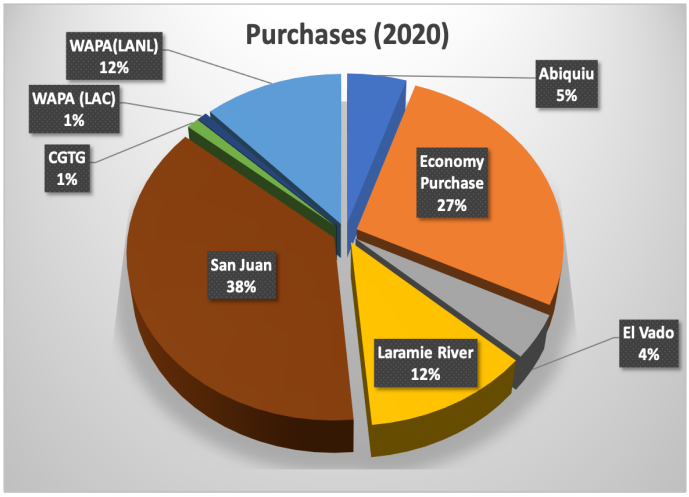


Figure E-1. Current breakdown of electricity energy purchases by source. Source: Los Alamos DPU.

We suggest that Los Alamos County (LAC) start to lead the nation in addressing climate change. We face a new era where concerns about short-term costs must be balanced with innovative and effective action. This may mean changing priorities and LAC codes, but is the only way to avoid the worst of the warming. While the current goal for net-zero carbon electricity is not due until 2040 at present, we cannot wait until the deadline. We must, as a community, address the coming challenges with the urgency that they demand.

An Energy Coordination Agreement (ECA) currently exists between LAC and Los Alamos National Laboratory (LANL). The LAC Department of Public Utilities (DPU) now manages all electricity used by the ECA signatories (the Los Alamos Power Pool [LAPP]). Roughly 20% of the total electricity managed by the DPU is used by LAC and 80% is used by LANL. This complicates the recommendations of this report, as it is unclear if the carbon-neutral goal addressed by LARES is for LAC alone or for the LAPP in general.

It is important to note that if the current ECA between LAC and LANL were to end, and LAC took possession of all the power generated by our hydroelectric resources and the Uniper Power Purchase Agreement (PPA), then LAC by itself would largely be a carbon-free electricity supplier. However, to faithfully achieve the goals of reduced carbon emissions and addressing imminent climate change, it is the opinion of the members of the LARES Electricity Subcommittee that LAC and LANL would be best served by working cooperatively to achieve their mutual carbon-zero goals. DPU quarterly reports from 2021 and 2022 state that a tentative agreement for extending the power sharing relationship between LAC and LANL is expected in 2023, and that a new ECA

will likely be signed in 2025. That agreement is expected to preserve essential features of the current ECA (i.e., that the DPU would continue to provide electrical power to LANL as part of an LAPP), though details of that agreement remain to be negotiated. An ideal agreement would include a provision for both LAC and LANL to contribute a proportionate share of carbon-neutral electricity. Over time, LAC should receive no less carbon-free electric energy than it contributes from its owned or controlled generating assets. Without detailed knowledge of the future agreement, we will assume that LAC-DPU will be responsible for obtaining most of the carbon-free power, which LANL will pay for as a user (LANL currently contributes the carbon-free Western Area Power Administration (WAPA) power, which in 2021 comprises 57% of the LAPP carbon-free electricity).

Currently, LAC owns several power generation assets representing a total of 73.9 MW of peak generation capacity. Of those resources, four are sources of carbon-free electricity:

- hydroelectric power from WAPA,
- El Vado and Abiquiu dams,
- the 1 MW PV installation on the Los Alamos Eco Station.

LANL's contribution is the WAPA agreement that provides carbon-free power to the LAPP. The combined contribution from these assets makes the carbon-free portion of LAPP's usage 21% (see Figure E-1). The two largest sources of electricity managed by LAC are fossil fuel sources, the San Juan Generating Station (SJGS) and short-term contracts purchased from the open market (38% and 27%, respectively). For 2020 we estimate that the LAPP resulted in 442,300 tons of CO_2 emissions, of which LAC's share is 88,460 tons CO_2.

This picture will change significantly when the PPA with Uniper comes into full effect in 2023, at which time the DPU will no longer purchase power from SJGS. The proportion of LAPP carbon-free electricity purchased and owned will increase from 21% to 39%. This is a tremendous step and the DPU/BPU should be commended for taking it. This brings LAPP close to the 2020 U.S. average of carbon-free power (according to the U.S. Energy Information Administration) of 39.5%.

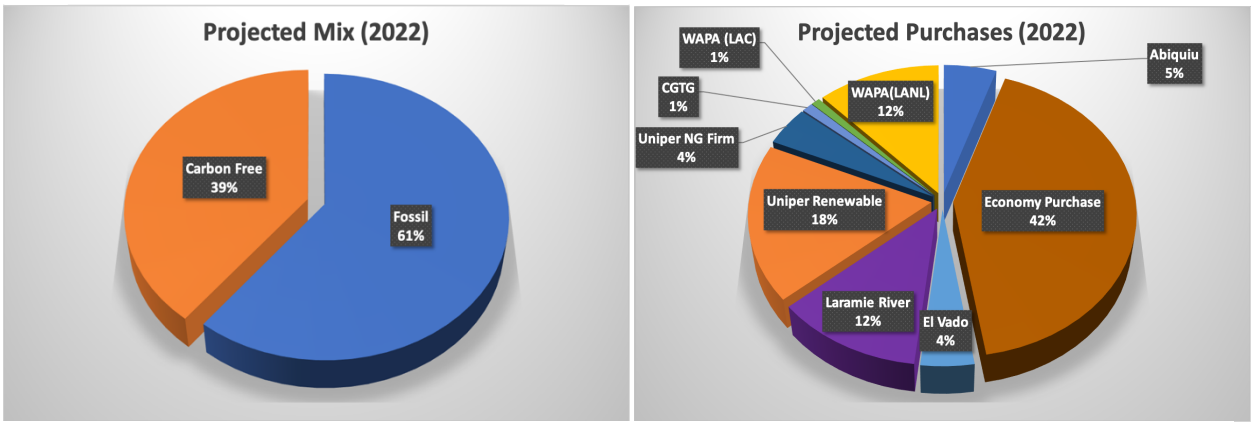


Figure E-2. The projected mix of fossil and carbon-free electricity energy purchases by 2023 (left). The expected contribution to total electricity energy purchases by source (right).

The current pace of change does not recognize the urgency of the scientific consensus regarding climate change [IPCC, AR6 Climate Change 2021]. The LAPP will be responsible for ~2,240,000 tons of CO_2 emissions between 2022 and 2030, of which LAC's contribution would be ~448,000 tons CO_2. If we want to avoid more costly adaptation in the future, we must aggressively pursue reductions in emissions.

There are many contributing factors that will put pressure on electricity demand for the LAPP over the coming years. These include possible population increase, growth at LANL, higher demand for summer air conditioning, more electric vehicles (EVs) (Table 1), and transition from natural gas (NG) to electric heating (Table 2). To adapt to the warming climate, prepare for increases in electrical demand, and meet the DPU's stated zero-carbon goal, additional carbon-free electricity resources will be needed.

	LAC	**LANL**	**Total LAPP**
Annual Demand (GWh)	20.8	3.4	24.2
Peak Load (MW)	5.2	1.9	7.1

Table E-1. Forecasted increase in demand for annual electricity usage and peak load owing to EV adoption for personal and county ("LAC"), and LANL by 2041. Totals represent the base case presented by FTI consulting as part of their 2021 Integrated Resource Plan presentation Nov. 2021.

	LAC	**LANL**	**Total LAPP**
Annual Demand (GWh)	54.6	104.7	159.3
Peak Load (MW)	11	21	32

Table E-2. Forecasted increase in annual electrical demand and peak load due to the conversion of natural gas heating to electrical heating by 2041. Totals represent the base case presented by FTI consulting as part of their 2021 Integrated Resource Plan presentation Nov. 2021. Forecasts assume 48.8% adoption of electrified heat-pumps by 2041. These are very close to the estimates contained in Table NG-1, which were derived totally independently.

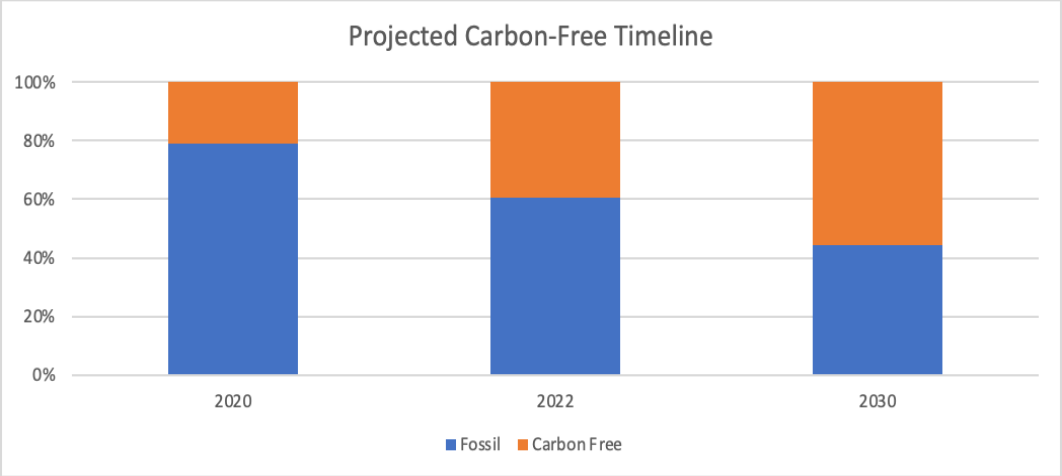
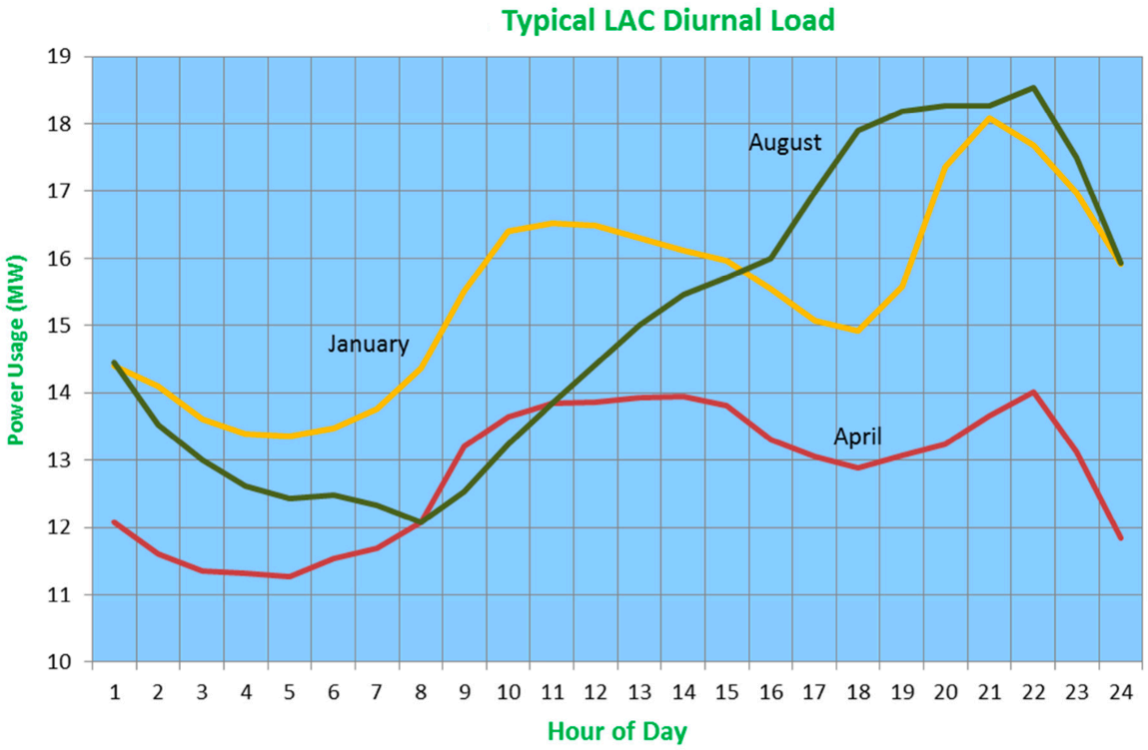


Figure E-3. Estimated carbon-free electricity purchases (2020) [where carbon-free resources initially include WAPA, El Vado, and Abiquiu], after the addition of Uniper PPA (2022), and after the CFPP (2030) are in full effect.

Transitioning our electrical supply is clearly not a plug-and-play type of situation: one cannot simply shut down a coal plant and insert a solar or wind farm. We need to maintain reliability and plot an optimal course. Fortunately, much research has been conducted looking into this transition and here is the general plan:

- **Beginning of the transition (2022-2025)**:
    - This is the time for acquiring utility wind and solar resources because (a) they are the cheapest carbon-free kWh that can be made, and (b) we have coal and gas resources that can firm up the intermittency of wind and solar.
    - This is also the time to implement time-of-use metering to encourage using more energy when wind and solar are most abundant (which is fortunately when electricity is at its lowest cost) for charging EVs, filling water towers, or using air conditioning.
    - Begin to gain experience with energy storage, starting with the most cost-effective option: batteries. The initial focus would target battery usage to assist during the most expensive time, the evening surge (see Figure E-4).



Source: LAC Future Energy Resources Report, 2015

Figure E-4. Typical diurnal load for LAC shows peak demand in the evening.

- **Mid-term of the transition (2025-2030):**
  - The larger the percentage of wind and solar on the grid, the more the need to manage intermittency. Fortunately, free market forces start to shape/optimize the process:
    - The cost for electricity from coal and gas will increase as fossil fuel plants begin to operate fewer hours per week; these plants will still provide most of the electricity at night.
    - The higher price for power in the evening incentivizes moving flexible loads to less expensive times, and it provides a market in which batteries can better compete as each kWh is worth a higher price. This creates the economies of scale to reduce the cost of energy storage.

- **Late-term of the transition (2030-2035):**
  - It is often stated that the first ~80% of any transition is "easy" while the last "20% is challenging and/or expensive. Some of the technologies that are important to this final phase are the following:
    - Nuclear power will be the only expandable, full-time, carbon-free power generation option.

- High-voltage transmission, particularly high-voltage-direct-current, has the ability to move power efficiently around the continent can average out much of the intermittency of renewables, making wind effectively a firm source of power.
- Long-duration, cost-effective 100+ hour electric energy storage systems are anticipated to become available.

We are witnessing of major technological innovations that will help us manage our carbon (or carbon equivalent) outputs in the future. Renewable energy storage options are becoming more and more advanced and available, and hopefully soon, affordable. It is in this context that the following recommendations are presented.

Recommendation E-1: Formalize the BPU/DPU and Los Alamos County Council goal to be a net-zero carbon electricity supplier by 2035.

Time Frame: Immediate

Background

The current pledge to be a net-carbon-zero electricity provider by 2040 is a goal of the BPU and the DPU. This goal was adopted by the BPU in late 2013, and then reaffirmed in 2014 and 2016. Since its adoption, LAC formed the Future Energy Resources Committee to provide recommended paths to achieve the 2040 goal. LAC, in cooperation with LANL, developed the 2015 Renewable Energy Photovoltaic (PV) Feasibility Study which identified five potential sites for solar installations that when combined could be the source of a peak power of ~60 MW. LAC also hired consulting firm Pace Global to produce the 2017 Integrated Resource Plan (IRP), assessing paths to achieve the 2040 goal. Since then, LANL has reduced their potential contribution of PV sites.

The goal set by the BPU to be a net-zero electricity provider could be amended, extended, or even abandoned at the sole discretion of a majority of BPU members. In that light, the County Council and the BPU should formalize this net-zero carbon commitment along with a timeline and benchmarks for its implementation. In our communication with the DPU, we have received affirmation that accelerating the net-carbon zero timeline would not be a problem for the DPU to implement; in fact, the 2035 goal has already been incorporated into the 2021 IRP currently being conducted by FTI Consulting. In addition, accelerating the timeline from 2040 to 2035 puts LAC in line with current federal and LANL emissions-reducing priorities.

Outcome

LAC DPU is fully net-zero carbon electricity provider by 2035.

Challenges & Anticipated Barriers

- Accelerating the reduction of fossil fuel generated power purchased from the grid requires finding alternative power sources.
- Replacing the amount of power purchased from the free market with dedicated wind and solar generation before 2030 and to include nuclear after 2030.
- The agreement with Laramie River Station (LRS) ends in 2042. Exiting the PPA with the Laramie River plant in Wyoming with cost-effective and firm resources is challenging.

References & Resources

AR6 Climate Change 2021, Intergovernmental Panel on Climate Change.

DOE Los Alamos National Laboratory - PV Feasibility Assessment, NREL 2015.

Future Electrical Energy Resources for Los Alamos County, July 2015.

Integrated Resource Plan Report, Pace Global, June 2017.

Los Alamos County Integrated Resource Plan Interim Discussion, FTI Consulting, November 2021.

View from Navajo Road on Barranca Mesa

Recommendation E-2: Develop a strategy that achieves LAC's net-zero carbon goals regardless of the nature of any future LAC/LANL power generation relationship.

Time Frame: Immediate

Background

We recognize that the collaboration between LAC and LANL through the Energy Coordination Agreement (ECA) has benefits for LAC as well as challenges. The benefits include (a) LAC obtained better economies of scale as LANL's electric usage is ~4 times that of LAC's, (b) LANL's energy use peaks in the day while LAC's peaks in the evening, providing synergistic needs, (c) LANL is a stable, long-duration economic partner as it is owned by the federal government, (d) LANL brings 57% of the carbon-free power to the LAPP through its WAPA investment. However, uncertainty in a future ECA has prevented the DPU/BPU from advancing more rapidly on its net carbon zero goals.

Outcome

Uncertainty in the ECA will no longer prevent purchasing carbon-free energy.

Strategy

For several years the DPU/BPU have been hesitant to purchase carbon-free resources out of concern for what would happen if the ECA ended, the fear being that LAC would be "stuck" with too many resources. A fundamental shift in risk tolerance is needed, realizing that assets can be sold to match any major changes in the ECA. Quarterly reports from 2021 and 2022 state that a tentative agreement between LAC and LANL is expected in June of 2023, with a final ECA expected in 2025. Though details are still under negotiation, it is the expectation of the DPU that the fundamental relationship between LANL and LAC will remain unchanged in the forthcoming ECA.

This change in strategy for handling the uncertainty in the ECA is important because the root cause of the uncertainty exists now and will likely exist in the future. We recommend BPU/DPU feel free to purchase utility-scale solar and wind projects and/or a greater amount of clean PPAs such as the Uniper contract. Ideally both LAC and LANL would contribute a proportionate share of carbon-neutral electricity; LAC should receive no less carbon-free electrical energy than it contributes from its owned or controlled generating assets.

Since we are recommending a greater risk tolerance, it is worth discussing what is at risk. We note that the cost of power from all three options - (a) utility scale solar, (b) utility scale wind and (c) the Uniper Contract - are all generally 50% to 100% lower in cost per unit of energy than the average cost of wholesale power in LAC. To make this point more explicit, the current levelized (lifetime, including construction and decommissioning) cost of energy for utility-scale solar and wind in the Southwest U.S. is ~$30/MWh (plus $6 to $14 transmission/distribution costs) [Excel Energy 2018 (includes subsidies), $29.50/MWh, LAZARD (no subsidies, but also no profit, single

axis, $28), NREL (no subsidies, solar capacity of Kansas City, MO, $41)]. Even if tax subsidies for solar are reduced in the future, the levelized cost should be less than $40/MWh. In recent years the average rate paid over a year by LAC has been between $50/MWh and $60/MWh. LAC can afford to take the risk of purchasing more of these low-cost resources, particularly in light of recent price spikes. It should not be difficult to sell these resources if needed or sell the energy produced on the open market. Solar and wind power are intermittent and require additional sources of electricity for firming when generation is not possible. The Uniper contract, for example, provides carbon-free power at $39/MWh and uses fossil power for firming (the anticipated mix is 85% carbon-free and 15% firmed NG). Recommendation E-3 (below) addresses this "intermittency" of renewable resources that are not available 24/7. The long-term solution is nuclear power, but there are several short-term alternatives discussed in Recommendation E-3. Energy storage will need to be addressed in the near future.

Economic Impact

Cost spikes have become more frequent in recent years. To quote one sentence from the June BPU meeting, "In June of 2021, the most recent heat wave again had market prices at $1,750/MWh ..." If we owned more solar resources, such market spikes would have less impact on LAC during the above average energy use period in the middle of the day. The price difference between ~$40/MWh and $1,750/MWh is so large that it is not necessary to avoid too many price spikes to make solar and wind economically advantageous. Price spikes in market purchases are the primary reason market purchases were the second most costly source of energy for LAC in 2020. The magnitude and duration of these spikes increases the cost benefit of spending less on short-term power purchases. Owning more wind and solar resources, even if LAC decides to not use them (curtailment), will render LAC less susceptible to large cost spikes.

Benefits Other than CO_2 Reduction

- Reduced vulnerability to price spikes in the free market.
- Purchasing zero-carbon emitting resources would be a concrete step toward meeting the BPUs net-carbon-zero goal.

Challenges & Anticipated Barriers

- If more risk is going to be taken, the risk needs to be researched and a mitigation strategy created.

References & Resources

David Roberts, Vox, List 2017 "all source solicitation" Request for Proposal data from Excel Energy, "In Colorado, A Glimpse of Renewable Energy's Insanely Cheap Future."

Lazard, "Levelized Cost Of Energy, Levelized Cost Of Storage, and Levelized Cost Of Hydrogen," Oct. 28, 2021.

Quantitative information quoted in this section were generally presented during BPU meetings in 2020 and 2021.

Vignesh Ramasamy, David Feldman, Jal Desai, and Robert Margolis, "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021," National Renewable Energy Technical Report, NREL/TP-7A40-80694, November 2021.

September wildflowers on the Ski Hill

Recommendation E-3: Develop an "Intermittency Management Strategy'' including but not limited to demand management, curtailment of generation, and time-of-use metering.

Time Frame: Short-term

Background

For environmental and economic reasons, the electric grid is changing rapidly. As stated in many places within this report, the need to manage the intermittency of wind and solar resources is clear. Which are the best approaches/techniques for LAC to apply at this time and which are best implemented later, or not at all, needs to be studied. In the following paragraphs, some of the common approaches for managing the intermittency of the grid are listed along with brief explanations.

Demand Management

The concept of demand management applies to those energy-consuming tasks that are flexible in time. The suggestion is that the County should make it easy for customers who are interested in shifting some of their consumption from high-cost time intervals to low-cost time intervals.

Such shifting is particularly appropriate for (a) charging of electric cars, (b) heating of water stored in tanks, and (c) air conditioning in the context of a house being cooled down between 3 and 5 pm in order to significantly lower energy needed to cool the house after 5 pm. This strategy results in less electricity being purchased during the expensive evening time.

The fortunate economic reality that aligns (a) cost savings with (b) reducing carbon generation is that utility scale solar and wind (levelized cost of energy ~$40/MWh plus transmission) in the southwestern U.S. costs less than the average cost of power for LAC ($50/MWh to $60/MWh). If we use more of these energy resources without needing to store them, LAC power customers save money and LAC emits less carbon. Evidence supporting this economic reality is available from Lazard, NREL, RFP bids to EXCEL Energy in Colorado, and our recent UNIPER contract.

Time-of-Use Metering

The concept of time-of-use metering describes a rate structure that varies with the time of day. It is one aspect of optimizing electricity use by incentivizing the consumer. We anticipate that the consultant hired for this task will educate LAC officials in the experience of other communities that have tried various approaches to time-of-use metering.

The consultant should investigate the feasibility of DPU, or a commercial entity, offering the customers the option to be part of a "virtual power plant." A virtual power plant is an entity that helps generation match the load by having a utility control, to some degree, when energy is used by the customer. Virtual power plants are voluntary arrangements by which customers allow the utility to manage some appliances in return for economic benefits.

The storage capacity of most electric cars sold today is about one or two days' worth of energy usage of a typical American home. The consultant should research (a) the feasibility and (b) the cost structure of using these cars as not only a demand response component but a possible supply of energy.

Curtailment of Generation

Curtailment involves the conscious decision *not* to put energy on the grid that is available at an electricity-generating facility; most commonly this is a technique used with wind and solar resources. Although this strategy is wasteful of energy, it can be useful in assuring that the load matches generation. Some factors related to this strategy:

- Curtailment, during the percentage of the time when it is necessary, may be more cost effective than purchasing storage or other management techniques.
- The availability of curtailment as a management strategy allows a utility to purchase more low-cost, zero-emission wind and solar resources without facing penalties for putting too much power on the grid. Thus, the utility is able to meet more of its energy needs with zero-carbon sources.
- Curtailment is an indication to those investing in transmission and storage of market opportunities. Free power will help pay for transmission and storage, as it improves the business case for building transmission or buying storage equipment.

Economic Impact

The purpose of this task is to make sure that the load is reliably supplied with electricity while cost-effectively transitioning to low-cost, zero-carbon generating resources. At this time we do not know what the economic impact would be.

Benefits Other than CO_2 Reduction

- The existence of more generating capacity reduces the likelihood of price spikes.
- The low cost of unsubsidized utility-scale wind and solar lowers economic disadvantages of possessing more generation capability than needed.
- New Mexico is blessed with excellent land for utility-scale wind and solar. As we reduce our state's dependence on natural gas, we would be wise to increase our capability to generate wind and solar and effectively manage those resources.

References & Resources

David Roberts, Vox, List 2017 "all source solicitation" Request for Proposal data from Excel Energy, "In Colorado, A Glimpse of Renewable Energy's Insanely Cheap Future."

Lazard, "Levelized Cost Of Energy, Levelized Cost Of Storage, and Levelized Cost Of Hydrogen," Oct. 28, 2021.

Vignesh Ramasamy, David Feldman, Jal Desai, and Robert Margolis, "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021," National Renewable Energy Technical Report, NREL/TP-7A40-80694, November 2021.

View from Deer Trap Mesa

Recommendation E-4: Implement the recommendations of the 2017 Integrated Resource Plan (IRP) and expected IRP recommendations in 2022.

Time Frame: Immediate, short-term, and ongoing

Background

The DPU and BPU, in order to develop a strategy to address upcoming power generation challenges, commissioned the 2017 Integrated Resource Plan. Key findings from that report that are related to these recommendations are below:

- **New Solar Generation:** The most balanced portfolio that meets renewable goals and carbon reduction targets is a one that relies on solar PV and battery storage (based on current indicative bids and market expectations). However, there are uncertainties whether sufficient local federal land is available for utility scale solar PV resources.
- **Relying on Market Purchases:** The recommended integrated resource plan results show that relying on some market purchases result in lower net present value costs in the current low market price environment. Adding no new capacity, however, not only compromises LAC and LANL's goals of increasing renewable generation, but also results in unacceptably high negative reserve margins to ensure a reliable means of serving LAC's load.

Exhibit 2: Key Elements of the Preferred Resource Plan

Portfolio	San Juan 4 Exit Date	LRS Exit	LAPP New Builds	Reserve Margin (2017-2036)
S8: Solar Firmed with RICE Short Capacity	2022	No Exit	**Large RICE:** • 2017- 18 MW; 2025- 18 MW; 2030- 18 MW **Solar PV:** • 2017- 25 MW; 2025- 25 MW; 2030- 25 MW	LAPP Summer: 9% LAPP Winter: -5%
S9: Solar with Storage Short Capacity	2022	No Exit	**Solar with Storage (onsite):** • 2017- 13 MW; 2025- 8 MW • 2030- 6 MW	LAPP Summer: -11% LAPP Winter: -26%
S10: SMR, Solar with Storage Short Capacity	2022	No Exit	**Solar with Storage (onsite):** • 2017- 13 MW; 2025- 4 MW **Nuclear (offsite):** • 2026- 16 MW	LAPP Summer: -9% LAPP Winter: -23%

Source: LAC, Pace Global.

Figure E-5 shows the preferred resource plan and timeline from the 2017 IRP. According to this plan LAC should have already developed 13 MW of solar generation capacity with plans to increase to 21 MW by 2025. Source: 2017 IRP, Pace Global.

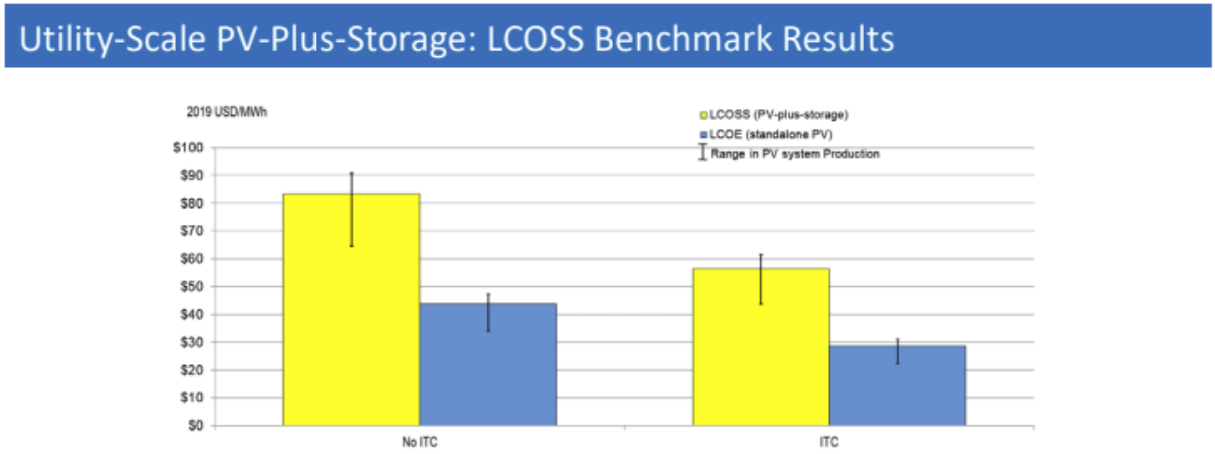


Figure E-6. Lifetime cost of solar plus storage (LCOSS), and lifetime cost of electricity (LOCE) for a 100 MW PV installation and a 100 MW PV installation with 60 MW/240 MWh storage battery. ITC refers to a 30% investment tax credit that may be available depending on when project construction begins. Source: NREL Cost Benchmark: Q1 2020

The solar resources suggested in the 2017 IRP were primarily to replace generation capacity lost when the SJGS goes offline in June 2022. Once the SJGS is no longer operational, the single largest contributor to LAC's fossil electricity portfolio will be market purchases. In total, those market purchases are the equivalent of an ~18 MW generation facility. Market purchases were the second most expensive power LAC purchased in 2020, only behind SJGS. At present the DPU has said that electricity from solar and wind installations are not available for purchase on the electricity markets. Given this, the only way for BPU to achieve its state goal of becoming net-carbon-zero while remaining in the LAPP will be to pursue the construction of new renewable generation resources such as those recommended in the 2017 IRP and expected in the 2021 IRP.

Capital costs of solar generation and battery storage have come down considerably faster than the 2017 IRP anticipated. Utility-scale wind and solar are among the lowest cost methods of electricity generation with levelized cost of energy around $40/MWh. When integrated with a 4-hour storage system the levelized cost of solar plus storage is $57/MWh [Reference NREL 2020], but remains reasonable and becomes both carbon-free and more firm. These costs reflect current tax incentives available for solar installations. For comparison's sake, the current target price of the CFPP is $58/MWh, but that may not be available for a decade. These recommendations represent the first steps for near-term investments.

If LAC were to invest in building its own solar resources, one question would be where to put them to both maximize potential generation and minimize transmission costs. Both the 2016 Future Energy Resources Committee and the 2017 IRP relied on earlier estimates of up to 60 MW of peak solar capacity available on LANL property. However, since that original report was published, LANL had reduced the potential siting area by over 50%. Building such resources within County-owned property would be difficult due to the general lack of space in LAC. One way of addressing the space requirements would be by locating generation anywhere else in our balancing area. Situated properly, a solar installation could generate ~20% more solar energy

annually than if it were located in LAC. This could decrease the size of the installation and thus the capital investment required. However, transmission costs (minimum $6/MWh within our balancing area) and routing are also important considerations. Current estimates put the capital cost of a utility-scale solar installation between $0.94/W and $1.01/W. This equates to an investment of ~$27 million for the solar array described in the 2017 IRP.

LAC should pursue an energy storage system on the scale of 10-20 MW (peak power) with 40-80 MWh capacity.

A note about storage in general: there are many different technologies at varying levels of development and commercialization. For a more complete description of the different technologies themselves, please refer to Appendix A. In this final report, we recommend pursuing lithium-ion storage batteries with 4-hour storage duration. They are one of the most mature and scalable technologies currently available for utility-scale storage purposes.

The 4-hour duration is the current economic "sweet-spot" for lithium–ion battery installations, but does not serve all eventualities for LAC. There are technologies that can provide for longer duration storage (days to weeks): pumped hydroelectric storage, compressed air energy storage, and hydrogen storage. However, due to locational requirements for deployment or technological immaturity, we cannot recommend that LAC make an investment in these systems on its own at this time.

To serve LAC, without considering LANL, an energy storage installation could be in the 10-20 MW output range with a usable capacity of 40-80 MWh (including LANL would require a system approximately 4 times this size). There are multiple ways to accomplish this goal depending on the technology used. The storage battery could be built within the County, or it could be collocated with the solar array described above. The ultimate cost of a centralized system is lower than for a distributed system. Current estimates from NREL put the cost of a lithium-ion battery system of this scale between $13.8 million and $27 million. While this is a considerable investment, there would be important savings from having more flexibility in timing power purchases and shifting peak load.

LAC should hire consultants to develop a strategy constituting multiple pathways for the development and deployment of carbon-free electricity generation and storage resources. This analysis should include centralized and distributed storage systems.

Examples in Other Communities

- 2017: Hornsdale Power Reserve (HPR) goes online in Hornsdale, South Australia. 194 MWh at 150 MW. HPR claims to have saved consumers more than $150 million AUD in its first 2 years of operation.

- 2020: Gateway Energy Storage, San Diego, CA. 250 MW.

Economic Impact

- **Savings:**
  - This recommendation provides a major economic benefit. Investment in generation and energy storage as part of a broader "intermittency management strategy" could significantly reduce electricity costs to LAC. Relying on market purchases leaves LAC and LAPP vulnerable to price spikes, as already witnessed in June of 2021. Incorporating a storage system could be used for peak shaving, as well as reduce the need for curtailment of generation. It would improve the DPU's flexibility in choosing when to purchase energy from the grid.

Benefits Other than CO_2 Reduction

- Increased reliability of electricity delivery to LAC customers by reducing short-duration and local power disruption.

References & Resources

DOE Los Alamos National Laboratory - PV Feasibility Assessment, NREL 2015.

Future Electrical Energy Resources for Los Alamos County, July 2015.

Hornsdale Power Reserve

Integrated Resource Plan Report, Pace Global, June 2017.

Los Alamos County Integrated Resource Plan Interim Discussion, FTI Consulting, November 2021.

Recommendation E-5: Investigate periodically the feasibility of restricting market purchases of electricity to carbon-free sources.

Time Frame: Medium-term

Background

With the loss of 36 MW of power from the SJGS and the acquisition of 15 MW of power from the PPA with Uniper, the LAPP's overall access to power has decreased from 73.9 MW to 57.9 MW, an overall decrease of 21%. With less access to generation capacity, the LAPP will be forced to purchase a greater amount of electricity on the open market. This has been confirmed in conversations with the DPU. In our analysis we expect market purchases to increase from 27% to 42%. Currently, these purchases come from coal and natural gas-utilizing resources. According to the DPU, non-fossil resources are unavailable on the electricity market; it is our understanding that this statement is applicable to the entire Western Interconnection. If that remains the case it will be impossible for DPU to fulfill the net-zero-carbon goal absent building, or buying all of our own generation capacity.

There are currently 1.2 GW of solar and 2.7 GW of wind generation in operation with another 1.6 GW of wind under construction in the state according to the New Mexico Energy, Minerals, and Natural Resources Department. The goals for the State of New Mexico are to steadily increase the carbon-free electricity generation to 50% by 2030, 80% by 2040, and 100% by 2045. PNM has signed on to become carbon-free by 2040. If these overall generation goals were met, some amount of carbon-free electricity would likely become available on the open market. We would like to know what flexibility is available to DPU in choosing which resources to purchase on the open market.

Outcome

The DPU no longer purchases electricity from CO_2 emitting sources.

Economic Impact

- The consequences of restricting electricity purchases to non-emitting sources will be unknown until the study is conducted.

References & Resources

New Mexico Energy, Minerals, and Natural Resources Department Website

Recommendation E-6: Continue to pursue the feasibility of small modular reactor technologies.

Time Frame: Immediate and ongoing

Background

The Carbon-Free Power Plan (CFPP) is a proposed small modular reactor to be built at the Idaho National Laboratory. As the plans currently stand, the installation will consist of six reactor modules each capable of 77 MW for a total of 462 MW generation capacity. LAC is subscribed for 1.8 MW with the option/expectation to increase to 8.6 MW once all modules are operational. The current cost target is $58/MWh. The small modular reactor is scheduled to be operational in 2030.

Nuclear energy has the potential to play an important role in the transition to carbon-free electricity. Unlike solar and wind, nuclear energy is a firm source of power. Remaining subscribed to the CFPP will be an important contribution to supporting the LAPP base load. This will become more important as we add intermittent resources to our generation portfolio.

Outcome

LAC remains subscribed to the CFPP.

Economic Impact

- **Costs:**
    - LAC has budgeted $1,260,00 for the subscription.

Benefits Other than CO_2 Reduction

- Clean base load for LAC.

Challenges & Anticipated Barriers

- The original operation date was 2022. However, this date has been pushed to 2030. As of yet, construction has not begun (early 2021), so further delays are possible.

References & Resources

Los Alamos Department of Public Utilities-CPFF SMR

Nuscale

UAMPS-CFPP

Recommendation E-7: Study distributed ("rooftop") electric generation and storage as potentially an integral part of LA's power supply.

Time Frame: Short-to-medium-term

Background

Distributed photovoltaic ("rooftop PV") electricity generation, storage, and heat pumps can be a more flexible heat source than direct solar thermal heating with thermal storage. Even without electrical energy storage, PV and heat pumps provide daytime cooling, which solar energy itself obviously does not.

As noted in the preceding section, total electric demand will exceed existing utility system capacity. That will require some combination of increased system capacity and increased distributed generation and storage in amounts yet to be determined.

Generally, utility-scale PV and storage costs roughly half as much as distributed. However, that does not take into account the costs of a higher capacity utility distribution system required for the former. The latter requires an electric distribution system upgraded in a different way, as a so-called "smart grid," to manage and distribute power to and from all the distributed assets.

Outcome

The goal of this study would be to obtain clear answers to the questions of how much LA should rely on distributed generation and storage and how it should be managed, i.e., should it be made "dispatchable" and, if so, how.

Economic Impact

- The price of solar photovoltaic (PV) cells and battery storage have declined rapidly, as is typical of new, widely adopted technologies. Further decreases can be expected. Although they produce no greenhouse gases at point of use, both have environmental impacts in production and disposal which need to be considered.

- Since installation is such a large part of the cost of PV arrays, system cost varies widely. $3.00 - $3.50/watt is typical. Hence, a typical 5 kW residential PV installation would cost around $16,000 today. At current electric rates, such an installation will pay for itself in 10-15 years, significantly less than its 20+ year expected lifetime.

- Battery packs (e.g., Tesla "Powerwall") are available for home installation in sizes that can power heat pumps all night. The issue is cost. Batteries installed in electric automobiles are typically large enough. It is technically practical to make those batteries serve dual use. Operational practicality is likely to depend on individual usage patterns. In any case, further analysis is necessary to estimate electrical storage requirements and, hence, costs.

- Substantial subsidies, in the form of tax credits, exist today for solar and other renewable energy installations. These credits were instituted to “jump start” these industries. It is uncertain how long they will last as these approaches become more mainstream.

Benefits Other Than CO_2 Reduction

- Although LA’s electric system is quite reliable, some people feel more secure having at least some of their own electricity stored.
- Renewable resources (primarily solar and wind) are more intermittent than traditional baseload electric power. Storage – at DPU, at individual properties, or both – will be necessary.

Challenges & Anticipated Barriers

- Not all existing homes have solar access.
- Many existing homes do not have roofs able to support a PV cell farm. “Community solar” fields (a utility scale PV field in which individual parcels are “owned” by residents instead of by DPU) is a possible alternative.
- Not all existing homes may have space for the necessary battery pack(s).

Recommendation E-8: Initiate a pilot program to support the addition of residential storage batteries to homes with and without rooftop solar.

Time Frame: Immediate and ongoing

Background

Distributed energy via rooftop solar (or rooftop photovoltaics [PV]) cannot reach its full potential in helping the County provide electricity without attendant battery storage. Storage allows the county to reduce peak demand, which usually occurs after sundown. This peak demand is currently filled by purchasing high-cost additional power from the grid. By using storage instead, the average cost of power to all citizens is reduced. In addition, homeowners are protected from power outages as the storage takes over.

Currently, LAC has approximately 2 MW of rooftop solar installed. We support the BPU and DPU's recent decision to triple the countywide rooftop PV installation limit to 6 MW. Rooftop solar has several benefits:

- The installation of residential rooftop and commercial solar is 100% financed by the homeowner or business at an approximate cost in the $20,000 to $30,000 range for home installations. The LAC rate payer not choosing to install rooftop solar is not funding the construction but will benefit from reduced demand for electricity in LAC, reducing expensive market power purchases.
- Once construction has begun, a residential solar installation can be operational within days, much faster than the current pace of DPU's adoption of utility-scale solar generation. The total installed cost of rooftop solar can be 2-3 times higher than centralized utility-scale solar power. However, the power is available immediately and the homeowners pay for the capital cost of purchase and installation.

Most residences do not have battery storage due to its high cost. Several community-based power companies are attempting to address this problem by compensating residents for installing storage that can be accessed by the utility. There are several variations on how to do

this. At least four communities have done successful pilot studies and moved on to full-scale programs (in Arizona, Colorado, Oregon, and Vermont—see references and appendices).

In addition, most of the communities in the references allow residents without rooftop solar to participate in a battery lease or incentive program, as even without solar, utility-managed distributed battery systems still contribute to reducing electricity demands during costly peak power use times. They may also provide the advantage of a backup power capability to the homeowner.

Outcome

An important benefit of rooftop solar, particularly when in concert with storage, is the reduced amount of transmission needed to meet the county's needs. Additionally, the current economic structure has the added financial advantage for the county that the infrastructure is 100% funded by the customer deciding to install rooftop solar.

Examples in Other Communities

Comparing with other small communities is an excellent way to learn what is feasible.

- Appendix A provides examples of residential and community rooftop solar PV projects.
- Appendix B provides an economic example of how Santa Fe Schools saved money by installing rooftop solar.

References & Resources

Arizona Residential Battery Storage Pilot Program

Green Mountain Power BYOD Program, VT

Green Mountain Power Battery Lease Program

Holy Cross Energy Power+ Program, CO

Portland General Electric Smart Battery Pilot, OR

VII. Transportation & Mobility

Introduction

Reducing our GHG emissions from transportation sources will contribute significantly to reducing our overall carbon footprint. Living in a spread out and isolated area like Los Alamos requires driving most places, and our emissions are higher than the nation's average. The LARES Task Force, using data from Christopher M. Jones and Daniel M. Kammen, estimates that LA County's emissions from transportation are closer to 37% of the County's total GHG emissions. Reducing single-rider car trips within the County and on/off "the Hill," encouraging public transportation use, widespread adoption of electric vehicle, and biking/walking as a means of commuting and getting around, and in general reducing daily miles traveled are where we as a community will see the biggest reductions in emissions.

Convenience is the major reason we drive as much as we do, and single-occupant vehicles are the largest problem. Changing behaviors and habits to use public transport and/or carpooling takes effort and planning. Convenient travel to and from public transportation stops is equally important as the main trip itself. If riders are unable to access a stop due to poor connection or inaccessibility, transit becomes ineffective. This is known as the "first/last mile" problem.

The more we bike, walk, carpool, and take public transportation, the fewer emissions and pollutants in our air. This will improve our community's health by breathing cleaner air and will also get us moving more. Some areas of the County are better connected to biking and walking/hiking trails than others. The better connected our network and the safer the pathways, the more people have access to healthy alternatives to driving personal vehicles.

Los Alamos County Public Works and Parks and Recreation, the Transportation Board (T-Board), and Atomic City Transit (ACT) have been working on addressing many of these issues, and we wish to acknowledge the work they have been doing: increasing bus ridership on ACT, experimenting with alternative bus route pick up/drop off access, electrifying the LAC and LAPS passenger fleet and the ACT bus fleet, installing Electric Vehicle (EV) charging stations at the LAC Municipal building, improving trails (specifically the expansion of the Canyon Rim Trail), and the T-Board's Bicycle Transportation Plan (BTP), which seeks to improve and expand the bicycling network and the safety/access of bicycling as transportation for residents and visitors.

In the same vein, the County of Los Alamos Resolution No. 10-32, A Resolution on the Policy of Designing Public Streets and Rights-of-Way in Los Alamos County, adopted on 9 November, 2010, to better accommodate "transit riders, pedestrians, cyclists, those with disabilities, and enhancing safety and convenience for us all," as well as "pursu[ing] community-wide independence from hydrocarbon energy sources." Our County Council has already recognized that we need to make changes to our community's habits and reduce our reliance on fossil-fuel vehicles. Incentivizing and encouraging carpooling, using the bus (school, ACT, Senior Van), adoption of EVs, walking and bicycling will help us meet this goal.

Recommendation TM-1: Increase and incentivize public transportation ridership.

In Recommendation 1, we outline 5 strategies to increase public transportation ridership within Los Alamos County and also for commuters who reside outside of LAC but who commute in on a regular basis.

Time Frame: Short-term and ongoing

Background

Approximately 60% of LANL employees live outside of Los Alamos County. This means the majority of Laboratory workers are commuting at least 34 miles round-trip each day (Espanola and Pojoaque are both 17 miles from Los Alamos, Santa Fe is 34 miles). While the LARES Charter does not include recommendations in regard to LANL's GHG reduction strategies, it is impossible to ignore the largest employer in the County who contributes to the majority of the traffic and emissions. We therefore recommend partnering with LANL to tackle this issue.

Outcome

More public transit riders means fewer emissions released, not only in Los Alamos County, but neighboring communities. More frequent buses and additional routes mean more convenience and more options for riders.

Strategy TM-1.1: In partnership with regional transit and Los Alamos National Laboratory (LANL), the County should work to increase and incentivize regional transit use for commuters and visitors from out of LA County.

Time Frame: Short-term and ongoing

Developing an "alternative transit" incentivization program for employees of LAC, LAPS, and community business and organizations will encourage residents and non-residents to change their driving habits. LANL will likely come up with their own program but could partner in this effort. This may be something as simple as a "Ride the bus 5 times and earn a free swim at the

pool" coupon or as complicated as financial bonuses or preferred parking status for carpoolers. Employees at LAC, LAPS, Los Alamos Medical Center, Chamber of Commerce and other local businesses can be surveyed as to their needs and desires for commuting.

Incentivization programs from employers are used in many cities across the country and the world, helping commuters choose a "greener" way to get to and from work. These programs have been successful in reducing traffic and emissions. Companies large and small, universities, and even the US Government offer their employees incentives to use public transit, to carpool, to give up their parking pass, or to "get to work another way." Many businesses organize vanpool and ride sharing for their employees. Mobile platforms and apps for rideshare matching or finding the quickest way around using public transportation and/or carpooling are easy to use, accessible to anyone with a smartphone, and very effective. "Gamification" (contests offering points or prizes) of getting around without a car has been successful in many communities, most recently and notably, a London suburb, who saw a 53% reduction in morning traffic during their contest "Beat the Street."

Finding parking off "the Hill" to reduce burden on riders to locate parking and encourage bus use will likely be key to the success of increasing public transit use.

Get to work another way!

Examples in Other Communities

Incentive programs around the country are helping workers get to their jobs in a "greener" way:

- Texas Children's Hospital in Houston, TX, offers options: a free bus pass, or, if you give up your parking pass, you get an extra $50/month.
- Neighborhood Eco-Pass in Boulder, CO, is subsidized by the city with the aim of reducing single occupant vehicle (SOV) trips. This pass, called NECO, offers a greatly reduced rate for an annual pass than single-trip tickets. SOV trips have declined by 7.7 percent since 1990. (National Research Center, Inc., 2016).
- The program "Access MIT" in the greater Boston area encourages employees to use mass transit by giving a free, unlimited access pass to all employees, offers flexible daily parking rates rather than a more expensive long-term pass, and subsidized parking at transit hubs.

- The City of Aurora, CO, offers discounted prices to the light rail and bus. They even designed the light rail to run past the City Building to encourage ridership.
- The City of Eugene, OR, offers free bus passes for all employees.
- US Customs and Border Protection offers employees a SmarTrip pass onto which the government loads a certain dollar amount each month to be used for transportation to/from work.
- FlexPass at UC Berkeley, CA: Parking is a problem on this campus. Employees and students are incentivized to use an alternative way to get to campus and earn money back on the parking permit they did not use. Up to $131 per month in parking rebates were issued to individuals during a 2015 trial. This was done via the FlexPass app.
- Princeton University in Princeton, NJ, offers a subsidized transit pass for commuters using public transportation.
- Acumed in Portland, OR, has annual $25 TRIMET (light rail and bus) passes and a commuting program with rewards for highest percentage of days biking to work.
- The town of Eagle, CO, has implemented a "behavior change" campaign to reduce single-occupancy vehicle commute trips 2 days per week by encouraging local businesses to provide smart commuting incentives or establish policies to support multi-modal commuting, flexible work arrangements, and remote work.
- Cities, universities and businesses alike use discounted transportation passes as well as prizes, drawings, cash benefits, and other incentives to encourage employees and residents to use the bus, tram, light rail, and train.
- Some cities and companies provide lunchtime shuttles to help facilitate commuters' needs.

Roundabout between North and Barranca Mesas

Economic Impact

- **Costs:**
  - Atomic City Transit is already free to residents. However, increasing frequency and number of routes will increase the need for drivers and will increase the fuel needs and maintenance of vehicles as well as upkeep of bus stops (or adding more).
  - Cost of incentives to riders/employees will largely fall to employers.

- **Savings:**
  - This may eliminate the need for a parking structure.

Benefits Other than CO_2 Reduction

- Public transport is a safer option than driving individually.
- Greater community connection ("bus friends," older and younger residents being more visible in the community).
- Citizens who do not drive have more options.
- Less car use means less money spent on fuel and repairs, as well as longer vehicle life.
- More money in the pockets of residents and other commuters may result in more local spending in local shops and restaurants.

Challenges & Anticipated Barriers

- The Anti-donation Clause of the New Mexico Constitution may prevent some challenges to this recommendation.

References & Resources

Fast Company: How One London Suburb Reduced its Morning Traffic by 53%

Luum Commute Management Platform

Metropia Carpooling/Mass Transit Website

US Department of Transportation Federal Highway Transportation Website

Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density (*Environ. Sci. Technol.*, 2013, dx.doi.org/10.1021/es4034364)

Strategy TM-1.2: To increase public transit use, address "first/last mile" needs.

Time Frame: Short-term and ongoing

Background

More and more cities and towns are addressing this "first/last" mile challenge of commuters, that is, closing the gap between the first/last mile of their commute via public transportation. Getting from home to a bus stop or from the bus stop to work may be the main reason people do not take the bus: if the stop is more than ¼ mile away, many people will not see it as convenient enough to "bother" with and will just drive their cars.

Multi-modal transportation, taking more than one mode of transit to a destination (riding a bike to the bus stop then taking the bus to work, for example), does not seem to come easily to Americans. Many ride their bikes, many ride the bus, but few do both.

Many communities have closed the "first/last mile" gap through various forms of micro-transit: bike/scooter shares, Lyft/Uber stops, shuttles that go from a main train/bus line to more residential or rural areas, "zipcars" (rentable cars for a short period of time), and other on-demand rideshare options. These are largely seen in big cities across the country (and the world), but are increasing in popularity in smaller cities and towns, including rural areas.

Outcome

Helping commuters access existing public transportation by addressing "first/last mile" needs will increase public transit ridership and encourage multi-modal transportation. Citizens who do not drive will have more options.

Examples in Other Communities

- Many communities are offering bike share programs, micro-transit, ride sharing apps and even bicycle taxis and even tuk-tuks to help commuters get to a bus stop or another public transportation hub.

Challenges & Anticipated Barriers

- Bike share programs and micro transit all cost money and require more physical infrastructure in the forms of more vehicles or bicycles. They may also require more staff.

References & Resources

American Public Transportation Association Website: First/Last Mile Solutions

American Public Transportation Association Website: Microtransit

Human Transit Website: Walking Distance to Transit

Our wonderful Atomic City Transit system in action.

Strategy TM-1.3: Continue to invest in increasing bus frequency and/or other kinds of on-demand service, including evening and weekend ACT service.

Time Frame: Short-term and ongoing

Background

It's no secret that the more convenient public transportation becomes, the more people will use it. While this is already a priority for Atomic City Transit, we would be remiss if we did not list this as a recommendation.

Outcome

The more frequent and convenient the bus service, the more people will consistently use the bus, reducing traffic, air pollution, parking problems, and GHG emissions. Fewer single-occupancy vehicles will be on the road also reducing the number of accidents.

Considerations

- Weekday evening service could run until 8:00pm.
- Saturday service could run from 8am to 8pm.
- Sunday service: 11am-5pm hourly main routes and/or a "Smith's" direct from each mesa/neighborhood area (call it something else, Trinity Express, perhaps) or micro transit to/from mesas/neighborhoods to high school where they would transfer to a bigger bus, and LA-WR service.

- Start evening/weekend service with summer Friday night concerts.
- Possible Ski Hill service in winter.
- "Small Business Saturday" service or other special event (like Ullr Fest).

Economic Impact

- **Costs**:
    - Increased service will require more drivers, more fuel (for combustion engine buses), more charging for electric buses, and more maintenance on all buses.
    - Community outreach and encouraging ridership (incentivization programs)

- **Savings**:
    - Residents will be driving less, which means less wear-and-tear on County roads
    - Cost savings to residents in gasoline and wear-and-tear on personal vehicles

Benefits Other than CO_2 Reduction

- Reduced traffic
- Reduced air pollution
- Job creation
- More citizen interaction and community connection
- Fewer parking issues
- More people eating out and attending evening events in town, which will increase revenue to local businesses and restaurants

Challenges & Anticipated Barriers

- Getting ridership "back up to normal pre-COVID" is already a challenge facing ACT
- Increasing ridership depends on increasing bus service/frequency, yet increasing bus service/frequency costs more money with no guarantee of increased ridership. Increased ridership will take time and patience on the part of ACT. At a certain point, empty buses circulating are just contributing to GHG emissions, so ACT and other transportation experts will need to carefully plan extended service routes, days and times.
- "First/last mile" problem
- We recognize that evening and weekend drivers will be harder to find than regular weekday daytime drivers.
- Driving one's own car is often more convenient (or seemingly so) than riding a bus

References & Resources

PedBikeInfo Website

Strategy TM-1.4: Develop a smartphone ridesharing app to help residents and commuters get around.

Time Frame: Medium-term

Background

New and innovative ways to encourage travelers to "get around another way" are greatly helped by smartphone apps. Mobile platforms such as AccessMyCommute (in Cambridge, MA), Metrotopia (Houston, TX), RubyRide (Phoenix, AZ), and many others, help travelers to find alternative modes of transportation and reduce single-occupancy vehicle (SOV) trips.

In an isolated community such as ours, "going off the Hill" for shopping or other needs is a necessity. Going to Espanola, Santa Fe, or Albuquerque is something most residents do with some frequency. This is easiest in one's own car, often resulting in a SOV trip. While most adult residents can come and go on and off the Hill as they please, this is harder for older residents and teenagers who cannot yet drive, as well as anyone with limitations. Transportation to these more commercial towns also presents a challenge to short-term residents or foreign visitors or workers who may or may not have a vehicle of their own.

Providing a ride-sharing platform online and via smartphone app will not only help teens, older citizens, and temporary residents get around, it will encourage others to carpool and "see if someone else is going." They can plan their trip together, whether one-way or round-trip. Persons with limited mobility will also find this helpful in getting to where they need.

Airport Travel: This ride-sharing app will also provide opportunity for residents to carpool to and from the Santa Fe and Albuquerque airports, reducing GHG emissions and creating a convenient alternative to driving or asking someone to drop you off and/or pick you up.

Ride sharing will not be limited to the Northern New Mexico area. Indeed, people could look for rides to/from neighboring states and cities (Tucson, El Paso, Las Cruces, Denver, Grand Junction and Salt Lake City), reducing car trips and plane rides. Making ride sharing convenient and accessible is critical for people to start to think of this as a viable means of getting around.

Ride-sharing takes effort and planning. Creating an app will make this much easier for all residents. Partnering with the City or County of Santa Fe may help offset some of the costs.

Outcome

Residents will have a convenient option to find and offer rides around Los Alamos and to/from outside of the County.

Examples in Other Communities

- Blablacar, a French app available in 22 countries (though not the USA), is a convenient and inexpensive way for residents and tourists to get rides from one place to another. After downloading the app, one simply inputs the date and time one needs (or can offer) a ride, the starting and ending locations, and the price. One author of this report has used this on many occasions with great success. According to the Blablacar website, 1.6 million tons of CO_2 were saved by BlaBlaCar carpoolers in 2018.

- In 2019, Park City, UT, (Municipal) partnered with Canyons Village Management Association, Deer Valley Resort, and Park City Mountain to launch Ride On Park City. This app/internet platform allows employees and partners of these organizations to find a carpool match, real time transit information, e-bikes, and more. Park City estimates that they have already prevented 46.1 tons of C02 emissions, and taken nearly 15,000 non-single occupancy trips in the region.

- In September 2020, the Houston Metropolitan Transit Authority launched an app to boost existing neighborhood on-demand shuttle programs.

Economic Impact

- **Costs**:
  - Initial cost of app development and ongoing maintenance, public awareness/advertising campaign.
- **Savings:**
  - If this encourages ride sharing/carpooling and increased bus ridership, this will reduce wear-and-tear on roads

One of the many improvements to ACT: a light-up signal to bus drivers during low-light times of day.

Benefits Other than CO_2 Reduction

- Convenience
- Residents without cars will have access to rides
- Community connection- many people make friends when ride sharing
- Reduced traffic

Challenges & Anticipated Barriers

- The use of this app will be voluntary. Anyone who may be concerned about personal privacy will not have to use this platform.

References & Resources

Massachussetts Institute of Technology (MIT) Sustainability Website

Metro Magazine Online: Questions to Ask Before Investing in Microtransit

US Department of Transportation Federal Highway Administration: Expanding Traveler Choices through the Use of Incentives

Strategy TM-1.5: Perform a County assessment for commuter and other transportation needs.

Time Frame: Short-term

Background

The 2015 Los Alamos Comprehensive Transit Study shows that commuter ridership from surrounding communities tripled between 2013 and 2015. Currently ACT is putting out an RFP for an updated Transit Study, and we look forward to these data.

It may work well to partner with LANL in collecting commuter data, as they are also trying to reduce traffic and parking issues. In this same vein, a partnership with the New Mexico Department of Transportation (NMDOT) and the North Central Regional Transit District (NCRTD), who currently run buses in and out of LA County, may conduct a needs analysis for mass transportation between neighboring communities and Los Alamos

Outcome

Performing an assessment for commuter and other transportation needs will help LAC better understand the market for commuting and the transportation needs of residents and non-residents, which will help us modify transportation schedules as needed based on these data. It can also help inform whether a local ride sharing app would be helpful.

Examples in Other Communities

- UNMet Transit Needs Study

Economic Impact

- **Costs:**
  - Cost of study/hiring consulting firm
  - Cost of potential new buses, fuel and staff
  - Cost of potential parking “off the Hill”

- **Savings:**

- Less wear-and-tear on the road
- Fewer accidents/clean-up/destruction
- Less fuel purchased by residents and non-residents
- Potential savings when partnering with other organizations

Benefits Other than CO_2 Reduction

- Reduced traffic and congestion during peak hours in Los Alamos and White Rock
- Fewer cars on the road means fewer accidents
- Increase in community connection
- Cleaner air

References & Resources

Rural Health Information Hub

Boulder, CO Transportation Plan

UNM Transit Study

Just a few of the many biking, hiking and walking trails in Los Alamos.

Recommendation TM-2: Improve bicycle and walking infrastructure to promote safe and convenient carbon-free transportation.

Time Frame: Short- to medium-term

It's no secret that bicycles offer a healthy and fun alternative to fossil fuel-based transportation while helping to curb emissions. It is important that bicycle transportation be safe for cyclists and motorized drivers. The safer and easier we make this option, the more people will see it as a realistic way to get around, whether it be the commute to and from work and school or going to friends' homes, accessing local businesses and public spaces, or even just a fun family ride around town.

Background

As previously stated, the LAC Transportation Board already has an excellent Bicycle Transportation Plan (BTP) in place. This plan was adopted on June 27, 2017. The LARES Task Force heartily endorses the recommendations in this document.

Normalizing and encouraging bicycle transportation is key to its success. Many US cities have ambitious biking and walking goals.

The Los Alamos townsite has a good start to a bike-friendly community with our many bike lanes, bike lane/slow vehicle signage, and sharrows. White Rock is already bike-friendly as it consists nearly entirely of residential streets. In fact, we have been awarded a Bronze Level designation from the League of American Bicyclists' Bike Friendly Communities Award team (see Appendix F). The new community of Mirador and a crossing to the rest of White Rock should be considered for future updates to the bicycle infrastructure.

Bike lane and bike/low speed vehicle signage on Diamond Drive near Golf Course, sharrow in downtown Los Alamos

Strategy TM-2.1: Implement the LAC Transportation Board's recommendations outlined in the Bicycle Transportation Plan.

Time Frame: Short-Term and ongoing

Background

The 2017 Bicycle Transportation Plan put out by the LAC Transportation Board is an excellent document with many practical and tangible recommendations. This document outlines plans, costs, and other information needed.

Outcome

Safer and increased number of bike lanes and cycle paths will encourage biking, helping residents be healthier and more fit while reducing GHG emissions. This will also reduce traffic and air pollution.

Benefits Other Than CO_2 Reduction

- Equity: While Los Alamos is in general a wealthy community, not all residents are economically secure. Improving the bicycle infrastructure for residents allows for getting around town via bike, bus or walking without having to own a car. This is an advantage for those who are unable to drive. We should design this with all ages and abilities in mind.
- Improved health through exercise
- Resident's fuel use and vehicle maintenance costs will decrease, longer vehicle life
- Reduced traffic and better air quality

References & Resources

LAC Transportation Board Bicycle Transportation Plan 2017

Strategy TM-2.2: Implement green boxed bike lanes, protected/buffered bike lanes, or similar safety features.

Time Frame: Short-term and ongoing

Background

Green boxed bike lanes are green-painted rectangles (with a white outline) at intersections and other areas of the bike lane that provide a safe refuge for bicyclists to either cue ahead of cars or to make a two-stage turn. Bike boxes help increase safety for bicyclists by reducing right-hand hooks by cars and by helping bicyclists navigate tricky intersections. These green bike lanes

enhance visibility where there is the potential for a problem and instead create safe, predictable pathways for bicycles so that cars know what to expect (cyclists) and where to expect them.

Thermoplastic is the most commonly-used material for this purpose in US cities as it lasts far longer than typical street paint.




Protected (or buffered) bike lanes with "shy" distances offer extra space and protection of bicyclists from cars, and have been shown to increase ridership and improve the confidence of cyclists in many communities in recent years. For example, the City of Seattle found that ridership increased more than 400% when a painted bike lane was upgraded to a protected bike lane using flexible posts (also known as bollards), similar to those we have coming down off of Barranca Mesa at the roundabout.


Buffered bike lane in Corvallis, OR.


Bollards at Barranca/North Mesa roundabout.

Protected bike lanes in Washington, DC.

Protected bike lanes not only offer safe cycling for riders but they also allow for extra parking for cars.

There are several areas of Los Alamos townsite that would benefit from green boxed bike lanes: downtown on Central and Trinity in several locations, the "new" roundabout at the entrance of town, the entrance to the Canyon Rim Trail and Entrada Drive as one leaves town, turning in and out of Northern Community (Urban Park area) streets from Diamond Drive, the "old" roundabout near Barranca and North Mesas, certain areas of North Mesa and downtown where there are a lot of apartments. Protected bike lanes can be considered for these and other areas.

White Rock is already a very safe bicycling community. The recent addition of the Mirador subdivision across NM4 in White Rock is a good place to consider highlighting some green boxed bike lanes.

Outcome

Higher visibility bike lanes will be safer bike lanes and bike riders as well as more aware drivers. Safer biking will lead to more bike commuters and a decrease in emissions as well as improved fitness of residents.

Case Study

The city of Corvallis, Oregon (population 55,000 and home to Oregon State University), identified the top 12 most critical intersections for the first year of implementation. Now that they're in 2nd year, they are expanding to another 12 intersections. We are awaiting data from Josh Capps at the City of Corvallis.

Examples in Other Communities

- Green boxed bike lanes are seen in:
    - Major cities such as Seattle, WA; Denver, CO; Portland, OR; Washington, DC; and Sacramento, CA
    - Medium-sized cities such as Arlington, VA; Salem, OR; Westminster, CO; and Eugene, OR

- Small cities such as Isle of Palms, SC; Bend, OR; and Durango, CO (to name just a handful!)

Economic Impact

- **Costs:**
  - As of February, 2020, the price for green thermoplastic was roughly $5.50/SF (square foot) (Corvallis, Oregon), or $3 – $6/SF for raw materials, $10 – $14/SF installed (NACTO)
  - The estimated cost for bollard installation is $105 per linear foot, which includes labor (2018 price from LAC)
  - There may be some cost considerations about how to deal with debris or snow in bike lanes

- **Savings:**
  - More bike commuters mean fewer vehicles on the road and thus less road maintenance

Benefits Other than CO_2 Reduction

- Safe transportation for those who cannot drive
- Increased biking leads to improved health and fitness
- Pleasure biking
- Family and community connectedness
- Reduced traffic

Challenges & Anticipated Barriers

- Parking, snow plowing, street sweeping may need to be considered.
- Winter maintenance: Salt Lake City prioritized "snow plowing schedule for bikeways" in their "Bicycle and Pedestrian Master Plan."
  - SLC uses small Kubota plows that fit within the protected bike lanes to clear them of snow; LAC's inventory shows a 3026 Bobcat Skid Steer w/ Plow (Parks & Rec Inventory) which looks as if it can do the job if needed.
- If there will be an increase of bike commuters, there will need to be more bike racks/bike "parking" in town and at work places.

References & Resources

Bend, OR Transportation Plan

Car Free Diet Website

City of Colorado Springs, CO Separated Bike Lane Design Guide

National Association of City Transportation Officials (NACTO) - Street Maintenance and Snow Issues

NACTO Website

NACTO Information on Colored Pavement

Pedestrian and Bicycle Information Center

Photographs: Bike lane photos courtesy of Dottie Knecht, Sunny Summers, Jill Summers (Salem, OR); Ryan Kanter (Corvallis, OR); and Sean Patton (Washington, DC)

Strategy TM-2.3: Create a bike-only path between Los Alamos and White Rock that is not on the main road.

Time Frame: Medium-to-long-term

Background

Biking on the shoulder of NM State Route 4 is only for the brave. Many local cyclists have at least one story of a "very close call" while riding on that road. Riding up Main Hill Road and Truck Route also present safety concerns, though arguably Truck Route is the safest path.

A bike-only (perhaps walking, too) path to/from White Rock and Los Alamos would be the safest way for cyclists to commute. It is likely that this path would increase biking in the community simply because it is not on the main road and is therefore much safer with no other traffic.

Outcome

A WR-LA bike path will increase commuting via biking, help ease traffic and congestion (particularly on NM4 from WR to Truck Route "T," reduce air pollution, and reduce the number of bicycle-related accidents and "near-misses."

Economic Impact

- **Costs** (not necessarily to LAC):
  - Cost of new bridge (whether with walking/biking paths built next to or underneath passenger vehicle traffic way) or other option
  - Cost of maintaining current bridge for foot and bike traffic only

Benefits Other than CO_2 Reduction

- More commuting by walking and biking

- Improved health and increased active lifestyles of residents
- More cyclists and walkers visible in the community (and to cars) encourage others to also walk/bike to work
- Higher biker visibility also means car traffic is more aware of others commuting by foot or bike, which makes it a safer mode of transport for everyone

Challenges & Anticipated Barriers

- A bike path would likely go through Tribal land, DOE land, and potentially other land. Gaining access/permission would require agreement of all parties.

Other Bike-Related Ideas:

-Active Travel Corridors- ways to get around that you can't access by car (paths, streets that don't go through for a car but do for a walker or a biker)
-Kids' bike training in elementary PE classes
-More bike parking/bike racks
-Amenities at work to facilitate biking (showers, changing room, lockers, etc.)
-Public-Private partnerships for discounts on biking needs and walking shoes
-Promotion of non-car use through alternative vehicle shows, bike repair clinics, bicycle/gear swaps/sales, etc.
-Encourage and support purchase and maintenance of non-car vehicles
-Extra bike lanes during major road construction

Recommendation TM-3: Increase publicly accessible electric vehicle charging infrastructure.

Time Frame: Medium-term and ongoing

Background

As time goes on, more and more electric vehicles will be manufactured. Estimates vary, but GM and other car makers have pledged to phase out gasoline engine vehicles as early as 2025. This means demand for EV charging stations will soar as they become the dominant vehicle driven by consumers. This will eventually mean competition in getting the limited amount of EV Charging parking spots in existence.

The County, schools, businesses, landlords, and other private enterprises will need to look into installing EV charging stations for employees and customers. Indeed, even residential areas may need charging stations. Yes, residents can charge at their homes, but there may be guests, out-of-towners, and other reasons for installing neighborhood charging stations. Likewise, apartment complexes and other multi-family housing areas will need EV charging infrastructure. Various public and private locations will also benefit from charging stations (see below).

EV charging infrastructure is more complicated than "simply" installing EV chargers in various locations. Connecting to power, running power lines if necessary, finding appropriate space within designated locations, materials and manpower, as well as determining which kind of chargers will all need to be worked out. Some chargers are solar powered. Some have a single charging port, others are dual ports. The DPU already has done a great deal of research into charger and infrastructure pricing, and we thank them for sharing their information.

Outcome

Increased availability and access to EV charging stations will encourage EV purchase among residents and will give EV owners (and County-owned EVs) better charging opportunities and options.

Strategy TM-3.1: Create an EV charging station implementation plan to put more EV charging stations at County-owned facilities and to expand charging infrastructure around the County.

- This plan should include EV charging (but not limited to) in the following public areas:
    - White Rock "Y"
    - LA and WR libraries and senior centers
    - WR Welcome Center
    - Schools (LAPS and UNM-LA)
    - Sports complexes and trail heads

    - Ashley Pond/Fuller Lodge
    - Aquatic center and golf course
    - County parks

- Privately owned properties should be encouraged and eventually required to install EV charging stations:

    - Private parking lots
    - Multi-family housing areas
    - Hotels
    - Churches
    - LAMC

- Charging stations are likely to improve in coming years and also become cheaper. Setting yearly or biyearly targets for at least a decade will get us started on more charging stations without "breaking the bank" immediately.

    - Keeping this in mind, we recognize that it would be more streamlined for the County to have as many of the same kinds of charging stations as possible rather than a new make/model each purchase cycle.

Strategy TM-3.2: Work with local property owners (businesses, apartment complexes, LAPS) to help facilitate installation of EV charging stations on their properties.

- LAC should encourage private property owners to install EV chargers. Eventually, this should be a requirement.

Strategy TM-3.3: Explore solar-powered charging stations.

- As technology matures and charging port prices come down, installing solar-powered EV chargers may be the "greenest" way to charge local vehicles.

Strategy TM-3.4: Require all new construction (residential, commercial, parking lots) to have EV-ready wiring and/or EV charging options.

- This will likely be through a building code update.

Strategy TM-3.5: Create public maps of EV charging placement.

- Maps to sites (hard copy, online, QR codes, signs in high traffic areas) showing charging placement will be necessary so people easily know where to find them.

Economic Impact

There may be some money available from the State of NM through the Volkswagen Environmental Mitigation Settlement.

- **Costs:**
  - Initial cost of each charging station as well as infrastructure implementation and labor—this is where most of the cost is. The DPU has pricing for this. Depending on the kind of charger and where it will be installed, the price ranges from around $19k to $85k per charging station.

- **Savings:**
  - County and police vehicles can be fueled/powered by renewable energy and will reduce the cost of gasoline purchased.

Benefits Other than CO_2 Reduction

- Convenience of charging stations in multiple locations around the County
- Encouraging and supporting residents to purchase EVs
- Cleaner air

Challenges & Anticipated Barriers

The following questions will need to be looked into:

- What voltage will these public charging stations supply?
- How long will consumers be permitted to charge?
- Will there be a penalty if they overstay their time?
- What times of day will charging be permitted? Does it matter?
- Will this take away parking (street parking, lot spaces, schools, other)?
- Are there federal grants/monies that can help establish this infrastructure?
- Are there tax incentives for property owners?

References & Resources

A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects

LAC Department of Public Utilities provided information on charging station costs.

Recommendation TM-4: Increase the number of electric vehicles in the County fleet by at least two per year, eventually making 100% of light duty (passenger cars and trucks) plug-in electric.

Time Frame: Immediate and ongoing

Background

Los Alamos County, ACT and PEEC are already investing in EVs for their fleets. ACT has two electric buses on order. Our community is lucky to have these entities taking the lead in the transition to electric vehicles. We need to continue to increase these efforts by setting an updated vehicle replacement policy, including police vehicles. We recommend that LAPS should do the same.

As technology matures, other non-combustion engine vehicles may be more affordable or more practical.

One excellent EV promotion toolkit from the Sierra Club gives the following examples of policies and other incentives to switch to EVs:

1. EXPANDING PERKS AND INCENTIVES
- Vehicle Rebates and Tax Credits
- Sales Tax Exemptions
- HOV Lane Access

2. ELECTRIFYING VEHICLE FLEETS
- Government Fleet Mandates
- Transit Bus Fleet Upgrades
- Using VW Settlement Funds for ZEB Adoption

3. EXPANDING CHARGING ACCESS
- EV-Ready Wiring Codes and Ordinances
- Multi-Unit Dwellings (MUDs)
- Streetlight and Power Pole Charging Access
- Right-of-way Charging
- EV-Utility Investments
- Best practices for installing EVSE
- Using VW Settlement Funds to Grow EV Charging Networks

4. EVALUATING VEHICLE REGISTRATION FEES
- Resisting Anti-EV Registration Fees
- States with Waived or Reduced Vehicle Registration Fees for EV Drivers

5. EXPANDING EQUITY AND ACCESS
- Rebates for low-income drivers
- Electric car-sharing programs
- Charging access for underserved communities

6. PROMOTING CONSUMER EDUCATION & PROTECTION
- EV Proclamations & Driver Bill of Rights
- Ride and Drive Events
- Open Access and Interoperability
- Uniform Signage Requirements

Outcome

With an all-electric fleet of vehicles, the County, Atomic City Transit, the Public Schools, and the Police will be greatly reducing their GHG emissions.

Strategy TM-4.1: The County should update their Vehicle Upgrades, Additions, and Replacement Policy to clearly state that any new vehicles purchased will be EVs.

- The current schedule of vehicle replacement was last updated in 2013; it seems reasonable that when a vehicle is scheduled to be replaced, it will be replaced with an EV. The County and other major players (schools, police, others) should be required to justify purchasing gas-burning vehicles as opposed to emission-free cars.

Strategy TM-4.2: The County will set targets as to how many vehicles will be replaced each year with an EV.

- Set official targets of *at least* 2 current-vehicle-to-EV replacements per year or more.

Examples in Other Communities

- Dozens of other communities large and small, as well as the US Government, are converting their municipal passenger and work trucks to electric vehicles.
- Car manufacturers are releasing new EVs in both passenger cars and trucks. Ford, for example, has just announced an electric F150 truck at a price point of $40k. A "regular," new, gas-burning Ford F150 costs $30k. GM has announced an electric Silverado pickup truck set for release in fall of 2023, starting price of just under $40k.

Economic Impact

- **Costs:**
  - For the next few years, the cost of new EVs will likely be more than "regular" vehicle replacement.
  - Training of technicians/mechanics to maintain EVs.

- **Savings:**
  - Estimates range that EVs cost 50-70% less to operate.
  - Lower gas/diesel bills as vehicles use less and less fossil fuel over time.

Benefits Other than CO_2 Reduction

- Air quality improvement/less pollution
- Lower risk of wildfire (sparks from cars, gasoline exploding in car crashes)
- Lower vehicle noise pollution

Challenges & Anticipated Barriers

- Auto mechanics will need to keep up with the changing technology (battery pack maintenance, coolant changing, suspension changes,). Knowledge of changing oil and old engine function will change to reflect the newer electric engines.

- Cost might be an early inhibitor, but as the market shifts, this may no longer be a deterrent to purchasing EVs over regular cars.

References & Resources

Biden plans to replace government fleet with electric vehicles. CNBC. Michael Wayland. January 2021.

Electrify NY Website

Ford.com Electric Truck Pricing

Sierra Club Toolkit on Switching to EVs

The International Council on Clean Transportation (ICCT): The Continued Transition to Electric Vehicles in the US. Peter Slowick, Nic Lutsey. July 2018.

Yahoo Finance: 600 Miles on a Single Charge

Recommendation TM-5: Revise and implement a County-wide "no idling" policy with shaded parking options.

From the US Department of Energy IdleBox Toolkit

Time Frame: Medium-term (with a few exceptions)

Background

Idling vehicles wastes fuel and creates unnecessary greenhouse gas emissions. Many municipalities and school districts around the country and the world have implemented "no idling" policies. Idling can use between quarter to a half gallon of fuel per hour, depending on type of vehicle, engine size, and whether the air conditioner is in use while idling. Argonne National Laboratory researchers estimate that restarting a vehicle takes the equivalent of **just 10 second's worth of fuel**, making it worthwhile to turn off an engine even for short stops.

Idling cars on hot days to keep vulnerable animals and humans (usually children and fragile adults/elderly) in can be understood. Most adults, however, can tolerate rolling down the windows as they wait in their cars. Idling a car on a cold day to stay warm, again, may be appropriate in rare cases. Most adults can sit in a cool car for a short period of time as they wait. We can also encourage (or incentivize) keeping a blanket or sweatshirt in the car.

Many areas in Los Alamos where people park and idle their cars do not have adequate shade to keep them cool on hot days; local schools and grocery store parking lots are prime examples of this. Working with schools and businesses to plant trees and create more shade will help reduce idling in parking lots, as will installing covered parking. Covered parking presents an opportunity for solar panel installation, which can help businesses and schools produce more of their own renewable energy, lower their utility bills, and reduce emissions even further.

Covered parking during hot seasons has clear benefits. Solar gain (warmth from the sun) has its advantages during cold months, and should not be ignored. Many parking spots will continue to be uncovered and will give drivers options to park in or out of the sun on cold days. There may be a way to design solar panel covers that change angles or have small holes to allow for the sun to come through on cold days.

The County already has a fuel conservation policy in place for its fleet, but does not appear to be followed or enforced. County trucks idle while employees check meters or perform maintenance, or sometimes just sit and chat. Training, buy-in from employees, and follow-through from superiors is needed to cut idling and the emissions caused by this unnecessary and wasteful action. Stickers on dashboards can remind drivers to turn off vehicles. This should become a habit to save the County money, fuel, and emissions.

Another source of idling is parents waiting for their children outside of schools. If school children took the bus which already goes to/from their homes and fewer parents were making extra trips to pick up their children (and concurrently idling their vehicles), we would make a nice dent in our GHG emissions. “No idling” signs outside of schools have been effective in many school districts around the country.

Idling cars can pose a safety threat. A car left in gear by mistake can accidentally run over a child, a resident, a pet or other animal. Indeed, USPS policy requires drivers to place the vehicle in “park” and to turn off their engines at each home so that no one is accidentally run over by a mail truck. This also prevents idling as mail carriers unload boxes and carry mail to multiple homes, walking to two or three houses before reloading or moving the vehicle.

Likewise, County vehicles driving from each individual house to the next may not be the most efficient way to check meters. Parking in a central location and walking from home to home not only uses less fuel but it also allows for exercise for the employee. Home owners will appreciate fewer idling cars on their streets and less wasted gas and taxpayer dollars.

Electric vehicles will not “idle” in the same way as gas and diesel cars and trucks. This no idling policy may eventually become obsolete as the majority of cars become electric (100 years from now!).

Argonne National Laboratories (ANL) have created an idling calculator to see how much fuel is used in idling vehicles (available in Appendix E).

The US Department of Energy's website has a fabulous “No Idling Toolkit” with a large array of all necessary materials to educate the community: outreach letters, idling savings calculators, bumper stickers, signs, and many other useful materials and data/information. The legwork on this has basically been “done,” we just need to access the resource and print/distribute materials.

Outcome

Preventing idling vehicles will lower GHG emissions and improve air quality. The County will save money on fuel use and wear on vehicle engines. Equipping sun shades in all vehicles will help reduce the need for idling to cool the vehicle. Shaded parking will provide cooler vehicles during hot months and will reduce the need for immediate AC consumption in cars, which ANL shows reduces fuel economy when turned on right away. Solar panels on shaded parking will supply businesses or other providers with renewable energy.

Strategy TM-5.1: Run a County-wide (including all public schools) "no idling" campaign.

Strategy TM-5.2: All County, police, and LAPS vehicles should be equipped with a sun shield for the front windscreen.

Strategy TM-5.3: Providing more shade in the form of trees and parking area "covers" will beautify our community (trees), provide carbon capture (trees) and an area where "rooftop solar" could be installed.

- Imagine the Smith's parking lot with shaded and County-owned solar on top!

Examples in Other Communities

- Many school districts, such as in Corvallis, OR, have student, teacher, and parent volunteers outside of school during major pick-up and drop-off times with signs reminding car drivers not to idle. Some volunteers need to knock on windows and politely remind/ask drivers to turn off their vehicles.

Economic Impact

- **Costs**:
  - Costs of "No Idling" campaign (signs, community outreach material, bumper stickers, etc.)
  - Costs of sun shades for all County, Police and LAPS vehicles
  - Installing shade for parking lots, outside schools, and other public places will be the major expense. These will, however, provide areas for rooftop solar.
  - Potential installation of rooftop solar

- **Savings:**
  - $70-$650 per vehicle per year (depending on type of vehicle and price of gasoline) in gas costs
  - $10 per vehicle per year on engine wear
  - Rooftop solar on shaded parking will help the County reduce energy bills

Benefits Other than CO_2 Reduction

- Shaded parking!
- Shade covers in parking lots could provide a place for “rooftop” solar panels
- Beautification with tree planting
- Carbon capture with tree planting

Challenges & Anticipated Barriers

- Asking private businesses and land owners to provide shaded parking
- Shaded parking during winter months reduces or eliminates solar gain. Consideration of some kind of hybrid “shade in the summer, sun in the winter” model will be a win-win.
- Tree planting in areas of concrete and/or asphalt

References & Resources

Argonne National Laboratory Idling Calculator in Appendix E.

Argonne National Laboratory. Stop and Restart Effects on Modern Vehicle Starting System Components – Longevity and Economic Factors. Paul R. Windover, et al. 2015.

US Department of Energy Fuel Economy Information

US Department of Energy IdleBox Toolkit

Recommendation TM-6: Launch a municipal bike share program.

Time Frame: Medium-term

Background

Bike share programs around the country are seeing success and are helping to increase the number of people regularly using bikes for transportation. While tourists will also benefit from this fun and convenient way to get around Los Alamos, residents young and old will have access to a bike (regular pedal or electric assist) whenever they need one.

Outcome

A municipal bike share program will provide more mobility options for all residents and visitors, reduce traffic, and increase health and fitness.

Examples in Other Communities

Many communities around the country have a bike share program.

Incentives to use bike/scooter shares in various other places include:

- One free ride and reduce rate ride program
- One free ride per tourist
- Reduced rate for punch pass/commuters/high schoolers/middle schoolers
- Raffle for free community passes
- Weekly, monthly, 3-month (this would be ideal for LANL summer students), yearly passes
- 1-ride and 1-day passes

Most towns and cities use bike share programs run by an outside company. Many bike share programs, such as that in Portland, OR, offer multiple pay-per-use options:

- For a single ride, cost is $1 to unlock the bike and $0.20 per minute
- Riders can pay a per-hour or per-day rate, some ares offer a per-week rate
- Annual membership for $99 per year plus $0.10/min with no unlock fees
- Many and varied plans/pay per use depending on company

From the Portland, OR Bike Share Program website.

Economic Impact

- **Costs:**
  - Initial cost of bike share program (bikes, multiple stations, charging if E-bike, public outreach campaign, cost of third party to manage bike share)
  - Ongoing costs of increasing number of bikes/stations around town

Benefits Other than CO_2 Reduction

- Contributes to micro-mobility aimed at commuters, residents, and tourists
- Helps address the "first/last mile" problem of public transportation
- Potential increase to spending at local restaurants during lunch hour
- Tourist attraction
- Increased bike riding = Fun!
- Increased health and wellness of community

Challenges & Anticipated Barriers

- Some communities observed that many people, including school children and economically disadvantaged citizens, were left out of the bike share program because they did not have a smartphone and/or a bank account.
- Many communities we contacted noted that this was best implemented using a third party who maintains the bikes and trouble-shoots. This was too much for city employees to manage. Bike repairs, parking issues, payment problems, etc. should go through the vendor.
- A few towns experienced the problem of the bike provider company going out of business, and then the municipality was left with unusable bikes. Two places who mentioned this are in the process of switching to a new bike share provider.
- It was suggested more than once to be sure to have clear parking guidelines and enough places for bikes to be parked "legally."
- Questions to ask:
  - How many bikes do we need?
  - How many bike station locations and where to place them?
  - How to keep the "load balanced," i.e. enough bikes at each station?
  - E-bike and/or regular bike?
  - Where can/can't people park bikes? The City of Seattle posts these bike parking guidelines: https://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-share
  - Whom should bike riders contact when there is a problem? Have vendor handle problems:
    - collision or injury
    - parking issue
    - bike mechanical problem
    - can't release or purchase
    - no bikes available at location

References & Resources

Bend, OR Transportation System Plan

Denver, CO Bike Share Program

Pedestrian Bicycle Information Center: Bike Shares

Portland, OR Bike Share Program

Seattle, WA Bike Share Program

View of the Sangre de Christo mountains from North Mesa.

Recommendation TM-7: Encourage private electric vehicle purchase and charging during non-peak hours.

Time Frame: Short-term and ongoing

Background

We need current data on Los Alamos County EV usage. If we follow national norms, it should be around 7%. We cannot control what kinds of vehicles residents buy, but there is growing interest in EVs and the market is heading in an "EV-only" direction. LAC can provide information to residents on the benefits of driving EVs so that residents can make decisions for their next vehicle purchase.

Charging EVs will start to become a challenge. Recommendation Tm-3 discusses EV charging infrastructure. Here we wish to highlight the importance of charging during non-peak hours. Increased demand on the electrical load increases prices, which make power more expensive. Currently it is less expensive to use electricity during the night than during the daytime hours. We do not know if this will stay the same in the future; as we become more reliant on renewables, we may need to change our energy-consumption habits with when power is cheapest. Solar energy will be plentiful during the day, but without storage, will not be available at night.

Convenience of charging at home (residential, apartment complexes) as well as in public locations will increase use of energy at *all* times of day. Whenever "non-peak" hours are in the future, we will want to encourage EV owners to charge during these times whenever possible.

We must be sure that non-peak time energy comes from renewables rather than coal or other fossil fuels. If not, charging during non-peak times will only increase our carbon footprint.

Outcome

Encouraging EV charging at non-peak hours will keep energy prices low for everyone.

Strategy TM-7.1: Run a public information campaign on energy prices and when to charge EVs at the lowest cost times.

- This may include mailers sent directly to residences and businesses, notes in utility bills, leaflets on EV car windows, banners on the overpasses, sandwich boards on sidewalks, booths at the farmer's market, interviews on TV and radio news programs, and other strategies. The EV Car Show may be another good way to distribute this information.

Examples in Other Communities

Many communities and utility providers have information available to consumers about peak charging times and rates. Some even provide a way to separate home utility bills from EV charging costs.

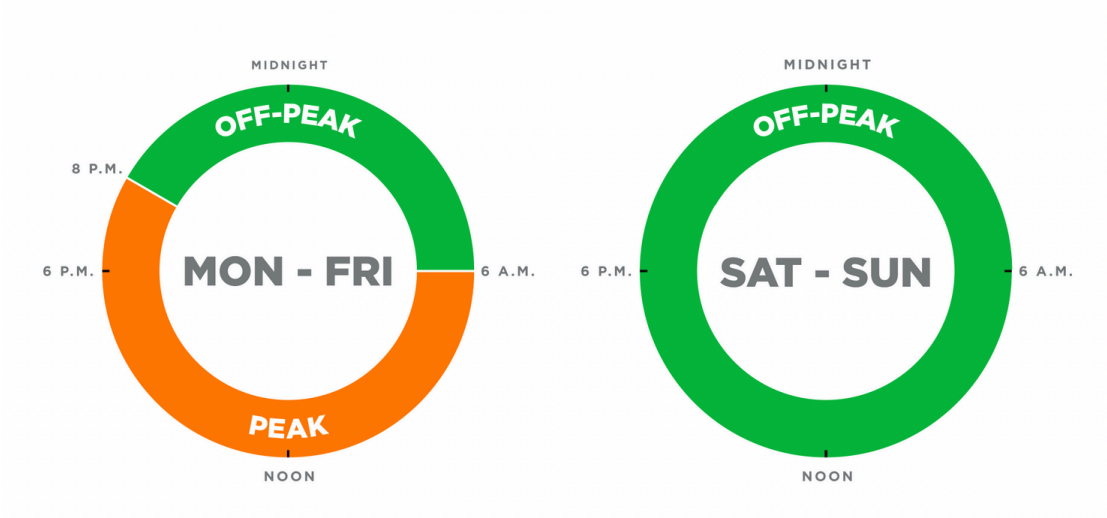


Image above from [The City of Westerville, OH website]

[Concord, MA "EV Miles" Program]

[Green Mountain Power in Vermont EV charging "rates"]

[PGE in California EV charging "plans"]

Economic Impact

- **Costs:**
  - Educational materials/campaign for getting information to residents and businesses.
  - Staff time to promote/organize information.

- **Savings:**
  - Once consumers are informed, the cost of all power should go down (or at least regulate) when charging EVs during non-peak times.

Benefits Other than CO_2 Reduction

- Potential reduction in power costs and utility bills when charging at non-peak times
- Increased access to EV charging stations for all residents and visitors to LA County

Anticipated Challenges & Barriers

- Getting information out to residents and being sure they understand rate structures.

References & Resources

American Automobile Association (AAA): True Cost of an EV

New Mexico Environment Department: VW Settlement

Pew Research on EVs in US

Sierra Club: AchiEVe: Model State & Local Policies to Accelerate Electric Vehicle Adoption, 2018

US Department of Energy: A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects, 2014.

Recommendation TM-8: Increase the number of solar-powered flashing light crosswalks.

Time Frame: Short-term and ongoing

Background

We already have a push-button crosswalk with flashing lights at the start of the golf course, and it works well. Installation of more of these, say on Trinity Drive, would help improve walking infrastructure for residents, and would promote more (and safer) walking in general.

Outcome

More people will walk (or use a combination of walking/biking and bussing) to get around town or for pleasure. This is especially helpful for those who do not drive.

Strategy TM-8.1: Install flashing light crosswalks in the following places:

- White Rock/Mirador
- Crosswalk on Diamond near Urban/Mountain
- North Mesa by middle school, maybe another location
- Downtown on Trinity Drive by 20th street/Ashley Pond

Flashing Light Crossing on Diamond near Golf Course and crosswalk signal Downtown.

Examples in Other Communities

- Carson, CA, intends to add solar-powered lighting and vehicle speed feedback signs near crosswalks to promote traffic calming and encourage active transportation.
- Minneapolis, MN, has a goal to increase pedestrian trips from 16% to 25% by 2030. Strategies include enhancing visibility at pedestrian crossings and increasing street lighting.

Economic Impact

- **Costs:**
    - The DPU will have pricing information for these kinds of light-up crosswalks.

Benefits Other than CO_2 Reduction

- Increased walking opportunities
- Safer walking opportunities (also safer for drivers!)
- Increased health and fitness

References & Resources

Bend, OR Transportation System Plan

Pedestrian and Bicycle Information Center

Recommendation TM-9: Convert municipal small engines, lawn/garden equipment, and golf carts, to be fossil fuel free within ten years.

Time Frame: Short-term and ongoing (until goal is met)

Background

Currently most LAC lawn and garden equipment use combustion engines to work. Golf carts are also fossil fuel powered. All equipment now has carbon-free replacement options. Replacing these with sustainable alternatives will take money and cannot be done overnight.

LAC has already purchased some battery-powered lawn and garden equipment. In speaking with LAC employees, some of these work well and others less so. On the plus side, many have battery packs that are interchangeable with other equipment, making this both convenient and efficient for replacing dead batteries with freshly charged ones. On the negative side, batteries can take a long time to charge with short time-of-use.

Many battery-powered alternatives are not yet as efficient or convenient as their combustion-engine counterparts. This will change as technology catches up with demand.

Outcome

Converting all municipal small engines to be fossil fuel free will reduce our carbon emissions and help us achieve net-zero by 2035.

Strategy TM-9.1: Develop a small engine replacement with a carbon-free alternative schedule.

Economic Impact

- **Costs:**
    - Replacing equipment as it "ages out" will cost money whether or not it is battery powered or gas powered. There may be additional costs for extra battery packs and/or charging ports.

- **Savings:**
    - Reduction in fuel use.

Benefits Other than CO_2 Reduction

- Battery-powered machinery is generally quieter than gas-powered equipment, reducing noise pollution.

Other Considerations

Air Travel

The Los Alamos Airport does not provide commercial air service and does not contribute in a major way to LA County GHG emissions. However, aviation gasoline, jet fuel, and kerosene (used for the air ambulance) are much "dirtier" burners than regular car gasoline. It is an important amenity to provide residents with emergency air service.

We recognize that the County and County Council have no jurisdiction over resident's air travel. It can, however, provide platforms to citizens to encourage alternative travel options (online forum for ride-shares for short trips (Santa Fe/Taos/ABQ), information about shuttles and/or carpooling options to the SF and ABQ airports, bus and train information for travel and to get to ABQ airport. For those residents who use Facebook, there could be a page for this service. For those who do not use Facebook there are many other options.

The County could work with RTD to provide a direct airport shuttle from LA to ABQ airport and back or work to provide one or two more buses to the Santa Fe railyard for people to take the train to ABQ. Would the County consider an on-demand or planned voyage shuttle service to/from the ABQ and/or SF airports?

Omega Bridge

The Omega Bridge as seen from Los Alamos Canyon.

The Omega Bridge was built in 1951, making it 60 years old and near the end of its useful life. Recently, maintenance was performed on the bridge, but it will not significantly extend its life. Whether there is a new bridge built in its place (or next to it), this presents an opportunity to provide safe walking and biking paths for commuters.

While the Omega Bridge is not in the LAC jurisdiction, we are hoping to have LAC and citizen input when the time comes to review its future. It would be great to see bike lanes and a walking path on the Omega Bridge.

The League of American Bicyclists has compiled a list of bridges around the country that offer bicycle- and pedestrian-friendly passage, with examples in Minnesota, Washington, California, Oregon, New Jersey, Pennsylvania, Connecticut, New York, and the District of Columbia. This is often a lane separated from passenger vehicles or a second "story," with the bicycle and foot traffic going over or under the cars.

Hydrogen Fuel Technology for Transportation

Hydrogen (H_2) can be used for all kinds of things, primarily as transportation fuel for personal vehicles, buses, and heavy-duty trucks (semis, garbage trucks, etc.), but we need an H_2 infrastructure to make this a reality. New Mexico Governor Michelle Luján Grisham and our US Congressional delegation are trying to make our state a "hydrogen hub" for the western Should we be the lucky winner, it is likely that LANL would be a part of this program. This would provide an opportunity for LAC to partner with LANL (as it does with power sharing) for both hydrogen production and storage.

H_2 for fuel is often created via steam methane reforming (SMR), which in itself is very carbon-heavy. Steam and natural gas (mostly methane, CH_4) are combined to produce H_2 and CO_2, creating what is known as "gray" hydrogen. "Blue" hydrogen is when they do carbon-capture at the point of SMR production, which is not significantly better than gray hydrogen. H_2 can also be produced using electrolysis (water splitting) and emits no carbon. This is known as "green" hydrogen. Ideally H_2 is produced via electrolysis, and produced using renewable energy, but this is currently the most expensive way to make H_2. The "Hydrogen Earth Shot" project is a goal from the US Department of Energy to make hydrogen-production costs come down significantly: to produce 1 kg H_2 for $ 1 within one decade; this is known as the 1:1:1. (Electrolysis H_2 is currently between $5-8/kg, MSR is roughly $2/kg).

Using H_2 to power fuel cell EVs can conceivably replace heavy-duty diesel vehicles, for which there is no, and not likely to be, a battery-powered equivalent (garbage trucks, construction vehicles, long-haul transport). When comparing emissions from methane-steam reforming to burning diesel fuel, SMR produces roughly half the emissions. There is also the added benefit of no particulate pollution and NO_x (and other damaging emissions) which occur when using diesel in a combustion engine. Consideration of emissions must also be given to methane lost due to leaks during transport and processing.

In accounting for emissions from electrolysis-produced hydrogen, it is important to take into account the source of the electricity used to produce it. If coal plants provide the power, more GHG are escaping to produce the H_2 than would be saved by sticking with diesel fuel. If, however, H_2 production is powered by carbon-free sources like solar, wind, and nuclear, this eliminates its production carbon footprint.

VIII. Waste, Consumption & Natural Resources

Introduction

Addressing climate change and the pollution that harms our health and the health of our planet is urgent and necessitates acting upon many different sources of GHGs and climate effects. Much emphasis has been placed on changing our electricity, heating and fuel sources, which is vital. However, a rapid, appropriate response to the challenges of climate change requires looking as broadly as possible at many causes and solutions to identify the most impactful and feasible actions. This must be an inclusive process to be most effective, providing opportunities for all who wish to be involved to engage in ways that work for their interests, abilities and means.

To ensure that the LARES Task Force comprehensively addresses GHG reduction and climate change adaptation, the WCNR Subcommittee was formed to make recommendations on these focus areas:

- Waste management, recycling and composting
- Consumption of goods, food and services
- Refrigerants and other fluorinated gases
- Water and wastewater
- Natural spaces, soils, land use, forests, and carbon sinks

Numerous studies of cities around the US have shown that these sources of emissions are often 50% or more of a community's GHG footprint. In addition, addressing these areas not only provides opportunities for GHG reductions using existing technologies and approaches, but also enhancement of climate change resiliency and sustainability, economic benefits, and improvements to health, equity, environment and quality of life.

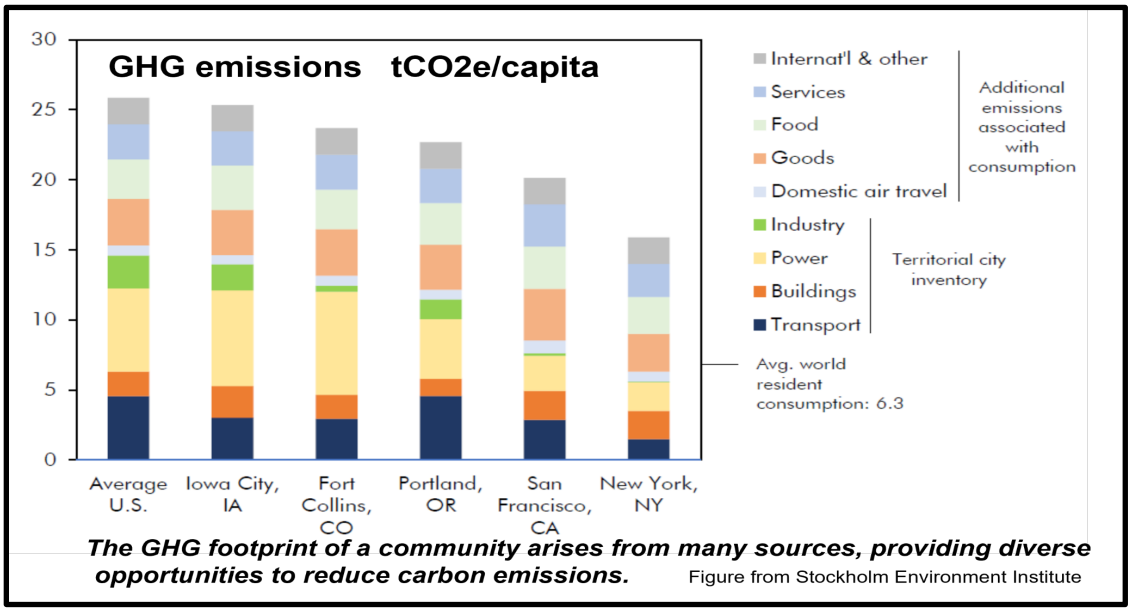


Figure WCNR-1. Estimated GHG emissions inventories for selected U.S. cities. Source: Stockholm Environment Institute.

Our approach has been to:

- Research significant sources of GHG emissions that fall outside the scope of other subcommittees, to enable more comprehensive accounting of Los Alamos' total carbon footprint, as well as opportunities for emissions reductions.
- Consult with County staff and leadership to understand their ongoing and future plans/work to address GHG emissions, waste, pollution, water quality/conservation and natural resource management.
- Investigate solutions that have been implemented in other communities to successfully address areas within the scope of our subcommittee.
- Identify additional areas that are critical to LAC resiliency and sustainability in the context of climate change as it is occurring and will occur in our region.
- Propose measures to reduce waste, pollution and GHG emissions and climate change impacts which are practically and economically feasible for County government, schools, businesses and residents.
- Begin a process to estimate costs and benefits of proposed GHG reduction and resiliency approaches, and identify short-, medium-, and long-term actions and goals.

Background

Specific background information is provided with each recommendation, along with data and references.

An excellent overview of diverse climate change solutions and their relative impacts can be found at Project Drawdown. A discussion of the inclusive approach to GHG and climate change mitigation taken by our subcommittee can be found in Jonathan Foley's article, "We Need to 'See the Whole Board' to Stop Climate Change"

Recommendation WCNR-1: Set a goal to eliminate municipal solid waste through reduction, reuse, recycling and composting (by e.g., 2035) following "Zero Waste" principles.

Time Frame: Immediate and long-term (using a stepwise approach to achieving goals within 10-15 years)

Background

Solid waste in Los Alamos is managed by the Los Alamos County Environmental Services Department (ESD). The ESD provides trash, recycling and yard trimming collection services to all residents and trash and recycling collection for commercial entities in the County. This includes 7,200 households, 333 commercial dumpsters in service and a 7 day per week transfer station operation. In 2019, residential waste collected represented 4,889 tons and commercial waste was 2,890 tons. In addition, municipal solid waste (MSW), which includes all commercial, residential and transfer station materials, was 16,509 tons and was shipped to the Rio Rancho landfill and disposed of at a cost to the County of approximately $1,000,000 in 2019 (including transportation and disposal.) The Rio Rancho landfill is predicted to close in the next 5-7 years and the next landfill will be further away and may increase the cost of hauling and disposal. The fact that disposal of waste currently costs the County around one million dollars a year, and that cost is likely to increase in the coming years, highlights the economic benefits of addressing this problem.

According to the US EPA, "Landfill gas (LFG) is a natural byproduct of the decomposition of organic material in landfills. LFG is composed of roughly 50% methane, 50% carbon dioxide and a small amount of non-methane organic compounds. Methane (CH_4) is a potent greenhouse gas 28 to 36 times more harmful than CO_2 (that is, more effective than CO_2 at trapping heat in the atmosphere) over a 100-year period. Municipal solid waste landfills are the third-largest source of human-related methane emissions in the United States, accounting for approximately 15.1 % of these emissions in 2019. The methane emissions from MSW landfills in 2019 were approximately equivalent to the greenhouse gas emissions from more than 21.6 million passenger vehicles driven for one year."

Mitigation of LFG can provide health benefits as well as reducing global warming. Landfill gas includes hazardous air pollutants that can increase the risk of cancer and cause respiratory issues. Recycling of materials vs. landfilling materials prevents emission of 2.94 metric tons CO_2 equivalent/ton of U.S. waste (EPA WARM, 2019). In 2021, recycling and composting by LAC ESD reduced GHG emissions from waste by over 5,000 tons CO_2e (vs. landfilling. See ESD Sustainability Report.)

The ESD and their associated Environmental Sustainability Board produced the latest version of the LAC Environmental Sustainability Plan in 2017. For the Los Alamos County waste recommendations, the LARES Task Force is recommending and reinforcing their Zero Waste approach. Zero Waste is a philosophical and programmatic strategy to minimize the environmental impact of materials disposal, a strategy employed by similar communities. In this

approach, all disposed materials from homes, businesses and County facilities would be reduced, reused, repurposed, recycled, or composted. This strategy includes a prioritized care of hazardous materials plan, so that disposal or recycling of these is done to have minimal (ideally zero) impact on the natural and human environments. In 2019, 21,194 tons of material, which included concrete and asphalt, yard trimmings, batteries, electronics, tires, pallets, metal, cardboard, glass, mixed recycle, oil and antifreeze, were diverted from the landfill (representing 56% of total material.). However, a significant amount of this material remains in the waste stream, and we pay for it to be shipped to our landfill in Rio Rancho. We need to find the gaps in this practice and build strategies to improve this.

In addition, LAC produces significant amounts of food waste. Food waste is one of the most important areas that needs to be addressed when it comes to resiliency and sustainability on a changing planet, and this is particularly true in New Mexico. Currently, 17% of our landfill waste is food waste. Los Alamos residents alone sent over 1.6 million pounds of food to the landfill in 2019, which may generate more than 4000 tons of GHGs. According to the ESD, 491 tons of food waste (37%) came from commercial enterprises and 831 tons (63%) came from residential homes. Reducing this will save the County a significant amount of money while also supporting food security for LAC residents and decreasing our own GHG and water use footprint.

Los Alamos County can be a leader in the work of Zero Waste through community commitment to reducing materials that end up in the waste stream, reusing or repurposing materials, and recycling. This is an innovative, socially connected community of scientists, nature enthusiasts, educators and people dedicated to service and innovation. With these attributes, we are well-poised to tackle the complexities and challenges of shifting toward a future that embraces Zero Waste practices.

Outcome

Elimination of municipal solid waste that is deposited in a landfill within the next 15 years.
Significantly reduced emissions from solid waste stream and transport of waste.

To do this, we need to set the following goals:

1. Increase diversion rate of materials to 90% of waste diverted from landfill within 7-10 years across the community (Municipal, residential, schools, commercial and industrial).
2. Reduce MSW generation per capita by 15% annually within 5 – 7 years.
3. Phase out sale and use of single-use plastics within 10 years (most of which are not readily recycled without significant environmental impact).
4. Eliminate organic waste going to landfill within 3-5 years.
5. Increase proportion of waste products and recyclables productively used or repurposed over time to 100% within 15 years.

We propose the following 10 strategies and accompanying tactics help meet these goals:

Strategy WCNR-1.1: Implement a Zero Waste approach (waste reduction, composting and recycling) at all County facilities, programs, schools, and household/business services.

Time Frame: Immediate and long-term

- Review policies and codes for opportunities to support Zero Waste goals around waste reduction, composting and recycling.
- Support the ESD in implementing County-wide composting, increased access to recycling, and producer responsibility practices.
- Include waste reduction strategies in disaster planning.

Strategy WCNR-1.2: Conduct Zero Waste education and outreach and provide programs, practices, and recommendations for individual, commercial and County/public entities to adopt this framework.

Time Frame: Immediate and long-term

- Support/incentivize local commerce innovations.
- Award local businesses with “Green Business” awards.
- Provide the support necessary to operate composting/recycling/waste reduction and promote Zero Waste education at all County events (concerts/parades/art fairs, etc.)

Strategy WCNR-1.3: Improve waste reduction and recycling practices.

Time Frame: Immediate and long-term

- Promote household education through the use of apps and programs like Recycle Coach.
- Improve recycling education to include environmental footprint, so people understand the percentage of materials that are transitioned to usable products.
- Look for ways to reuse materials that are generated in Los Alamos County.
- Support commercial recycling through policies, codes and services that improve recycling practices.
- Affix a sticker on every household recycling bin and trash can with visuals of what does and does not go in the bin. Many other places, including Santa Fe, do this. The photo below is from a household trash bin in Punta Gorda, FL.

Strategy WCNR-1.4: Support the ESD efforts to recycle refrigerants and improve refrigerant management and use by individuals, businesses and government operations.

Time Frame: Immediate and long-term

Background

Every refrigerator and air conditioner contains chemical refrigerants that absorb and release heat to enable chilling. Hydrofluorocarbons (HFCs), the primary replacement for ozone-depleting substances, spare the ozone layer, but have 1,000 to 9,000 times greater capacity to warm the atmosphere than carbon dioxide. The U.S. Environmental Protection Agency signed a final rule phasing down production and use of HFCs in September 2021. The State of New Mexico is currently formulating its own rules to phase out HFCs.

- Adopt policies and practices as outlined in Project Drawdown.
- Convene large entities using refrigeration (groceries, municipal government, schools, LAMC) to ensure proper maintenance/leak prevention and disposal procedures are in use.
- Support ESD's program to destroy/recycle refrigerants at end of life. Consider DPU participation in UAMPS' "See Ya' Later Refrigerator" program, which provides cash incentives to retire and properly dispose of old refrigerators and freezers. Facilitate transport of residential refrigeration units to Eco Station for proper extraction and disposal of HFCs.
- Educate regarding HFCs, options for purchasing non-HFC appliances, and ways to safely dispose of appliances at end of life. Consider local policy and practice recommendations to support state and national efforts to reduce GHG emitting refrigerants. (information here and national examples here.)

Strategy WCNR-1.5: Improve household hazardous waste reduction and safe disposal of environmental contaminants.

Time Frame: Immediate and long-term

Background

Household hazardous waste (HHW) includes cleaners, solvents, automotive fluids, batteries, garden chemicals, and other materials that pose hazards to solid waste workers and the public. Currently, this material sometimes inadvertently ends up in the landfill, even though the LAC ESD has programs to divert this material. Proper disposal is necessary to prevent injury, illness, or environmental contamination. The Resource and Recovery Act gives guidance and puts the regulation of HHW in the hands of local/regional and state governments**.** A safe and, ideally, circular economy for this material in Los Alamos is critical.

- Promote the reduction of County and community purchases of products that contain hazardous ingredients.
- Provide consumer education on currently available, viable alternatives to hazardous materials.
- Provide the support necessary for the ESD to continue to advance collection programs, events, and opportunities.
- Provide a visual on trash cans of what does/does not go in the cart.
- Utilize information resources from the EPA, NMED, and NM Recycling Coalition.
- Provide the support necessary for the ESD's ongoing efforts to reduce community single-use battery dependence, as well as recycling and disposal programs.
- Address the issue of harmful pesticide sale, use and safe disposal at both the County and community levels.

Strategy WCNR-1.6: Encourage recycling and repurposing of construction materials as well as housing conservation and refurbishing projects in Los Alamos.

Time Frame: Immediate and long-term

- Where possible, support the reuse/rehabilitation of existing buildings through renovation and refurbishment (vs. demolition/new build).
- Repurpose construction materials, for example purchase or donate to the Habitat for Humanity Re-Store.
- Consider the Sustainable Materials Management (SMM) approaches for C&D materials. SMM is a systemic approach to using and reusing materials more productively over their entire life cycles. These include:
    - Best practices for Reducing, Reusing, and Recycling Construction and Demolition Materials: Best Practices for Reducing, Reusing, and Recycling Construction and Demolition Materials | US EPA.
    - Design for Disassembly Design for Disassembly (DfD) - Construction Recycling.
    - NM Construction & Demolition Recycling Guide, C&D Guide 2010.
- Use reclaimed asphalt and concrete in projects in Los Alamos.
- Conduct a feasibility study of materials and waste exchanges through reuse centers, which are markets for buying and selling reusable and recyclable commodities.

Strategy WCNR-1.7: Increase organic waste prevention/diversion with a goal of 100% diversion of organic/compostable materials from the landfill.

Time Frame: Immediate and long-term

- Implement food waste composting, including policies for residential, County and commercial food waste reduction and composting. For example:
    - Restaurants and schools: compostable to-go containers and utensils
    - Households, apartments, schools and businesses will have compost pick up

    - More backyard composting kits with education outreach on wildlife safety
- Increase collection and composting of yard trimmings to recover 100% of materials. (Currently, 70% of households have yard trimming carts.)
- See WCNR Recommendation 2, Strategy #2 for food waste prevention strategies

Strategy WCNR-1.8: Reduce reliance on and use of single use items.

Time Frame: Immediate and long-term

Background

Single use plastics (info here) and Styrofoam represent a significant impact on the environment through GHG emissions during production, and air, water, and soil pollution. Local communities need to act at their level, while national action is also being considered.

The ESD/ESB in collaboration with County and community programs should develop a comprehensive single use materials plan including the following:

- Implement best practices that support reusable materials.
- Integrate water bottle filling stations throughout downtown.
- Conduct a community campaign to bring your own cups everywhere.
- Work with restaurants, grocery and food vendors to reduce the impact of "to go." Implement reusable "To Go" boxes.
- Consider a ban on single-use plastics for LA County.
    - This could be banning the sale and use on County land, including public events. It could be a more comprehensive ban on single-use plastics (no sale of or use in restaurants). These policies are being enacted globally and LA County could adopt a ban for 5-8 years from now to allow time for the community and local businesses to plan.

Strategy WCNR-1.9: Support reusing, repurposing and repair.

Time Frame: Immediate and long-term

- Create an exchange center for sharing of reusable household items. Support online groups (such as "Freecycle" and "Buy Nothing Los Alamos") for sharing of goods.
- Create/support a re-maker space (such as LA Makers) with community to fix and repair and trade. Host community "fix-it" days once or twice per year.
- Create a "tool library" from which residents can borrow tools
- Support resale/thrift stores, and reestablish a thrift store in White Rock.
- Support local rental and repair businesses.
- Incentivize businesses who bring these services to LA County.

Strategy WCNR-1.10: Beyond cradle-to-grave, fund/support "regenerative circular solutions."

Time Frame: Immediate and long-term

- Evaluate the use of anaerobic digesters for methane recovery from solid waste, to be refined and piped into other processes (heating, electricity generation).
    - Anaerobic digesters harness the power of microbes to transform scraps and sludge and produce two main products: biogas, an energy source, and solids called digestate, a nutrient-rich fertilizer.
    - A potential is the closed landfill. Rather than the current practice of flaring the methane gas and generating the associated air emissions, the landfill methane can be tapped, captured, and used as a fairly clean energy source for generating electricity or heat. The climate benefit is twofold: prevent landfill emissions and displace coal, oil, or natural gas that might otherwise be used.

Economic Impact

- **Costs & Savings:**
    - By moving to a circular economy on waste, there are increased job and industry opportunities. There is an added impact on County environmental services to manage and transport waste, but costs could be traded from landfill to diversion efforts. With a single use plastics ban there would be less burden to recycle that material - since there will be less of it - and this could go to municipal composting and industrial products recycle/reuse services. Businesses phasing out single-use items will save money.

Benefits Other than CO_2 Reduction

- Benefits will be reduced burden on environmental services to manage waste.
- Health benefits from reduction of hazardous waste, LFG and other pollutants
- Production of useful soil amendments from composting
- Potential for energy/heat generation from captured methane/anaerobic digestion
- Community building through sharing of goods
- Beautification of community through reduction of single-use item litter (bags, cups, etc.)
- Potential for job/business creation in resale, rental and repair

Challenges & Anticipated Barriers

- Planning for zero waste is an incremental process and the County will need to weigh the local community's desire for convenience against the cost of continuing to create the amount of waste that we are currently producing. Working with the community to assist with voluntary behavior change is always the best option, and having a commitment to zero waste practices as a County and encouraging our industry and business partners in the community is of utmost importance.

- Where policies can be implemented to reduce the burden on the individual consumer, these should be implemented.

Community Outreach

The LA County Zero Waste Team and the ESB have a comprehensive community education and outreach plan. Leveraging the plan along with some educational funding we can continue to engage, learn and adapt to new ways of consuming as well as greatly reducing our waste production.

Examples in Other Communities

Los Angeles County Sustainability Plan

EPA Website on Zero Waste

Fort Collins, CO Road to Zero Waste

Marin County, CA Zero Waste

References & Resources

MIT Science Policy Review: Institutions and governments can slow climate change by regulating and reducing halocarbon refrigerant use

Challenges and Recommended Policies for Simultaneous Global Implementation of Low-GWP Refrigerants and High Efficiency in Room Air Conditioners

Sustainable Materials Management, US EPA Website

Project Drawdown Solutions

New Mexico Environment Department, Waste Management Website

New Mexico Recycling Coalition

Protecting Our Climate by Reducing Use of HFCs, EPA Website

How Does Anaerobic Digestion Work?

US EPA Landfill Methane Outreach Program (LMOP)

Recommendation WCNR-2: Reduce consumption-associated greenhouse gas emissions through sustainable purchasing and consumption/disposal of food, goods, and services.

Time Frame: Immediate and long-term (using a stepwise approach to achieving goals within 10-15 years)

Background

Across the US, everyday choices made by individuals, businesses and governments account for a large portion of GHG emissions. While behavior change in isolation cannot eliminate emissions, actions taken voluntarily at household and local levels can significantly contribute to overall emissions reductions and can do so immediately, equitably and in the absence of State or Federal policy.

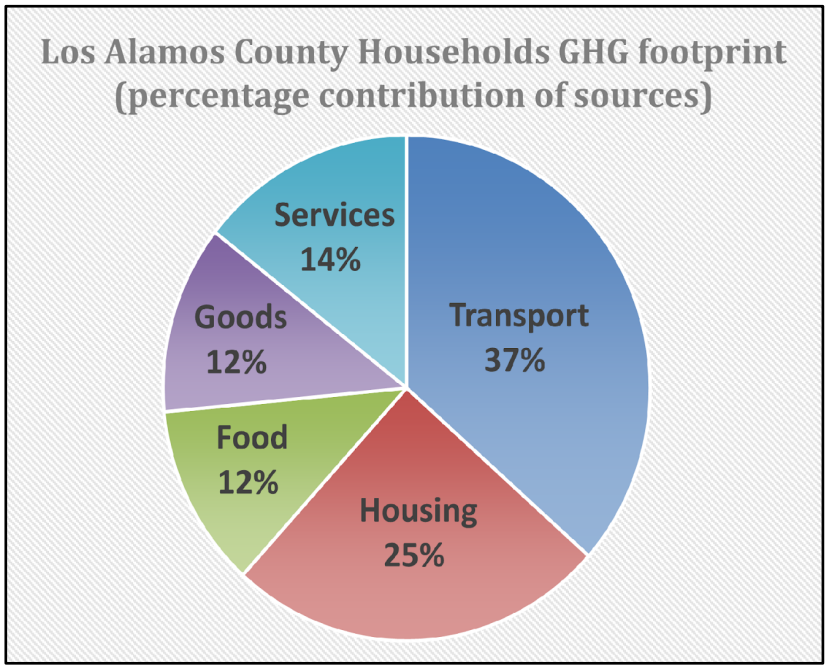


Figure WCNR-2. Graph based on data from Christopher M. Jones and Daniel M. Kammen, Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density.

Project Drawdown's Solutions Analysis indicates that "individual and household actions have the potential to produce roughly 25–30 percent of the total emissions reductions needed to avoid dangerous climate change (>1.5°C rise)."

The Intergovernmental Panel on Climate Change (IPCC)'s Assessment Reports highlight the considerable influence of behavior, lifestyles and culture, including consumption patterns and dietary changes, on emissions. The most recent Report recognizes that, "The consumption patterns of higher income consumers are associated with large carbon footprints," and, "The top 10% emitters (the global wealthiest 10% on a per capita basis) contribute 10 times as much to global emissions as the poorest 10%." (Note: LAC median household income of $121k places us in the top 10% globally).

Recent data show that individuals with high-carbon lifestyles can cut their emissions by 50% in less than a single year with maintained or enhanced quality of life.

Many people would like to reduce personal emissions, but understanding of these sources, and how to reduce them, is often limited. Individuals and entities have different desires and capabilities for reducing their carbon footprint and should have choices in how to do so. Taking action is an important way to reduce personal anxiety about climate change, and has been shown to promote support for policy and systems change.

GHG emissions resulting from the purchase of food, goods and services consumed in Los Alamos, although they are often produced outside of the County, likely make up a substantial portion of carbon emissions for which we are responsible.

Production of new material goods results in considerable embedded/embodied carbon emissions (total GHG released during manufacture, transport and sale) and other impacts. Young adults in particular are interested in making durable, local and "green" purchases, reducing waste and saving money through repair, reuse and sharing of goods.

According to the United Nations (UN), food systems are responsible for at least one-third of global greenhouse gas emissions, The US is among the top emitters. Dietary choices and food waste have substantial impact on these emissions.

Local services produce 2-3 times fewer emissions per dollar than goods, while supporting businesses and building community.

Air travel and construction materials also have large associated GHG emissions.

Outcome

- Extensive public education campaigns will result in greater community understanding of important sources of GHG, where they occur in daily life, and the options available to reduce them. Material and social incentives are provided to help engage the community.
- Increased local sharing, rental, refurbishment, reuse and repair of material goods permits residents to reduce purchase of new goods. Residents build community connections and local resilience while supporting local businesses, saving money and reducing waste to landfill.
- Residents, restaurants, groceries and schools understand the costs of wasting food, and are given easy-to-implement ways to reduce food waste and divert edible food to food banks. Residents are empowered and encouraged to shift to diets with a higher share of plant-based protein, resulting in improved health and cost savings. Schools participate in this, helping to educate children to make healthier choices around food.
- Residents reduce air travel emissions by changing travel habits. Businesses and municipal government support methods for employees to work without long-distance travel to meetings.
- Personal understanding of GHG sources promotes educated civic engagement regarding other local, regional and national climate change initiatives.
- Opportunities are provided and supported for **all** residents and entities to participate in climate change actions of their choosing, suited to their interests, means and resources.
- County departments lead by example through environmentally preferred purchasing and by utilizing lower carbon building materials in construction projects.
- In addition to reducing GHG emissions, these actions also help address other issues, such as physical and mental health, community resilience, equity, waste and food insecurity.

Case Study/Public Education

The production and disposal of food accounts for as much as one-third of anthropogenic GHG emissions. Environmental Services data show that residents purchase significantly more food than they use, sending nearly 100 lb. of food per person per year to the landfill as waste. Since 2016, Environmental Services and Zero Waste Team have implemented an extensive outreach program ("Save the Food") to reduce food waste in all sectors of the community (residents, retail, restaurants and schools.) LAC County Council approved funding for this program in 2019, which enabled expansion of efforts. To date, the program has reached dozens of businesses and schools and thousands of residents, providing them with information and tools to prevent food waste and save money.

Strategy WCNR-2.1: Education and Community Involvement

Time Frame: Immediate and long-term

- Develop/aggregate online resources for use by the community to explore GHG footprints and mitigation actions. Publicize this widely as a "One-Stop for Reducing your Carbon Footprint" (perhaps as part of a larger "Sustainable Living" web resource).
- Research and evaluate existing carbon footprint calculators and accompanying information on GHG reduction actions and engage community in using them to estimate GHG emissions. Consider providing calculator URLs/links on utility bills and many other relevant publications.
- Develop/Implement "Los Alamos Carbon-Free Challenge" and other campaigns to engage the community in reducing GHG emissions. These campaigns will include education, social engagement, and competitions, and involve youth, adults, businesses, and local government employees.
- Provide personalized GHG emissions information, available on bills and online, based on customer utility use from Smart Meters, so households and businesses can see their GHG impacts as well as understand how their energy/NG/water consumption compares with others in the community. Include relevant suggestions on how to reduce usage in ongoing DPU communications.

Strategy WCNR-2.2: Addressing Food Waste and Food Choices.

Time Frame: Immediate and long-term

Reduce the wasting of food and promote a shift towards healthy, lower-carbon (more plant-based) food choices through educational outreach and support to residents, schools, restaurants and businesses.

- Continue and expand Environmental Services' "Save the Food" food waste reduction campaign to involve all residents, businesses, schools and other entities. Engage groceries, restaurants and other food-related businesses in "point-of-sale" information campaigns. Support food rescue groups and food banks. Facilitate "gleaning" to channel surplus produce from home and commercial gardens to food banks.
- Leverage the buying power of government, schools and community organizations to purchase and serve low-carbon, minimally processed foods. Promote better food choices through nutritional and health counseling programs, and LAPS/UNM-LA youth education. Support Farmers' Markets, home gardening and community/school gardens.

Strategy WCNR-2.3: Addressing Material Goods.

Time Frame: Immediate and long-term

- Promote a "circular economy" for material goods, emphasizing reuse, rental, repair, refurbishment, sharing and recycling. See WCNR Recommendation 1, Strategy 9 for more details.
- Assess current green purchasing policies used in County government and schools. Implement "Green"/environmentally-preferred purchasing policies (such as LANL uses) requiring GHG emissions criteria to be considered in all purchases and contracts. Adopt policies that require justification away from the least polluting purchase, otherwise the least emitting equipment and processes must be purchased. Increase the level of justified costs beyond the current 5%. Recognize the power of municipal government services and schools to "lead by example" in promoting sustainable community behaviors.

Strategy WCNR-2.4: Addressing Services.

Time Frame: Immediate and long-term

- Promote services, entertainment and social activities downtown and throughout the County, and encourage "gifting" of services, which have lower carbon footprints vs. material goods.
- Encourage reduction in air travel through promotion of local/regional travel, and options for businesses and LAC staff to conduct work without travel to meetings etc. Educate regarding how to reduce GHG emissions from air travel (take direct/daytime flights, fly economy class, choose airlines using biofuels, purchase carbon offsets, etc.)

Strategy WCNR-2.5: Addressing Construction Materials.

Time Frame: Immediate and long-term

- Shift to lower-carbon construction materials (low-carbon cement, supplementary cementitious materials, warm mix asphalt, etc.) and reduce use of virgin concrete, steel and asphalt through education, increased availability of alternative and recycled materials, and possibly building code adjustment. Consider requirements for use of low-embodied carbon materials in all municipal construction.

Examples in Other Communities

- Park City, UT implemented a public education campaign entitled "Low Carbon Diet", which included a workbook and online resources to guide households through a variety of conservation and efficiency measures with the end goal of reducing CO_2 emissions by at least 5,000 lbs per person.
- Since 2011 The City of Paris, France has used its Health Nutrition Program to encourage residents to consume healthy, local, low-carbon foods. Minneapolis, MN schools developed "True Food, No Waste", a comprehensive food waste reduction plan for all Minneapolis Public Schools. New York City's "Meatless Mondays" program in all public schools provides students with healthy, all-vegetarian breakfast and lunch menus every Monday.
- Portland, OR's "Be Resourceful" campaign focuses on connecting residents to information and resources to get things they need through reuse, repair, renting and sharing, as well as "buy smart" strategies (plan purchases, buy low-C goods, buy durable goods, gift services, etc.)

  Colorado recently passed "Buy Clean Colorado" legislation, which requires that future public construction projects will have to meet clear GHG criteria for the use of seven common construction materials.

Economic Impact

- **Costs:**
  - Funding for educational outreach to the community including staff time, advertising, purchase of incentives ($1-5 per resident). Funding to include GHG emissions information as part of Smart Meter utility usage reporting to customers.
  - Shifting to higher quality, lower carbon food and goods may have higher up-front costs.
  - Purchasing and utilization of lower-carbon materials and contracts by County government and schools will require staff time to research, and may be more costly.

- **Savings:**
  - Conservation of energy, natural gas, and water and reduction in waste production will save residents and County services money.

- Reducing food waste can save the average family of four $1600/yr or more. Since food waste makes up 17% of what we send to the landfill, prevention of this waste reduces Environmental Services costs. Shifting to a lower carbon diet with greater consumption of plant foods can have numerous health benefits and attendant savings. Reducing meat, dairy and fish purchases can result in significant savings.
- Purchase of more durable goods, and increasing rental, repair, sharing and reuse of goods, can all save residents money, and reduce County disposal costs. Promotion of rental, repair and resale businesses and other services keeps dollars local.
- Local/regional travel (vs. overseas) can save vacation costs and support local tourism economy. Reduced business travel can result in significant cost savings.
- Use of reclaimed/recycled building materials and/or repurposing of existing buildings may save on construction costs. The EcoStation already collects construction debris, reuse of this would create a local market for that material.

Benefits Other than CO_2 Reduction

- Helping residents learn about their own carbon footprints raises awareness and inspires choice in actions to take in reducing emissions, customizable to household/business budget, capabilities and resources. Actions taken to reduce carbon footprint often also result in more mindful decision-making for water conservation, waste reduction, and other environmental benefits.
- Engaging residents in action-oriented GHG reduction campaigns builds community cohesion, educates and reduces anxiety regarding climate change, sustainability and resiliency, and encourages involvement in wider social and policy action.
- Support of local/regional agriculture and home gardening can lead to health improvement, air/water/land pollution reduction, and increased resilience and self-reliance. Increase in donations to food banks reduces food insecurity.
- Promotion of sharing enhances social connection and community. Reduced consumption of new goods conserves water, minerals, fossil fuels, labor, capital, etc. Shift to use of services over purchase of material goods supports local businesses. Increased repair and reuse skills and services enhance individual and local resourcefulness and self-sufficiency.
- Reduction of air travel supports the local travel and tourism industries.
- Reuse of reclaimed construction materials reduces landfill waste and use of virgin resources.

Challenges & Anticipated Barriers

- Educating and engaging a large percentage of the community can be difficult, but is achievable with diverse effort sustained over time.
- Since food is wasted at many points during its use, addressing all of these requires several behavior changes that may be inconvenient (meal planning, proper storage) or unwanted (eating leftovers.) Food choices are influenced by many important factors (culture, habit, economics, personal preferences), and shifting these can be difficult. Many high carbon foods (meat, dairy, etc.) and processed foods are heavily subsidized and sometimes less expensive than low-carbon plant foods.

- Purchase of new material goods can be more convenient than fixing existing goods or seeking out used materials. LAC lacks many options for repair or rental of goods. Some residents may feel that new goods are "better" than used. Advertising culture and retail merchants promote excessive consumption.
- Options for long-distance travel from New Mexico, other than by air, are limited.
- Availability of low carbon and/or recycled construction materials may be limited. Local contractors may lack knowledge of how to use low-carbon materials.

References & Resources

Project Drawdown provides data and solutions for over 100 GHG sources. For example, it lists "Reduced Food Waste" and "Plant-Rich Diets" among the top four solutions having the most impact in reducing emissions worldwide. See also The Powerful Role of Household Actions in Solving Climate Change. The current program, Regeneration, provides a comprehensive website of climate change causes and solutions (implementable at every level of society).

Several household carbon footprint calculators are available, and most incorporate suggestions on actions to take to lower emissions. These include web-based calculators (CoolClimate, Footprint Calculator), as well as phone apps (Earth Hero).

Resources for carbon footprint estimation and mitigation for schools, businesses, local government and other entities are available. For youth: Kids Calculator - Park City For businesses: Carbon Footprint Calculators for Businesses, Green Places | Erase Your Company Footprint and CoolClimate Calculator.

Several platforms are available for community-wide engagement in GHG reduction initiatives, including BrightAction and EcoChallenge. These are customizable for a community's needs (see Eugene (OR) Carbon Free Challenge). National/international community platforms include the UN's A World in Support of Act Now and Count Us In.

The USDN Sustainable Consumption Toolkit provides extensive resources to advance sustainable consumption in cities including a "Smart Shift" guide to help local governments promote sustainable consumption.

1.5-Degree Lifestyles: Targets and options for reducing lifestyle carbon footprints. 2019. Institute for Global Environmental Strategies Aalto University and D-mat ltd.

The UN's EAT-Lancet Planetary Health Diet outlines changes to the food system that reduce GHG emissions substantially, while improving human health.

IPCC, 2019: Summary for Policymakers. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*

The EPA's From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste reveals the climate and environmental impacts of producing, processing, distributing, and retailing food that

is ultimately wasted. LAC Environmental Services Food Waste Prevention webpage contains information on food waste and how to prevent it. The US EPA's "Sustainable Management of Food" page also has many helpful resources on food waste reduction.

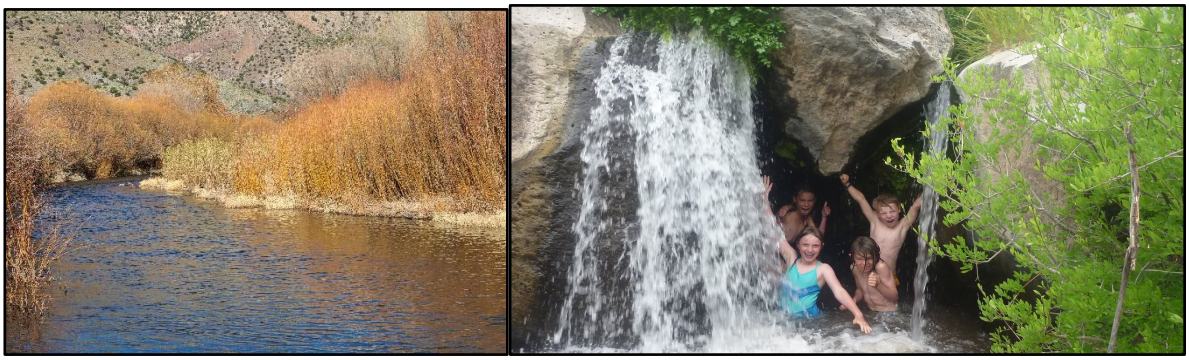
LANL has a Green Purchasing and Green Technology policy. The West Coast Climate Forum's Climate-Friendly Purchasing Toolkit provides guidance on specific purchasing strategies to reduce local governments' carbon footprint.

Article on GHG emissions from air travel, and how to mitigate: Flying Is Bad for the Planet. You Can Help Make It Better. (Published 2017)

Five Key Ways to Reduce GHG Emissions in Building Construction

HB21-1303: Global Warming Potential for Public Project Materials which limits the global warming potential for certain materials used in Colorado public projects.

Annually since 2017, LAC Environmental Services and the Environmental Sustainability Board have conducted a community-wide "EcoChallenge," which has engaged hundreds of residents in reducing their environmental footprints.



Recommendation WCNR-3: Develop and adopt a comprehensive water conservation and watershed stewardship plan to maintain and enhance the quality and quantity of LAC's water supply.

Recommendation WCNR-4: Develop and implement a plan to capture stormwater runoff and reduce contamination through green infrastructure approaches.

Time Frame: Immediate and ongoing (for both WCNR-3 and WCNR-4)

Background

Reliable, safe water is essential to Los Alamos County's continued tenure on the Pajarito Plateau. We have been experiencing increased warming, shorter winters, less snowpack, and subsequently, reduced surface water. This has resulted in a severe long-term drought in New Mexico and Los Alamos County. Like many communities in New Mexico, we are experiencing a population increase and expanded private and commercial development in our community. These factors place increasing pressure on our water supply. LANL studies indicate that levels in our aquifer are declining by as much as 6-12 inches per year. As we increase reliance on an ever-diminishing supply of groundwater, we face long-term problems with sustaining our community and short-term problems with increased pumping costs (Reference: Long-Range Water Supply Plan for Los Alamos County [LRWSP], 2018).

In addition, climate change is causing important weather pattern variability in NM and this is expected to continue to increase the severity of some monsoon storms. Drought and fire have impacted our landscape and increased storm severity will continue to cause flooding and topsoil, as well as contaminant, runoff from our community and LANL into the watershed. Our community is contending with LANL legacy wastes as well as toxins from residential, business and municipal use of herbicides, pesticides, and other chemicals. Runoff of these materials poses a threat to the health of communities and environment at home and downstream along our watershed and the Rio Grande Valley. To address/mitigate these issues, the Los Alamos's LRWSP has stated that, "Stormwater management is a key issue for the County and LANL." We agree and encourage LAC leadership and the County Council to work on a comprehensive plan that takes future weather and drought and loss of nature from fire into consideration in that plan.

We want to highlight Section 502 of the Clean Water Act which defines green infrastructure as "...the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters." Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. Research and monitoring should be conducted to fill knowledge gaps and enhance planning capabilities. Addressing storm water through a comprehensive stormwater runoff program that includes permaculture strategies will give us the opportunity to prevent contamination of our watershed, as well as improve our land and soil quality and create and support the Los Alamos and White Rock microclimates.

Outcome

- Preservation of critical water supply quantity and quality.
- Reduced need for location and development of new, deeper water wells and expensive development of (dwindling) San Juan-Chama water resource.
- Potential for replenishment of aquifer through surface water infiltration and recharge.
- Reduced maintenance and operational costs of water, sewer and water treatment infrastructure.
- Increase in drought-friendly watering options for irrigation of landscapes, gardens, parks and recreational areas, and other non-potable uses.
- Reduced runoff of contaminants into stormwater, aquifer, local landscapes and canyons, Rio Grande, and downstream communities. Health and environmental benefits as contaminants are reduced.
- Improved water monitoring and ability for proactive approach to minimize pollution.
- Ability to show if certain actions give measurable results such as any relevant clean-up work or any reductions in chemical use.
- Public confidence in water safety.

Strategy WCNR-3.1: Conduct regular (annual) updates of the DPU Energy and Water Conservation Plan including ongoing analysis of projected climate change impacts and provide revised goals and policies that mitigate those impacts to water supply and quality.

Time Frame: Immediate and ongoing

- Ensure that the LAC Long-Range Water Supply Plan provides guidance on how to monitor and integrate climate change information into water supply planning and is updated regularly.
- Incorporate findings of the New Mexico 50-Year Water Plan, a new analysis of the projected climate change induced impacts on water resources to 2070.
- Support and enhance DPU goal for FY 2022 to reduce consumption by 12 percent by 2030 using 2020 calendar data as a baseline. As a goal is attained, set new goals for conservation.

- Provide our smart meter data on water usage to organizations working on water conservation and sustainability like https://newmexicowaterdata.org and similar initiatives to increase knowledge and solutions.
- Prioritize and increase funding to education outreach organizations like PEEC.
- Support recommendations of 2020 BPU Conservation Committee for incorporation into revision of Energy and Water Conservation plan, along with previously identified Plan goals.
    - Many possible strategies to reduce water use have been identified by consultants, DPU, BPU and the 2020 Conservation Committee. Use polls and other outreach tools to identify those which are most likely to be embraced by the community and integrate with water use reduction potential and cost estimates, to prioritize actions. Consult with Coalition of Sustainable Communities NM and plans from other communities for further guidance and lessons learned. Revisit progress on these goals annually and refine as indicated.
    - Since residential water use (particularly landscaping and water appliances/fixtures) are the biggest contributors to water use, focus on customer education, incentives, and rebates to reduce water use.

Strategy WCNR-3.2: Encourage and support greater use of greywater, reclaimed water and rainwater for residential, business, and municipal purposes, to reduce use of drinking water for landscape maintenance.

Time Frame: Immediate and ongoing

- Implement gray water policies and build capacity to help our community safely use gray water and rainwater for irrigation and other non-potable uses.
- Support water harvesting through education, incentives, and code changes (if needed).
- Employ reclamation and use of greywater/rainwater at County facilities and schools, to educate and lead by example.
- Prioritize chasing funding for water conservation and sustainability measures as a County. Explore state and federal funding to build and support infrastructure to use treated wastewater to supply County and school land and fields, and other residential, business and LANL uses. DPU already has much of the needed infrastructure in place for reclaimed water use and needs outside funding to enable usage at White Rock schools, Pueblo Complex sports fields, Urban Park, High School and UNM-LA practice fields.
- Evaluate all current County water related practices and implement effective water conservation and sustainability changes.
- Prioritize professional evaluation and optimization of Golf Course turf management and design to reduce water use.
- Address the problem of fire hydrant testing which targets a flow of 1500 gallons per minute for each hydrant, resulting in thousands of gallons of potable water per hydrant that is currently being flushed down the drains. There are over 9,000 fire hydrants in Los Alamos County. Possible change is to have hydrant testing water collected during test and used elsewhere.

- Update Los Alamos County Non-Potable Water System Master Plan (2013) to incorporate climate change effects, post-fire changes to landscape and water, and changes to water infrastructure (including WR Water Resource Recovery Facility).
- Identify new opportunities for reclamation and reuse of non-potable water.

Strategy WCNR-4.1: Use well-established stormwater capture methods to reduce stormwater runoff, and test and record quality of stormwater runoff and aquifer.

Time Frame: Immediate and ongoing

- As part of a comprehensive stormwater runoff program that includes permaculture strategies, create Low Impact Development Controls (LIDs) using established retention, detention, and water quality testing.
    - These techniques can help to develop a soil matrix that provides filtration and reduces the rate of flow and allows for deep infiltration to prevent contamination of our watershed and aquifer, as well as improve our land and soil quality.
- Consider partnering with LANL for local/regional water management to collaboratively implement the EPA best practices for stormwater runoff (National Menu of Best Management Practices (BMPs) for Stormwater | US EPA) and work toward improved quality and quantity solutions.
- Educate the community about runoff issues, pesticide/herbicide/etc. reduction, not dumping antifreeze down the sewer, etc.
- Hire an environmental consultant for proper stormwater capture, testing and database setup.
- Develop programs, policies, and practices that encourage local facilities, businesses, residents, and stakeholders to integrate natural systems with vegetation and soils for use in the capture, slowdown, and filter of stormwater runoff (e.g., swales, French drains, rain barrels, green roofs, rain gardens, etc.).

Examples in Other Communities

- Los Alamos, NM: DPU has set and successfully achieved a goal of reducing water use by 12% through use of reclaimed water as well as residential water conservation.
- Santa Fe, NM: City of Santa Fe Water Conservation and Drought Management Plan 2015: 2020 Addendum
- Albuquerque, NM: Conservation & Rebates Overview – Albuquerque (Bernalillo County) Water Utility Authority
- Farmington, NM: Stormwater Management Plan
- Boulder, CO: Sustainability Plan, Chapter 8: Water
- Portland, OR: Stormwater Management Manual

Economic Impact

- **Costs:**

- Funding for consultant (or staff time) to incorporate climate change impacts and mitigation into DPU Energy and Water Conservation Plan
- Staff time and materials for education/outreach
- Funding to PEEC for expanded water conservation education
- Programming for billing system to tell customers about comparative use
- Reduction in tax and permit revenue (if not increasing tax assessment or charging permit fees for conservation improvements)
- Potential loss of water service fee revenue
- Staff time for water monitoring (or outside contractor)
- Water quality testing
- Cost for incentives and/or rebates for fixtures, appliances, and other equipment
- Comprehensive storm water program for Los Alamos and White Rock with LIDs would need to be developed.

- **Savings:**
  - Substantial savings possible due to decreased need for new well drilling, development of San Juan-Chama water resource, infrastructure maintenance and improvement, and wastewater processing. Potential for avoidance of NMED fines for non-compliance with water use and quality regulations.
  - Water use savings for residents and businesses.

Benefits Other than CO_2 Reduction: see "Outcome" section (above)

Challenges & Anticipated Barriers

- Costs as listed in 'costs' above
- Unique geographical and soil type challenges of our area and location
- Development and implementation of comprehensive stormwater capture program is complex
- Community and County staff education will need to be extensive and ongoing
- State and Federal funding to support expanded use of reclaimed water may be difficult to obtain

Public Educational Materials

- Public education by PEEC regarding water conservation, Water Festival, rainwater harvesting etc. Similar but higher funded and more focused resource in local area: https://savewatersantafe.com.
- Education through DPU as well as ESB, PRB.

Case Study

What is Green Infrastructure? U.S. EPA Resources, Initiatives, Case Studies.

References & Resources

2021 Survey of DPU Environmental Goals

Basic Information about Water Reuse, US EPA Website

BPU Conservation Committee Report, July 2020

Erosion 101: Everything You Need to Know About Soil Erosion

Future water resource shifts in the high desert Southwest of Northern New Mexico, USA

FY 2020 DPU Annual Report

Industrial Stormwater Monitoring and Sampling Guide , US EPA

LAC DPU 2015-2019 Energy and Water Conservation Plan

LAC Long Range Water Supply Plan, 2018

Los Alamos County Non-Potable Water System Master Plan

National Research Council 2007. *Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory: Final Report*. Washington, DC: The National Academies Press. New Mexico 50-Year Water Plan

US Federal Archives: Notice of Availability of Final Designation of Certain Stormwater Discharges in the State of New Mexico Under the National Pollutant Discharge Elimination System of the Clean Water Act

What You Can Do to Soak Up the Rain, US EPA Website

Recommendation WCNR-5: Manage natural and community landscapes for climate mitigation, resiliency, community, cultural and wildlife values, and carbon sequestration.

Time Frame Immediate and ongoing

A fresh snowfall on Los Alamos and Santa Fe.

Background

Los Alamos County is blessed with abundant natural areas within and beyond its borders, and preservation of that space is a top priority of residents. Climate change has already altered these areas in numerous ways, and will continue to do so as drought, temperature increase, changes in precipitation timing and amount, and other effects progress. Ongoing, proactive management, especially in the areas of fire prevention, forest restoration, soil health, and habitat preservation, are critical. In addition, population expansion will place mounting pressure on natural areas through increased development, recreation, and indirect effects such as habitat fragmentation. How we manage these lands through these changes will profoundly affect the quality of life for all who live here.

Our natural spaces also have the potential to mitigate climate change effects, reduce our greenhouse gas emissions and improve our resiliency to future changes. The US EPA estimates that land management is associated with 16% of US GHG emissions, while the land-based carbon sink is equivalent to 13% of emissions. Carbon sequestration in soil, trees and other vegetation is recognized as a critically important natural process that significantly reduces global GHG levels. With 4000 acres of open space, much of it forested, Los Alamos County contains abundant potential for carbon storage, along with other ecosystem services. Vegetation and soils in urban and other developed areas can play a role, too, both in carbon sequestration and in resiliency to climate change effects. Careful management of all our outdoor spaces incorporating best practices for carbon reduction, soil and water retention, habitat preservation, human health and wellbeing, recreation and future resiliency should be a key aspect of our planning for climate change.

Outcome

- LAC Open Space Management Plan, as part of Community Services Department's (CSD) Integrated Master Plan, is revised and updated to comprehensively address land use practices and proactively describe actions to be taken to mitigate predicted climate change effects.
- Residents, businesses, schools and County employees take stewardship of our lands and actively participate in enjoying, maintaining and enhancing our natural environment.

- Residents, businesses, schools and County are given information, incentives and tools to support best practices for landscape management under climate change.
- Improved management of natural and urban areas, informed by predicted climate change effects, reduces wildfire risk, and enhances forests, recreation, open space, neighborhoods and downtown areas.
- Increased carbon sequestration within County areas makes attainment of net-zero-carbon goal more feasible.

Case Study

Graduation Canyon Restoration Project

Strategy WCNR-5.1: Update, expand and implement LAC Open Space Management Plan (2015) to include understanding of projected climate change impacts (similar to LAC Long-Range Water Supply Plan) and potential for carbon sequestration on County open space lands.

Time Frame: Immediate and ongoing

- Evaluate possible adaptation actions that can help sustain healthy ecosystems and achieve management goals in the face of climate change.
- Prioritize professional evaluation and optimization of Golf Course turf management and design to reduce water use and encourage regeneration of sustainable organic subsoil to maintain lower water needs going forward.
- Together with experts and stakeholders, revise Plan to mitigate projected environmental changes.
- Regularly review and proactively update Plan and strategies as conditions change and lessons are learned.
- Consider creation of an "Urban Landscape Plan" which addresses management of downtown and residential areas and encourages stewardship of mature trees, fire prevention, climate-wise landscaping, beautification, wildlife protection and other practices that enhance climate resilience and resident well-being.
- Ensure that strategies and actions identified in Plan are implemented in a timely manner.

Strategy WCNR- 5.2: Advance policies, plans, and best management practices for improving soil health.

Time Frame: Immediate and ongoing

- Promote policies for residential, school, municipal and business properties which:
- Encourage lawns and landscaping that adhere to permaculture practices, and include a diverse mix of native plants and grasses.

- Address monoculture turf lawns that require added water to grow, and have the secondary problem of needing chemical fertilizer that contributes to ground and surface water contamination.
- Locate and address large areas of gravel, pavement, or concrete that contribute to storm water runoff.
- Encourage biodiverse landscaping with drought-tolerant plants that maintain healthy soil and support biodiversity along the food chain. This does not mean overgrown, unmanaged front yards. Pollinator gardens and cover crops can be made to look organized and intentional. Well-kept native plants should not have height restrictions or be considered weeds.
- Encourage vegetable gardening and composting of food and plant material:
    - For backyard composting, it may be necessary to recommend fencing adequate to exclude large wildlife.
    - Implement community composting (see Strategy WCNR-1.7)
    - Encourage and offer training in composting and urban gardening methods.

Strategy WCNR-5.3: Support broad education and implementation of Integrated Pest Management strategies across LAC.

Time Frame: Immediate and ongoing

- Implement training and support for relevant County departments including Parks and Recreation, Public Works, and Environmental Services, Code Enforcement, Public Utilities, and any related citizen boards and commissions that set standards for policy and practices. Encourage regular, structured communication between County departments and citizen boards and commissions, in order to have consistency in creating and enforcing policies and code requirements.
- Support local residents in implementing Integrated Pest Management strategies through education on best practices and the safety and environmental consequences of using pesticides.

Strategy WCNR-5.4: Continue and expand ongoing practices for wildfire mitigation, habitat restoration, wildlife corridors, landscape preservation, recreation enhancement, etc.

Time Frame: Immediate and ongoing

- Fuel mitigation on public and private lands, wildfire preparedness, post-fire recovery actions
- Continued support for Rio Grande Water Fund efforts to maintain forest health and recovery in the Jemez Mountains
- Canyon restoration projects
- Engagement of youth and community members in conservation projects
- Maintenance and improvement of County trails and other recreation areas

- Supporting state and national "30 by 30" initiatives to conserve 30% of natural areas by 2030, preserving natural areas where possible.

Strategy WCNR-5.5: Review LAC Comprehensive Plan to ensure that it is compatible with identified goals for GHG mitigation and climate change resilience.

Time Frame: Immediate and ongoing

- Concentrate new development within, or adjacent to, existing developed areas. Limit or curtail development within forested areas to prevent habitat fragmentation and tree loss, and to reduce fire risk to homes. Require developers to minimize forest loss and other environmental disturbances. Plan for restoration of landscape disturbance after development.
- Proactively address land use for any planned transfer of DOE property to County, to ensure that landscape health, fire mitigation and cultural, recreational and environmental assets are preserved.

Strategy WCNR 5-6: Work with NMSU Extension, Master Gardeners, foresters, ecologists, landscapers and others to inform climate-wise landscaping recommendations for residential and County developed areas.

Time Frame: Immediate and ongoing

- Research and evaluate xeriscaping vs. natural landscaping recommendations for home and municipal landscaping, balancing water use with other goals such as water retention, carbon accumulation in soils and vegetation, tree canopy preservation and habitat restoration.
- Provide education, resources and incentives to homeowners for landscaping and property maintenance.
- Update County landscaping program to include climate-wise practices when maintaining, renovating or installing new municipal landscaping.
- Partner with and educate local landscaping companies to promote sustainable, climate-informed practices.

Strategy WCNR 5-7: Estimate carbon sequestration potential for LAC undeveloped areas and landscapes.

Time Frame: Immediate and ongoing

- Research and identify approaches for estimating CO_2 production and sequestration in County natural spaces, including undeveloped open space, parks, and other large spaces.
- Carbon capture can be enhanced by forest management practices that enhance tree growth and minimize tree decomposition.

- Carry out carbon source/sink estimate, using County staff or consultant.
- Use data in creation and revision of Open Space Management Plan as part of CSD Integrated Master Plan and other County efforts that impact natural spaces.
- Use estimate in calculation of progress on net-zero goal.

Examples in Other Communities

- Albuquerque, NM: The Nature Conservancy is partnering with the City of Albuquerque Parks and Recreation Department, Albuquerque Bernalillo County Water Utility Authority, Tree New Mexico, State Forestry, and Bernalillo County Parks and Open Space Division. They are working to get people involved in planting new trees, caring for aging trees and tracking progress to a cooler, healthier Albuquerque. So far, 6874 trees have been planted, many by volunteers. The Water Authority offers a 25% "Treebate" on water bills for planting selected tree species.

- Fort Collins, CO: Ft. Collins's "Nature in the City" program is developing a connected network of nature for people and wildlife on public and private lands in the City. It prioritizes Easy Access to Nature: Ensure every resident is within a 10-minute walk to nature from their home or workplace; High Quality Natural Spaces: Conserve, create and enhance natural spaces to provide diverse social and ecological opportunities; and Land Stewardship: Shift the landscape aesthetic to more diverse forms that support healthy environments for people and wildlife. This vision will be accomplished through private/public partnerships; restoring existing natural spaces to increase the natural quality of sites for people and wildlife; working on neighborhood-scale enhancement projects; design guidelines to illustrate how nature can be incorporated into the urban environment; education, incentives and resources for landowners, business owners and landscapers; and ongoing partnerships on new and existing City plans, policies and practices.

- Minneapolis, MN: The Minneapolis Urban Forest Policy provides guidance to protect, maintain and manage the Minneapolis urban forest. It applies to all departments, developers, and contractors. The city has integrated its forestry policy throughout its ordinances and codes, and won accolades for this work. Research estimates that the city's trees provide $24.9 million worth of benefits annually, more than twice the amount of money the city spends maintaining that asset. $6.8 million of that benefit comes from reduced energy costs for buildings. Through its Urban Forestry Project, the city offers trees to businesses and residences for a reduced price. Meanwhile, the city frequently ranks high on assessments of greenest cities, best places to live, and healthiest cities.

Economic Impact

- **Costs:**
  - Staff (and possibly consultant) time for research and revision of Open Space Management Plan as part of CSD Integrated Master Plan and estimation of carbon sequestration.

- Staff time and materials for tree care, vegetation maintenance, fire mitigation, soil erosion prevention, and other open and urban space management.
- Staff time and materials for educational outreach to community, businesses and County staff.

- **Savings:**
  - Potential for large savings if wildfire damage is avoided due to mitigation measures.
  - Reduction in insurance costs to County, businesses and residents due to decreased wildfire risk.
  - Increased tree cover can reduce costs for building cooling.
  - Increase in property values due to beautification and other natural amenities.
  - Increase in recreational quality brings additional tourism dollars.
  - Reduction in health care costs from improved air quality, outdoor recreation increase, and other benefits of improved environment.

Benefits Other than CO_2 Reduction

- Improved forest and landscape health, reduced wildfire danger, reduced flooding and run-off of contaminants.
- Improved livability of developed areas due to reduced heat and drought effects
- Beautification of neighborhood and urban areas
- Improved quality of recreation opportunities
- Increase in property values
- Energy and water conservation
- Traffic calming
- Reduced noise
- Attraction of new residents and LANL hires
- Enhanced health and quality of life

Challenges & Anticipated Barriers

- Current (2015) Open Space Management Plan may require extensive revision especially to be a functional part of CSD Integrated Master Plan. The Plan as written has many good "Suggested Actions", but should be more proactive, based on anticipated climate change effects. Actions identified will need to be implemented, requiring investment of time and funds.
- Residents may be resistant to suggestions regarding fire mitigation actions on private property.
- Increased recreation in open space will need to be managed carefully to prevent damaging effects to the environment. Some activities may need to be prohibited (fire restrictions, etc.).
- Requirements for preservation of tree canopy and other landscape aspects may constrain development location and intensity.

Community Outreach & Public Education

- Need for development of education campaign and materials to help residents and businesses consider and implement climate-wise landscaping approaches. These can be promoted and distributed by NMSU Extension Office, Master Gardeners, PEEC, landscapers, County website and offices, and retail businesses.
- Good opportunity to partner with schools to revise landscaping while educating students about the importance of landscape management and other ecological principles.

References & Resources

Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters. McPherson, Gregory, and James Simpson, USDA Forest Service, 1999.

East Jemez Landscape Futures project

Forest Management for Carbon Sequestration and Climate Adaptation.

Forest management under megadrought: Urgent actions needed at finer-scale and higher intensity (2020) Frontiers in Forests and Global Change. Jason P. Field, David D. Breshears, John Bradford, Darin J. Law, Xiaohui Feng, and Craig D. Allen (note: Craig Allen is a local expert and potential resource)

Forest Adaptation Resources: Climate change tools and approaches for land managers, 2nd edition; Swanston et al. 2016; Ge. Tech. Rep. NRS-GTR-87-2. Newtown Square, PA. U.S. Department of Agriculture, Forest Service, Northern Research Station; and the corresponding online interactive tool, Adaptation Workbook.

Fort Collins (CO) Nature In The City Strategic Plan

Los Alamos County Open Space Management Plan (2015)

Minneapolis (MN) Urban Forest Policy

Rio Grande Water Fund (The Nature Conservancy of New Mexico)

Soil in the City: Sustainably Improving Urban Soils, Kumar, K. and Hundal, L.S. (2016), Journal of Environmental Quality

The Carbon-Free City Handbook: Biological Resources. Rocky Mountain Institute (2017)

USDA Forest Service i-Tree Tool for assessing and managing forests and community trees

USDA-NFS Climate Change Resource Center Compendium of Adaptation Approaches

Vibrant Cities Lab (created by U.S. Forest Service, American Forests, and the National Association of Regional Councils). "Urban Forestry Toolkit."

Why Soil Matters, ClientEarth Communications (2020)

IX. Community Planning

Introduction

International Residential Code (2015 IRC) and 2018 New Mexico Residential Energy Codes (2018 IECC) are the current building codes adopted in Los Alamos County. These apply to new construction and to renovations requiring a building permit, not to unaltered homes. Los Alamos codes requiring a permit are extensive in their applicability, but do not cover interior work without plumbing or electrical changes.

The County should consider a local stretch code to address the steps needed to reduce greenhouse gas emissions and other sustainability issues. Several cities, both large and small, have supplemental codes, commonly referred to as stretch or reach codes, which address issues beyond current requirements. Codes for other cities vary from expediting permitting, reducing permit costs, and enhancing tree cover to detailed construction techniques that supersede the code. Some jurisdictions have put their stretch codes to a public vote before implementation.

Eliminating or reducing the need for energy use is the most effective way to minimize greenhouse gas emissions. Conversion of natural gas heating and appliances to electric requires careful planning to assure that greenhouse gas emissions are actually reduced since a straight transfer to electricity, without changes to reduce the carbon footprint of electrical power generation, can increase the overall carbon footprint. Refer to the Natural Gas and Electricity section for detailed recommendations.

Since the building code covers all aspects of building and landscaping, a stretch or reach code can incorporate other sustainability recommendations. Since most of Los Alamos County is already built out in terms of housing and commercial buildings, little new development on open land is likely. New construction triggers the code requirements. Newer requirements are also triggered when renovations are planned for the property. Incentives are commonly used in many states to promote change to higher energy efficiency, but with the New Mexico Constitution's "anti-donation clause," only federal incentives will be available to Los Alamos.

Some issues to address include:

1. The overlay code should encourage energy efficiency improvements beyond the current code in effect. New Mexico is in the process of adopting the 2021 International Residential Code (IRC) which will trigger a significant change to building construction to reduce energy loss. The 2021 IRC and the 2021 IECC have identical insulation requirements. The stretch code could address tighter energy loss requirements beyond the then-current code, installation of connections for solar panels, use of heat pumps as the prescriptive method for space heating and air conditioning, installation of 50-amp circuits in the kitchen for potential gas stove replacement, etc.

2. The County should advocate with others, such as the Coalition for Sustainable Communities NM, to the State for greater flexibility to invest locally with their funds for a

loan program similar to Fort Collins, CO, and other locales that incentivize energy reduction and decarbonization projects to reduce GHG emissions. Unfortunately, New Mexico's anti-donation clause appears to limit these activities.

3. Educate existing homeowners on the importance of replacing single pane windows, adding insulation, and other energy-saving – hence GHG-reducing – renovations.

4. The County should set an example with its purchasing and contracting. The County has an environmental preference policy, but it requires justification to choose the least emitting option, not justification to choose away from the lowest emitting option. There are several carbon databases to evaluate the lowest emitting option, from manufacturing, transportation, use, lifecycle, and disposal for common building and finishing materials. Adopting a sustainability purchasing policy that includes manufacturing and transportation should be developed by the County.

5. The County should include some commercial zoning in every section of town to promote neighborhood community buildings and reduce longer-distance transportation needs.

Recommendation CP-1: Adopt a local overlay code that incorporates additional locally-specific greenhouse gas reduction provisions.

Time Frame: Short-to-medium term

Background

In general, buildings consume 40% of US energy which can be from a mix of fossil fuels and other sources. The 1972 energy crisis encouraged energy-efficient homes as the building codes responded. The 40% number may not apply specifically to Los Alamos, but for energy produced and consumed within Los Alamos it is relevant as the age of the building stock is predominantly pre-1972. For reference, the 1970 Uniform Building code, predecessor to the current International Building Code, focuses on structural strength and barely mentions insulation. Most pre-1970 homes have 2 to 3 inches of insulation in the attic. The NG section supplies additional information.

IRC 2015 and the 2018 New Mexico Energy Code are the current building codes adopted in Los Alamos County, but the 2021 IRC is in the process of adoption. Recent changes to the building code focus on the building envelope. The code has significantly changed the R-value required for insulation (to minimize heat loss) and changed the solar heat gain coefficient required for windows. New homes and retrofits requiring a permit will need far less energy than the typical home in Los Alamos. Buildings not retrofitted are the large challenge.

To decarbonize the power system a local code that prepares homes to transition to an all-electric mode can be incorporated. This is called an “overlay code” (sometimes called “stretch” or “reach” code). Steps could range from additional reserved space for solar panels and/or EV charging on the electrical breaker, 50-amp connections in the kitchen for gas stove replacements, establishing heat pumps as prescriptive for space heating and air conditioning, additional insulation requirements, orientation requirements for new buildings, and other items. Adding connections at the time of build so that conversions can be made conveniently will help the transition. One of the differences between natural gas and heat pump installations can be vent sizing to avoid velocity-induced noise. Engineering this out at the design stage will ease implementation and be less irritating.

Time Frame for the change to heat pumps and solar installations must be carefully managed. More electric power will eventually be required. Adding the connections now and later moving to installations will have the overall effect of reducing greenhouse gas emissions.

Outcome

The transition will be easier. A local code draws a clear distinction detailing the community's requirements versus the standard applied codes.

Examples in Other Communities

- California Title 24- This code was awaiting final approval in 12/2021.
- Santa Fe Green Code
- Most local codes offer expedited permits in exchange for additional items. Seattle's local code eliminates new fossil fuel connections for heating and eliminates new electric resistance heating, essentially requiring electric heat pumps. Seattle new homes must have electrical connections at gas-fired appliances in preparation for a switch to electric, and provide connections for solar readiness. The Albuquerque Green Code provides expedited permitting review for Leadership in Energy and Environmental Design (LEED) and Home Energy Rating System (HERS) building permits.

Caution should be applied to choose only sections applicable to the changes desired in the Los Alamos community.

Economic Impact

- **Costs:**
    - There will be costs for staff time, economic impact studies, and code writing as well as education for public acceptance. Fortunately, there are many examples of local codes from California Title 24 that identifies the prescriptive measures above the national energy codes and the Santa Fe Green Code that focuses on installation and assurance.

Challenges & Anticipated Barriers

- Any time new requirements are added that cost additional funds there will be pushback. Education before implementation will be key. No homeowner renovating their home desires to have the costs increased. New home construction companies are generally more accepting of additional requirements.
- Additional code requirements and associated expense can discourage some property owners from making otherwise-desirable renovations.

Recommendation CP-2: Advocate for change or clarification of the NM Anti-Donation Clause to allow governments to provide incentives for energy-reduction projects.

Time Frame: Medium-term

Background

Many communities offer incentives to help address improvements beyond the standard building codes. Fort Collins, CO, developed an interest-bearing loan program in support of comprehensive projects that include solar, energy storage, and electrification. Their utilities department started with the utility reserves, and reimbursement was paid through borrowers' electric bills. Although Fort Collins is larger in population (337,000 versus 19,000), the loan program has served an income range from $30,000 to $580,000. Fort Collins has a median income of $108,000 which is similar to Los Alamos's median income of $107,000.

From 2013 to 2018, their program utilized only utility reserves, but then was expanded as a public-private partnership to increase access. In February 2021 the maximum loan amount was raised to $50,000 to cover the higher costs associated with more comprehensive projects, but to-date the average loan amount has been ~$12,000. Their loan program charges interest so it is not a donation. In fact, they have made more money than what their reserves were accruing. They charge about 3% and their loan terms range from 3 to 15 years. It is recorded as a loan on the property (similar to a mortgage), and is handled the same way. It is available to homeowners and renters, but the loan is to the property owner.

Los Alamos has established a loan program to address safety issues for low-income homeowners through the Los Alamos Housing Partnership (LAHP). Los Alamos needs funds to serve residents whose assets exceed LAHP thresholds. Unfortunately, the New Mexico anti-donation clause (NM Constitution Art IX, Sec. 14), in the LA County attorney's opinion, prohibits this type of investment. The County should explore with other like-minded groups, such as the Coalition of Sustainable Communities NM, paths to allow local governments to invest their resources to achieve their greenhouse gas emission goals locally. This may require legislative change, an Attorney General opinion, possibly a Constitutional amendment, or other efforts. The county may achieve a higher rate of return on its money than current investments.

Economic Impact

- **Costs:**
    - Staff time

Recommendation CP-3: Educate property owners on potential energy-saving renovations to their buildings.

Time frame: Short-term and ongoing

Background

To start this discussion, we would like to thank Ben Hill, an architect and member of the Community Planning Subcommittee for this work. He modeled a typical 1950s residence to quantify changes in energy loss with various renovations.

Chart CP-1 (in following pages) reflects the difference for a residential dwelling with typical 1956 construction and one with energy efficiency improvements added. The chart shows that single-pane windows are the largest heat loss for the home (at 40% of the total heat loss). Conversion to multiple pane windows will make the largest difference in home energy consumption. Current code for windows requires a higher insulating value, commonly represented in the U-value (reciprocal of R-value), which is based on climate and elevation. Replacing single-pane windows should be considered a priority to achieve energy loss goals from housing and reduce CO_2e emissions. The extent of single pane windows left in the community is unknown. The County could consider collecting this data as part of the assessor information it collects with building information for tax purposes. This can be completed over time, but it will identify homeowners who can provide greater energy savings reductions.

Less expensive and the next step after windows are replaced is adding attic insulation. Chart CP-1 reflects adding 12 inches of attic insulation. This is effectively R-49, if blown over the typical 3 inches found in 1950s construction. This is fairly easy and significantly less expensive than windows. It is an attainable goal for houses with attics. This change in the attic alone combined with windows reduces the overall space heating energy demand of a house by 60%. Mobile homes and flat roofs are not suitable for this conversion, and other opportunities must be found.

Adding exterior insulation to walls is the next most effective method but must be carefully engineered to control where the dew point falls in the wall to avoid mold issues. Next in line is crawl space insulation which can be difficult to install, thus more expensive, due to limited access (especially in older homes).

Older manufactured homes, i.e., mobile homes, cannot easily be retrofitted and must be addressed separately. Manufactured housing constructed prior to 1976 codes are much less energy efficient than newer models. There appear to be several of these older mobile homes in Los Alamos County. The US Department of Housing and Urban Development (HUD) has identified the following measures for earlier homes as:

- Install energy-efficient windows and doors
- Add insulation to the belly or a belly wrap
- Make general repairs (caulking, ducts, etc.)

- Add insulation to walls
- Install insulated skirting
- Add insulation to the roof or install a roof cap.

Careful attention must be addressed to dewpoint and vapor barriers to avoid mold and corrosion issues. Still, these measures achieve only a 30% reduction in fuel usage. These modifications are very expensive given the value of the home. The County may need to consider other options to address this subset of homes. New manufactured housing must meet higher standards established in 2009. Homes are available with Energy Star ratings and are eligible for a state tax credit, though non-Energy Star models can still be purchased. The County should advocate to the State to impose a restriction that only Energy Star manufactured homes be sold in the NM.

Quadplexes will require a unique solution as they fall under the commercial code and frequently have different owners. For multi-family buildings, New York City is developing a one-stop shopping effort to provide owners with a proposal with detailed plans, cost estimates, and financing information. This may be an option for Los Alamos given the large number of quads.
Homeowners who have the most opportunity to reduce energy use may need assistance to incorporate these changes. The Los Alamos Housing Partnership (LAHP) should be utilized to the greatest extent possible. It would also help if a way can be found "around" the anti-donation clause to allow County community investment to owners not qualifying for LAHP.

Examples in Other Communities

- Holland, Michigan, Home Energy Retrofit Program

Economic Impact

- **Costs:**
    - Staff time to gather data and implement outreach to affected owners

Challenges & Anticipated Barriers

- Some residents will not support expenditures for staff time.

Design Temperature and Fuel Type Inputs https://www.builditsolar.com/References/Calculators/HeatLoss/HeatLoss.htm

Title	Typ LA Home circa 1956					Revisions						
Design outdoor Temperature		Degrees F	9			Ceiling add 12" blown in insulation				Heating with electricity @ .12/KWH		
Heating Degree Days		Degree F - day	6330			Walls add 2" exterior insulation & stucco				less infiltration due to new windows		
Natural Gas	0.84			85%	Furnace Efficiency	Upgrade windows & Doors						
Electricity						Crawl space -Add 3" exterior insulation and Stucco						
Area and Rvalue Inputs						**Area and Rvalue Inputs**						
	Area (sqft)	**Rvalue**	**UA (BTU/hr-F)**	**Design Loss (BTU/hr)**	**Yearly Heat Loss (million BTU/yr)**		**Area (sqft)**	**Rvalue**	**UA (BTU/hr-F)**	**Design Loss (BTU/hr)**	**Yearly Heat Loss (million BTU/yr)**	**% Difference**
Ceiling 1	961	11	87.4	5329	13.3	Ceiling 1	961	49	19.6	1196	3	22.56%
wall 1	850	11	77.3	4714	11.7	wall 1	850	22	38.6	2357	5.9	50.43%
Doors	40	2.5	16	976	2.4	Doors	40	5	8	488	1.2	50.00%
Windows	162	0.9	180	10980	27.3	Windows	162	3.4	47.6	2906	7.2	26.37%
Crawl space wall	526	9	58.4	3565	8.9	Crawl space wall	526	24	21.9	1337	3.3	37.08%
Infiltration	total volume of the heated space of the house cubic feet					Infiltration	total volume of the heated space of the house cubic feet					
	Typical Air Changes Per Hour:						Typical Air Changes Per Hour:					
	0.33 -- very tight -- minimum for health						0.33 -- very tight -- minimum for health					
	0.5 -- tight -- new, careful construction						0.5 -- tight -- new, careful construction					
	1.0 -- leaky -- typical existing construction??						1.0 -- leaky -- typical existing construction??					
					Yearly Heat Loss						Yearly Heat Loss	
	House Volum (cubic ft)	Air Changes p	UA (BTU/hr-F)	Design Loss (BTU/hr)	(million BTU/yr)		House Volur (cubic ft)	Air Changes p	UA (BTU/hr-F)	Design Loss (BTU/hr)	(million BTU/yr)	
Whole House	4695	1	85	4226	6.5	Whole House	4695	0.5	42	2578	6.4	
Int. Heat Gains	These are heat gains from warm bodies, lights, appliances, ...					Int. Heat Gains	These are heat gains from warm bodies, lights, appliances, ...					
	This is heat that your furnace does not need to provide.						This is heat that your furnace does not need to provide.					
					Yearly Heat Loss						Yearly Heat Loss	
	Number of Occupants		Internal Gains (BTU/hr)	Design Loss (BTU/hr)	(million BTU/yr)		Number of Occupants		Internal Gains (BTU/hr)	Design Loss (BTU/hr)	(million BTU/yr)	
	3		1362	-1362	-11.9		3		1362	-1362	-11.9	

Summary							**Summary**						
Item	**UA (BTU/hr-F)**	**Design Loss (BTU/hr)**	**Year Loss (Million BTU/**	**Fuel Cost (US dollars)**	**Ten Year Cost 10% infla $"s**	**Green-house Gas (lb CO2)**	**Item**	**UA (BTU/hr-F)**	**Design Loss (BTU/hr)**	**Year Loss (Million BTU/**	**Fuel Cost (US dollars)**	**Ten Year Cost 10% infla $"s**	**Green-house Gas (lb CO2)**
Ceiling Loss	87	5329	13.3	$131.00	2089	1874	Ceiling Loss	20	1196	3	$52.00	835	654
Wall Loss	77	4714	11.7	$116.00	1848	1657	Wall Loss	39	2357	5.9	$103.00	1644	1288
Window Loss	196	11956	29.8	$294.00	4688	4204	Window Loss	56	3394	8.5	$149.00	2368	1856
Crawl space wall	58	3565	8.9	$88.00	1398	1253	Crawl space wall	22	1337	3.3	$59.00	933	731
Slab Loss	0	0	0	$0.00	0	0	Slab Loss	0	0	0	$0.00	0	0
Infiltration	138	8441	208	$208.00	3310	2968	Infiltration	42	2578	6.4	$113.00	1798	1409
Totals	**556**	**34005**	**271.7**	**$837.00**	**13333**	**11956**	**Totals**	**179**	**10862**	**27.1**	**$476.00**	**7578**	**5938**
							Assumes 200% heat pump efficiency						
							3.8KW for heating and 3.8KW for other = electrical 20 PV panels						0

	Area (sqft)	**Cost**	**Total**
Attic Insulation	961	$1.75	$1,681.75
2" Insul & Stucco	850	$7.00	$5,950.00
Doors	2	$1,200.00	$2,400.00
Windows	11	$1,000.00	$11,000.00
3"Insul & Stucco	526	$7.50	$3,945.00
5.625kW Solar PV	5,625	$3.25	$18,281.25
Solar Tax Credit	26%	10%	-$6,581.25
Heat Pumps	1	$8,000.00	$8,000.00
Uprgade elec service			$3,500.00
			$48,176.75
Alt Tax Credits			
Uprgade elec service			$3,500.00
Battery Storage			$3,500.00
5.625kW Solar PV	5,625	$3.25	$18,281.25
Solar Tax Credit	26%	10%	-$9,101.25
		TTL	$16,180.00

US rate of 1.5 lbs CO2 per KWH
3,959 KWH / 329KWH month for heating
If electricity is wind or solar

Other tax credits my be available for certain upgrades:
http://www.emnrd.state.nm.us/ECMD/CleanEnergyTaxIncentives/cleanenergytaxincentives.html
https://www.nm-prc.org/wp-content/uploads/2021/06/New-Mexico-TRM-2018_ErrataFINAL_04102019.pdf
https://www.energystar.gov/about/federal_tax_credits

Chart CP-1. Design temperature and fuel type inputs.

Recommendation CP-4: Strengthen the County's environmental purchasing policy.

Time Frame: Short-term (policy change) and medium-term (procedures for evaluation)

Background

Los Alamos code Section 31-262 contains the environmental purchasing clause. It is fairly weak compared to codes required by authorities regulating industry. In the Los Alamos 2020 code it is:

> "An additional preference factor of up to five percent for environmentally preferable purchases may be applied for any competitive procurement. If a preference factor is to be applied, it will be noted in the solicitation."

Compare this to industry requirements:

> "Attach a description of why the proposed air pollution emission control strategy is the best available for the process at the time of application submission. This can take the form of a written explanation or, for larger projects, a top-down best available control technology analysis (BACT)."

BACT, the best available control technology, is applied across all of the USA. It is a process that requires justification away from the least polluting purchase, otherwise the least emitting equipment must be purchased and installed."

Data are available on CO_2e emissions for products purchased in the construction industry. One of these databases is hosted by buildingtransparency.org. The Environmental Protection Agency (EPA) and GSA websites also contain information on many green products used throughout the government. The County could establish as policy that environmental preference is always included in any purchase and rate materials as part of the evaluation process.

Economic Impact

- **Costs:**
  - Staff time to develop policy and procedures.

Challenges & Anticipated Barriers

- It is important that the material meets the required technical specifications. This is generally not an issue for purchasing everyday consumables, but is essential for code-related work. Justification of alternative products can take time.
- Some environmentally preferable products may be more expensive but an allowance should be given for sustainability. The current 5% differential is too low.

Recommendation CP-5. Add commercial zoning within each area of town, such as each mesa and within White Rock.

Time Frame: Medium-term (the County is currently revisiting the development plan now. This should be considered.)

Background

Los Alamos is a small community where transportation from White rock and each Townsite mesa to downtown occurs for almost every need. There is opportunity to re-envision what Los Alamos could look like with more walking-accessible retail on each mesa. Think of each mesa as a small village on its own where community gathering, a coffee shop, and a transit stop accessing major shops in the downtown corridor could happen. In larger cities it is known as the "urban village" concept.

Currently, some mesas have easy access to a commercially zoned area where they can access a last-minute supply or meet a friend without using the car. Others, such as Barranca and North Mesa, do not. There are natural gathering areas near schools where communities tend to congregate that would be convenient for a small section of commercial zoning. White Rock has incorporated commercial areas readily accessible to its neighborhoods in the proposed community plans.

The school district is in the process of transferring a parcel of land on North Mesa for housing. This is a prime opportunity to implement a change. Zoning a lot as commercial does not ensure that a project will materialize, but not zoning any commercial space does ensure that there will never be a store, coffee shop, or other community gathering place. This is directly controlled by zoning policies.

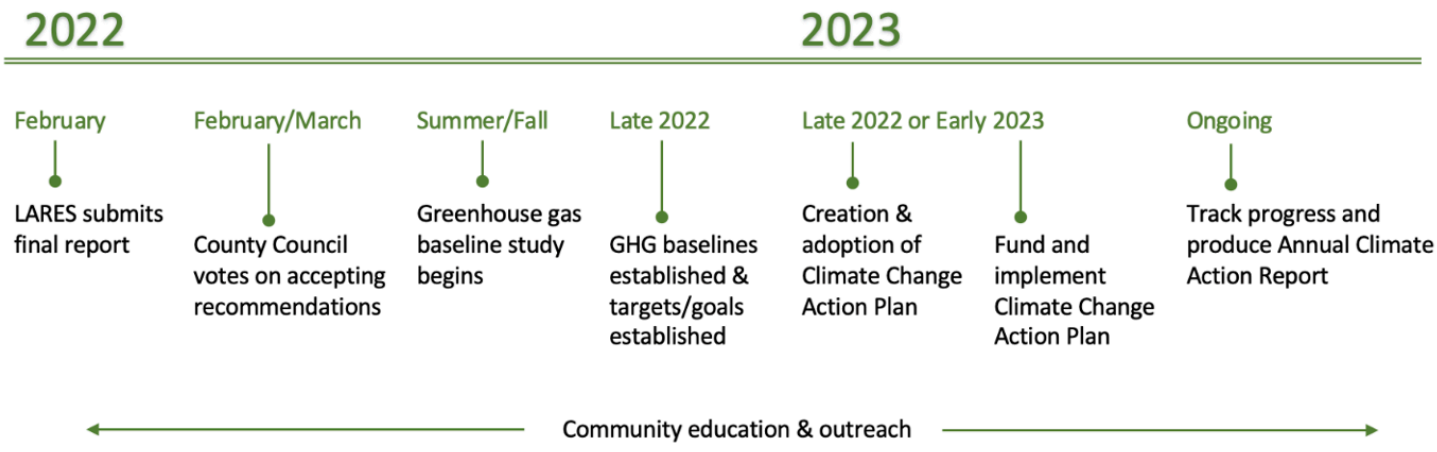
Economic Impact

- **Costs:** Unknown

Challenges & Anticipated Barriers

- The area may not be population dense enough to support a retail site, but it may be enough for a food truck to operate.
- There may be resistance by downtown businesses to additional competition, but the market for downtown is serving a different audience. Their market is people who are already downtown, such as office workers, or those needing more than a cup of coffee or a gallon of milk.

X. Proposed Timeline Moving Forward



XI. Acronym Guide

ACT – Atomic City Transit
BACT – Best Available Control Technology
BTP – Bicycle Transportation Plan
BTU – British Thermal Unit
BMP – Best Management Practices
BPU – Board of Public Utilities
CAP – Climate Action Plan
CB – Consumption-Based
CDAB – LAC Community Development Advisory Board
CFPP – Carbon-Free Power Project
CO_2 e – Carbon Dioxide Equivalent
COP – Coefficient of Performance
CSCNM – Coalition of Sustainable Communities New Mexico
CSD – LAC Community Services Department
DOE – US Department of Energy
EPA – US Environmental Protection Agency
ESB – Environmental Sustainability Board
ESD – LAC Environmental Services Department
EV – Electric Vehicle
FTE – Full Time Employee
GHG – Greenhouse Gas(es)
GW – Gigawatt
GPC – Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
HFC – Hydrofluorocarbon
HHW – Household Hazardous Waste
IECC – International Energy Conservation Codes
IPCC – Intergovernmental Panel on Climate Change
LAC – Los Alamos County
LAHP – Los Alamos Housing Partnership
LANL – Los Alamos National Laboratory
LAPS – Los Alamos Public Schools
LARES – Los Alamos Resiliency, Energy and Sustainability (Task Force)
LEED – Leadership in Energy and Environmental Design Rating System
LFG – Landfill Gas
LIDS – Low Impact Development Controls
LRWSP – (Los Alamos County) Long-Range Water Supply Plan
MSW – Municipal Solid Waste

PPA – Power Purchase Agreement
NG – Natural Gas
NREL – National Renewable Energy Laboratory
P & Z – LAC Planning and Zoning Commission
PEEC – Pajarito Environmental Education Center
PPA – Power Purchase Agreement
PRB – LAC Parks and Recreation Board
RFP – Request for Proposal
RTD – Regional Transit District
SF – Square foot
SJGS – San Juan Generating Station
SMM – Sustainable Materials Management
SMR – Steam Methane Reforming
SOV – Single-Occupant Vehicle
T-Board – Transportation Board
UAMPS – Utah Associated Municipal Power Systems
UN – United Nations
WCNR – Waste, Consumption & Natural Resources Subcommittee
UNM-LA – University of New Mexico Los Alamos campus

XII. Related LAC Reports & Other Documents

Future Energy Resources Report, 2015

Energy Use and Greenhouse Gas Emissions in Los Alamos County, 2021

LAC Environmental Sustainability Plan, 2019

LAC Department of Public Utilities Energy and Water Conservation Plan, 2015-2019

LAC Environmental Sustainability Initiative, March 2008

LAC Fuel Conservation Policy

LAC Vehicle Upgrades, Additions, and Replacement Policy

Save as you Throw Report

A perfect fall day in LA

XIII. Appendices

APPENDIX A: Usefulness of Residential and Community Rooftop Solar PV

Santa Fe's Goals for Non-Carbon Energy:

- Establish a clean energy landscape with a secure and diversified portfolio that maintains reliable, low-cost, efficient, low water use, and low air and carbon emissions services.
- Reduce community electricity and natural gas consumption by one percent per year (representing a reduction of 6 million kilowatt-hours (kWh) of electricity and 615,000 therms of natural gas annually).
- Identify and increase participation in community renewable energy programs, including on-site solar installations and community solar projects.
- Reduce electric consumption annually with energy efficiency at City facilities.
- Increase use of renewable energy at City facilities.
- Ensure that publicly accessible electric vehicle charging stations are located with 5 miles of any part of Santa Fe.

If you want a model of how to build a broad coalition around aggressive climate policy, take a look at what Oregon's doing:

- The state's Democratic majority failed to pass an economy-wide carbon cap-and-trade bill in 2019 and 2020. Now the legislature is on the verge of passing HB 2021, a more targeted clean power and environmental justice policy, Jeff reports.
- The bill would cut carbon emissions from Oregon's electricity system 80 percent by 2030, 90 percent by 2035 and 100 percent by 2040.
- Utilities Portland General Electric and Pacific Power, which will have to execute that directive, support the legislation.
- That's one of many examples nationwide of electric utilities pushing for more aggressive decarbonization timelines.
- The bill bans new natural gas plant construction within the state. Oregon already eliminated in-state coal plants.

- The catch: By focusing on the grid, the bill doesn't decarbonize buildings, transportation, industry or land use.

Those sectors are crucial for comprehensive climate policy. But, having a clear pathway to carbon-free electricity is crucial for later electrifying the rest of the economy.

Interim Report - Net-Zero America: Potential Pathways, Infrastructure, and Impacts

New Mexico Solar Panels : Guide to Solar Incentives, Costs and Savings in NM!

What It Really Means to Require Solar Panels on All New Buildings

Green Electricity Can Be Unstable. Big Battery Backups Are The Solution.

The changeover from fossil fuels to renewables behooves US governments as well as fossil energy companies to look at what South Australia has learned.

We reference a recent set of recommendations of the special BPU Conservation Subcommittee 2020 that went to the Utilities Board. These are excellent and should be part of this document's recommendations.

Appendix B: Santa Fe Schools experience with rooftop solar PV

Santa Fe Public Schools is 22% Solar Powered!

2.3 megawatts of SFPS owned solar photovoltaic (PV) generation capacity, as of May 2021:

- Kearny Elementary - 143 kW ground mount (June 2020)
- Milagro Middle School - 166 kW carports (June 2019)
- Nina Otero Community School - 110 kW ground mount (May 2019)
- Capital High School - 339 kW ground mount (Aug 2018)
- El Camino Real Academy - 68 kW parking canopy (Aug 2018)
- Ramirez Thomas Elementary - 104 kW parking canopy (Nov 2016)
- Santa Fe High School - 867 kW ground mount; powers 65% of Santa Fe High, Chaparral
- ECO Campus, and Facility and Maintenance Building (Oct 2016)
- Acequia Madre Elementary – 26 kW shade structure (Mar 2015)
- Atalaya Elementary – 39 kW shade structure (Nov 2015)
- Capital High School – 196 kW ground mount (Oct 2015)
- Pinon Elementary – 46 kW shade structure (Sept 2015)
- El Camino Real Academy – 75 kW parking canopy (July 2014)
- Nina Otero Community School – 63 kW parking canopy (July 2014)
- Amy Biehl Community School – 74 kW rooftop (April 2013)
- El Dorado Community School – 2.6 kW side of building (2011)
- Gonzales Community School – 3.1 kW side of building and pole mount (Jan 2011)
- Santa Fe High – 4 kW ground mount (Sept 2010) (removed because of construction in 2019)

SFPS Solar PV Program Facts

More than 6 million pounds of carbon kept from entering the atmosphere every year
More than 1.5 million gallons of water saved annually by generating our own power
An average of $450,000 in annual savings; supporting the Operational Budget, and paying the Debt Service on Clean Energy Revenue Bonds

Facility Analysis

All SFPS facilities and properties are being assessed for solar PV compatibility.

Funding Sources

General Obligation Bonds - every 4 year election cycle
Clean Energy Revenue Bonds through New Mexico Finance Authority
Legislative Appropriation

APPENDIX C: This Vermont Utility Is Revolutionizing Its Power Grid to Fight Climate Change. Will the Rest of the Country Follow Suit? *Time Magazine* ALEJANDRO DE LA GARZA

It's heartbreaking to see weather events come through, and to see the impacts of climate change happening all over the country," says Green Mountain Power=GMP (Colchester, Vermont) CEO Mari McClure, sitting in a conference room at company headquarters.

Rural Panton, Vt., is home to GMP's newest effort to remake the electric system: a "microgrid" attached to a solar power plant, which can distribute its electricity to parts of the nearby community in case they get cut off from the main energy network due to falling trees or heavy snows, common occurrences in this isolated New England town. GMP engineers spent two years modeling electrical scenarios and testing components to make sure the system would work safely. "I can come up with 10,000 reasons why you wouldn't pursue this," says Josh Castonguay, VP of engineering and innovation at GMP, standing near a 4.9-megawatt storage battery that helps power the grid when the sun isn't shining, and which doubles as a local energy supply for the town in an emergency. "This won't work. That won't work. They're all things that you've just gotta engineer through."

For one thing, power-line circuit breakers—which cut off electricity if, say, a tree knocks down a utility pole—weren't designed to operate with only a single battery pumping power through their lines. GMP's solution is a novel use of a type of transformer known as a grounding bank to increase the voltage of Panton's microgrid high enough to make sure its breakers trip if electrical wires are damaged.

Another of GMP's grid-modernization projects is to lease Tesla Powerwall battery backup systems to homeowners at below-market rates—and then use them, with homeowners' permission, to help cover a community's electricity needs during peak times. Other U.S. utilities have since started similar battery grid programs, many with advice from GMP. With its Powerwall program, GMP can offset some of that peak demand, dumping stored electricity onto the grid from garages and basements around the state, a type of setup known as a "virtual power plant" (VPP).

Battery-making firms and installers like Sonnen and Sunrun have partnered with utilities, participated in utility programs that allowed multiple installers to contribute batteries, or, in Sonnen's case, networked their own U.S. home battery communities. (The U.S. is playing catchup here to some extent; such initiatives have existed outside the country since 2015.)

Meanwhile, GMP has expanded its own VPP initiative, investing about $30 million to sign up more than 2,000 homes in one of the largest utility-coordinated home battery programs in the country. Many residents also joined out of concern for a warming climate

Energy experts say VPP systems are essential in the near term, in part because they can help prevent overloads like the one that crippled Texas earlier this year.

In the U.K., Kaluza, a spin-off of British energy supplier Ovo, is paying customers to access their electric-car batteries while they're charging in order to help manage electrical peaks (company representatives say the firm will expand to the U.S. in coming months). A similar, decentralized initiative from Ford, which uses batteries on its upcoming electric F-150, may be years away.

Contact Green Mountain Power=GMP (Colchester, Vermont) CEO Mari McClure for information about how they leased storage to residents and made appropriate changes to the electrical system to accommodate their use. They claim to have saved > $3 million in the first 3 quarters of 2020.

APPENDIX D: Description of Energy Storage Technologies

Mechanical Storage

Pumped Storage Hydroelectricity (PSH) - When electricity is available, water is pumped from a low source to a higher elevation reservoir. Once power is needed the water is allowed to flow back to the lower source, powering a turbine generator. This is also the most mature and has the longest lifetime (~55 y) of all utility-scale energy storage schemes. In addition, PSH is the lowest cost per MWh when properly located. Taking those factors into consideration, if an opportunity arises to invest in a PSH system elsewhere such as adding pumps to an already existing dam, LAC would be well served to pursue a stake in it.

Compressed Air Energy Storage (CAES) - Energy is stored in the form of compressed air while electricity is available. Once needed, the accumulated pressure is released and air is allowed to pass through a turbine generator. In large-scale systems the compressed air is stored in geological formations.

Gravitational Storage - In this method a mass is raised to store gravitational potential energy. Once energy is needed, the mass is lowered while powering a generator. Such a system can be very efficient, but the energy stored is limited by the mass of the object raised and its change in elevation.

Flywheel Energy Storage - Energy is stored by accelerating a rotating mass. Once needed, the rotating mass is used to drive a generator. In this approach, AC can be used directly to spin up the flywheel and be generated during spin down, saving losses during DC to AC conversion. A large number of flywheels can be arranged in an array to increase the amount of energy stored. However, it is generally considered to be a small scale, short duration storage scheme.

Electrochemical Storage

Stationary Batteries - There are several chemistries that are in use (Lead-Acid, Sodium Sulfur (NaS), and Lithium-ion batteries [LIBs]). LIBs are currently the most attractive technology for utility-scale electricity storage when a few hours of storage is the main goal. There are several installations in the 100-200MW scale currently in operation. LIBs are very efficient, respond quickly when needed, and are well suited to supply electricity for multiple hours. The size of the battery scales linearly with the capacity.

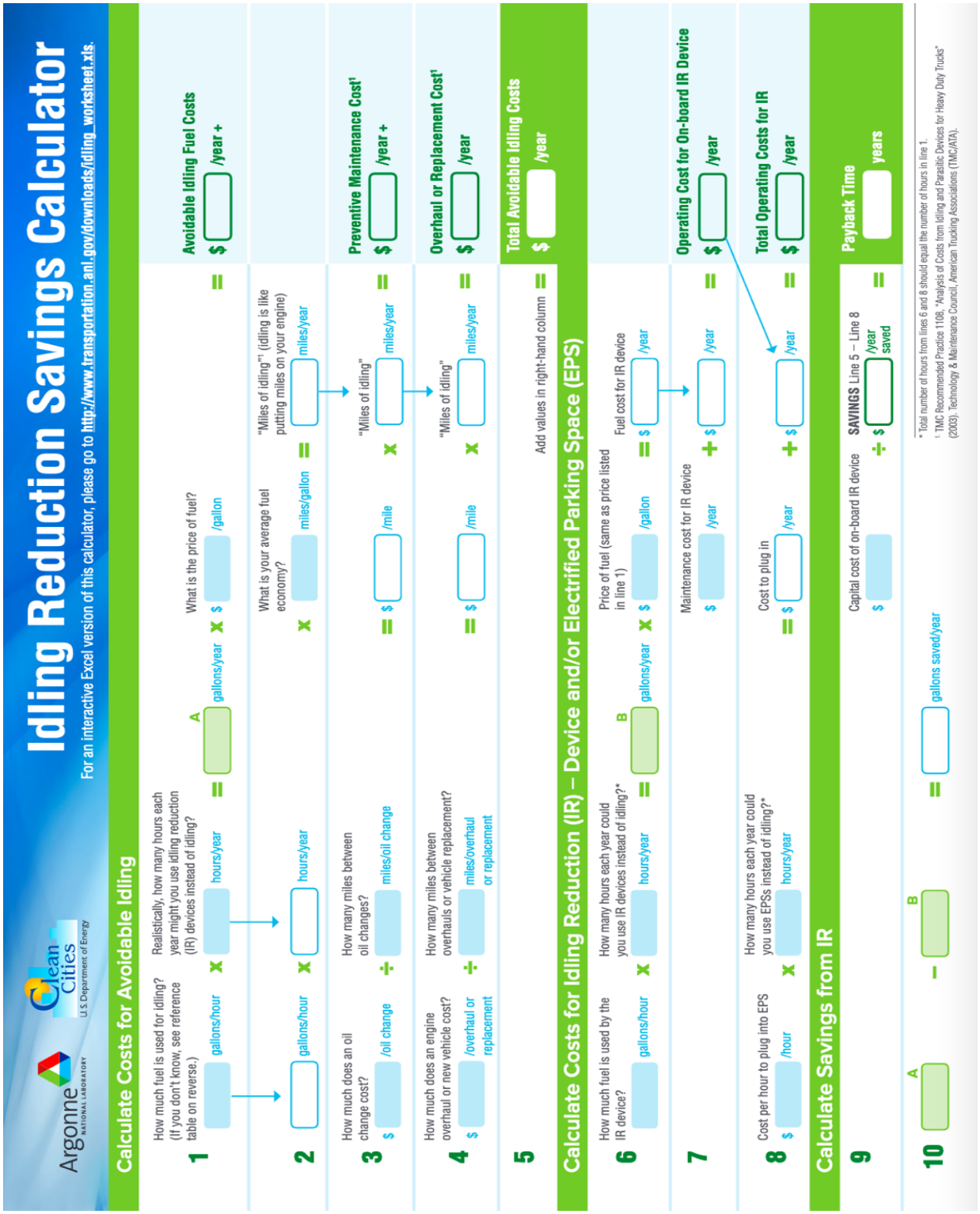
Redox-flow Batteries- These batteries differ from traditional batteries in that rather than having the active materials stored within the body of the battery, the energy is stored in two electrolyte solutions that flow through an electrochemical cell to produce the electricity. As a result, it is easier to scale a redox-flow battery system for longer duration storage. There are several different chemistries that are used, with vanadium redox-flow batteries being the most widely known. There are a couple of installations for flow batteries in the 100-200 MW range, in China and Germany, that also have capacities in the 100-800 MWh.

Chemical Storage

Hydrogen - Storing electricity as a chemical fuel, like hydrogen, is a different type of storage from those previously discussed. In such a scheme hydrogen would be produced via electrolysis of water, and the hydrogen generated would be compressed and stored in tanks. When needed the hydrogen could be used to create electricity either by using fuel cells, or gas turbines (100% hydrogen compatible turbines are commercially available).

While hydrogen for electricity production may have an exciting future there are other functions that may be of more direct use to LAC. Hydrogen is a tradable commodity that can serve more than one function. Stored hydrogen could be used for transportation fuel, chemical synthesis, electricity, or even heat. If LAC were to pursue its own infrastructure for hydrogen, the best application would be as transportation fuel to replace current diesel assets. Fuel Cell buses are already in operation and could be purchased, or existing buses could be retrofitted for fuel cell operation.

Appendix E: [Argonne National Laboratory Idling Calculator]



How Much Fuel Is Used for Idling?

Vehicle Type	Class	Fuel Type	Size Indicator		Idling Fuel Use (gal/h)		Source
			Engine Size (l)	GVWR (lb)	No load	With load	
Passenger Car (Ford Focus)	1	G	2	–	0.16	0.29	ANL 1
Passenger Car (Volkswagen Jetta)	1	D	2	–	0.17	0.39	ANL 1
Passenger Car (Ford Crown Victoria)	1	G	4.6	–	0.39	0.59	ANL 1 & 2
Medium Heavy Truck	6	G	5–7	19,700–26,000	0.84	–	WVU
Delivery Truck	5	D	–	19,500	0.84	1.1[1]	NREL
Tow Truck	6	D	–	26,000	0.59	1.14[2]	ORNL
Medium Heavy Truck	6–7	D	6–10	23,000–33,000	0.44	–	WVU
Transit Bus	7	D	–	30,000	0.97	–	ORNL
Combination Truck	7	D	–	32,000	0.49	–	ORNL
Bucket Truck	8	D	–	37,000	0.90	1.50[2]	ORNL
Tractor-Semitrailer	8	D	–	80,000	0.64	1.15[3,1]	TMC

D = diesel. G = gasoline. Gal = gallon(s). GVWR = gross vehicle weight rating. h = hour(s). l = liter(s). lb = pound(s). PTO = power take-off.

1. High idle.
2. PTO on.
3. Air conditioning on.

Sources

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ANL 2: Rask, E.; Keller, G.; Lohse-Busch, H.; et al. (2013). "Final Report: Police Cruiser Fuel Consumption Characterization." Work performed by Argonne National Laboratory for the Illinois Tollway Authority.

NREL: National Renewable Energy Laboratory Project Draft Final Report for the Period August 1, 2012, through March 31, 2014, "Data Collection, Testing and Analysis of Hybrid Electric Trucks and Buses Operating in California Fleets." ARB Agreement Number 11-600, NREL Contract Number FIA-12-1763, April 15, 2014.

ORNL: Lascurain, M.B.; Franzese, O.; Capps, G.; et al. (2012). *Medium Truck Duty Cycle Data from Real-World Driving Environments: Project Final Report* (ORNL/TM-2012/240). Work performed by Oak Ridge National Laboratory for the U.S. DOE.

TMC: TMC Recommended Practice 1108, "Analysis of Costs from Idling and Parasitic Devices for Heavy Duty Trucks" (2003). Technology & Maintenance Council, American Trucking Associations (TMC/ATA).

WVU: Khan, ABM S.; Clark, N.N.; Gautam, M.; et al. (2009). "Idle Emissions from Medium Heavy Duty Diesel and Gasoline Trucks." *Journal of the Air & Waste Management Association* (59:3) 354–359.

Other Idling Reduction Resources

- IdleBox www.cleancities.energy.gov/idlebox
- IdleBase http://cleancities.energy.gov/idlebase
- *National Idling Reduction Network News* energy.gov/eere/vehicles/vehicle-technologies-office-national-idling-reduction-network-news
- Argonne National Laboratory http://www.transportation.anl.gov/engines/idling.html
- Alternative Fuels Data Center http://www.afdc.energy.gov/conserve/idle_reduction_basics.html

Appendix F: League of American Bicyclists Bronze Level "Bicycle Friendly Community" Designation

THE LEAGUE OF AMERICAN BICYCLISTS
since 1880

Leading the movement to create a bicycle-friendly America for everyone

1612 K STREET NW, SUITE 1102, WASHINGTON, DC 20006 | *phone* 202-822-1333 | *fax* 202-822-1334 | WWW.BIKELEAGUE.ORG

December 8, 2021

Eric Martinez
County Engineer
Public Works
Los Alamos County
1000 Central Avenue, Suite 160
Los Alamos, NM, 87544

Dear Eric,

Congratulations to Los Alamos on renewing the Bicycle Friendly Community designation at the Bronze level! This award is presented only to communities with impressive commitments to bicycling.

Enclosed you will find your 2021 Bicycle Friendly Community Award Certificate. If you would like to order Bicycle Friendly Community road signs, certificate duplicates, or Smart Cycling educational materials, please visit the League store online at: bikeleague.org/bfcstore.

I have also included information from our partners at Eco-Counter to help your community more effectively collect and track ridership data to improve your Evaluation & Planning efforts.

Your 2021 BFC award status will be promoted by the League for four years, after which time your designation must again be renewed. You will be reminded via email prior to the Fall 2025 application deadline. Until then, your community's 2021 award status and report card will be publicly available in our online award database: bikeleague.org/bfa/awards#community.

Once again, congratulations on your efforts to create a great Bicycle Friendly Community! Thank you for your engagement with the Bicycle Friendly Community program and for your commitment to improve bicycling conditions in your community.

Best Regards,

Amelia Neptune
Director, Bicycle Friendly America Program
League of American Bicyclists

CFC #11563

THE LEAGUE
OF AMERICAN BICYCLISTS
since 1880

is pleased to designate

Los Alamos, NM

as a

BICYCLE FRIENDLY COMMUNITY

in recognition of your outstanding efforts to encourage bicycling in your community

2021 - 2025 » BRONZE

PRESIDENT

THE LEAGUE » BICYCLE FRIENDLY AMERICA

CHAIR, BOARD OF DIRECTORS

XIV. Other Communities' Climate Action Plans

The following list contains examples of sustainability/climate change action plans from various communities around the country large and small. We know that we are at the beginning of this journey; many of these plans have been in place for over a decade and have been reworked, modified, and updated based on needs and changes. We expect our plan to be a "living" document which will also be modified and updated as needed.

- Albuquerque, NM
- Anchorage, AK
- Bend, OR
- Boulder, CO
- Eagle, CO
- Eugene, OR
- Fort Collins, CO
- Hillsboro, OR
- Las Cruces, NM
- Los Angeles County, CA
- Marin County, CA
- Park City, UT
- Phoenix, AZ
- Salt Lake City, UT
- San Louis Obispo, CA
- Santa Fe, NM
- Seattle, WA
- Sedona, AZ
- Telluride, CO
- Westminster, CO
- List of 50 Largest Cities in US Climate Mitigation Plans
- C40 Website (World's Biggest Cities Committed to Fighting Climate change)

XV. Acknowledgements

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