To: Sara Lillevand and Paul Benoit
From: Piedmont Connect Pool Committee (Tom Webster, Indira Balkissoon, Garrett Keating, Margaret Ovenden)
Re: Achieving a Zero GHG Emissions Pool Facility
Date: April 28, 2021

Context

Both the State of California and the City of Piedmont, in its Climate Action Plan 2.0 (approved in 2018), have committed to reducing our greenhouse gas (GHG) emissions to 80% or more below 2005 levels by 2050, with an interim target of 40% below 2005 levels by 2030 (a mere nine years from now). Since 2018, assessments of the climate emergency by various bodies, including the U.N.'s Intergovernmental Panel on Climate Change, have become more dire, and more ambitious goals are being urged. Most saliently, President Biden has recently set the goal of the U.S. reducing its current emissions by 50% below 2005 levels by 2030, which means that Piedmont's current goal of reducing emissions by only 40% below 2005 levels is less ambitious than the national goal (and probably should be reevaluated, but that is a different conversation).

As the CAP 2.0 points out, although some of its targeted emissions reductions will come through legislation at higher levels of government and changes in how various goods (cars, appliances, etc.) are manufactured and fueled, those external reductions will not be sufficient for Piedmont to reach its emissions reduction targets. We will still need to carry out every action in the CAP 2.0, especially in the building energy and transportation sectors, our two largest GHG-producing sectors, both for the residential and municipal sectors.

Unfortunately, Piedmont's latest annual GHG inventory (for 2018, though 2019 should be coming soon), shows that we are making little progress. According to the staff report accompanying the 2018 inventory:

> The inventories completed thus far reveal that, for the most part, the changes from year to year are caused by external forces, and that the City still has a long way to go to make substantive changes to the building energy sector and the transportation sector so that it can meet the City's 2030 and 2050 goals. 2019 is expected to be the first inventory in which a significant drop in emissions is due to action taken by Piedmonters [(joining East Bay Community Energy)]. But the sobering fact is that if Piedmont wants to reach its CAP 2.0 goal of reducing its emissions by 40% from 2005 by 2030 (29,291 metric tons of CO2e), it needs to decrease 2018's emissions by 13.56%. The consumption of carbon free electricity alone will not get us there (p. 8, 2018 GHG Inventory Staff Report).

The role of the City in implementing the CAP 2.0 goes beyond meeting emissions reduction targets for the municipal sector; It is also vital that the City serve as a role model and informational resource for the residential sector, which generates the majority of Piedmont's GHG emissions. So far, the City has put a good effort into providing residents with informational resources, but, apart from enrolling in East Bay Community Energy's 100% Renewable

electricity plan (along with 90% of Piedmont residents), it has not done enough to serve as a role model through reducing emissions in its own facilities. In fact, Piedmont's annual GHG inventories show that there has been a 13.9% increase in emissions associated with municipal buildings and facilities since 2016, likely partially attributable to ageing facilities (p. 6, 2018 GHG Inventory Staff Report). While the next (2019) inventory is estimated to show a 10% reduction in municipal emissions as a result of EBCE enrollment, the municipal sector still has a long way to go.

The CAP 2.0 highlights the importance of fuel switching for the municipal sector, both in transportation (electrifying the vehicle fleet and employee transportation) and in building energy (replacing furnaces, water heaters, etc. with efficient electric models as they reach their end of life). It also calls for any new municipal facilities to be built to emit zero carbon emissions:

> **Action MUN-2.1B:** Construct new City buildings to ZNE and green building certification standards. (CAP 2.0)

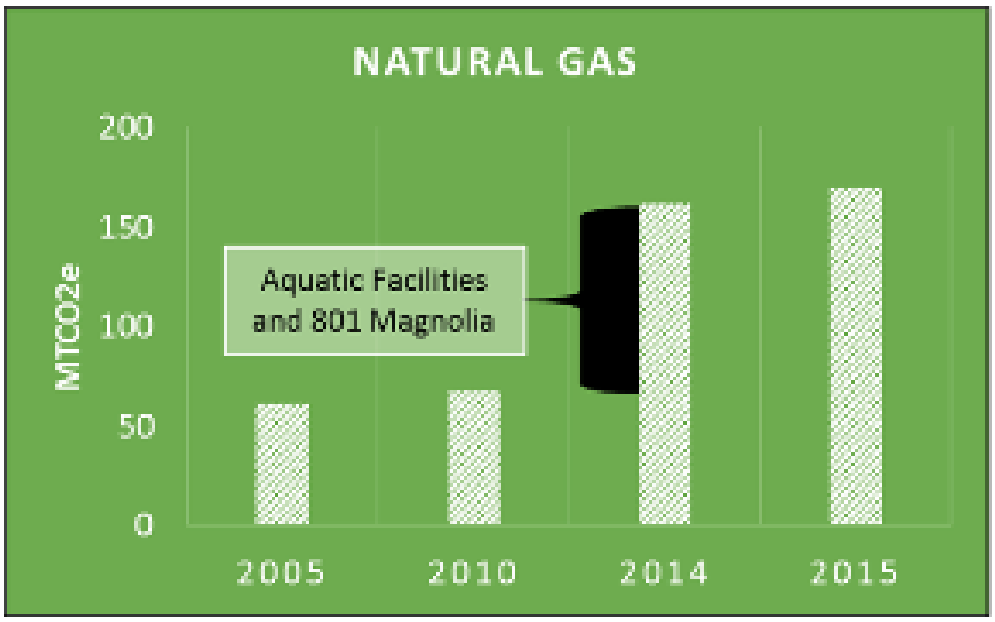
In other words, according to our ratified Climate Action Plan, any new municipal construction, including the planned new community aquatic facility, must be built to emit zero greenhouse gasses (GHG) from the start. We are out of time for using natural gas as a "transitional" fuel.

In December 2020, after the passage of Measure UU, Piedmont Connect formed a committee to research what would be entailed in designing a zero carbon emissions pool facility. We are pleased to report that our preliminary findings, although needing further data to back them up, show that such a design is both technologically and economically feasible.

GHG Emissions of Old Pool Facility

Although this fact is not widely recognized, the old pool facility's natural gas usage may have constituted around two thirds of overall gas usage in Piedmont's municipal facilities. City staff involved in the development of the CAP 2.0 prepared the following chart, which shows that municipal natural gas usage (and thus GHG emissions) almost tripled when the Aquatic Facility and 801 Magnolia became part of the City buildings and facilities portfolio. The CAP 2.0 states that this increase was almost exclusively driven by the Aquatic Facility. We were not able to replicate this assessment using the PG&E data we had access to, but it nonetheless seems highly likely that the old pool was the major source of municipal GHG emissions, due to its use of natural gas for pool heating. The good news in this is that designing the new pool facility to emit zero greenhouse gasses will *significantly* lower the municipal sector's GHG emissions, constituting a big step towards meeting the CAP emissions reduction targets and enhancing residents' perception of the City as being an entity that is willing to "walk the talk ."

Municipal Energy Consumption: Buildings & Lights (from CAP 2.0 p. 64)



The chart indicates that if the municipal sector is going to have a fighting chance of reaching the goal of reducing its emissions to 40% below its 2005 levels by 2030 and 80% below by 2050, the new pool facility needs to be Zero Net Carbon, or all-electric, *just to get municipal emissions back to their 2005 level.*

Data Sources and Methods of Analysis

We used 2019 annual pool billing data and extrapolated from the old 4,690 square foot pool to the proposed new 13,500 square foot pools. A more thorough analysis would need access to additional data, such as the data the firm Councilman-Hunsaker used in preparing their conceptual design for the new facility, as well as first principles energy evaluations for heating and electrical loads during the preliminary design phase, to verify our findings.

We conducted an analysis of performance and costs of the proposed aquatic center to evaluate the potential of different designs to achieve zero net carbon usage and to decrease municipal GHG emissions. The amount of energy that will be needed to power the proposed aquatic facility for a year is significant. The 2019 utility bill for the current pool shows that it used 25,396 therms of gas and 110 MWh of electricity, equivalent to 854 MWh. The proposed new pools have three times the surface area of the current pool and therefore could consume three times this amount of energy in a steady state. This is a conservative estimate that does not account for the community pool being a warm pool and the increased depth of the competition pool. If the new pools were to still be heated 100% by natural gas, which no one is proposing, this would represent a *tripling* of the aquatic facility's current (2019) GHG emissions.

Analysis of Conceptual Design

The conceptual design of the new aquatic facility prepared by the firm Councilman-Hunsaker (https://piedmont.ca.gov/UserFiles/Servers/Server_13659739/File/Government/Departments/City%20Clerk/Pool%20Documents/OperationalAquaticsMasterPlan652017.pdf) projects that a solar PV array can provide 5% of the electricity needed for the new aquatic facility, and a solar tube array (solar thermal) can supply 55% of the thermal energy needed for pool heating. These elements are described as "Green Tech." The rest of the electricity for pool operation (water pumping and filtration) would come from the electric grid, and natural gas would be needed for heating the other 45% of the pool water. Because of the tripling of pool surface space over the old pool facility, the conceptual design will still significantly increase the natural gas usage of the old pool, even with the "green tech" features. It is far from a zero net carbon design and would significantly harm the City's GHG emissions reduction efforts. Our analysis of this design indicates that the proposal may *overestimate* the amount of thermal energy the solar tube array would provide. We suspect that GHG emissions from this design would likely be even higher than stated above. An additional concern is that a solar tube array would not provide sufficient year-round heating capacity. In general, solar thermal is an older and less efficient solar technology than solar PV.

As a first step towards developing a more accurate analysis of the conceptual design, we reviewed utility data for the existing pool and extrapolated usage to the proposed aquatic center. Our initial assessment is that the solar tubes may, in fact, cover less of the pool heating needs, thus leaving more to be covered by natural gas. However, without more specifics about the sources of the data used in the conceptual design, we were unable to provide a reliable assessment of the whole Councilman-Hunsaker plan. For the purposes of GHG emissions and financial cost comparisons we carried out (which will be discussed shortly), we took the Councilman-Hunsaker conceptual plan at its face value and used the numbers they provided, just to be conservative in our argument for the benefits of an all-electric alternative design.

Design with Electric Heat Pumps Powered by Electric Grid

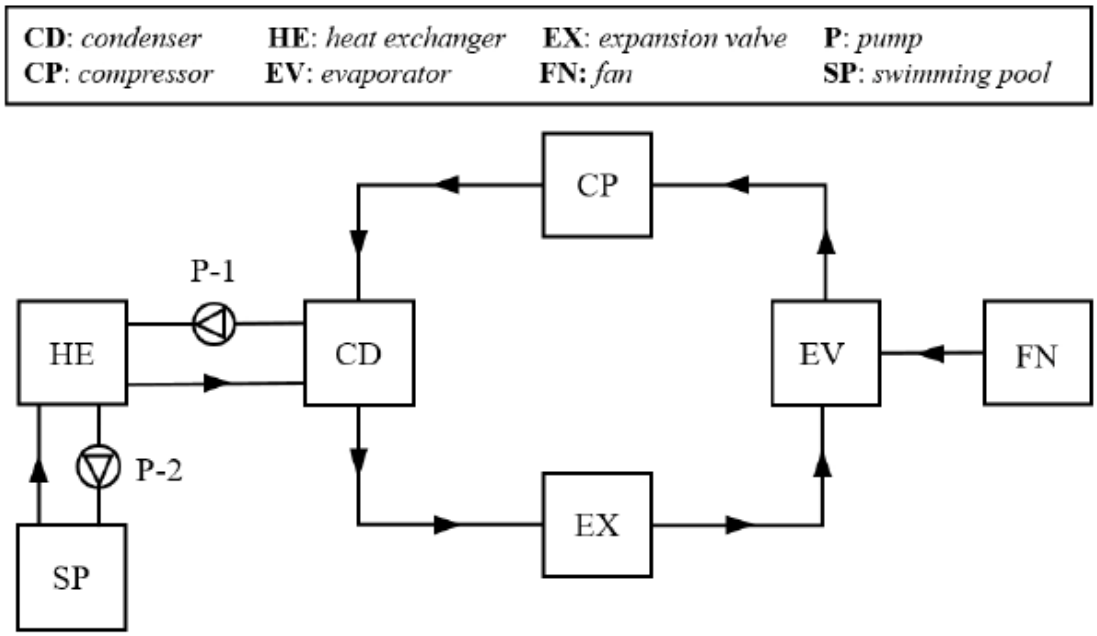
We then turned our attention to evaluating how the use of efficient electric air-to-water heat pumps could be used in the design of a zero net carbon pool facility. This is a new approach in municipal pool design, and the only current example of such a design we could find was with the City of Mountain View. It is certainly the direction municipal pools will be going in the future. The project manager and design team for Piedmont's new pool facility must be willing to step outside conventional natural-gas dependent pool design models, as well as be highly committed to and experienced in Zero Net Carbon design and complex energy financial analysis.

Our comparison of options for heating with natural gas versus electric heat pumps showed not only that heat pumps are more energy efficient but also that this efficiency itself reduces GHG emissions. (For this analysis, the efficiency factors used were a coefficient of performance

(COP) of 4 and a COP of 6. The higher a heat pump's COP, the higher its efficiency.) Using efficient electric air-to-water heat pumps to heat the pools would eliminate the GHG emissions that come from natural gas. A small PV array could be used for electrical and HVAC loads. Since the City is enrolled in EBCE's 100% Renewable rate plan, the new pool could be claimed as Zero Net Carbon from the beginning, and it would move towards being more truly Zero Net Carbon as California's electricity mix moves towards the 2045 goal of being 100% from renewable sources. In other words, GHG emissions associated with the facility's use of electricity from the electric grid would decrease over time, giving us a truly carbon neutral pool facility by 2050.

Financially, using high efficiency air-to-water heat pumps for pool heating would not be more expensive than the status quo (of using only natural gas). Thus, although it might seem, on the surface of things, that the current cheaper price of natural gas over grid electricity, means that heating the new pools with natural gas is the cheaper option, the attached spreadsheet of our calculations shows that the costs of the two options are very close, due to the high levels of efficiency of electric heat pumps.

Design schematic for all-heat pump design:



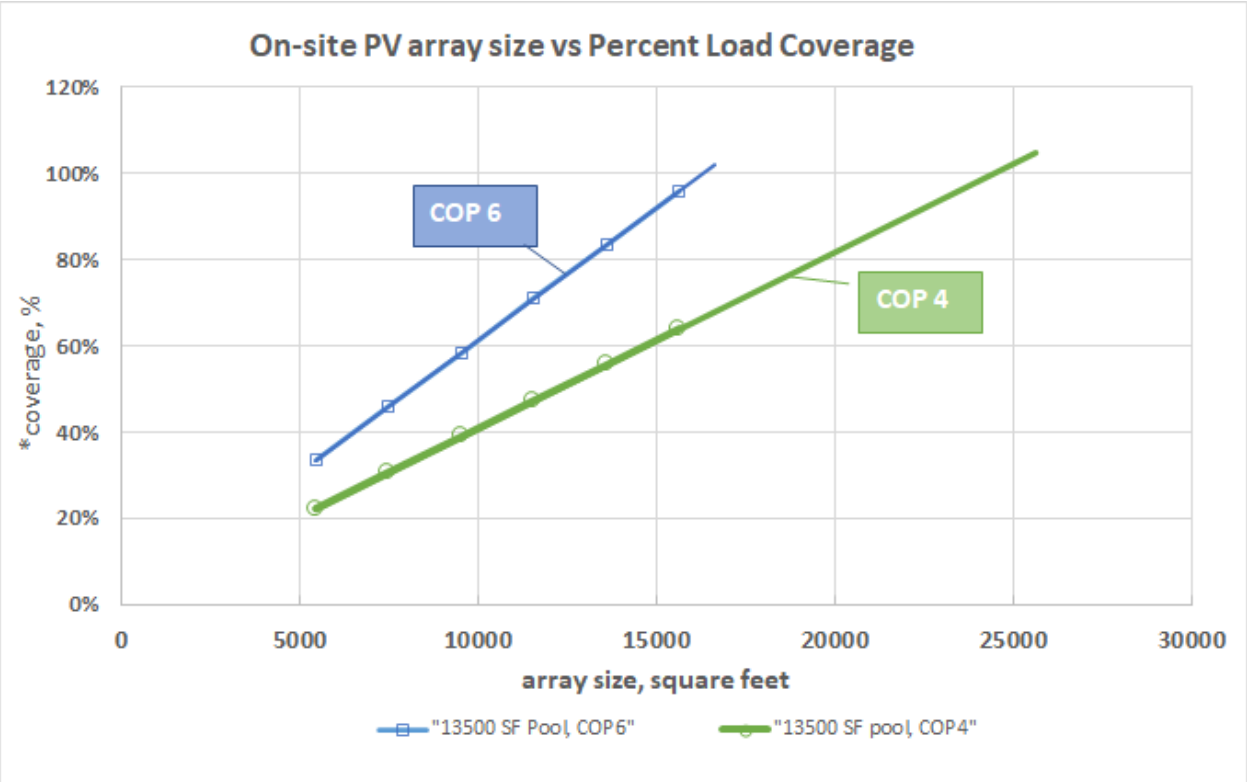
Design Combining Electric Heat Pumps and Onsite Solar PV Array (our recommendation)

We then explored a scenario of using a large onsite solar PV array to power the efficient electric air-to-water heat pumps (rather than relying solely on grid electricity to power the heat pumps). By using solar-generated electricity to power the heat pumps, the electric grid could be used only as backup for pool heating needs. This all-electric design would be a more deeply zero net carbon system than the all-heat pump scenario, as it would be generating electricity on site,

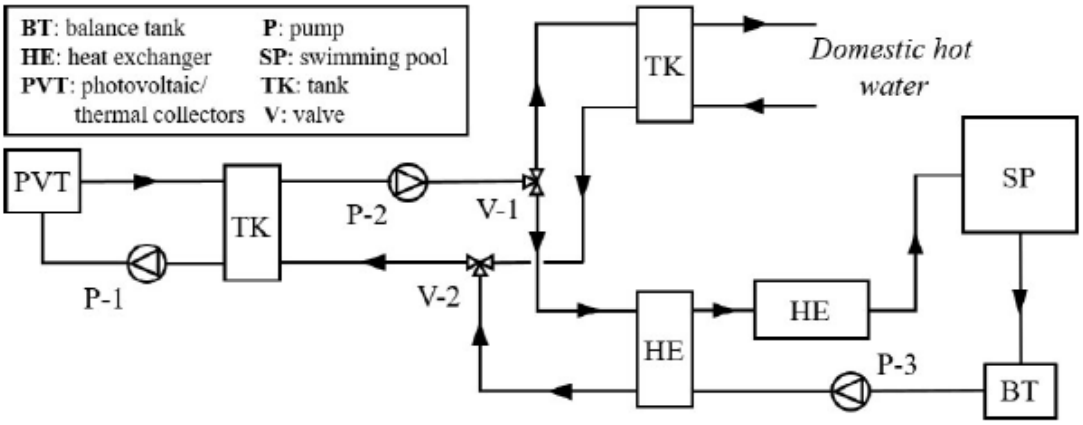
rather than relying on grid electricity, which not only is more expensive but also will not be 100% renewable until 2045.

Our calculations showed that the size of the solar array that would be needed to provide 100% of the electricity for the heat pumps could not be accommodated at the pool facility site. However, a heat pump with a Coefficient of Performance (COP) of 4 would need only ~25,000 square feet of PV panel space -- or 1190 panels. A higher efficiency heat pump (COP of 6) would bring down the panel space needed even further, as well as lower operating costs. (See chart below and photos of trellis and other overhead structures for PV panels after that.)

The initial cost of a design that combines electric heat pumps with an onsite solar PV array would be more than that of an electric heat pump-only design, because of the cost of installing a large solar PV array. However, the operating cost would be lower, since much of the needed electricity would be generated on-site, rather than purchased from the grid, which is more expensive.



Design schematic for one version of a system that increases the efficiency of the system by combining electric heat pumps with solar PV and solar thermal:



Potential Locations for Solar PV Panels

PV panels could go on the roof of the community building, as well as on a trellis or other type of overhead structures such as these. (Keep in mind that with temperature rise, pool users will be grateful for some shaded area):

Cost Comparisons

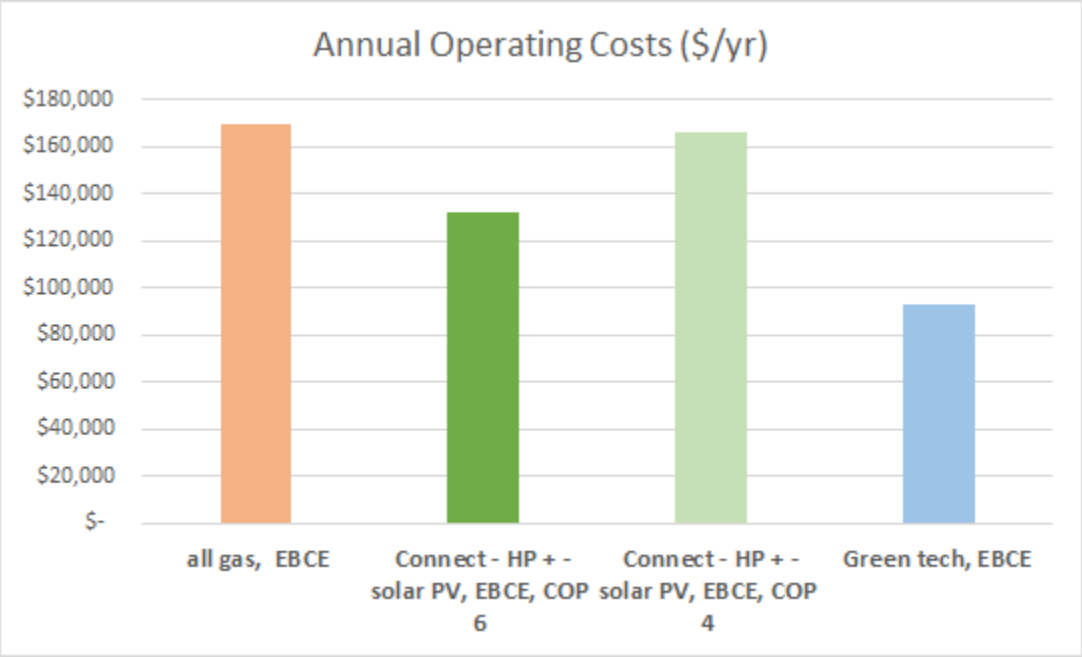
The following chart compares GHG emissions and annual energy costs (gas + electric) for these four scenarios:

- All-gas for pool heating, EBCE for electric load
- Heat pump with Co-efficient of Performance of 6, solar PV, EBCE
- Heat pump with Co-efficient of Performance of 4, solar PV, EBCE
- “Green Tech” conceptual design*

* needs verification of assumptions	all gas, EBCE	Connect - HP + - solar PV, EBCE, COP 6	Connect - HP + - solar PV, EBCE, COP 4	Green tech*,EBCE
Total annual gas+elect emissions, EBCE MT CO2	493.83	0.00	0.00	67.87
Total Operating Costs	$169,924	$ 132,211	$ 165,744	$ 93,220

* Although we believe the percentage of pool heating needs the “Green Tech” design’s solar tubes will cover is lower than stated in the conceptual design, we are being generous and using their numbers here. Their assumptions need investigation.

Putting just the cost figures from the previous chart into graph form, one sees that the estimated annual operating costs (for heating and electrical) are as follows. Using a heat pump with a COP of 6, rather than 4, will significantly lower operating costs. Again, we believe that actual operating costs of the "Green Tech" approach proposed in the conceptual design (which still relies on natural gas) will be higher, indeed probably closer to those of an all-electric system with heat pumps with a COP of 6 powered by solar PV, with EBCE backup.



Additional Considerations

While the cost comparisons indicate that annual operating costs for the "Green Tech" conceptual plan will be less (though it is debatable how much less) than those of the electric heat pump and solar PV approach, only the electric heat pump and solar PV designs generate zero carbon emissions in the course of the facility's annual operations. Since the "Green Tech" approach still relies on a significant amount of natural gas (at least 67.87 metric tons of CO2 per year, but most likely more), constructing a pool facility based on this design would prevent Piedmont from reaching its CAP 2.0 emissions reduction targets. In fact, it would represent the loss of a significant opportunity to not only reduce emissions in the municipal sector, but also to educate residents about the importance of not using natural gas in new construction and new appliances. The recently approved Reach Codes mandate that all new residential construction be all-electric. If the City were to refuse to apply this mandate to its own new construction, its moral voice in the Piedmont community's effort to combat climate change would be

compromised and its ability to get Piedmont residents on board with reducing their own emissions would be diminished.

The are several other important arguments for the construction of an all-electric pool facility design:

Accounting for the externalities of natural gas: Market forces do not currently pass on to the consumer of natural gas the cost of mitigating a number of significant “external” consequences of natural gas production and distribution. This is why natural gas is currently less expensive than other forms of energy. In evaluating the climate and environmental impacts of using natural gas, one must not only consider the direct GHG emissions generated by the burning of natural gas for a specific application (such as pool heating); One must also take into account that the drilling and extraction of natural gas from wells and its transportation in pipelines results in the leakage of methane, a primary component of natural gas that is 34 times stronger than CO2 at trapping heat over a 100-year period and 86 times stronger over 20 years. Methane leakage from natural gas wells and pipelines is a major problem throughout the U.S. and a significant contributor to our overall GHG emissions.

Environmental Justice: The “externalities” of natural gas fall most heavily on the communities in or near the facilities where natural gas extraction and production takes place, typically low-income communities of color. Some areas where drilling occurs have experienced increases in concentrations of hazardous air pollutants as well as particulate matter and ozone plus its precursors. Exposure to elevated levels of these air pollutants can lead to adverse health outcomes, including respiratory symptoms, cardiovascular disease, and cancer. A recent study found that residents living less than half a mile from natural gas well sites were at greater risk of health effects from air pollution from this natural gas development than those living farther from the well sites. (Union of Concerned Scientists) For a privileged community such as Piedmont to insist on being allowed to use natural gas for a recreational facility, because of the money it might save us for a decade or so, would be highly unjust to the communities that are most directly suffering the consequences of natural gas production. We have a moral obligation to use our resources to develop a zero net carbon facility, even if this makes the design process more complex.

Carbon offsets should not be considered as a mechanism for reducing the pool facility’s carbon footprint. In addition to the general ways carbon offsets are problematic (a big topic), offsets allow purchasers to buy their way out of emissions, while the communities living close to pollution sources continue to bear the brunt of the pollution.

Becoming a Stranded Asset: A natural gas dependent pool risks becoming a stranded asset. California is in the process of phasing out natural gas, led

significantly by the actions of cities such as Piedmont passing Reach Codes that prohibit the use of natural gas in new construction. The California Building codes will soon also be reflecting this transition. Although deadlines for the final phasing out of natural gas have not yet been set (most likely due to lobbying by the natural gas industry), energy experts are saying that a combination of legislation to regulate or stop fracking, or even curtail the use of natural gas will become law in the next four years. In addition, with Biden's new climate plans, we are at the beginning of a rapid transition by all major industries to more sustainable forms of energy. At some point, the companies responsible for drilling, moving, and selling natural gas will give up. The Center for Strategic and International Studies predicts that phasing natural gas out entirely will happen some time after 2040, well within the lifetime of this new pool facility. Having to completely redo the energy infrastructure of the pool facility well before the end of its lifetime would represent a cost Piedmont voters would be reluctant to shoulder. We need to build now for the energy landscape of the near future, rather than follow an outmoded fossil-fuel dependent paradigm.

Recommendations

For Piedmont's municipal sector to reach its GHG reduction targets as set by the CAP 2.0, an all-electric Net Zero Carbon system has to be the focus of the aquatic facility design from the very beginning -- carbon neutrality cannot be added later as an afterthought. The Project Manager and Design Team must be willing to step outside conventional natural gas-dependent pool design models. They must not only be experienced in aquatic facility design but also highly committed to and experienced in Net Zero Carbon design and complex energy financial analyses.