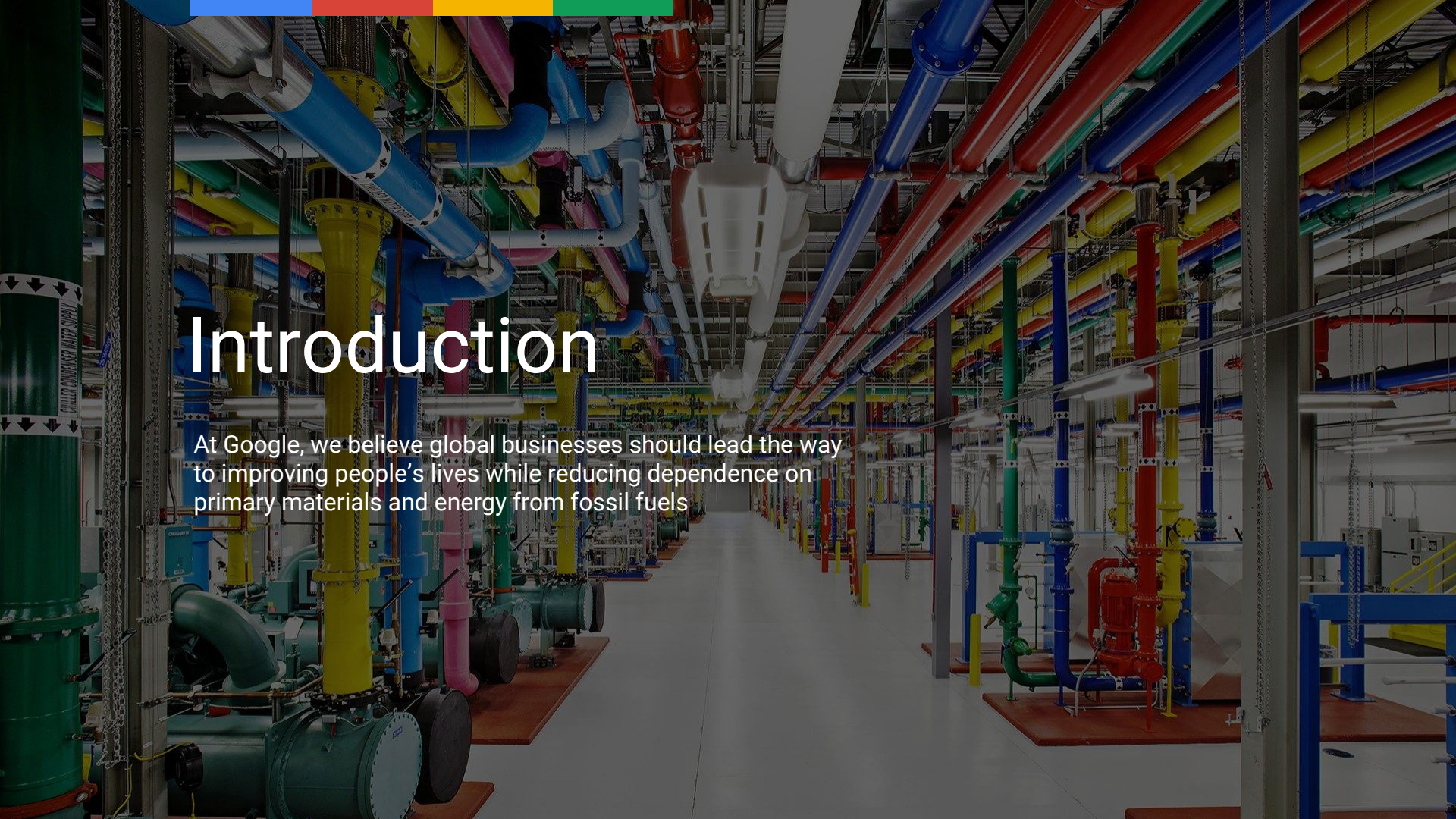
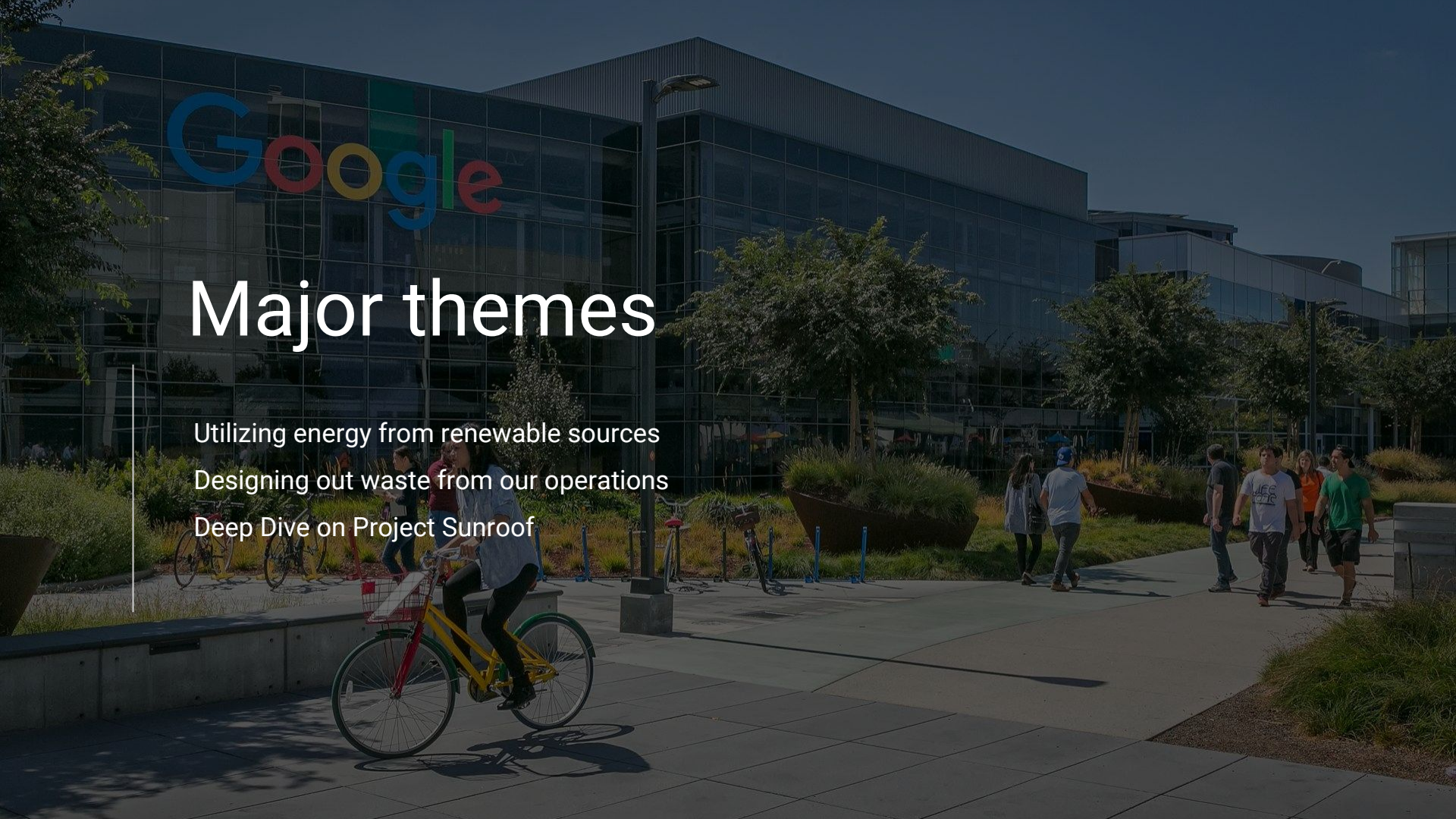

Google
Sustainability



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

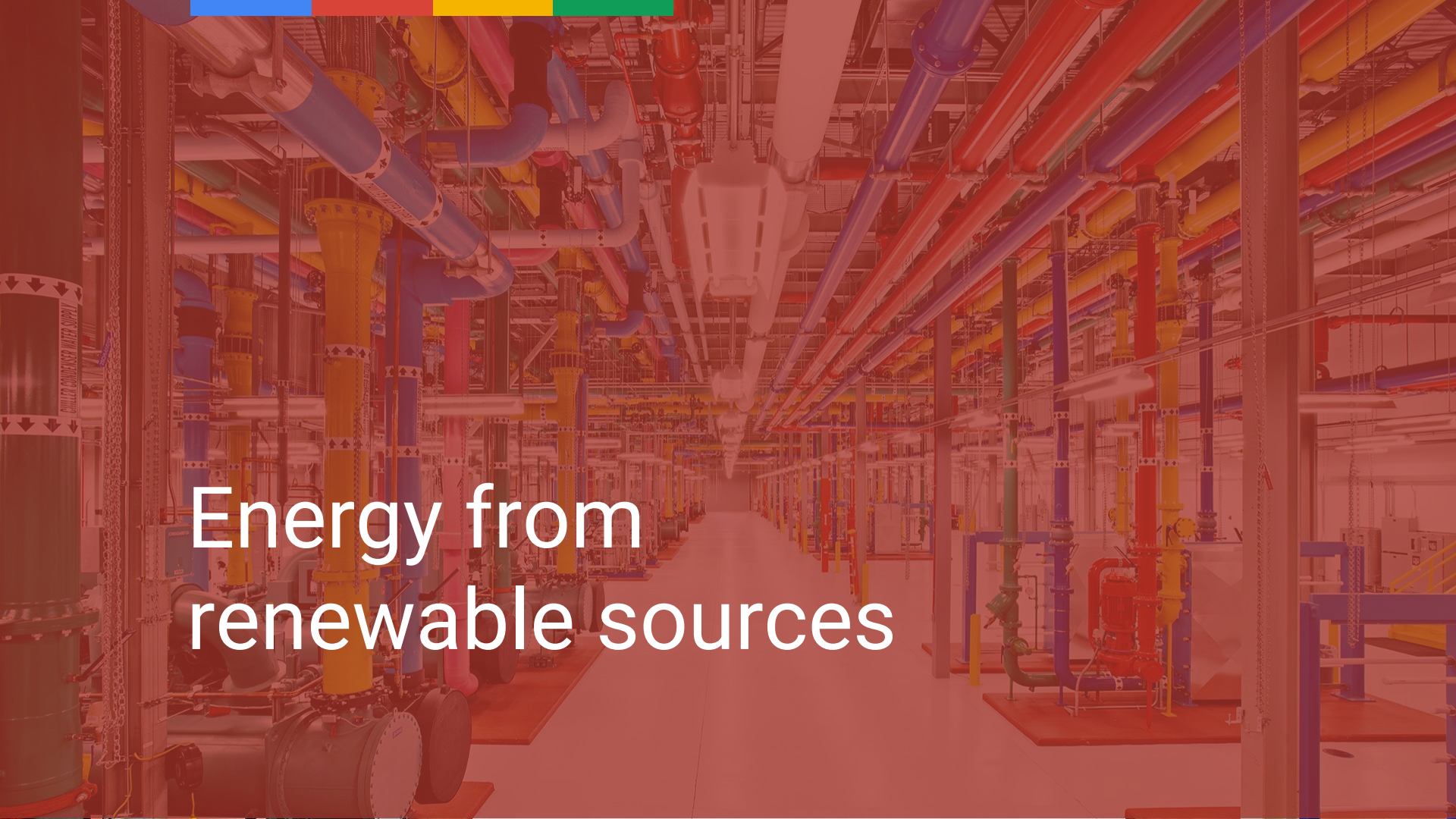


Major themes

Utilizing energy from renewable sources

Designing out waste from our operations

Deep Dive on Project Sunroof



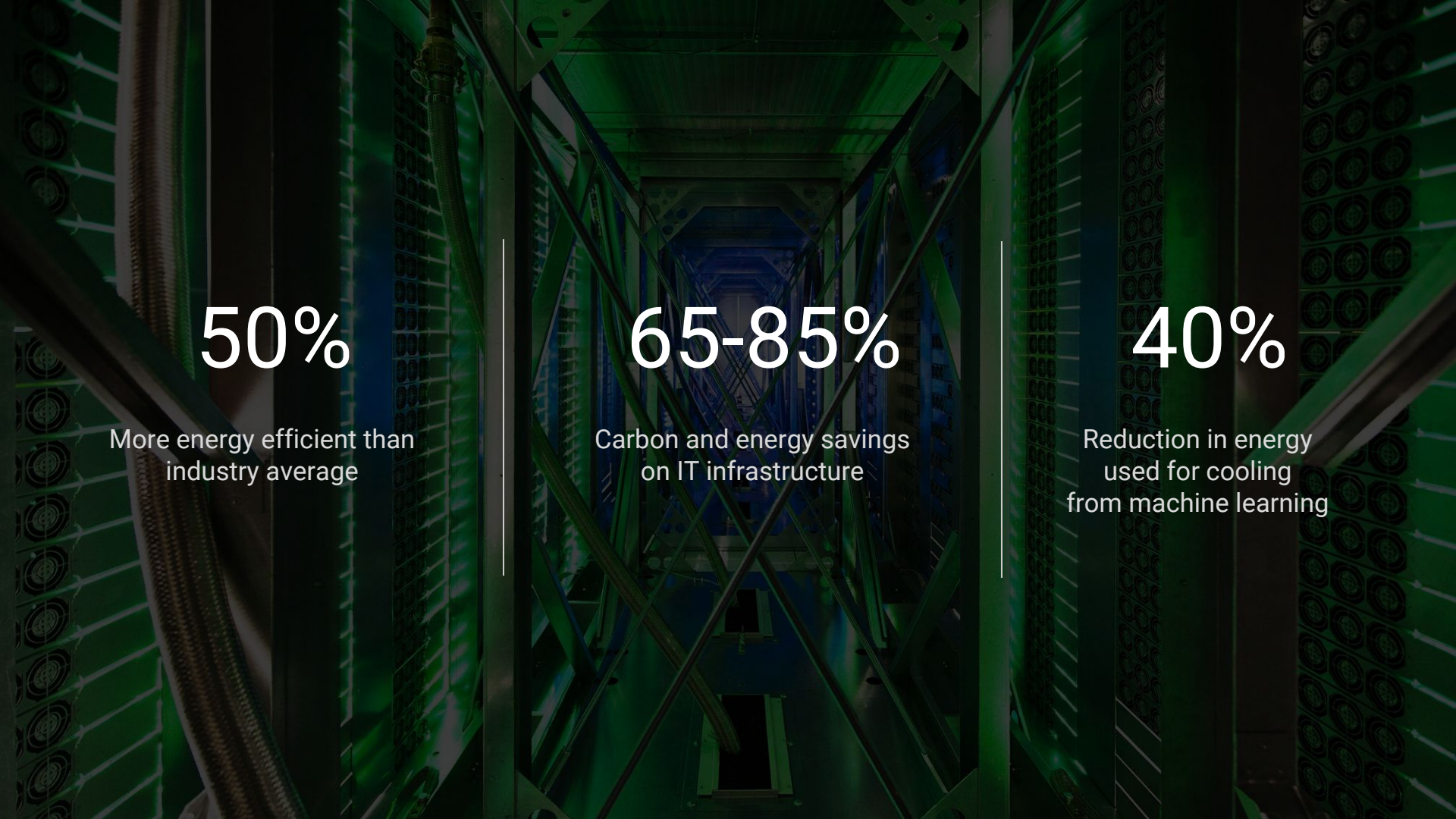
Energy from renewable sources

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

Designing out waste


Douglas County, Georgia



50%

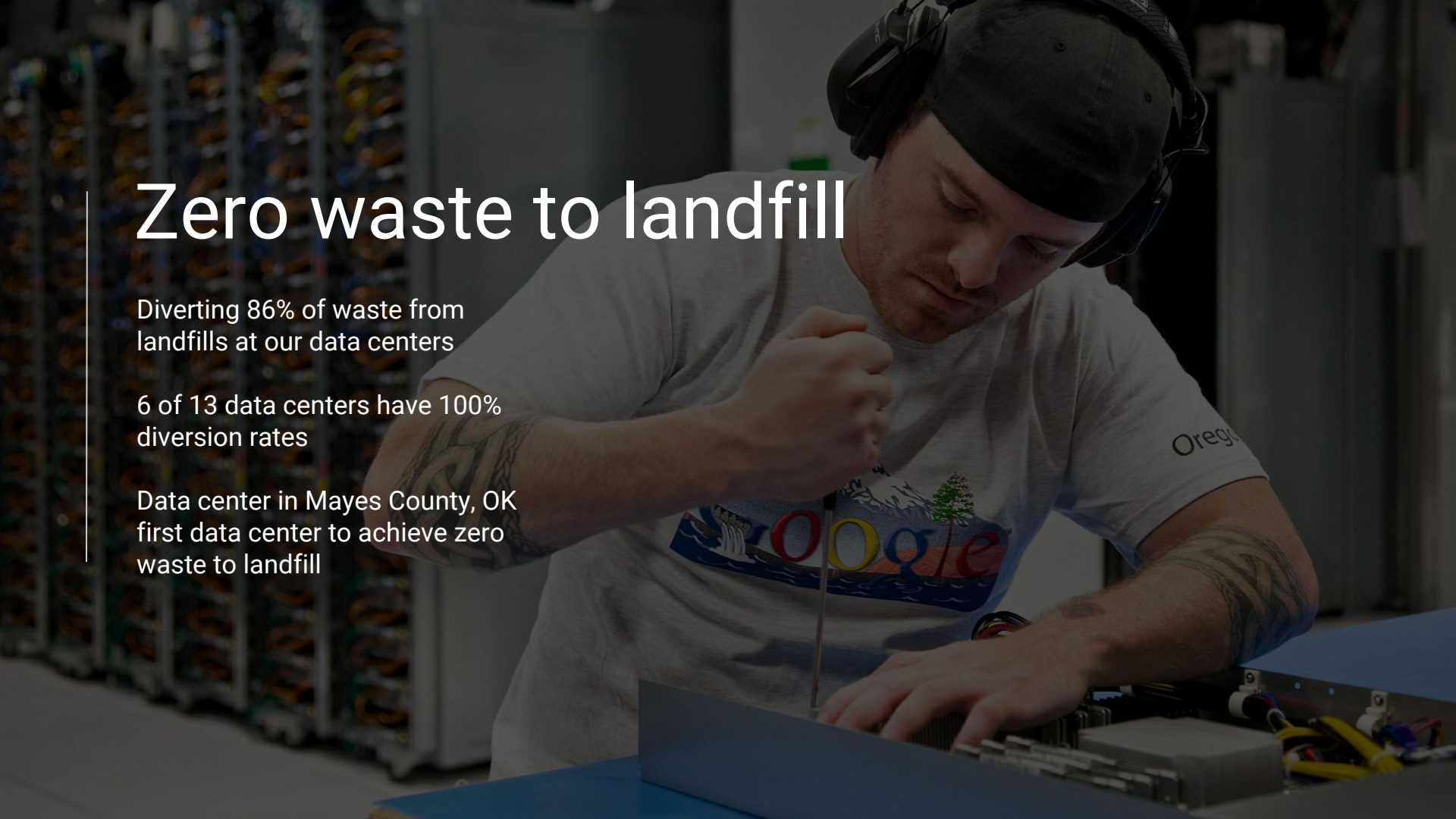
More energy efficient than industry average

65-85%

Carbon and energy savings on IT infrastructure

40%

Reduction in energy used for cooling from machine learning

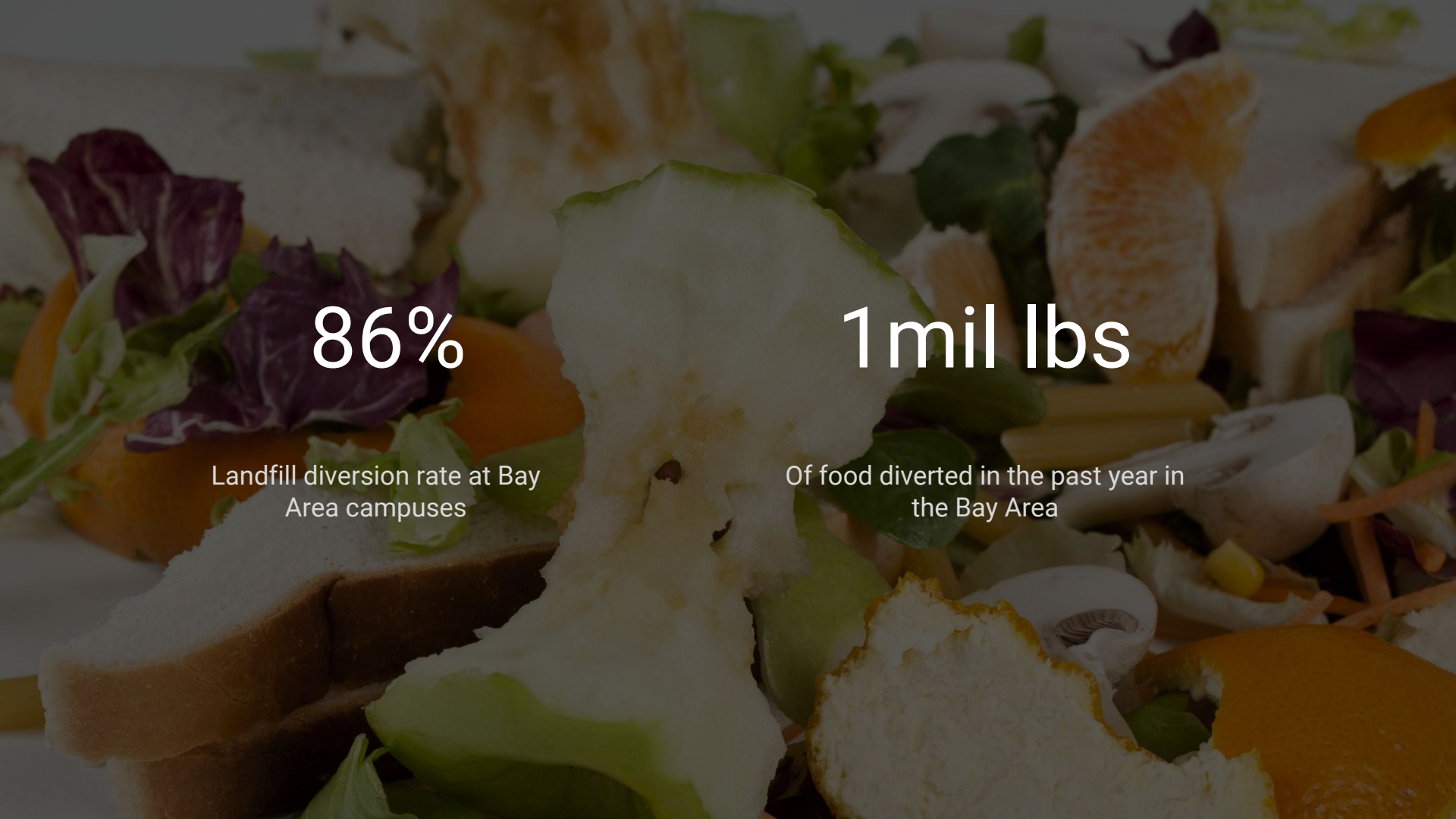


Zero waste to landfill

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

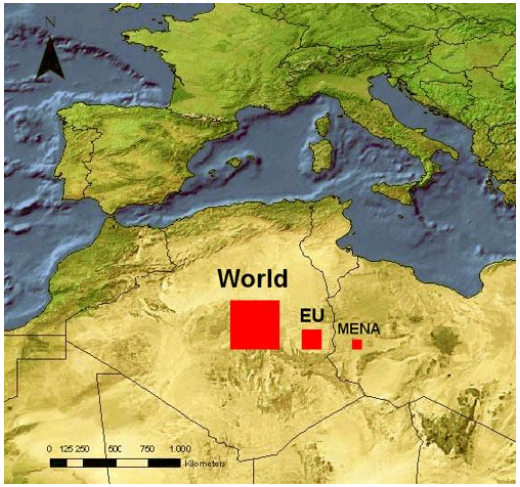
HOW CAN GOOGLE CONTRIBUTE?

Project Sunroof

1hr World's energy for a year

20% Electricity savings

Low Carbon emissions

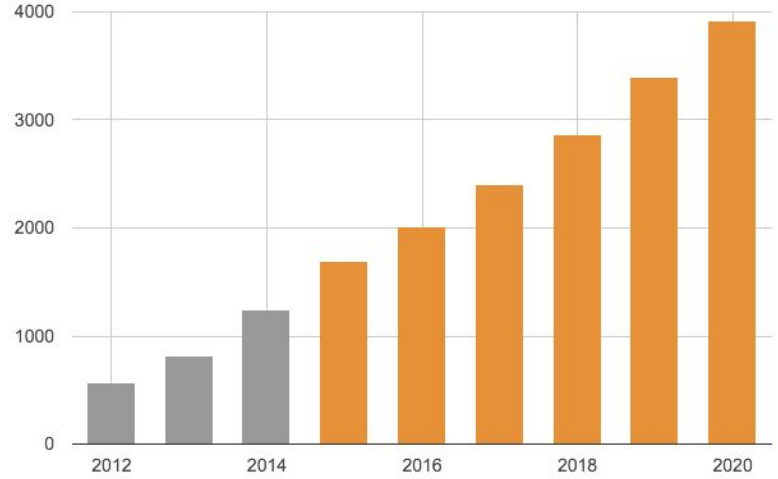


Covering a portion of the Sahara Desert in panels could generate enough energy to power the world.

Project Sunroof

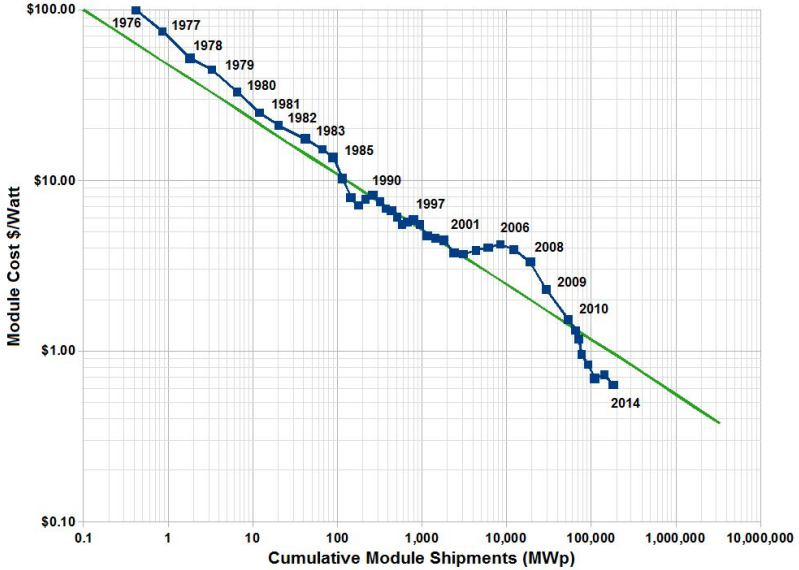
Residential solar seeing rapid growth due to falling panel costs

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

SUNROOF LEVERAGE POINTS

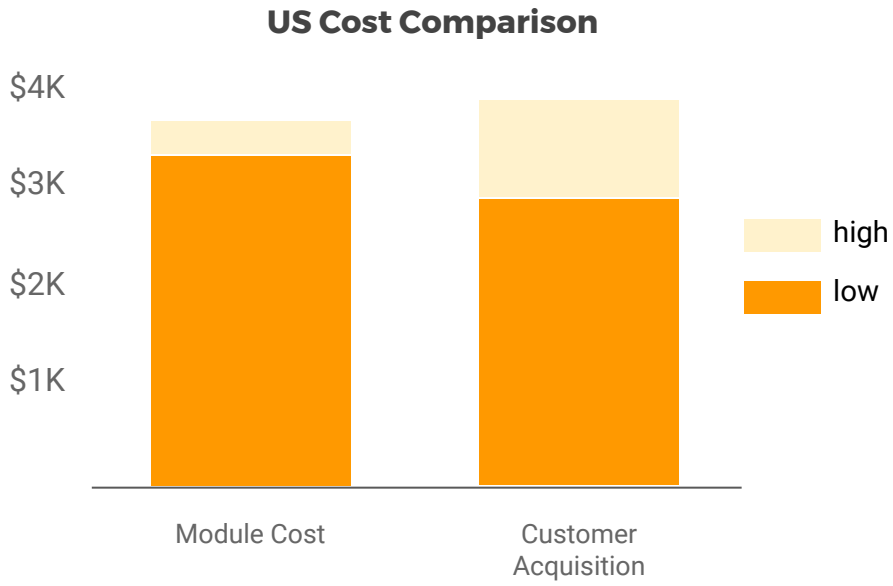
SLOWING GROWTH

➡ **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.



Source: Bloomberg New Energy Finance, financial statement

Google

Project Sunroof

Project Sunroof

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?

Project Sunroof

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?

Project Sunroof

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

Project Sunroof

Oblique images numbering in the millions

ROOFTOP ESTIMATION

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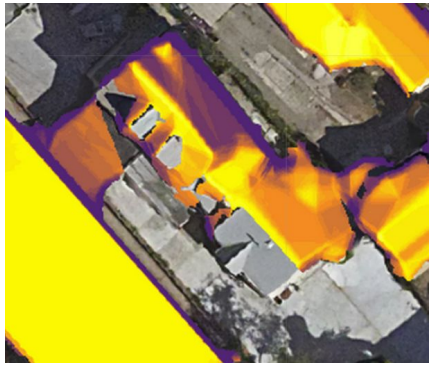
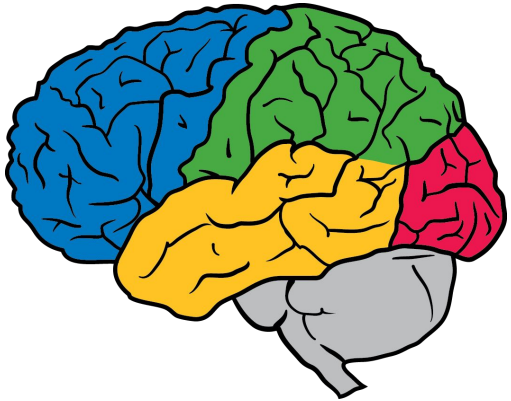
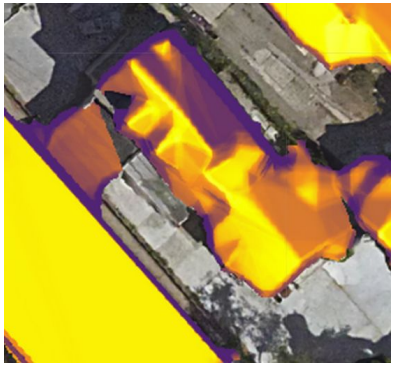


Initial maps data +
heuristic refinement



Google Brain



Better roof maps

Project Sunroof

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

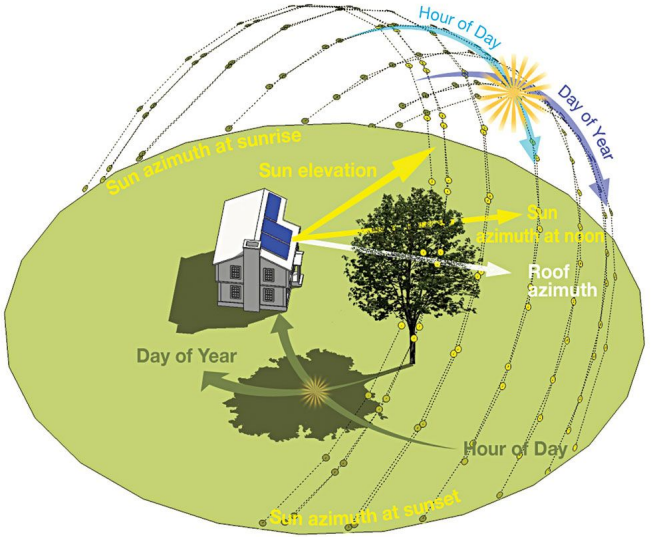
For every roof
  For every pixel on roof
    For every hour in a typical year

Sun location

Attenuate light

Blocked by tree?

Cloudy?



Project Sunroof

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

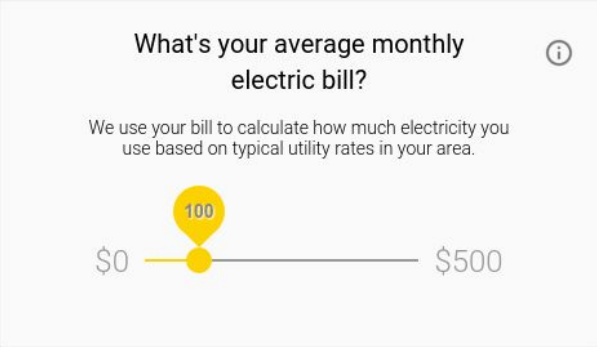
Project Sunroof

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?**

Project Sunroof

Ask the user!



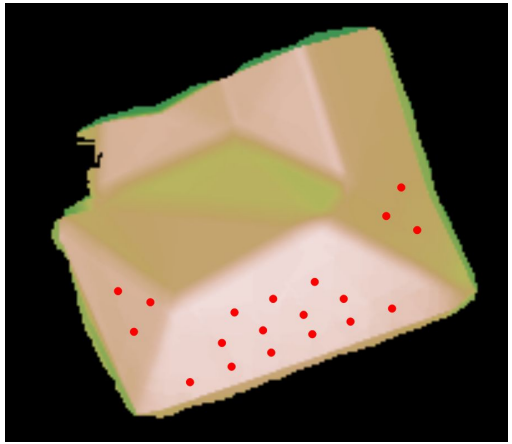
+ Utility rates = kWh

DOES IT WORK?

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

Detailed analysis conducted on 337 systems

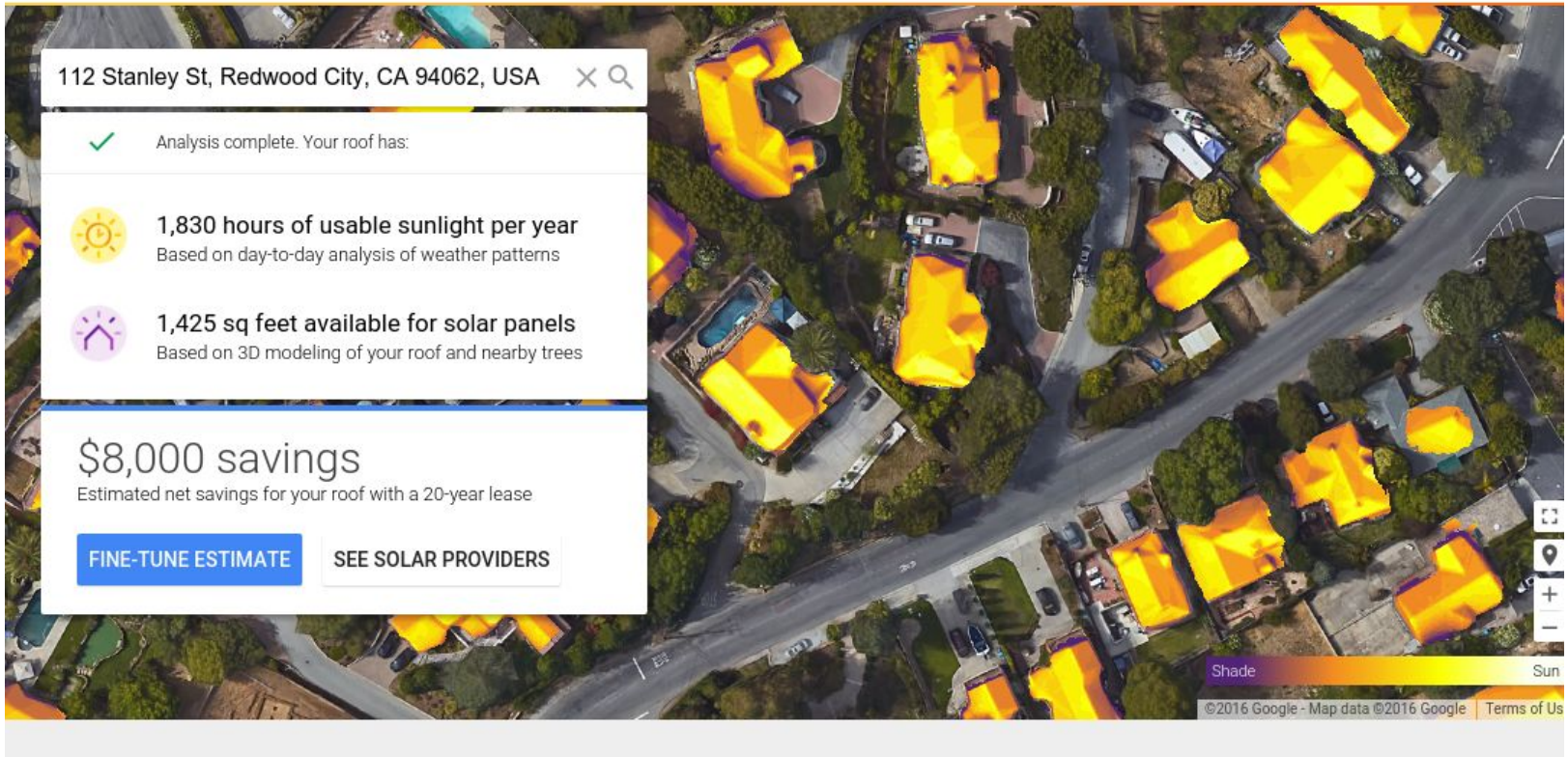
Sunroof Analysis



SunEye 210

THE RESULTS

Project Sunroof



GOING BEYOND SINGLE HOMES

Project Sunroof

Solar potential data can:

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

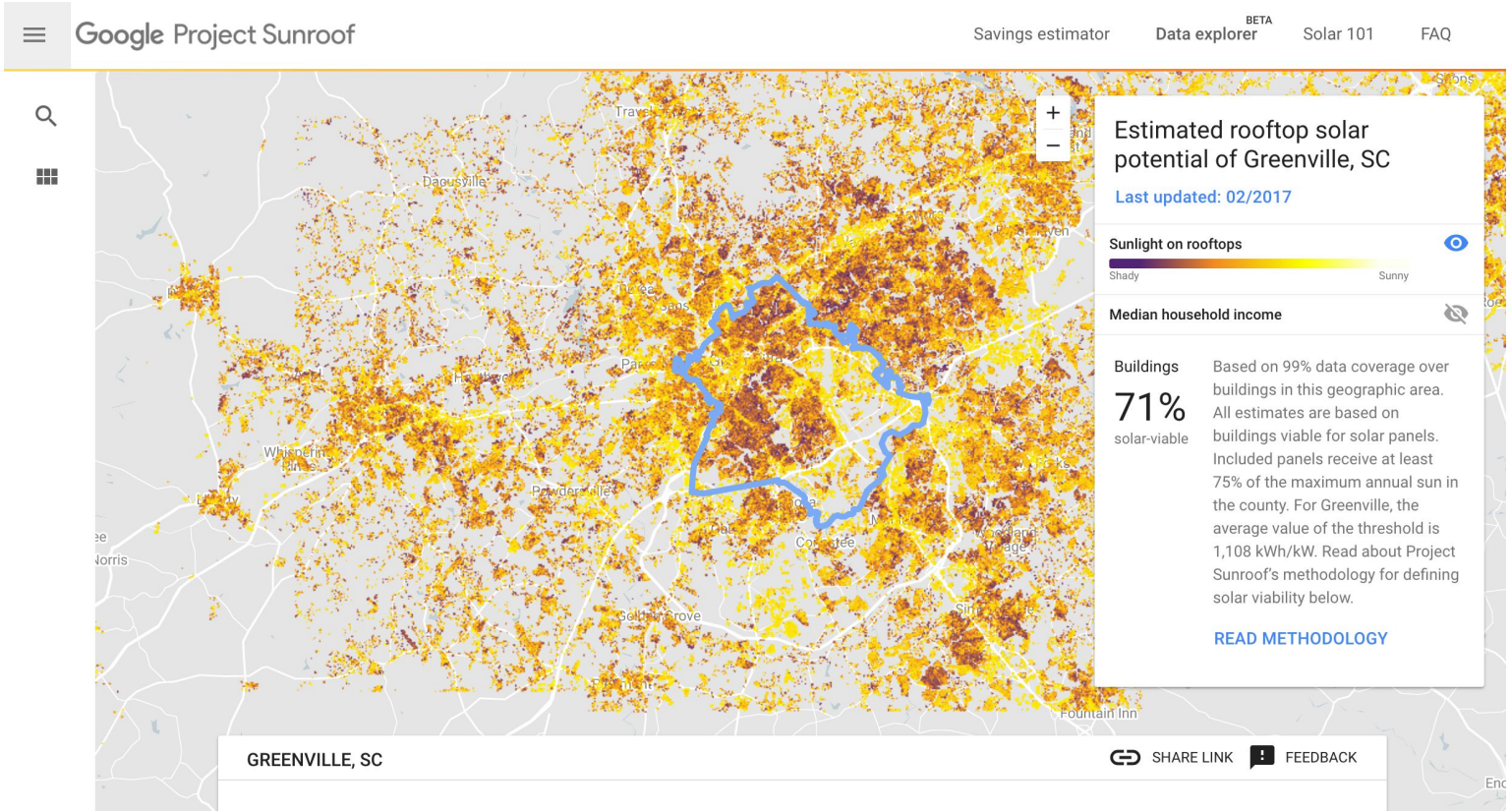
Help elected officials understand the size of the solar market and how much it can grow, so they can make informed decisions about solar.

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

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

THE RESULTS

Project Sunroof



IMPACT

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Project Sunroof

2,000,000+ Sunroof site visitors

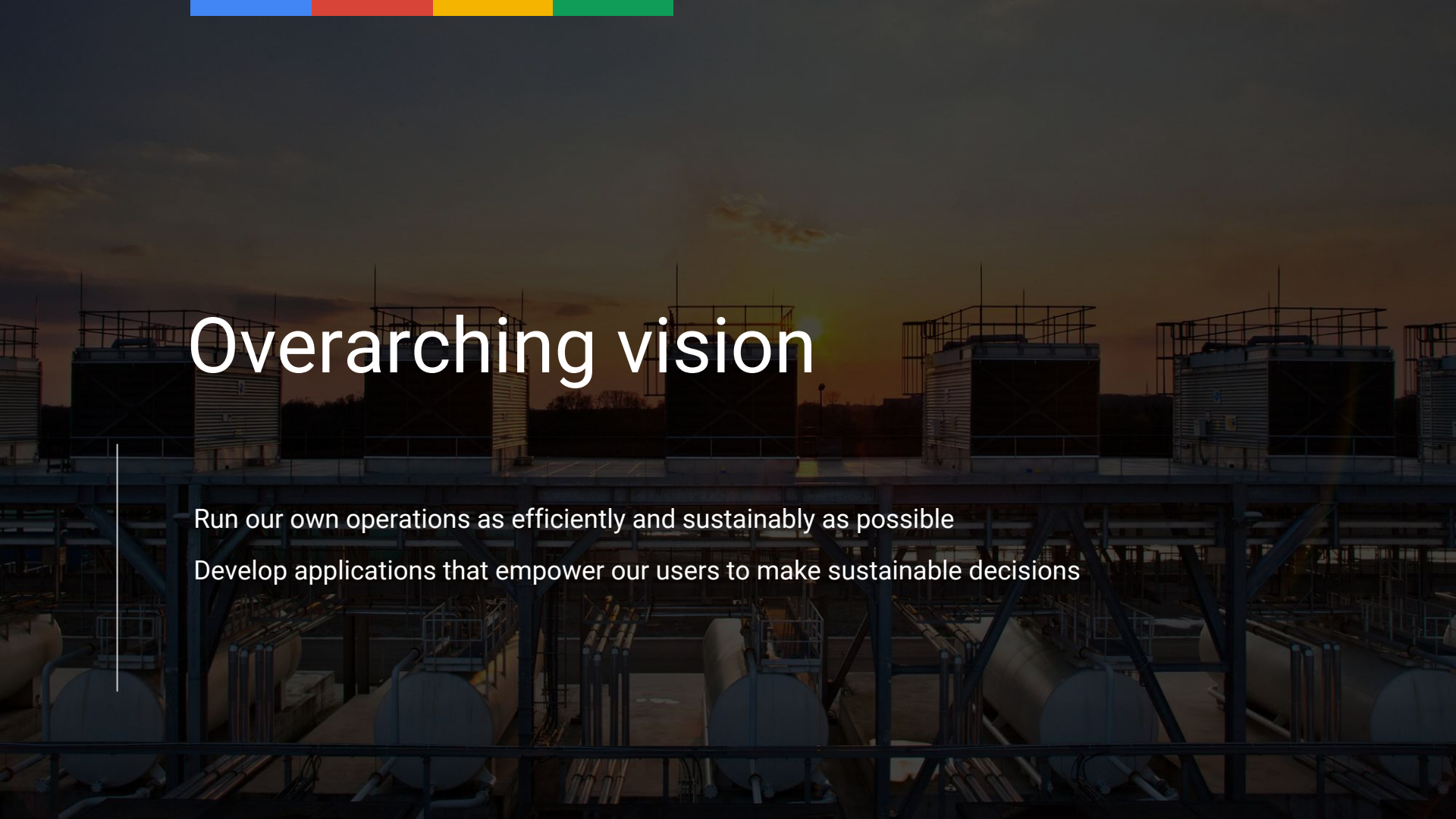
2,000,000+ YouTube views

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



Overarching vision

Run our own operations as efficiently and sustainably as possible

Develop applications that empower our users to make sustainable decisions