

ACRES & WATTS: **CONSIDERING SCALE** **& RENEWABLE ENERGY**

DRAFT

for discussion on July 14, 2010

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& Energy Foundation

INVESTING IN RENEWABLE ENERGY

- Health & safety
- Job creation
- Energy from free raw materials
- National security
- Protect biodiversity by limiting climate change
- Prevent the worst effects of climate change



GREENHOUSE GASES (GHGs) & TEMPERATURE

SOURCE FOR PROJECTIONS: IPCC FOURTH ASSESSMENT

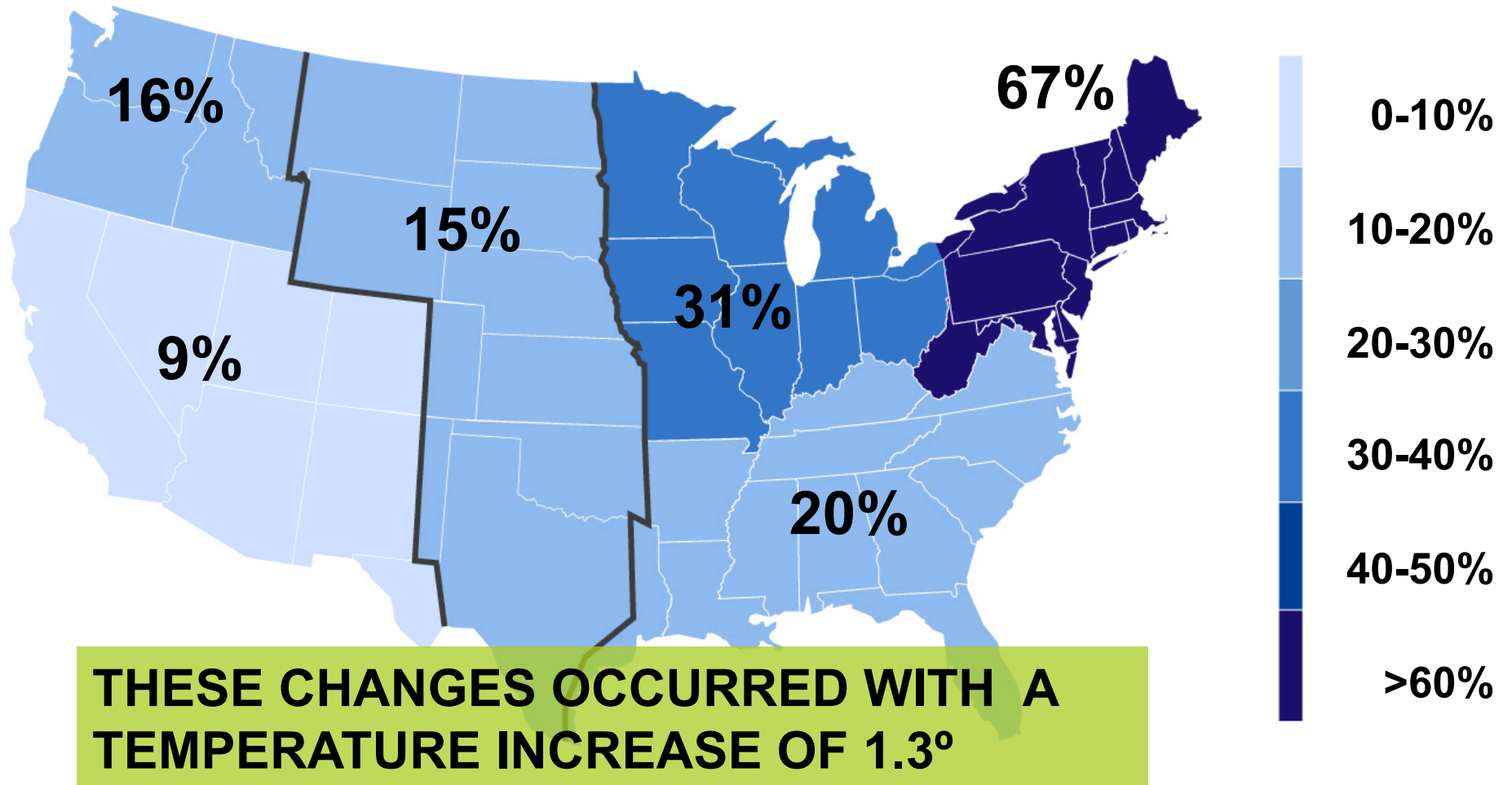
- Before industrialization, atmospheric carbon was roughly 250 ppm
- Today, carbon is at roughly 400, and temps have increased 1.3°F
- Some degree of additional increase cannot be avoided

* Temps represent middle of IPCC Fourth Assessment 5-95% projections

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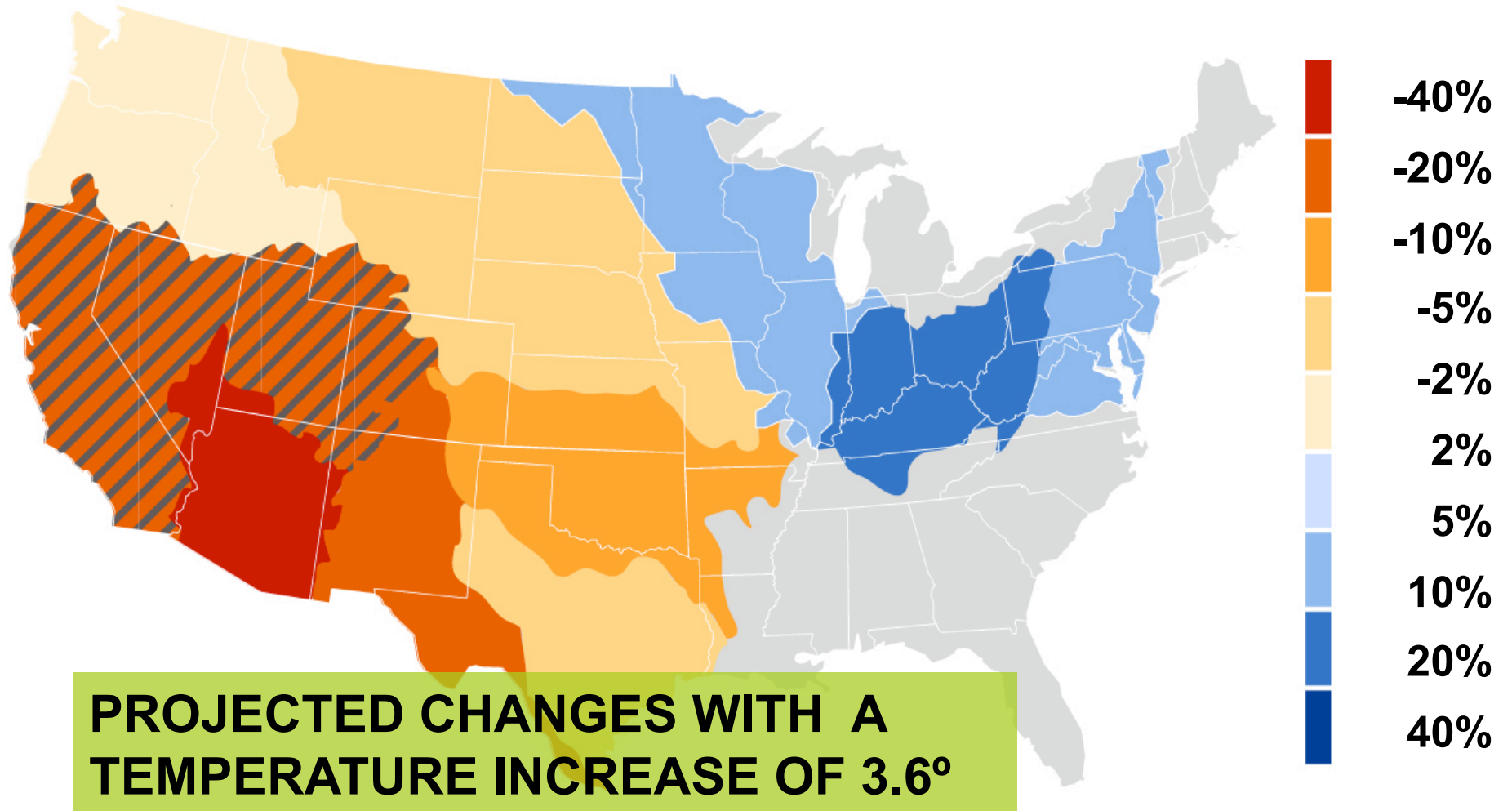
PAST CHANGES IN HEAVY PRECIPITATION EVENTS

Comparison: 1958 to 2007



PROJECTED CHANGES IN RUNOFF

Projected changes in median runoff for 2041-2060. Baseline:1901-1970



GREENHOUSE GASES (GHGs) & TEMPERATURE

SOURCE FOR PROJECTIONS: IPCC FOURTH ASSESSMENT

- Before industrialization, atmospheric carbon was roughly 250 ppm
- Today, carbon is at roughly 400, and temps have increased 1.3°F
- If carbon stabilizes at 450, temps* are likely to increase a total of 3.6°F (2°C)
- If carbon stabilizes at 550, temps* are likely to increase a total of 5.4°F
- If carbon stabilizes at 650, temps* are likely to increase a total of 7°F

* Temps represent middle of IPCC Fourth Assessment 5-95% projections

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McKINSEY & COMPANY: PATHWAYS TO A LOW-CARBON ECONOMY

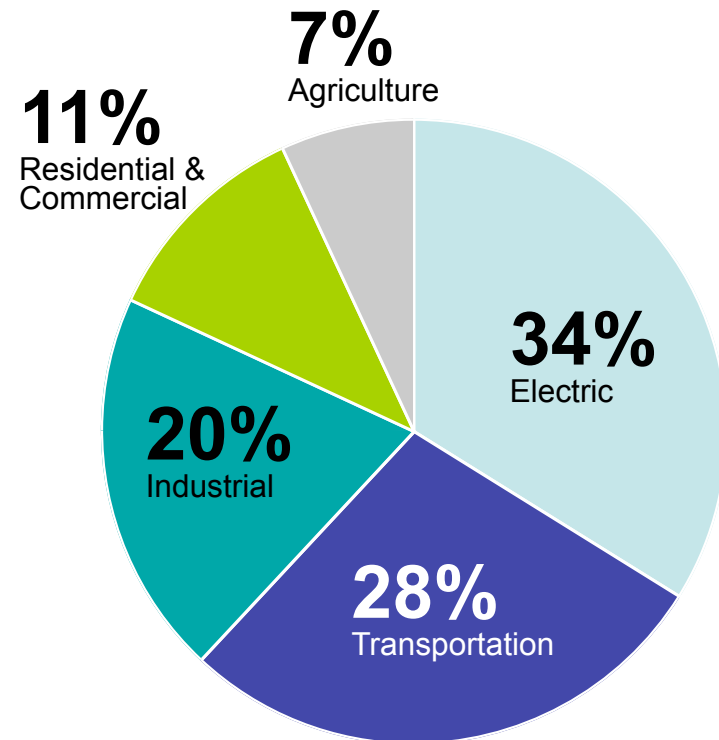
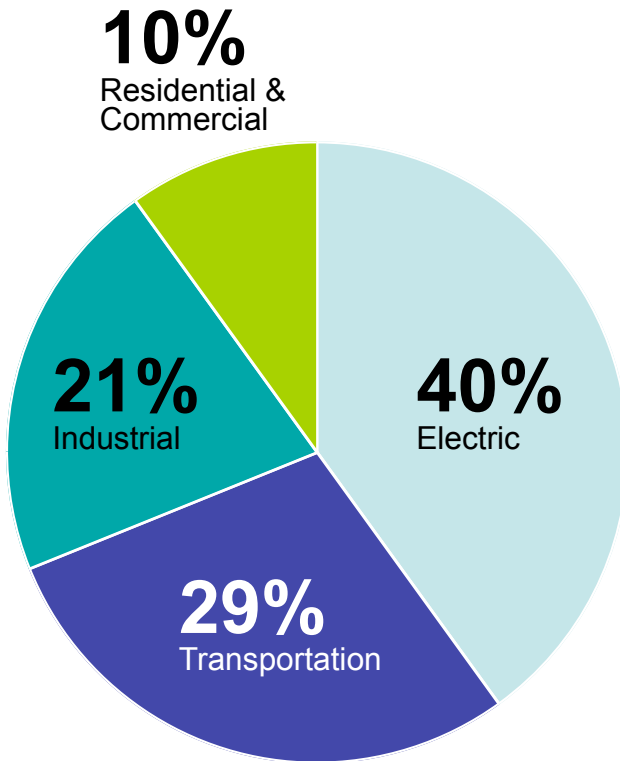
- “A 10-year delay in taking abatement action would make it virtually impossible to keep global warming below 2 degrees Celsius.”
- “Our model shows that if global abatement action were to start in 2020 instead of 2010, it would be challenging to achieve even a 550 ppm stabilization path.”

U.S. ENERGY CONSUMPTION

(by sector, 2007)

U.S. CARBON EMISSIONS

(by sector, 2007)



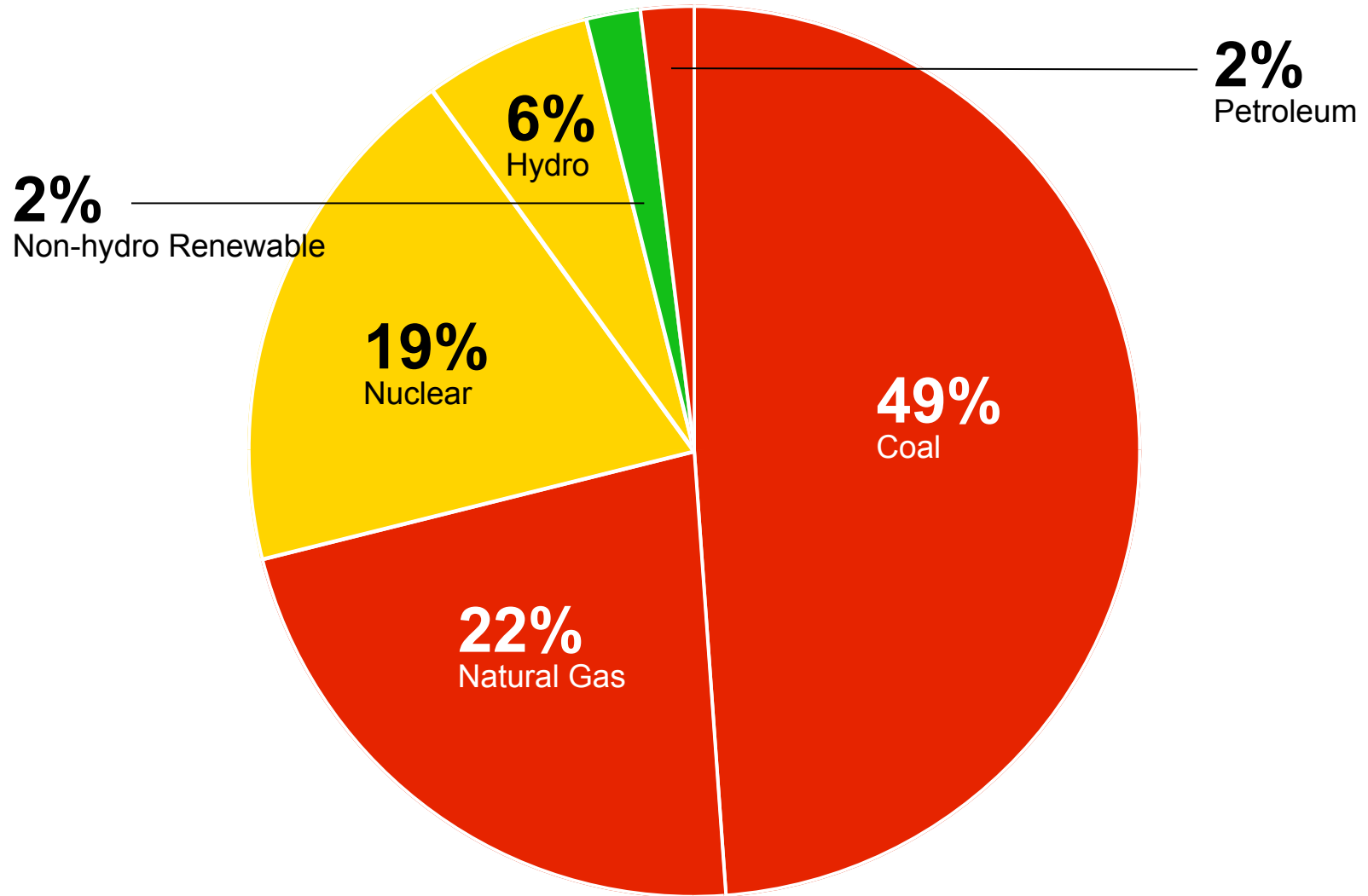
Source: Institute for Energy Research, Data Source: EIA, AER 2007

Source: U.S. Environmental Protection Agency (EPA), [Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007](#), Table ES-7, 2009.

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U.S. NET ELECTRICITY GENERATION

(by energy sector, 2007)



Source: Energy Information Administration (EIA), [Annual Energy Review 2007](#), Table 8.2a, 2008 via Pew Center.

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NATIONAL ENERGY & CLIMATE SCENARIOS

- Repower America (Al Gore)
 - 100% clean electricity by 2020
 - Retain, but don't expand, existing hydro and nuclear
 - Use solar and wind power to replace all electricity from coal and natural gas – achieving carbon-free electricity
- Union of Concerned Scientists
 - 33% savings from efficiency
 - Heavy investments in renewable energy
 - Cuts U.S. emissions from 2005 levels by 26% by 2020
 - Cuts U.S. emissions from 2005 levels by 56% by 2030

NATIONAL ENERGY & CLIMATE SCENARIOS

- Google Clean Energy 2030
 - Eliminate all electricity from coal, use 50% less natural gas
 - Begin converting transport fleet to plug-in hybrids
 - Cuts U.S. emissions from current levels by 41% by 2030
- McKinsey & Company
 - Stress efficiency & lifestyle changes; note cost effectiveness
 - Stress the need for a diversified approach
 - Cuts U.S. emissions from 2007 levels by 30% by 2030
- Pickens Plan
 - 22% of US electricity from wind power by 2020
- US DOE Wind Energy Study
 - 300 GW (20% of projected demand) by 2030

SAMPLE SCENARIO: GOOGLE 2030

WHAT IT ACHIEVES

 **88%** less fossil fuel used to produce

 **95%** less carbon emissions from electricity

 **45%** less emissions from vehicles

 **41%** less emissions overall

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SAMPLE SCENARIO: GOOGLE 2030

WHAT IT REQUIRES:



Energy Efficiency



Distributed Generation



Plug-in HEVs in 2030

- **90%** of new cars in 2030
- **41%** of overall fleet



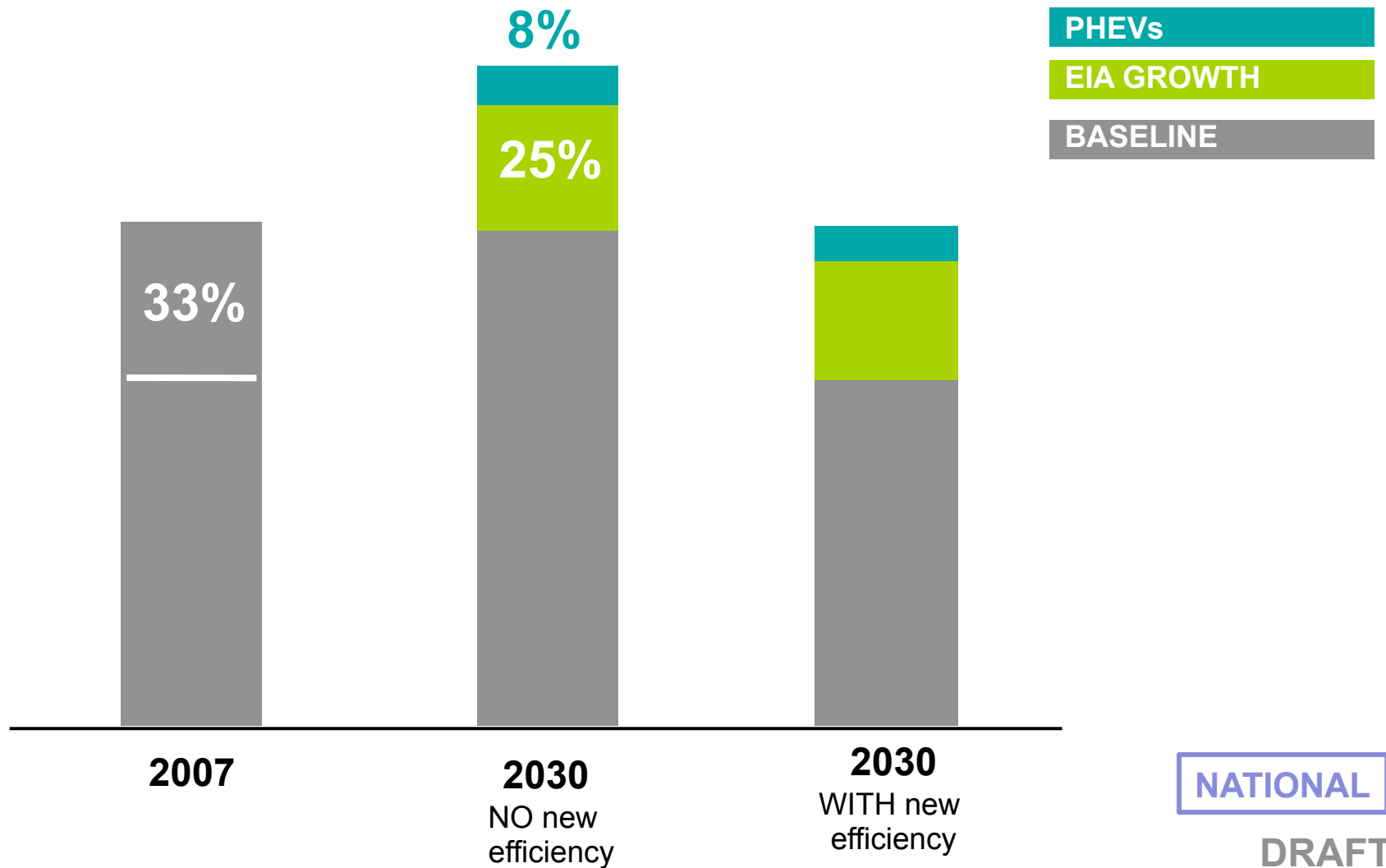
Use renewable energy to:

- Replace **all** coal
- Replace **half** natural gas

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SAMPLE SCENARIO: GOOGLE 2030 INVESTING IN EFFICIENCY



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GOOGLE 2030
DISTRIBUTED GENERATION

170 GW of Distributed Generation solar PV:

85GW

from 35 million
residential
rooftops

85GW

from commercial
rooftops

15%

of projected
electricity
demand for
2030



GOOGLE 2030

DISTRIBUTED GENERATION

170 GW of Distributed Generation solar PV:

25% of residential
rooftops –
for the entire U.S.

2.6% is the highest current
concentration of rooftop
PV for a **single U.S. city**

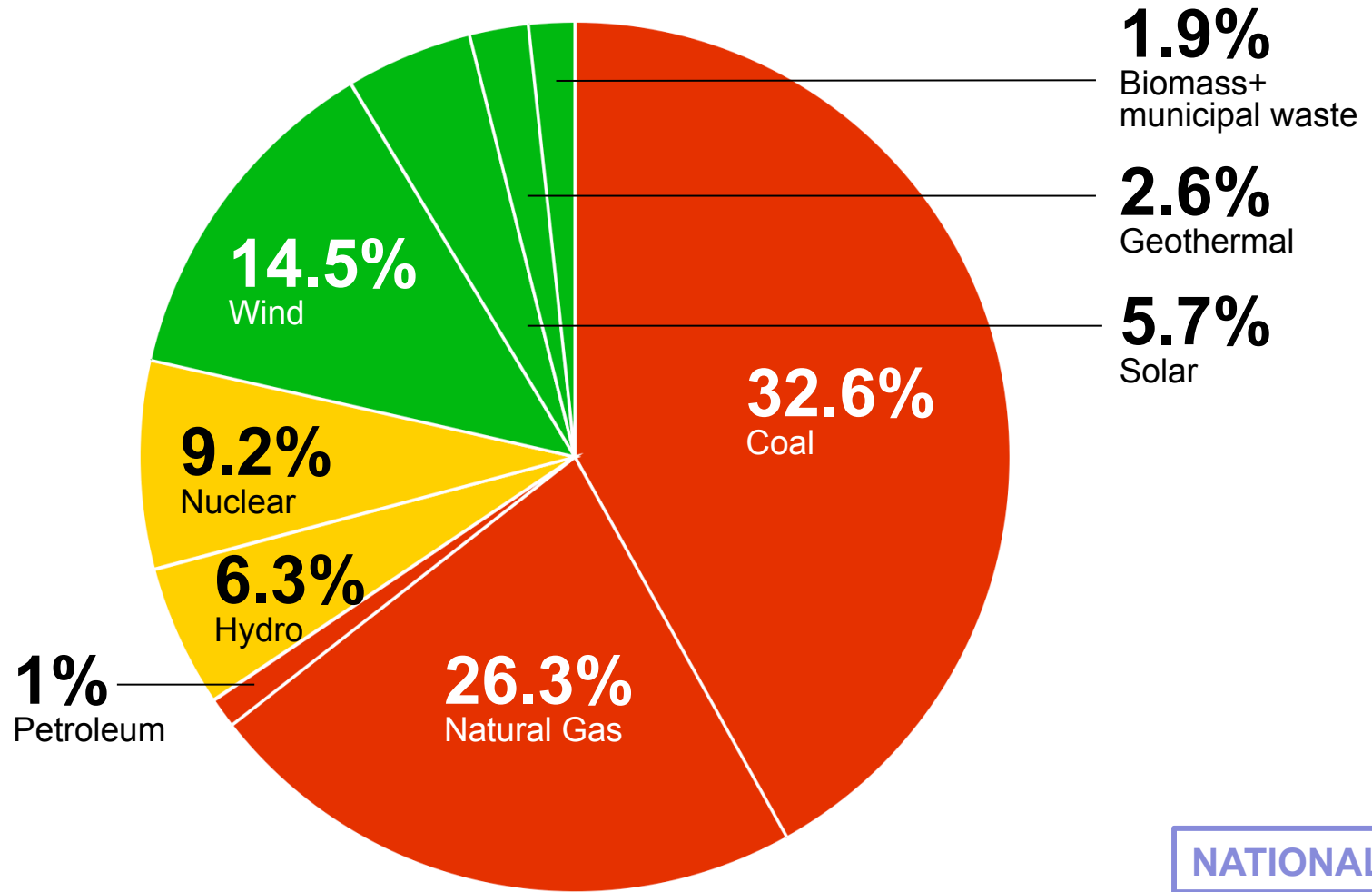
GOOGLE 2030 U.S. ELECTRICITY MIX

2020

70%



2007 CO2



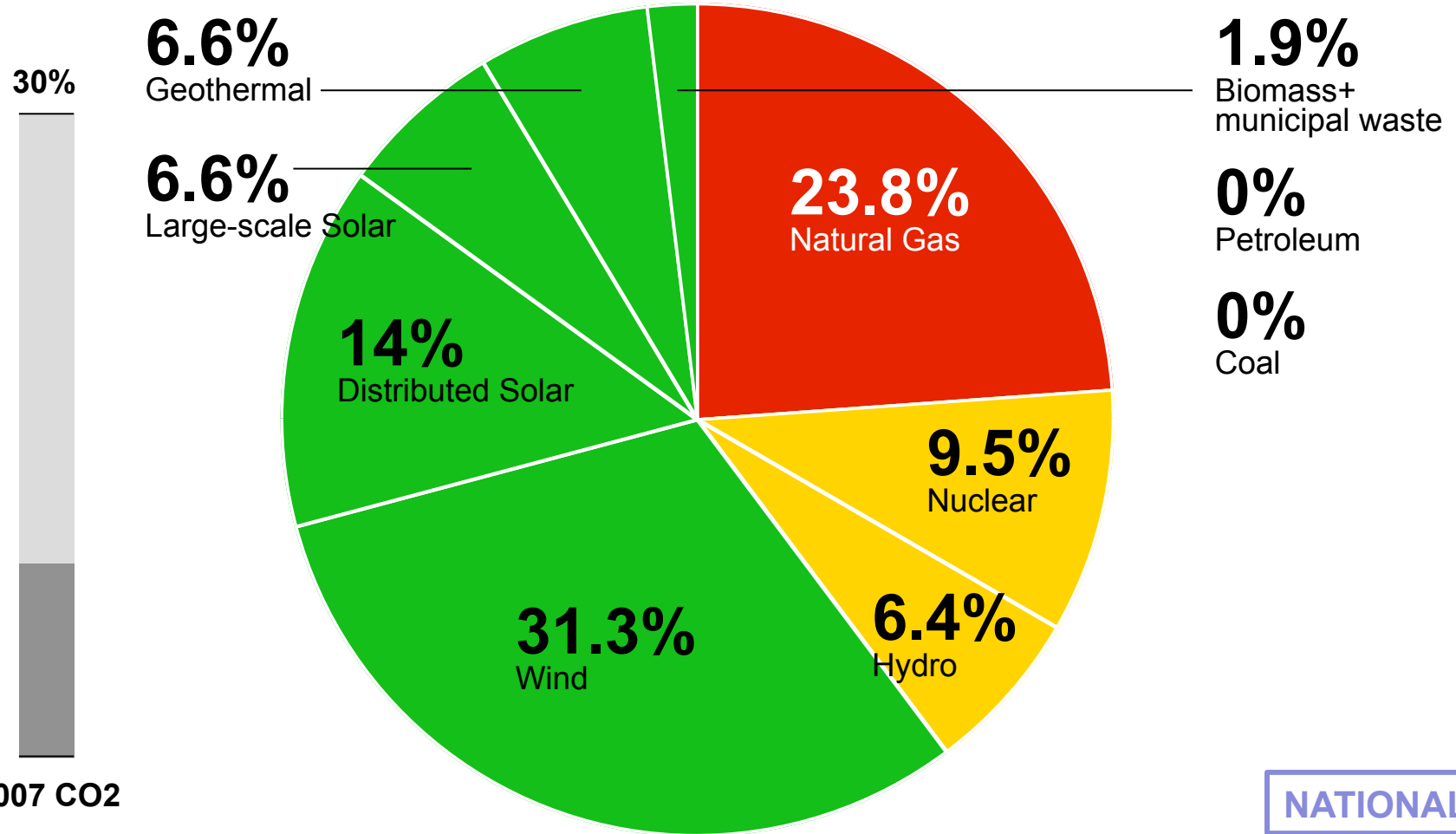
NATIONAL

Source:

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GOOGLE 2030 U.S. ELECTRICITY MIX

2030



Source:

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SAMPLE SCENARIO: GOOGLE 2030 UTILITY SCALE RENEWABLES

GOALS:

(In addition to **170 GW** from distributed generation)

***328 GW** is current coal plant capacity

300 GW

WIND

80 GW

OFFSHORE WIND

80 GW

LARGE-SCALE SOLAR POWER

65 GW

ENHANCED GEOTHERMAL

15 GW

CONVENTIONAL GEOTHERMAL

540 GW

UTILITY-SCALE RENEWABLE

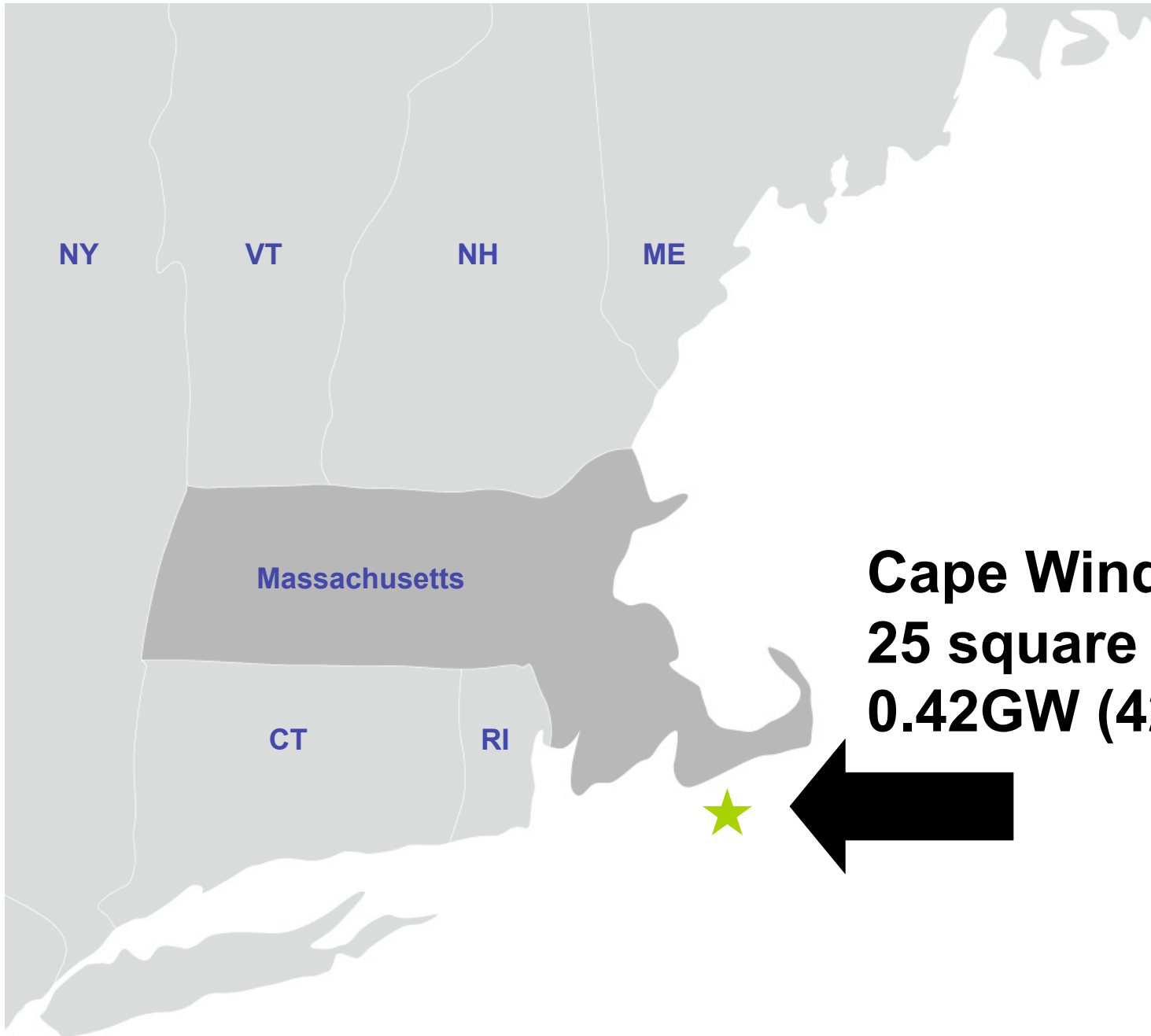
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CONSIDERING SCALE:

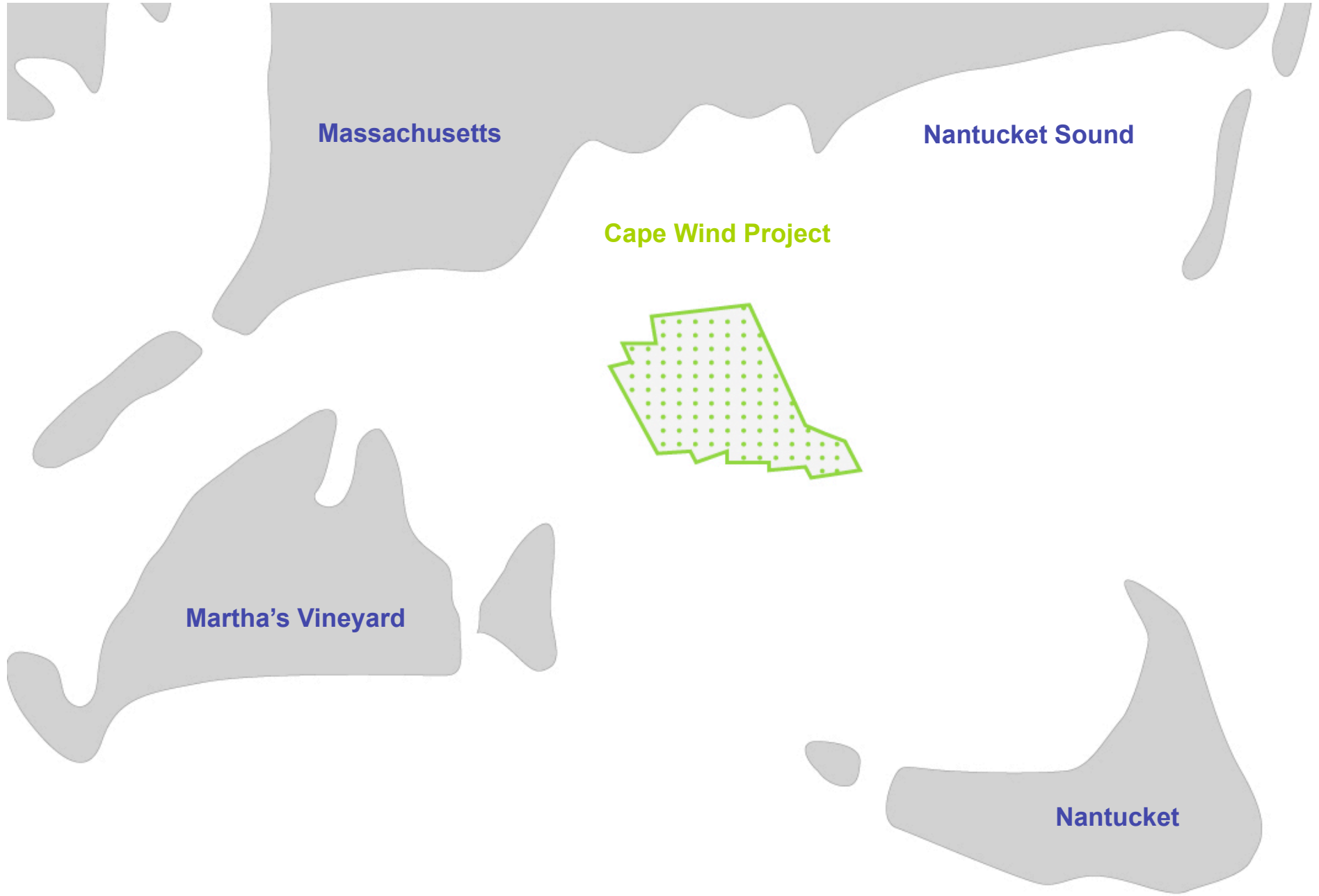
80 GW

**SAMPLE NATIONAL TARGET
OFFSHORE WIND**

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Cape Wind
25 square miles
0.42GW (420MW)



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**Proposed view from Conuit:
5.6 miles**



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190 @ .42GW

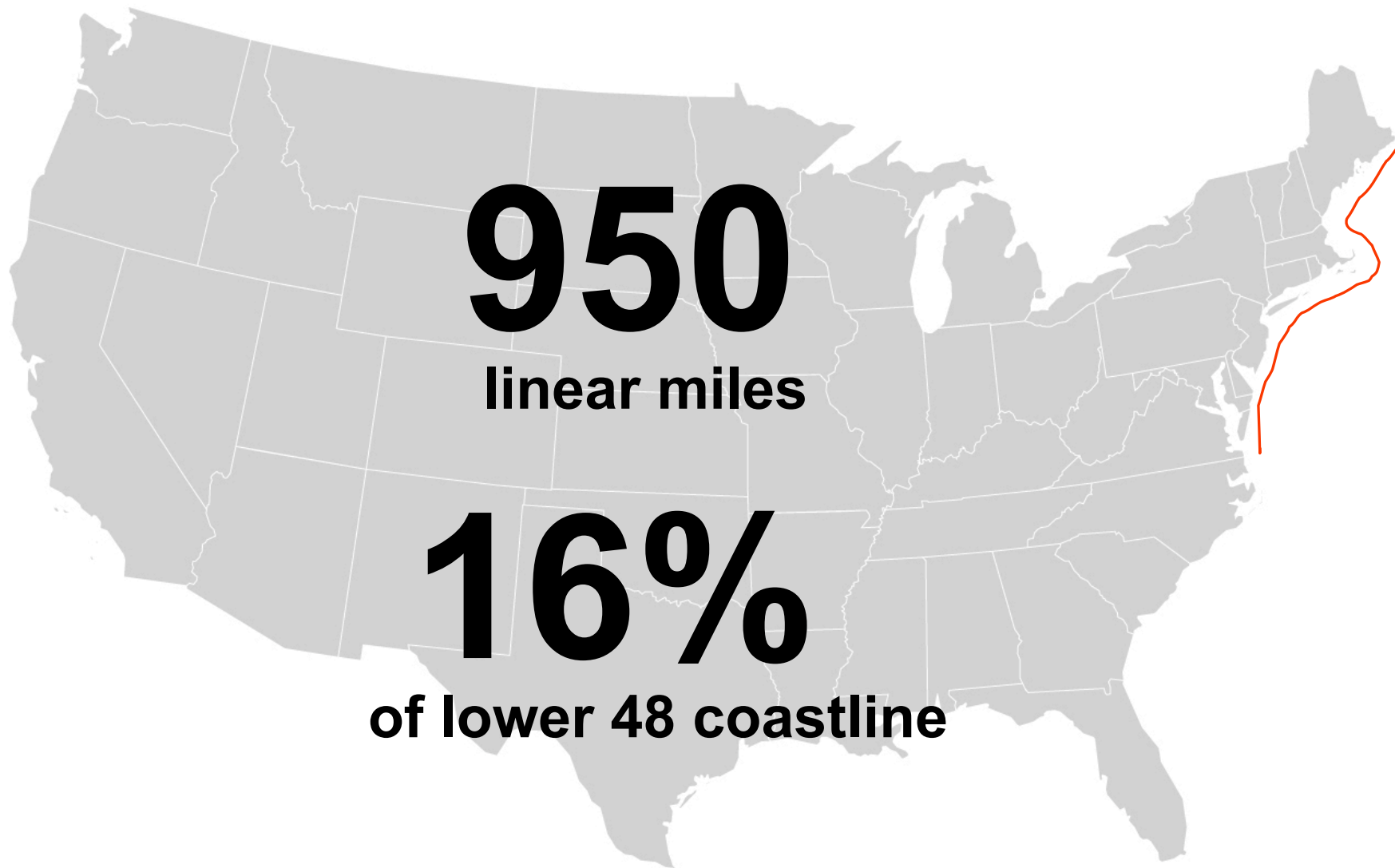
WIND FARMS

CAPACITY

80

GIGAWATTS

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950

linear miles

16%

of lower 48 coastline

A map of the Gulf of Mexico region, showing the coastline of the United States and Mexico. A green outline highlights a large area in the Gulf. A smaller, shaded green area is located in the northern part of this outlined region, near the coast of Mexico. The text '4,750 square miles' is centered over the map.

4,750
square miles

May 2 closure: 6,800 square miles

June 2 closure: 88,502 square miles

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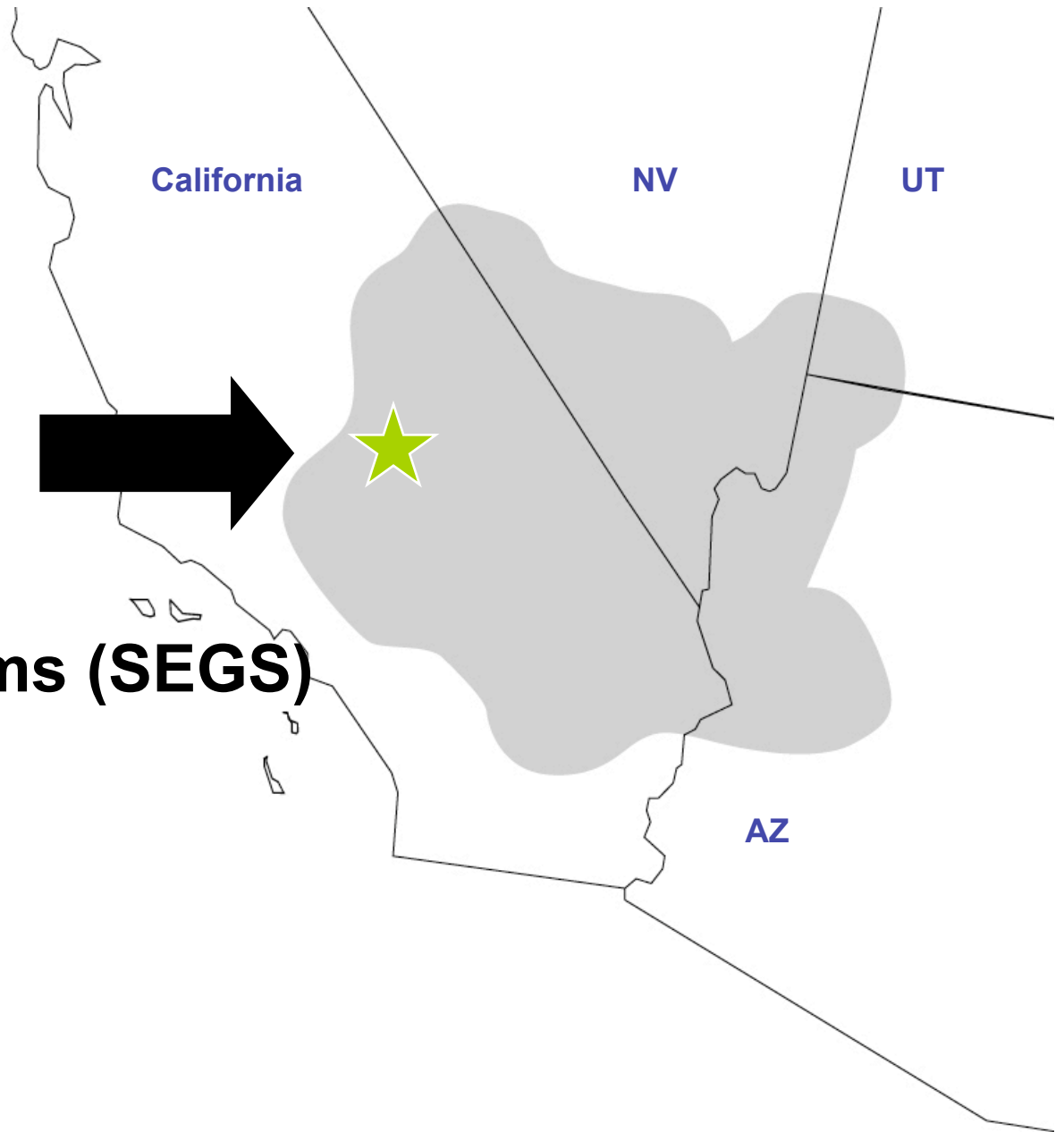
CONSIDERING SCALE:

80 GW

**SAMPLE NATIONAL TARGET
LARGE-SCALE SOLAR**

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**Solar Energy
Generating Systems (SEGS)
1600 acres
0.354GW (354MW)**





1600

ACRES

2.5

SQUARE MILES

1.5

MILES ON A SIDE

6

MILES TO WALK AROUND THE SITE



INDIVIDUAL SITE

PLANT (Technology)	GW	ACRES
Nevada Solar 1 (Troughs)	.075	400
SEGS (Troughs)	.354	1,600
Ivanpah (Solar towers)	.392	3,500
AV Solar (PV array)	.230	2,100

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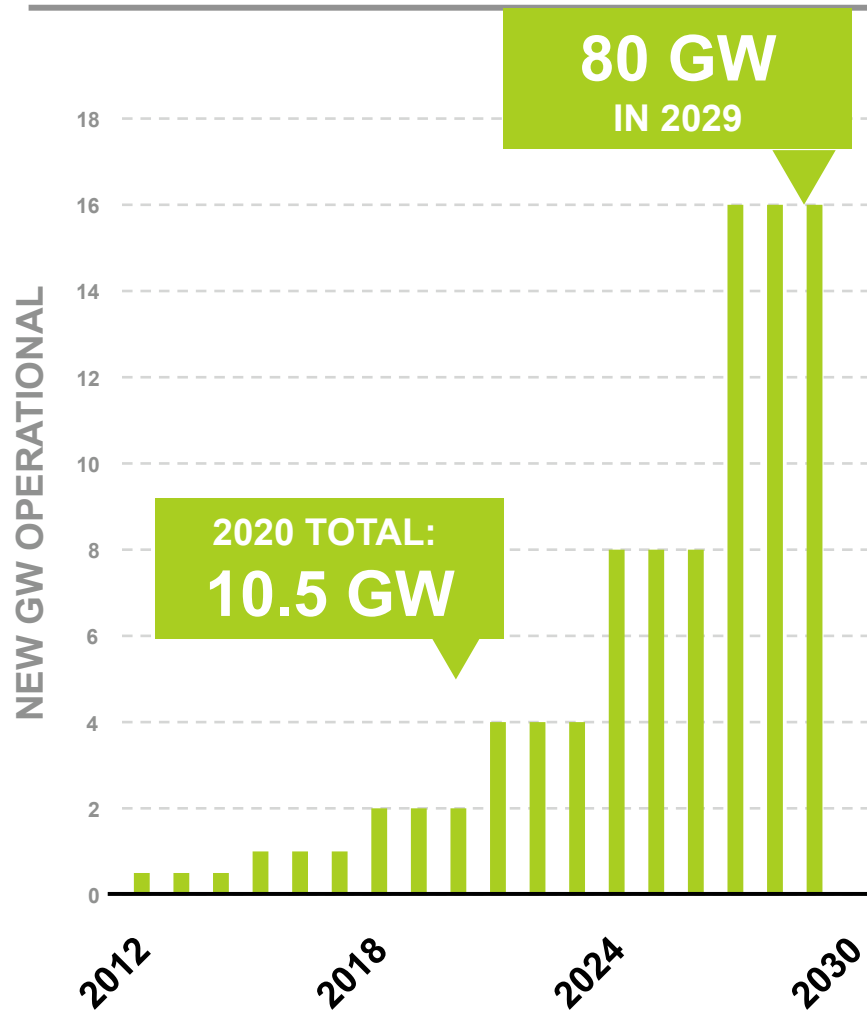
PLANT (Technology)	INDIVIDUAL SITE		SITES TO REACH 80 GW	
	GW	ACRES	# OF SITES	# OF ACRES
Nevada Solar 1 (Troughs)	.075	400	1,065	426,000
SEGS (Troughs)	.354	1,600	225	360,000
Ivanpah (Solar towers)	.392	3,500	204	714,000
AV Solar (PV array)	.230	2,100	347	729,000
Average*				500,000

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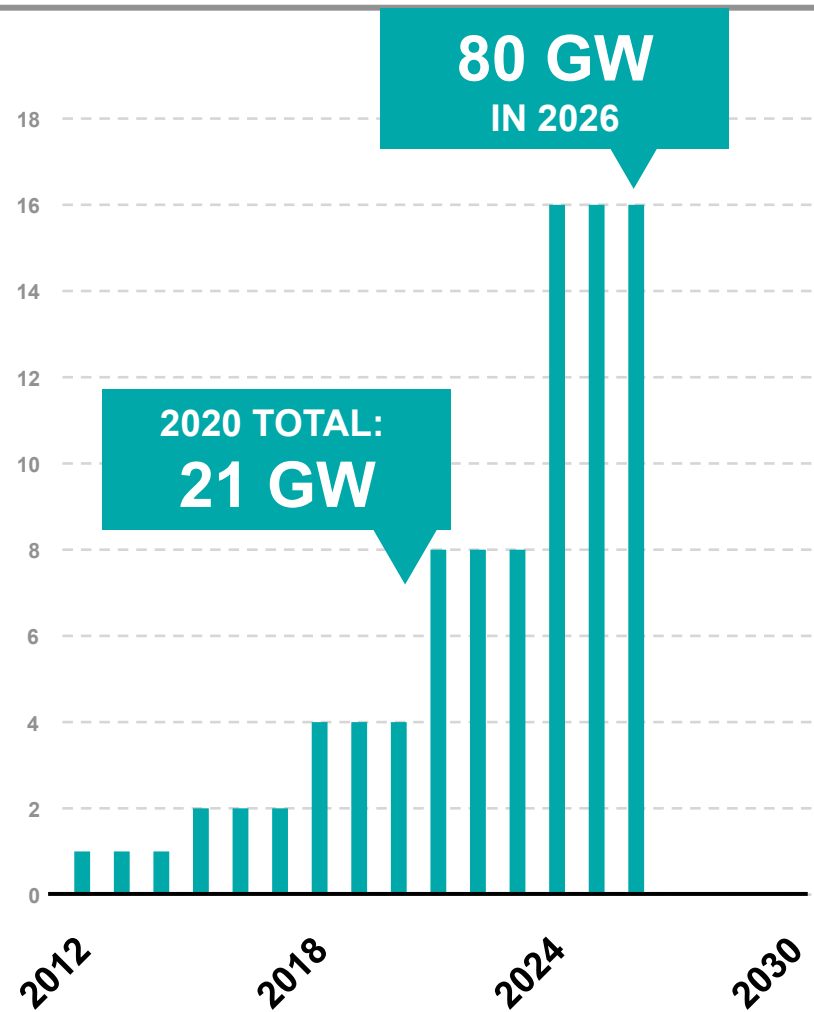
Source:

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**ANNUAL GW INCREASE,
DOUBLED EVERY 3 YEARS,
STARTING AT .5 GW**



**ANNUAL GW INCREASE,
DOUBLED EVERY 3 YEARS,
STARTING AT 1 GW**



CONSIDERING SCALE:

8 GW

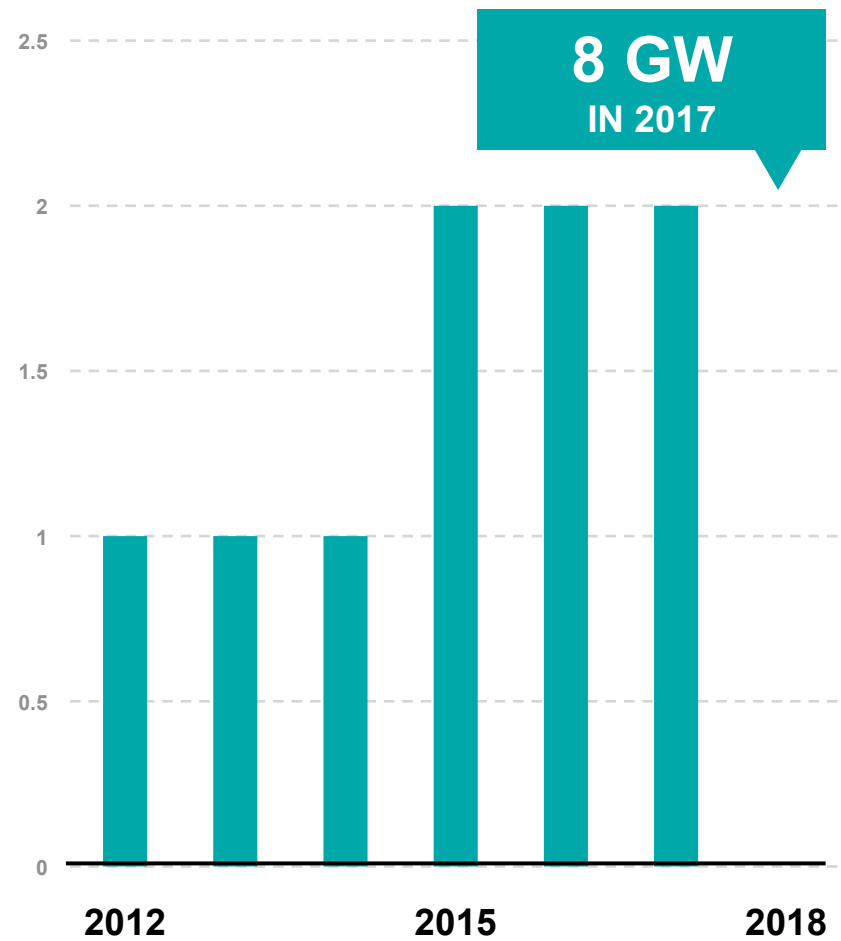
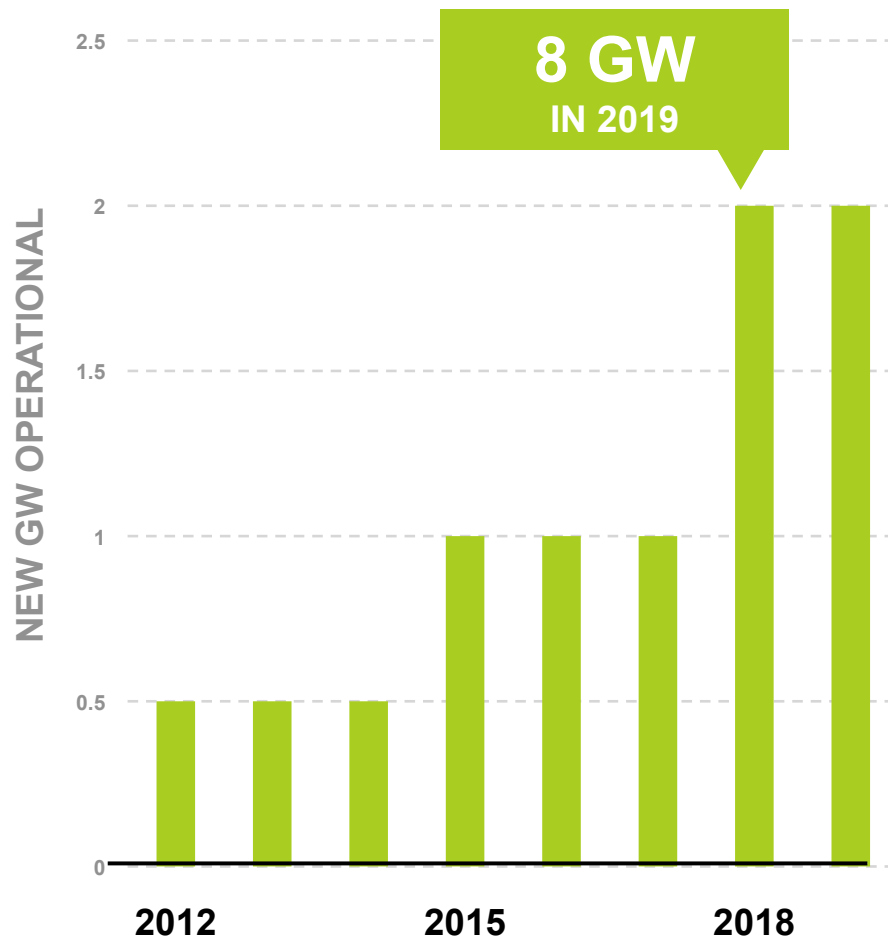
**SAMPLE CALIFORNIA DESERT TARGET
LARGE-SCALE SOLAR**

50,000 ACRES?




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**ANNUAL GW INCREASE,
DOUBLED EVERY 3 YEARS,
STARTING AT .5 GW**

**ANNUAL GW INCREASE,
DOUBLED EVERY 3 YEARS,
STARTING AT 1 GW**



CONSIDERING SCALE: WHEN RAINFALL CHANGES

-  **40%** Los Angeles **would have the rainfall of San Francisco**
-  **20%** Portland **would have the rainfall of San Antonio**
-  **40%** San Francisco **would have the rainfall of Tucson**

GENERAL GORDON R. SULLIVAN (RET.)
FORMER CHIEF OF STAFF, U.S. ARMY

ON ACTING WITH INCOMPLETE INFORMATION:

We seem to be standing by and, frankly, asking for perfectness in science. People... want to know the climate science projections with 100 percent certainty. Well, we know a great deal, and even with that, there is still uncertainty. But the trend line is very clear.

We never have 100 percent certainty. We never have it. If you wait until you have 100 percent certainty, something bad is going to happen on the battlefield. That's something we know. You have to act with incomplete information.

CONSIDERING SCALE: MULTIPLE FUTURES

What is your GW target? Why?

What is your timeline for hitting that target? Why?

Is your focus on California's 33% target? Are you considering additional goals? Why or why not?

What is your strategy for working with incomplete information?

With climate change, does "somewhere else" exist?

Extra Slides

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500,000 Acres of CSP:

3%

All in one place, it would take 3% of the Mojave Desert

1%

One-third of it would take 1% of the Mojave Desert

.5%

All of it would take less than half a percent of the 4 largest US deserts

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500,000 Acres of CSP:

3% All in one place, it would take 3% of the Mojave Desert

1% One-third of it would take 1% of the Mojave Desert

.5% All of it would take less than half a percent of the 4 largest US deserts

Other desert impacts:

5% 5% less rainfall in Great Basin under best IPCC scenario

15% 15% less rainfall in the Great Basin under mid-range scenario

50% 50% of bird, mammal & butterfly species in the Chihuahuah Desert in danger of being replaced by 2055

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50,000 Acres of CSP:

1.5%

It would be 1.5%
of the military
lands in the CA
desert .

Other desert impacts:

15%

15% of the desert
tortoises transported
from Ft. Irwin were
killed by coyotes.

CALIFORNIA