THE CLIMATE CRISIS AND THE NEED TO TRANSITION TO & MAXIMIZE RENEWABLE ENERGY

Sacha Spector
Doris Duke Charitable Foundation

THE GRIM, THE HOPEFUL, & THE SMART

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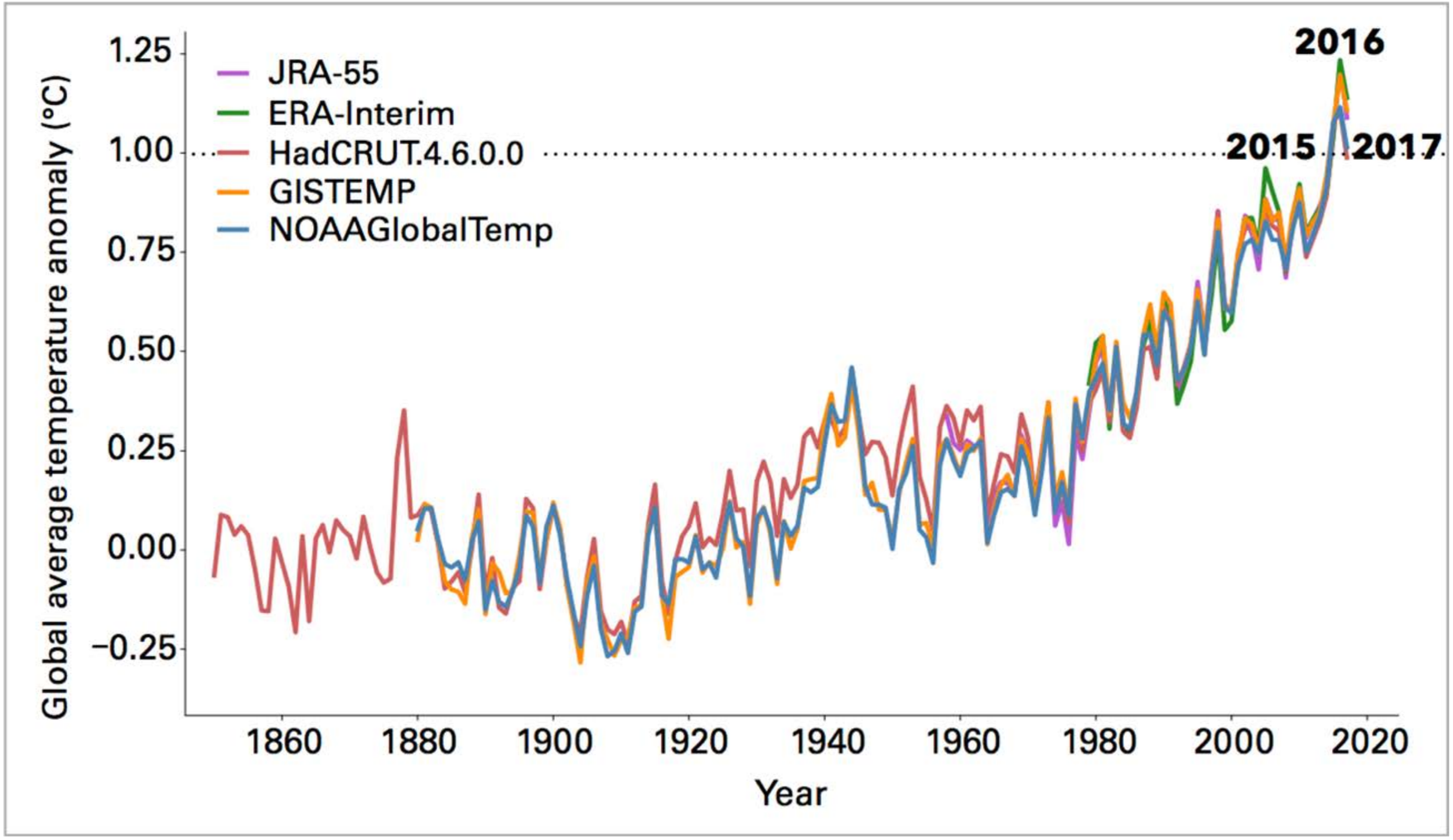
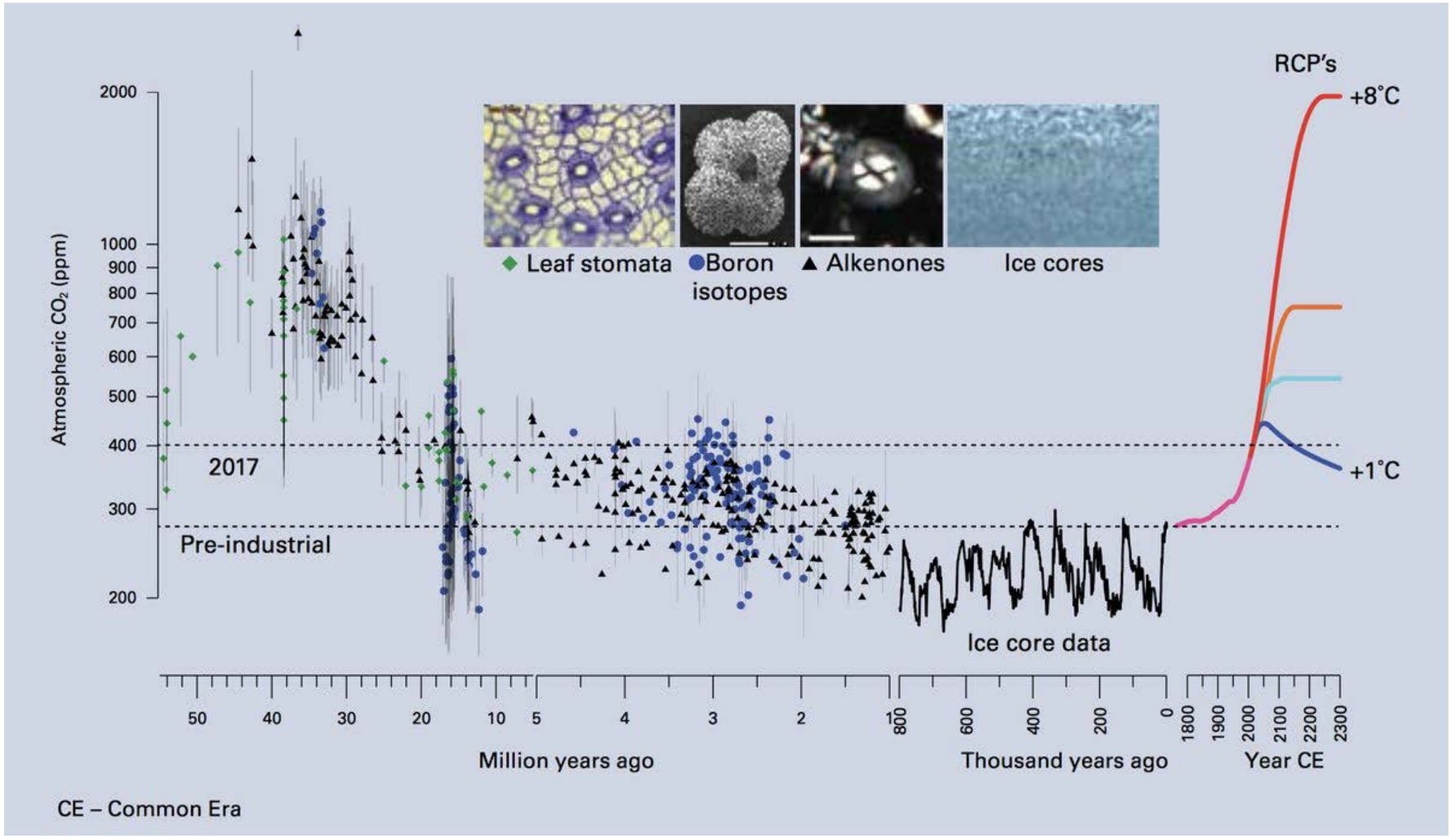
THE GRIM

Welcome to a 1° World



WMO Statement on the State of the Global Climate in 2017 WMO-No. 1212

Welcome to a 1° World



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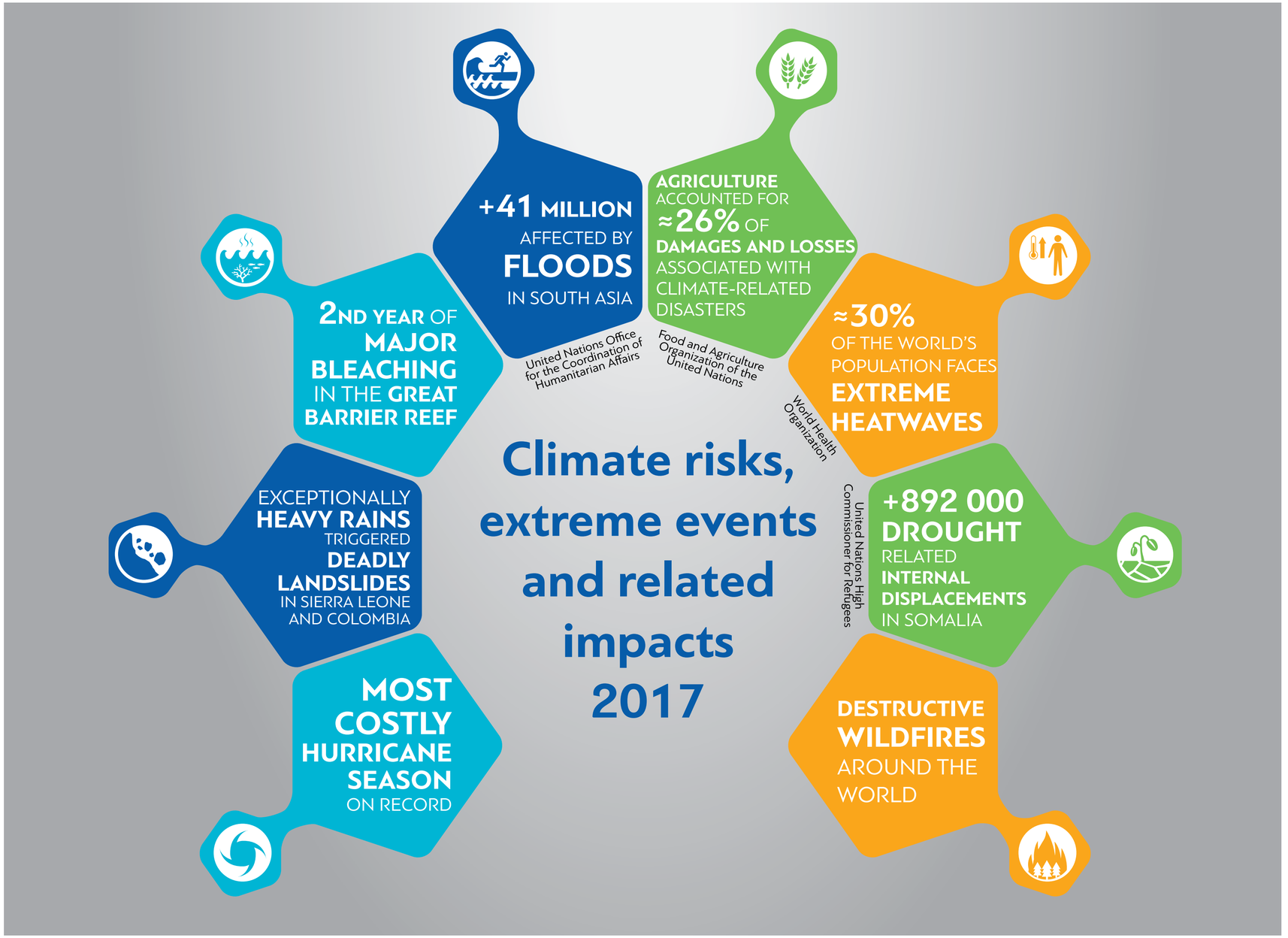

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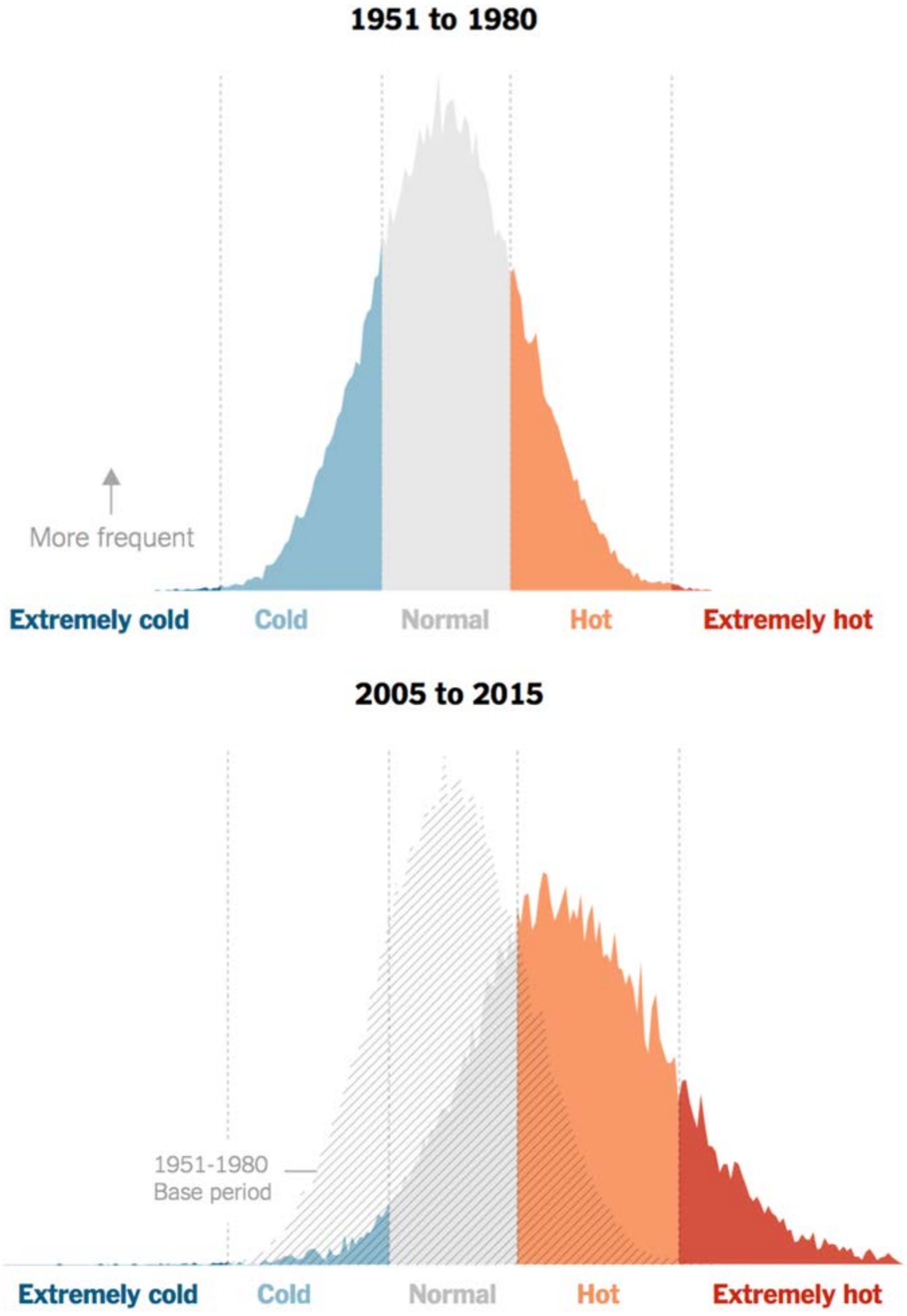
Heat

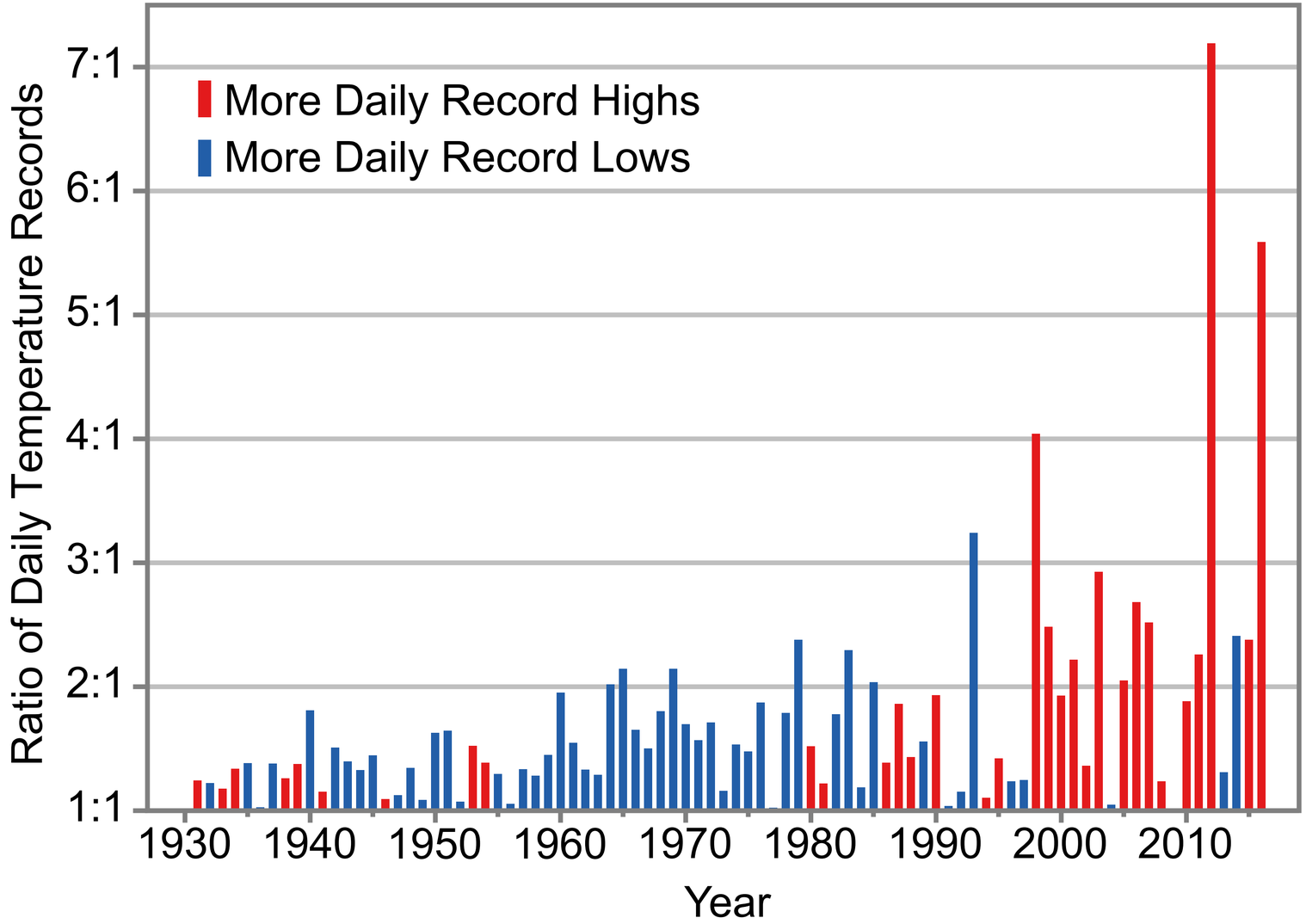
Global temp ~1.1 C higher than pre-industrial level



Heat

Global temp ~1.1 C higher than pre-industrial level

Significantly more record highs than lows



USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I

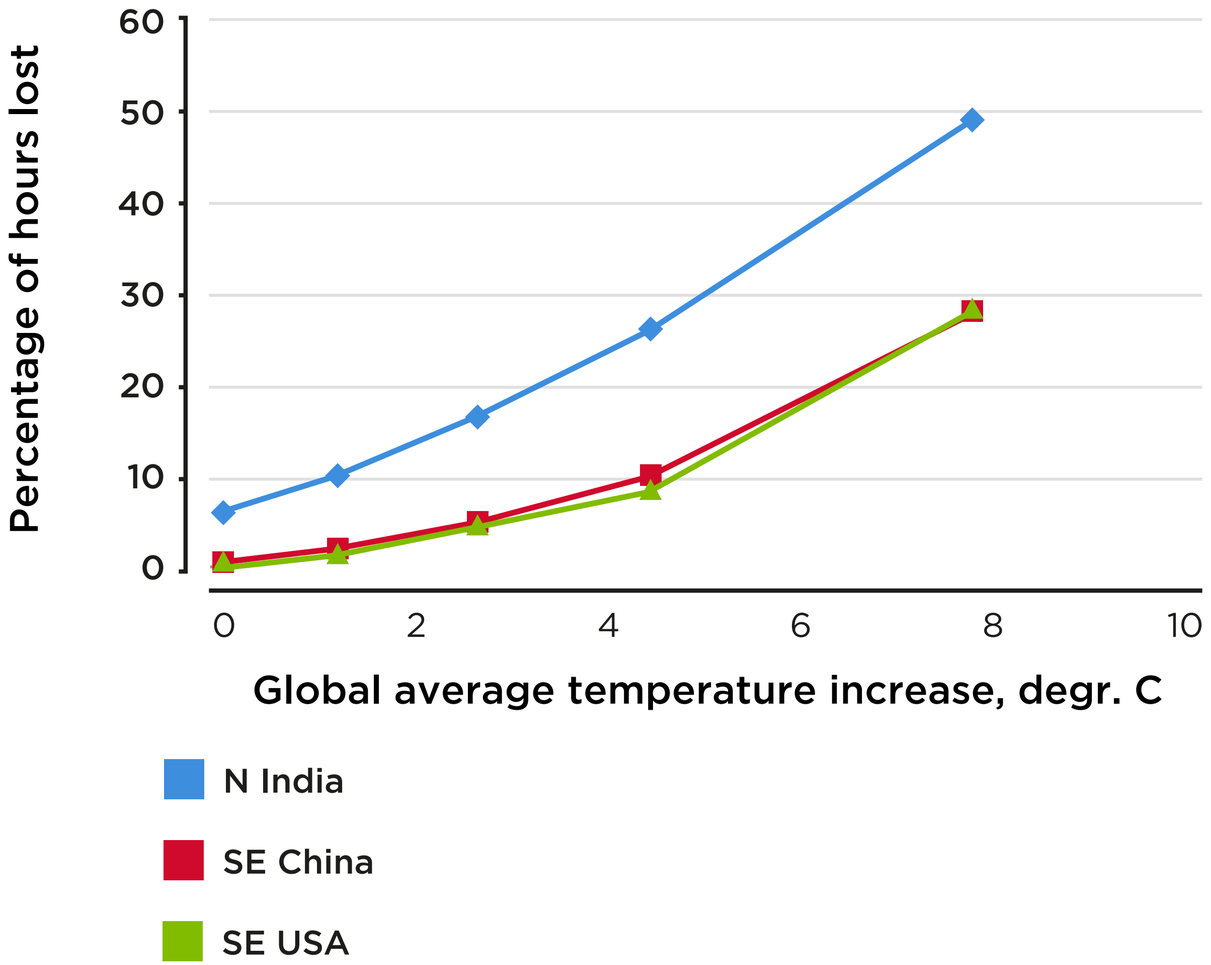
Heat

Global temp ~1.1 C higher than pre-industrial level

Significantly more record highs than lows

Increasing heat stress on humans and natural systems

Lost annual daylight work hours (%) for people working hourly at 300W



King et al 2017, Climate Change: A Risk Assessment

Rising Seas

21st Century SLR is more rapid and appears to be accelerating

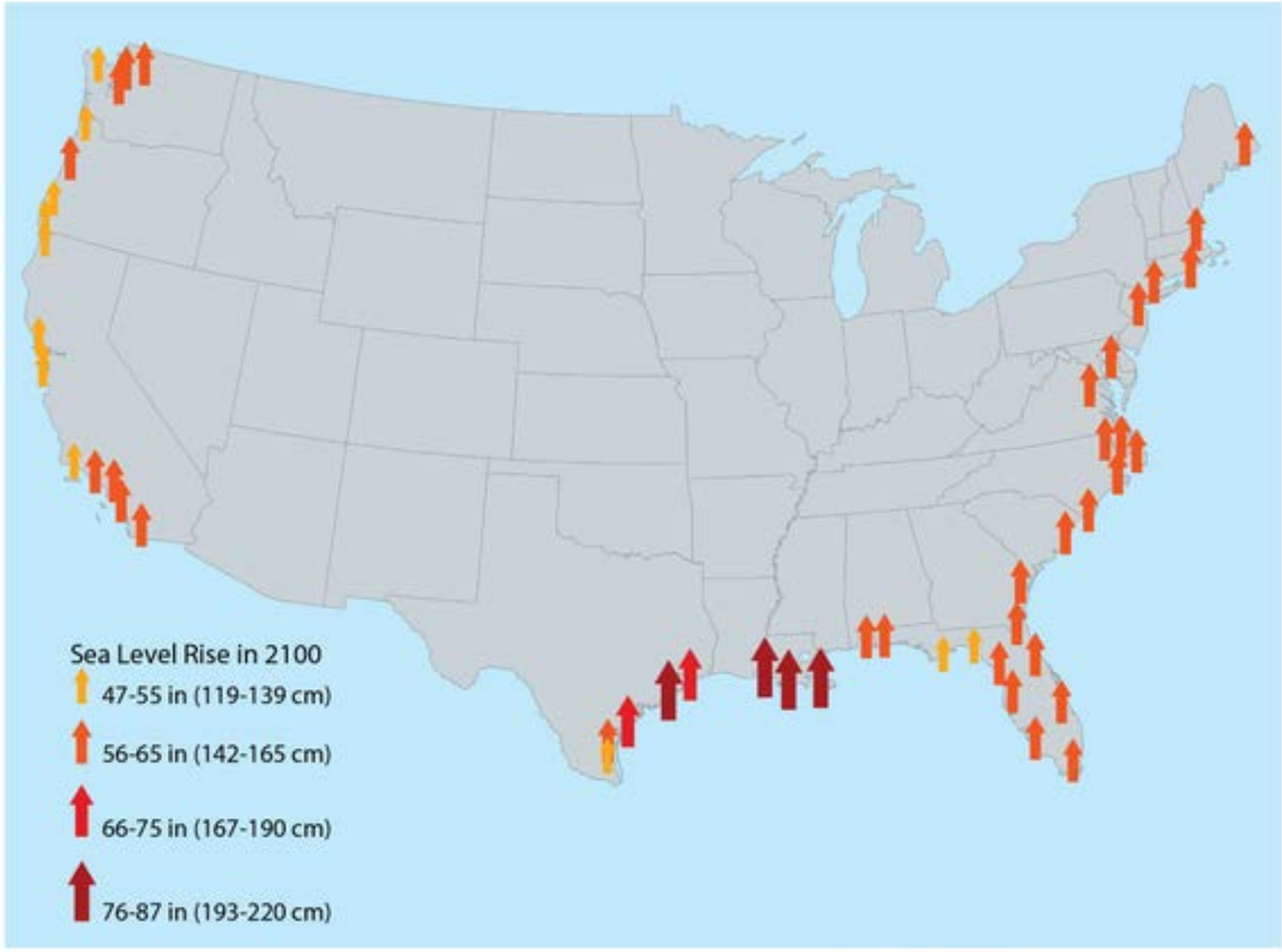
Storm surges & nusiance flooding are increasing risks to coasts and waterfront

47-87 inches of rise by 2100 if no action

Over $1 Trillion in residential real estate

Projected Sea Level Rise in 2100 Without Climate Action

Projections are based on global mean sea level rise in 2100 (56 inches), adjusted for local subsidence and uplift.



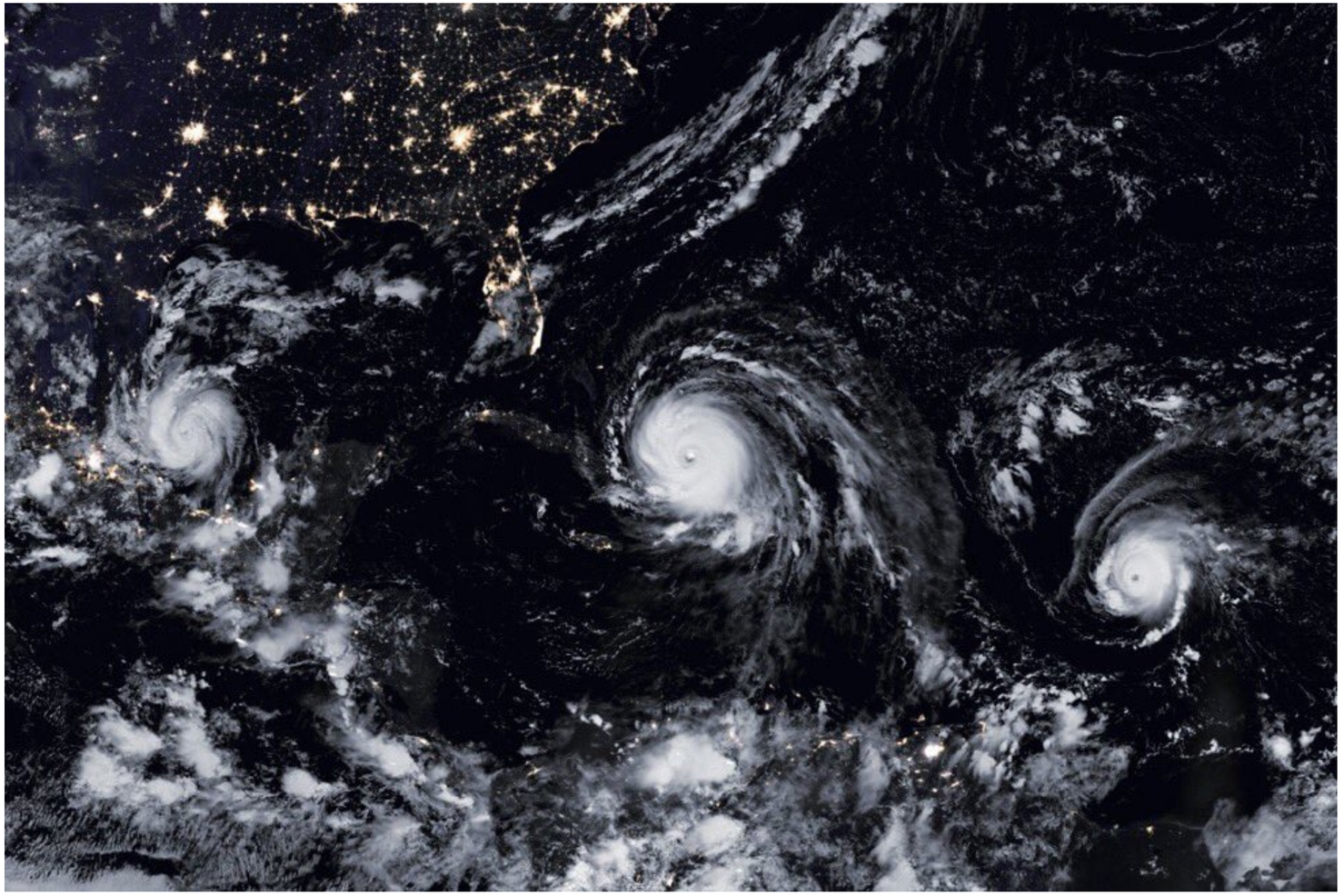
See www.epa.gov/cira for more information.

Extreme Storms

10-15% more precipitation in Northeast U.S.

More intense tropical cyclones

More frequent storm surges

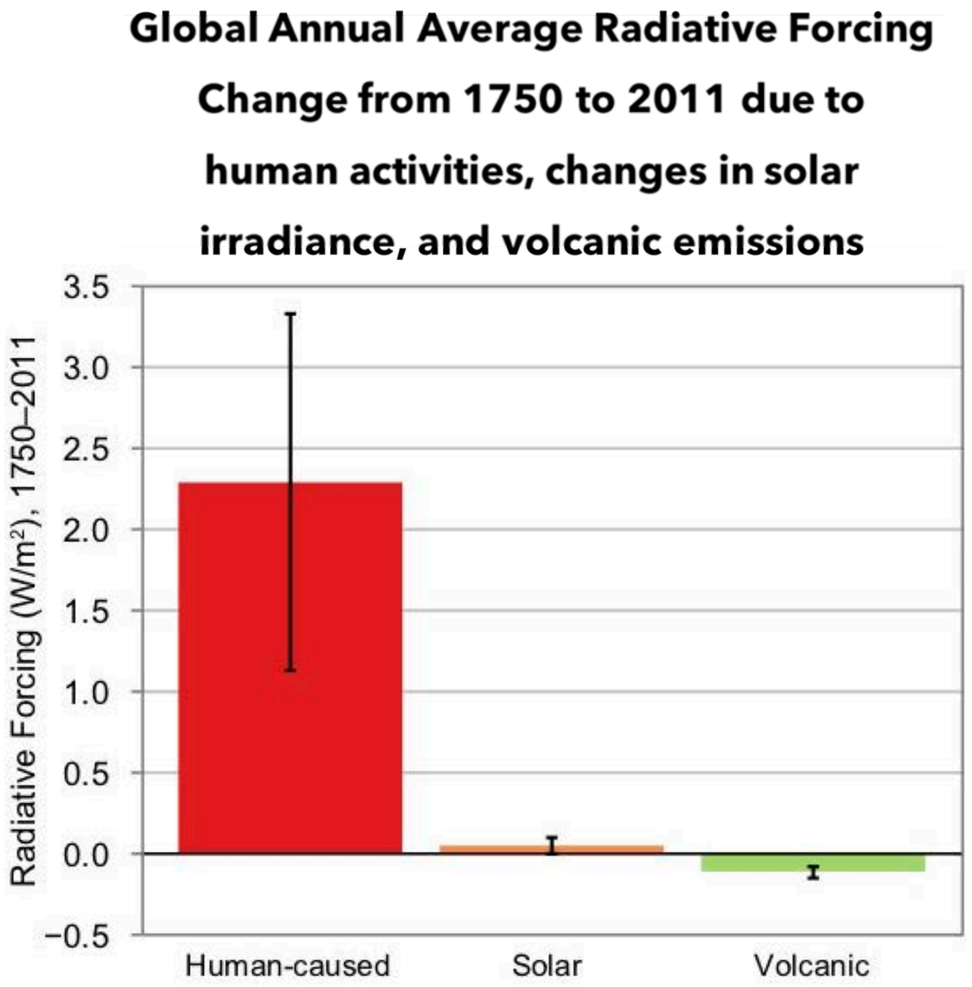


Climigration

13.1 million people in 319 coastal U.S. counties could be forced to move if sea level rises 1.8 meters by the year 2100

Projected water stress could force movement from Southwest

Hauer, 2017 *Nature Climate Change*

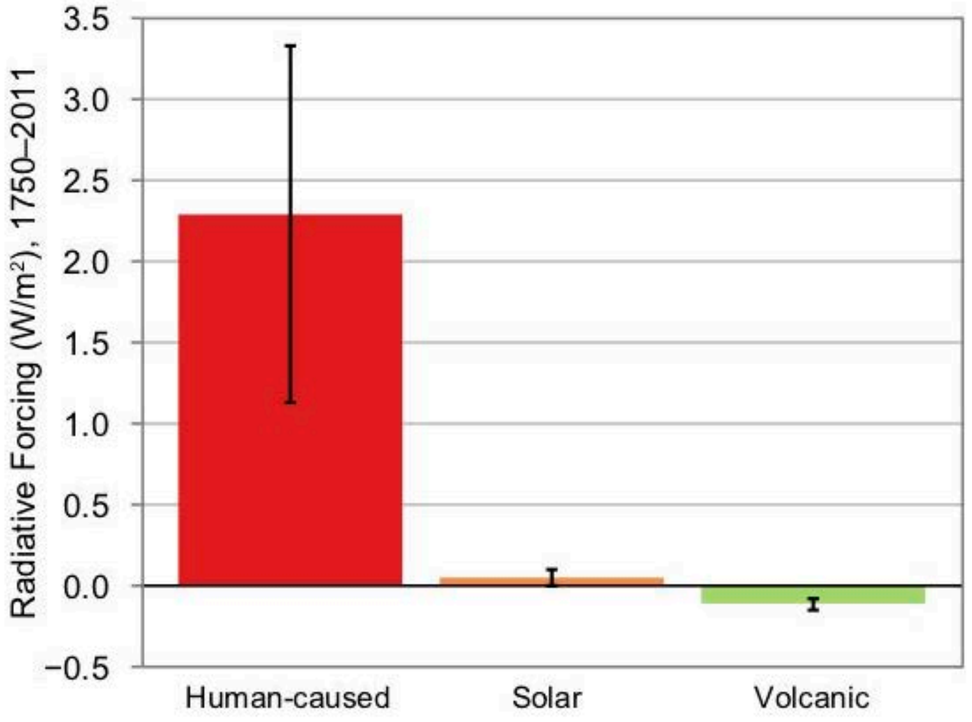


(left) **USGCRP**, 2017: *Climate Science Special Report: Fourth National Climate Assessment, Volume I*

It's Us

Global Annual Average Radiative Forcing

Change from 1750 to 2011 due to human activities, changes in solar irradiance, and volcanic emissions



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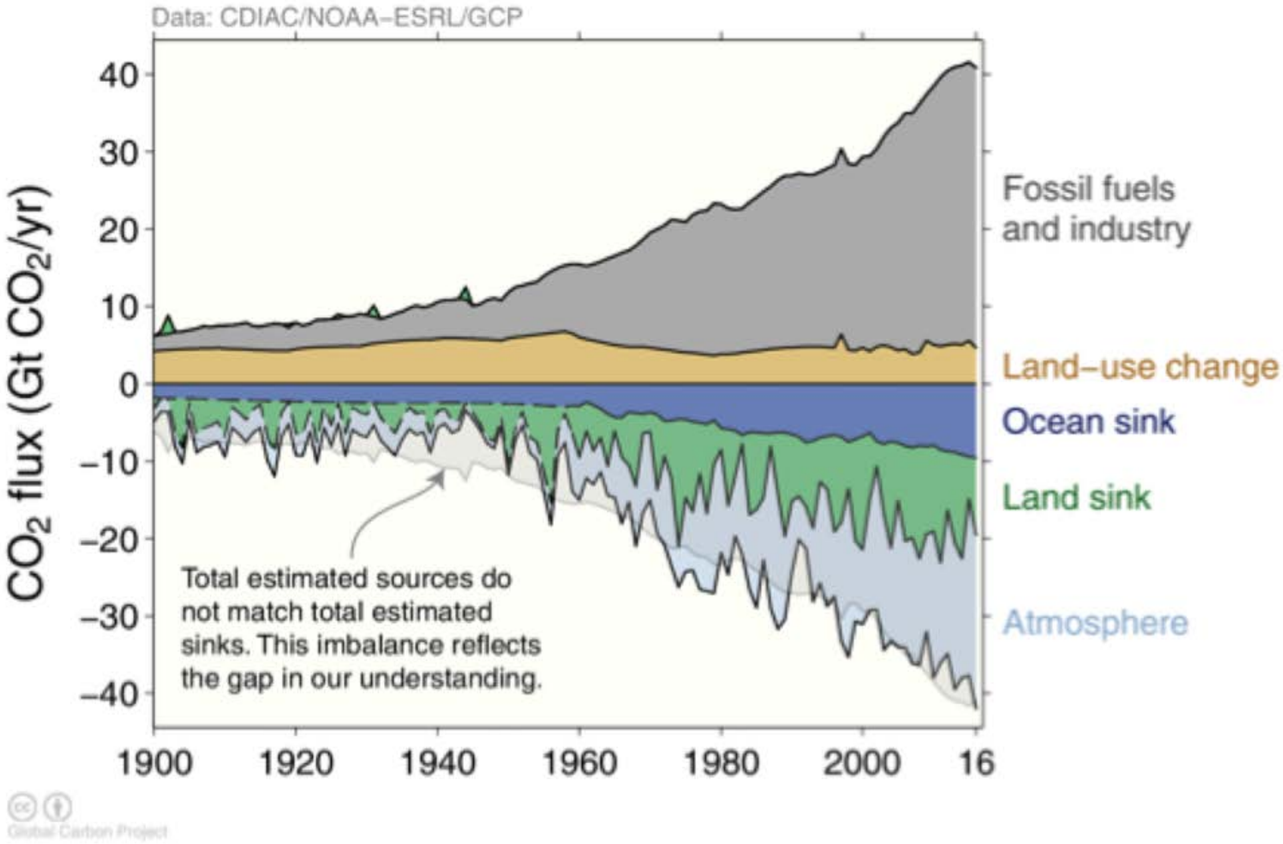
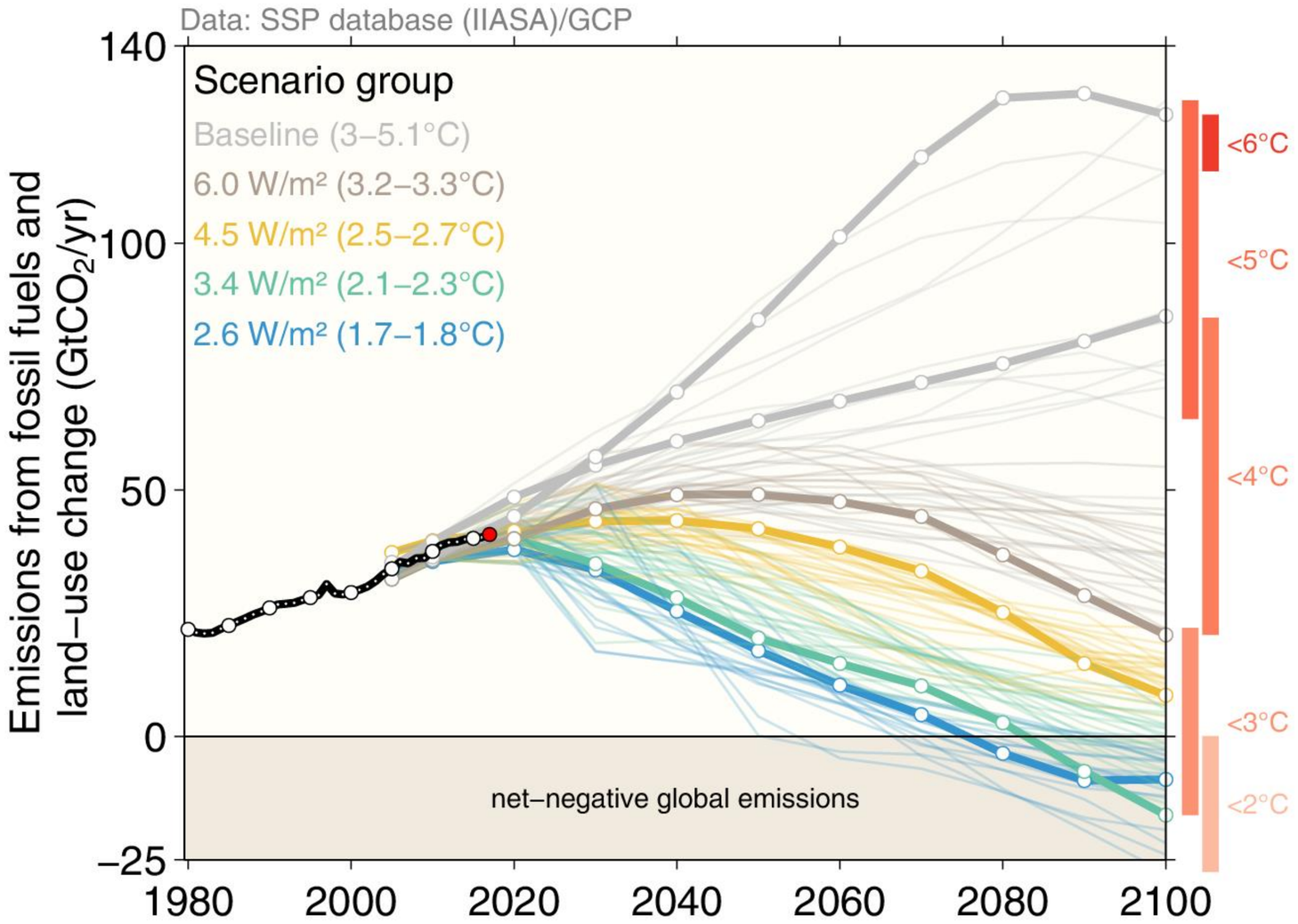


(right) CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Joos et al 2013; Khatiwala et al. 2013; DeVries 2014; Le Quéré et al 2017; Global Carbon Budget 2017

It's Us

Five Shared Socioeconomic Pathways (SSPs)

In Upcoming Intergovernmental Panel on Climate Change



Achieving the Paris Agreement targets of 2°C or 1.5°C requires rapid decarbonization (and negative emissions)

Paths to Safety

Sources: Source: Riahi et al. 2016; IIASA SSP Database; Global Carbon Budget 2017

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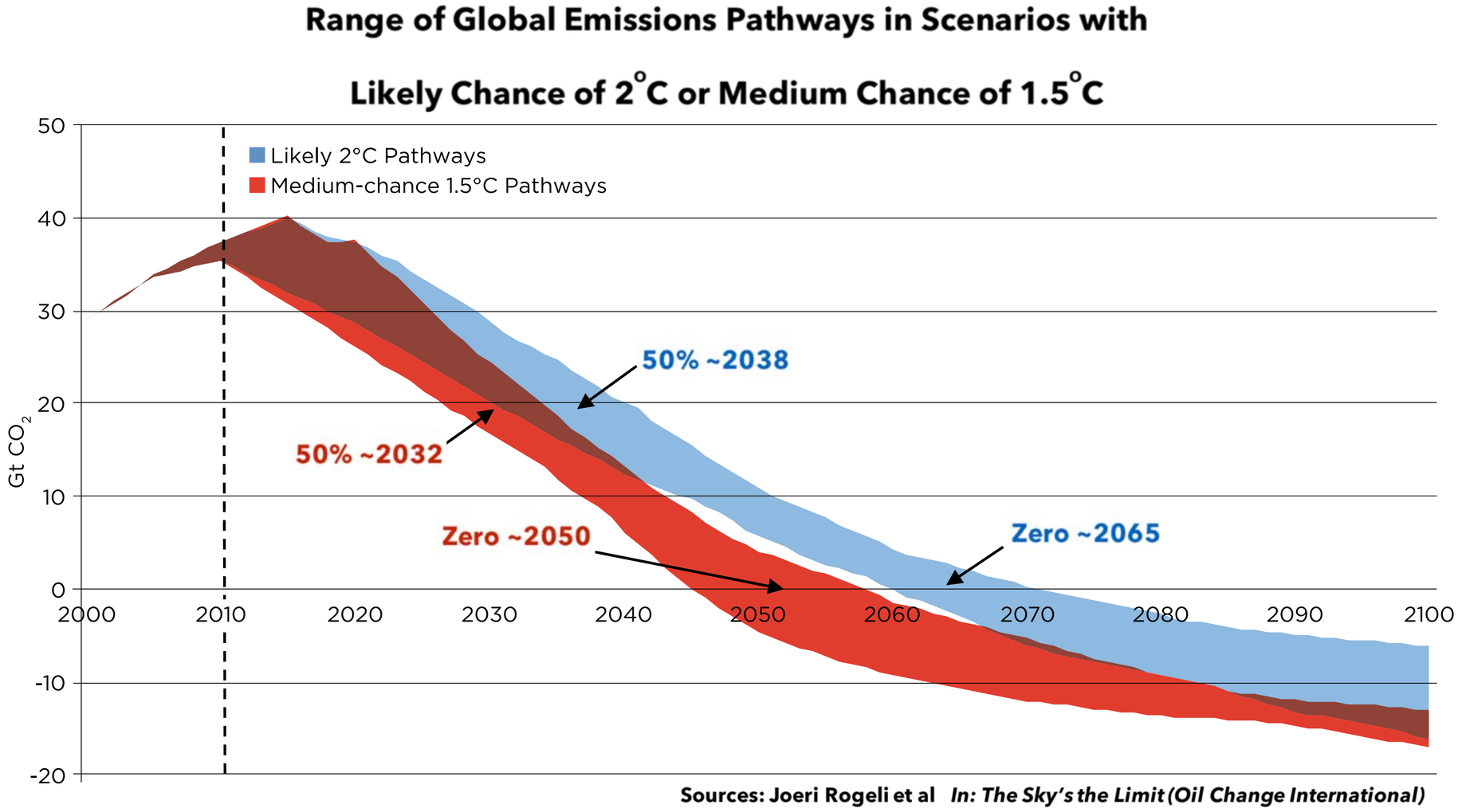


Sources: Joeri Rogeli et al *In: The Sky's the Limit (Oil Change International)*

Paths to Safety

Energy Efficiency Gains

100%

Electrify Everything

100%

Rapid Transition to Zero-Carbon Energy

37%

Natural Climate Solutions (land, agriculture & food)

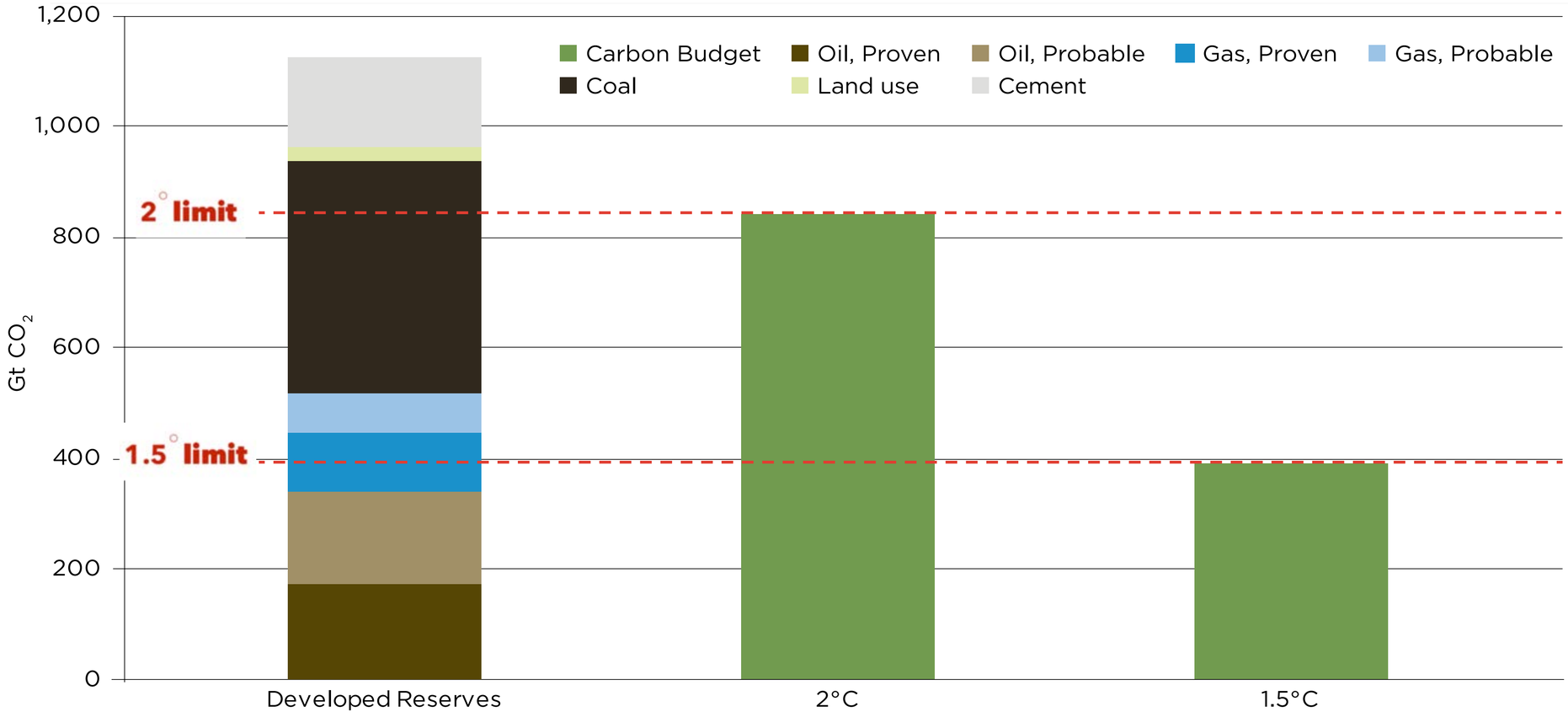
Paths to Safety

The potential carbon emissions from the oil, gas, and coal in the world's currently operating fields and mines would take us beyond 2°C of warming.

The reserves in currently operating oil and gas fields alone, even with no coal, would take the world beyond 1.5°C.

Figu

Emissions from Developed Fossil Fuel Reserves, Plus Projected Land Use and Cement Manufacture



Sources: Sources: Rystad Energy, International Energy Agency (IEA), World Energy Council, Intergovernmental Panel on Climate Change (IPCC)

In: The Sky's the Limit (Oil Change International)

Reality Check

Every Ton Counts

1.5° - 8 years
2.0° - 19 years

- **Carbon budget remaining**

- **Burning 1 liter of oil adds 647 liters of melt water to ocean**

$69
$2,500
$27,000

- **Social Cost per metric ton of CO2, CH4, NO2**

(3% average discount rate, for 2050, in 2007 dollars)

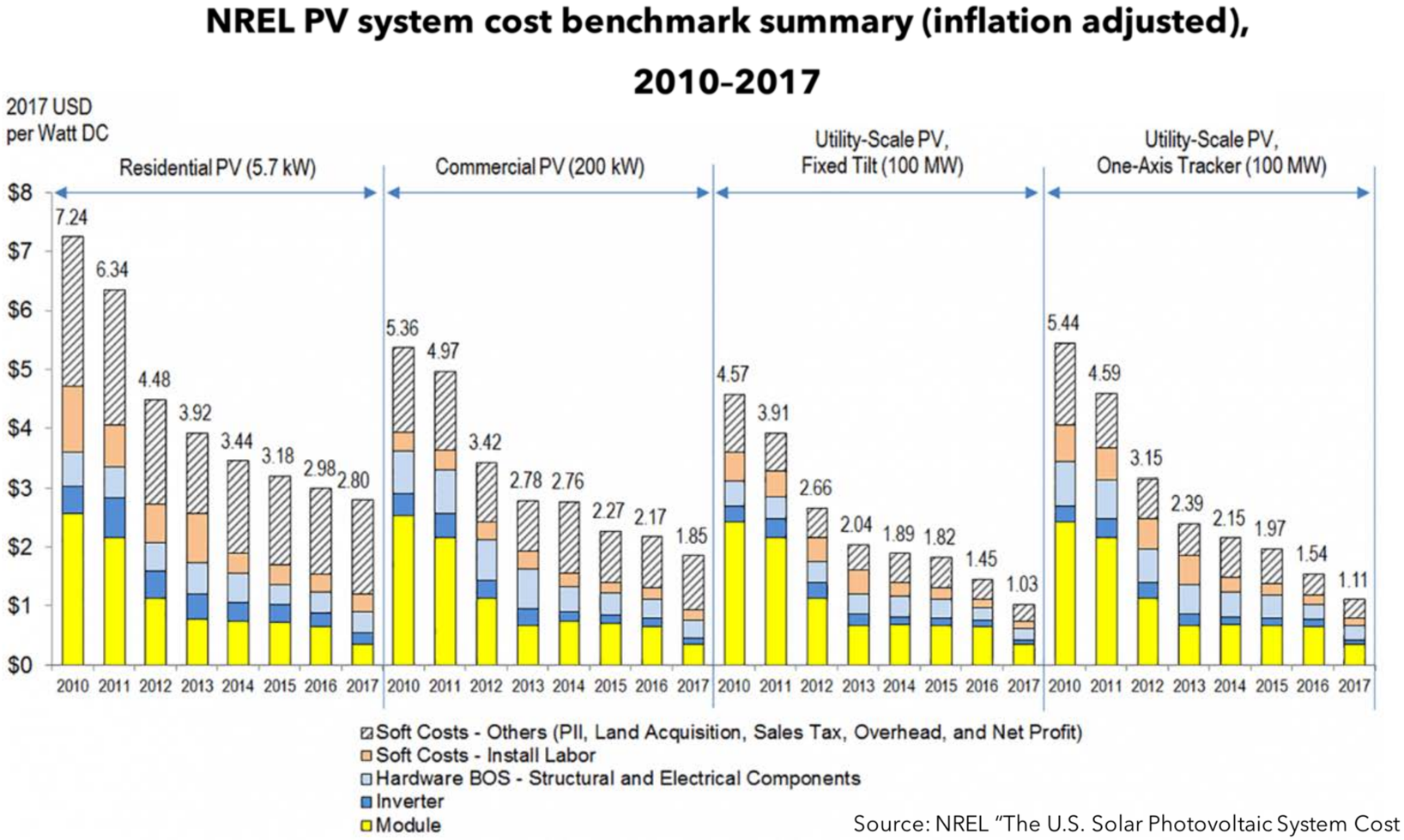
Source: Marzeion et al 2018 *Nature Climate Change*

Source: Strauss 2013 *PNAS*

Source: USEPA 2010 SC-CO_2 TSD


THE HOPEFUL

Solar PV costs ~80% lower since 2009



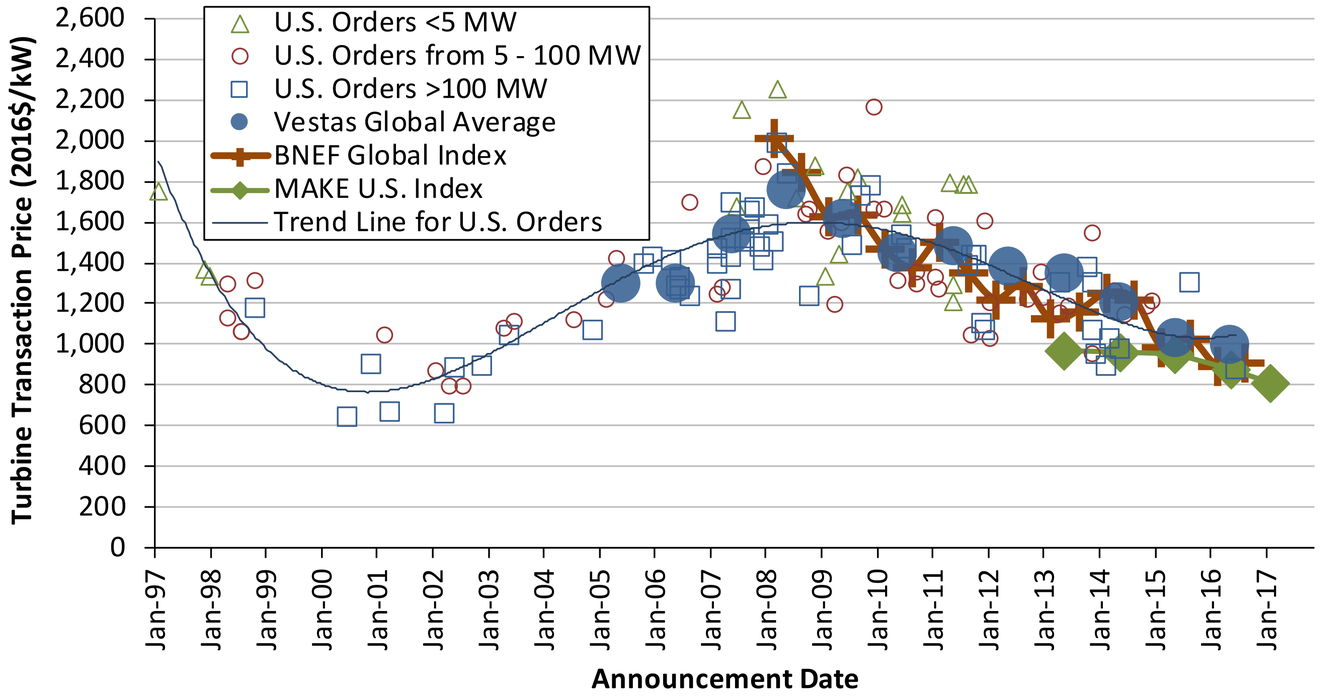
Source: NREL "The U.S. Solar Photovoltaic System Cost Benchmark: Q1 2017

Renewable Revolution

Solar PV costs ~80% lower since 2009

Wind price declines of as much as 50% since late 2008

Reported wind turbine transaction prices over time



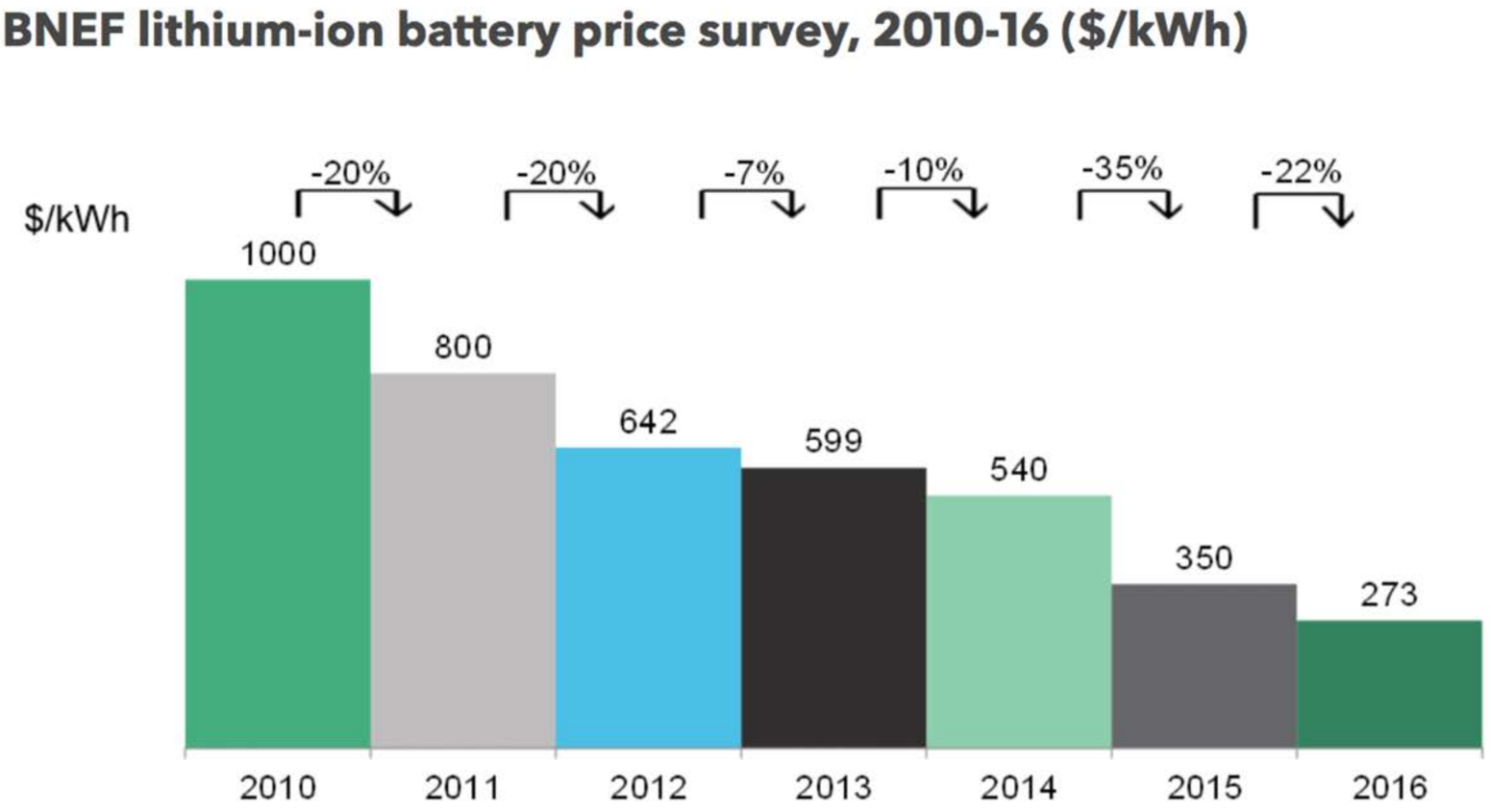
Source: US DOE 2016 Wind Technologies Market Report

Renewable Revolution

Solar PV costs ~80% lower since 2009

Wind price declines of as much as 50% since late 2008

Li-ion battery price declines of 75% since 2010



Renewable Revolution

Source: Bloomberg New Energy Finance (BNEF)

Renewable Revolution

"Electricity from renewables will soon be consistently cheaper than from most fossil fuels."

"By 2020, all the renewable power generation technologies that are now in commercial use are expected to fall within the fossil fuel-fired cost range, with most at the lower end or undercutting fossil fuels."

-International Renewable Energy Agency

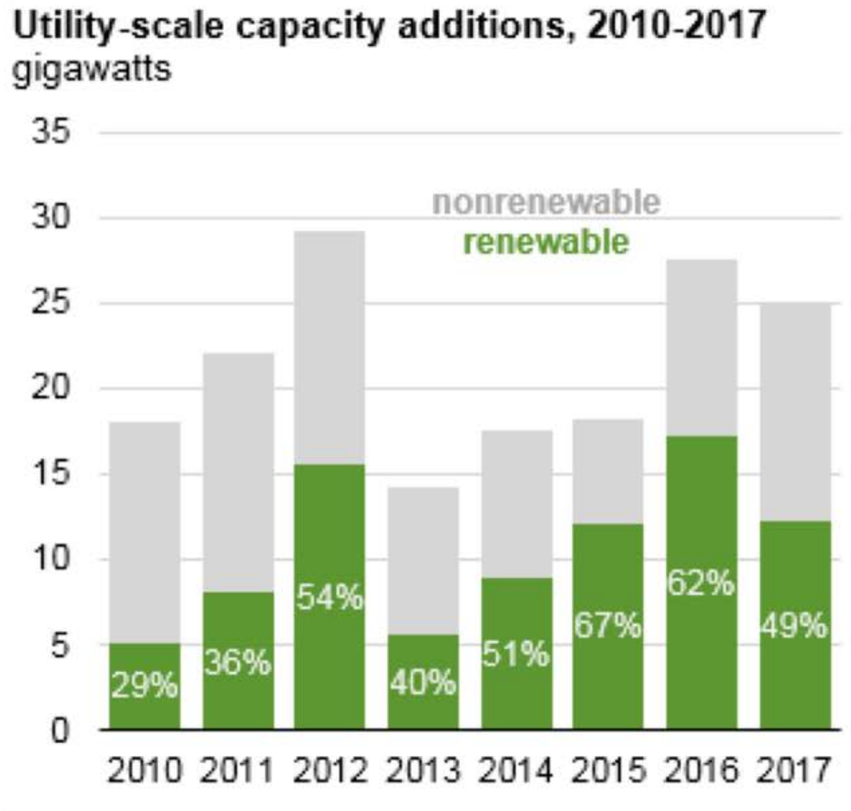
Renewable Energy Generation Costs 2017 Report

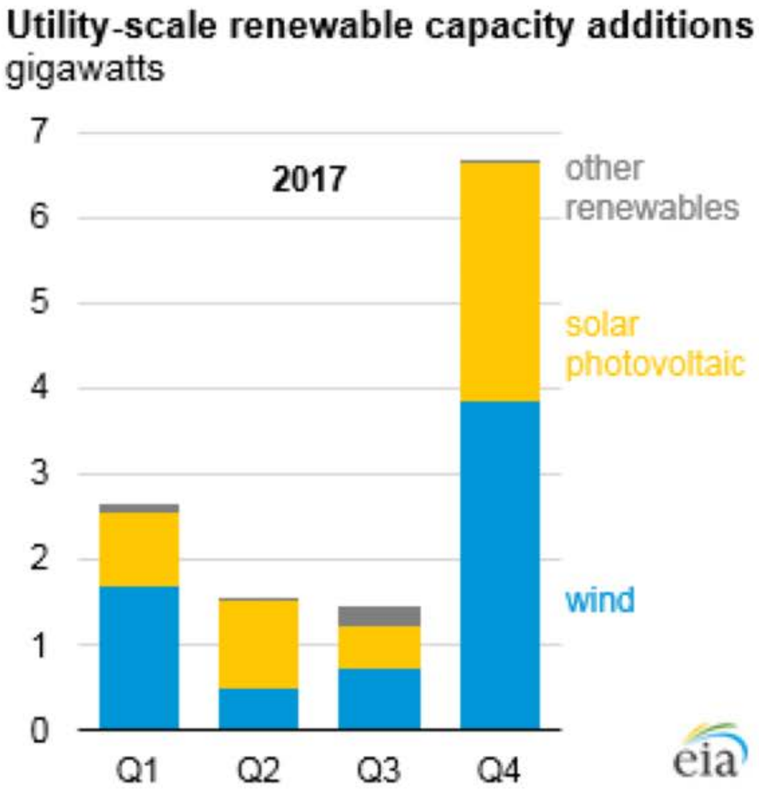
2017, Colorado :
Median bid for new wind + storage appears to be lower than the operating cost of all coal plants in CO

Median new solar + storage bid could be lower than 74% of operating coal capacity

Renewable Revolution

Renewables are majority of new utility-scale additions over past 5 years

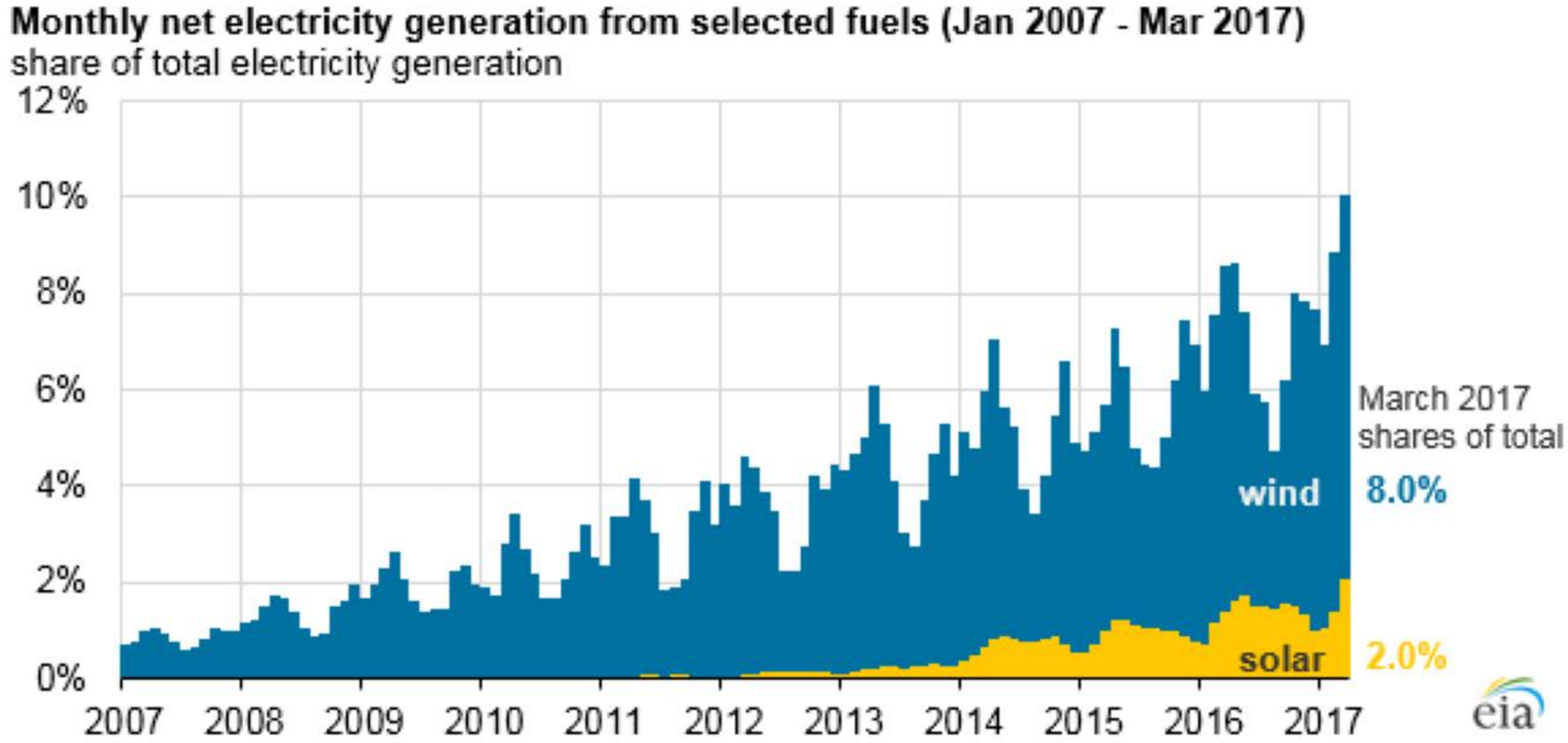




Getting to 100%

Source: U.S. Energy Information Administration, Form EIA-860M Preliminary Monthly Electric Generator Inventory

Wind & Solar electricity generation reached 10% for the first time (March 2017)



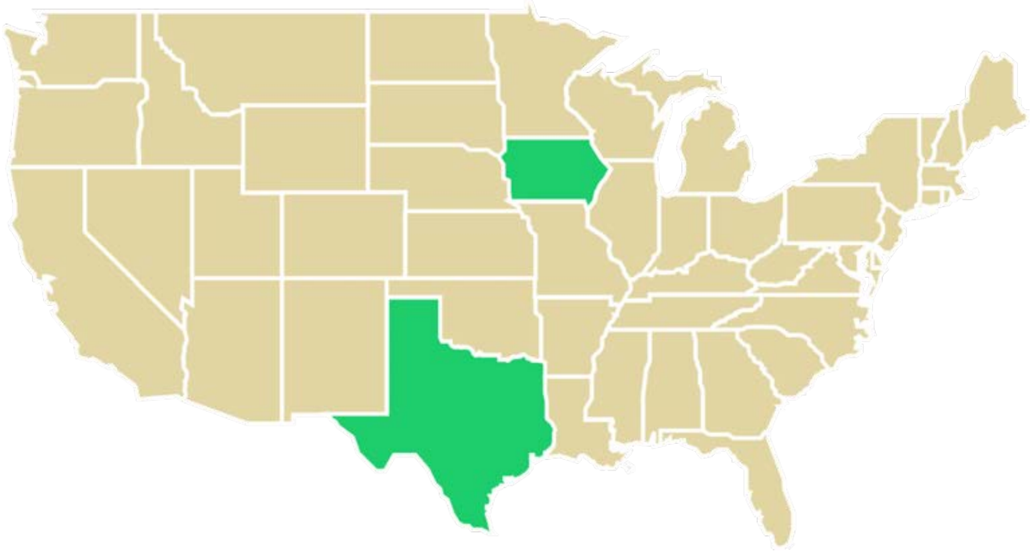
Milestones

Source: U.S. Energy Information Administration, Electric Power Monthly

Texas generated more wind and solar energy than any other state, nearly all of which came from wind.

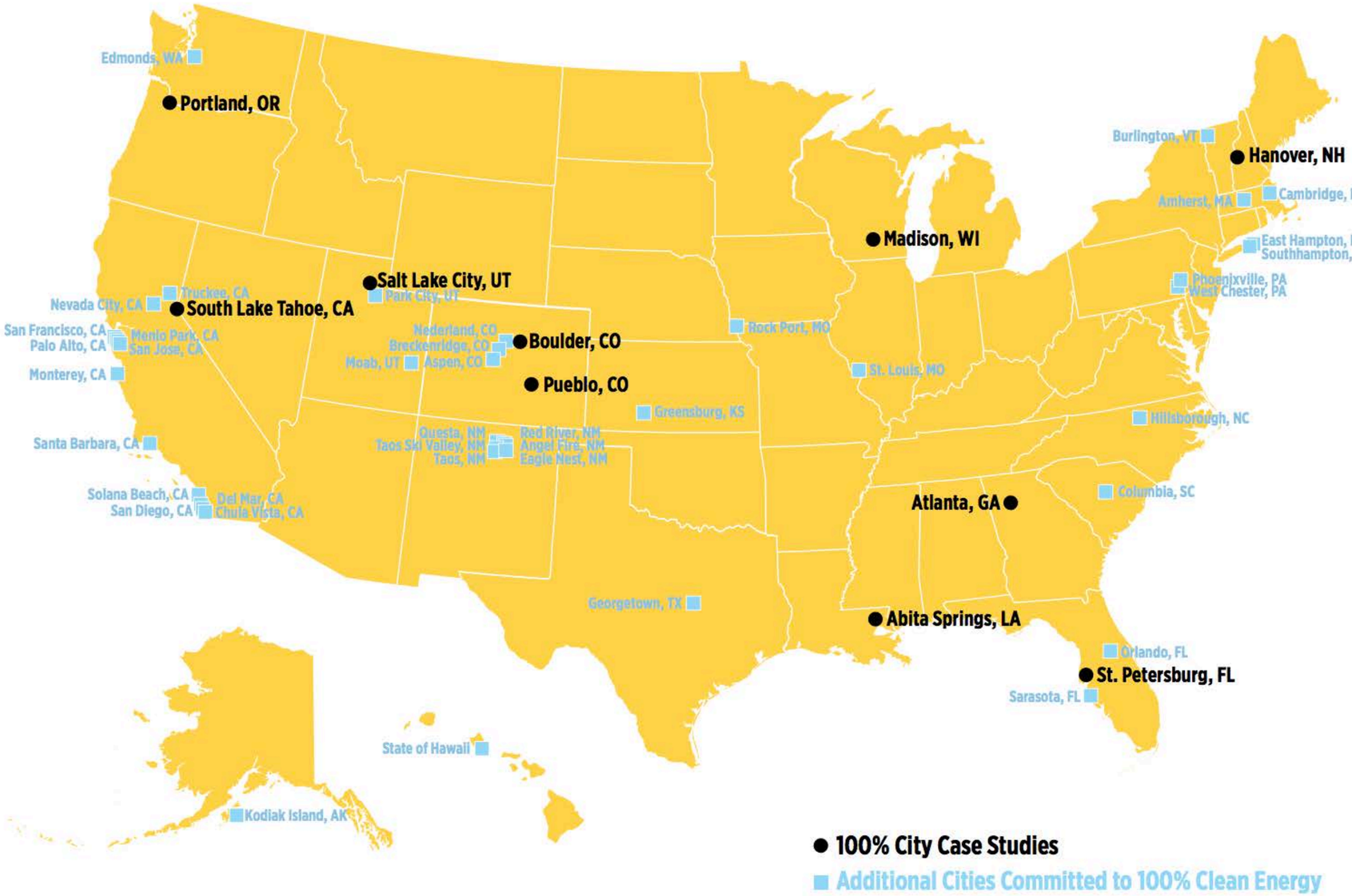
37%

Over a third of Iowa's energy now comes from wind and solar power.



Getting to 100%

Committed to 100% RE



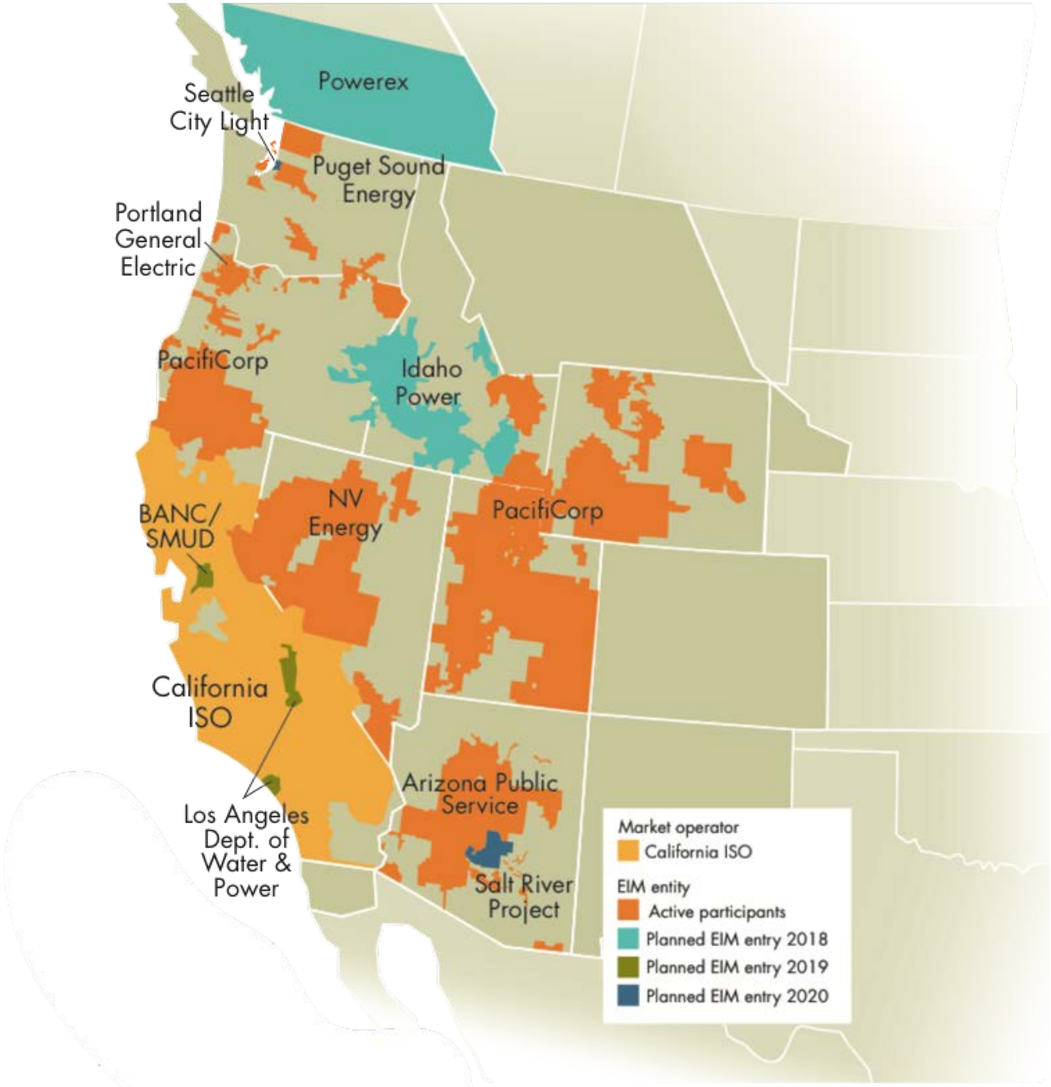
Getting to 100%

image: Sierra Club

CISO and PacifiCorp launched the western Energy Imbalance Market in 2014 to balance energy supply with demand in real time and across six western states.

67%

On 13 May 2017, California Independent System Operator got 67.2 percent of its energy from renewables

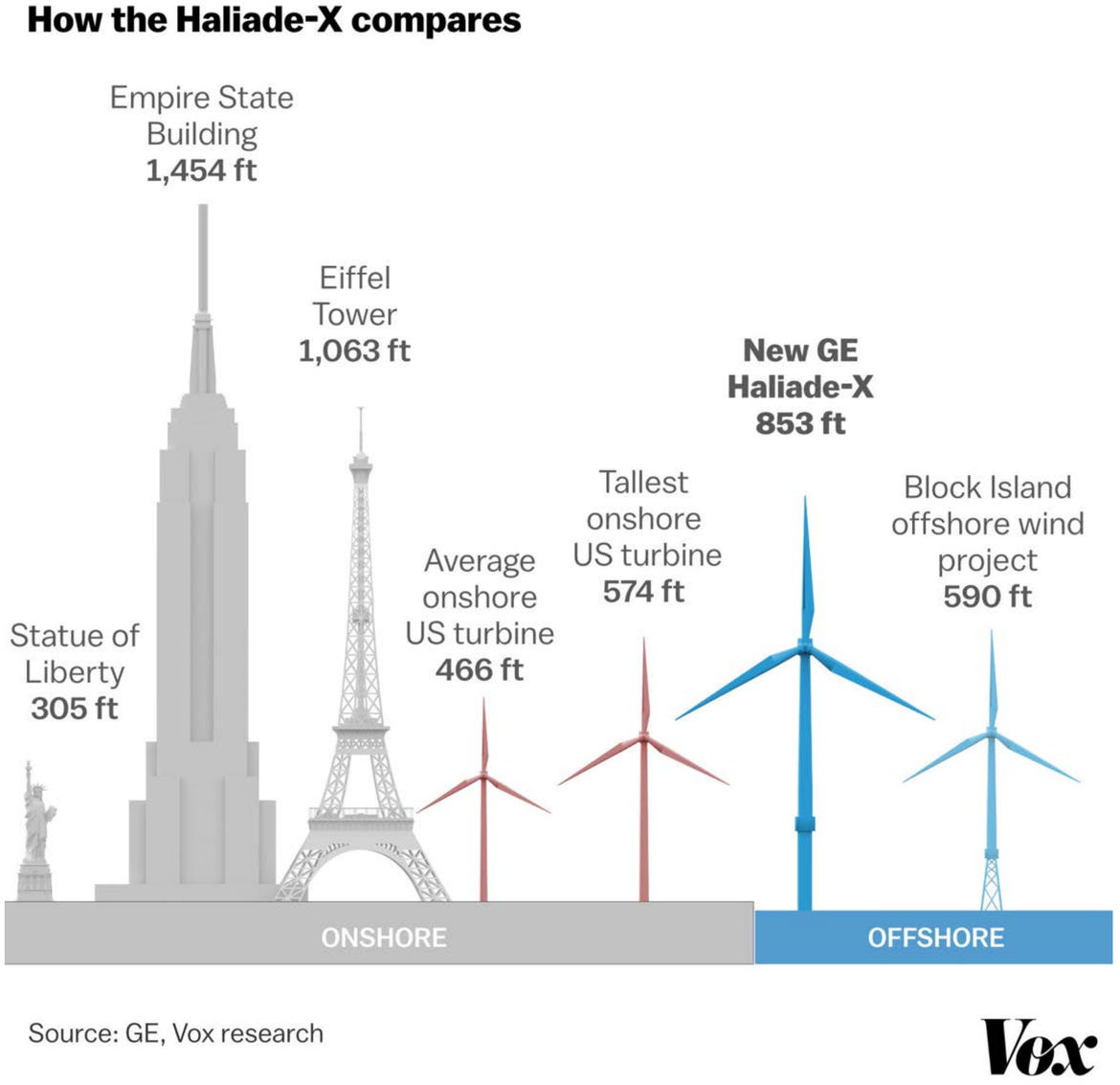


Getting to 100%

Balancing the Grid

60%

Expected capacity factor of new 12MW offshore turbines provide "less-variable" renewable energy



Getting to 100%

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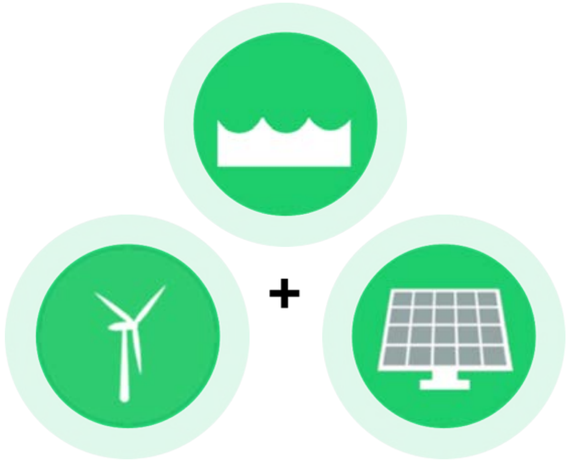
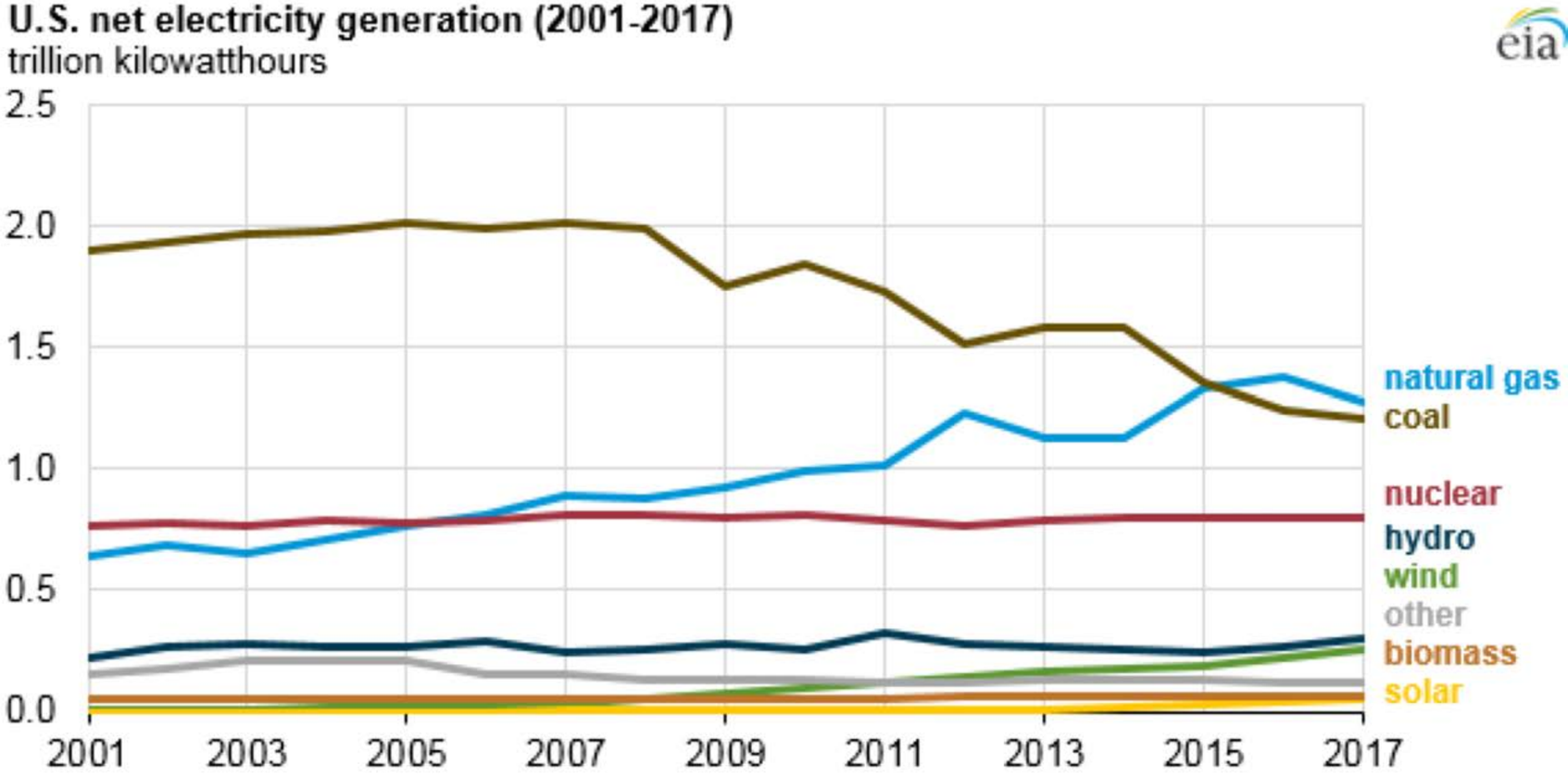


Renewable generation ~15% in 2017

It will take us >100 years to get to 100% at the current build rate…

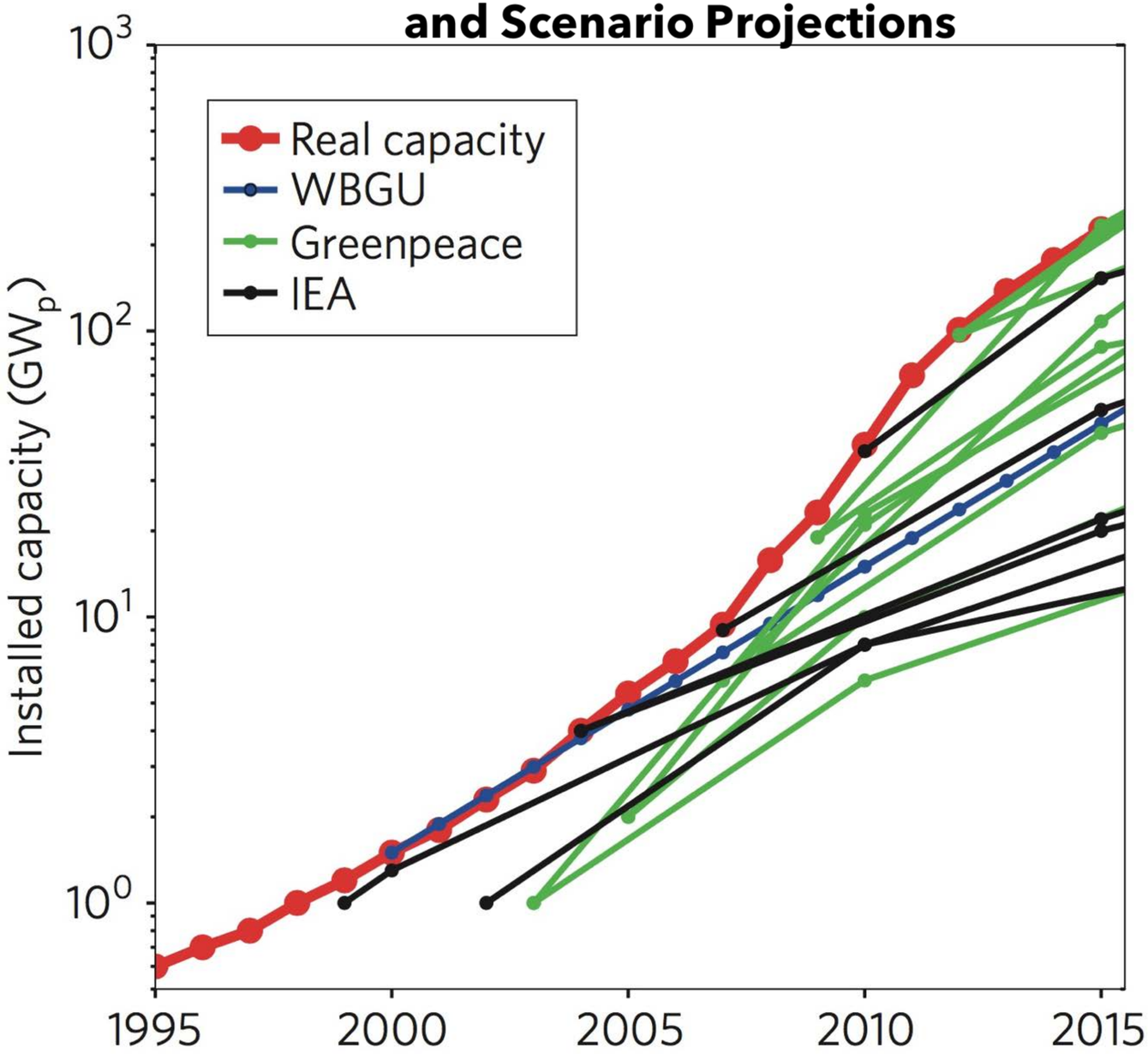


Reality Check

Predictions have repeatedly fallen far short of the rise of solar photovoltaic (PV) energy

Reality Check

Growth in PV Capacity and Scenario Projections



Creutzig et al 2017 *Nature Energy*

THE SMART

Per unit energy, renewable energy generally has a greater direct footprint than extractive energy.

Energy Sprawl

Trainor et al 2016, PLoS ONE

Energy Sprawl

Per unit energy, renewable energy generally has a greater direct footprint than extractive energy.

Projected footprint of renewables is small compared to fossils and biomass…but not if we achieve 100% RE

Trainor et al 2016, PLoS ONE

Ivanpah Concentrated Solar

Energy Sprawl

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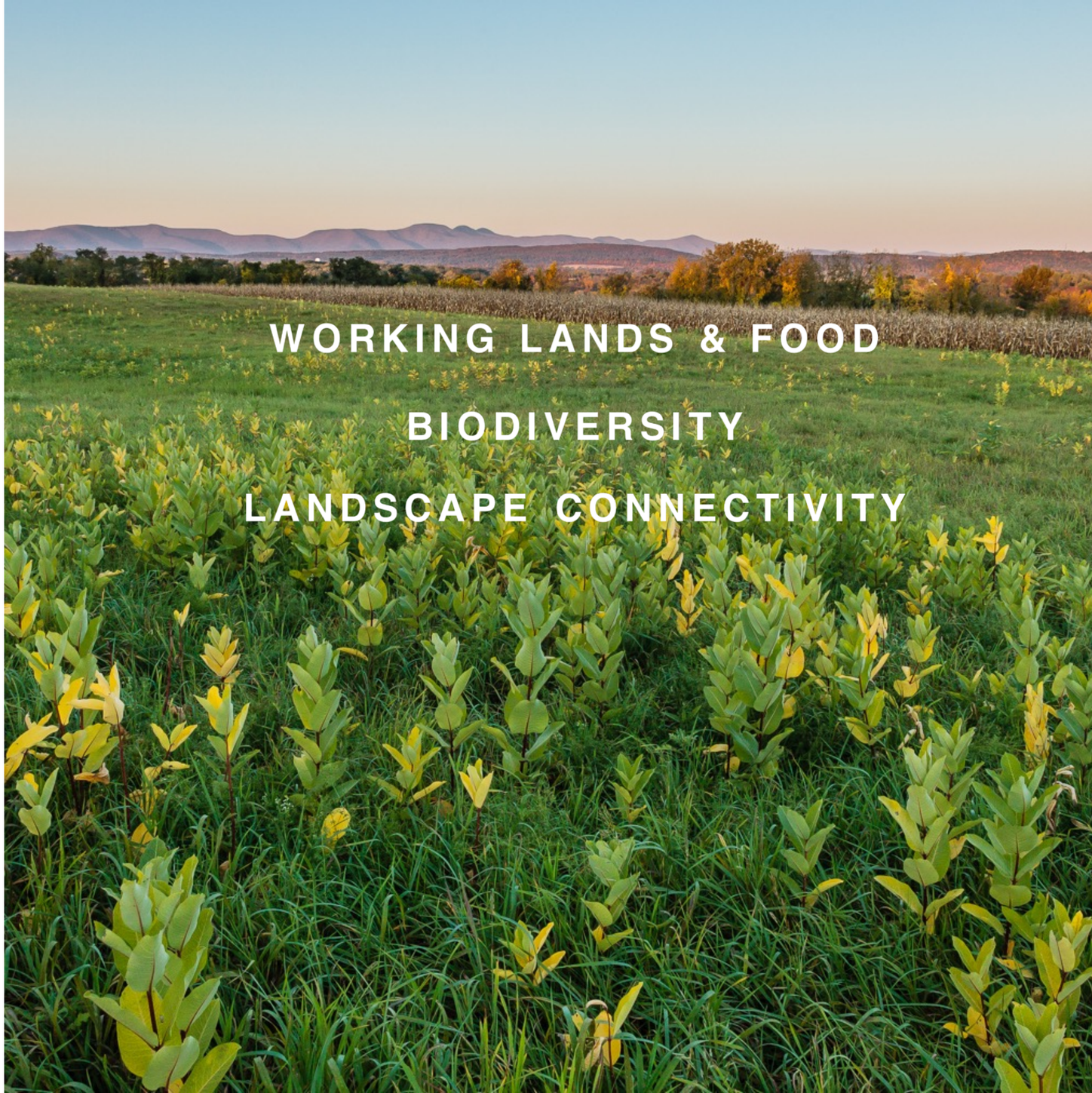
Trainor et al 2016, PLoS ONE

Our Challenge

How do we reconcile the need to develop renewable energy projects with our need to protect wildlife, natural resources, and other valued assets over the long-term?



- Solar or Wind Resource

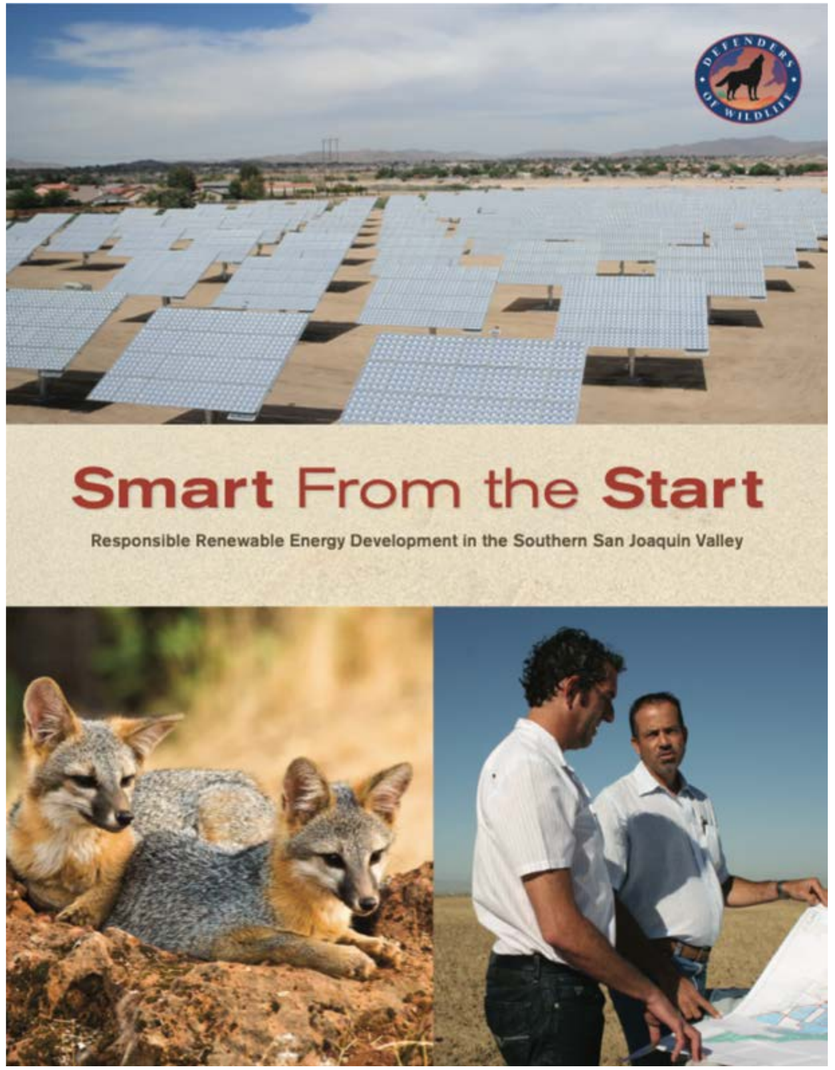
- Existing or Planned Transmission

- Proximity to Market

Old Paradigm to Siting

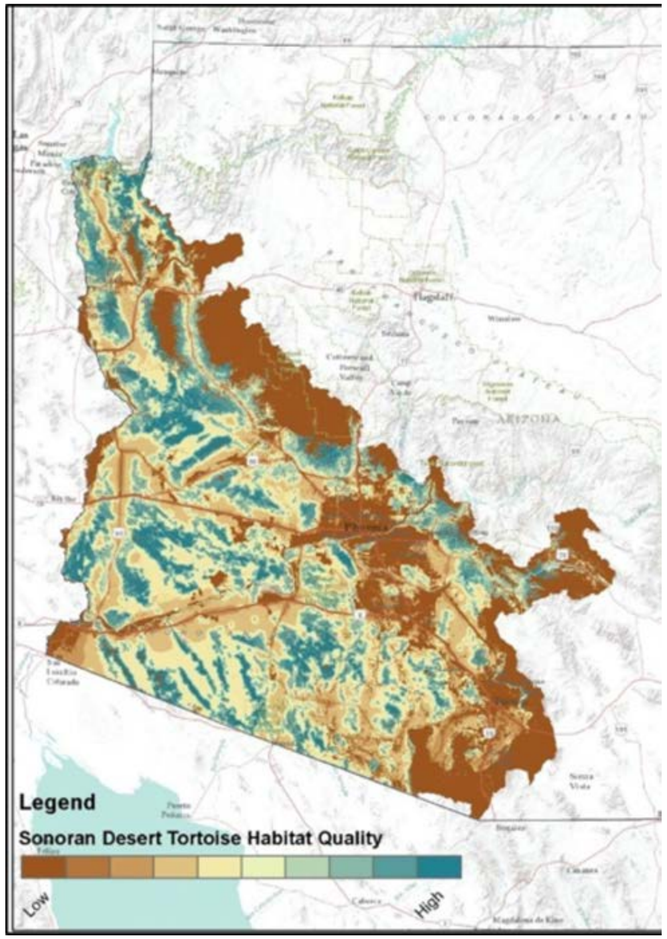
- **ENGAGE diverse range of stakeholders**
- **AVOID lands with highest natural resource conflicts (e.g., endangered species, migratory corridors, important habitat)**
- **DIRECT development to lands with lower resource conflicts and renewable energy potential**
- **MITIGATE impacts fully**

Smart From the Start

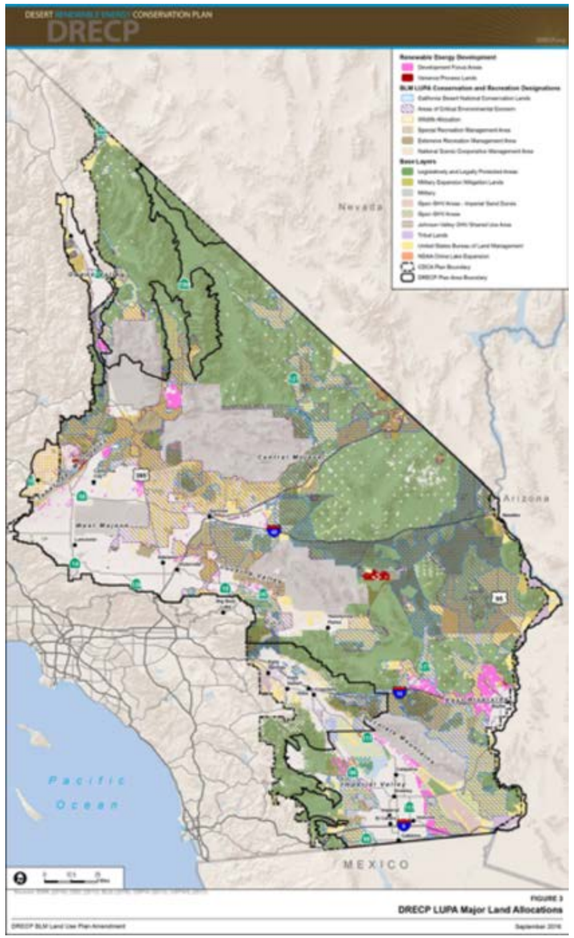


A strategic approach to planning, siting, and operating renewable energy projects.

SCIENCE BASED



LANDSCAPE SCALE



INDUSTRY FRIENDLY

res AMERICAS powering change
LSA LARGE-SCALE SOLAR ASSOCIATION
AWEA AMERICAN WIND ENERGY ASSOCIATION
IBERDROLA
First Solar
SunEdison simplifying solar
Invenergy

Smart From the Start

DEFENDERS OF WILDLIFE
The Nature Conservancy
NRDC THE EARTH'S BEST DEFENSE
THE WILDERNESS SOCIETY

- Solar or Wind Resource

- Existing or Planned Transmission

- Proximity to Market

- Direct Impacts

- Habitat Quality

- Landscape Connectivity

Smart From the Start

FWS Mitigation Policies

BLM Solar Program

Wind & Solar Leasing Rule

BLM Planning 2.0

DOE Wind Vision

DRECP

Smart From the Start

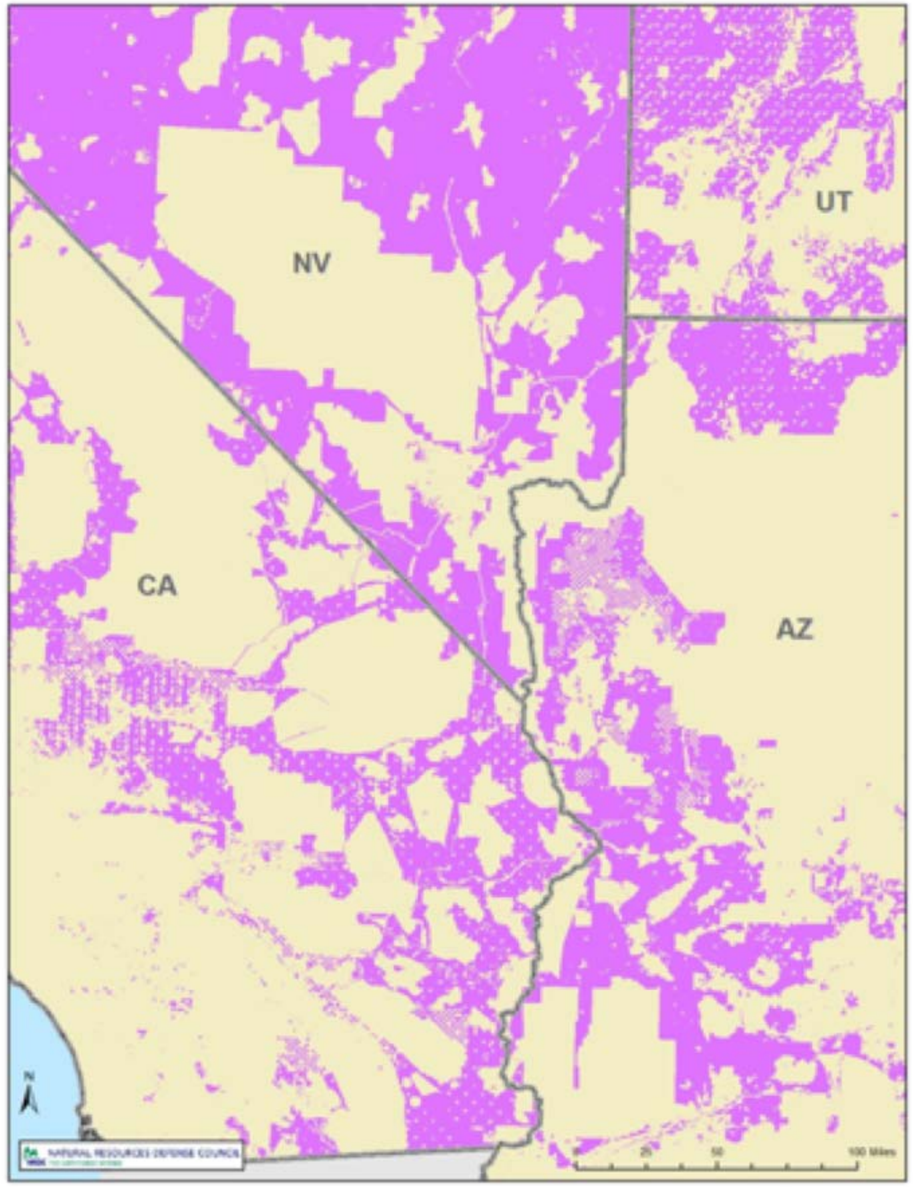
Directed Development Federal Rules & Policies for Renewable Power Infrastructure

700,000 acres of designated leasing areas on public lands across 6 southwestern states.

pre 2011

80+ million acres

No consideration of impacts to wildlife or landscape connectivity



Directed Solar Development

pre 2011

80+ million acres

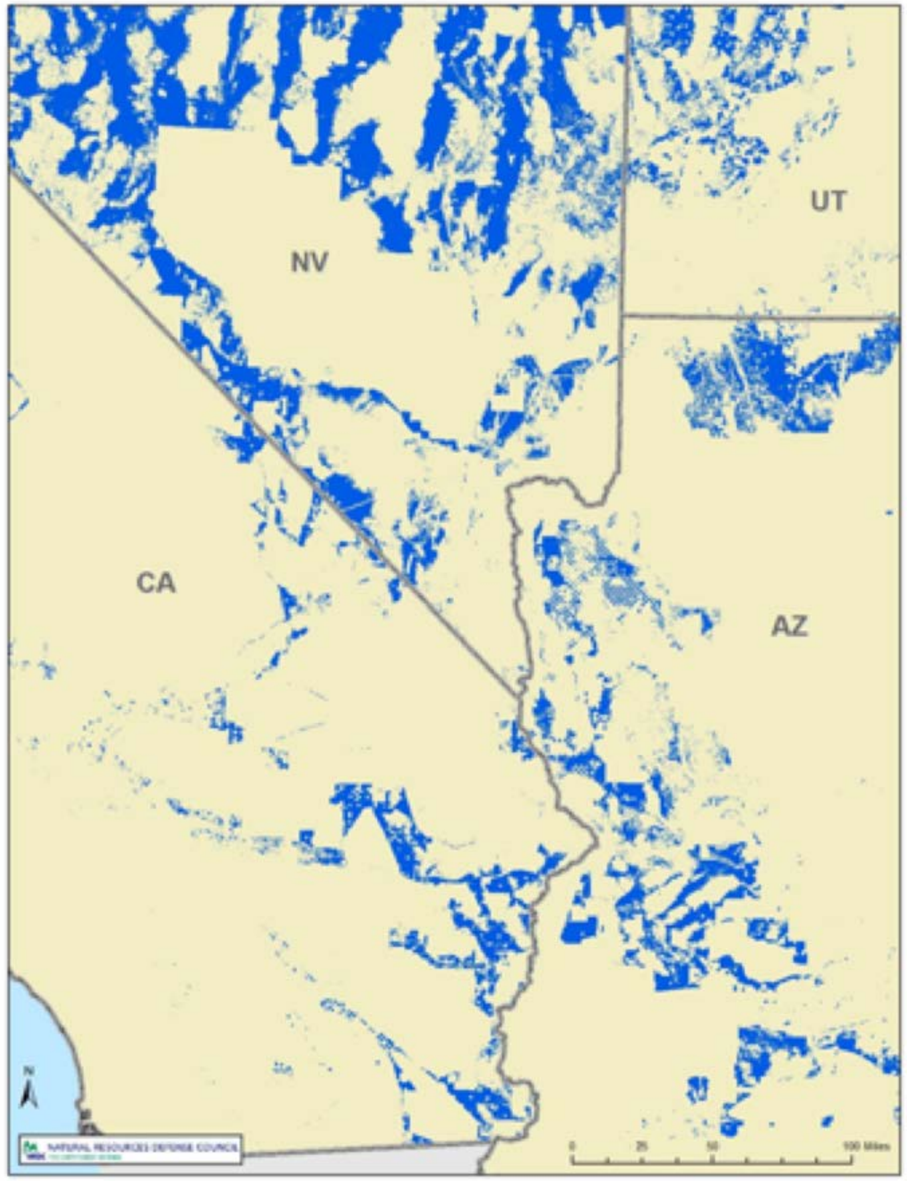
No consideration of impacts to wildlife or landscape connectivity

2011

22 million acres open

Directed to high solar potential

Poor safeguards for wildlife



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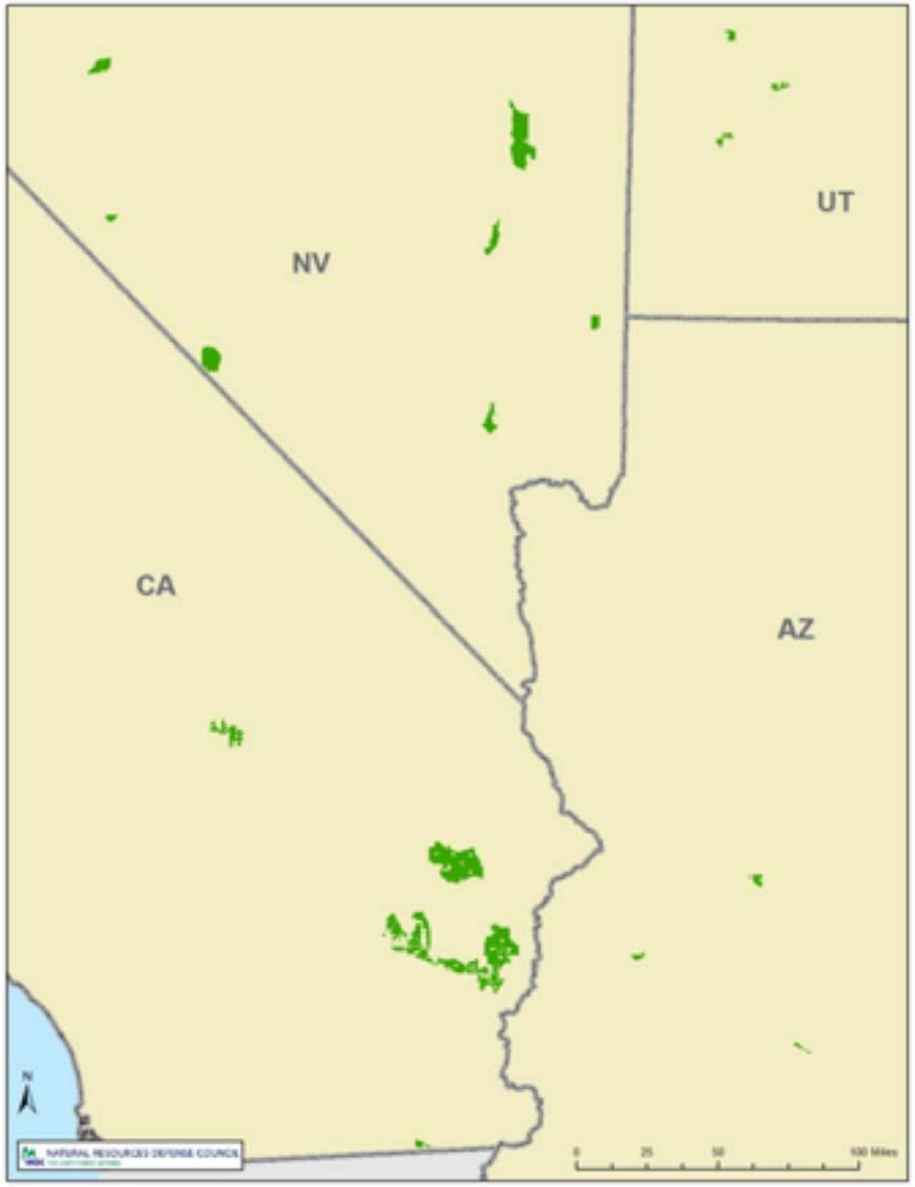
2012

687,000 acres open

24 Solar Energy Zones

Reduced wildlife impacts (still some)



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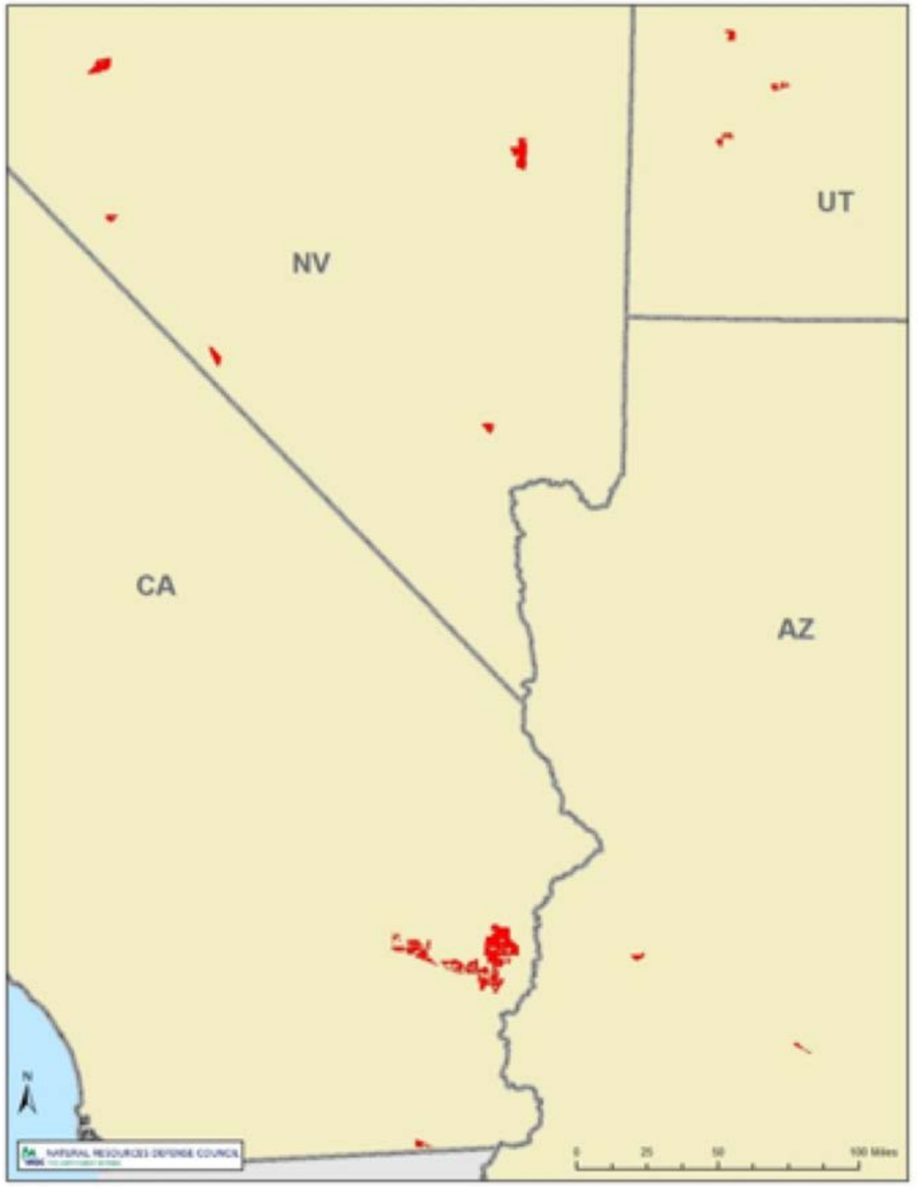
Reduced wildlife impacts (still some)

NOW

285,000 acres open

17 Solar Zones - 57 GW of energy potential

Critical habitat areas dropped



Directed Solar Development

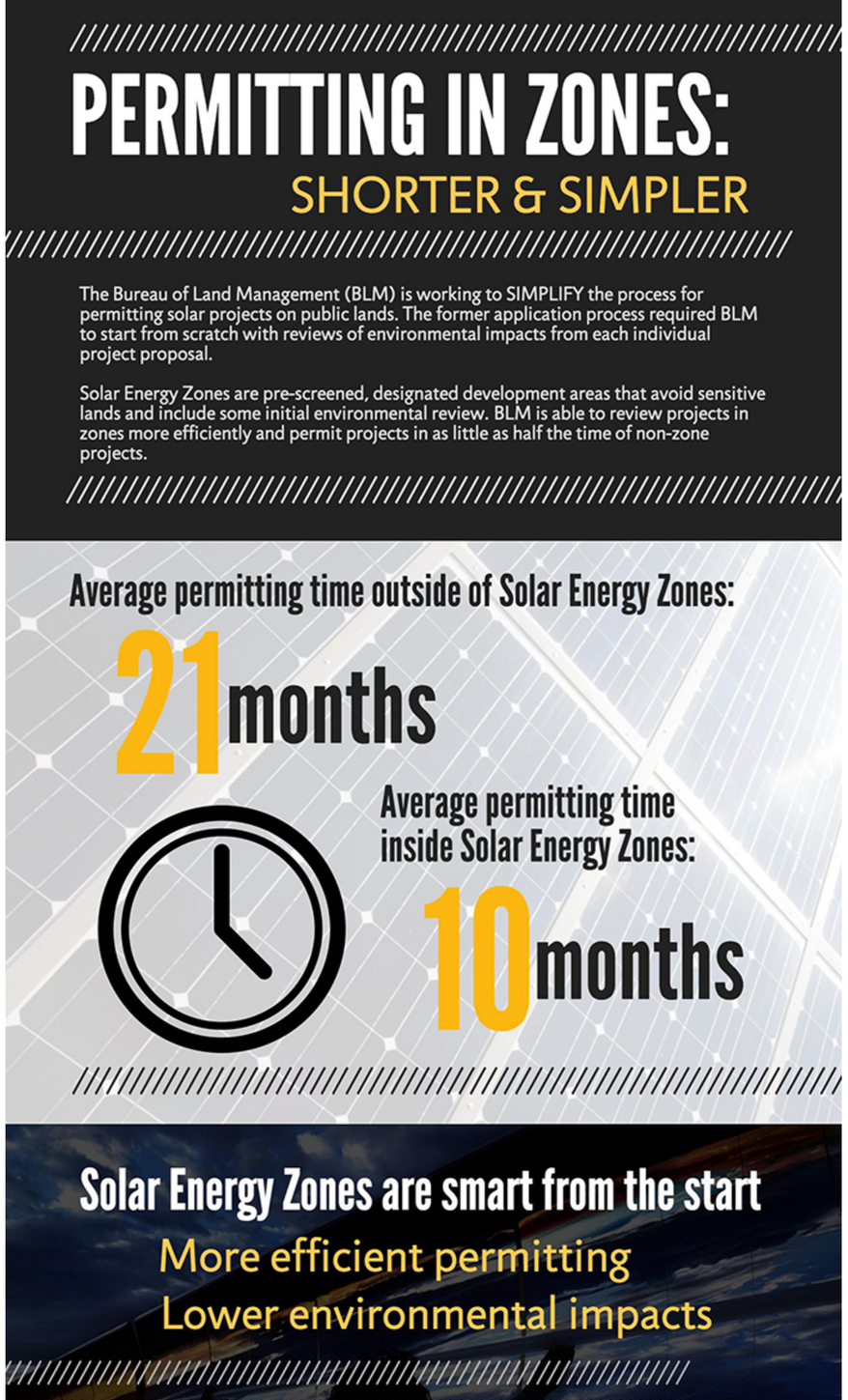
Smart From the Start

Shorter and Simpler Permitting

Reduced Soft Costs & Uncertainty

Lower Environmental Impacts

Broader Stakeholder Buy-in



Smart From the Start

Shorter and Simpler Permitting

Reduced Soft Costs & Uncertainty

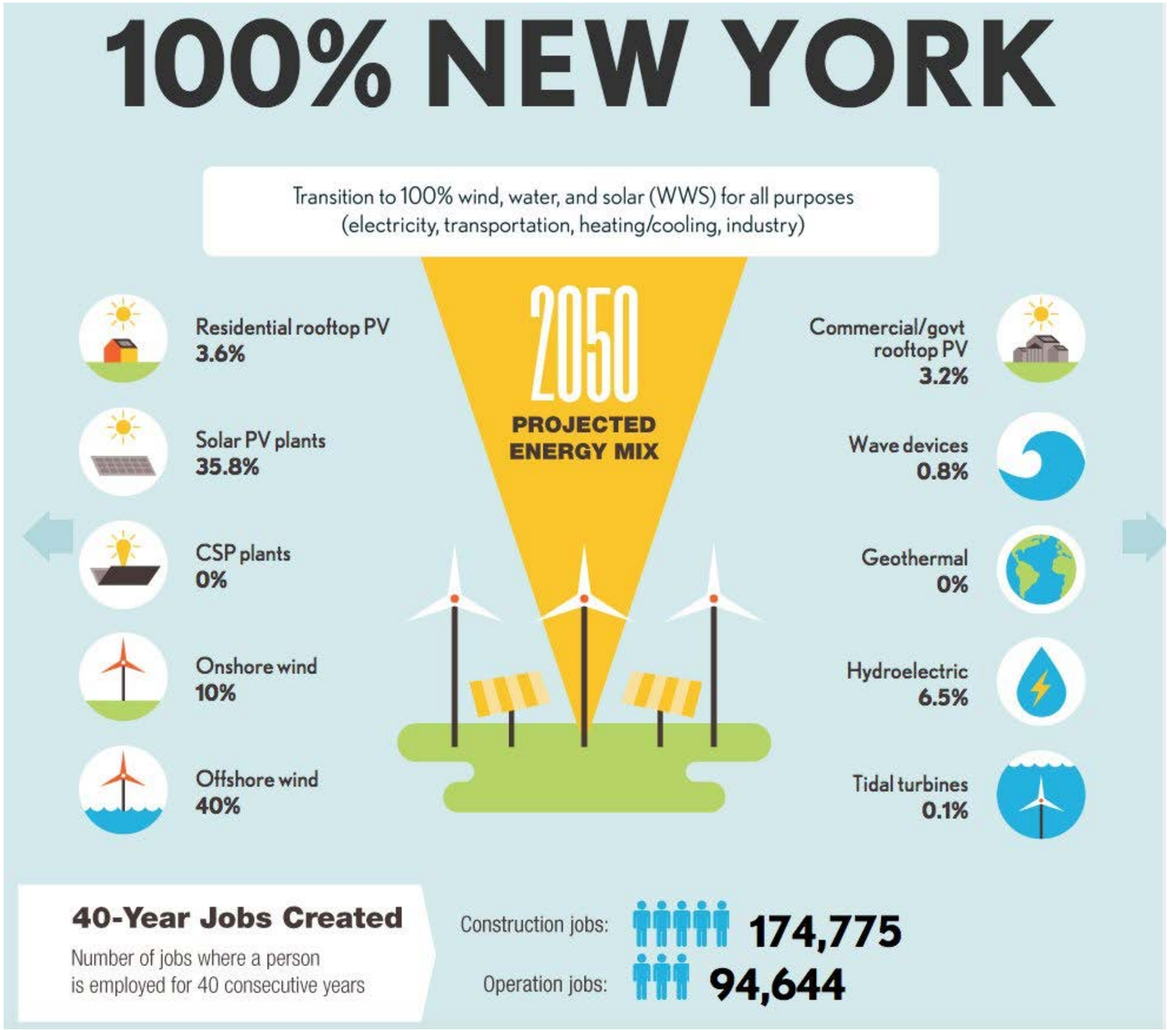
Lower Environmental Impacts

Broader Stakeholder Buy-in

Dry Lake Solar Zone, Nevada

The Opportunity

- **Accelerate the pace of renewable energy projects within New York and the Hudson Valley**
- **Take a Smart from the Start approach to achieve a vision for renewable energy**



Source: NYSERDA

Source: World Economic Forum