DENVER
CLIMATE ACTION, SUSTAINABILITY & RESILIENCY

Dear All,

My name is Drew Halpern and I am the City and County of Denver's project manager for the Community Solar Garden Agrivoltaics project at Denver Botanic Gardens Chatfield Farms. This project is a collaboration between my office – Denver's Office of Climate Action, Sustainability, and Resiliency (CASR) – and the Denver Botanic Garden Chatfield Farm. The goals of this project are to:

- Conduct research into the positive impacts of co-locating solar with agriculture
- Develop workforce and educational opportunities
- Generate clean electricity for both the Farm and the community at large.

We take our impact and responsibility seriously. We would not move forward with any project without using the latest research available ensuring our work will be safe and beneficial. We've worked closely with the Golden-based National Renewable Energy Lab (NREL) in the design and implementation of the Chatfield Farms solar program. While you've seen the top line benefits of the program in the recent HOA letter, I wanted to follow up with some more information about a few questions you had about the new solar array at Chatfield Farms.

Size and Scale of the Planned Chatfield Farms Solar Array: The starting point for a utility scale "solar farm" is usually set at between 1 megawatt (MW) and 5 MW and typically measured in peak – or the maximum possible - alternating current (AC) output. Our project will produce 0.96MW of peak power measured in AC, which means it is at the very lower limit of what would be considered a utility-scale solar farm.

Life Cycle of Materials Used and Maintained in the Solar Arrays: Aside from the solar panels used, the other materials used in our project are the same as any other construction project – steel for structural members, copper and aluminum wire for conducting the electrical energy, PVC conduit to protect the wiring, and a small amount of concrete to create a safe working area around some of the equipment. The panels themselves, however, are made from the most abundant element on the planet – silicon – with a small but not insignificant amount of various metals including silver, lead, cadmium, and gallium. Solar power is generated in the solar panel by exciting the electrons trapped in the silicon cell, not by combustion or any other chemical process.

Denver's Office of Climate Action, Sustainability and Resiliency has contracted the operations and maintenance services for this array for the life of the system – at least 25 years. This maintenance will include annual – or more frequent when required – physical inspections of every component of the system from the modules all the way back to the control equipment and electrical switch gear. The inspections take into account not only the electrical but also the mechanical characteristics of each component and will initiate a repair or replacement for any component that poses any risk to the system or those who work around it.

The panels used in this system are planned to be stored and sent for materials recovery (i.e. recycling) at the end of their useful life in 25 to 30 years. To reduce the risk from fire, our site is being built to

the latest National Electric Code (NEC) and utilizes technology developed to comply with various Underwriters Laboratories (UL) and Institute of Electrical and Electronics Engineers (IEEE) safety standards that require automatic system shutdown capabilities in the event of any loss of power, include that would occur during a fire event. Typically, the risk of fire related to solar installation comes from the proximity of those systems to a building that provides the flammable material.

Health and Safety: The World Health Organization (WHO) conducted a comprehensive review[1] of all available literature and research and concluded that there is no measurable risk to health and safety from low-strength electromagnetic fields (EMF) such as that in the vicinity of the solar array. The power generated within the array will be transformed up to 13.2kV and sent along Xcel's typical power lines, similar to those found in every neighborhood that deliver the power to your homes. The power generated would pose no additional risk compared to the power already being transmitted through the grid.

Glare: The Chatfield Farms solar array is being installed with solar panels manufactured with an anti-glare coating and is a single-axis tracker (SAT) meaning the solar panels will rotate around an axle to follow the path of the sun and maximize the amount of light energy that is converted to electricity. Typically, in a ground-mounted array that is not a SAT, the panels are tilted as close to due south as possible since the sun is always to our south in the Northern Hemisphere. However, in our case, the panels will start tilted towards the east in the morning and move throughout the day towards the west following an algorithm that anticipates the position of the sun at each moment throughout the solar year. In this way, any glare that is produced would always be directed between the northeast and northwest directions, which is generally away from the TrailMark properties, and at an angle away from the Earth equal to the angle of the sun above the horizon. Additionally, to prevent shading on the panels, the array does not track the sun all the way to sundown but will "backtrack" to the east as the sun approaches the horizon, further reducing any possible glare – in the visible OR near-visible ultraviolet (UV) and infrared (IR) spectrums – from being directed toward our neighbors. As such, the system creates no additional risk from the effects of the visible, UV or IR radiation emitted from the sun.

Environmental Impact: Consideration of environmental impact has been critical in project planning for the Chatfield Farms solar array. We incorporated two mitigations: first, we are not installing any fences around the solar installation which would prevent the typical movement of animals through the area. Second, the spacing between each row is considerably greater than in a typical ground-mounted array which should reduce the potential interference between wild animals and the solar system. Animal movements will be more impacted by the agricultural activity that will be happening within the array than by the array itself. We still expect wild animals to pass through the area, although we do recognize that their patterns will change – no more and no less than the impact of the TrailMark community itself or Chatfield Farms overall operation.

Biodiversity Benefits: This project is being co-located with farming activities – a practice referred to as "agrivoltaics." This is an area of research that has been identified as highly important to the state of Colorado in the most recent legislative session and we are proud to be contributing to that work. Various types of crops and pollinators will be planted and tended amongst the solar array's rows with

[1] https://www.who.int/initiatives/the-international-emf-project

early data indicating this will lead to less water usage **and** increased yields for the same land area – which is a double-net-positive for the environmental challenges we face as a state. This design concept also breaks up the continuous rows of solar panels and will result in a less 'industrial' look to the system. The siting of the array was completed with this in mind to maintain proximity to the equipment and related infrastructure – including irrigating water and farm fields – already in place at the farm.

Property Values: The latest research available from the Lawrence Berkeley National Lab[2] indicates that the impact of living near a solar array, which for the purposes of the study was defined as anything larger than 1MW, is minimal. Although Colorado was not a state included in the study, the authors conclude that the average negative impact in the six states studied on homes within 0.5 miles of a solar array was 1.5%. However, the vast majority of the arrays in the study varied from approximately 7MW to 50MW, significantly larger than the array at Chatfield Farms, which potentially indicates that smaller arrays induce a lesser impact. This notion is supported by earlier research from the University of Texas at Austin[3] that shows a negative correlation between the change in value of a home and the size of the array – in other words, as the size of the array goes up, the change in value becomes more negative. Therefore, smaller arrays would have a smaller negative effect. We have been and remain mindful of these impacts when developing and siting our projects.

I would be remiss if I would not mention the widespread positive impacts of projects like this that everyone in our community will benefit from. With this installation and many others like it, we are doing our part to increase the share of electricity on Xcel's power grid that is generated by renewables. By doing so, we reduce the use of fossil fuels to generate electricity, and in turn reduce the associated greenhouse gas emissions and small particulate pollution that have significant negative health impacts on those members of our community that live close to Xcel's power plants. We also see a great deal of importance to the research on the interaction between agriculture and solar power generation that will help to unlock many new opportunities to expand solar generation in our state. Colorado and the Denver metro area are leading the nation in our efforts to provide safe, affordable, and reliable carbon-free power for our residents. We hope that the benefits of the project as well as the consideration of the potential risks and the steps we've taken to mitigate them will relieve some of your concerns about our work.

I look forward to collaborating more with you on this project in the future.

Sincerely,

Drew Halpern

Drew Halpern
Sr. Energy Project Manager
Denver Office of Climate Action, Sustainability, and Resiliency

[2] https://eta-publications.lbl.gov/sites/default/files/lspvp_journal_article.pdf
[3] https://emp.lbl.gov/sites/default/files/property-value_impacts_near_utility-scale_solar_installations.pdf