NREL
NATIONAL RENEWABLE ENERGY LABORATORY

REACHING 100% RENEWABLE ENERGY

City of Aspen and the National Renewable Energy Laboratory develop and implement a strategy to cost-effectively reach a ground-breaking goal

In 2004, the City of Aspen, Colorado, adopted an ambitious goal to supply 100% of its electricity from renewable energy resources by 2015. Through a combination of city-owned and operated hydroelectric projects and power purchase contracts, approximately three-quarters of Aspen's electricity had been sourced from renewables by 2014.[1]

The city had planned to construct and own a hydroelectric facility on nearby Castle Creek to generate additional renewable energy. It had also conducted engineering, ecological, and financial studies, and it had purchased some equipment and undertaken some preliminary infrastructure construction, but the project was placed on hold to address various issues and evaluate alternatives.

Seeking impartial assistance, the city contacted the National Renewable Energy Laboratory (NREL). After initial discussions, the city decided to partner with NREL through a technical services agreement (TSA). Through the course of the partnering process, NREL staff familiarized themselves with relevant historical documents, outlined available options to help the city meet its renewable energy goal, and presented these options to the Aspen City Council during open council meetings.

Even though the city had already implemented a broad list of energy efficiency programs to reduce electricity consumption, NREL was asked to consider both demand- and supply-side options to meet the city's goal. NREL staff with expertise in energy efficiency reviewed the city's previous and current programs and efforts, and they identified additional efficiency measures for the city to consider. The city chose to separate the demand-side analysis[2] from the process for identifying supply-side options to keep city council discussions focused and make effective use of the skills of city staff.

Over the course of the project, NREL staff worked closely with Aspen's municipal utility staff, who provided data used for the analysis, documents such as the contracts with their wholesale electricity provider, as well as background reports and past feasibility studies.

Early in the project, it became clear that some critical definitions and assumptions about the 100% renewable goal needed to be clarified before options could be identified. Although the city had clearly stated a goal of 100% renewable energy, the specific technologies and project types that would be considered eligible as "renewable" energy had not been defined. It was also necessary to clarify other details that

THE CITY OF ASPEN

[1]The percentage of renewable energy varies from year to year, depending on variations in load and the amount of snow and rainfall available for hydroelectric production.
[2]The demand-side analysis is not included in this brochure.

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impacted the options available to the city, such as whether the purchase of renewable energy certificates needed to be bundled with an energy purchase.

The method and process NREL staff used for the City of Aspen was based on similar work that NREL has conducted with other partners with ambitious renewable energy goals, such as the U.S. Navy. As it does with many of these types of partnerships, NREL encouraged all members of the public that made contact with NREL to direct inquiries and comments to Aspen city staff; NREL did not take a public-facing role during the project.

PHASE 1: DEFINING "RENEWABLE" AND CLARIFYING CITY PRIORITIES

During the first city council meeting involving NREL, the team developed a process to help council members clarify goals and prioritize project selection criteria. This was referred to as Phase 1.

NREL facilitated discussion and answered questions to assist the city council in defining which technologies and resources the city would consider "renewable" and thus eligible to meet the city's goal. The council also discussed and decided what type of renewable energy certificates would be required to meet the city's goal. Figure 1 shows the list of eligible renewable energy resources and those resources that would not be considered renewable. Of particular note is the council's decision to consider the limited use of "unbundled" renewable energy certificates as a mechanism to maintain the city's 100% renewable status from year to year. Renewable energy certificates would serve as a balancing mechanism to enable the city to consistently meet 100% of its electricity demand with renewable energy, given the natural fluctuations in energy consumption and supply.

Renewable
Solar, wind, geothermal, hydro (small and large)
Considered on an individual project basis dependent upon the conditions of each unique project
Biomass, landfill gas, sewage gas, directed biogas
Technologies remaining under consideration
Municipal solid waste to energy, coal mine methane
Non-renewable (not considered in this process)
Nuclear, natural gas, coal, oil

Figure 1. City of Aspen's definition of renewable generation resources

NREL also presented a broad list of selection criteria that could be used to help council members prioritize project opportunities and narrow the project options. Each council member selected his or her top three priority criteria from the broad list. This process helped identify the criteria of greatest importance to the city council, and it guided NREL and city staff efforts toward the opportunities that aligned with these priorities. The criteria were also used as a basis for discussion and to informally rank the opportunities during the second presentation to the council. Figure 2 shows the ranking of criteria by the council.

PHASE 2: IDENTIFYING PROJECT OPPORTUNITIES

Once the definitions and priorities had been clarified, NREL and city staff collaborated to identify the opportunities to bring the city to 100% renewable energy. The list of renewable energy options included an extensive list of opportunities that city staff had identified and studied before requesting NREL's assistance as well as numerous new options that had not previously been considered. In total, data were collected for approximately 17 opportunities under consideration. Efforts were focused on gathering detailed information for options that demonstrated the potential to prove both feasible (contractually, financially, ecologically, and otherwise) and consistent with city priorities.

Once the complete list of opportunities was built, they were characterized according to the priorities stated by the council during the Phase 1 meeting (See examples in Figure 3). No project opportunities were dismissed for not matching the priorities. However, a "short list" of opportunities that matched several of the stated council priorities and appeared feasible were presented in detail during the Phase 2 meeting. Project opportunities that were not included on the short list were summarized and council was asked if they would like to move other opportunities to the "short list" category.

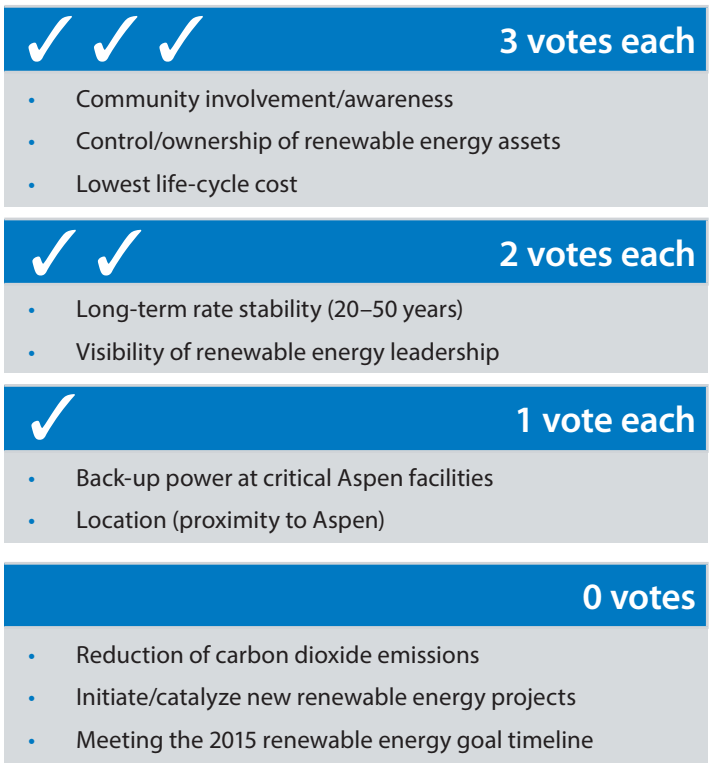

Figure 2. City of Aspen's criteria for selecting new renewable energy projects

Based on the discussion during the Phase 2 council meeting, the council selected two options for further investigation: executing power purchase contracts for additional wind energy and energy from a landfill gas project in Iowa. Although these two options were not local and scored low on some of city priorities identified during Phase 1, both were feasible and cost-effective options. The identification of priorities was still considered important in guiding and focusing the analysis and discussion of the many project opportunities.

Throughout the process, NREL's role was to support the City of Aspen with its decision-making process. All objectives, definitions, and preferences used to identify options were those stated by the Aspen City Council. NREL remained neutral with regard to technologies, policies, and projects.

PHASE 3: PURSUING THE SELECTED OPPORTUNITIES

Phase 3 represented a transition in the roles and levels of effort by NREL and city staff. Whereas NREL played a significant role in the analysis and presentations during Phases 1 and 2, city staff took the lead role during Phase 3, with NREL providing support as requested. The transition was useful in several respects. It conserved limited funding resources while allowing city staff to take ownership of the effort, become very familiar with the details of the projects being pursued, and build strong foundations with individuals in organizations related to the project opportunities. The transition also helped city council to build trust with city staff and their ability to take their selected opportunities to completion.

Subsequent to the transition, city staff began negotiations with their wholesale energy supplier, the Municipal Energy Agency of Nebraska. Discussions focused on defining the

Technology	Output megawatt-hour/year	Lifecycle Cost megawatt-hour/year	Control or Ownership	Community Involvement	Rate Stability	Visibility Leadership	Back-up Power	Location (proximity to Aspen)
Photovoltaics	Up to 1,500 limit	~$130+	Yes	High	~25 years	High	Low	In Aspen
Hydro	5,500	~$63	Yes	Medium	~75 years	High	Up to 5,500 MWh	In Aspen
Landfill Gas	Up to 18,000	$96 (current cost)	Low	Low	varies over 20 years	Low	No	900 miles away
Wind	5,000–20,000	~$90	Low	Low	up to 3 years	Low	No	Colorado or Western United States

Figure 3. Examples of renewable energy opportunities presented to the Aspen City Council in 2014.

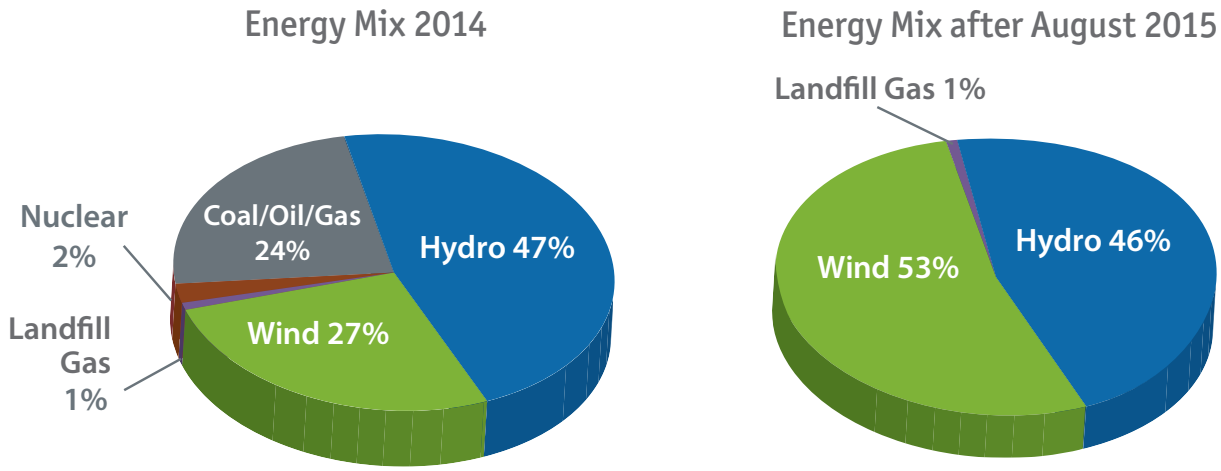

Figure 4. City of Aspen's energy mix for 2014 and as planned for August 2015[a]

[a] The city has a small percentage of energy produced by a solar-electric system, which is not evident within the scale of these graphs.

specific energy products that could be provided, how the energy would be shaped and balanced with existing supplies, pricing structures and other details. Obtaining a product that both achieved 100% renewable energy and addressed priorities identified by city council guided these negotiations.

2015 AND BEYOND: MEETING THE GOAL AND INCREASED LOCAL OWNERSHIP

The City of Aspen met its goal of 100% renewable energy in August of 2015 (Figure 4) with the approval of new power purchase contracts for wind and landfill gas. The new wind contract, which provides 95% of the new renewable energy, differs from the city's two existing wind contracts in that it is not a "take-or-pay" agreement, meaning the new contract does not require set monthly purchases of wind energy. Rather, the new contract allows the city to only buy what it needs to keep it close to 100% renewables in any given month. The advantage of this arrangement is that it affords crucial supply management flexibility for dealing with inconsistencies in energy production from Aspen's other resources (i.e., inconsistencies that are due to drought or wet year hydropower fluctuations), and it allows the city to avoid situations in which they are forced to buy energy they cannot use.

In addition to helping the City of Aspen achieve its ambitious renewable energy goals, electricity rates in Aspen will remain among the least expensive in Colorado. Even after meeting its goal of 100% renewable energy, the City of Aspen will continue to pursue demand-side energy reduction and opportunities that allow for local ownership of renewable generation, including micro-hydro and solar energy.

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