Mike Snead
President
Spacefaring Institute LLC

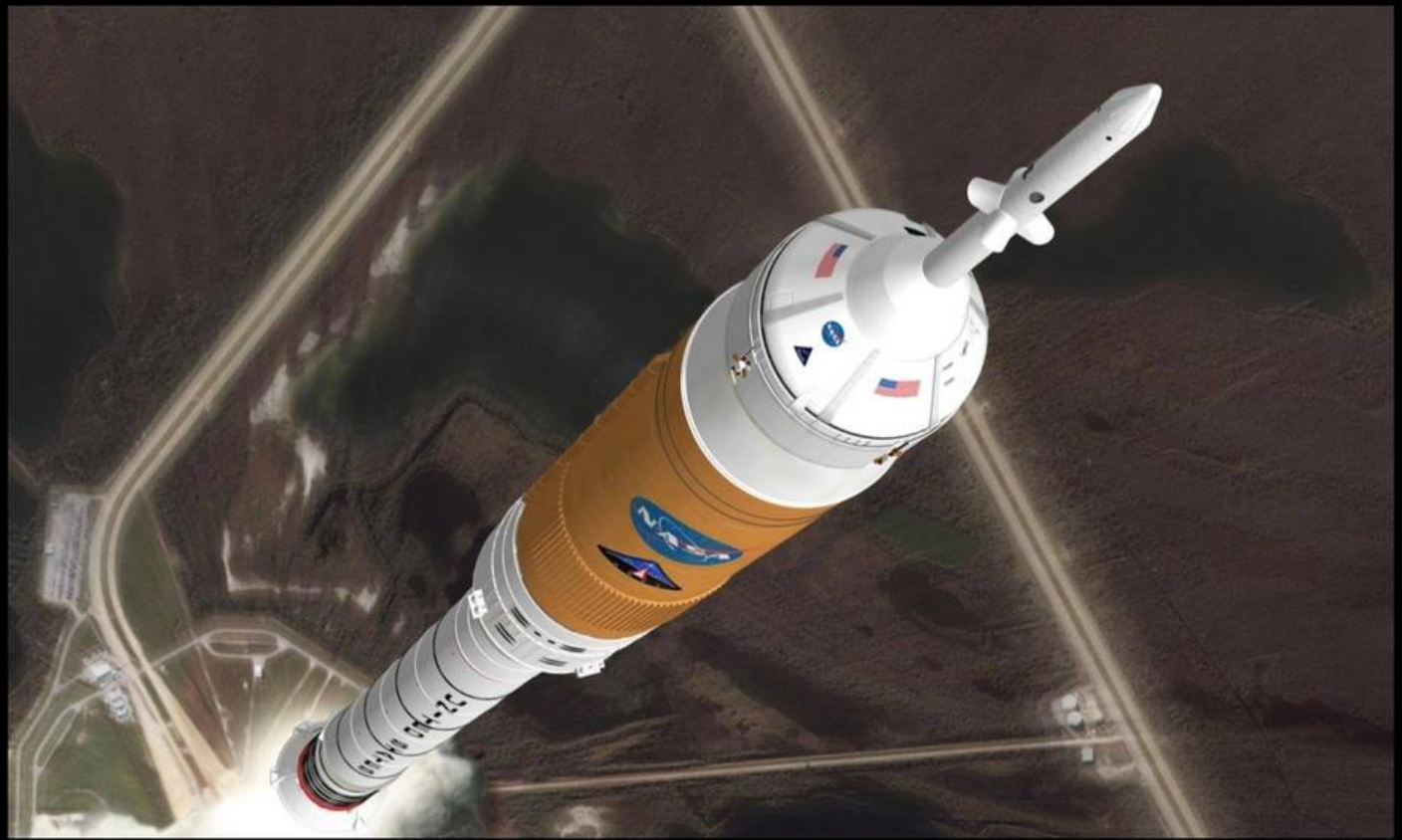
Energy, SSP, and Jumpstarting America's Spacefaring Future

Why America's Pro-Human Spacefaring Community Should Strongly Advocate Starting Commercial Development of Space Solar Power

As the Space Shuttle era ends, America's human spacefaring enterprise is at a critical point

Without proactive change, America's human spacefaring future is in doubt

America must change course away from the prominence of only NASA human space exploration …

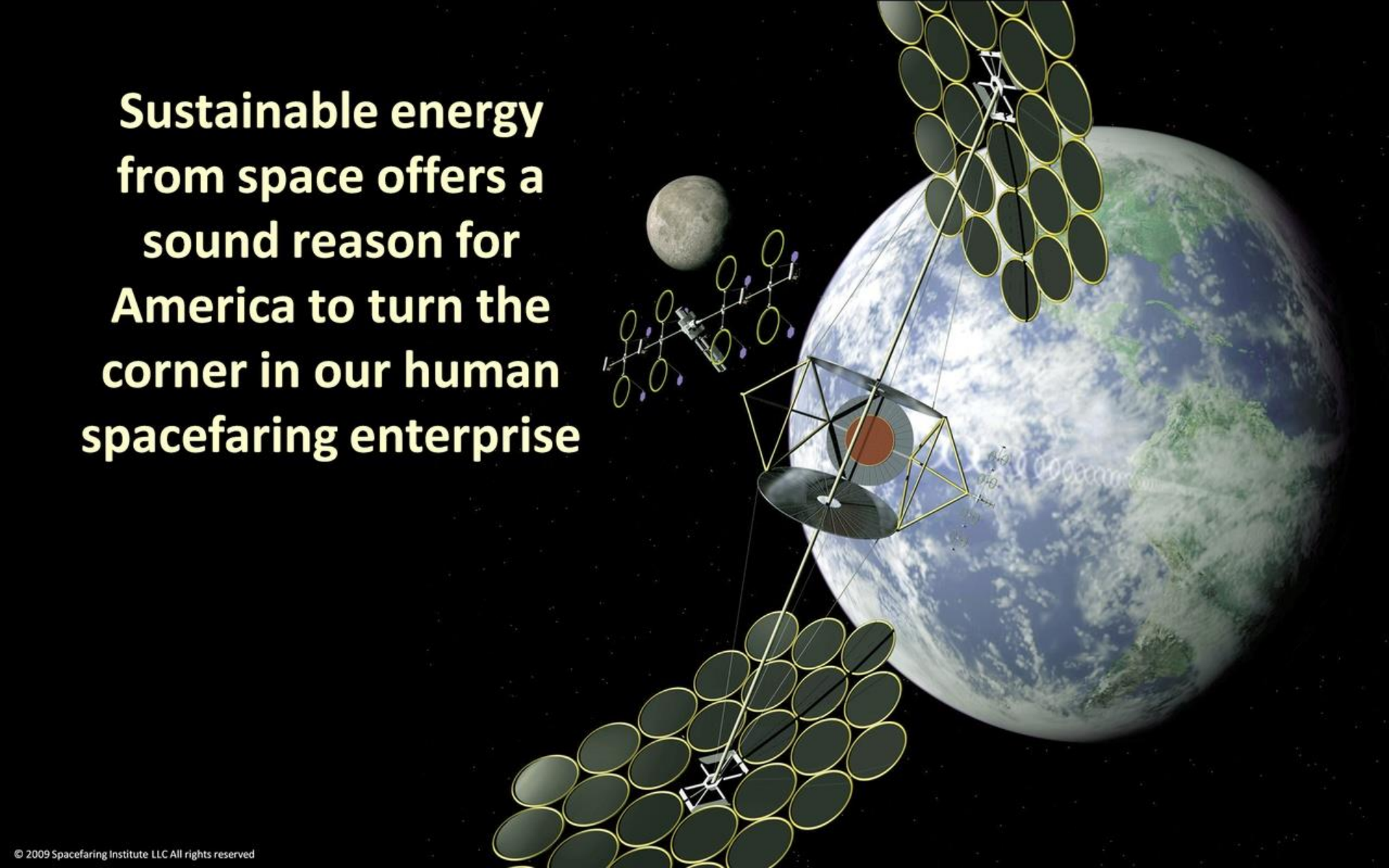


… to a better course that will transform America into a true spacefaring nation

America and the world are facing a serious shortage of energy – a situation that must be addressed

America needs a well-reasoned and executable sustainable energy strategy

Sustainable energy from space offers a sound reason for America to turn the corner in our human spacefaring enterprise

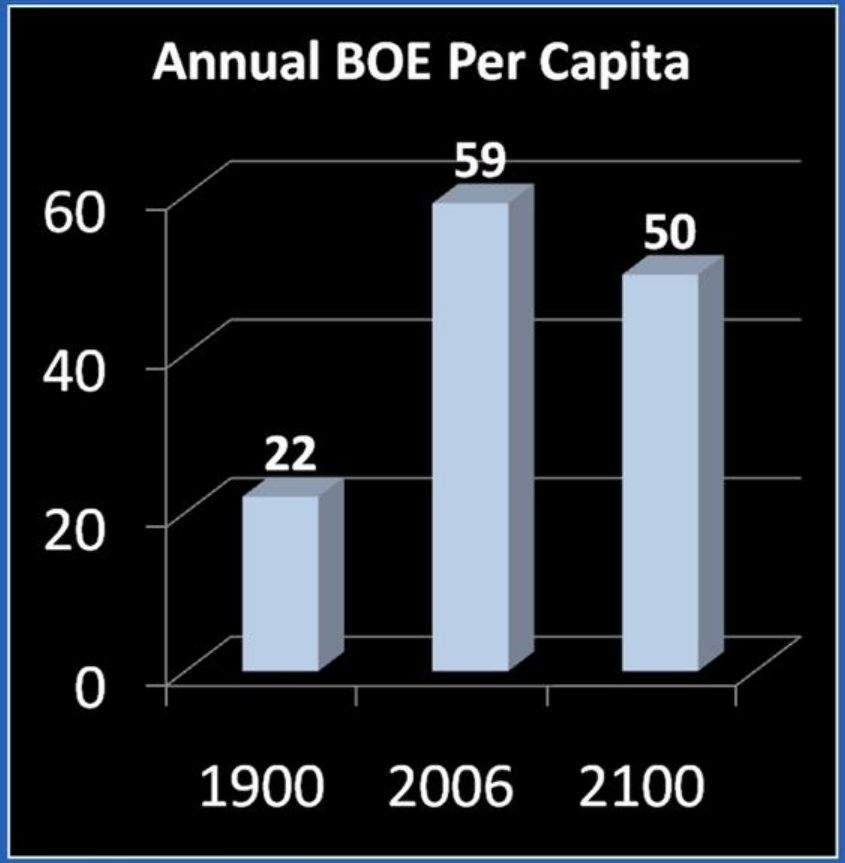


A standard energy unit is the barrel of oil equivalent or BOE

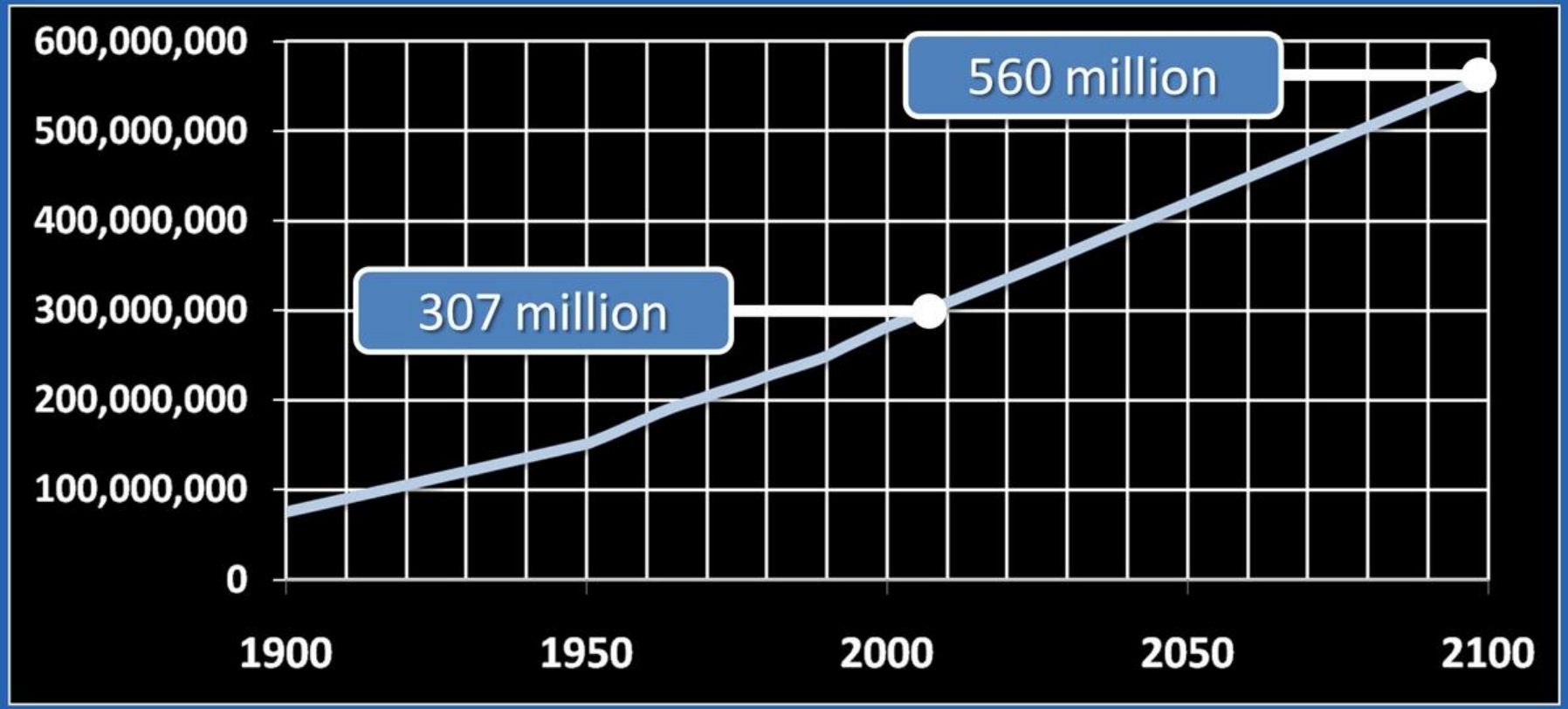
- Standard Oil's "blue barrel"
- Industry standard
- Holds 42 gallons of oil
- 5,800,000 BTU in BOE

Mulberry St., New York City, 1900

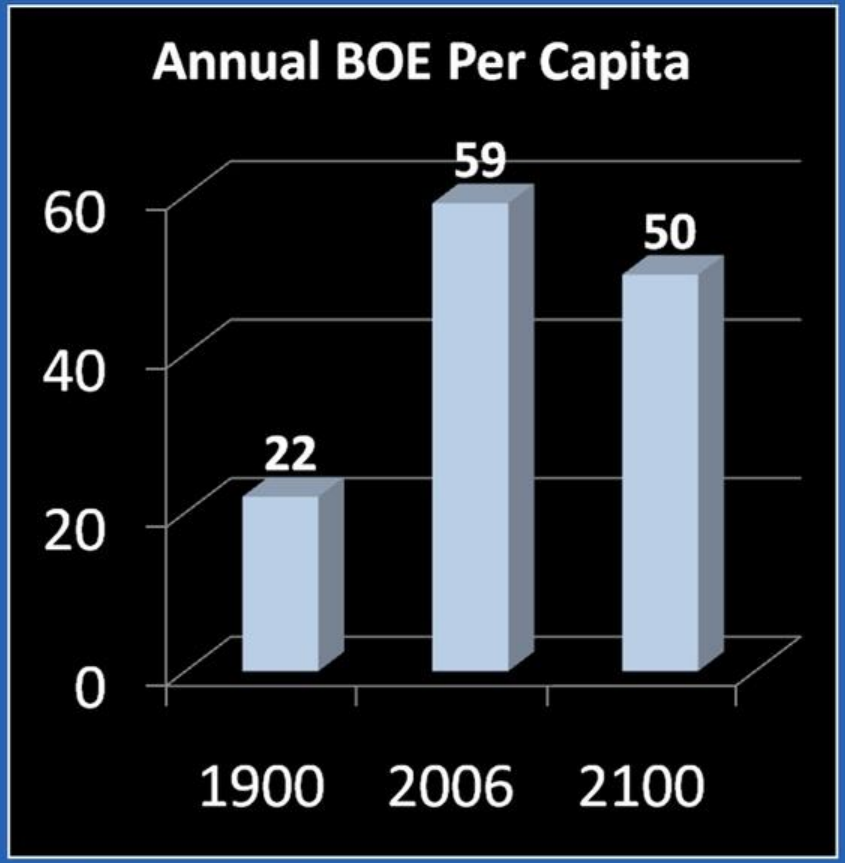
U.S. per capita energy use is closely tied to our standard of living

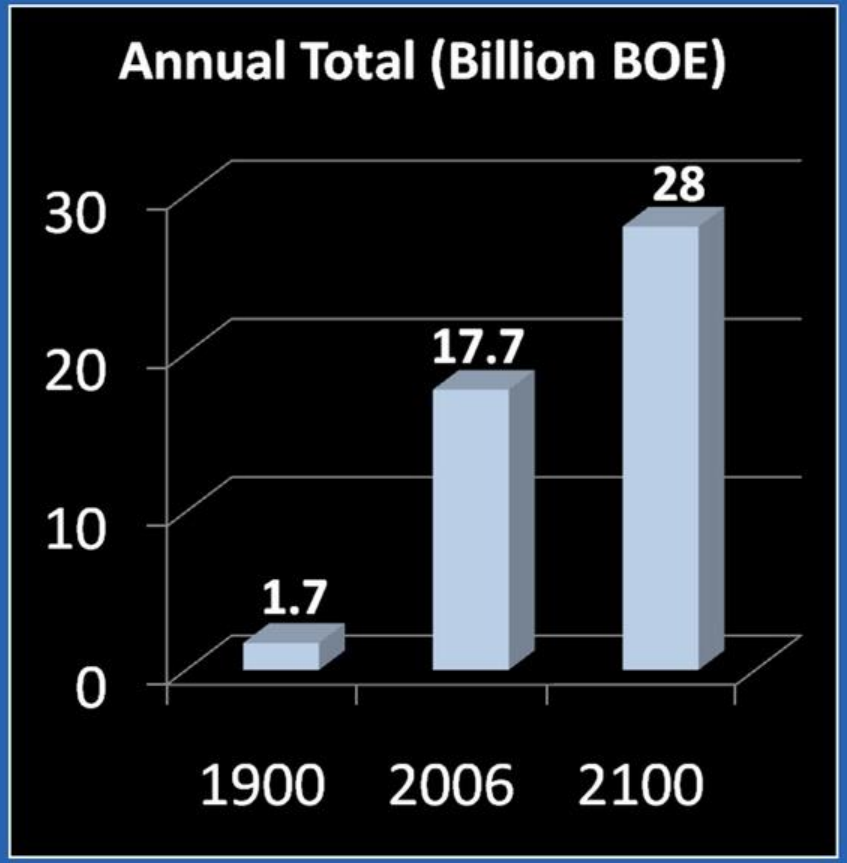


U.S. population will nearly double by 2100

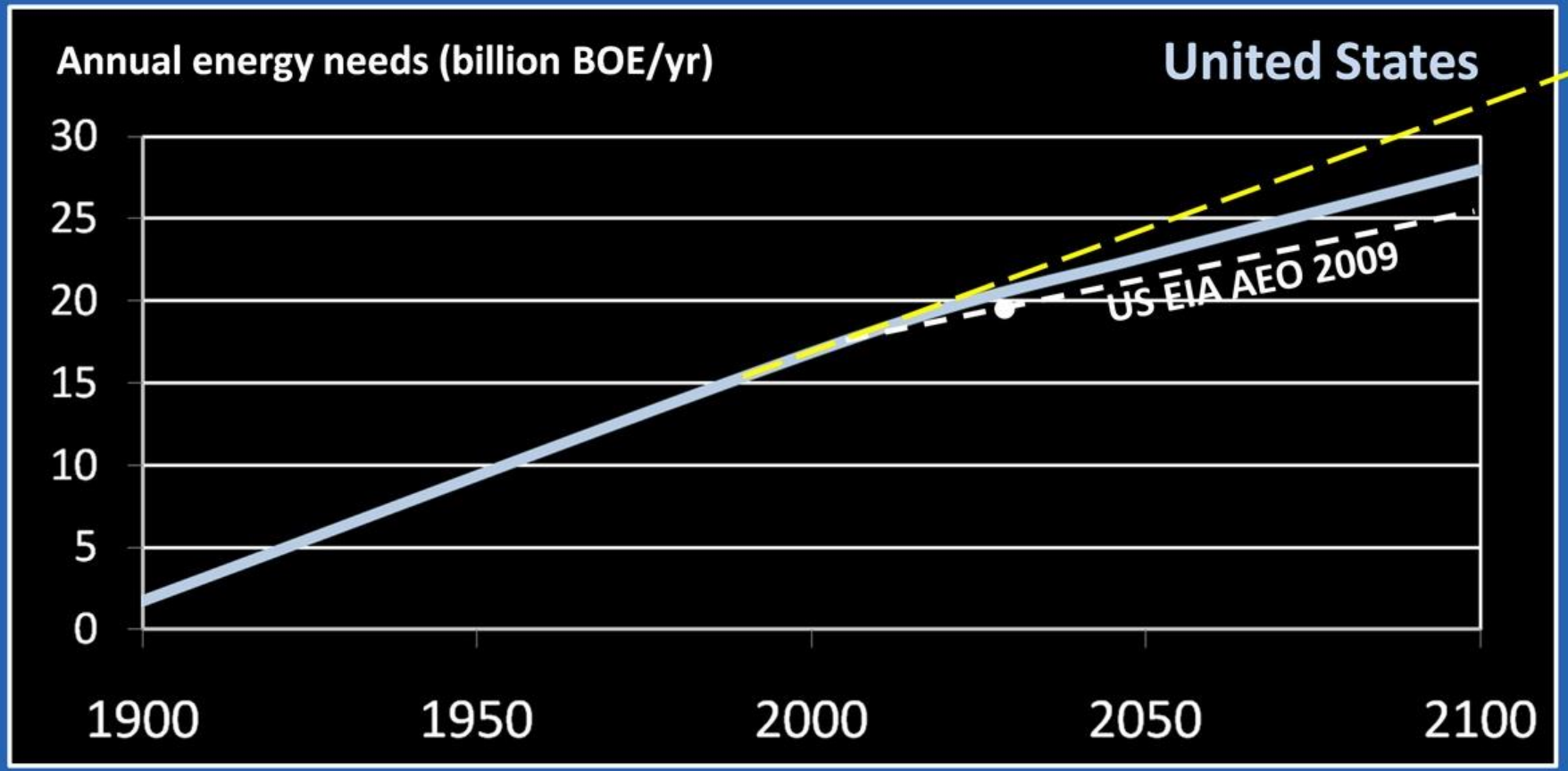


U.S. population growth will drive total consumption energy growth going forward

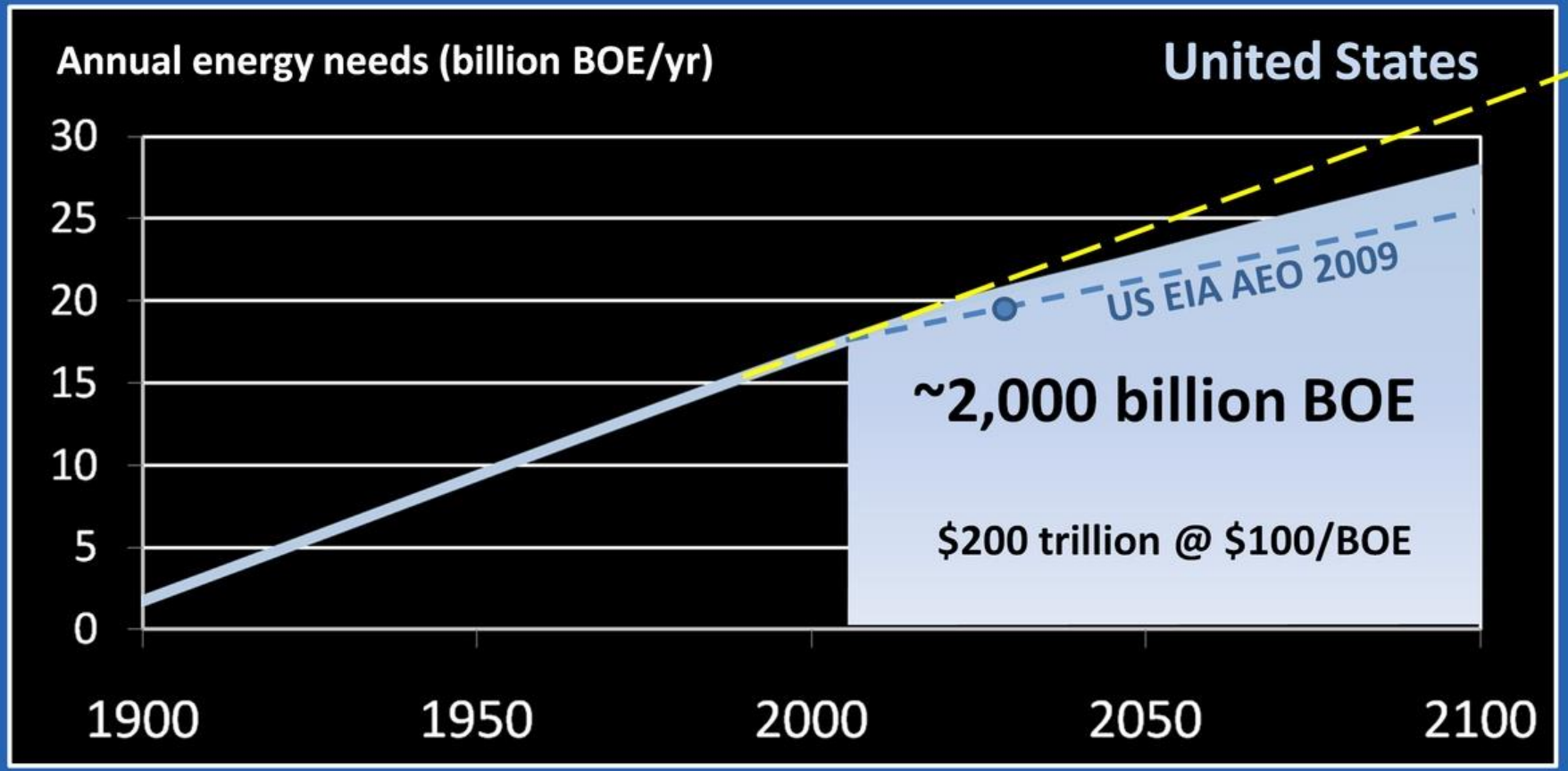




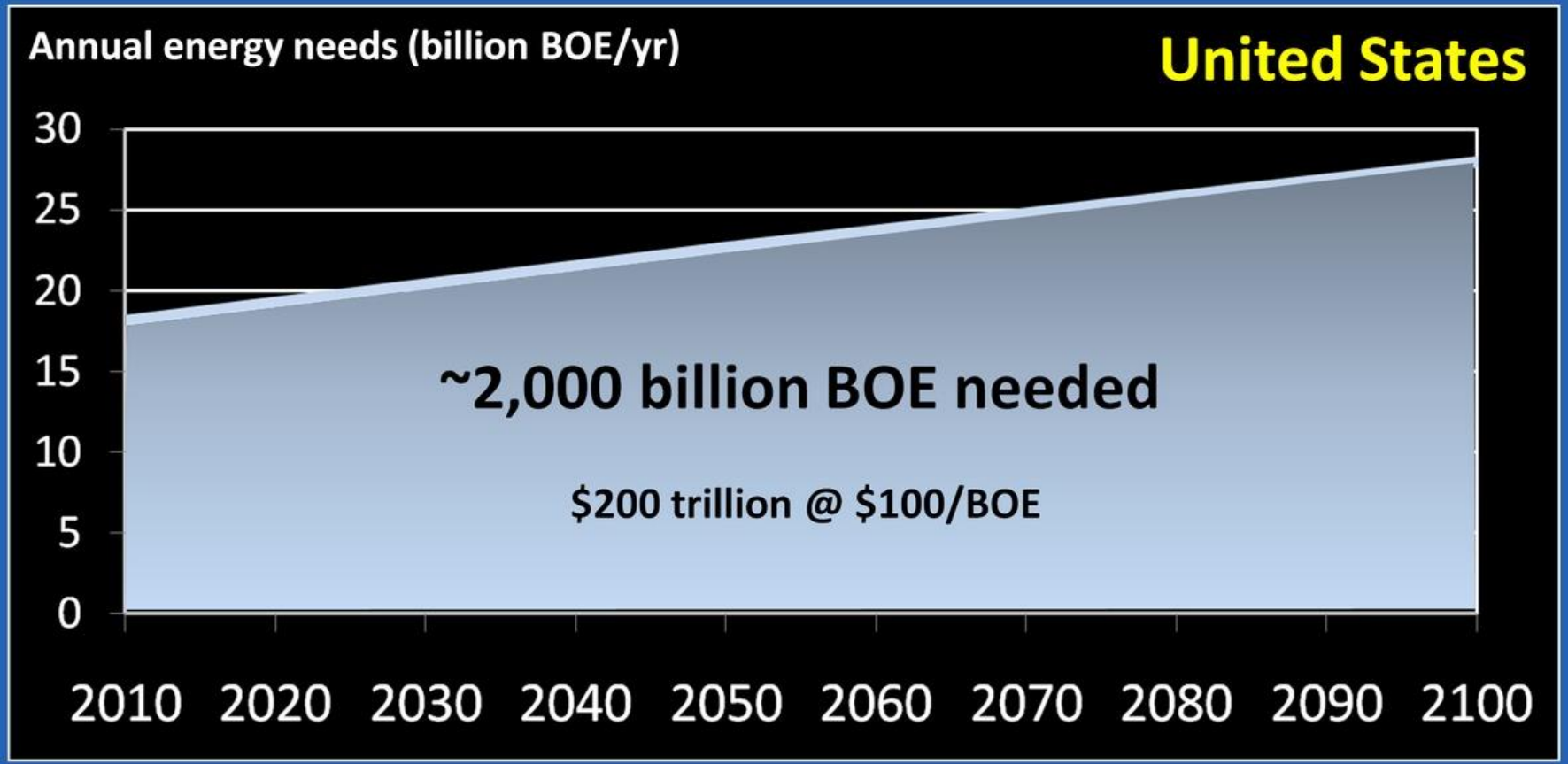
U.S. annual energy consumption is assumed to taper off modestly



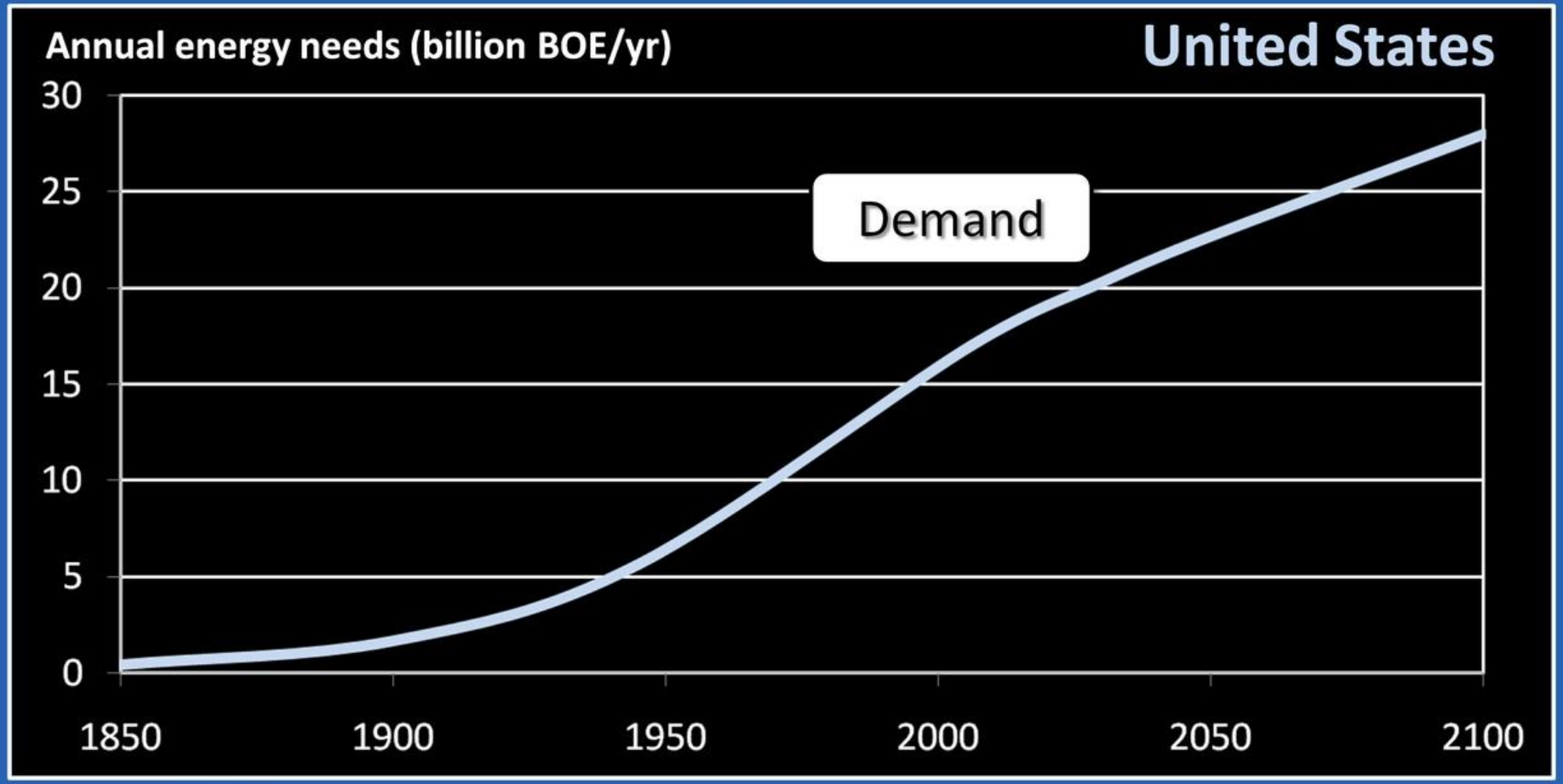
U.S. total energy consumption will need about 2 trillion BOE by 2100



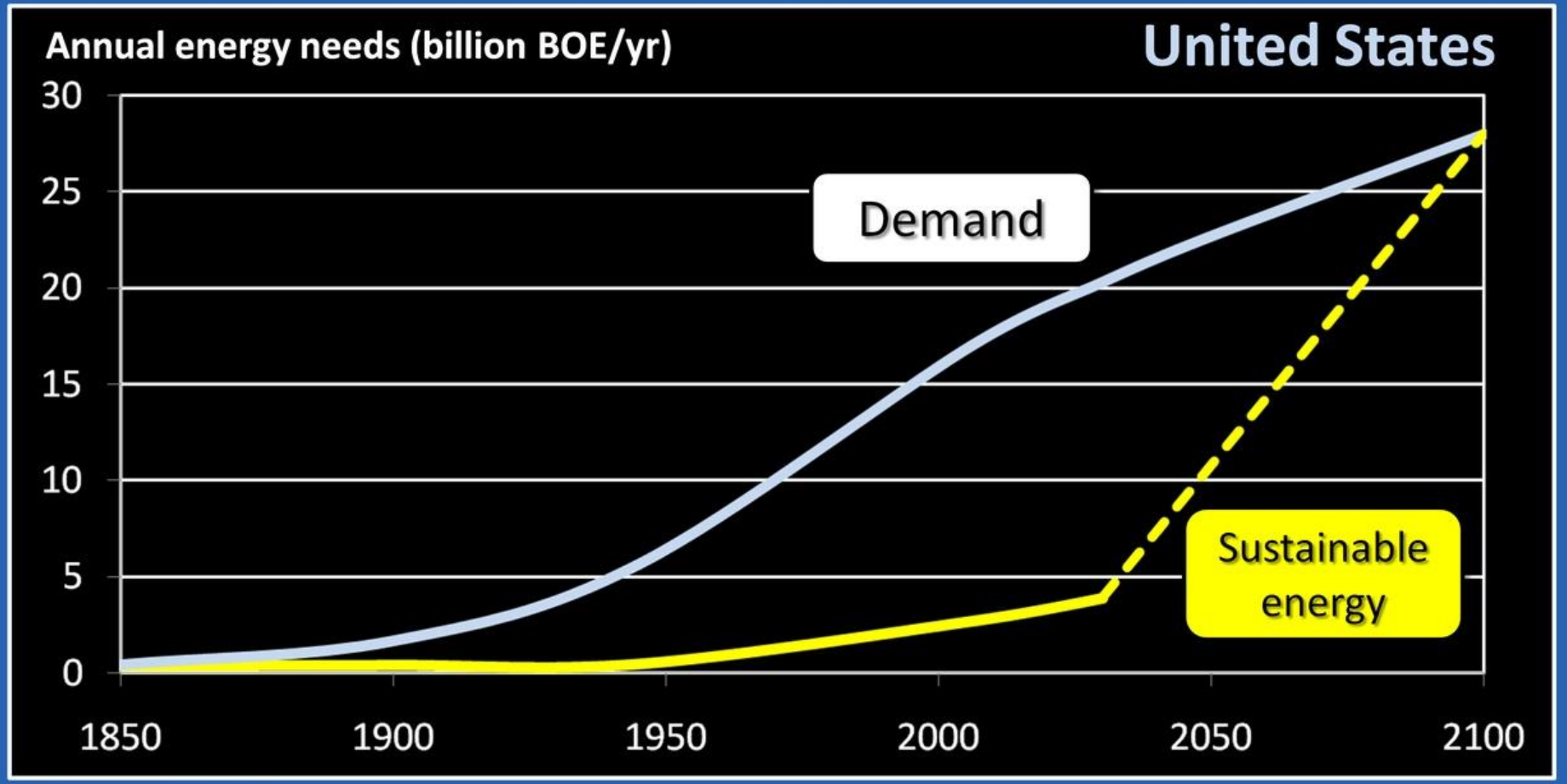
America will need 2 trillion BOE by the end of the century



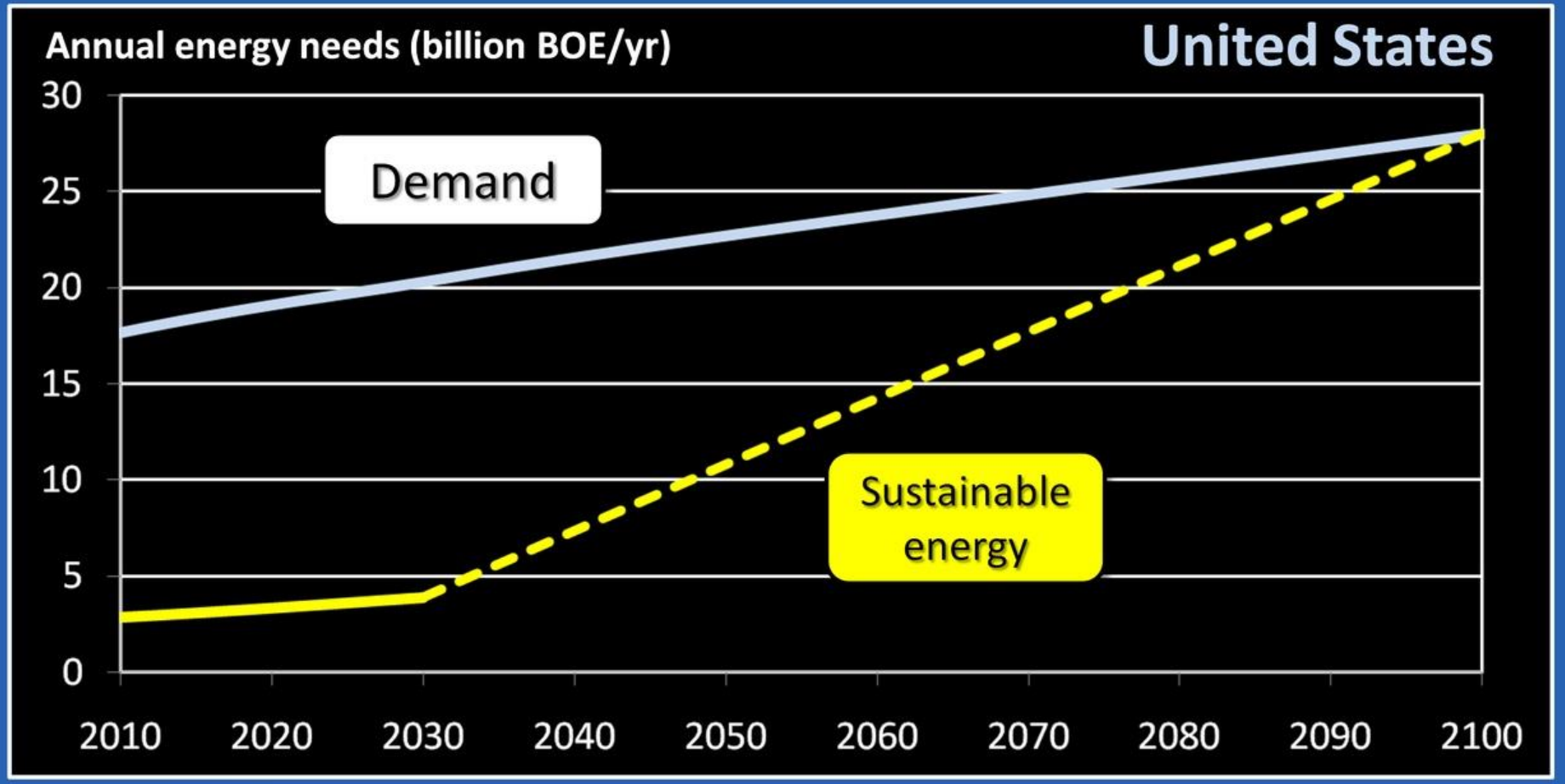
Projected U.S. energy consumption through 2100



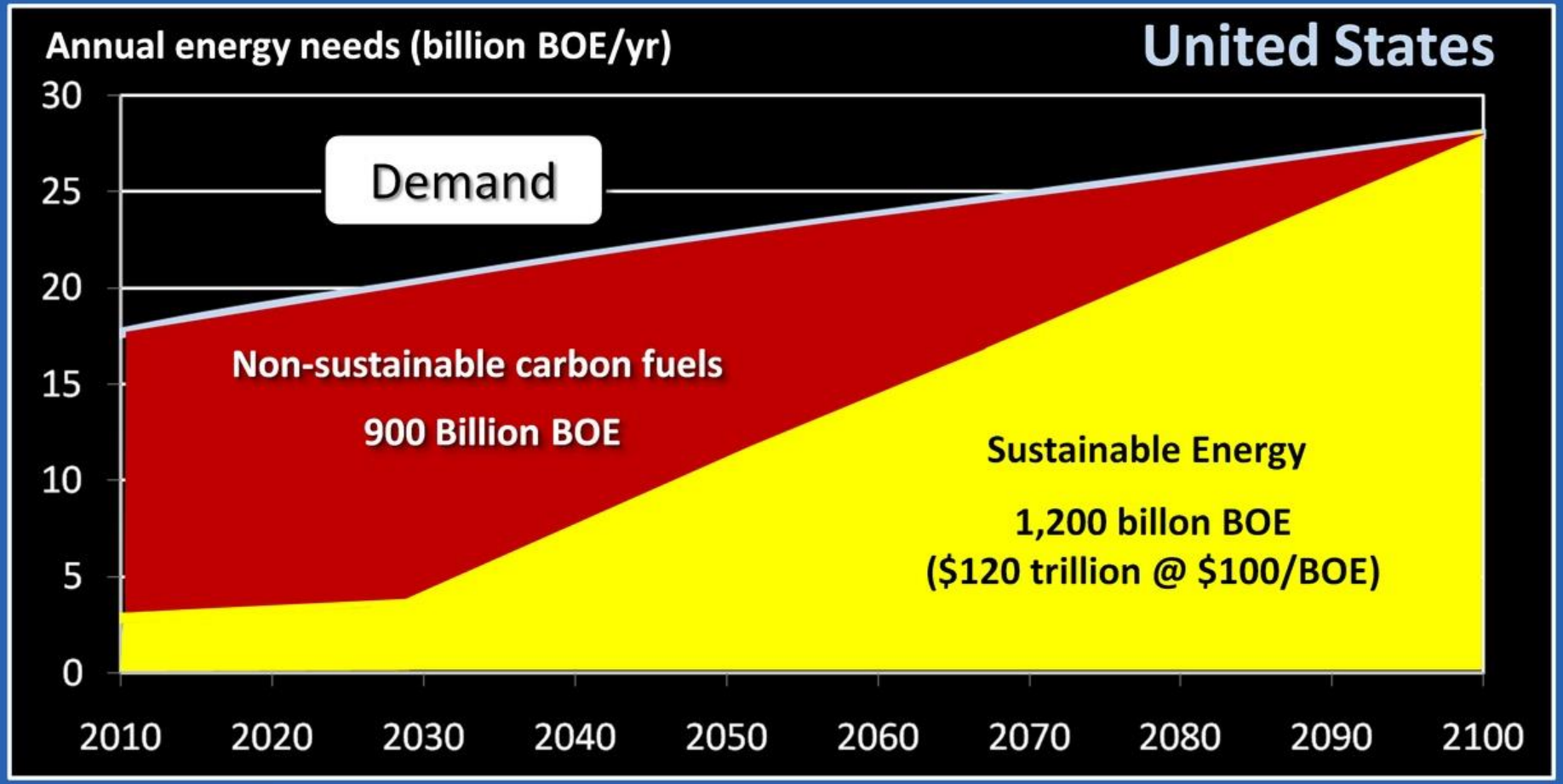
Starting in 2030, the U.S. would need to accelerate sustainable energy development



Starting in 2030, the U.S. would need to accelerate sustainable energy development



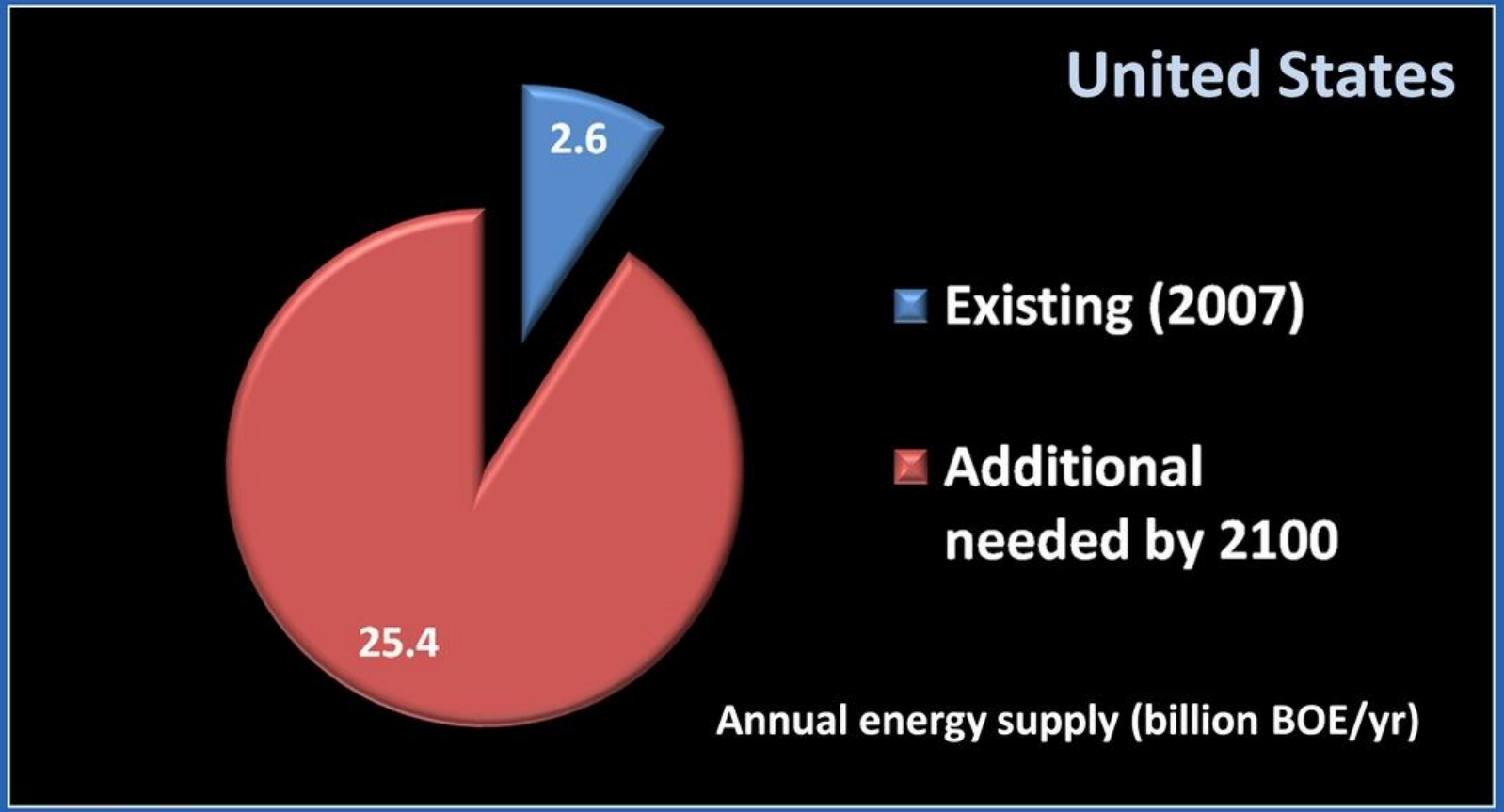
By 2100, more U.S. energy will be provided by sustainable energy



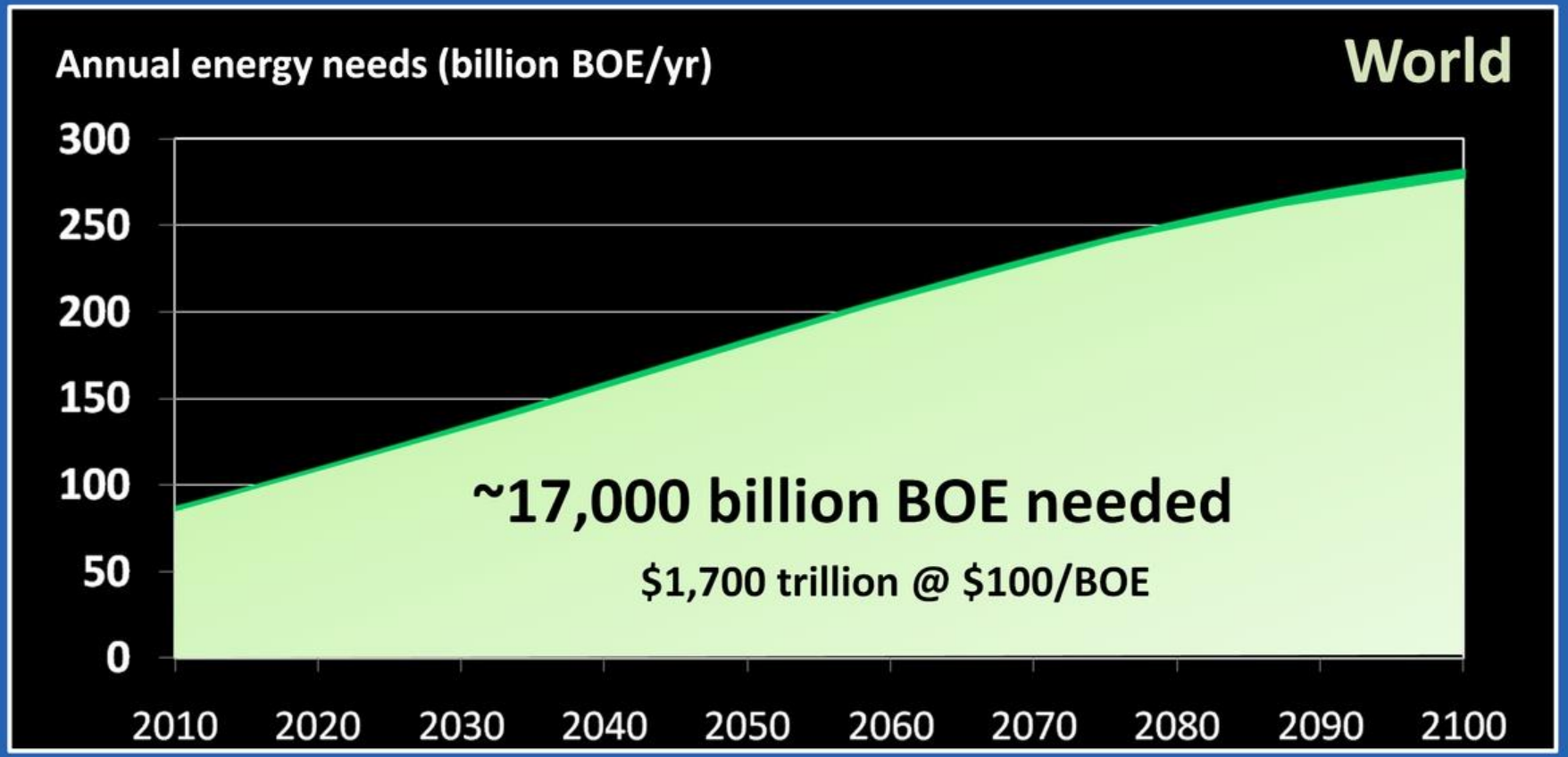
U.S. easy energy resources are large, but not sustainable

- Oil, coal, and natural gas: 1,100 billion BOE (proved reserves)
  - About 85% is coal
- Shale oil: 2,000 billion BOE in-place resources
  - Assume 50% delivered: 1,000 billion BOE
- Total: ~2,000 billion BOE of useable production
  - With substantial shale oil production

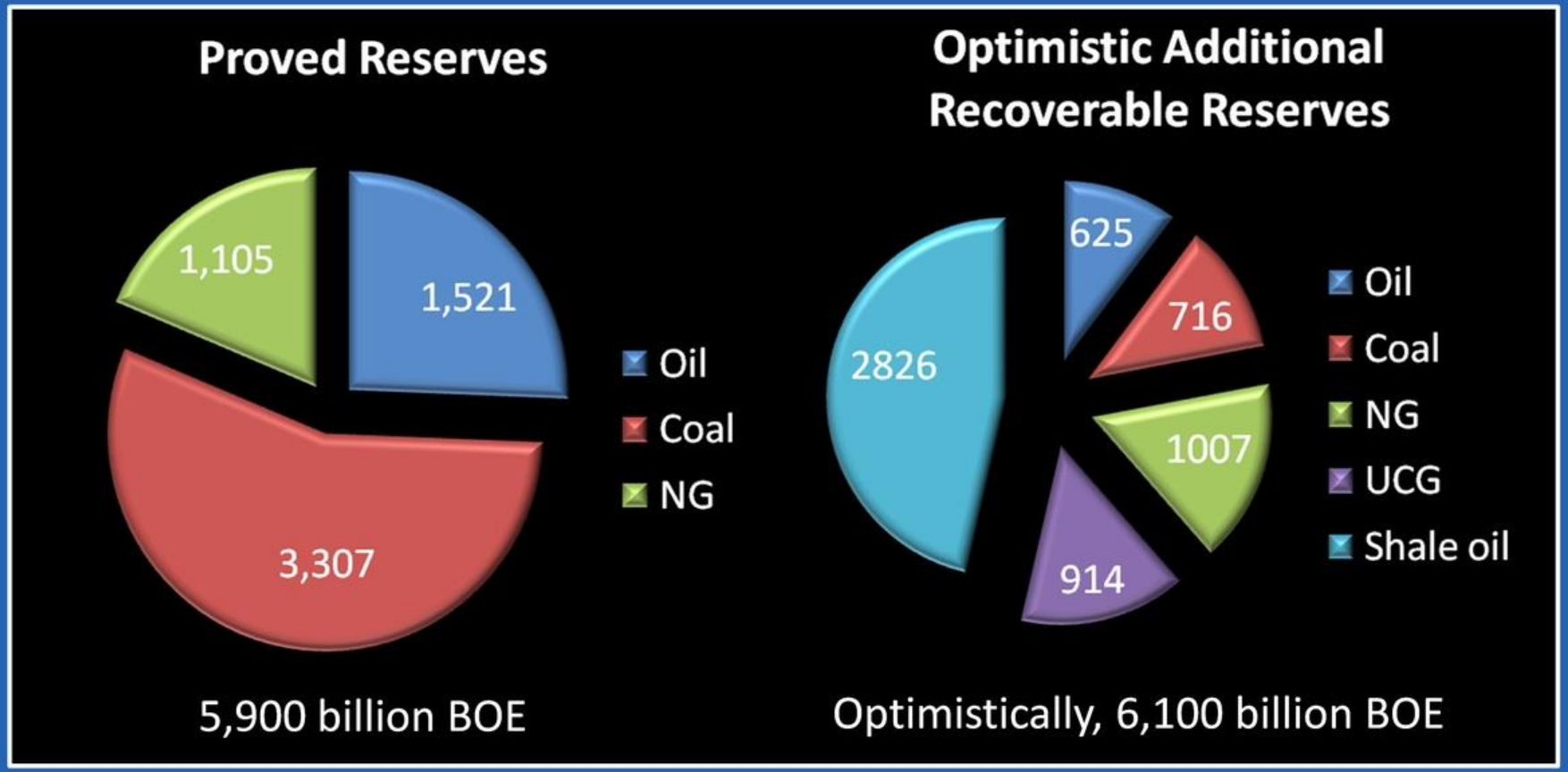
By 2100, the U.S. must expand its current sustainable energy by 10X



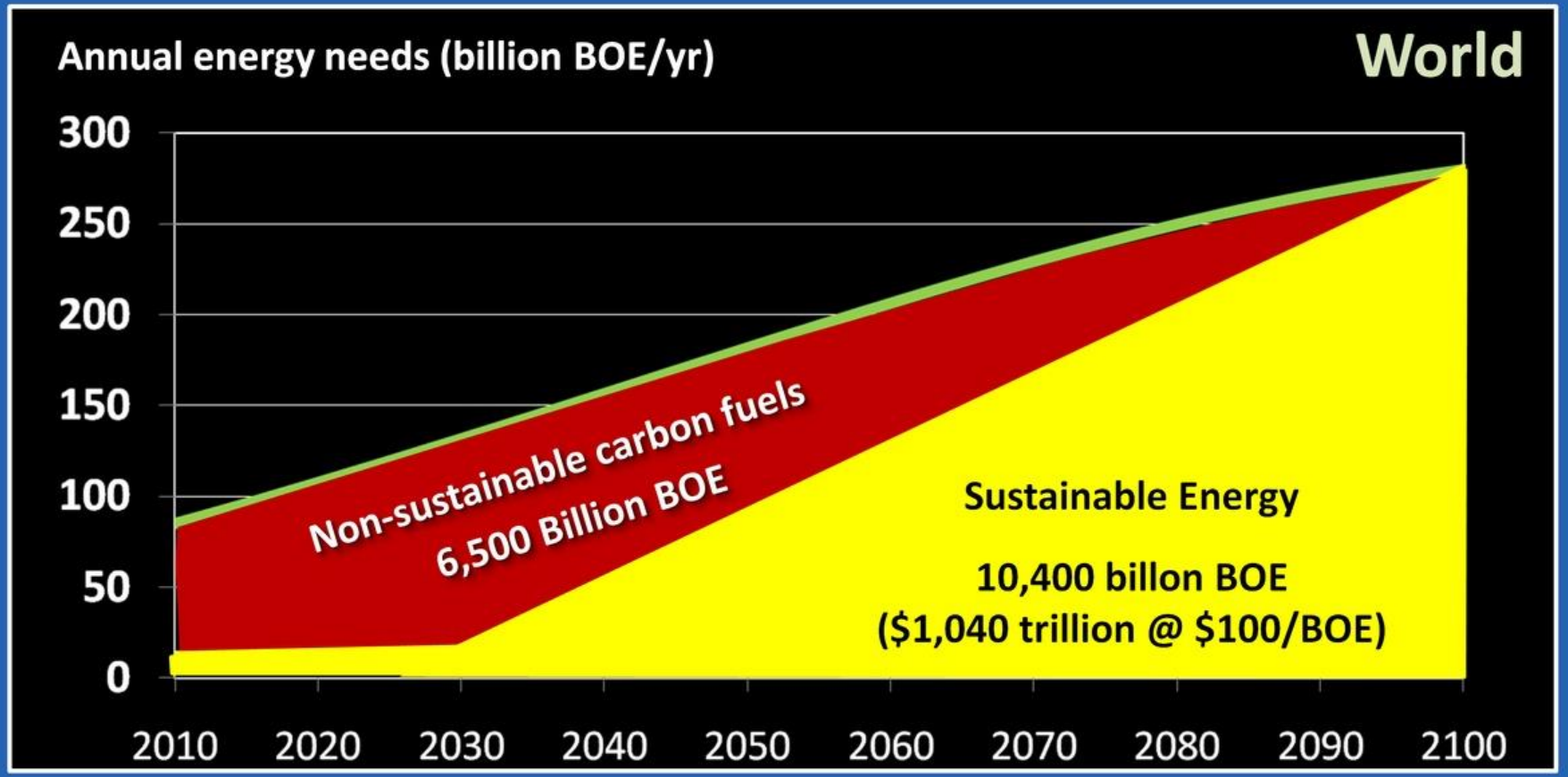
The world will need 17 trillion BOE by the end of the century



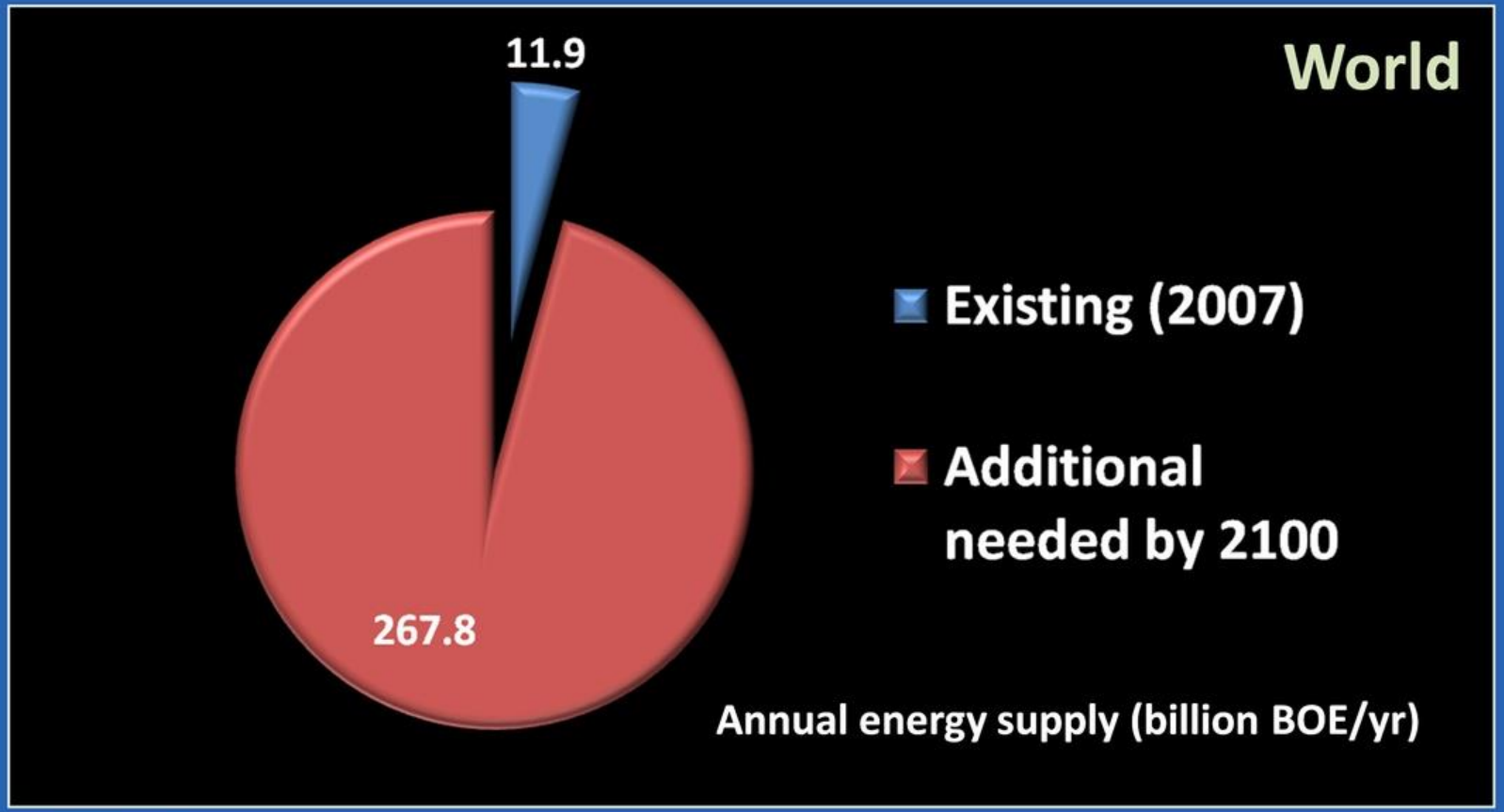
World easy energy resources optimistically total 12,000 billion BOE



From 2030-2100, world sustainable energy production would exceed easy energy production



By 2100, the world must expand its current sustainable energy by 22X



Key 2100 energy needs headlines

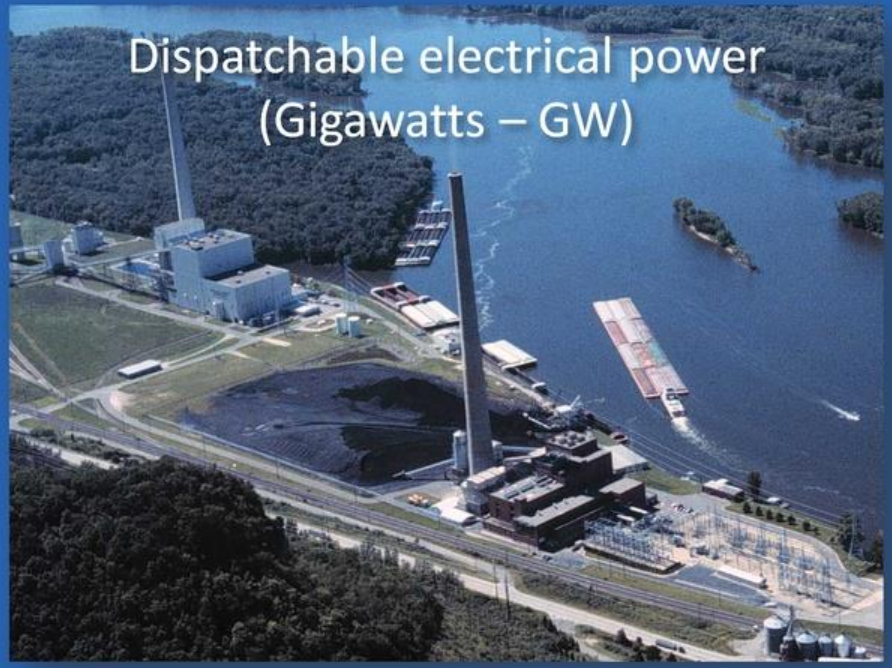
- U.S. will add 250 million energy consumers
  - Need 2 trillion BOE of energy
  - Need 1.2 trillion BOE of sustainable energy
- World will add 5 billion energy consumers
  - Need 17 trillion BOE of energy
  - Need 10 trillion BOE of sustainable energy

Let's explore the potential of current developed sustainable solutions

Developed solutions

- [x] Conventional nuclear
- [x] Hydroelectric
- [x] Geothermal
- [x] Wind
- [x] Ground solar electric
- [x] Biomass
- [ ] Methane hydrates (non-sustainable)
- [ ] Advanced nuclear
- [ ] Algae biofuels
- [ ] Space solar power

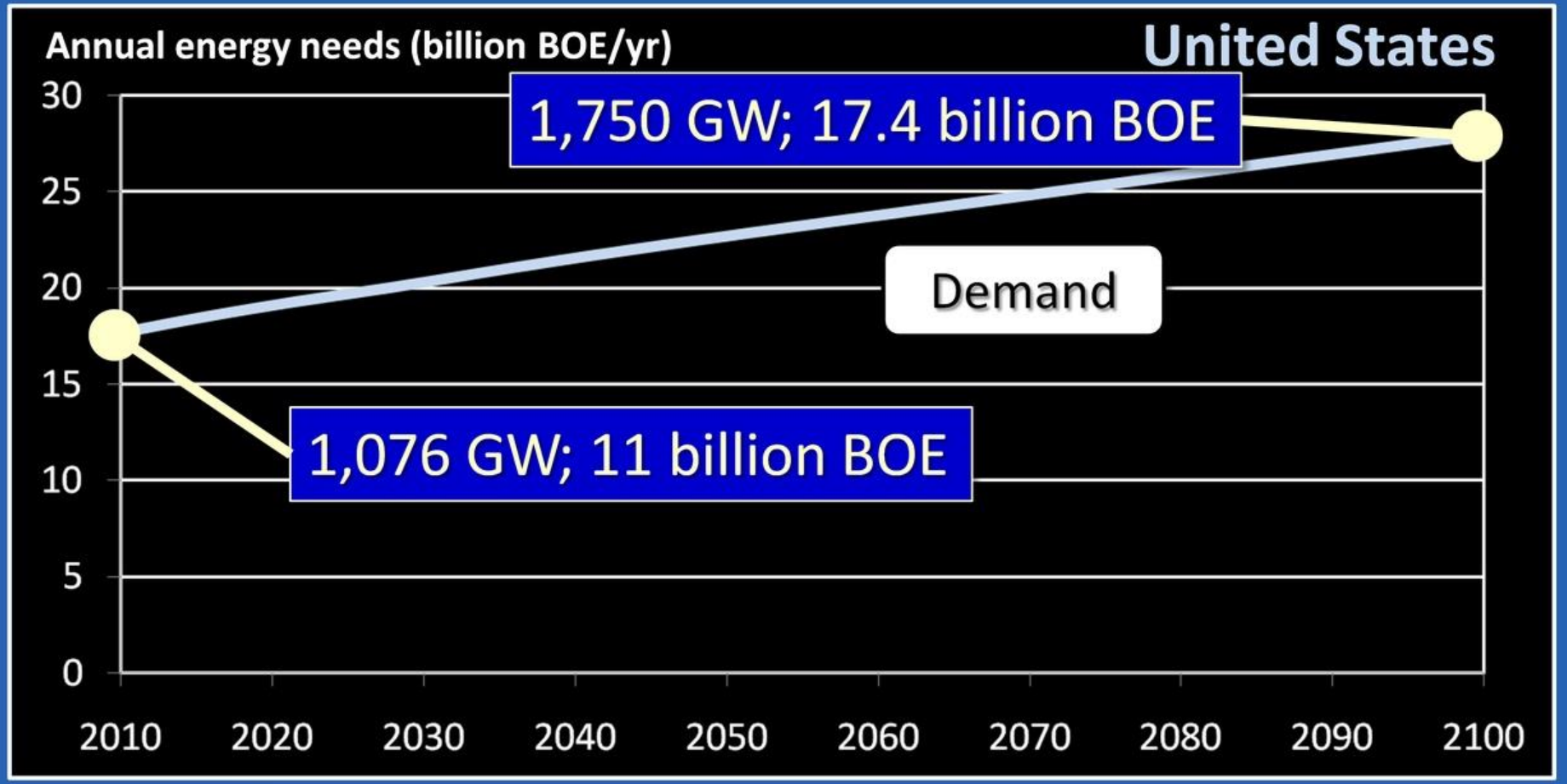
Energy supplies fall into two categories: utility electrical power generation and fuels



Reliable 365/24 availability
to meet customer demand

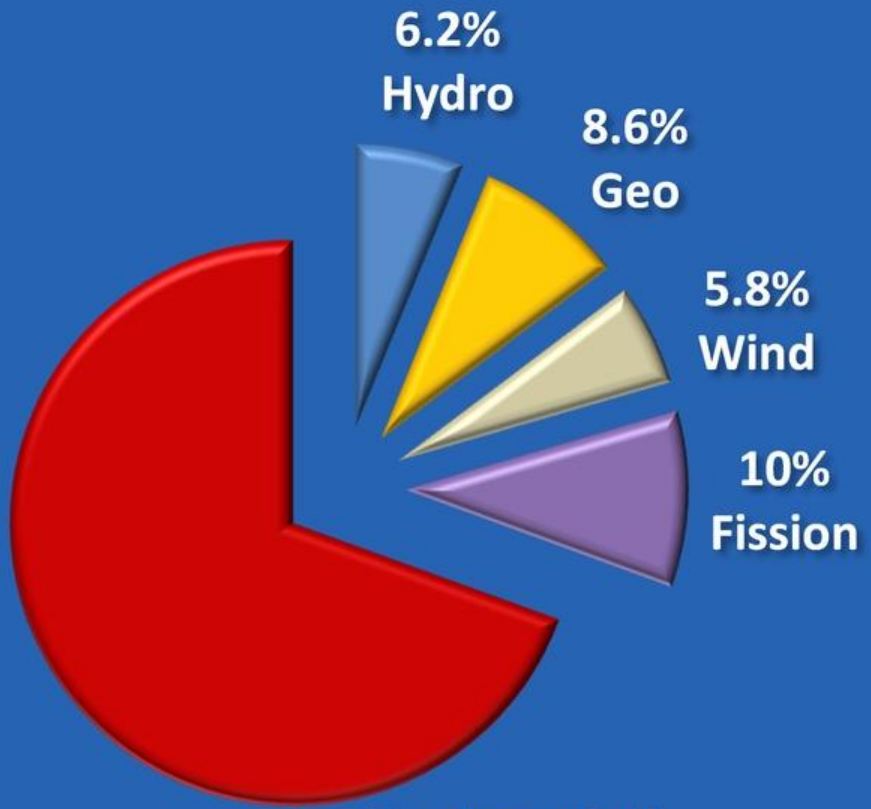
Storable, transportable fuels

Both electrical power generation capacity and fuels production must be increased



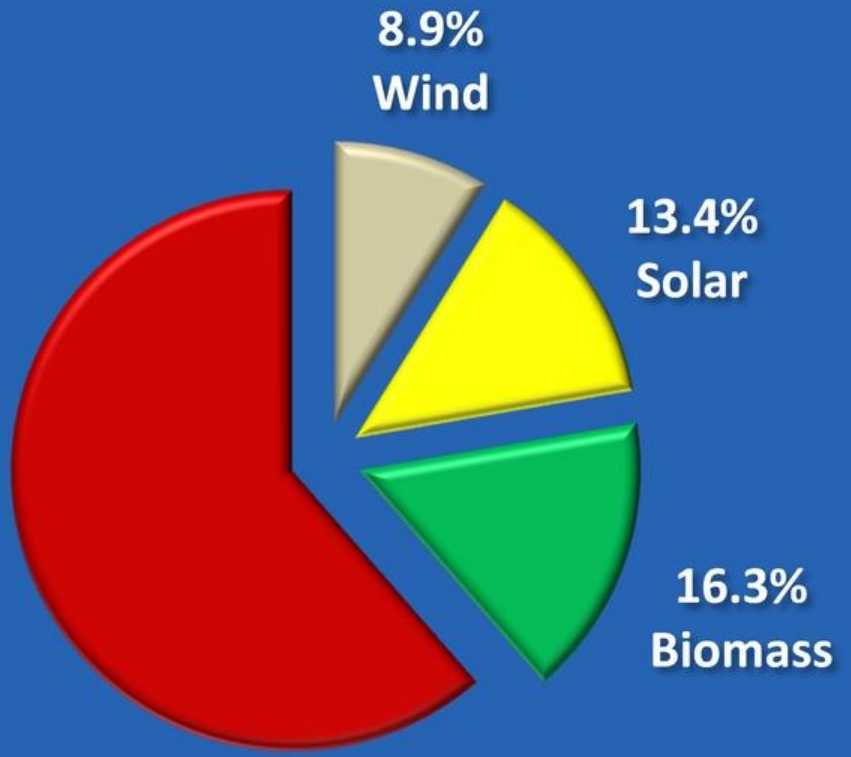
U.S. sustainable, dispatchable electrical generation capacity will fall well short of 2100 needs

- About 1,100 GW today
  - 3.5 kW per capita
- About 1,750 GW needed by 2100
  - 3.1 kW per capita
- Only about 30% of 2100 need can be met
  - **0.9 kW per capita**



U.S. sustainable fuels generation potential will also leave a large 2100 shortfall

- About 11 billion BOE supplied today
  - 36 BOE per capita/yr
- About 17.4 billion BOE needed in 2100
  - 31 BOE per capita/yr
- Only about 40% of 2100 need can be met
  - **12 BOE per capita/yr**



Over 200,000 sq. mi. of the U.S. will look like this

Key sustainable energy supply headlines

- U.S. conventional sustainable potential
  - 70% shortfall in dispatchable electrical power generation capacity
  - 60% shortfall in annual sustainable fuels production
- World conventional sustainable potential
  - 50% shortfall in dispatchable electrical power generation capacity
  - 60% shortfall in annual sustainable fuels production

What's the engineering readiness of advanced sustainable solutions?

- ☐ Conventional nuclear
- ☐ Hydroelectric
- ☐ Geothermal
- ☐ Wind
- ☐ Ground solar electric
- ☐ Biomass

Developed solutions

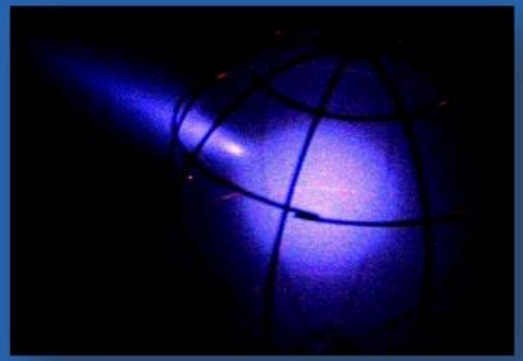
- ☑ Methane hydrates (non-sustainable)
- ☑ Advanced nuclear
- ☑ Algae biofuels
- ☑ Space solar power

Methane hydrates may become a new non-sustainable carbon fuel source

- Potential resources: Comparable to fossil fuels
- Issues:
  - Recovery technology immaturity
  - Environmental uncertainties
  - Industrial scale recovery uncertainty
  - Completion timeline unknown
  - Not now able to enter engineering development
- Conclusions:
  - Non-executable now to support energy scarcity-avoidance planning
  - Fund continued research

Advanced nuclear energy holds the hope for an acceptable new scalable energy source

- Potential: 365/24 sustainable electrical power
- Issues:
  - Technology immaturity
  - Environmental uncertainties
  - Completion timeline unknown
  - Not now able to enter engineering development
- Conclusions:
  - Non-executable now to support energy scarcity-avoidance planning
  - Fund continued research



Algae may be able to provide substantially more BOE's per acre than traditional crops

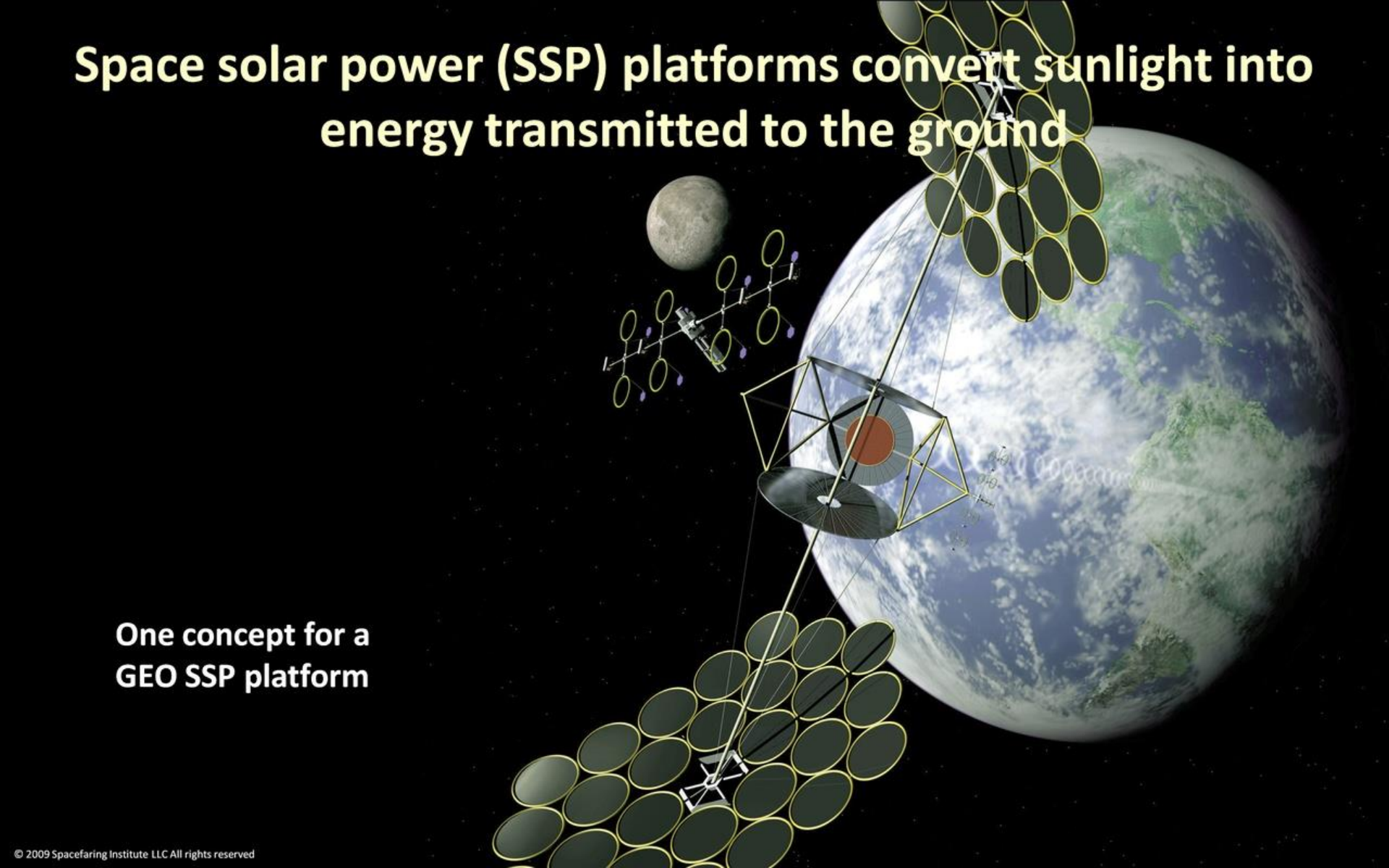
Warm-climate open pond algae biofuel = 53,000 BOE per sq. mi. per year

Biofuels produced by algae provides a new renewable fuel source

- Potential: fuel, hydrogen, and protein production
- Issues:
  - Land and water use
  - Disease/contamination
  - Evaporation byproduct disposal
  - Early stage of commercial development
    - Especially closed environment approaches

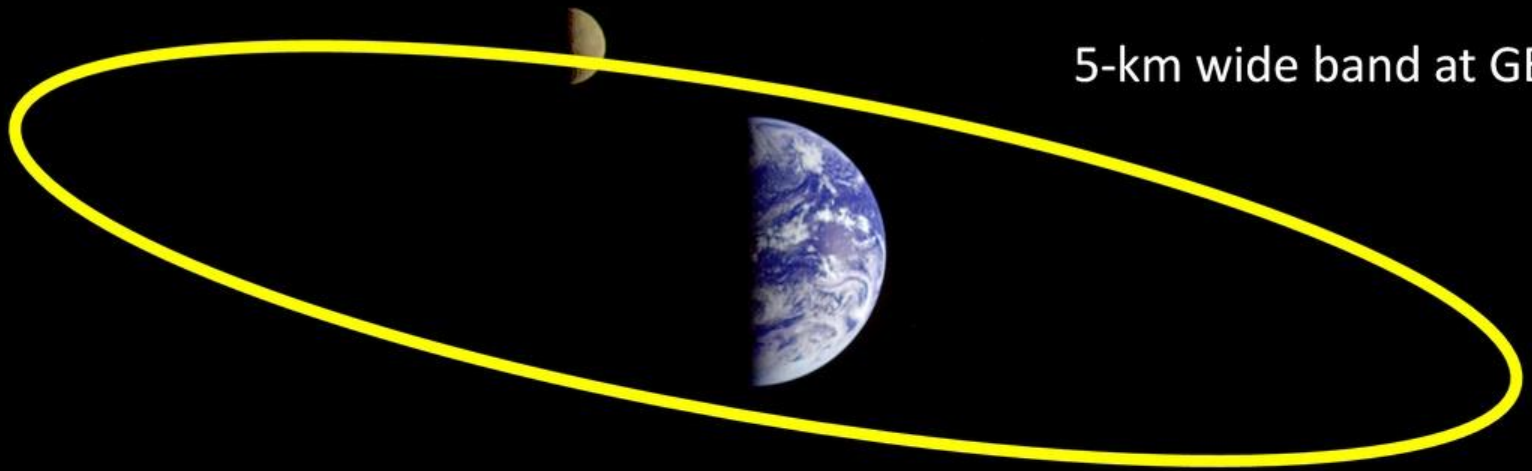
- Conclusions:
  - Expand commercial open pond production
  - Fund continued research especially on closed-environment production

Space solar power (SSP) platforms convert sunlight into energy transmitted to the ground



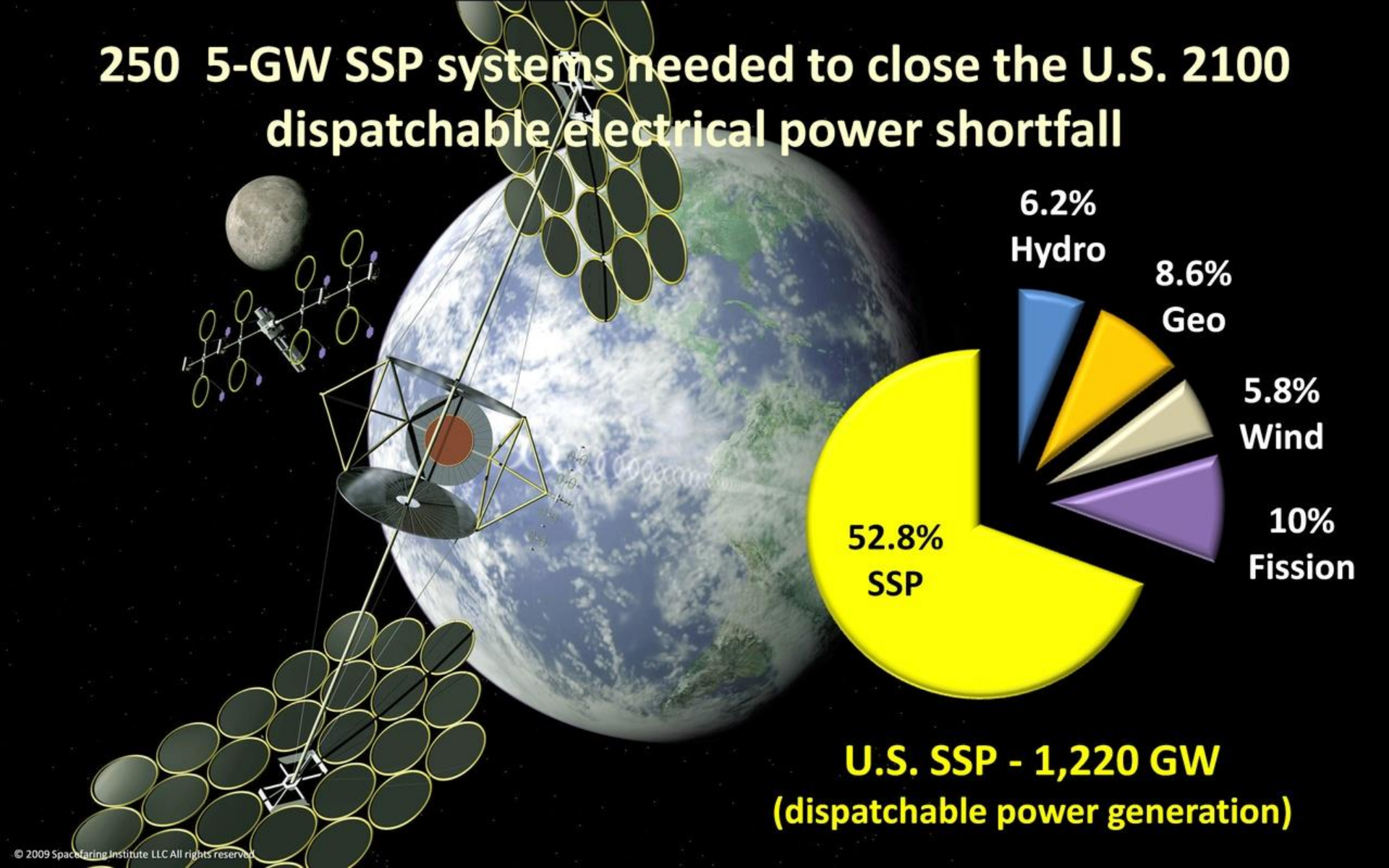
One concept for a GEO SSP platform

GEO is an orbit 26,200 miles above the Earth and 164,600 miles in circumference



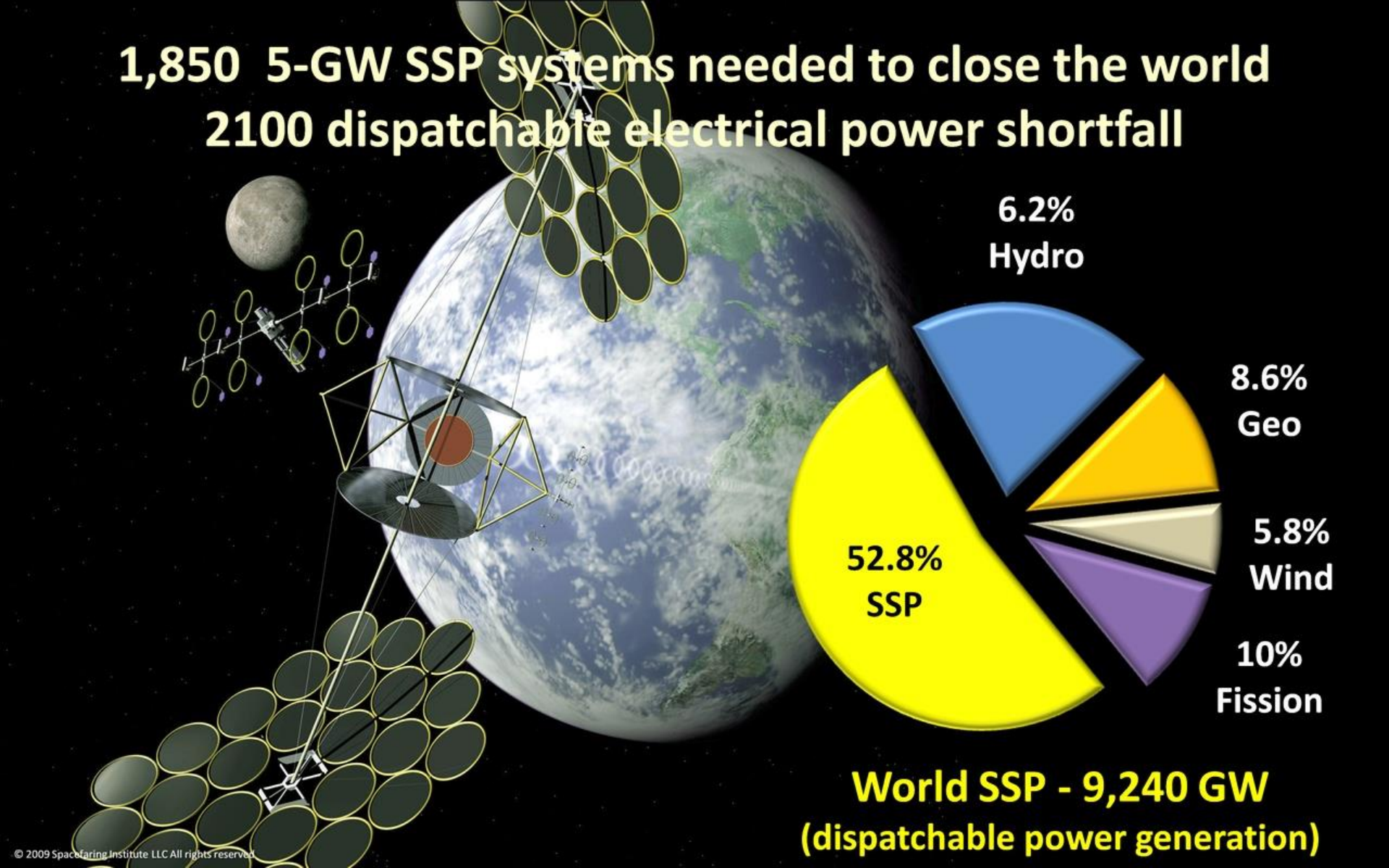
- $14 trillion/yr @ 5 cents per kW-hr
- 33,100 GW-yrs of energy/yr
- 6,620 5-GW SSP platforms (10% slot use)

250 5-GW SSP systems needed to close the U.S. 2100 dispatchable electrical power shortfall



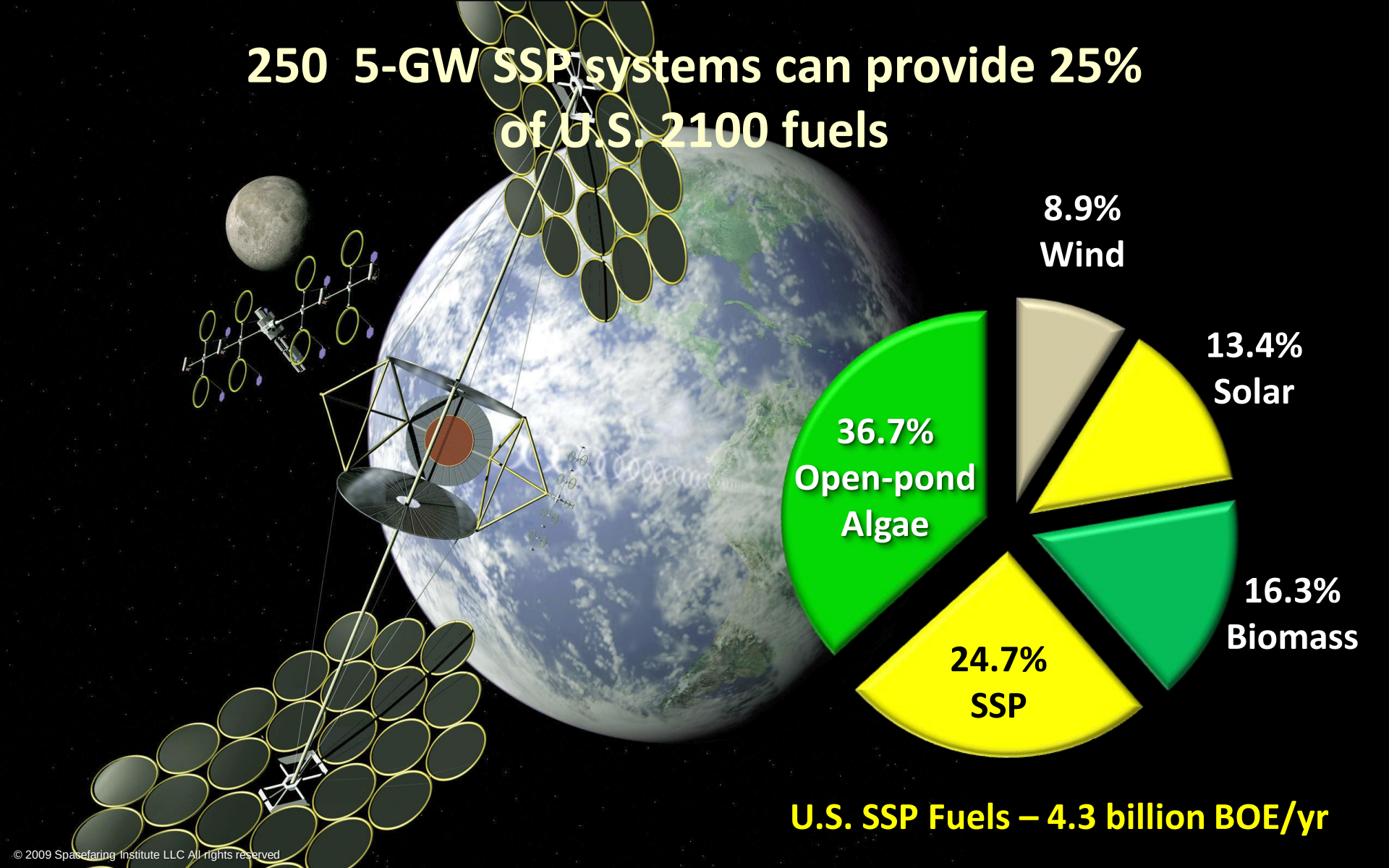
U.S. SSP - 1,220 GW
(dispatchable power generation)

1,850 5-GW SSP systems needed to close the world 2100 dispatchable electrical power shortfall



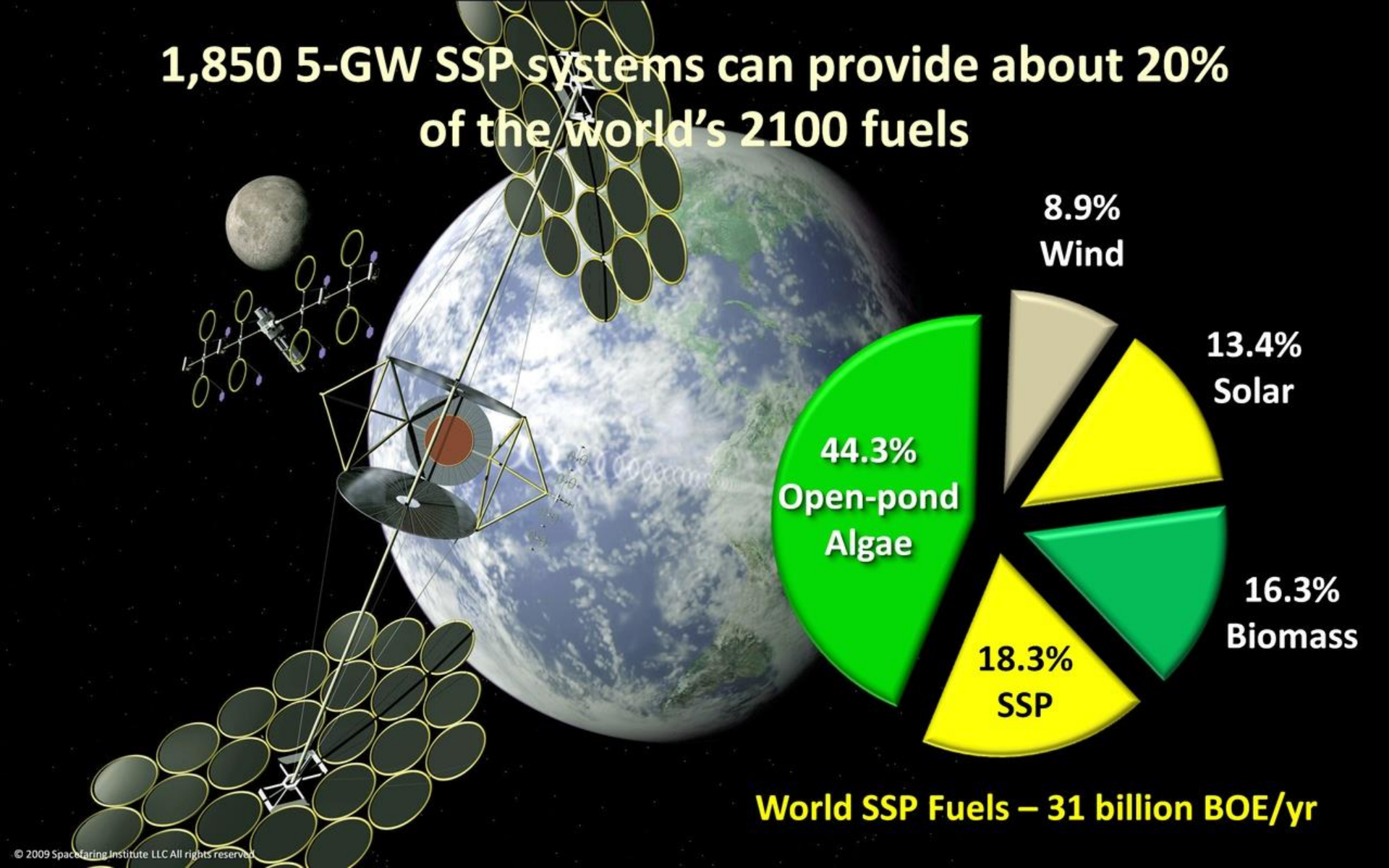
World SSP - 9,240 GW
(dispatchable power generation)

250 5-GW SSP systems can provide 25% of U.S. 2100 fuels



U.S. SSP Fuels – 4.3 billion BOE/yr

1,850 5-GW SSP systems can provide about 20% of the world's 2100 fuels



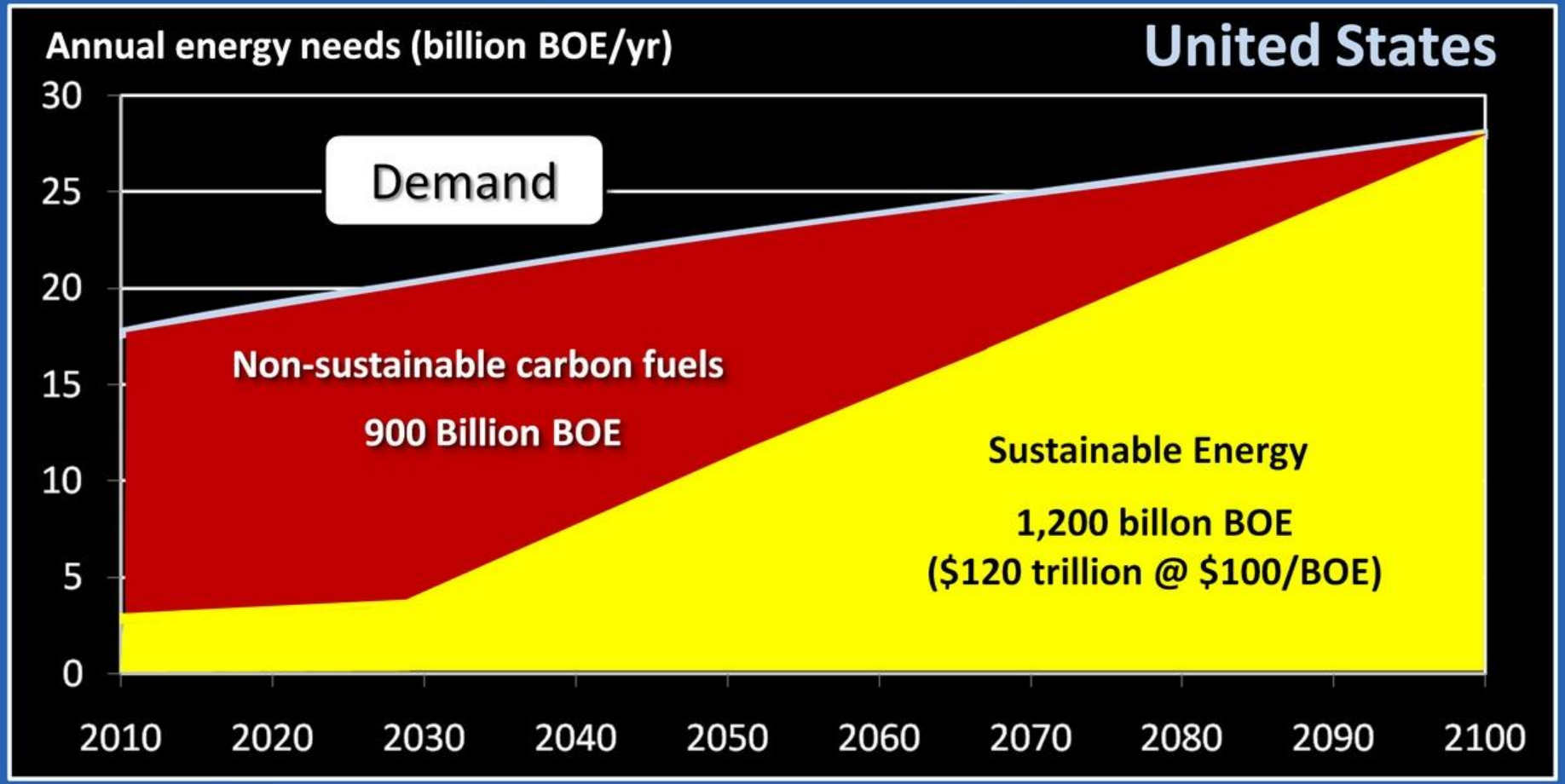
World SSP Fuels – 31 billion BOE/yr

Key energy scarcity avoidance headlines

- SSP is today's engineering ready solution
  - Baseload electrical power
  - Hydrogen fuels
- SSP will help U.S. and world close sustainable energy supply shortfalls
- Only a true spacefaring America can undertaken SSP

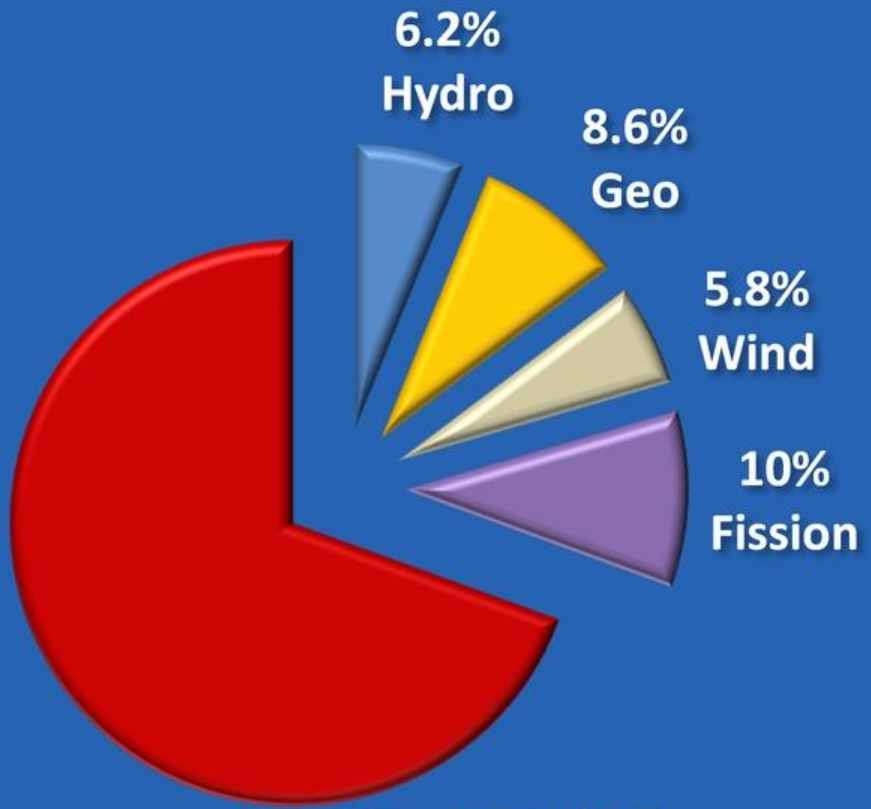
America needs a well-reasoned and executable sustainable energy strategy

By 2100, more U.S. energy will need to be provided by sustainable energy

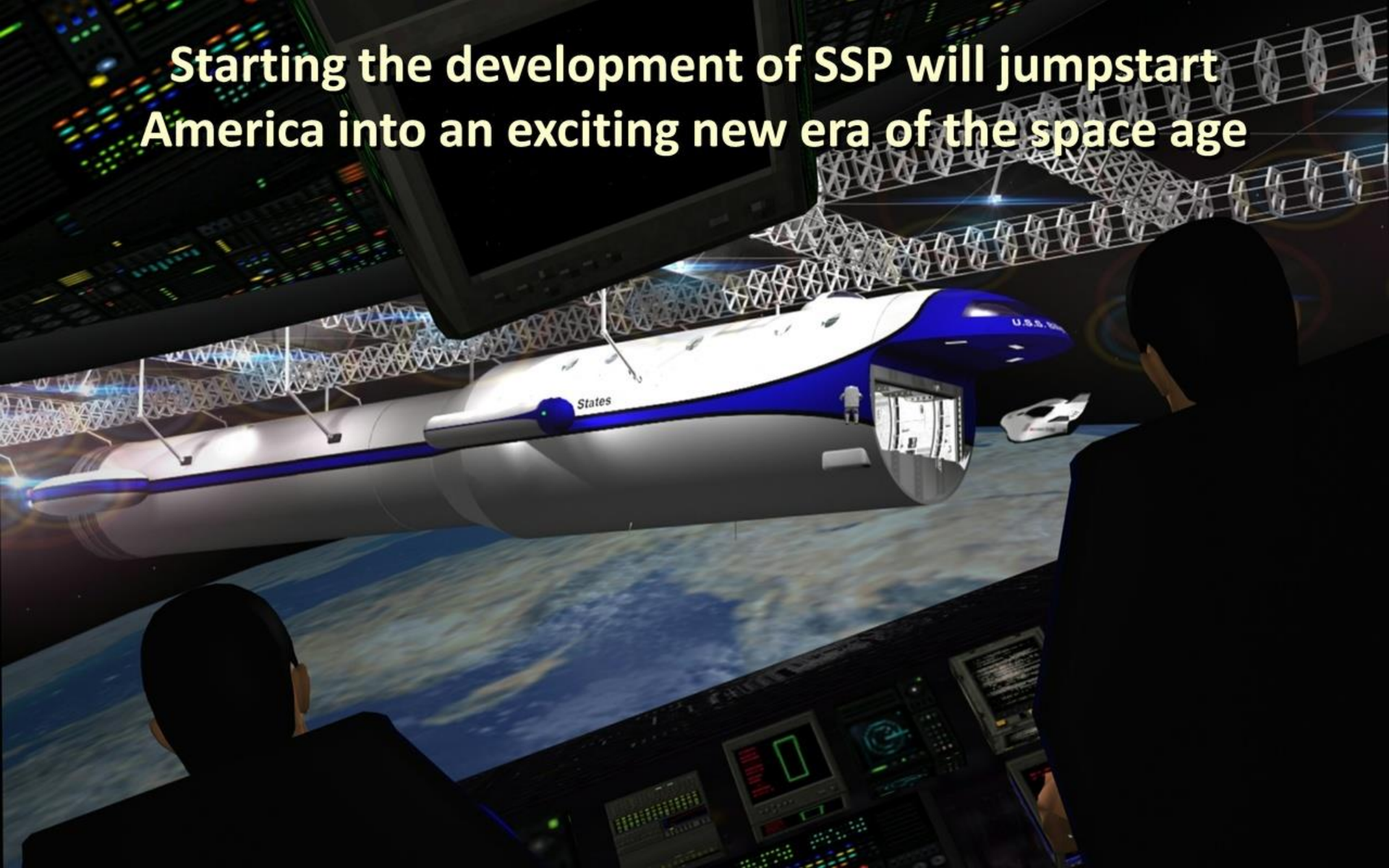


U.S. sustainable, dispatchable electrical generation capacity will fall well short of 2100 needs without SSP

- About 1,100 GW today
  - 3.5 kW per capita
- About 1,750 GW needed by 2100
  - 3.1 kW per capita
- Only about 30% of 2100 need can be met
  - **0.9 kW per capita**



Space solar power is today's "engineering-ready" new sustainable energy source


Starting the development of SSP will jumpstart
America into an exciting new era of the space age
States

Version 1.01

The End of Easy Energy
and
What to Do About It

James Michael Snead, P.E.

Beavercreek, Ohio, USA
jamesmsnead@aol.com
November 19, 2008

Abstract

Easy energy refers to the current oil, coal, and natural gas energy sources that provide about 86% of the U.S.'s and the world's energy. An increasing average world per capita demand for easy energy combined with a growing U.S. and world population will exhaust recoverable resources of easy energy this century, probably within the lifetime of today's young children. Current

info@spacefaringinstitute.com http://spacefaringinstitute.com