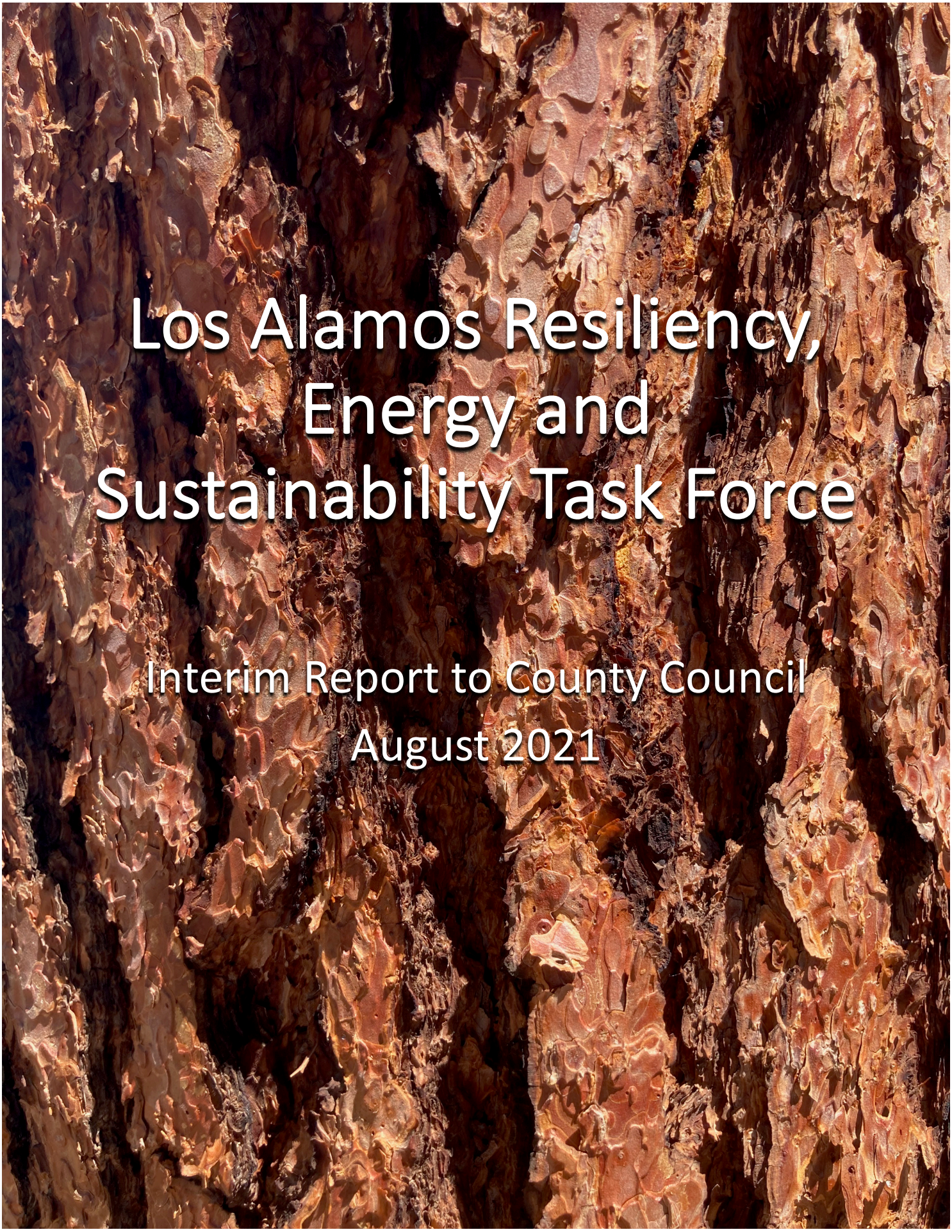

Los Alamos Resiliency, Energy and Sustainability Task Force

Interim Report to County Council

August 2021

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I. Personnel

Los Alamos County Councilors

Randall Ryti, Chair
James Robinson, Vice-Chair
Denise Derkacs
David Izraelevitz
David Reagor
Sarah Scott
Sean Williams

Task Force Members

Katie Leonard, Chair
Robert Gibson, Vice Chair
Sue Barns
Elizabeth Daly
Chick Keller
Roy Michelotti
Heidi Rogers
Steve Tobin

Community Subcommittee Members

Lia Brodnax (Natural Gas Reduction/Community Planning & Zoning)
Skip Dunn (Community Planning & Zoning/Natural Gas Reduction)
Ben Hill (Natural Gas Reduction/Community Planning & Zoning)
Jack Kennison (Waste, Consumption & Natural Resources)
Daniel Leonard (Electricity Supply & Demand)
Dina Pesenson (Waste, Consumption & Natural Resources)
Oral Saulters (Waste, Consumption & Natural Resources)
Greg White (Natural Gas Reduction/Community Planning & Zoning)

Los Alamos County Staff

Angelica Gurule, Environmental Services Manager
Anne Laurent, Director of Public Works
Amy Danforth, LAC Senior Office Specialist

II. Los Alamos Resiliency, Energy and Sustainability (RES) Task Force Charter

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 recommendation 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.

View of the Sangre de Christos from North Mesa

III. Glossary of Terms

ACT – Atomic City Transit
BACT – Best Available Control Technology
CB – Consumption-Based
CAP – Climate Action Plan
CO_2 e – Carbon Dioxide Equivalent
CSCNM – Coalition of Sustainable Communities New Mexico
EV – Electric Vehicle
GHG – Greenhouse Gas(es)
HFC – Hydrofluorocarbon
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)
LRWSP – (Los Alamos County) Long-Range Water Supply Plan
NG – Natural Gas
RFP – Request for Proposal
RTD -— Regional Transit District
SOV – Single-Occupant Vehicle
T-Board – Transportation Board
WCNR – Waste, Consumption & Natural Resources Subcommittee

IV. Time Frames

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

Lovely Los Alamos

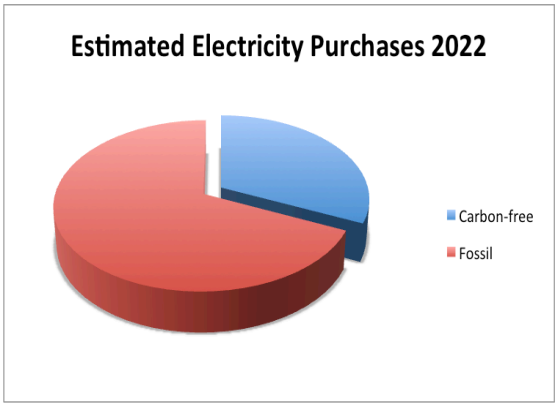
V. Executive Summary

Climate change represents an existential threat to our community, with impacts becoming evident at an accelerating rate: hotter temperatures in the summer, reduced precipitation year-round, and animals seeking food are more present in our town.

This Interim Report contains six sections of recommendations: General Recommendations, and recommendations in the areas of Community Planning & Zoning, Electricity Supply and Demand, Natural Gas Reduction, Transportation & Mobility, and Waste, Consumption & Natural Resources, all aiming to reduce our carbon footprint and mitigate climate change.

Los Alamos County has already taken some action to address climate change in several ways: Atomic City Transit helps residents get around without driving their own cars, we have increased our renewable energy sources, the Eco Station helps us recycle materials and mulch yard waste, and LAC has started to invest in electric vehicles for its fleet. We applaud these efforts. It is time, however, to go further: to create our own Climate Change Action Plan and to follow it. In order to create this plan, we will need to perform a baseline GHG study from which we will set reduction targets and timelines. Success in meeting these reduction goals will depend on support from County Council, LAC staff, local businesses, schools, and residents.

The Board of Public Utilities (BPU) made the original commitment to become a net zero electricity provider in 2013. Since that time, the Department of Public Utilities (DPU) and BPU have made measurable progress in decreasing Los Alamos County's (LAC) carbon footprint by entering into the Power Purchase Agreement (PPA) with Uniper, which goes into effect in 2022. This is important progress. The accompanying figure shows the distance LAC still has to go. The Carbon-Free Power Plan (CFPP), will only increase the carbon-free portion of electricity generation by a maximum of ~10% once fully operational.



To effectively implement a GHG reduction plan, the County must address the building sector. The vehicle for this change is through the county building codes which affect new buildings, both residential and commercial, and retrofit projects that require permits. The County should consider incorporating a local overlay code addressing steps to reduce GHG emissions and other sustainability issues. Given the County is essentially built out in terms of housing, an incentive program is needed to voluntarily initiate GHG reduction changes. The County should consider developing an interest-bearing loan program for retrofits for those whose incomes exceed the low-income threshold served by the Los Alamos Housing Authority. Increased insulation and replacement windows should be targeted first to reduce energy usage and assist in the transition

to cleaner electric energy sources. All of our recommendations have been implemented in other jurisdictions.

Virtually the entire Los Alamos community is heated by combustion of natural gas (NG). Residential space heating is the majority of that demand. Both NG itself, when it escapes, and the carbon dioxide it produces, when burned, are GHG that cause climate change. The Board of Public Utilities has adopted a strategic goal to phase out NG use in Los Alamos by 2070. No single "silver bullet" will replace NG, though technology, economics, and regulatory factors will evolve to ease this difficult task. Technically and economically viable approaches to new construction and existing homes already exist. 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. Peak electrical demand may exceed present electric supply system capacity. Distributed ("rooftop") solar photovoltaic generation and storage may be necessary.

GHG emissions caused by transportation make up roughly 30% 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, are important ways to reduce GHG release. Encouraging the purchase of electric vehicles (EV) for County, businesses, and residents is another key way to reduce transportation-based GHG emissions: we must also supply adequate EV charging stations around town to support this transition from gas-powered vehicles to EVs. Eventually all gas-powered equipment (lawn/garden, golf carts, etc.) will need to be powered by carbon-free sources. In addition, installing shaded parking and implementing a "no idling" policy will reduce unnecessary emissions from vehicles.

In order to comprehensively address Los Alamos County's GHG emissions, as well as plan for resiliency and sustainability in the face of climate change, it is necessary to consider broadly the activities and resources of the community. We must not overlook the areas of waste management; consumption of goods, food and services; refrigerants and other fluorinated gases; water and wastewater; and management of natural spaces, soil, land use, deforestation/reforestation, 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, but also enhancement of climate change resiliency and sustainability, economic benefits, and improvements to health, equity, environment and quality of life.

Community education and outreach will be critical to educate LAC employees and residents about reducing their carbon footprints and to encourage them to make GHG-reducing lifestyle choices.

VI. General Recommendations

The General Recommendations are presented in order of priority and action: Recommendations 2-5 will depend on Recommendations “Zero” and 1 being put into place.

Recommendation "Zero:" Establish "Net Zero" GHG emissions as a long-term goal for County government and the community (exclusive of LANL) as a whole.

Recommendation 1: Perform a baseline GHG emissions study from which to set reduction targets and other goals and against which to measure progress. Consider hiring a consulting firm to gather baseline data, to create accountability metrics, and to generate strategy recommendations to ensure we have a transparent accountability system for measuring progress. This should be conducted within one year of this Task Force’s submission of final recommendations.

Recommendation 2: Create a Climate Change Action Plan which includes baseline data, GHG reduction targets, and climate mitigation strategies, to be updated every 5 years or as needed.

Recommendation 3: Produce an annual Climate Change Action Report to be presented to County Council and shared with the community. Publicity and outreach to residents so they are aware of its contents will be important, much like the Annual Water Quality Report. A condensed version (1-2 page) of the report should be made available to all residents.

Recommendation 4: Create an on-going citizen body tasked to advise Council on reducing GHG emissions. This could be, e.g., a continuation of the current RES 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.

Recommendation 5: Integrate the goal of net zero GHG emissions, practices to achieve net zero, and other sustainability practices into all County government operations and interactions with the community. Provide information, recommendations, and education to the community. To support this mission, appropriate staffing additions or redirection may be necessary, as is being done by other communities. Point(s) of contact for the community and other LAC boards and departments should be established and clear.

All of these recommendations will require community outreach and education.

VII. Recommendations Overview

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

Community Planning & Zoning

1. Develop an Overlay Code Superseding the Current Building Code with Energy Improvements and Connections to Help Transition to a Cleaner Electrical Energy Source.
2. Consider a "Design-To" Concept for Changes Rather Than Audits or Certifications for LEED or HERs Compliance.
3. Educate Contractors and Home Owners on the Importance of Selecting Energy Star Appliances. Listen to and Address Their Concerns.
4. The County Should Set an Example with its Purchasing and Contracting by Incorporating an Evaluation of CO_2 Equivalents in its Selection Process.
5. The County Should Advocate to the State, Supporting Greater Flexibility in Code Requirements With Respect to "Replacement" Options. Current Code Requirements for a Replacement Window Cost 50% More than a Standard Double-Pane Window. The 2018 Code Typically Triggers Triple-Pane Windows Rather Than Double-Pane Windows. Items Like This Disincentivize Voluntary Retrofit Replacements to Reduce GHG Emissions.
6. The County Should Include Some Commercial Zoning in Every Section of Town for a Gathering Place, such as Coffee Shop or Store, to Minimize Trips and Encourage Community Gathering.
7. Develop a Loan Program, Repaid Through Utility Payments, for Existing Home Retrofits for the Addition of Insulation and Replacement of Windows and Including Other Recommendations to Reduce GHG Emissions. The Program Should Address All Costs Associated with Retrofits, Including Mold remediation, Asbestos Removal, etc.

Electricity Supply & Demand

1. The County Council and the BPU Should Formalize the Net Zero Carbon Electrical Power Commitment and Adopt a More Ambitious Timeline to Make LAC Net Carbon Zero Electricity by 2035.
2. The DPU and BPU Should Evaluate Options and Develop a Plan Regarding the LANL/LAC Power Generation Relationship and What it Means in Terms of LAC's Achievement of its Net Carbon Zero Goals.
3. DPU/BPU Should Develop an "Intermittency Management Strategy'' Including But Not Limited to Demand Management, Energy Storage Resources, Curtailment of Generation, and Time-of-Use metering.
4. LAC Should Pursue Investment in Energy Storage Resources. In Addition, LAC Should Study Centralized Community Storage, Residential Storage, or Both.

5. The County Should Either Purchase Utility-Scale Solar and Wind Resources, or Purchase Those Resources From an Entity that Aggregates Renewable Energy Resources.
6. LAC should Continue to Pursue the Feasibility of Small Modular Reactors or Other Mature Nuclear Technologies.
7. LAC Should Support and Incentivize the Continued Adoption of Residential PV Installation While Establishing a Program to Enable Homeowners to Purchase or Lease Residential Storage Battery Units That are Either Coupled With Their PV Installations or as Stand-Alone Systems.
8. The DPU and BPU Should Support the Expansion of EVs and EV Charging Infrastructure.
9. LAC Should Adopt a Community Education Strategy Around Electrification of Efficient Appliances for Residential Use, i.e. Heat Pumps, Air Conditioning, Water Heaters, Magnetic-Induction Stoves, etc.

Natural Gas Reduction

Except for #8, all recommendations are preliminary. Most represent intent ("should"), not yet refined and finalized into actionable policy recommendations. The term "encourage" as used below could mean education, promotion, or even outright mandate at various points in time.

1. Compact Architectures Should be Encouraged in New Construction.
2. New Construction Should Derive a Significant Portion of its Heating Energy From the Sun.
3. All New Construction Should Have Solar Access.
4. Reduce Average Heat Loading in Residences to 0.30 therms/sq. ft. or Less.
5. Heat Pumps Should be Substituted When NG-Fired Furnaces and Boilers are Replaced.
6. Solar Thermal, Heat Pump, or Point-of-Use Tankless Water Heaters Should be Substituted When Traditional Hot Water Heaters are Replaced.
7. Electric Induction Ranges Should be Substituted When Traditional Cookstoves are Replaced.
8. NG Pilot Lights Should be Discouraged or Banned in New or Replacement Gas Appliances.
9. Institutional Spaces Should be Heated Without Natural Gas *(placeholder pending specific recommendation(s) in final report).*
10. Base-Load Electrical Generating, Transmission, and Distribution Requirements to Meet Overnight Heating Energy Demand Should be Included in Electrical Utility Supply Planning.
11. Distributed ("Rooftop") Electric Generation and Storage Should be Encouraged.
12. Natural Gas Hookups Should Not be Allowed for New Construction After Some Point in Time.

Transportation & Mobility

1. Increase Public Transportation Ridership
    a. In Partnership with Regional Transit, Increase and Incentivize Regional Transit Use for Commuters and Visitors from Out of LA County
    b. Develop an "Alternative Transit" Incentivization Program for Employees of County, Schools, and Community Business (and LANL)
    c. To Encourage and Improve Local Public Transit Ridership, Address "First and Last Mile" Needs
    d. Continue to Invest to Increase Bus Frequency and/or Other Kinds of On-Demand Service
    e. Provide Evening and Weekend Atomic City Transit Service
    f. Develop a Smartphone Ridesharing App to Help Residents and Commuters Get Around
    g. Do a County Assessment for Commuter and Other Transportation Needs
2. Improve Bicycle and Walking Infrastructure to Promote Safe and Convenient Carbon-Free Transportation
    a. Implement the Transportation Board's Recommendations Outlined in the Bicycle Transportation Plan
    b. Green Boxed Bike Lanes and Protected Bike Lanes
    c. Create a Bike-Only Path Between Los Alamos and White Rock (not on the main road)
    d. Bike Lane and Walking Path on Omega Bridge (or Other Option)
3. Increase publicly accessible electric vehicle charging infrastructure
4. Increase the Number of Electric Vehicles (EV) in LAC, ACT, and LAPS Fleets, Eventually Making 100% EV
5. Implement Shaded Parking and a County-Wide No Idling Policy
6. Launch Municipal Bike Share Program
7. Encourage Private Electric Vehicle Purchase and Charging During Low Peak Hours
8. Increase Number of Crosswalks (Some with Lighting)
9. Convert Municipal Small Engines, Such as Golf Carts and Lawn/Garden Equipment, to be Fossil Fuel-Free
10. Invest in Consistent, Ongoing Community Outreach and Education

Waste, Consumption & Natural Resources

1. Perform consumption-based GHG analysis for LAC
2. Following "Zero Waste" principles, eliminate municipal waste sent to landfill through reduction, re-use, recycling and composting with a goal of 100% diversion by a period of time to be determined
3. Educate community regarding sources of GHG emissions and provide information on reduction of personal carbon footprints

4. Reduce consumption-associated emissions by encouraging and supporting sustainable purchasing, use and disposal of food, goods and services, refrigerant management, and low-carbon construction materials
5. Build a comprehensive water conservation and watershed stewardship plan for the Los Alamos and White Rock communities
6. Manage natural and community landscapes for climate change mitigation, resilience, community, cultural and wildlife values, and carbon sequestration

Pajarito Ski Hill

VIII. Introduction

Communities all around the world, large and small, are creating action plans to address climate change. The recommendations outlined in this interim report are based on research and data, and include recommendations and policies that other nations, cities, and towns are adopting.

We have taken into account our unique location and population: a high-altitude, mountainous desert location with a fairly stable population (in terms of numbers) composed of highly educated citizens and their families. 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 cannot completely ignore its presence or its impact on our community.

Our intention in submitting these recommendations is for the County and its employees and residents to do our part to slow climate change and to create an action 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.

As the future unfolds, we will all need to "do our bit" to stem the tide of climate change, as individuals, as families, as employees, and as a community. This will mean changing some of our behaviors and sacrificing some of our luxuries, comforts, and conveniences. These changes will take consistent and dedicated community education and outreach. It will take planning, effort, and people power. Most of these changes will also bring benefits other than GHG reduction: improved health and quality of life, economic boosts, and beautification of the community.

New Mexico Governor Michelle Lujan Grisham acknowledges that climate change is happening and is human-caused, and has set ambitious climate change action goals in Executive Order (EO) 2019-003 (https://www.governor.state.nm.us/wp-content/uploads/2019/01/EO_2019-003.pdf):

- 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

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.

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

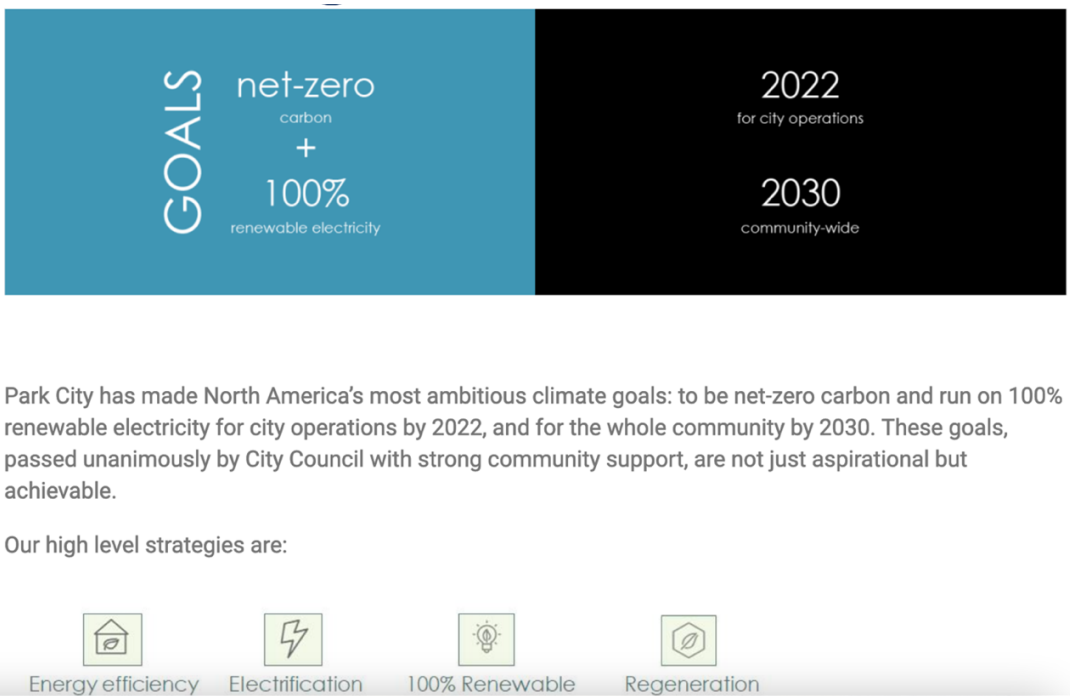


Photo from the Park City, UT, sustainability website:
https://www.parkcity.org/departments/sustainability

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):

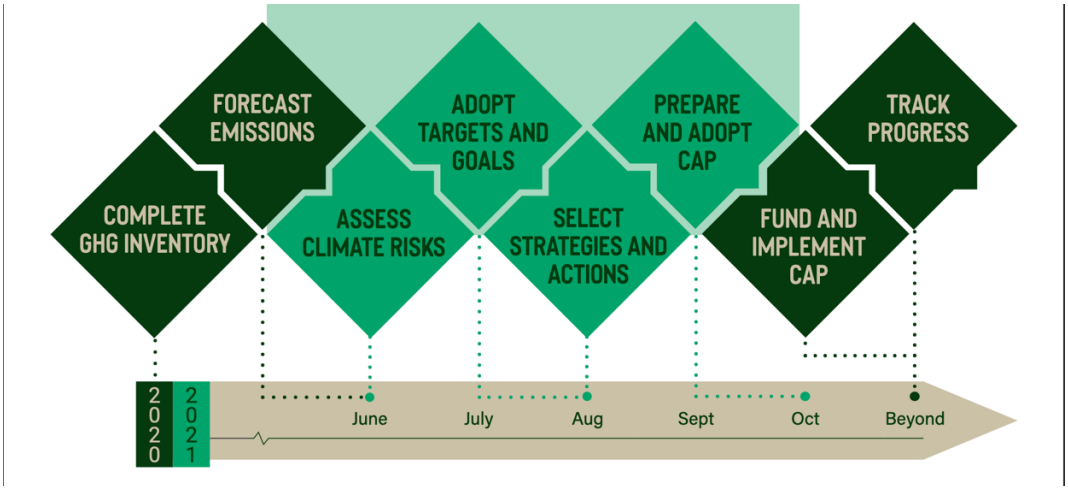


Photo from Telluride's Climate Action Plan Fact Sheet website:
https://mcusercontent.com/45794dd4deb0a48d92b415574/files/db86a259-d6c2-6dcb-7cd6-be4f41ac845e/Town_of_Telluride_CAP_Factsheet_FNL_6.25.pdf

Since its founding, Los Alamos has been an innovator, a leader, and a hub of scientific research. We must continue to lead the way to address climate change and create a sustainable future for generations to come. We, too, must create a climate change action plan. Without a stable and safe future, our children, grandchildren, and their children and grandchildren will not 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."

Notes

- The research effort for each subcommittee's focus areas (as well as General Recommendations) has been undertaken by one or more than one member of each subcommittee or the Task Force, and the recommendations below reflect various stages of completion.
- As this is the Interim Report, all recommendations are subject to further modification, addition or elimination as subcommittee work continues through to the end of the charter in 2022.
- Some of these recommendations may not represent every Task Force member's view on a particular subject.

View from Deer Trap Mesa

IX. Recommendations: Community Planning & Zoning

Introduction

IRC 2018 and New Mexico Residential Energy Codes are the current building codes adopted in Los Alamos County. These apply to new construction and to renovation modifications requiring a permit, not to unaltered homes. Los Alamos codes requiring a permit are extensive in their applicability, but do not cover interior changes without plumbing or electrical changes.

The County should consider a local overlay code to address the steps needed to reduce GHG emissions and other sustainability issues. Several cities, both large and small, have supplemental codes commonly referred to as "Green Codes" which address issues beyond current requirements. Green Codes for other cities vary from expediting permitting, reducing permit costs, enhancing tree cover, to detailed construction techniques that supersede the code. Some jurisdictions have put their green 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 consumption to electricity requires careful planning to assure that greenhouse gas emissions are actually reduced. Refer to the Natural Gas Sub-Committee for detailed alternatives to consider. Since the building code covers all aspects of building, and landscaping, an overlay code can incorporate other sustainability recommendations discussed in the LARES committee report. However, most of Los Alamos County is already built out so few residences will automatically trigger the code requirements. Incentives to promote change and provide easy pathways to implement significant energy saving measures must be addressed.

Some issues to address include:

1) The overlay code should encourage energy efficiency improvements such as replacing windows and attic insulation to existing homes that are not being renovated. The code should also incorporate requirements for the future by requiring preparation for heat pump installation (conversion from natural gas heating) and preparation for solar readiness. Establishing a method to subsidize the costs will be important to assure that least energy efficient residences are converted. To incentivize residential housing changes the County should consider establishing a utility loan fund from its reserves for energy reducing improvements where low interest loans are issued but paid back through the electric bill. This is discussed in more detail below.

2) The County should consider using the "design to" concept rather than a third party audited installation. The cost of third-party audits with certifications is not insignificant and can deter installations for energy reduction projects.

3) The international residential building code of 2018 does not incorporate energy standards for appliances, as the standards are set by the Federal government. The County should educate housing owners and add a special outreach to the tradespeople who install furnaces, water heaters, and other natural gas consuming equipment regarding the importance of installing energy star appliances. If education does not yield change, then the County should consider narrowing the list of Federally allowed appliances to the more energy efficient ones, such as energy star appliances, for installations throughout Los Alamos County by reviewing if the County business license process can be utilized to incorporate the requirements.

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.

5) The New Mexico codes incorporate little flexibility for replacements in kind and require significantly more expensive options for higher elevation areas, The County should consider advocating to the state for greater flexibility for the County permitting staff. The County cannot ignore a code requirement and code modifications are needed. For example, a same size replacement window in Los Alamos will require triple pane windows, rather than double pane as in done in Albuquerque, which cost 50% more. Replacements in-kind are allowed in other jurisdictions without triggering the new code requirements.

6) The County should include some commercial zoning in every section of town.

Background

In general buildings consume 40% of US energy which can be a mix of fossil fuels and other sources. The 1972 energy crisis encouraged energy efficient homes as the building codes responded to current events. The 40% number may not apply specifically to Los Alamos given the LANL transportation 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 natural gas committee report supplies additional information.

IRC 2018 and the New Mexico energy code are the current building codes adopted in Los Alamos County. 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 have far less energy requirements than the typical home in Los Alamos, NM. Buildings not retrofitted remain the issue.

To address improvements beyond the standard building code, several cities and towns have a "Green Code" that applies in addition to the required code. Most of the Green Codes focus on expedited permitting for new construction with energy saving projects or reduced permitting costs. This may not be a sufficient incentive for Los Alamos construction. Portland, OR, has a Green Code that funds new energy conservation projects, but Los Alamos needs proven ideas implemented to reduce greenhouse gases.

- Seattle's new Green Code eliminates new fossil fuel connections for heating and eliminates new electric resistance heating, essentially requiring electric heat pumps for heating. 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 LEED and HERS building permits.

- The Denver, CO, Green Code was passed with a public vote and provides financing options for energy efficient construction.

- Holland, MI, has a fund to rebate 20% of the energy improvements as well as a fund to borrow $5000 to $30,000 at a fixed low interest and pay it back via the electric bill.

Fort Collins, CO, developed an interest-bearing loan program in support of comprehensive projects that include solar, storage, and electrification. Their utilities department started with their utility reserves and reimbursement was paid through electric bills. Although larger in population size (337,000 versus 19,000), their 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 it was expanded as a public private partnership to expand 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 the low-income homeowners through the Los Alamos Housing Partnership (LAHP). Los Alamos has addressed the

issue that many counties face which is how to increase low-income participation. Los Alamos needs funds to serve residents whose assets exceed the LAHP requirements.

Several states have established funds to cover the pre-weatherization issues such as addressing moisture, structure, and wiring issues that are not covered by federal programs. The many ideas listed above are some that we hope the County will incorporate, and any loan fund should include these.

View from Navajo Road on Barranca Mesa

Recommendation 1: Develop an Overlay Code Superseding the Current Building Code with Energy Improvements and Connections to Help Transition to a Cleaner Electrical Energy Source.

- To start this discussion, the Community Planning & Zoning subcommittee would like to thank Ben Hill, an architect and member of the subcommittee, for this work. He modeled a typical 1950s residence and changes to current code to reflect the changes in energy loss.

- Chart 1 (p. 26) reflects the difference for a residential dwelling with typical 1956 construction and with energy efficiency improvements added. From the chart, 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 known as the R value, which is based on not just climate but also elevation. Los Alamos's R value is different from Albuquerque and costs for windows will be higher than most of the rest of the state.

- To meet the new requirements for Los Alamos some double panes are available but for most manufacturer's triple panes will have to be installed. At this time the industry is adjusting to the new requirements and costs are higher and supplies are limited. Given the high cost of window replacement but the higher energy savings associated with replacement some enticement will be needed to help homeowners pursue this path. Increased efficiency gains would still be significant if 2015 code double pane windows were installed or if the R value for the rest of the state was used but the current code does not have an allowable exemption. Changes made without replacing the windows from a single pane are without value as single pane windows are essentially holes in the wall letting the heat out. Replacing single pane windows should be considered a priority to achieve energy loss goals from housing and reduce CO2e emissions. The extent of single pane windows left in the community is an unknown factor.

- The County could consider collecting this data as part of the assessor information it collects for 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 1 reflects adding 12 inches of attic insulation. This is effectively R49, the new 2018 code, 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 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.

- Homeowners who have the most opportunity to reduce energy use, such as those with single pane windows and without additional insulation added in the attic above pre-construction levels, may need assistance to incorporate these changes. Establishing a loan fund to help these homeowners pay for the energy reductions over time, while meeting New Mexico's anti-donation law, should be addressed. The fund should also cover pre-weatherization issues such as asbestos demolition, addressing mold concerns, structural and wiring issues, and other modifications necessary to install energy use modifications that reduce greenhouse gas emissions. Pre-weatherization modification costs have been a factor in not pursuing energy retrofits as the costs can be significant.

- The above changes are all reflected in the current code so new homes and additions requiring retrofits are covered. However, requirements to prepare the buildings for a clean energy future are not. As clean energy becomes more available and natural gas, propane, or fuel oil are phased out, preparing the home for heat pump installation and preparation for solar readiness is not addressed. Adding connections at the time of build so that the conversions can be made conveniently will help everyone 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.

- Timing for the change to heat pumps and solar installations must be carefully managed. Electricity is not as efficient as natural gas for energy use, in fact from an energy consumption point of view it can be 3 to 5 times higher. This is a substantial change for any power grid, and changes can be complex and expensive. Adding the connections now and later moving to installations will have the overall effect of reducing greenhouse gas emissions.

- The Council should be aware that older manufactured homes, aka 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. HUD has identified the following measures for older homes:

    - Install energy-efficient windows and doors
    - Add insulation to the belly
    - Make general repairs (caulking, ducts, etc.)
    - Add insulation to your walls

- Install insulated skirting
- Install a belly wrap
- Add insulation to your roof or install a roof cap

- Careful attention must be paid to dewpoint and vapor barrier issues to avoid mold concerns and corrosion issues. Still, these measures achieve only a 30% reduction in fuel gas 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 but non-energy star models can still be purchased.

- Quad-plexes will require a unique solution as they fall under the under commercial code and frequently have different owners. New York City is developing for the multi-family buildings a one-stop shopping effort where they have developed for the owners a proposal with detailed plans, cost estimates, and financing information. This may be an option for Los Alamos given the large number of quads.

Recommendation 2: Consider a "Design-To" Concept for Changes Rather Than Audits or Certifications for LEED or HERs Compliance.

- The County should consider a "design to" concept rather than specifying a LEEDS or HERS design. These require third party audits, which is nice for assurance but drives costs up. In Los Alamos we simply need energy savings improvements installed, not third-party assurance. The County should consider waiving permit fees for projects involving only energy saving modifications. For energy savings modifications, a simple list of modifications that would not need a permit review or a permit fee could be maintained and replaced with a notice that the work and a description of the work was being performed. This is a practice maintained for industry by some clean air authorities in the USA. Making the process extremely simple and convenient should be the goal for energy savings projects.

Recommendation 3: Educate Contractors and Home Owners on the Importance of Selecting Energy Star Appliances. Listen to and Address Their Concerns.

- Federal law sets the standard for energy star appliances but non-energy star appliances can still be sold. Implementing in the Green Code a requirement that only “energy star” appliances can be sold or installed within Los Alamos County will reduce energy use and consequently GHG emissions.

- The County should provide education to homeowners and contractors about the importance of using energy star appliances as a start to reducing energy use and address the concerns they raise. Contractors have influence in the selection of installed equipment as they converse with the homeowner about options to install, the costs, and reliability. Outreach is essential.

- If education does not yield significant results the County could consider adding an addendum to their business license process. Los Alamos requires a business license for all companies doing work in the County. As noted on the business license page for the County:

    - "Any person, group, organization, business or entity proposing to engage in business within the County and that is required by the state to pay gross receipts taxes on its business is required to apply for a business registration or business license and pay the applicable fee." (Los Alamos Code of Ordinances, Chapter 12).

- From the code of ordinances Chapter 12, business is defined as:

    - *“Business* means any commercial enterprise, trade, occupation, calling, profession, vocation or activity engaged in, conducted or carried on by any person, his agent or employee, or by the use of automatic machines, except news racks, for the purpose of gain, benefit or advantage, either direct or indirect, on which state gross receipts tax is paid or payable. A charitable organization shall be deemed to be a business if it is required to pay gross receipt taxes on a business conducted in the County.”

    - Given the wording, this will capture not only local stores but “off the Hill” stores that install appliances in Los Alamos County. This will not capture all appliances as some are self-installed but will capture a greater percentage than are being installed now and greenhouse gas emissions will be reduced over time.

Recommendation 4: The County Should Set an Example with its Purchasing and Contracting by Incorporating an Evaluation of CO_2 Equivalents in its Selection Process.

- 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 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. An older rule of thumb was $2000 per tonne of annual emissions was an expectation set by regulators. This top-down philosophy, rather than bottom-up philosophy, has created change when replacement in kind was being sought but an exact model replacement was not available for purchase. The County should consider adopting the philosophy change, incorporate an evaluation of CO2e emissions in their purchasing and contracting and increase the level of justified increase in costs from 5%. Awareness drives change.

- This recommendation should be applied to all public entities in the County such as the Los Alamos Public school system, not just the County, as support for a cleaner environment.

Recommendation 5: The County Should Advocate to the State, Supporting Greater Flexibility in Code Requirements With Respect to "Replacement" Options. Current Code Requirements for a Replacement Window Cost 50% More than a Standard Double-Pane Window. The 2018 Code Typically Triggers Triple-Pane Windows Rather Than Double-Pane Windows. Items Like This Disincentivize Voluntary Retrofit Replacements to Reduce GHG Emissions.

- New Mexico has progressive energy codes for remodels and new construction but ignores the effects of these codes on simple "replacements in kind." Modifications for something as simple as window replacement triggers the new code with significantly higher costs. It discourages more renovations that reduce energy when the costs are 50% higher. The County staff cannot ignore these code requirements but the County can influence the state to allow greater flexibility for what normally would be considered small changes.

Recommendation 6: The County Should Include Some Commercial Zoning in Every Section of Town for a Gathering Place, such as Coffee Shop or Store, to Minimize Trips and Encourage Community Gathering.

- Last but not least, Los Alamos is a small community but transportation from each mesa to town still occurs for almost every need. Encouraging community gathering, walking, biking or reduced driving to a store, while at the same time meeting a need can be achieved.

- Some mesas have easy access to a commercially zoned area where a store, coffee shop, or food truck could be located. Others such as Barranca and North Mesa do not. There are natural gathering areas near schools where communities tend to gather that would be convenient for a small section of commercial zoning. The County is in the process of transferring land and rezoning to residential areas near the middle school but has not included any commercial zoning. Zoning a lot as commercial does not ensure that there will be a project that 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 the Council with its zoning policies.

Chart 1

Design Temperature and Fuel Type Inputs https://www.builditsolar.com/References/Calculators/HeatLoss/HeatLoss.htm

Title	Typ LA Home circa 1956				
Design outdoor Temperature		Degrees F	9		
Heating Degree Days		Degree F - day	6330		
Natural Gas	0.84			85%	Furnace Efficiency
Electricity					

Area and Rvalue Inputs

	Area (sqft)	Rvalue	UA (BTU/hr-F)	Design Loss (BTU/hr)	Yearly Heat Loss (million BTU/yr)
Ceiling 1	961	11	87.4	5329	13.3
wall 1	850	11	77.3	4714	11.7
Doors	40	2.5	16	976	2.4
Windows	162	0.9	180	10980	27.3
Crawl space wall	526	9	58.4	3565	8.9
Infiltration	total volume of the heated space of the house cubic feet				
	Typical Air Changes Per Hour:				
	0.33 -- very tight -- minimum for health				
	0.5 -- tight -- new, careful construction				
	1.0 -- leaky -- typical existing construction??				
	House Volur (cubic ft)	Air Changes p	UA (BTU/hr-F)	Design Loss (BTU/hr)	Yearly Heat Loss (million BTU/yr)
Whole House	4695	1	85	4226	6.5
Int. Heat Gains	These are heat gains from warm bodies, lights, appliances, ...				
	This is heat that your furnace does not need to provide.				
	Number of Occupants		Internal Gains (BTU/hr)	Design Loss (BTU/hr)	Yearly Heat Loss (million BTU/yr)
	3		1362	-1362	-11.9

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)
Ceiling Loss	87	5329	13.3	$131.00	2089	1874
Wall Loss	77	4714	11.7	$116.00	1848	1657
Window Loss	196	11956	29.8	$294.00	4688	4204
Crawl space wall	58	3565	8.9	$88.00	1398	1253
Slab Loss	0	0	0	$0.00	0	0
Infiltration	138	8441	208	$208.00	3310	2968
Totals	**556**	**34005**	**271.7**	**$837.00**	**13333**	**11956**

Revisions			
Ceiling add 12" blown in insulation		Heating with electricity @ .12/KWH	
Walls add 2" exterior insulation & stucco		less infiltration due to new windows	
Upgrade windows & Doors			
Crawl space -Add 3" exterior insulation and Stucco			

Area and Rvalue Inputs

	Area (sqft)	Rvalue	UA (BTU/hr-F)	Design Loss (BTU/hr)	Yearly Heat Loss (million BTU/yr)	% Difference
Ceiling 1	961	49	19.6	1196	3	22.56%
wall 1	850	22	38.6	2357	5.9	50.43%
Doors	40	5	8	488	1.2	50.00%
Windows	162	3.4	47.6	2906	7.2	26.37%
Crawl space wall	526	24	21.9	1337	3.3	37.08%
Infiltration	total volume of the heated space of the house cubic feet					
	Typical Air Changes Per Hour:					
	0.33 -- very tight -- minimum for health					
	0.5 -- tight -- new, careful construction					
	1.0 -- leaky -- typical existing construction??					
	House Volur (cubic ft)	Air Changes p	UA (BTU/hr-F)	Design Loss (BTU/hr)	Yearly Heat Loss (million BTU/yr)	
Whole House	4695	0.5	42	2578	6.4	
Int. Heat Gains	These are heat gains from warm bodies, lights, appliances, ...					
	This is heat that your furnace does not need to provide.					
	Number of Occupants		Internal Gains (BTU/hr)	Design Loss (BTU/hr)	Yearly Heat Loss (million BTU/yr)	
	3		1362	-1362	-11.9	

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)
Ceiling Loss	20	1196	3	$52.00	835	654
Wall Loss	39	2357	5.9	$103.00	1644	1288
Window Loss	56	3394	8.5	$149.00	2368	1856
Crawl space wall	22	1337	3.3	$59.00	933	731
Slab Loss	0	0	0	$0.00	0	0
Infiltration	42	2578	6.4	$113.00	1798	1409
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

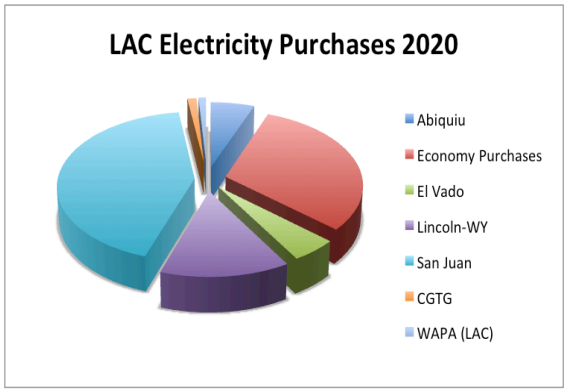
X. General Recommendations: Electricity Supply & Demand

Note of Thanks

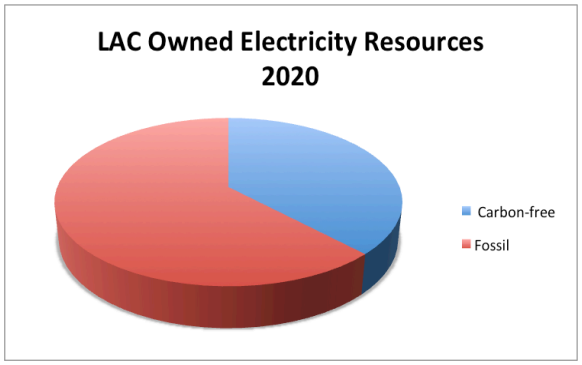
We wish to thank the members of the County Council and the employees of the DPU for delivering essential services to our community. This is done so seamlessly that citizens often do not notice or acknowledge all of the work you do. So, at the very beginning, a BIG THANKS!!! Please find in the following pages our *preliminary* recommendations.

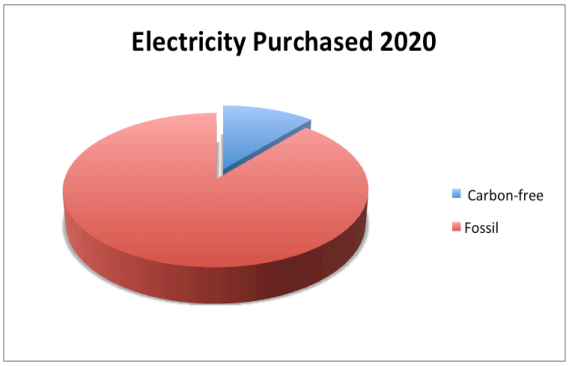
We would love to sit down with subject matter experts at the DPU in the near term to receive your feedback. We realize that in our effort to formulate our thoughts we likely missed the full picture and/or historical context - please do not take offense. This is a draft and we look forward to improving this document with your help in the coming months. Again, thank you.

Introduction

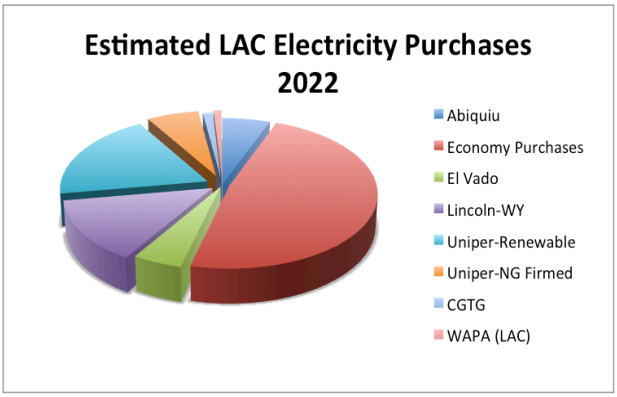


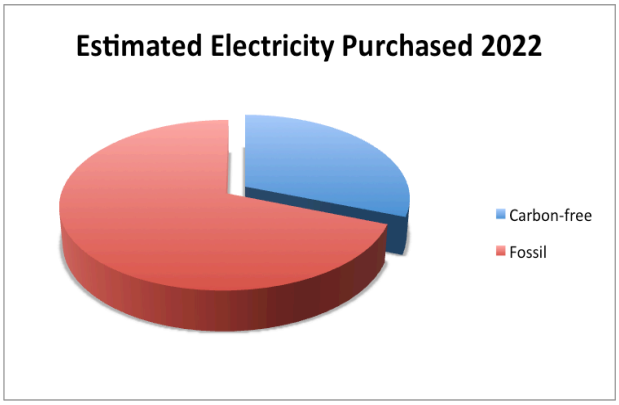
Currently, Los Alamos County (LAC) owns several power generation assets representing a total of 73.9 MW of generation capacity. Of those resources, four are sources of carbon-free electricity, hydroelectric power from Western Area Power Administration (WAPA), El Vado and Abiquiu dams, and the 1 MW PV installation on the Los Alamos Eco Station. Using only the headline electricity production shows ~38% of our electricity is from renewable sources. However, when examining the actual electricity purchase in 2020, the combined contribution from these assets decreases the carbon-free portion of LAC's usage substantially to only 11.5%. The two largest sources of electricity are the San Juan Generating Station (SJGS) and short-term contracts purchased from the free energy market (42% and 30%, respectively).





This picture will change significantly when the power purchase agreement (PPA) with Uniper comes into effect in 2022, and the Department of Utilities (DPU) no longer purchases power from SJGS. The proportion of carbon-free electricity assets will increase to ~81% of owned assets, and the estimated carbon-free electricity purchases will increase from 11.5% to 32%. This is a tremendous step and the LAC DPU and BPU should be commended for taking it. We look forward to continued progress.





The major motivation for transitioning to carbon-free energy within the County is the imminent threat of climate change. Climate change models of the Southwest United States predict a higher likelihood of droughts and high temperature events. Lower precipitation will directly impact Los Alamos County's ability to generate hydro-electric electricity. The predictions are for Los Alamos to experience 100 degree plus heat waves within the next 20 years and higher after that. Given these predictions, we don't look forward to the partial desertification of the County—loss of Ponderosa Pines and encroachment of pinon-juniper trees.

It is in this context that we make these recommendations. We face a new era where concerns about cost must be minimized in favor of innovative and effective action. This may mean changing charters and codes, but is the only way to avoid the worst of the warming. In this spirit we recommend a variety of actions that may at first sound somewhat radical, but in the current situation are not radical but necessary.

Recommendation 1: The County Council and the BPU Should Formalize the Net Zero Carbon Electrical Power Commitment and Adopt a More Ambitious Timeline to Make LAC Net Carbon Zero Electricity by 2035.

Background

- The current pledge to be a net carbon zero electricity provider by 2040 constitutes a goal of the BPU for the DPU. This goal was voted on and 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 recommendations as to the paths to achieve the 2040 goal. LAC, in cooperation with LANL, developed the 2015 Renewable Energy Photovoltaic Feasibility Study which identified five potential sites for solar installations that when combined could be the source of ~60 MW. LAC also hired Pace Global to produce the 2017 Integrated Resource Plan, assessing paths to achieve the 2040 goal.

- As noted earlier, the Uniper contract is a big step forward, the most significant since the net carbon neutron goal was adopted about 9 years ago. We strongly suggest building upon this. An administrative means of doing so is to have the County Council to formalize this net-zero carbon commitment with a timeline and benchmarks for its implementation. In addition, to be in line with current federal guidance on the issue, the carbon neutrality timeline for electricity generation should be accelerated from 2040 to 2035.

Outcome

- LAC DPU is 75% net-zero carbon electricity provider by 2030, and fully net-zero by 2035.

Challenges & Anticipated Barriers

- Reducing the amount of power purchased from the grid.
- Exiting the PPA with the Laramie River power plant in WY.

References/Resources

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.

Recommendation 2: The DPU and BPU Should Evaluate Options and Develop a Plan Regarding the LANL/LAC Power Generation Relationship and What it Means in Terms of LAC's Achievement of its Net Carbon Zero Goals.

Time Frame: CY2022

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 original ECA was negotiated in 1985 for a term of 30 years, and was renewed in 2016. The current ECA will expire in 2025 and negotiations as to how, or whether this agreement will persist are currently underway. As it stands, LANL is the single largest electricity customer to DPU, accounting for 80-85% of total demand. The effects of two potential outcomes are addressed in this report. They are as follows:

    - The ECA, or equivalent agreement, remains between LANL and LAC
    - LAC and LANL decide to end the ECA

Outcome

- BPU/DPU will not use uncertainty in the ECA as a reason for not purchasing carbon-free energy.

Strategy

1. The ECA, or some equivalent arrangement, remains between LANL and LAC.

- If the ECA remains in effect, then LANL and LAC will pool electricity resources. The combined need for both LANL and LAC are ~100 MW. These have been supplied by the 73 MW of generation capacity that LAC owns along with purchases from the grid. For several years the DPU and BPU have been hesitant to purchase carbon-free resources out of concern for what would happen if the ECA ended; the concern being that LAC would be "stuck" with too many resources. This has resulted in inaction and very high carbon emissions. A fundamental shift in risk tolerance is needed, realizing that assets can be sold to match any major changes in the ECA.

- We recommend BPU/DPU should feel free to purchase utility scale solar and wind projects and or a great amount of PPA such as the Uniper Contract.

- 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% in cost per unit energy than the average cost of wholesale power in LAC. [Uniper contract, Lazard, NREL]. To make this point more explicit, the current market rate for utility scale solar and wind in the Southwest U.S. is ~$30/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.

- Since LANL consumes roughly four times as much electricity as LAC, a far larger emissions impact would be made by maintaining the ECA while also pursuing more carbon-free sources of electricity. This would bring both LANL and LAC toward net-zero carbon together.

2. LAC and LANL decide to end the ECA.

- In this circumstance LAC and LANL would need to manage their own electricity demand. LAC would need to provide only ~25 MW to residents at any given time. In this arrangement the hydroelectric assets on the Abiquiu and El Vado dams, which are wholly owned by LAC, would service only LAC. This would greatly increase the amount of zero-carbon energy used by LAC and make the realization of the net-zero carbon electricity goal much closer. In doing so LAC would no longer have any direct influence on LANL's choices regarding its electricity needs. While LAC's goal would come closer, the overall emissions reduction would be much smaller if LANL did not pursue a net-zero carbon path.

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 much less impact on LAC during the above average energy use period in the middle of the day. The price difference between ~$30/MWh and $1,750/MWh is

so large that the low cost solar and wind is likely to be cost effective. 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, 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, that risk needs to be researched and a mitigation strategy created.

Recommendation 3: DPU/BPU Should Develop an "Intermittency Management Strategy'' Including But Not Limited to Demand Management, Energy Storage Resources, Curtailment of Generation, and Time-of-Use Metering.

Time Frame: ASAP

Strategy

- 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 list 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 much less electricity being purchased during the expensive evening time interval.

    - The fortunate economic reality that aligns (a) cost savings with (b) reducing carbon generation is that utility scale solar and wind (~$30/MWh) in the Southwest U.S. cost significantly 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, RFPs bids to EXCEL Energy in Colorado, our recent UNIPER contract, among other sources.

    - **Time-of-use metering** is one aspect of incentivizing demand management. A utility could have a fixed rate structure that varies with the time of day, or rates could be allowed to float with the actual market rate during the day. We anticipate that the consultant hired for this task will educate LAC officials as to 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 DPU customers the ability to be part of a "**virtual power plant**." A virtual power plant is an entity that helps generation match the load by having a third-party control, to some degree, when energy is used by a customer. Virtual power plants are voluntary arrangements by which customers allow the third party to manage some appliances in return for economic benefits.

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

- Demand management focused on County/school operations:

  - Subject matter experts should be engaged to see (a) if the current waste treatment plants can take advantage of time of use strategies in order to use as much low-cost renewable energy as reasonable, (b) might investment in equipment such as larger tanks be advisable from a demand management perspective. It might be cost effective to operate the plant differently to use more low cost, zero carbon energy in the middle of the day.

- **Curtailment of Generation**: Curtailment involves the conscious decision to not put on the grid energy that is freely 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.

- Storage, as outlined in Recommendation 4, is anticipated to be a significant part of any **"Intermittency Management Strategy,"** and as such, it is suggested that the same consultant be used to juxtapose the positive and negative aspects of all the available intermittency management options.

- Because wind and solar resources are intermittent due to weather effects such as where clouds are and where the wind is blowing, it is beneficial to spread generation facilities over as large a geographic area as possible to average out these effects. [MacDonald et al. of NIST-Boulder]

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.

Benefits Other than CO_2 Reduction

- If generation curtailment as a means of managing intermittency is used; it results in the total supply of low-cost power increasing. The existence of more and more generating capacity reduces the likelihood of price spikes. The extremely low cost of unsubsidized utility scale wind and solar make the economic downside of possessing more generation capability than needed less than was historically the case.

- 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.

Recommendation 4: LAC Should Pursue Investment in Energy Storage Resources. In Addition, LAC Should Study Centralized Community Storage, Residential Storage, or Both.

Background

- Renewable resources such as wind and solar PV are intermittent and electricity generation does not always align well with user demand. For example, LAC's peak electricity demand is in the evening between the hours of 6:00 and 10:00 PM, yet, the peak production time of local solar PV is between 9:00 AM and 3:00 PM. Optimal use of intermittent resources, without resorting to natural gas fueled turbines or reciprocating engines to fill the gap, is advanced by the incorporation of some means of energy storage. In fact, the recommendation for LAC to invest in solar energy development with storage was a major conclusion of the 2017 Integrated Resource Plan (IRP).

- There are many different technologies at various levels of development and maturity. The different methods can be separated into three overall groups, mechanical energy storage, electrochemical energy storage, and chemical energy storage. The applicability of each of these technologies really depends on their planned use. They differ greatly in the potential quantity of energy that can be stored, duration of discharge, how quickly they can respond, as well as overall footprint and cost.

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, 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.

Centralized vs. Distributed Energy Storage

- To fully 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. There are multiple ways to accomplish this goal depending on the technology used. A centralized storage system describes an installation of sufficient scale to serve the needs of the whole community. This could be built within the County, or it could be sited in close proximity to the generation resource used to power it. The ultimate cost of a centralized system is lower than for a distributed system. However, raising funds, designing, and building such a system may delay its implementation and slow its impact on carbon emissions.

- For that reason, we advocate that LAC study the potential of distributed energy storage where the storage systems could be leased to homeowners and landlords. A large and very resilient system would be like that studied by NREL, a 5 kW battery with 20 kWh of storage. If such a system were installed into 2,000 homes, the DPU would have a distributed equivalent to the centralized storage case described above. Such installations could be integrated into an overall “intermittency management strategy” described in recommendation 3. While the cost would be higher than a centralized system, adoption could be much faster and allow for the maximum of community participation. A very successful pilot program has already been instituted by Green Mountain Power in Vt. Homes that have no suitable photovoltaic site could still contribute to the decarbonization of LAC’s electrical use - see Appendix C for more detail on the Green Mountain Power system.

- There is also a case to study the integration of customer-owned electric vehicles as storage batteries when plugged into the grid. A typical electric vehicle battery stores 60 to 75 kWh of energy, enough to power 12 homes for ~4 hours of average usage. Currently, the use of vehicle batteries as storage batteries to support a home is not

universal among manufacturers. But as vehicle electrification increases the potential of those battery resources cannot be ignored.

Outcome

- LAC should hire consultants to develop a strategy constituting multiple pathways for the development and deployment of energy storage resources. This analysis should include centralized vs. community vs. distributed storage systems.

Impact/Examples in Other Communities

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

- 2017- Green Mountain Power (GMP) created a voluntary program to install storage batteries in customer homes. Since 2017 GMP has installed ~3,000 systems and claims to have saved ~$3 million.

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

- 2025 - Conversion of the Intermountain Power Plant in Delta, UT This project will convert the 1,800 MW coal-burning plant to a 840 MW natural gas combined cycle turbine. In addition to natural gas, the turbine will be fueled by 30% electrolysis derived hydrogen that will be stored in salt domes in close proximity to the plant. It will serve the Los Angeles area and should achieve 75% CO_2 reduction. While initially 30% hydrogen will be used, the project plans to increase the hydrogen mix to 100% by 2045.

Economic Impact

- Investment in energy storage as part of a broader “intermittency management strategy” could significantly reduce electricity costs to LAC. 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.
Integrated Resource Plan Report, Pace Global, June 2017.
Hornsdale Power Reserve - (https://hornsdalepowerreserve.com.au/)
Green Mountain Power - https://greenmountainpower.com/network-of-powerwall-batteries-delivers-first-in-new-england-benefit-for-customers/

Recommendation 5: The County Should Either Purchase Utility-Scale Solar and Wind Resources or Purchase Those Resources From an Entity That Aggregates Renewable Energy Resources.

Time Frame: ASAP

Background

- With the decommissioning of the SJGS, the total quantity of energy resources owned either directly or via a PPA by LAC will decrease from ~74 MW to ~53 MW. Unless other resources are obtained, LAC will have to purchase more power on the open market to meet customer demand. This will decrease the flexibility that the DPU has in the timing of power purchases from the grid. This is especially true as customer demand will likely increase due to the adaptations to climate change and increased electrification due to the transition from natural gas.

- Utility-scale wind and solar are among the lowest cost methods of electricity generation with costs around $30/MWh. When integrated with storage, those costs increase, but remain reasonable. The National Renewable Energy Laboratory's "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020" put the cost of utility-scale solar with battery storage at $57/MWh with the 30% investment in solar tax credit. This cost is slightly less than the current targeted price of the CFPP. Even without the tax credit, the cost of solar with storage would be equivalent to the cost for power from our hydroelectric resources at Abiquiu and El Vado Dams.

- If LAC were to invest in building its own solar resources, the main consideration would be where to put them. The 2015 "DOE Los Alamos National Laboratory - PV Feasibility Assessment" identified five areas on LANL property that could accommodate ~60 MW of solar generation. Building such resources within County-owned property would be difficult due to the general lack of space in LAC. However, if LAC were to expand its window of potential building sites to outside LANL and County-owned land, there is a good chance that sufficient area could be found to build the solar resources LAC would need within our balancing area.

- Absent LAC building resources of its own, there are other entities similar to Uniper that aggregate renewable electricity resources. LAC could purchase a fraction of a large wind and/or solar facility in the same manner that we purchase a fraction of the large San Juan Generating Station.

Outcome

- Increases the amount of carbon-free power owned by LAC.

Economic Impact

- Given that the Uniper contract provides firm power at ~66% of the average power paid by LAC, the economic impact could be to lower the rate paid by LAC customers. Or the DPU/BPU could use the cost savings inherent in the lower generation cost of utility scale wind and solar to pay for the inherent intermittency that comes with these resources by purchasing storage or enabling some of the other approaches to managing the intermittency of wind and solar.

Benefits Other than CO_2 Reduction

- Depending on the terms of the agreement reached, LAC may or may not have to manage the intermittency of the power purchased.
- Purchasing more resources in longer term contracts makes LAC less vulnerable to the price spikes that have become more frequent in the past ~2 years.

References/Resources

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.
NREL- U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020, January 2020.

Recommendation 6: LAC Should Continue to Pursue the Feasibility of Small Modular Reactors or Other Mature Nuclear Technologies.

Time Frame: 2030

Background

- The Carbon-Free Power Plan (CFPP) is a proposed small modular reactor (SMR) 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 to increase to 8.6 MW once all modules are operational. The current cost target is $58/MWh. Expected operation date for the first of its six modules is 2030.

Outcome

- LAC remains subscribed to the CFPP.

Economic Impact

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

Challenges & Anticipated Barriers

- The original operation date was 2022, however since this plant is the first of its kind this date has been pushed to 2030.

Recommendation 7: LAC Should Support and Incentivize the Continued Adoption of Residential PV Installation While Establishing a Program to Enable Homeowners to Purchase or Lease Residential Storage Battery Units That are Either Coupled With Their PV Installations or as Stand-Alone Systems.

Background

- Currently LAC has approximately 2 MW of rooftop solar. We support the BPU/DPU recent decision to triple the County wide limit on the amount of rooftop solar to 6 MW. We note that rooftop solar has the following benefits to LAC customers:
    - 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; thus, the LAC rate payer not choosing to install rooftop solar is not funding the construction.
    - Solar generation within LAC reduces the average transmission capacity needed to serve the LAC load. **Money not spent on transmission is money saved by all customers**. Of note, storage located within the County is an important component of realizing this saving in transmission costs.
    - The BPU/DPU are customer serving organizations. Rooftop solar is one concrete manner in which LAC customers can act upon their desire to have zero carbon electricity.
- Residential and Community solar PV can assist County power management given the increase in electricity consumption expected as LAC moves away from petroleum and natural gas. Rooftop solar provides an independent source of infrastructure financing at no upfront cost to LAC utility customers.

- Many of the topics of interest to the LAC-RES Task Force are of interest to multiple groups. One recommendation related to rooftop solar that the electric group would like the Buildings/Code Group to consider is that rooftop solar connection hardware be required for all new construction within LAC.

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.

Impact/Examples in Other Communities

- Comparing among small communities is an excellent way to learn what has proven to be feasible. Appendices A and B provide some such examples:

    - **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.

Recommendation 8: DPU and BPU Support the Expansion of EVS and EV Charging Infrastructure.

Time Frame: As outlined by the transportation section of this task force.

Background

- Electric car charging infrastructure is primarily addressed by the transportation group of this task force. It is included here to emphasize the demand management aspects of electric car infrastructure. In the context of demand management: If we are going to enable our customers to charge when power is at its lowest cost and lowest carbon content, LAC businesses and DPU need a plan for how the infrastructure is to be created. Additionally, as many individuals come to LAC for work during the day, providing charging opportunities is a chance to increase the customer base of the DPU.

Recommendation 9: LAC Should Adopt a Community Education Strategy Around Electrification of Efficient Appliances for Residential Use, i.e., Heat Pumps, Air Conditioning, Water Heaters, Magnetic-Induction Stoves, etc.

Background

- One of the overarching philosophies of reducing carbon emission is to (1) make electric generation free of carbon and (2) replace the direct use of fossil fuels with electricity. This two-step process is simple to understand but implementation is not so straightforward as it is generally easiest to simply replace any appliance you have with an equivalent unit. To avoid duplication with work performed by the natural gas subcommittee of the task force, we will conclude with a high-level list of the main items that are expected to be involved in this transition and which community wide education is needed:

    1. Change gas water heater and ovens to electric water heaters and ovens
    2. Change gas stoves to electric induction stoves
    3. Change gas heating systems to heat pumps
    4. Change internal combustion cars to electric cars

- The first two items on this list are thought to be somewhat straightforward though not trivial. The latter two are significant changes. The utility customers of LAC will likely benefit with educational information in a variety of forms. A home tour along the lines of the homes built by the Japanese vendors along Trinity Drive during that technology demonstration project are expected to be of particular utility.

APPENDICES

APPENDIX A: Usefulness of Residential and Community Rooftop Solar PV

1. 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.

2. 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

3. Interim Report - Net-Zero America: Potential Pathways, Infrastructure, and Impacts https://environmenthalfcentury.princeton.edu/sites/g/files/toruqf331/files/2020-12/Princeton_NZA_Interim_Report_15_Dec_2020_FINAL.pdf

4. New Mexico solar panels | guide to solar incentives, costs and savings in NM! https://www.solar-estimate.org/residential-solar/solar-panels/new-mexico?aff=4713&cam=45&gclid=Cj0KCQjwp86EBhD7ARIsAFkgakjcsHlygeUHGU6gx46CGwsICUoEIDxy0mOzTWvLPYl2z1EhStfPXzoaAh4DEALw_wcB

5. What It Really Means to Require Solar Panels on All New Buildings https://www.greentechmedia.com/articles/read/what-it-really-means-to-require-solar-panels-on-all-new-buildings

6. 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.

7. Forbes: https://apple.news/AP8K1k9A-R5edZqSzKbk2GA

8. 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.

(https://losalamos.legistar.com/View.ashx?M=F&ID=8655258&GUID=B92A64E8-ED62-44AE-83AC-C2C3FF3B9D29**)**

Appendix B: Santa Fe Schools experience with rooftop solar PV

SFPS 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?

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.

Solar array on North Mesa near Middle School

XI. Recommendations: 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 adopted a strategic goal to "support elimination of natural gas usage by 2070." The exact date is not important. Starting on "elimination" is.

Background

Almost all buildings in Los Alamos 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 about 8,600,000 therms (average for 2010-2019).

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 eliminated using the same approaches as for NG, but the quantity is small enough it is not included in the statistics in this report.

NG use closely follows ambient air temperatures, as expected. It 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. (Again, these are 2010-2019 averages.) Summer use indicates how much gas is used for purposes other than space heating – water heating, cooking, and pilot lights. Those secondary uses are undoubtedly greater in colder weather when more water heating is necessary and more cooking is done, 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.

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." Some "commercial" use is actually also residential. 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. 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. Hence, the NG Reduction Subcommittee has so far focused on it, while recognizing that secondary and non-residential uses will need to be addressed more completely, 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 get started with the tools at hand.

Downtown Los Alamos

Recommendation 1: Compact Architectures Should be Encouraged in New Construction.

Time Frame: Ongoing

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 energy-efficient the building can be. In homes, 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 cooling in hot weather, although much heat comes from direct solar radiation rather than through conduction from outside air.

- Los Alamos housing is already being forced to be more compact by limitations 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.

Case Study

- 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.

This will be confirmed through analysis of data on existing buildings.

Strategy

- Encourage construction of attached and multi-story buildings for both residential and commercial applications.

Economic Impact

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

Benefits Other than CO_2 Reduction

- Vertical development within downtown could increase foot traffic to local merchants.
- 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. (This would not be seen as a benefit by many people.)
- Higher housing density in downtown or near any future shopping area(s) may increase walking and reduce motor vehicle trips for some services.

Challenges & Anticipated Barriers

- Compact housing architectures may not be as desirable to the consumer.

There may be fear that "multi-story" will turn into "high-rise," a concept historically unpopular in LA.

Recommendation 2: New Construction Should Derive a Significant Portion of its Heating Energy From the Sun.

Time Frame: Ongoing

This subject will be addressed in the final report.

Natural gas site (and wildlife) on Diamond Drive

Recommendation 3: All New Construction Should Have Solar Access.

Time Frame: Ongoing

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. At least the roof and as much of the rest of the building as possible 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.)

- Increased demand for electrical usage is possible during warmer days for cooling.

Strategy

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

Economic Impact

- Requiring solar access could result in iterations of new construction planning which may cost the customer time and money or result in an unsatisfactory building plan for them.

Challenges & Anticipated Barriers

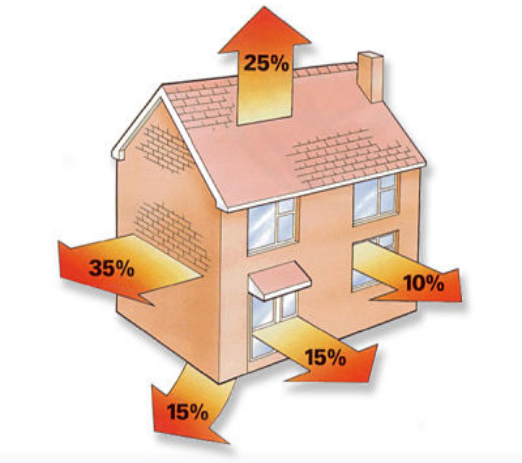
- Solar access creates an additional planning/design/permitting constraint on new construction which may reduce utilization of some of the unusual land parcel shapes available in the community.
- Reduced shade from trees and other buildings increases undesired heating and potential cooling loads in warm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

Recommendation 4: Reduce Average Heat Loading in Residences to 0.30 therms/sq. ft. or Less.

Time Frame: Ongoing

Background

- After basic structural style, heat loss can be minimized through 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. Image below from https://www.mygreenhomeblog.com/four-key-areas-home-must-maintain/.



- New Mexico has adopted, with some modifications, the 2018 International Energy Conservation Code (IECC 2018) as the NM Residential Energy Code, which applies to new construction and changes substantial enough to require permits. Where its provisions are not binding, it is still useful as guidance for any property upgrades.

- Simply put, IECC 2018 requires windows in LA to have a U-Factor no more than 0.3, ceiling insulation of at least R-49, and wall insulation of at least R-20. Foundations and crawl spaces also have insulation requirements.

- Windows represent a major heat loss in most home envelopes. Their heat loss is rated in "U-Factor," or BTU/hr•sq.ft•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.

- 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 and artificial heat.

- Many homes in LA 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 heat loading of government housing averages about 0.48 therms/sq. ft. Significant numbers of those buildings have heat loadings exceeding 0.75 therms/sq. ft., but there are also significant numbers with loadings of 0.35 therms/sq. ft. or less, demonstrating that energy-efficient upgrading is possible.

- Private construction of homes began about 1960. The average home originally built in the 1960s has a heat loading around 0.35 therms/sq. ft. By about 1980, annual heat loading dropped to around 0.30 therms/sq. ft., where it has remained. Some of the newer, higher density housing has heat loadings around 0.25 therms/sq. ft. More and better insulation, double-pane and coated windows, more efficient furnaces and boilers, and transition from forced air to hydronic heat have all contributed to this improvement.

- Overall, annual energy loading of existing LA housing averages 0.42 therms/sq. ft. 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/sq. ft. By itself, that would reduce heating energy needs by 29%.

Outcome

- Newly constructed residences would all have heat loadings of no more than 0.25 therms/sq. ft.
- Overall average residential heat loading would be reduced to ≤0.30 therms/sq. ft.
- Reduced heat loading, by itself, would reduce heating energy needs by at least 30%.

Case Studies *(to be added in final report)*

Current average home size in LA is slightly more than 2000 sq. ft. That nominal size will be used for all examples except the older (usually smaller) government homes. Other sizes can be estimated by direct scaling based on square footage.

These will include technical approach(es), lifetime costs (initial, operating, and replacement), and typical and peak electrical power requirements.

1. New construction, 2000 sq. ft. home

2. Retrofit government home

3. Retrofit 2000 sq. ft. single-story detached ranch style home (common 1960s & 70s construction) with forced-air heat

4. Retrofit newer (1980+) 2000 sq. ft. detached home with hydronic heat

5. Summary Table

Strategy

Reducing heat loss through building envelopes will require increased insulation and better doors and windows. Building design standards should incorporate them. Inclusion into updates of building codes may be necessary at some point.

- 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. The Dept. of Public Utilities once provided this service. It could again at modest staff cost.

Economic Impact

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

- Depending on the individual existing home, the easiest and most "bang for the buck" improvement is likely from adding insulation in the attic if the home has one. Insulation can be added to walls cost-effectively, too. Window and door upgrades can have the largest effect, but are also the most expensive.

- 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/sq. ft. 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+/ sq. ft.

- While window and door replacement is typically not cost-effective for purely energy use reduction, upgrading during remodeling may add little additional cost while significantly reducing heat loading.

Benefits Other than CO_2 Reduction

- Well-insulated homes tend to have a more uniform interior temperature, which most people find more comfortable. Drafts not related to forced-air systems are essentially eliminated.
- 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.

Recommendation 5: Heat Pumps Should be Substituted When NG-Fired Furnaces and Boilers are Replaced.

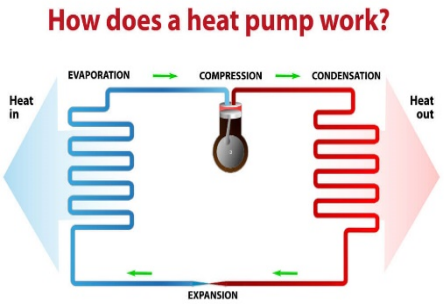
Time Frame: Ongoing

Background

- 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 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. It is. At current nominal rates in Los Alamos ($0.55/therm for NG and $0.115/kWh for electricity in March, 2021) electricity costs about six 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. Image from https://thesunriseguide.com/how-a-heat-pump-works/.



- 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.

- Heat pumps can substitute for a furnace or central air conditioner, heating or cooling 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.

- In a heat pump, electricity is not turned into heat. It only runs the pump. The colder the source, the more work the pump has to do – and the more electricity is required – to pump heat energy "uphill." Heat pumps are 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 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 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.

Outcome

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

- NG should 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.

Economic Impact

- 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.

- The initial cost to install a heat pump is substantially higher than the cost to replace an existing NG-fired furnace or boiler, of order 2-3 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. The range covers a factor of several, although they are buffered

somewhat for LA retail customers by DPU's long-term contracts. Government actions to discourage use of carbon-based products (e.g., a "carbon tax") may well drive prices higher, also. In March, 2021, the LA residential rate was $0.55/therm. At that NG rate and the current residential electricity rate of $0.115/kWh, and assuming an average heat pump COP of 3.5., the commodity cost for electricity to run a heat pump would be about 1.75 times the cost of gas for the same amount of heat. While that factor does not look favorable for conversion from NG to heat pumps, NG prices are likely to be much higher in future decades, making the cost comparison more attractive.

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.

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.

Natural gas site on Barranca Mesa

Recommendation 6: Solar Thermal, Heat Pump, or Point-of-Use Tankless Water Heaters Should be Substituted When Traditional Hot Water Heaters are Replaced.

Time Frame: Ongoing

Background

- 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. What is not used then sits in the pipe and cools down to room temperature, wasting all its 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. Image from https://cleanenergysummit.org/best-solar-water-heaters/.

- 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 hot 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.

    - Use of electrically-heated "tankless" hot water heaters. 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. Tankless hot water heaters tend to last longer than traditional tank types.

Much more detail will be added to this section in final report.

Recommendation 7: Electric Induction Ranges Should be Substituted When Traditional Electric or NG 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. They are more energy efficient than either traditional electric or NG ranges.

Economic Impact

- Purchase prices for induction ranges are still higher than traditional electric or natural gas ranges, but are dropping rapidly as they become more common. Ranges tend to be replaced every few decades. The incremental cost of an induction range is small at replacement time.

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. 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.

Challenges & Anticipated Barriers

- Cookware must have iron in it. Cast iron or stainless steel cookware will both work; aluminum, glass, or ceramic will not. Smooth surfaces facilitate energy transfer. Hence, some households may need new cookware.
- Kitchens with NG ranges may need to be rewired for electric induction stoves.

Recommendation 8: NG Pilot Lights Should be Discouraged or Banned in New or Replacement Gas Appliances.

Time Frame: Short-term

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. It should replace all of them in the next replacement cycle even if the unit itself continues to use NG. Retrofit kits are available for the pilot lights in some existing units.

Outcome

- No new pilot lights should be installed.

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 banned.

Economic Impact

- A single, continuously operating NG pilot light burns typically 400-800 BTU/hr. Using 600 BTU/hr. as a base rate, that is 5.26 M BTU/yr. or 53 therms/yr. At $0.55/therm, the annual cost is about $29/yr. Kits to replace NG pilot lights with electric ignition run ~$200 plus the cost of installation. Replacement may not be cost effective, but 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 in the kitchen, drapes, 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.

Recommendation 9: Institutional Spaces Should be Heated Without Natural Gas *(placeholder pending specific recommendations in final report).*

Background

- 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 lossy window area. For others (e.g., offices, schools) the bright, open, airy indoors areas enabled by extensive use of glass exterior walls may be a luxury we cannot afford. 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 set-backs are already common.

- The typically larger roof areas and reduced emphasis on aesthetics in institutional buildings makes rooftop solar PV installations to power heat pumps more attractive than they are for residences.

Quantitative examples will be included in the final report.

- Although institutional structures account for slightly less than 25% of LA's NG use, there are far fewer of them than there are residences. Changes are less "personal" than those associated with residences. Changes in requirements for new construction and physical modifications to existing buildings may be easier to accept.

Recommendation 10: Base-Load Electrical Generating, Transmission, and Distribution Requirements to Meet Overnight Heating Energy Demand Should be Included in Electrical Utility Supply Planning.

Time Frame: Short-term and Ongoing

Background

- 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 DPU 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.

- A more fundamental problem is the overall demand on the electric supply and distribution system. Normal electrical use in LA, exclusive of the Lab, is typically 8-20 MW, with occasional peaks in the low 20s. The daily peak is typically in evenings. Lowest demand occurs overnight. Peak County-wide NG use in recent years was 5060 therms/hr. on the single-digits morning of 8 February 2019. Simply replacing all NG-fired furnaces and boilers with heat pumps with a COP of 3 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 above will significantly reduce that potential increase in demand for electric power just for space heating. *Estimates will be included in the final report.*

- 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.

Recommendation 11: Distributed ("Rooftop") Electric Generation and Storage Should be Encouraged.

Time Frame: Ongoing

Background

- Distributed ("rooftop") photovoltaic (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 is likely to exceed existing utility system capacity. That will require some combination of increased system capacity and increased distributed generation in amounts yet to be determined.

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.

Recommendation 12: Natural Gas Hookups Should Not be Allowed for New Construction After Some Point in Time.

Time Frame: Medium-Term

Background

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

Case Study

- A century or so ago, 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, 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.

Strategy

- Discourage new hookups, starting very soon. Buildings already in design or permitted should not be forced to change course.
- Reliability/risk studies will be necessary to establish confidence that reliability will match or exceed present NG heating systems with electric controls. If reliability is determined to be any less with electric-only heat, outage mitigation plans will need to be in place.
- Set a date, probably a few years away, after which new NG hookups will not be permitted, with few exceptions.

Economic Impact

- 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.

- Eventually, the NG utility can be shut down, saving its annual operating cost, currently about $4M/yr., not including capital investments. That, too, is decades away and cannot be considered until adequate confidence in NG-free heat and back-up plans are established.

Benefits Other Than CO_2 Reduction

- The small, but real, risk of fires from gas leaks is eliminated.
- Gas valve stations can disappear.

Challenges & Anticipated Barriers

- Developers and builders will complain loudly, asserting that costs will skyrocket. They may threaten not to do business in LA. The reality is that this will require them to change what they build ,and change is hard.

Administrative Notes & Caveats

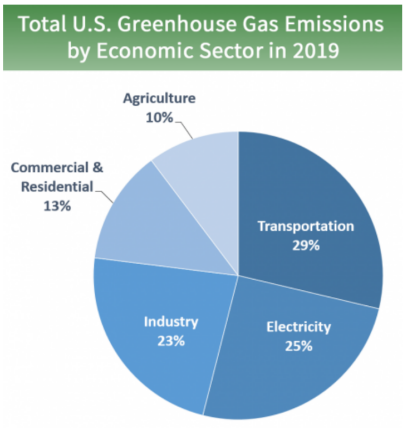
Members of the Natural Gas Reduction Subcommittee are: Lia Brodnax, Elizabeth Daly, Robert Gibson, and Greg White. In May, 2021, the subcommittee was temporarily combined with the Community Planning and Zoning Subcommittee, which also includes Ben Hill and Skip Dunn. This report includes only the NG part of the combined subcommittee's work. All members of the combined subcommittee contributed to it.

This is a preliminary report to indicate the general direction of the subcommittee's thinking and work. It is incomplete. Almost all numbers are subject to verification and refinement.

The County Assessor's office kindly supplied reports on all taxed properties in the County. This data includes year originally constructed, occupied square footage, basic architectural type, type of heat, and whether or not the space is air-conditioned. DPU supplied NG usage data for all 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 is available, but it is not clear 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.

XII. Recommendations: Transportation & Mobility

Introduction



Reducing our GHG emissions from transportation sources will contribute significantly to reducing our overall carbon footprint. The Environmental Protection Agency (EPA) estimates that 29% of our nation's GHG emissions come from transportation (https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions). 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's Waste, Consumption and Natural Resources subcommittee, using data from Christopher M. Jones and Daniel M. Kammen in their paper 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) 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 commonly known as the "first and 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 LAC, T-Board and ACT 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 walking/biking 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, students, and visitors.

This thorough and detailed plan already proposes many of the recommendations of the LARES Task Force's Transportation Subcommittee. Indeed, this excellent document shares the data collection and community outreach efforts, the completed bicycle infrastructure improvement projects such as "sharrows," side paths, multi-use paths, and "priority streets," as well as future projects such as biking trails and improved infrastructure. After reviewing this document, this subcommittee feels there is little to significantly improve upon what has already been presented in this plan. Minor updates and recommendations which are NOT listed in the BTP document will be submitted in this report under the "Recommendation for Improvement of Bicycle Infrastructure" section.

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.

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

Transportation Subcommittee Scope of Work

The Transportation committee will address topics related to reducing LAC's carbon footprint from fossil-fuel-based and other transportation. Our Scope of Work will include but may not be limited to:

- Review and summarize current transportation-relevant plans, polices, requirements etc. that are applicable within Los Alamos County. Motorized and non-motorized transport policies will be included (walking, biking, other).
- Research ways to create a baseline indicator for current carbon footprint.

- Review, summarize and evaluate transportation-GHG footprint-reducing practices that have been implemented by other communities, and recommend policies that Los Alamos County could implement.

- Propose measures to reduce carbon emissions which are practically and economically feasible for County government, businesses and residents.
- Estimate costs and benefits of proposed GHG reduction approaches, and identify short-, medium- and long-term actions and goals.
- Reach out to neighboring and local communities (including LANL and Bandelier NM) to understand what transportation plans exist, and how they will interface with, or otherwise impact, Los Alamos County, and review and summarize relevant findings.

    - Treat LANL, Bandelier NM, and Pueblos as a GHG bordering communities.

September wildflowers on the Ski Hill

Recommendation 1: Increase Public Transportation Ridership

Strategy: ***This strategy is not yet complete.***

- In Partnership with Regional Transit, Increase and Incentivize Regional Transit Use for Commuters and Visitors From Out of LA County (Espanola, Pojoaque, Santa Fe, Albuquerque)
    - Partner with workers from LAC, LANL, and LAMC on needs, desires, and incentives for commuting to LAC for work
    - Find land parking off "the Hill" to reduce burden on riders to locate parking and encourage bus use

Time Frame: Short-Term and Ongoing

Examples in Other Communities

- In some cities and companies provide lunchtime shuttles increase in frequency to help facilitate commuters' needs.

*Consideration of Fuel Cell buses- ask Annette Granillo about this

Strategy

- Develop an "Alternative Transit" Incentivization Program for Employees of County, Schools, and Community Business (and LANL)

Time Frame: Short-Term and Ongoing as Needs Change


Get to work another way!

Background

- Approximately 60% of LANL employees live outside of Los Alamos County (https://apnews.com/article/new-mexico-science-los-alamos-nm-state-wire-4e212834a77d42b0b5727f5d04c1148e). 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).

- 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.

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.

Case Study

The case study is from a Seattle-area company. While Seattle is a much larger community, like Los Alamos they have commuters from all around their region northwestern Washington, some driving over an hour to arrive at work (like Santa Fe commuters).

The following information is taken/modified from https://ops.fhwa.dot.gov/publications/fhwahop18071/ch4.htm:

In 2016, the Luum company worked with Delta Dental of Washington (DDWA) to implement an incentivized commuter program. Employees had the ability to decide how best to commute to

work on a daily basis and to meet the parking constraints of their new office, through various options (Luum, 2017), including flexible parking rates based on how many times per month they park, bonuses for each day they commuted by any other mode than driving (including telecommuting), free parking for vanpools and split parking charges for carpools to discourage SOC, and subsidized Seattle-region bus/ferry/train rides.

Since starting its MyCommute program, DDWA has achieved the following (Luum, 2017):

- A 60 percent reduction in the drive-alone rate, down to 15 percent post-move.
- A 100 percent participation rate in the MyCommute program.
- Four new vanpools.
- Retention of 100 percent of employees after moving from the old office to the new office.

Impact and 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 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.

- 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.

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:** LAC will save money with fewer drivers on the road, i.e. less wear-and-tear on the roads and thus less road maintenance and less frequent repaving, painting, and filling of potholes. It may also result in fewer accidents and the repairs needed afterwards. This may also eliminate the need for a parking structure.

Benefits Other than CO_2 Reduction

- Community & Individual Benefits:
    - Public transport is a safer option than driving individually
    - Greater community connection ("bus friends," older and younger residents being more visible in the community)
    - 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 shops and restaurants
    - Increase of access to downtown

Challenges & Anticipated Barriers

- The Anti-donation Clause of the New Mexico Constitution may prevent some challenges to this recommendation :
  https://ua.unm.edu/anti-donation.html,
  https://www.rodey.com/uploads/FileLinks/cff57958d69146eb9e548fa755102759/rodey_anti_donation_clause_history.pdf

Community Outreach

- Changing habits is hard. The County and other players will need to undertake a major public campaign for increased routes/service and upping ridership. ACT is already working on this, as the Pandemic crushed ridership rates.

Roundabout between North and Barranca Mesas

References/Resources

Most data and information in this section were found here:
https://ops.fhwa.dot.gov/publications/fhwahop18071/ch4.htm
https://www.cbp.gov/employee-resources/worklife-balance/transportation-benefits/ptip
https://bouldercolorado.gov/goboulder/neighborhood-eco-pass
https://www.luum.com/
http://www.metropia.com/

Strategy

- To Encourage and Improve Public Transit Ridership, Address "First and Last Mile" Needs

This strategy is not yet complete.

Time Frame: Short-Term (1-2 years) and Ongoing as Transit Changes

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 (https://humantransit.org/2011/04/basics-walking-distance-to-transit.html), 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, or shuttles that go from a main train/bus line to more residential or 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.

References/Resources
https://www.apta.com/research-technical-resources/mobility-innovation-hub/first-last-mile-solutions/

Our wonderful ACT system in action

Strategy

- Continue to Invest to Increase Bus Frequency and/or Other Kinds of On-Demand Service

This strategy is not yet complete.

Time Frame: Immediate and Ongoing

Background

- 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, and GHG emissions.

Economic Impact

- **Costs**:
    - Increased service will require more drivers and more maintenance on buses
    - Community outreach and encouraging ridership

Benefits Other than CO_2 Reduction

- Reduced Traffic
- Reduced air pollution
- More citizen interaction and community connection
- Fewer parking issues

Challenges & Anticipated Barriers

- Getting ridership "back up to normal pre-COVID" is already a challenge facing ACT
- "First/last mile" problem

References/Resources
https://www.pedbikeinfo.org/factsfigures/facts_environment.cfm

Strategy

- Provide Evening and Weekend Atomic City Transit Service

This strategy is not yet complete.

Time Frame: Short-Term and Ongoing

Outcome

- Increased frequency of buses means more convenience to riders, which will increase ridership and reduce GHG emissions from passenger cars (often SOVs).

Tactics

- Weekday evening service could run until 8:00pm
- Saturday service could run from 8am to 8pm
- Sunday service? Maybe just main routes and/or a "Smith's" direct from each mesa/neighborhood area (call it something else) and LA-WR service
- Consider starting evening and weekend service with Friday night concerts
- Consider Ski Hill service in winter

Economic Impact

- **Costs:**
  - This will require more staff/drivers for extended routes/hours as well as potential
  - Increased maintenance on buses

- **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

- Job Creation
- Less traffic
- 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

- 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.

- We recognize that evening and weekend drivers will be harder to find than regular weekday daytime drivers.

Community Outreach

- As addressed just above in "challenges" section, increased ridership and increased bus service go hand-in-hand. A successful increase in residents riding the bus will depend on reliable service, convenient routes, and public outreach. The community must know of increased service and must be encouraged (using multiple means) to start riding the bus. Marketing campaigns, newspaper articles, banners on the overpasses, flyers in mailboxes, sandwich boards, table tents in restaurants, social media, and other strategies must be employed to really "get the word out."

Strategy

- Develop a Smartphone Ridesharing App to Help Residents and Commuters Get Around

Time Frame: Short-Term and Ongoing

Background

- New and innovative ways to encourage travelers to "get around another way" are greatly helped by smartphone apps. Mobile platforms such as AccessMyCommute, Metrotopia, RubyRide (and many others) help travelers to find alternative modes of transportation and reduce single-occupancy vehicle 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 all 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. This also presents a challenge to short-term residents or foreign visitors or workers who may or may not have a vehicle.

- 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.

- Airport Travel: This ride-sharing app will also provide opportunity for residents to carpool to and from the Santa Fe and Albuquerque airports.

- 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.

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.

Economic Impact

- **Costs**:
  - Initial cost of app development and ongoing maintenance, public awareness/advertising campaign.

Benefits Other than CO_2 Reduction

- Community connection- many people make friends when ride sharing
- Residents without cars will have access to rides
- Residents with cars can make a little money by sharing rides

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.

Community Outreach

- There will need to be community education about the app's existence and how to use it effectively.

References/Resources

https://ops.fhwa.dot.gov/publications/fhwahop18071/ch4.htm
https://www.blablacar.com/
https://parkcity.rideamigos.com/#/

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

Strategy

- Perform a County Assessment for Commuter and Other Transportation Needs

This strategy is not yet complete.

Time Frame: Short-Term

Background/Data

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

Outcome

- Understand the market for commuting
- Understand current needs of residents and non-residents
- Modify transportation schedules as needed based on these data

Case Study

Comprehensive Transportation Data Collection: Case Study in the Greater Golden Horseshoe, Canada

Sub-strategies

- In partnership with NMDOT and NCRTD, conduct a needs analysis for mass transportation between neighboring communities and Los Alamos

Examples in Other Communities

Example of strategy and questionnaire for 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

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 Transportation Plan

Recommendation 2: Improve Bicycle and Walking Infrastructure to Promote Safe and Convenient Carbon-Free Transportation

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. Minneapolis, MN has a goal to increase bike trips from 3% to 10% by 2030. In California, San Francisco's goal of converting 80% of all local trips to bicycling, walking or public transit by 2080 by continuing to implement its "Transit-First Policy" as well as engaging with businesses, employers and residents to encourage using active and public transportation (https://www.pedbikeinfo.org/factsfigures/facts_environment.cfm).

- The Los Alamos townsite has a good start to a bike-friendly community by creating bike lanes, bike lane/slow vehicle signage, and sharrows. White Rock is already bike-friendly as it consists nearly entirely of residential streets; the new community of Mirador and a crossing to the rest of White Rock should be considered.

Bike lane and bike/low speed vehicle signage on Diamond Drive near Golf Course, "Sharrow" downtown

Strategy

- Implement the 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.

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 young people and 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

References/Resources
https://www.losalamosnm.us/UserFiles/Servers/Server_6435726/File/Government/Departments/Public%20Works/Engineering%20and%20Project%20Management%20Division/2017%20Bicycle%20Transportation%20Plan%20Adopted%206-27-17.pdf

Strategy

- Green Boxed Bike Lanes and Protected/Buffered Bike Lanes

Time Frame: Immediate 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.




Photos courtesy of Dottie Knecht, Sunny Summers, Jill Summers (Salem, OR) and Sean Patton (Washington, DC)

- 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, photo courtesy of Ryan Kanter (Corvallis, OR)

Bollards at the North/Barranca Mesa roundabout

Protected bike lanes, photos courtesy of Sean Patton (Washington, DC)

- Protected bike lanes in Washington, DC, not only offer safe cycling for riders but they also allow for extra parking for cars.

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.

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.

  ***waiting on data from Josh Capps of City of Corvallis

Tactics

- 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.

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

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/Sq. Ft. (Corvallis, Oregon), or $3 – $6 Sq. Ft. for raw materials, $10 – $14 Sq. Ft 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 means 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

Challenges, Anticipated Barriers & Other Needs

- 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.”
  - This city 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

Street maintenance and snow issues: https://nacto.org/downsized-street-maintenance-vehicles/
carfreediet.com
nacto.org (in general)
https://www.pedbikeinfo.org/factsfigures/facts_environment.cfm

https://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/colored-pavement-material-guidance/
https://www.pedbikeinfo.org/factsfigures/facts_environment.cfm
https://coloradosprings.gov/sites/default/files/fhwa-separatedbikelane_design-guide-small_0.pdf
https://www.bendoregon.gov/home/showpublisheddocument/47764/637381859539770000

Strategy

- Create a Bike-Only Path Between Los Alamos and White Rock that is not on the Main Road

This strategy is not yet complete.

Time Frame: Medium-to-Long-Term and Ongoing

The Omega Bridge as seen from Los Alamos Canyon

Strategy

- Bike Lane and Walking Path on Omega Bridge (or Other Option)

Time Frame: Medium-Term (address when Omega Bridge is replaced)

Background

- The Omega Bridge was built in 1951, making it 60 years old and near the end of its useful life. Currently there is maintenance being performed of the bridge, but it will not significantly extend the life of this bridge. 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.

Outcome

- Increased commuting via walking and biking
- Less traffic and congestion
- Less air pollution

Examples in Other Communities

- 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. https://bikeleague.org/sites/default/files/selected_interstate_bridges_bicycle_access.pdf

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

- The Omega Bridge is owned and maintained by the Federal Government, which means that the bridge's future may be out of our hands. Hopefully they will seek input from the community using the bridge as to what happens next.

Community Outreach

- Community members should be able to give input of what they would likely to see in a new, updated commuter bridge.

References/Resources
https://bikeleague.org/sites/default/files/selected_interstate_bridges_bicycle_access.pdf

<u>Other Bike-related ideas:</u>

-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

Recommendation 3: Increase Publicly Accessible Electric Vehicle Charging Infrastructure

This recommendation is not yet complete.

Background/Research/Data (Baseline or other)

- 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 mean competition in getting the limited amount of EV Charging parking spots in existence.

- Schools, businesses, the County, 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.

- Other public locations such as sports complexes, hiking trail heads, and the White Rock Y will need EV charging infrastructure.

Outcome

- Increased availability and access to EV charging stations will encourage EV purchase among residents

    - EV Charging Access in Public Locations and Private Parking Lots
    - EV Charging Access in Multi-Family Housing Areas
    - EV Charging in Neighborhoods

Economic Impact

- **Costs:**
    - Initial cost of each charging station as well as infrastructure implementation and labor—this is where most of the cost is.

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

Benefits Other than CO_2 Reduction

- Convenience

- Encouraging and supporting residents to purchase EVs
- Cleaner air (less pollution)

Questions, Challenges & Anticipated Barriers

- 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? Does it matter?
- Will this take away parking (street parking, lot spaces, schools, other)?
- Will this be provided by the County or by the landlords/property owners? Both? Schools?

Community Outreach

- There will need to be a lot of outreach to residents about how and when to use EV charging stations.

Recommendation 4: Increase the Number of Electric Vehicles (EV) in LAC, ACT, and LAPS fleets, Eventually Making 100% of Light Duty (Passenger Cars and Trucks) Plug-In Electric

This recommendation is not yet complete.

Time Frame: As Many and As Soon As Possible, Yearly Additions

Background

- Los Alamos County, ACT and PEEC are already investing in EVs for their fleet. 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 and to step up these efforts, and expand them to the Schools and Police vehicles.

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

- The County will set targets as to how many vehicles will be replaced each year with an EV. We know there is a schedule of vehicle replacement; 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, other) should be required to justify purchasing gas-burning vehicles as opposed to emission-free cars.

Examples in Other Communities

- Dozens of other communities large and small, from Atlanta to Austin to Nashville to Las Vegas, 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-buring Ford F150 costs $30k. https://www.ford.com/trucks/f150/f150-lightning/2022/reservation-information/?dealerPACode=05778&postalCode=INSERTDEALERZI&gclid=CjwKCAjw_o-HBhAsEiwANqYhpyuGNiKwQ7c257eyqLyjd9HTLWXzg341Zi-T1yMa3cMdU57x2yNHjhoC6H0QAvD_BwE

Economic Impact

- **Costs:**

- Cost of new vehicles and training of technicians/mechanics to maintain EVs

- **Savings:**
  - Estimates range that EVs cost 50-70% less to operate (https://electrifyny.org/ev-municipal-toolkit/)
  - 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.

References/Resources

https://electrifyny.org/ev-municipal-toolkit/
https://www.cnbc.com/2021/01/25/biden-plans-to-replace-government-fleet-with-electric-vehicles.html
https://theicct.org/sites/default/files/publications/Transition_EV_US_Cities_20180724.pdf

Recommendation 5: Implement Shaded Parking and a County-Wide No Idling Policy

https://cleancities.energy.gov/technical-assistance/idlebox/

Time Frame: Immediate and Ongoing (permanent), with a few exceptions

Background

- Idling vehicles wastes fuel and creates unnecessary greenhouse gas emissions, and many municipalities and school districts 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 (AC) is in use (https://www.fueleconomy.gov/feg/driveHabits.jsp).

- Argonne National Laboratory researchers estimate that restarting a vehicle takes the equivalent of just 10 second's worth of fuel. (Argonne National Laboratory. 2015. Stop and Restart Effects on Modern Vehicle Starting System Components – Longevity and Economic Factors.) The Environmental Defense Fund has found that idling cars use between 1/5 and 7/10 of a gallon of fuel when idling per hour (https://www.edf.org/attention-drivers-turn-your-idling-engines).

- Idling cars on hot days to keep vulnerable animals and humans (usually children and fragile adults/elderly) in rare cases can be permitted. Most adults 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. Most waiting in cars is less than 20 minutes.

- 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 covered parking.

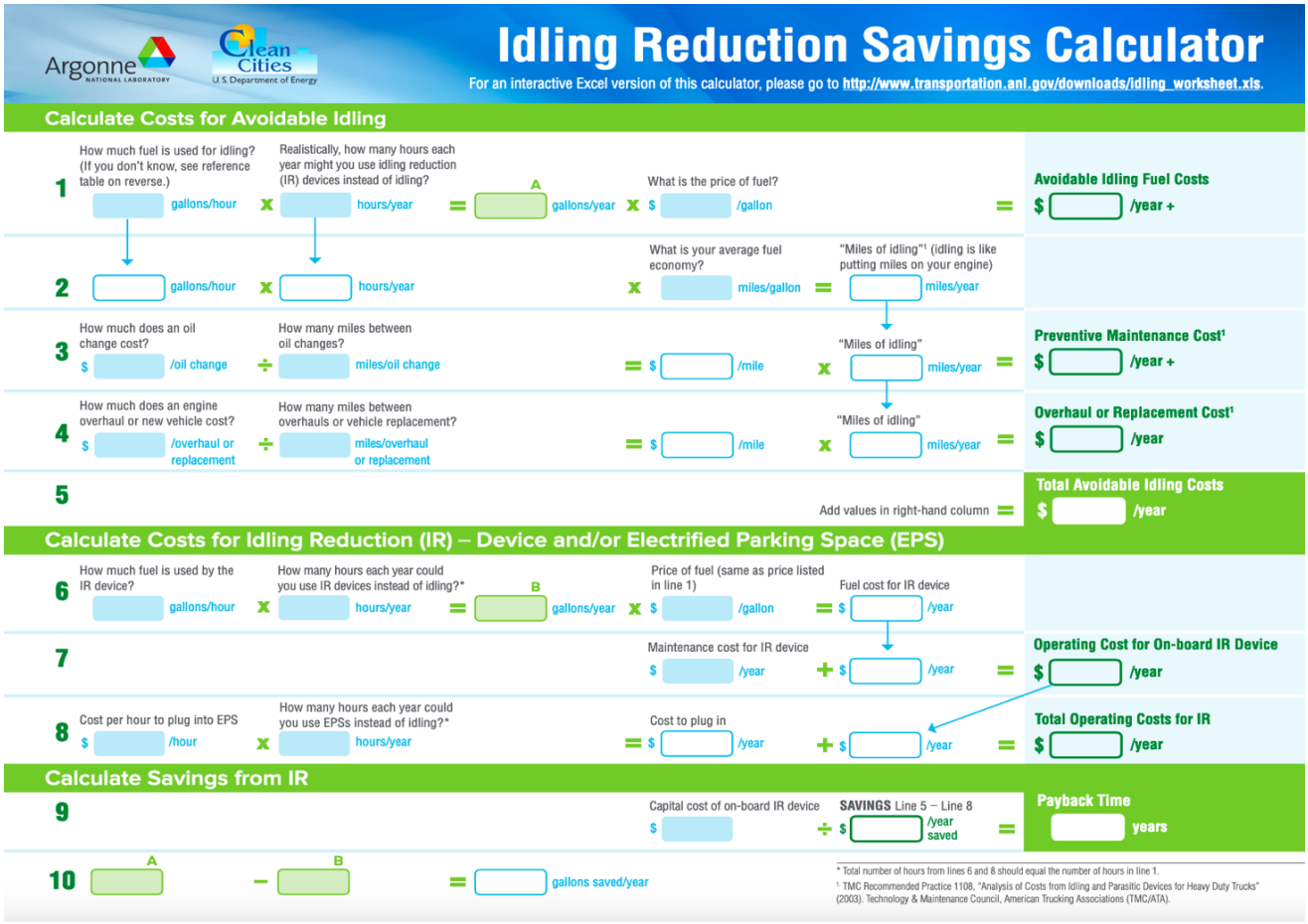
- One source of prolific idling is parents waiting for their children outside of school. If school children took the bus which already goes to/from their homes and fewer parents were making extra trips to pick up their children (and concurrently idling their vehicles), we would make a nice dent in our GHG emissions.

- The County already has a "no idling" policy in place for its fleet, but it is not followed or enforced. County trucks while employees check meters or perform maintenance, or just sitting and chatting. School trucks idle on streets and in parking lots. 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.

- Idling cars also 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.

Argonne National Laboratories have created an idling calculator to see how much fuel is used in idling vehicles:



Idling Reduction Savings Calculator

Argonne NATIONAL LABORATORY

Clean Cities U.S. Department of Energy

For an interactive Excel version of this calculator, please go to http://www.transportation.anl.gov/downloads/idling_worksheet.xls.

Calculate Costs for Avoidable Idling

1 How much fuel is used for idling? (If you don't know, see reference table on reverse.) ____ gallons/hour × Realistically, how many hours each year might you use idling reduction (IR) devices instead of idling? ____ hours/year = A ____ gallons/year × What is the price of fuel? $ ____ /gallon = **Avoidable Idling Fuel Costs** $ ____ /year +

2 ____ gallons/hour × ____ hours/year × What is your average fuel economy? ____ miles/gallon = "Miles of idling"[1] (idling is like putting miles on your engine) ____ miles/year

3 How much does an oil change cost? $ ____ /oil change ÷ How many miles between oil changes? ____ miles/oil change = $ ____ /mile × "Miles of idling" ____ miles/year = **Preventive Maintenance Cost[1]** $ ____ /year +

4 How much does an engine overhaul or new vehicle cost? $ ____ /overhaul or replacement ÷ How many miles between overhauls or vehicle replacement? ____ miles/overhaul or replacement = $ ____ /mile × "Miles of idling" ____ miles/year = **Overhaul or Replacement Cost[1]** $ ____ /year

5 Add values in right-hand column = **Total Avoidable Idling Costs** $ ____ /year

Calculate Costs for Idling Reduction (IR) – Device and/or Electrified Parking Space (EPS)

6 How much fuel is used by the IR device? ____ gallons/hour × How many hours each year could you use IR devices instead of idling?* ____ hours/year = B ____ gallons/year × Price of fuel (same as price listed in line 1) $ ____ /gallon = Fuel cost for IR device $ ____ /year

7 Maintenance cost for IR device $ ____ /year + $ ____ /year = **Operating Cost for On-board IR Device** $ ____ /year

8 Cost per hour to plug into EPS $ ____ /hour × How many hours each year could you use EPSs instead of idling?* ____ hours/year = Cost to plug in $ ____ /year + $ ____ /year = **Total Operating Costs for IR** $ ____ /year

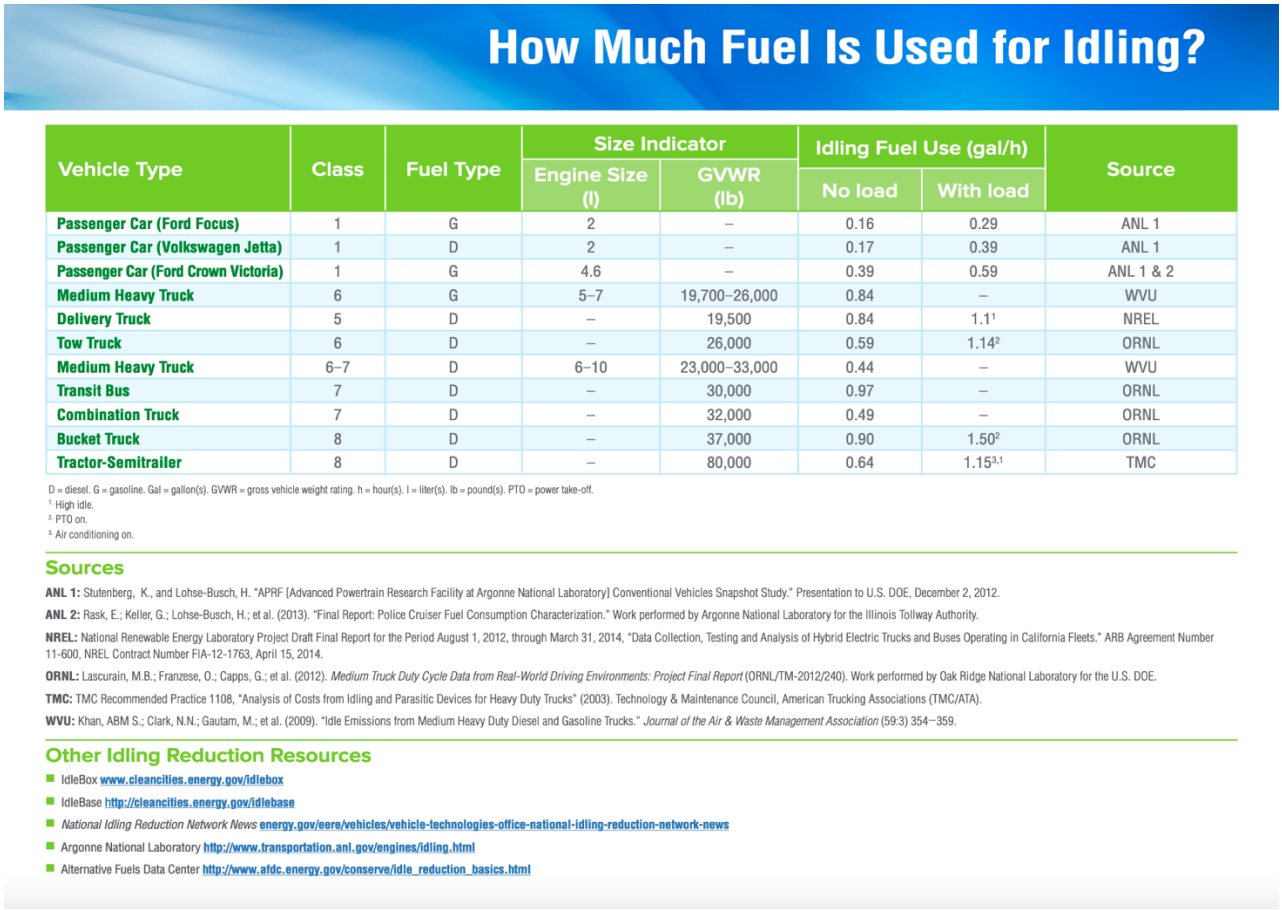
Calculate Savings from IR

9 Capital cost of on-board IR device $ ____ ÷ **SAVINGS** Line 5 – Line 8 $ ____ /year saved = **Payback Time** ____ years

10 A ____ – B ____ = ____ gallons saved/year

* Total number of hours from lines 6 and 8 should equal the number of hours in line 1.

[1] 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).



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

ANL 1: Stutenberg, K., and Lohse-Busch, H. "APRF [Advanced Powertrain Research Facility at Argonne National Laboratory] Conventional Vehicles Snapshot Study." Presentation to U.S. DOE, December 2, 2012.

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

https://www.anl.gov/sites/www/files/2018-02/idling_worksheet.pdf

Note: Electric vehicles will not "idle" in the same way as gas and diesel cars and trucks. This policy may eventually become obsolete as the majority of cars become electric (100 years from now!).

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.

Tactics

- Run a County-wide (including all public schools) "no idling" campaign

- All County, Police, and LAPS vehicles should be equipped with a sun shield for the front windscreen.

- 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

- Some school districts, such as 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
- Tree planting in areas of concrete and/or asphalt

Community Outreach/Educational Materials

- 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.

- Community outreach will be through articles in the newspaper, mailers in utility bills (or electronic attachments in e-bills), "No Idling" signage in public locations (streets, schools, parking lots), schools will inform parents and other frequent guests of their no idling policy.

References/Resources

https://cleancities.energy.gov/technical-assistance/idlebox/
https://www.fueleconomy.gov/feg/driveHabits.jsp
https://www.edf.org/attention-drivers-turn-your-idling-engines

Recommendation 6: Launch Municipal Bike Share Program

This recommendation is not yet complete.

Time Frame: Short-to-Medium-Term and Ongoing

Outcome

- 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.

Examples in Other Communities

- Incentives to use bike shares in various other places:
  - 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

https://www.biketownpdx.com/

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. all should go through the vendor.

- A few towns had a problem with the bike provider company "going under," and then the municipality was left with unusable bikes. Two places who had mentioned this are in the process of switching to a new bike share provider.

- Be sure to have clear parking guidelines and enough places for bikes to be parked "legally"

- Questions to Ask:
  - How many bikes?
  - How many locations?
  - How to keep the "load balanced," i.e. enough bikes at each station?
  - Whom to 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

- E-bike and/or regular bike?
- Where can/can't people park bikes? Seattle posts bike parking guidelines: https://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-share

References/Resources

https://www.pedbikeinfo.org/topics/bikeshare.cfm
https://www.denvergov.org/Government/Departments/Department-of-Transportation-and-Infrastructure/Programs-Services/Micromobility-Program?BestBetMatch=bike%20program|95c94ae0-247e-4b0c-b511-f9439cc122bd|c4f1b630-3cf4-4ec1-8110-c4784b6aa32e|en-US
https://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-share
https://www.biketownpdx.com/
https://www.bendoregon.gov/home/showpublisheddocument/47764/637381859539770000

Recommendation 7: Encourage Private Electric Vehicle Purchase and Charging During Non-Peak Hours

This recommendation is not yet complete.

Time Frame: Short-Term and Ongoing

Background/Data

We need current data on Los Alamos County EV usage. If we follow national norms, should be around 7%. (https://www.pewresearch.org/fact-tank/2021/06/07/todays-electric-vehicle-market-slow-growth-in-u-s-faster-in-china-europe/)

Tactic

- Implement more EV charging stations at apartment complexes (see Recommendation 3)
- One excellent EV promotion toolkit from the Sierra Club gives the following examples of policies and other incentives to switch to EVs: https://www.sierraclub.org/sites/www.sierraclub.org/files/program/documents/EV%20Policy%20Toolkit.pdf

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

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

- Using VW Settlement Funds to Grow EV Charging Networks

Examples in Other Communities
https://afdc.energy.gov/files/u/publication/guide_ev_projects.pdf

Economic Impact
It seems there may be some money available from the State of NM through the Volkswagen Environmental Mitigation Settlement https://www.env.nm.gov/air-quality/vw-settlement/

Benefits Other than CO_2 Reduction
- Improved air quality
- Increased access to EV charging stations for all residents and visitors to LA County

References/Resources
https://www.sierraclub.org/sites/www.sierraclub.org/files/program/documents/EV%20Policy%20Toolkit.pdf
https://afdc.energy.gov/files/u/publication/guide_ev_projects.pdf
https://www.env.nm.gov/air-quality/vw-settlement/
https://afdc.energy.gov/laws/all?state=NM

Recommendation 8: Increase Number of Solar-Powered Flashing Light Crosswalks

This recommendation is not yet complete.

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.

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.

Tactics

- 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

Impact 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.

References/Resources
https://www.pedbikeinfo.org/factsfigures/facts_environment.cfm
https://www.bendoregon.gov/home/showpublisheddocument/47764/637381859539770000

Recommendation 9: Convert Municipal Small Engines, Such as Lawn/Garden Equipment and Golf Carts, to be Fossil Fuel Free

This recommendation is not yet complete.

Recommendation 10: Invest in Consistent, Ongoing Community Outreach and Education to Facilitate Sustainable Transportation Options

This recommendation is not yet complete.

Time Frame: Immediate and Ongoing

References/Resources
https://www.bendoregon.gov/home/showpublisheddocument/47764/637381859539770000

Expected Benefits to Community Besides Carbon Reduction

- "Green" Job Creation
- Mobility Improvement for All Citizens
- Increased Health and Fitness

- Short- and Long-Term Cost Savings to County and Residents through less wear-and-tear on vehicles, fuel cost savings, and less road maintenance
- Raise Awareness of the Impact of Climate change
- Role Model for Other Communities
- Closer Community - “bus friends,” more out-and-about citizens (bikes, walking, other)
- Educational Opportunities
- Ecosystem and Water Quality Protection
- Public Health and Air Quality Protection
- Noise Pollution Reduction
- Reduced Fire Risk

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 important to provide 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?

Carpooling

- 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.

Aerial Tramway

- An aerial tramway from WR to LA or between North Mesa, Barranca Mesa and Downtown, would be a fun and very expensive mode of public transportation. Lunchtime diners could hop on the tram and go to WR for lunch. Morning and evening commuters between WR and LA would no longer clog State Road 4, Main Hill/ Road and the Truck Route. Visiting tourists and locals alike would be attracted by this beautiful and dramatic ride. This would be fun for all ages! Rough estimates start at $30M.

- Questions:
    - Could it go over Lab property? Pajarito Road?
    - Would that be less complicated/fewer players than going through Pueblo land?

Hydrogen Fuel Technology for Transportation

- Hydrogen can be used for all kinds of things, primarily as transportation fuel including personal vehicles, buses, and heavy-duty trucks (semis, garbage trucks, etc.). We would need to invest (in tandem with LANL?) in hydrogen production and storage in order for this to be a viable option.

XIII. Recommendations: Waste, Consumption & Natural Resources

Introduction

In 2021 addressing climate change is urgent and complex and this necessitates considering and 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 challenge of climate change mitigation requires looking as broadly as possible at many causes and solutions in order to identify the most impactful, feasible and scalable 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. We must also be prepared to deal with the effects of climate change, which is already impacting our community, our environment and our water supply, and foster a resilient Los Alamos that continues to flourish.

In order to ensure that the RES Task Force comprehensively addresses GHG reduction and climate change mitigation, 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

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
- Identify additional areas critical to LAC climate change resiliency and sustainability
- Review approaches taken by other communities as described in their climate action plans
- Identify and understand current activities in the County that address these areas
- Propose measures to reduce emissions and climate change impacts which are practically and economically feasible for County government, businesses and residents
- Estimate costs and benefits of proposed GHG reduction and resiliency approaches, and identify short-, medium-, and long-term actions and goals

The research effort for each focus area has been undertaken by one or two members of WCNR, and the recommendations below reflect various stages of completion. All recommendations are subject to further modification, addition or elimination as subcommittee work continues through 2021.

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 (https://drawdown.org/). 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"

Additional sources of information, such as climate action plans from other cities, are available on request.

Protocol Followed

See Recommendation 1 for discussion of the need for appropriate GHG inventory for LAC emissions utilizing a consumption-based protocol (TBD).

Recommendation 1: Perform Consumption-Based GHG Analysis for LAC

Time Frame: Medium Term; 2022, and ongoing

Background Research & Data

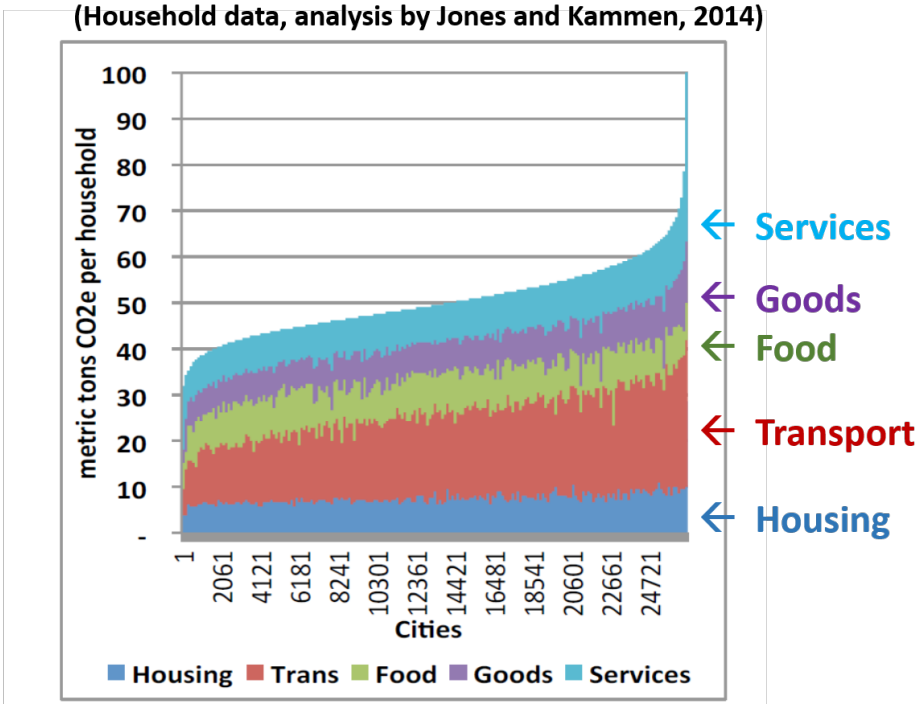
- Existing LAC estimates account for GHG emissions from electricity production, natural gas use, transportation fuel and solid waste (R. Gibson, 2021 report.) Per capita CO_2 e estimate = 11.9 tonnes/yr

- The total LAC community GHG footprint, which includes the above plus emissions associated with goods, food and services consumed by a community (a "consumption-based" [CB] estimate), is likely to be considerably higher (based on results from GHG inventories of middle-high income communities in N. America and Europe.)

- One CB study, performed for each zip code in the US, calculates LAC per capita GHG emissions to be 24 tonnes/capita/yr (Jones & Kammen, 2014), about **twice the current estimate.**

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.

Outcome

- More comprehensive understanding of total CO_2 e emissions resulting from the various activities of residents, businesses, County government and schools.
- Identification of most timely, urgent and in some cases, easy activities to target in efforts to reduce GHG emissions.
- Help insure equitable actions for GHG reduction initiatives.
- 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.
- Impetus and support for individuals and entities to undertake carbon footprint analyses and adjust patterns of consumption of goods, food and services (see Recommendations 3 and 4 below).

Strategies

- Evaluate existing methods used by other communities for suitability and feasibility
- Determine scope of analysis, given LAC goals
- Determine if analysis should be done by LAC Staff and/or external consultant
- Perform analysis
- Provide results to County Council, Boards and staff, and residents, together with strategies that target GHG sources identified in analysis
- Monitor changes to GHG emissions through ongoing and periodic analyses

Impact/Examples in Other Communities

- King County, WA: Performed a CB GHG analysis, and found that 63% of emissions were due to goods, food, services and construction.
- Eugene, OR found that consumption-based emissions were more than 2.5 times greater than previously estimated local emissions.
- Multnomah County, OR: A CB analysis found that 53% of GHG emissions resulted from food, goods and services consumed in the County.
- Lake Oswego, OR: A CB analysis found that 46% of GHG emissions were due to production, transport and disposal of goods, food and services.

- Denver, CO: is in the process of updating its GHG inventory, setting a new baseline using CB estimates.

Economic Impact

- **Anticipated Costs:**
  - LAC Staff time to prepare RFP (if using consultant), hire and work with consultant
  - LAC Staff time to gather relevant data for analysis
    - Possible additional cost to purchase economic data and/or conduct spending surveys of community
  - Fee for analysis by consultant (if used)
  - Funds for education/outreach to community regarding results and GHG mitigation actions

- **Anticipated Economic Benefits:**
  - Provides data to inform selection of most impactful and cost-effective interventions to lower GHG emissions
  - Economic/spending data obtained should also be useful to Economic Development and local businesses.

Benefits Other than CO_2 Reduction

- More honest accounting of GHG sources adds to credibility of Task Force report and recommendations
- Potential for greater equity in actions recommended and taken to lower GHG emissions (Lower-income HHs typically have lower CB emissions, and from different sources, than more affluent HHs.)
- Opportunity to educate community on full environmental impacts of lifestyle
- Allows community and leadership to take a critical look at LAC GHGe and assess anticipated reduction by mitigation strategy (aid in prioritization of strategies)

Challenges & Anticipated Barriers

- Economic/spending data for analysis may need to be gathered.
- Consumption-based measures, based on economic data, 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.

Community Outreach

- Potential for educational outreach done while collecting data on household/business/municipal government/school spending
- Educational outreach based on analysis outcome, with suggestions for actions to be taken by residents, etc. to reduce GHG emissions

References/Resources

- *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) *CBEI Guidebook - USDN Sustainable Consumption Toolkit*
- *PAS 2070: 2013 Specification for the Assessment of Greenhouse Gas Emissions of a City (PAS 2070)* Specification for the assessment of greenhouse gas emissions of a city – Direct plus supply chain and consumption-based methodologies
- *Under-reporting of greenhouse gas emissions in U.S. cities.* NATURE COMMUNICATIONS | (2021) 12:553 | Under-reporting of greenhouse gas emissions in US cities
- 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*., 2013, dx.doi.org/10.1021/es4034364

Waste Management, Recycling and Composting

Recommendation 2: Following "Zero Waste" Principles, Eliminate Municipal Waste Sent to Landfill Through Reduction, Re-use, Recycling and Composting With a Goal of 100% Diversion by a Period of Time to be Determined

Time Frame: Current and Ongoing

Background/Research/Data

- 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, commercial waste was 2,890 tons. The diverted waste (recycled, reclaimed, or composted) is approximately 21,194 tons/annually or 56% of all waste generated. In addition, the municipal solid waste, which includes all commercial, residential and transfer stations, is 16,509 tons and is shipped to the Rio Rancho landfill at a cost to the County of approximately $1,000,000 in 2019, which includes transportation and disposal. The Rio Rancho landfill is predicted to close in the next 5-7 years and the next landfill will be a further distance and may increase the cost of hauling and disposal.

- The Environmental Services Department submits a monthly report on waste diversion and GHG benefits and costs of these activities in their monthly sustainability report HERE. You can also read the 2017 Environmental Sustainability Plan HERE.For the Los Alamos County waste recommendations, the LARES Task Force is recommending a Zero Waste approach, which was adopted by the US Conference of Mayors in 2015. Zero Waste is a philosophical and programmatic strategy to minimize the environmental impact of materials disposal. Ideally, all materials and products would be reduced, or re-used, re-purposed, recycled or composted. This strategy prioritizes care of hazardous materials, so that disposal or recycling of these is done to have a minimal (ideally zero) impact on the natural and human environments.

- Los Alamos County has the opportunity to be a leader in the work of Zero Waste through community commitment to reducing materials that end up in the waste stream, reusing or re-purposing materials, and recycling. This is an innovative, socially connected community of scientists, nature enthusiasts, educators and people dedicated to service and innovation. We are also the healthiest county in the United States. With these attributes, we are well-poised to tackle the complexities and challenges of shifting toward a future that embraces Zero Waste practices. It is estimated that 21,194 tons of material, which include concrete and asphalt, recycle, yard trimmings, batteries, electronics, tires, pallets, metal, cardboard, mixed recycle,

oil and antifreeze, were diverted from the landfill in 2019. Seventeen percent of waste is food waste, of which 491 tons (37%) come from commercial enterprises and 831 tons (63%) come from residential homes.

Outcome

- Decrease (over time to 100%) the amount of municipal solid waste (MSW) that is deposited in a landfill:
  - Increase diversion rate of materials to 90% of waste diverted from landfill by TBD (example from Los Angeles, CA: 90% by 2025, 95% by 2030 and 100% by 2050)
  - Reduce municipal solid waste generation per capita by 15% by TBD, including phase out of single use plastics by TBD
  - Eliminate organic waste going to landfill (by TBD)
  - Increase proportion of waste products and recyclables productively used or repurposed by X % in TBD and X% by TBD
  - Increase commercial and industry participation in County goals by a certain % per year - to get to 100% by TBS

Case Study/Public Education/Educational Materials

Los Angeles County Sustainability Plan
EPA website on Zero Waste
Fort Collins Road to Zero Waste
Marin County Zero Waste

- **Strategy 1: Integrate concepts of Zero Waste into all aspects of LAC. This includes education, programs and practices as well as supported outreach on Zero Waste goals, strategies and benefits.**

  - Tactic 1: With resource allocation (staffing/consultants) implement policies to support reduction of single use materials and waste produced, and support repurposing and recycling where indicated.
    - Considerations:
      - Responsible waste management systems (trash, compost, recycling)
      - Improve County recycling and compost operations - to increase capacity
      - Hazardous waste reduction best practices
      - Disaster planning to include waste reduction strategies
  - Tactic 2: Implement waste reduction, composting and recycling at all County facilities, programs and household services.

- Considerations:
    - Policies and codes need to be reviewed for opportunities to support Zero Waste goals.

- Tactic 3: Conduct waste education and outreach on Zero Waste and programs, practices and recommendations for individual, commercial and County/public entities to adopt this framework.
    - Considerations:
        - Support/incentivize local commerce innovations
        - Green business awards
        - Promote Zero Waste outreach at events (support needed)

- Tactic 4: Improve recycling practices - through 100% recycling and at the same time, decreasing reliance on single use materials.
    - Considerations:
        - Use apps and programs like Recycle Coach
        - Improve recycling education to include environmental footprint, so people understand the % of materials that are actually 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.

- Tactic 5: Improve refrigerant management policies and recycling
    - 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. In May 2021, the U.S. Environmental Protection Agency (EPA) proposed its first rule under the American Innovation and Manufacturing (AIM) Act of 2020 to phase down the production and consumption of HFCs.
    - Consequently, adopt policies and practices *as outlined in* Project Drawdown to:
        - avoid leaks from refrigerants
        - destroy refrigerants at end of life, both after the adoption of alternatives to HFC refrigerants such as propane, isobutene,

ammonium, etc.

- Consider policy recommendations to reduce GHG emitting refrigerants examples here.

- Tactic 6: Improve household hazardous waste reduction and safe disposal

    - 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. Proper disposal is necessary to prevent injury, illness, or environmental contamination. Although HHW is excluded from Subtitle C of the Resource Conservation and Recovery Act, it is regulated under Subtitle D of this law as a solid waste. In other words, household hazardous waste is regulated on the state and local level.

    - Considerations:

        - Reduce purchases of products that contain hazardous ingredients for viable alternatives. Advance collection programs, events, and opportunities. Utilize information resources from the EPA, NMED, and NM Recycling Coalition.
        - Battery use, recycling and disposal.
        - Pesticide sale, use and safe disposal.

- Tactic 7: Encourage recycling and repurposing of construction materials for construction projects in Los Alamos.

    - Construction material re-purposing, for example the Habitat for Humanity Re-Store.
    - Sustainable Materials Management approaches for C&D materials should be considered. These include best practices for 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. Sustainable materials management (SMM) is a systemic approach to using and reusing materials more productively over their entire life cycles. Technical guidance, tools, and models such as: EPA SMM Strategic Plan Examples:
        - EPA Sustainable Materials Management Program Strategic Plan for Fiscal Years 2017 – 2022 | US EPA

- Road Ahead report Sustainable Materials Management: The Road Ahead Waste Reduction Model (WARM) Basic Information about the Waste Reduction Model (WARM) | US EPA should be explored for applicability. Feasibility of materials and waste exchanges through Reuse Centers, which are markets for buying and selling reusable and recyclable commodities, should be investigated.

- Tactic 8: Increase organic waste diversion

    - Goals: 0% of compostable materials will be sent to landfill
    - Increase composting of yard trimmings to 100%. Currently, 70% of households have yard trimming carts.
    - Implement food waste composting – community compost pick up for food waste, policies for public, County and commercial food waste reduction and composting
        - Examples:
            - Restaurants: compostable to-go containers and utensils or encourage customers to bring their own containers and utensils, having an "ask before giving" disposable utensils policy
            - Households, apartments, schools and businesses will have compost pick up
            - More backyard composting kits with education outreach on wildlife safety
            - Partner with schools, churches, extracurricular activities and nutrition services to reduce food waste through left over challenges
            - Guerilla food app – for fruit trees and Gaia's Pantry project

- Tactic 9: Reduce reliance on single use items

    - Implement best practices that support reusable materials
    - Integrate water bottle filling stations throughout downtown
    - Conduct a community campaign to bring own cups everywhere
    - Work with grocery and food vendors to reduce impact of "to go"
    - 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 more comprehensive - ban on restaurants or even sale of single use plastics. 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.

- Tactic 10: Support reusing, repurposing and repair

        - Exchange center for sharing of reusable household items
        - Create a re-maker space with community to fix and repair and trade
        - Incentivize businesses who bring these services to LA County

- Tactic 11: Incentivize, fund/support "Waste to Energy Solutions"

    - Considerations:

        - LA County could look into the use of anaerobic digestors for methane recovery - refinement and pipe into other processes. Organic wastes can emit fugitive methane gases as they decompose. Methane creates a greenhouse warming effect 34 times stronger than carbon dioxide over a century. One option to control decomposition of organic waste is in tanks called anaerobic digesters. They 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 source would be the closed landfill. Overall, landfills can be a top source of methane emissions, releasing 12 percent of the world's total. Landfill methane can be tapped, captured, and used as a fairly clean energy source for generating electricity or heat, rather than leaking into the air or being dispersed as waste. The climate benefit is twofold: prevent landfill emissions and displace coal, oil, or natural gas that might otherwise be used.

Economic Impact

- 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, costs could be traded from diversion to landfill and with a single use plastics ban, 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.

Benefits Other than CO_2 Reduction

- Benefits will be reduced burden on environmental services to manage waste

Challenges & Anticipated Barriers

- Many local cities and counties are addressing these issues, and this will be increasingly becoming the norm for local communities. 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, with some educational funding, and novel approaches to community building around this, we can continue to engage, learn and adapt to new ways of consuming as well as our waste production.

References/Resources

Los Angeles County Sustainability Plan
EPA website on Zero Waste
Fort Collins Road to Zero Waste
Marin County Zero Waste
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 https://www.epa.gov/smm
Project Drawdown Solutions, https://drawdown.org/solutions
New Mexico Environment Department, Waste Management https://www.env.nm.gov/waste/
New Mexico Recycling Coalition, https://www.recyclenewmexico.com/
Protecting Our Climate by Reducing Use of HFCs, https://www.epa.gov/climate-hfcs-reduction
How Does Anaerobic Digestion Work? https://www.epa.gov/agstar/how-does-anaerobic-digestion-work
US EPA Landfill Methane Outreach Program (LMOP), https://www.epa.gov/lmop

Our waste disposal system in action

Consumption of Goods, Food and Services; Refrigerants; Construction Materials

Recommendation 3: Educate community regarding sources of GHG emissions and provide information on reduction of personal carbon footprint

Time Frame: Ongoing

Background

- Community GHG emissions arise from diverse activities of residents, businesses and other entities. Rapid reduction of emissions requires addressing as many of these important sources as possible, by as many people as possible. Many people would like to take action to reduce personal emissions, but general understanding of these sources, and how to reduce them, is often limited. Also, individuals and entities have different desires and capabilities to reduce their carbon footprint and should have choices in how to do so.

Outcome

- Extensive public education campaign results in greater community understanding of important sources of GHG, where they arise in daily life, and the options available to reduce them.
- Resources are readily available for residents and other entities to use to estimate personal GHG emissions and learn ways to address them.
- Material and social incentives are provided to help engage the community in learning about and acting on GHG reduction options.
- 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.

Case Study/Public Education

- Annually since 2017, LAC Environmental Services and the Environmental Sustainability Board (ESB) have conducted a community-wide "EcoChallenge." This fun, interactive program utilizes an on-line platform to engage residents in learning about ways to reduce their environmental impact. Dozens of teams have participated, including many school groups, and hundreds of residents have taken action to learn about

and reduce their carbon footprint, energy, water and fuel use, and other sustainability measures.

Strategy

- Research and evaluate existing carbon footprint calculators and accompanying information on GHG reduction actions
- Develop/aggregate online resources for use by the community to explore GHG footprints and actions to take to mitigate. Publicize widely as a "One-Stop Shop for Reducing your Carbon Footprint" (perhaps as part of larger "Sustainable Living" web resource)
- 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 target youth, adults, businesses, and local government employees.
- Provide CO_2 e information on all utility billing, so customers can see their GHG impacts as well as understand how their energy/NG/water consumption compares with others in the community.

Impact/Examples in Other Communities

- Eugene, OR implemented a "Carbon Free Challenge" which engaged city residents in online and in-person carbon reduction activities and competitions.
- The Oregon Department of Environmental Quality provides a Carbon Footprint Calculator on its website, together with "Take Action" options and pledges for its residents.

Economic Impact

- **Costs:** Funding for educational outreach to community including staff time, advertising, purchase of incentives ($1-5 per resident)

- **Savings:** To County—from reduced energy and water use, waste disposal, etc. To Residents/Businesses—from energy/water conservation and reduced purchasing

Benefits Other than CO_2 Reduction

- Helping residents learn about their own carbon footprints permits choice in actions to take in reducing emissions, customizable to household/business budget, capabilities and resources.

- Engaging residents in action-oriented GHG reduction campaigns builds community, and educates regarding climate change, sustainability and resiliency.
- Actions taken to reduce carbon footprint often also result in water conservation, waste reduction, and other environmental benefits.

Challenges & Anticipated Barriers

- Educating and engaging a large percentage of the community can be difficult but is achievable with diverse effort sustained over time.

Community Outreach

- See above

References/Resources

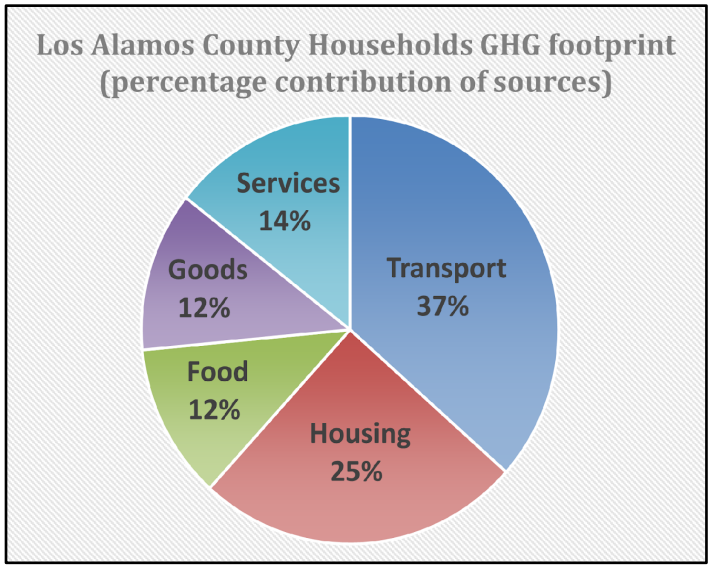
- Several household carbon footprint calculators are available, and most incorporate suggestions on actions to take to lower emissions. These include: *US EPA Household Carbon Footprint Calculator* (Household Carbon Footprint Calculator | US EPA), *and* CoolClimate Calculator. App-based calculators, which use personal spending data to calculate emissions, include *Joro*, *OroEco* and *JouleBug*.
- 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). Other platforms include BeChange and Count Us In.
- Resources for carbon footprint estimation and mitigation for schools, businesses, local government and other entities will be evaluated for use in the County. For youth: Kids Calculator - Park City For businesses: Carbon Footprint Calculators for Businesses, Green Places | Erase Your Company Footprint and CoolClimate Calculator

Recommendation 4: Reduce consumption-associated emissions by encouraging and supporting sustainable purchasing, use and disposal of food, goods and services, refrigerant management, and low-carbon construction materials

Time Frame: Immediate and Ongoing

Background/Research/Data

- GHG emissions resulting from the purchase of food, goods and services consumed in Los Alamos, although they are produced outside of the County, likely make up a substantial portion of carbon emissions for which we are responsible. (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. *Environ. Sci. Technol.*, 2013, dx.doi.org/10.1021/es4034364.)



- Refrigeration, air travel and construction also have substantial associated GHG emissions.
- Reducing these is critical to achieving net zero emissions, and will also help address other sustainability issues, such as health, community resilience, waste and food insecurity.

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Outcome

- Educational outreach to the community will result in better understanding of all sources of GHG emissions, their impacts, and ways to reduce them.
- Residents are empowered and encouraged to shift to lower-carbon diets and waste less food, resulting in improved health and cost savings.
- Increased local reuse and repair of material goods permits residents to reduce purchase of new goods. Residents build community connections and local resilience while saving money and reducing waste to landfill.
- Businesses and residents are encouraged to purchase non-hydrofluorocarbon (HFC) refrigerators, freezers and AC units (as needed), and educated on safe maintenance and disposal of appliances containing HFCs.

- Residents reduce air travel emissions by changing travel habits. Businesses support methods for employees to work without long-distance travel to meetings, etc.
- County departments lead by example in utilizing lower carbon building materials in all CIP and other construction projects.

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, the ESB 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

- 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" campaign to involve all residents, businesses, schools and other entities. Support Farmers' Markets, home gardening and community/school gardens, as well as local food rescue groups/food banks. Leverage the buying power of government, schools and community organizations to purchase low-carbon, minimally processed foods. Promote better food choices through nutritional and health counseling programs. Facilitate "gleaning" to channel surplus produce from home gardens to food banks.

- Promote a "circular economy" for material goods, emphasizing reduction of purchases through reuse, repair, sharing and recycling. Promote community "Fix It" clinics, rental businesses, thrift stores, tool lending "libraries", and sharing groups. Encourage consumption of local services (such as gift cards for services) over purchase of material goods. Reduce use of disposable goods such as service ware, and emphasize purchase of durable, reusable goods.

- Assess current green purchasing policies used in County government and schools. Implement sustainable purchasing policies 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 from the current 5%.

- Educate regarding HFCs, options for purchasing non-HFC appliances, and ways to safely dispose of appliances at end of life. Convene large entities using refrigeration (groceries, schools, LAMC) to ensure proper maintenance/leak prevention and disposal procedures are in use. Facilitate transport of residential refrigeration units to Eco Station for proper extraction and disposal of HFCs at end of life.

- Encourage reduction in air travel through promotion of local/regional travel, and options for businesses to conduct work without travel to meetings etc. Educate regarding how to reduce CO_2 emissions from air travel (take direct flights, fly economy class, choose airlines using biofuels, purchase carbon offsets, etc.) County staff should lead by example.

- Promote 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. Promote deconstruction and reclamation of high-value materials, possibly through a "deconstruction ordinance." Develop and implement GHG reporting criteria in planning all CIP construction projects.

Impact/Examples in Other Communities

- 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.

- 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.).

- Eugene, OR, plans to convene community partners who use refrigerants to identify options to reduce leaks from appliances and commercial refrigeration systems.

- The Town of Chapel Hill, NC, provides builders with a list of building materials that are required to be recycled or salvaged when a building is being torn down and requires documentation of material recycling or salvage.

Economic Impact

- **Costs:**
    - Education/outreach will require staff time, and educational and promotional materials.
    - Shifting to higher quality, lower carbon food and goods may have higher up-front costs.
    - Replacement of HFC-containing appliances and AC units (at end of life) to ones containing non-HFC coolants will incur cost.
    - 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:**

    - 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 consumption can result in significant savings. 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.
    - Purchase of more durable goods, and increasing rental, repair, sharing and reuse of goods, can all save consumers money. Promotion of rental, repair and resale businesses supports local economy.
    - Refrigerant extraction and recycling is currently a cost for Environmental Services. Shifting to non-HFC gases (which can be cheaply vented) will save on disposal costs.
    - Local/regional travel (vs. overseas) can save vacation costs and support local tourism economy. Less business travel can result in significant cost savings.
    - Use of reclaimed/recycled building materials may save on construction costs. EcoStation already collects construction debris, reuse of this would create a local market for that material.

Benefits Other than CO_2 Reduction

- Support of local/regional agriculture and home gardening, waste reduction, health improvement, air/water/land pollution reduction, reduction in agricultural use of land, water and other resources. Increase in donations to food banks, reducing food insecurity

- Promotion of sharing enhances social connection and community. Support of local businesses, services and non-profits involved in circular economy. Reduce waste to landfill. Reduce consumption of water, minerals, fossil fuels, labor, capital, etc. used to produce goods and services. Shift to use of services over purchase of material goods supports local businesses. Increase skills for resourcefulness and self-sufficiency
- Reduction of air travel can support local travel and tourism industries
- Reuse of reclaimed construction materials reduces landfill waste and use of virgin resources

Challenges & Anticipated Barriers

- 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.
- Most release of HFCs is thought to occur during use of commercial refrigeration by businesses, over which there is no control or oversight.
- Options for long-distance travel from Los Alamos, 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.

Community Outreach

- See above

References/Resources

- Project Drawdown (https://drawdown.org/) 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.
- The USDN "Sustainable Consumption Toolkit" provides extensive resources to advance sustainable consumption in cities: USDN Sustainable Consumption Toolkit, including a "Smart Shift" guide to help local governments promote sustainable consumption.

- The UN's EAT-Lancet Planetary Health Diet outlines changes to the food system that reduce GHG emissions substantially, while improving human health: The Planetary Health Diet
- LAC Environmental Services "Food Waste Prevention" webpage (Food Waste Prevention) 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 (Tools for Preventing and Diverting Wasted Food | US EPA).
- The West Coast Climate Forum's "Climate-Friendly Purchasing Toolkit" provides guidance on specific purchasing strategies to reduce local governments' carbon footprint: Climate Friendly Purchasing Toolkit
- US EPA information on HFC refrigerants, their impacts, and legislation to phase-down their production in the next 15 yrs: Protecting Our Climate by Reducing Use of HFCs | US EPA (NMED is also writing rules to mitigate HFC emissions, including entirely phasing out the use of HFCs in New Mexico.)
- 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" 5 key ways to reduce GHG emissions in building construction

Food Waste Prevention Toolkit materials distributed by Environmental Services Zero Waste Team to members of the community at outreach events

Water and Wastewater

Recommendation 5: Build a Comprehensive Water Conservation (and Specifically Watershed Stewardship) Plan for the Los Alamos and White Rock Communities in Order to Maintain and Enhance the Quantity and Quality of Water Available to the Los Alamos community, While Reducing Runoff Contamination Through Green Infrastructure Approaches. Ensure Progressive Leadership and Exemplify Best Forward-Looking Practices in Water Efficiency and Water Quality Efforts that Ensure Sufficient Clean Water for Current and Future Natural Landscapes and Generations. (We plan to consult with Philo Shelton and other relevant County department directors on strategies listed below).

Time Frame: Immediate and ongoing

Background

- Reliable, safe water is essential to Los Alamos County's continued tenure on the Pajarito Plateau. Increased warming, drought, and shifts in precipitation timing due to climate change, together with population increase and development, impact water availability and quality, placing increasing pressure on our supply. LANL studies indicate that levels in our aquifer are declining, and predict that water quality will be impacted, with increased pumping costs (Long Range Water Supply Plan for Los Alamos County [LRWSP]).

- While it is likely that our aquifer contains sufficient water to supply the community for many decades to come, reducing demand will help compensate for these changes without impacting availability or expanding production, together with lowering costs and bringing other benefits. In addition, longer periods of excessive heat and drought will also occur in LA County, and building resilience to excessive heat days, long periods of drought as well as increasing severity of monsoon rainfall and subsequent flooding will be key. Our community has successfully embraced water conservation measures in the past and continues to support efforts to conserve.

- Surface waters in Los Alamos are subject to contamination with not only LANL legacy wastes but also toxins from residential, business and municipal use of herbicides, pesticides, and other chemicals. Runoff of these poses a threat to the health of

communities and environment at home and downstream along the Rio Grande. Climate change is predicted to cause increased frequency and severity of flooding and greater runoff due to tree loss and other landscape changes. Los Alamos' LRWSP has stated that, "Stormwater management is a key issue for the County and LANL. Section 502 of the Clean Water Act 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

- Reduced water use, increased water security, savings to County and residents
- Reduced need for location and development of new, deeper water wells and development of (dwindling) San Juan-Chama water resource.
- 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, 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

Case Study/Public Education/Educational Materials

- DPU has set and successfully achieved a goal of reducing water use by 12%.
- 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
- What is Green Infrastructure? U.S. EPA Resources, Initiatives, Case Studies, https://www.epa.gov/green-infrastructure/what-green-infrastructure

Strategies

1. Updates of DPU Energy and Water Conservation Plan should include ongoing analysis of projected climate change impacts, and provide revised goals and policies that mitigate those impacts to water supply and quality.

- LAC Long Range Water Supply Plan provides guidance on how to monitor and integrate climate change information into water supply planning, and should be 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.
- 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.
    - Prioritize and increase funding to education outreach organizations like PEEC.

2. Encourage and support greater use of greywater and rainwater for residential, business and municipal purposes, to reduce use of drinking water.

- Implement gray water policies and build capacity to help 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.)
- Reclamation and use of greywater/rainwater should be employed at County facilities and schools, to educate and lead by example. Identify relevant state and federal funding sources needed to build infrastructure (that cannot be built with DPU funding - for example extension of grey water infrastructure to schools and other non-County watered areas).

3. Increase use of reclaimed water to decrease burden on aquifer

- Actively prioritize chasing funding for water conservation and sustainability measures as a county.
    - DPU already has much of the needed infrastructure in place for grey water use and needs outside funding to enable grey water usage at White Rock schools, Pueblo Complex sports fields, Urban Park, High School and UNM-LA practice fields. Actively supporting DPU's efforts by looking at funding sources outside of DPU reach will enable grey water use at those facilities sooner.
- 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.
    - Fire hydrant testing targets flow of 1500 gallons per minute for each hydrant, that's 1000s 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.
- Actively search out 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.

4. Use Well-Established Stormwater Capture Methods to Address Open Space Stormwater Runoff. Test and Record Quality of Stormwater Runoff and Aquifer, Checking for a Range of Urban Contaminants Including Plastics, Heavy Metals, Herbicides, Pesticides, etc.

- 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 and filter into area, which reduces the rate of flow and allows for deep infiltration 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.

- Consider partnering with LANL to pay for and implement the EPA best practices for stormwater runoff (National Menu of Best Management Practices (BMPs) for Stormwater | US EPA) to capture as much water on the hill as possible.

- Educate community re. runoff issues, pesticide/herbicide/etc. reduction, don't dump antifreeze down the sewer etc.

- Hire an environmental contractor/consultant for proper stormwater capture, testing and database setup.

Impact/Examples in Other Communities

- 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 http://www.fmtn.org/306/Stormwater-Management
- Boulder, CO https://assets.bouldercounty.org/wp-content/uploads/2018/08/2018-sustainability-plan-chapter-8.pdf
- Portland, OR https://www.portlandoregon.gov/bes/64040

Economic Impact

- **Costs:**
    - Funding for consultant (or staff time) to incorporate climate change impacts and mitigation into DPU 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); loss of water service fee revenue; (or just "see Conservation Committee Recs for additional info on economic impact"?)
    - 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 understood.

- **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.

Water tower on North Mesa

Benefits Other than CO_2 Reduction

- Health of community and environment

Community Outreach

- Education through DPU and PEEC as well as ESB, PRB.

References/Resources

- LAC Long Range Water Plan -- 2018 https://www.losalamosnm.us/common/pages/DisplayFile.aspx?itemId=14437322
- DPU Energy and Water Conservation Plan: 2015-2019 2015-2019 Energy and Water Conservation Plan
- BPU Conservation Committee report-- July 2020 https://www.losalamosnm.us/common/pages/DisplayFile.aspx?itemId=16924287
- 2021Survey of DPU Environmental Goals: https://www.losalamosnm.us/UserFiles/Servers/Server_6435726/File/Government/Departments/Public%20Utilities/Environment/Goals%20Survey/20210120-Env.Goals-rev.pdf
- Los Alamos County Non-Potable Water System Master Plan: https://www.losalamosnm.us/common/pages/DisplayFile.aspx?itemId=7151931
- FY 2020 DPU Annual Report https://indd.adobe.com/view/9e860bda-e2d4-45aa-b5b9-6bf8dd3c4e03
- New Mexico 50-Year Water Plan
- Future water resource shifts in the high desert Southwest of Northern New Mexico, USA
- Erosion 101: Everything You Need to Know About Soil Erosion
- What You Can Do to Soak Up the Rain | US EPA
- Basic Information about Water Reuse | US EPA
- https://www.env.nm.gov/surface-water-quality/stormwater/
- https://www.federalregister.gov/documents/2020/01/22/2020-00981/notice-of-availability-of-final-designation-of-certain-stormwater-discharges-in-the-state-of-new
- https://www3.epa.gov/npdes/pubs/msgp_monitoring_guide.pdf

- National Research Council 2007. *Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory: Final Report*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11883.

Natural Spaces, Soils, Land Use, Forests, and Carbon Sinks

Recommendation 6: Manage Natural and Community Landscapes for Climate Change Mitigation, Resilience, Community, Cultural and Wildlife Values, and Carbon Sequestration

Time Frame Current and Ongoing

Background & Data

- 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, 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 resilience. 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 impacts 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 resilience 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 resilience should be a key aspect of our planning for climate change.

Outcome

- Revised and updated LAC Open Space Management Plan comprehensively addresses land use practices, and proactively describes actions to be taken to mitigate predicted climate change effects
- Residents, businesses and County employees take stewardship of our lands, and actively participate in enjoying, maintaining and enhancing our natural environment
- Residents, businesses 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

- 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.

    - 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

- Continue and expand ongoing practices for wildfire mitigation, habitat restoration, wildlife corridors, landscape preservation, recreation enhancement, etc. including:

- Fuel mitigation on public and private lands, wildfire preparedness, post-fire recovery actions.
- Support of 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

- Review LAC Comprehensive Plan to ensure that it is compatible with identified goals for GHG mitigation and climate change resilience.

  - 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

- Work with NMSU Extension, Master Gardeners, ecologists, landscapers and others to inform climate-wise landscaping recommendations for residential and County developed areas .

  - 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

- Estimate carbon sequestration potential for LAC undeveloped areas and landscapes.

  - Research and identify approaches to estimating CO_2 production and sequestration in County natural spaces, including undeveloped open space, parks, and other large spaces
  - Carry out carbon source/sink estimate, using County staff or consultant
  - Use data in revision of Open Space Management Plan and other County efforts that impact natural spaces
  - Use estimate in calculation of progress on net-zero goal

Impact/Examples in Other Communities

- 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' "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 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, and improved quality of recreation opportunities, with concomitant increase in property values, energy and water conservation, traffic calming, reduced noise, attraction of new residents and LANL hires, and enhanced health and quality of life

Challenges & Anticipated Barriers

- Current (2015) Open Space Management Plan may require extensive revision. 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 environment. Some activities may need to be prohibited (ATV use, 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 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

- Los Alamos County Open Space Management Plan (2015)
- The Carbon-Free City Handbook: Biological Resources. Rocky Mountain Institute (2017)
- Rio Grande Water Fund (The Nature Conservancy of New Mexico)
- East Jemez Landscape Futures project
- Forest Management for Carbon Sequestration and Climate Adaptation. Todd A. Ontl et al. (2020) Journal of Forestry, 2020, 86–101 doi:10.1093/jofore/fvz062
- 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)
- Vibrant Cities Lab (created by U.S. Forest Service, American Forests, and the National Association of Regional Councils). "Urban Forestry Toolkit."
- USDA Forest Service i-Tree Tool for assessing and managing forests and community trees
- McPherson, Gregory, and James Simpson. Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters. USDA Forest Service, 1999
- Forest Adaptation Resources: Climate change tools and approaches for land managers and Adaptation Workbook, 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. 161 p. www.nrs.fs.fed.us/pubs/52760 and the corresponding online interactive tool: adaptationworkbook.org
- USDA-NFS Climate Change Resource Center Compendium of Adaptation Approaches
- Minneapolis (MN) Urban Forest Policy
- Fort Collins (CO) Nature In The City Strategic Plan

XIV. Other Communities' Sustainability 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: http://www.cabq.gov/sustainability/climate-action-plan
- Bend, OR: https://www.bendoregon.gov/city-projects/sustainability/-selectview-1
- Boulder, CO: https://www.pyxeraglobal.org/how-boulder-colorado-created-a-zero-waste-roadmap/
- and https://www.bouldercounty.org/environment/sustainability/sustainability-plan/
- Eugene, OR: https://drive.google.com/file/d/1Z-JHsnHyhy7qHn-8MOaNm57DxSAoAZwN/view
- Fort Collins, CO: https://www.fcgov.com/sustainability/files/2019-sustainabilityandadaptationplan.pdf
- Hillsboro, OR: https://www.hillsboro-oregon.gov/departments/city-manager-s-office/sustainability
- Park City, UT: https://www.parkcity.org/departments/sustainability
- Phoenix, AZ: https://www.phoenix.gov/sustainability/goalhttps://www.phoenix.gov/sustainabilitysite/Documents/Final%20COP%202015-16%20Sustainability%20Brochure%2003.27.17.pdf
- Salt Lake City, UT: https://www.slc.gov/sustainability/climate-positive/
- Santa Fe, NM: https://www.santafenm.gov/sustainable_santa_fe_plan
- Seattle, WA: https://www.seattle.gov/environment/climate-change/climate-planning/climate-action-plan
- https://www.seattle.gov/Documents/Departments/Environment/ClimateChange/2013_CAP_20130612.pdf
- Sedona, AZ: https://www.sedonaaz.gov/home/showpublisheddocument?id=40957
- Telluride, CO: https://mcusercontent.com/45794dd4deb0a48d92b415574/files/db86a259-d6c2-6dcb-7cd6-be4f41ac845e/Town_of_Telluride_CAP_Factsheet_FNL_6.25.pdf
- Westminster, CO: https://www.cityofwestminster.us/Residents/CityServices/Sustainability/SustainabilityPlan
- List of 50 Largest Cities in US Climate Mitigation Plans: https://ballotpedia.org/Climate_action_plans_in_the_50_largest_
- C40 (World's Biggest Cities Committed to Fighting Climate change): https://www.c40.org/other/agenda-for-a-green-and-just-recovery

XV. Acknowledgements

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