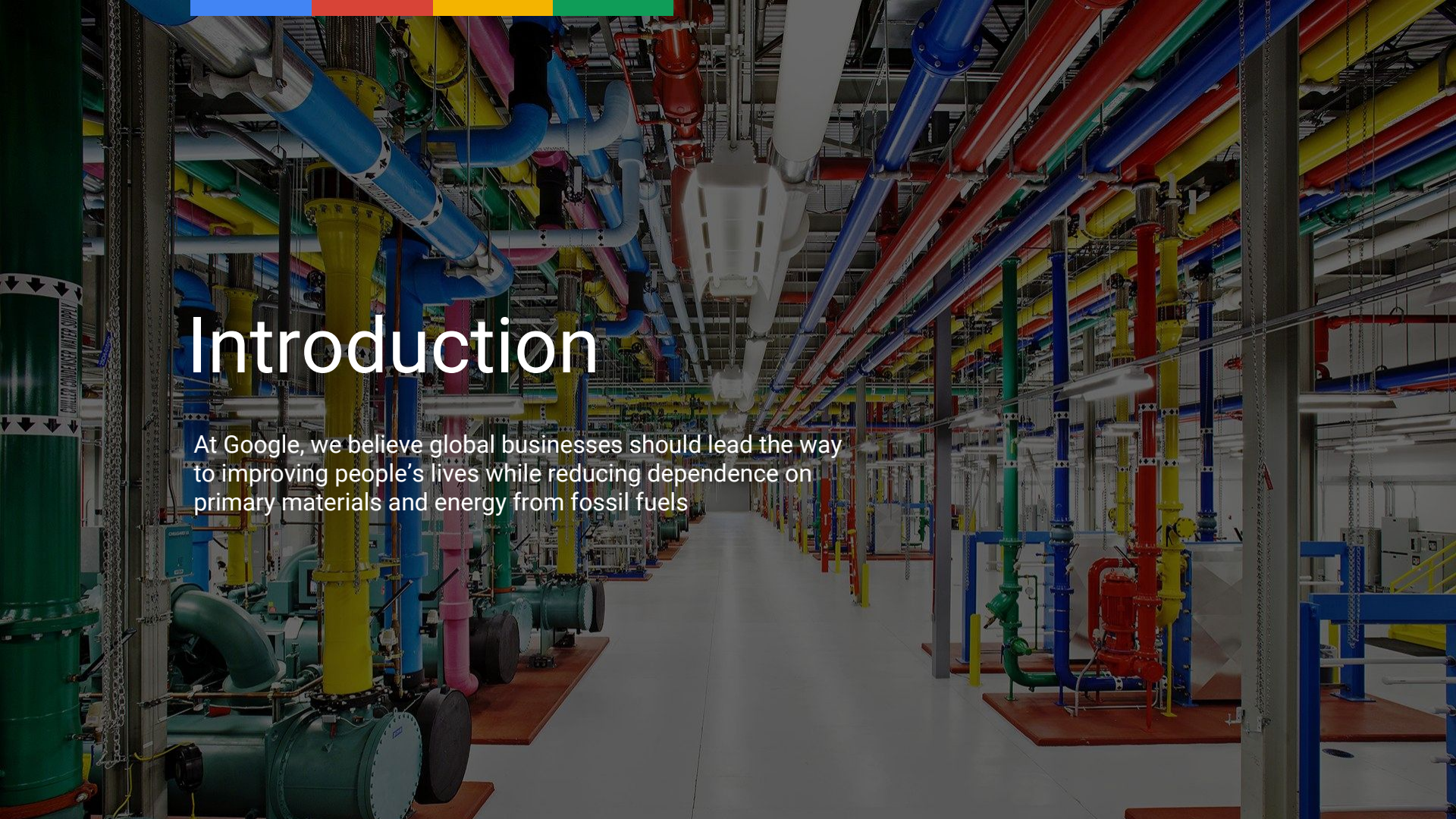


An aerial photograph of a complex highway interchange with multiple overpasses and ramps. The image is dark and serves as a background for the text. The Google logo is positioned on the left side of the frame.

Google

Sustainability



Introduction

At Google, we believe global businesses should lead the way to improving people's lives while reducing dependence on primary materials and energy from fossil fuels

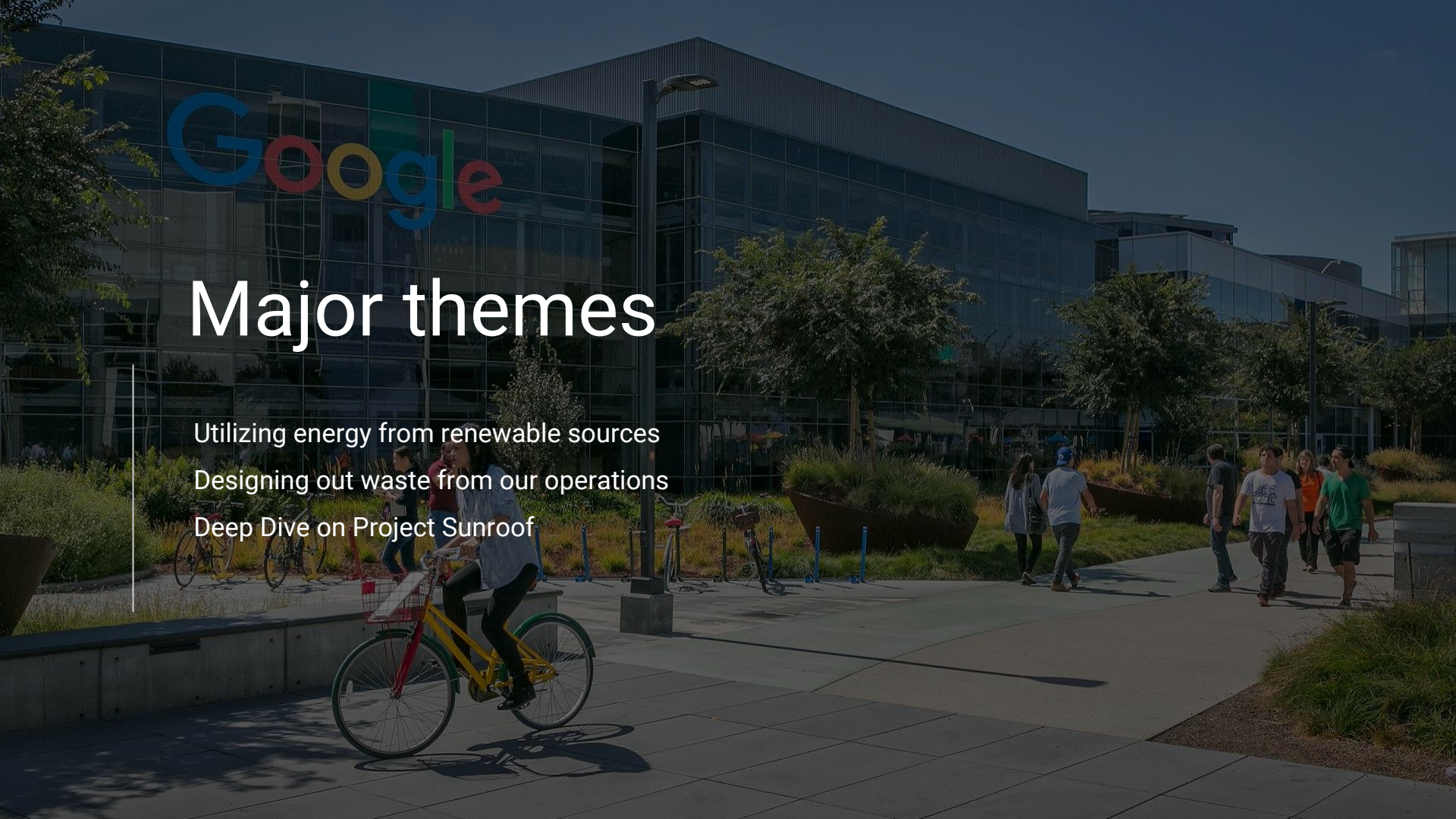


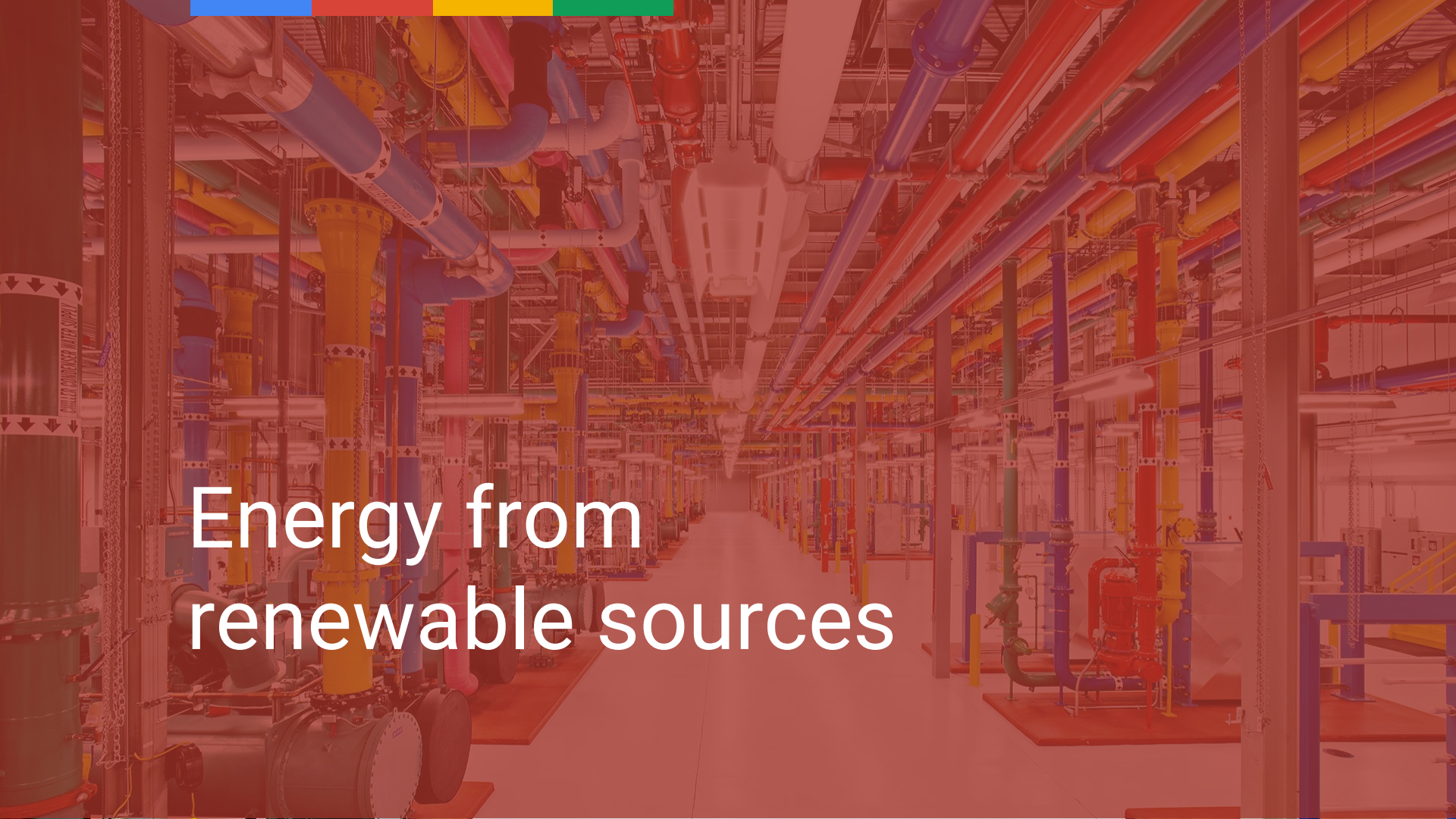
Major themes

Utilizing energy from renewable sources

Designing out waste from our operations

Deep Dive on Project Sunroof





Energy from renewable sources



2007

Carbon neutral

2010

Began buying renewable energy at scale

2016

Largest, non-utility, corporate renewable energy purchaser in the world



Recurrent Energy, Sacramento, California

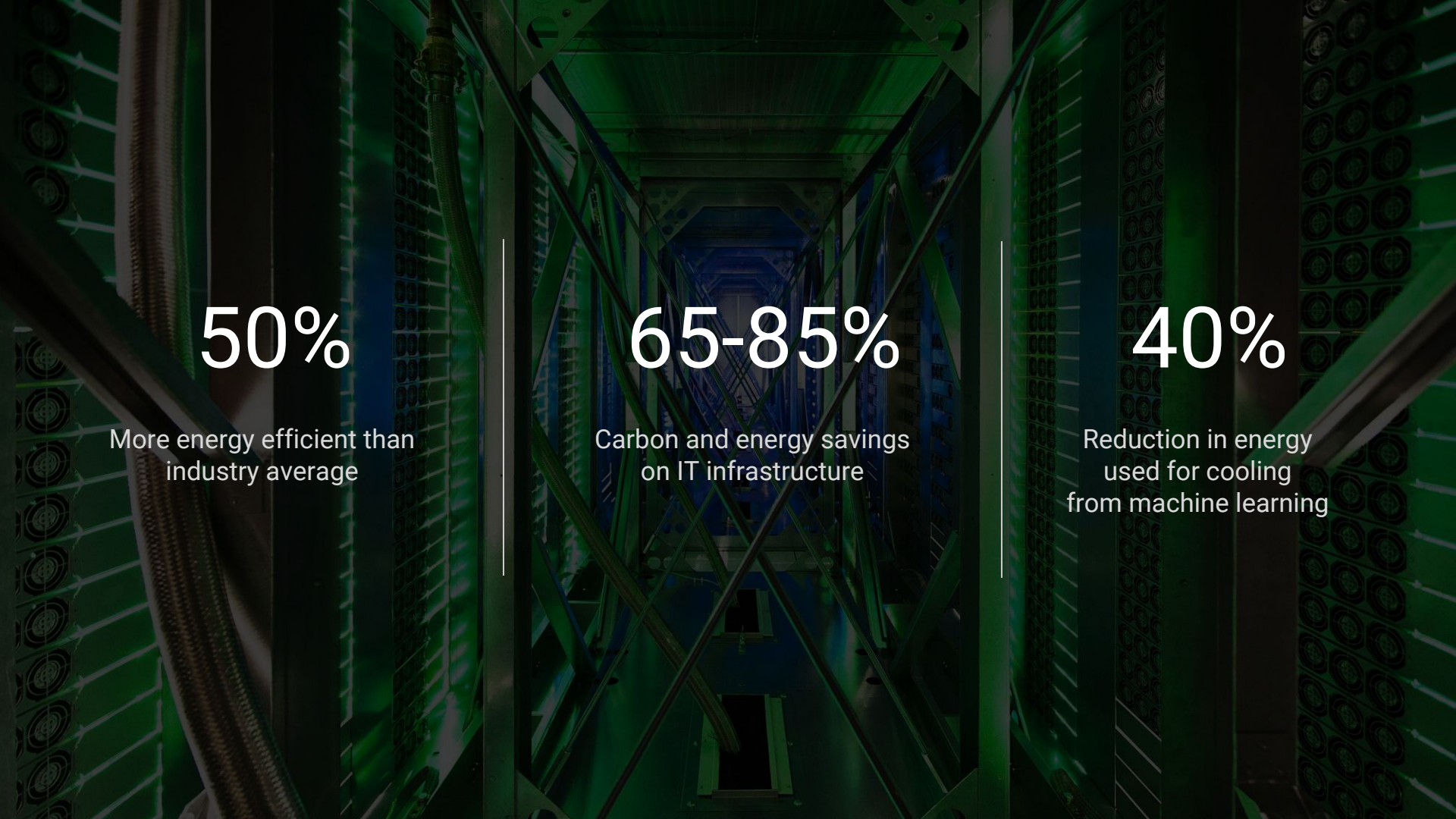


A photograph of a large industrial facility, possibly a water treatment plant, featuring a complex network of colorful pipes (blue, yellow, red, green) and machinery. The scene is viewed from a perspective looking down a long, brightly lit corridor. The image is overlaid with a semi-transparent green filter. At the top of the image, there is a horizontal bar with segments of red, orange, yellow, and green. The text "Designing out waste" is centered in the lower half of the image in a white, sans-serif font.

Designing out waste



Douglas County, Georgia



50%

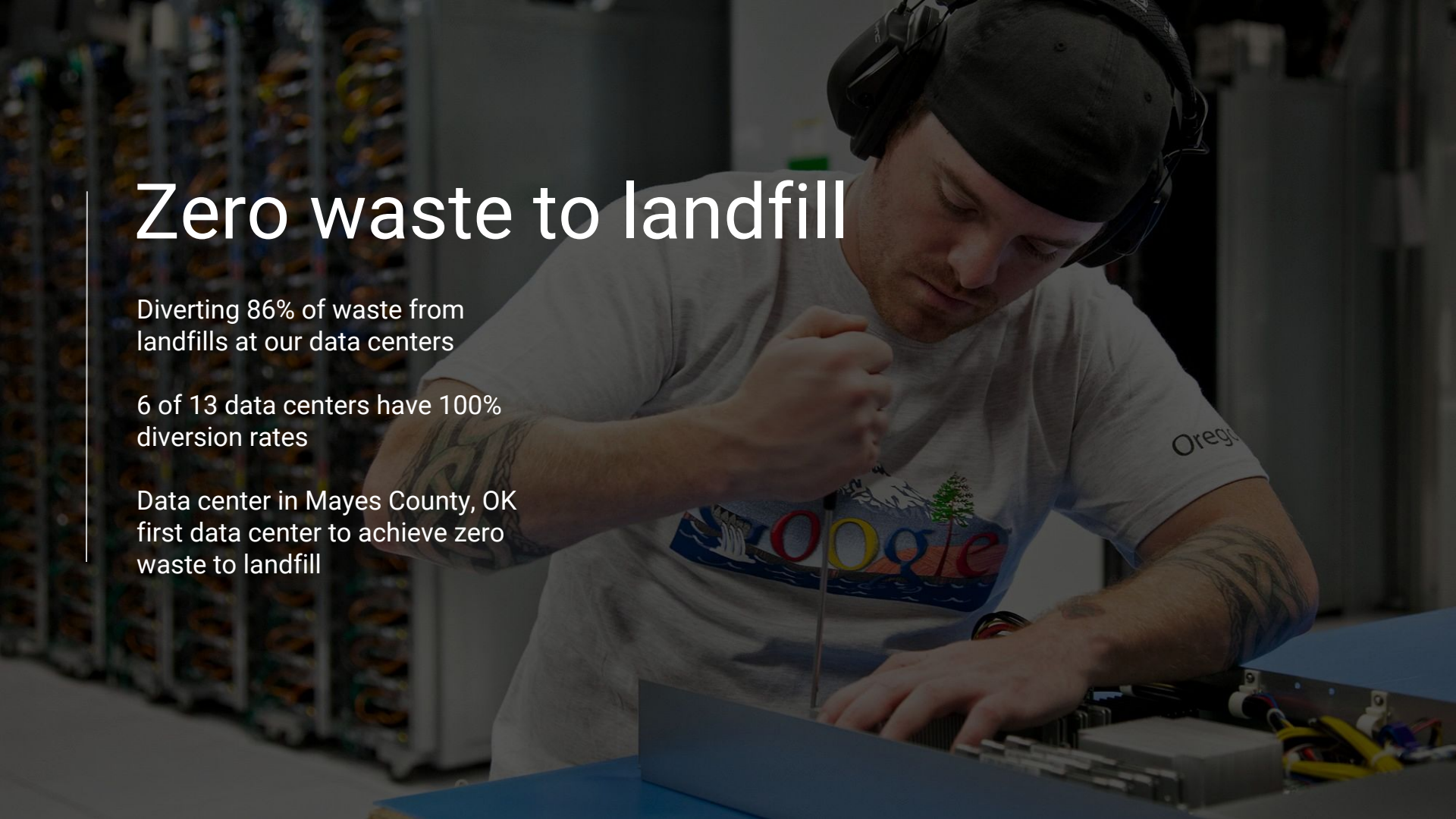
More energy efficient than
industry average

65-85%

Carbon and energy savings
on IT infrastructure

40%

Reduction in energy
used for cooling
from machine learning

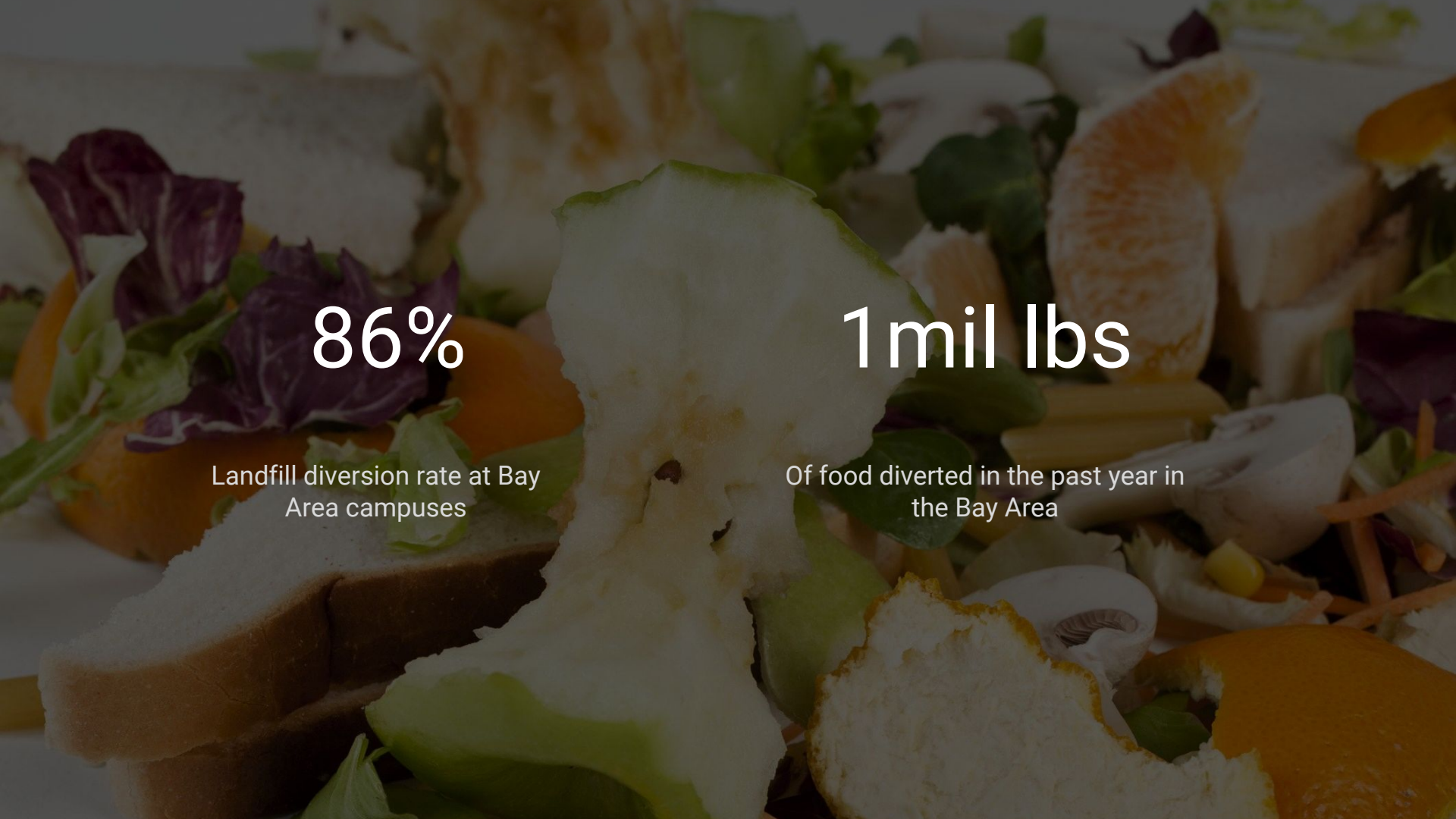
A man wearing a black baseball cap, large headphones, and a white t-shirt with the Google logo is focused on working on a server. He is using a screwdriver to open a blue server rack. The background shows rows of server racks in a data center.

Zero waste to landfill

Diverting 86% of waste from
landfills at our data centers

6 of 13 data centers have 100%
diversion rates

Data center in Mayes County, OK
first data center to achieve zero
waste to landfill



86%

Landfill diversion rate at Bay
Area campuses

1mil lbs

Of food diverted in the past year in
the Bay Area



Project Sunroof

SOLAR ENERGY

HOW CAN GOOGLE CONTRIBUTE?

1hr

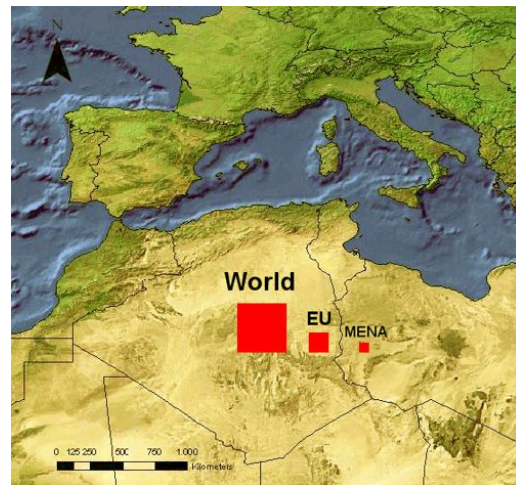
World's energy for a year

20%

Electricity savings

Low

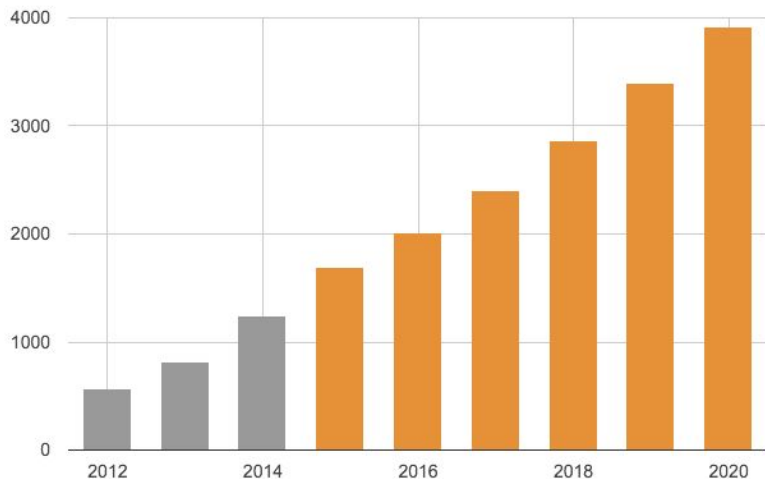
Carbon emissions



Covering a portion of the Sahara Desert in panels could generate enough energy to power the world.

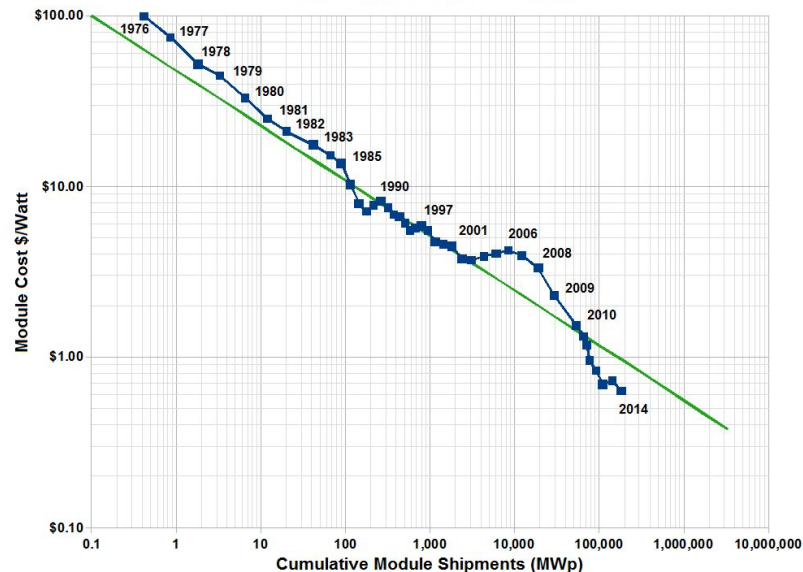
Residential solar seeing rapid growth due to falling panel costs

Actual & Forecasted Residential Solar Growth (MW)

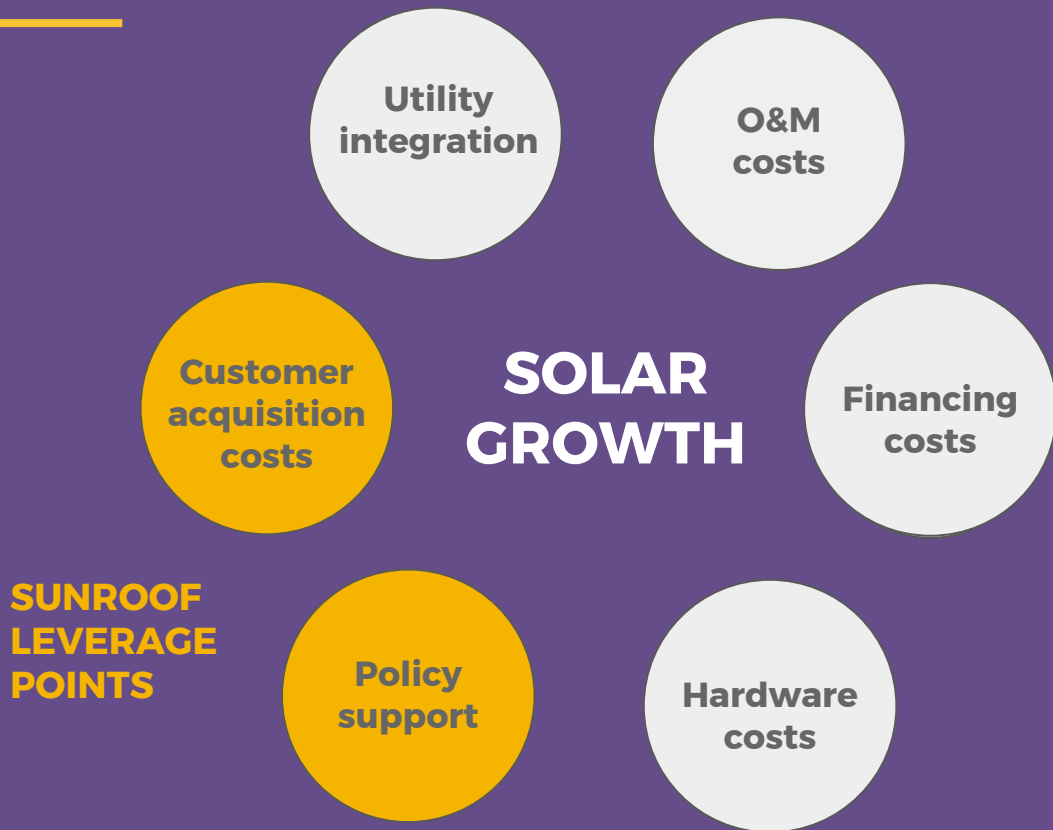


Source: SEIA Solar Market Report

The Solar Moore's Law "Swanson's Law" Declining prices with rising volume



MAJOR HEADWINDS



SLOWING GROWTH

➡ US

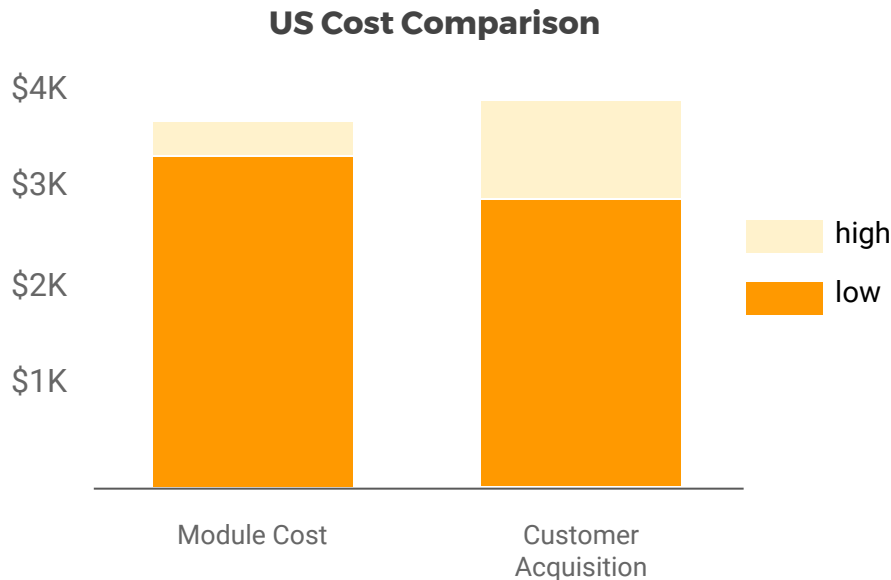
Slowing from 57% CAGR (2006-2015) to 11% (2015 - 2021E)

➡ GERMANY

At 52% of installation targets in 2015, despite being #1 market in world

KEY CHALLENGES | RISING CUSTOMER ACQUISITION COSTS

Account for up to 30% of overall residential solar costs.



Project Sunroof's goal:

Provide high quality information to accelerate the growth of solar and help the world transition to clean energy.

Google strengths

- Expansive aerial imagery
- Powerful, low cost computing
- Large user base
- Trusted brand

TECHNICAL DETAILS

HOW DO WE DO IT?

What do we need to know?

- Where are the roofs?
- How much energy can each roof produce?
- How much will it cost to get solar panels?
- How much energy does the household use?

What do we need to know?

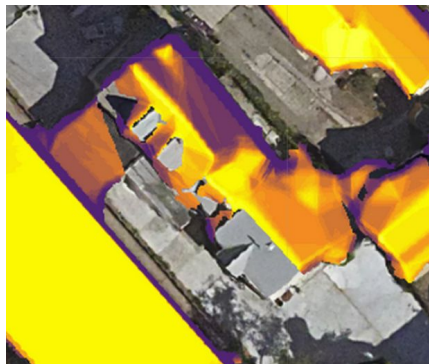
- **Where are the roofs?**
- How much energy can each roof produce?
- How much will it cost to get solar panels?
- How much energy does the household use?

IMAGERY AT GOOGLE

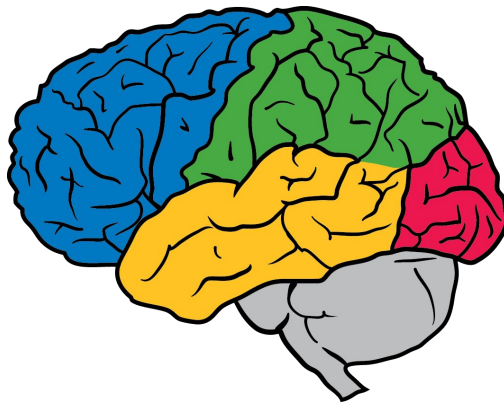
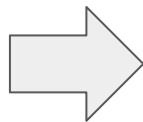
**Oblique images
numbering in the
millions**



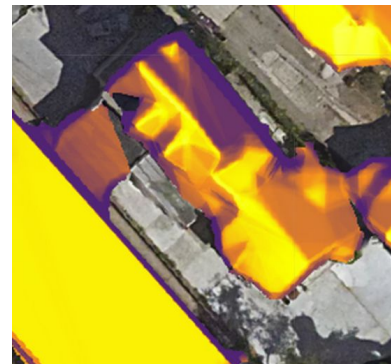
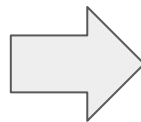
ROOFTOP ESTIMATION



Initial maps data +
heuristic refinement



Google Brain



Better roof maps

What do we need to know?

- Where are the roofs?
- **How much energy can each roof produce?**
- How much will it cost to get solar panels?
- How much energy does the household use?

SUNROOF OVERVIEW

Sunroof uses 3D models from aerial imagery to assess energy production potential

For every roof

For every pixel on roof

For every hour in a typical year

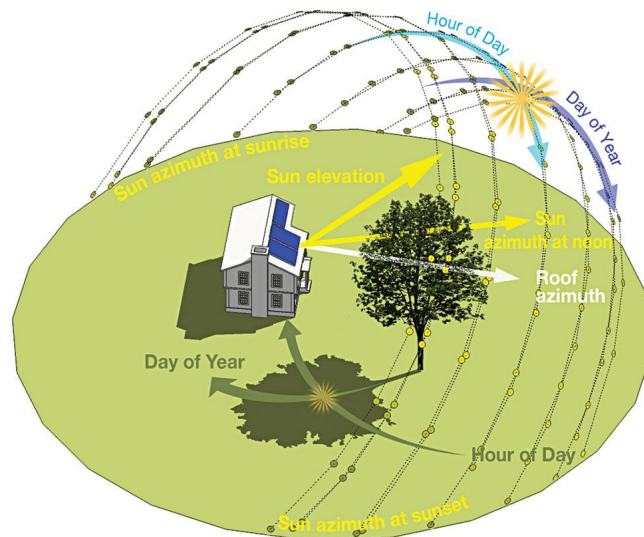


Sun location

Attenuate light

Blocked by
tree?

Cloudy?



What do we need to know?

- Where are the roofs?
- How much energy can each roof produce?
- **How much will it cost to get solar panels?**
- How much energy does the household use?

Import third-party data

Panel Cost

Financing

Incentives

What do we need to know?

- Where are the roofs?
- How much energy can each roof produce?
- How much will it cost to get solar panels?
- **How much energy does the household use?**

Ask the user!

What's your average monthly electric bill? ⓘ

We use your bill to calculate how much electricity you use based on typical utility rates in your area.

\$0 \$500

+

Utility rates

=

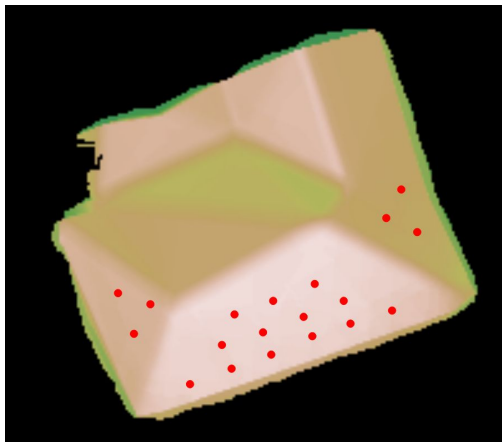
kWh

DOES IT WORK?

SUNROOF ESTIMATES APPEAR **AS GOOD OR BETTER THAN** CURRENT INDUSTRY PRACTICES

Sunroof Analysis

Detailed analysis conducted on 337 systems



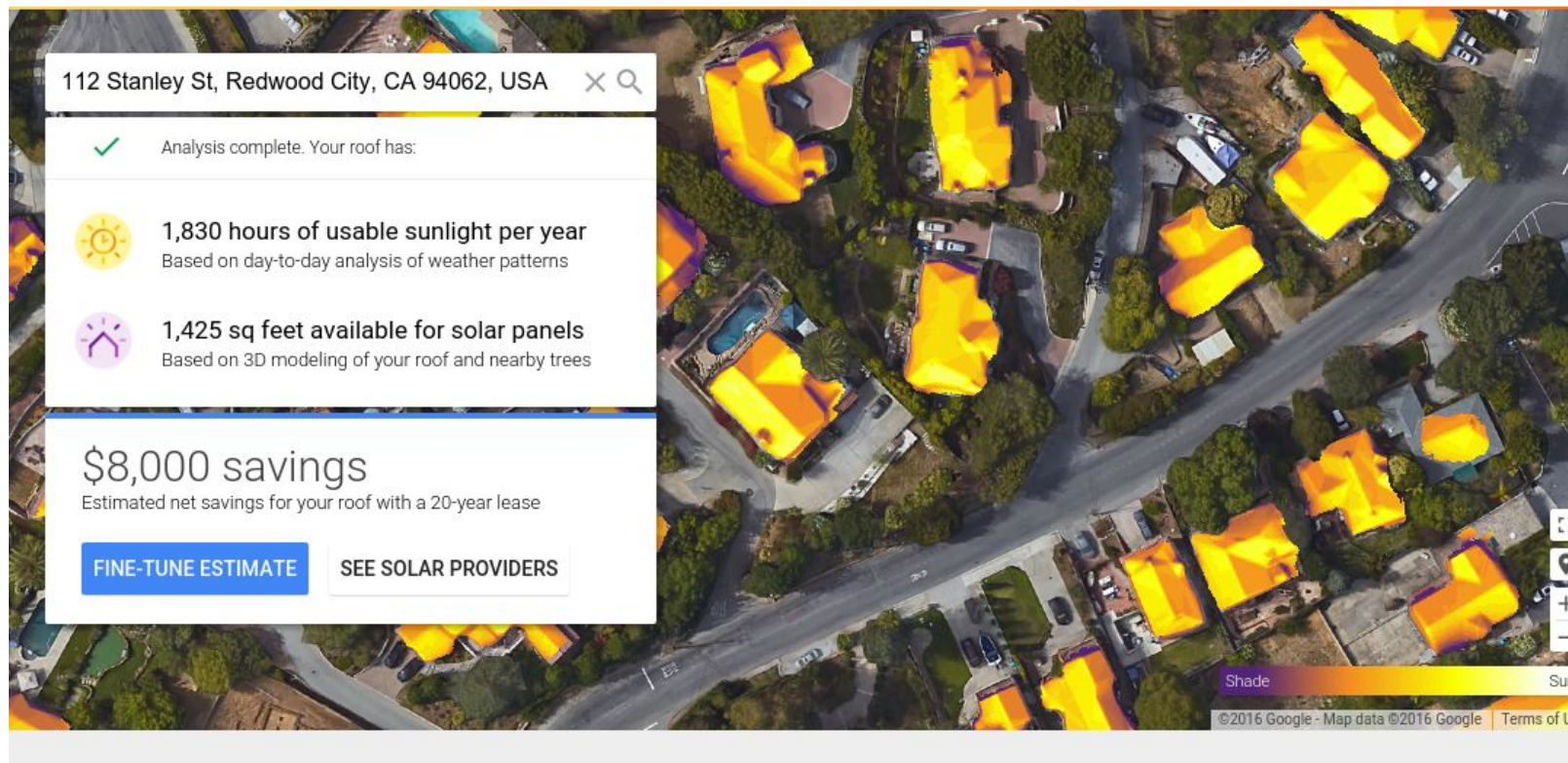
SunEye 210



THE RESULTS



Google Project Sunroof



GOING BEYOND SINGLE HOMES

Solar potential data can:

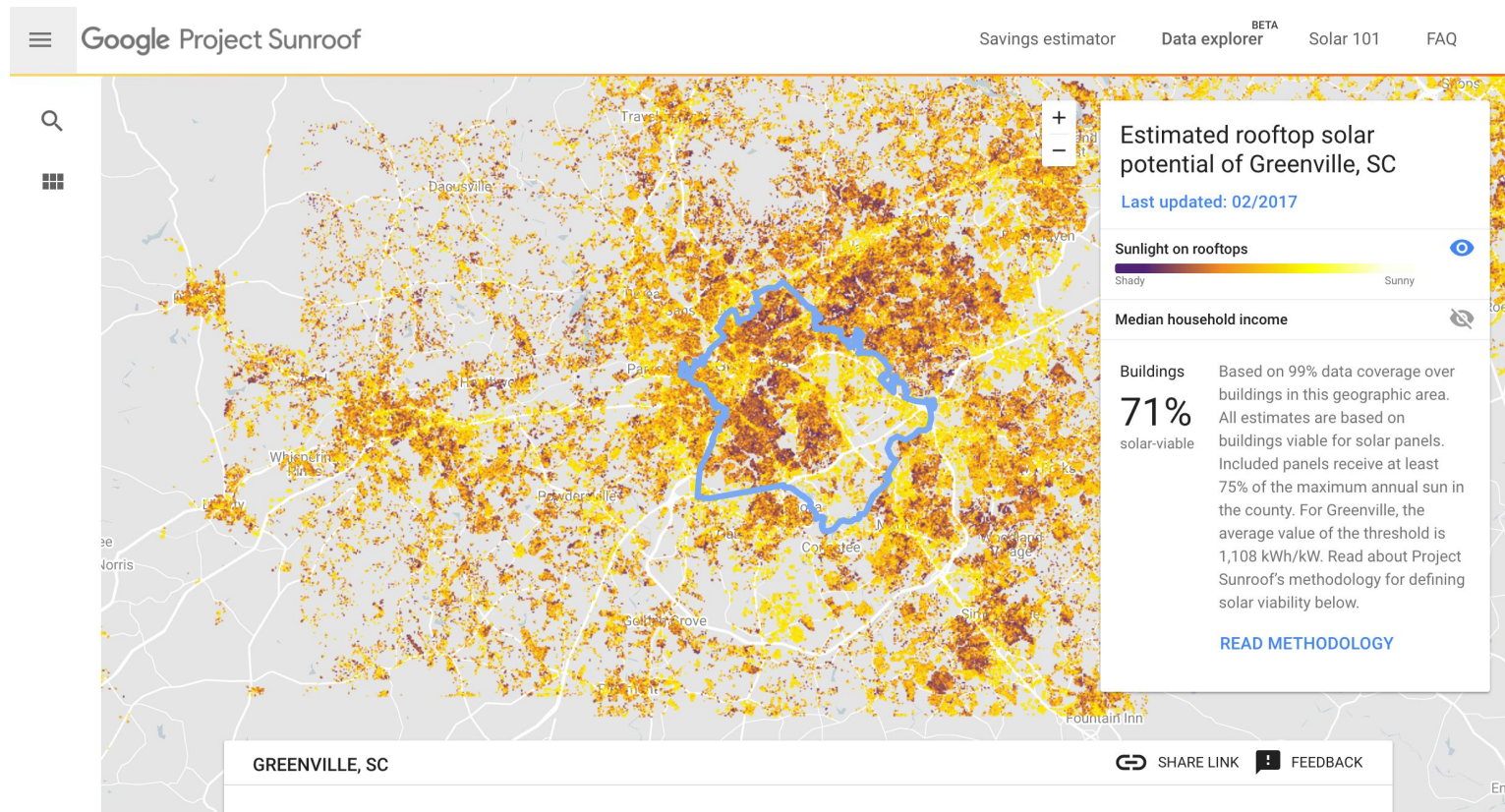
Enable advocacy for solar-friendly initiatives through grassroots outreach and policy-maker lobbying.

Aid government agencies in the creation and implementation of clean energy goals focused, for example, on low-income housing or public buildings.

Help elected officials understand the size of the solar market and how much it can grow, so they can make informed decisions about solar.

Help demonstrate the potential impact of new rate structures and regulations on the solar industry.

THE RESULTS



IMPACT

IMPACT

2,000,000+ Sunroof site visitors

2,000,000+ YouTube views

500+ news stories

Including positive press from NYTimes, Business Insider, HuffPost, ABC, NBC, Slate, Forbes, etc.

1,000+ inquiries from solar installers

1 shout-out from President Obama

UN Momentum for Change “Lighthouse” award



Bernie Sanders ✓

March 28 at 8:05am · 🌐

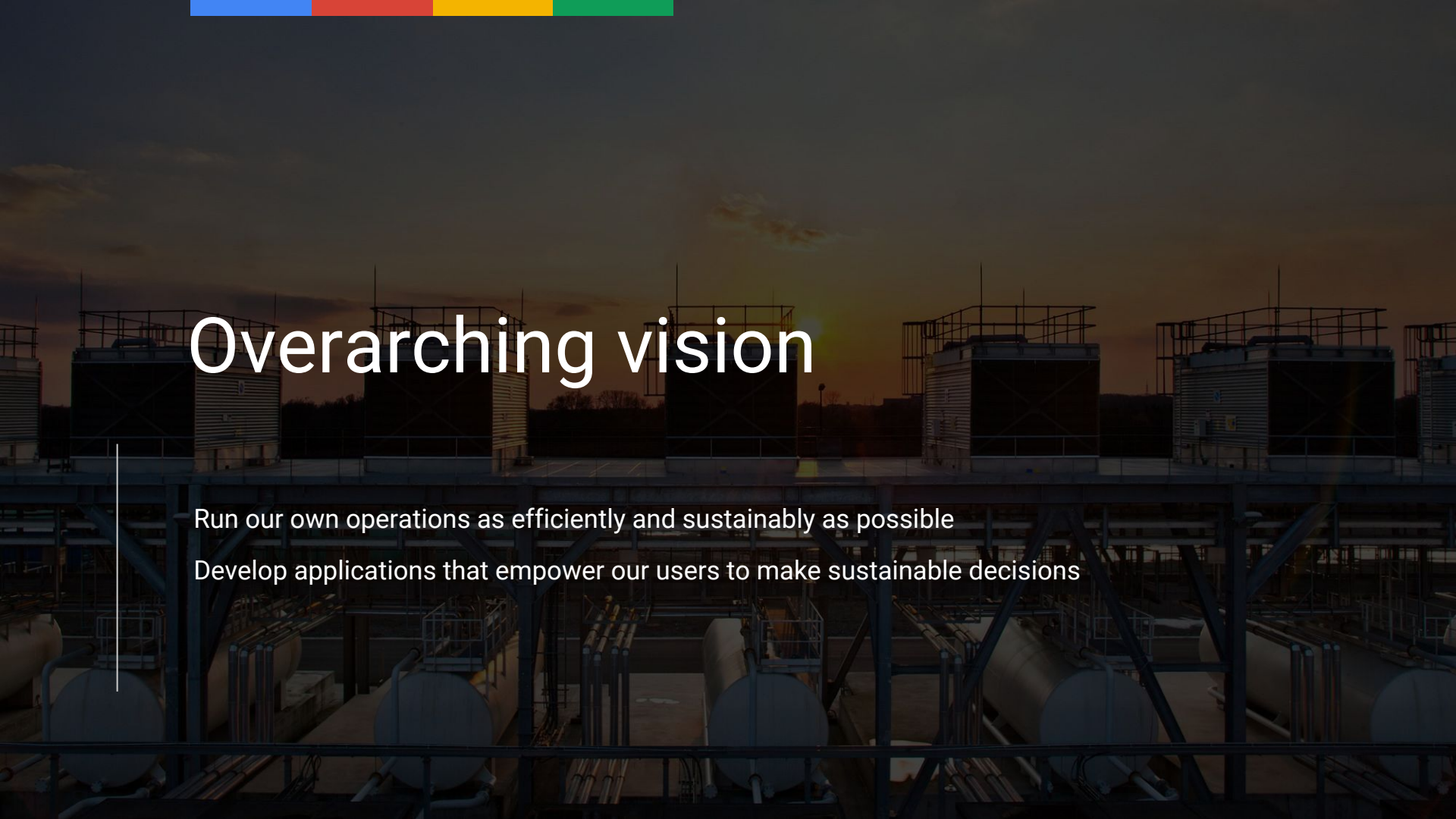
Transforming our energy system will surely be challenging. But here is the good news. An analysis of 60 million rooftops in the country showed that as much as 79% of them are viable for solar power. That is enormous potential for sustainable energy. We can go forward to create millions of jobs and lead the world in transitioning away from fossil fuels. Our job is to keep fighting for a system of renewable energy, not fossil fuels—in spite of those who try to hold back our progress.



There's Vast Untapped Potential for Solar Rooftops in the US, Says Google

Google's Project Sunroof has expanded its coverage enormously.

[GREENTECHMEDIA.COM](http://greentechmedia.com)

A photograph of an industrial facility, possibly a refinery or chemical plant, at sunset. The sky is a mix of orange, yellow, and dark blue. In the foreground, there are several large, cylindrical storage tanks and a complex network of pipes and structural steel. In the background, there are several large, rectangular industrial buildings with metal siding and scaffolding. The overall scene is dimly lit, with the primary light source being the setting sun.

Overarching vision

Run our own operations as efficiently and sustainably as possible

Develop applications that empower our users to make sustainable decisions