

# **Renewable Energy Technology Opportunities: *Responding to Global Energy Challenges***

Presented at  
Beijing International Renewable Energy Conference  
The Great Hall of the People

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# CSD Energy Cycle is a Critical Opportunity to Increase Access to Modern Energy Services

UN Process

World Summit on Sustainable Development (WSSD)



Commission on Sustainable Development CSD 14/15



Renewables Track

Need to measure our success by results on the ground

Bonn International Conference on Renewable Energies



Beijing International Renewable Energy Conference (BIREC)



September 2002

June 2004

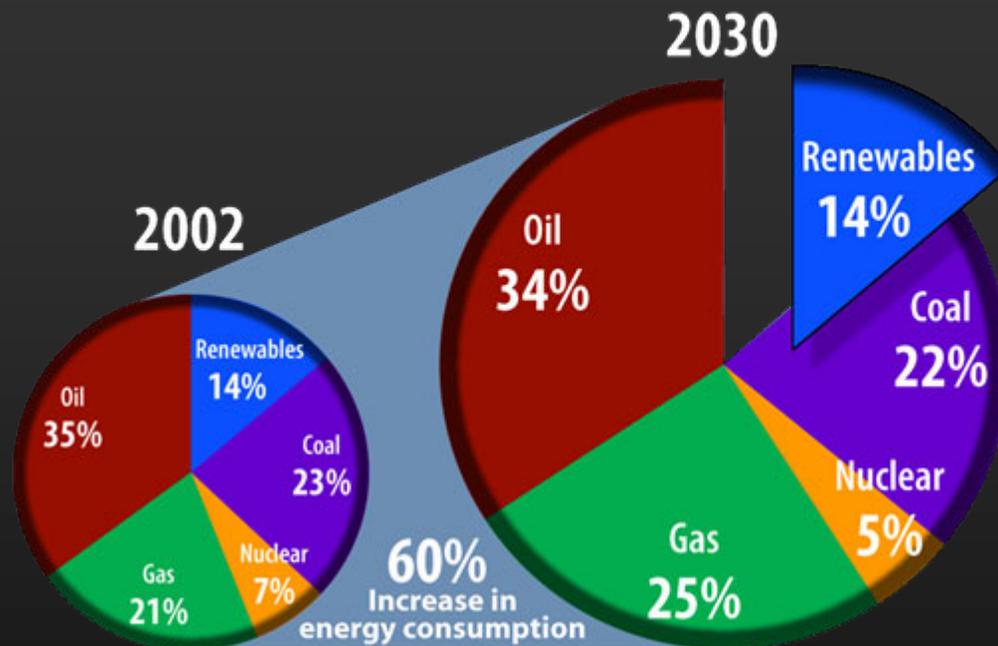
November 2005

May 2006/2007

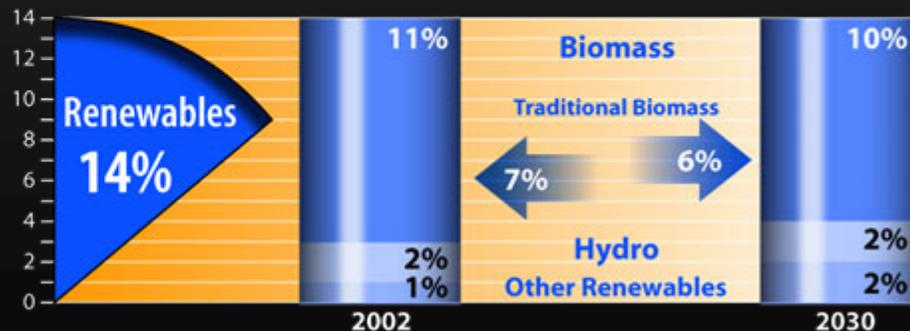
# Contents

- Global Renewable Energy Market Overview
- Highlights from Expert Paper

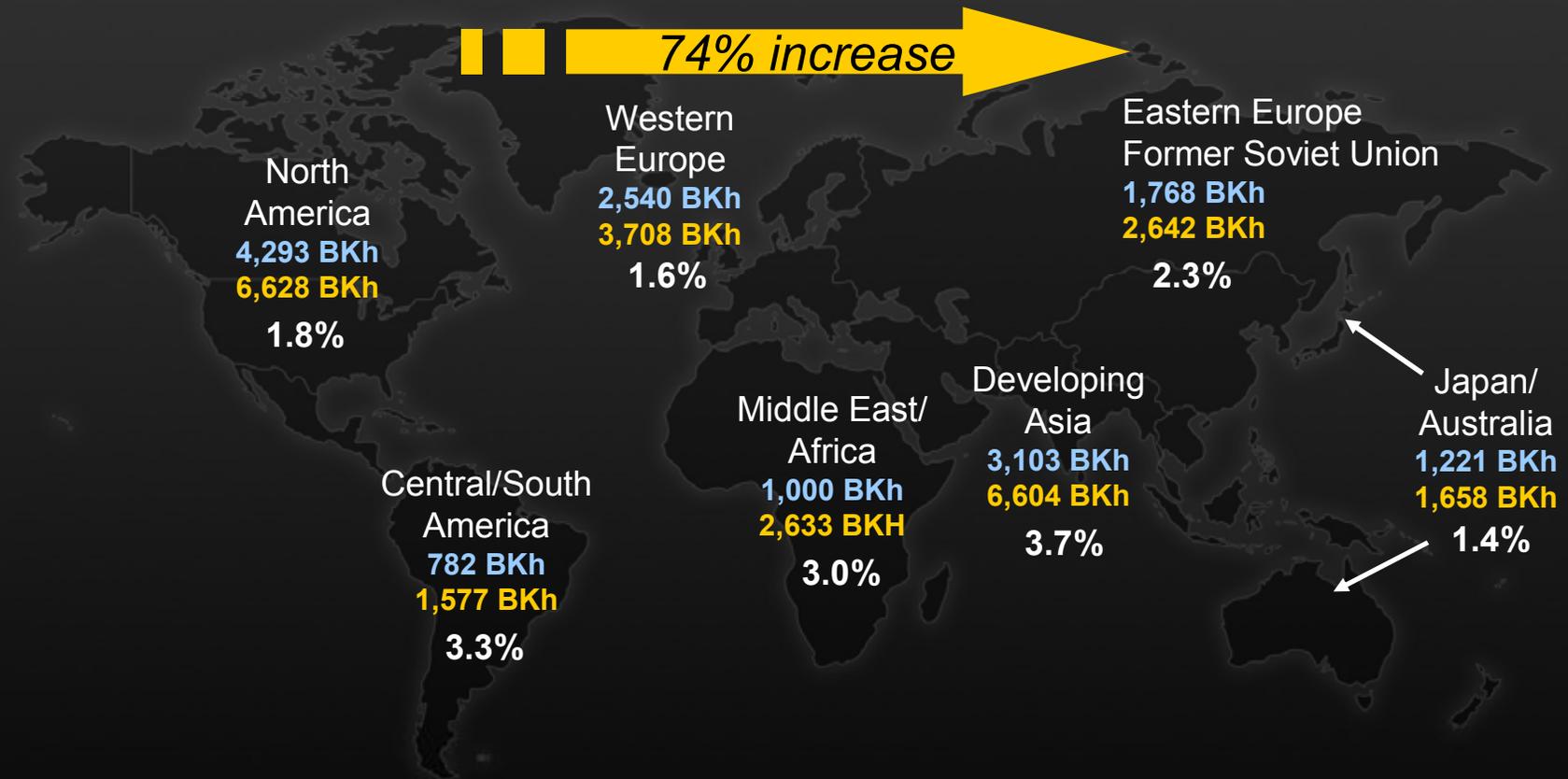
# The Role of Renewables in the World Energy Supply



Source: OECD/IEA, 2004

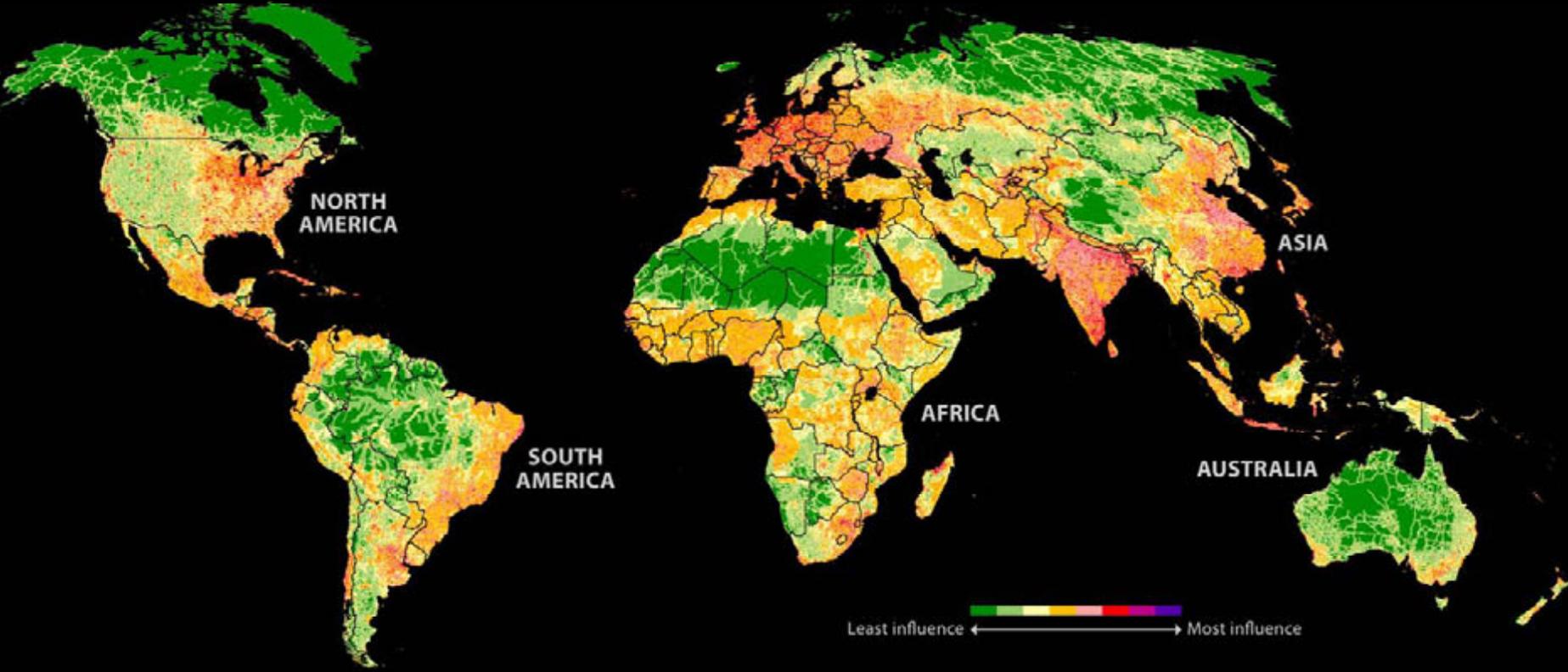


# Electricity Outlook: 2001-2025



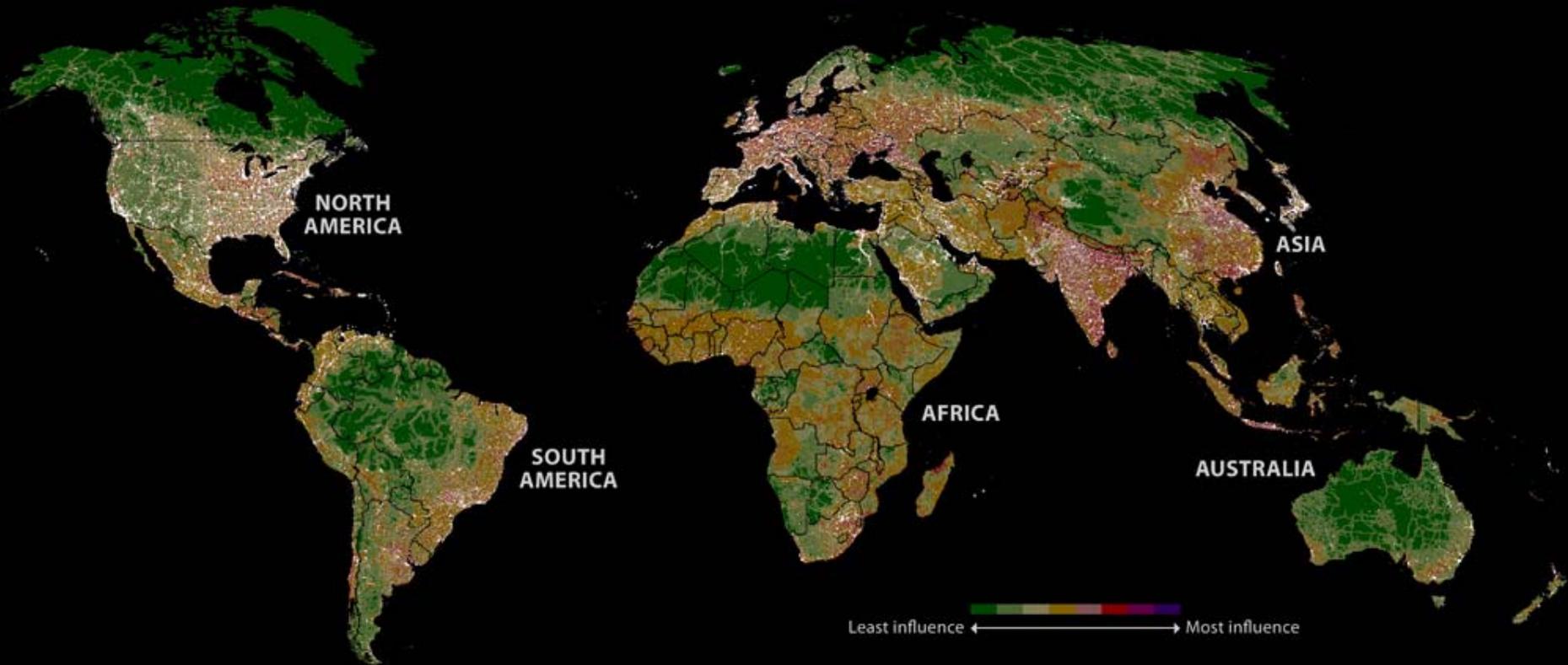
- Total annual average world electricity growth - 2.4% from 2001 to 2025
- Growth rates in transitioning economies higher than developed economies
- Natural gas and coal will be near-term fuels of choice for generation
- Distributed generation and renewable will offer attractive options

# Human Impact on the Earth 2005



Adapted from National Geographic, September 2005

# Human Density vs. Electricity Global Perspective



Adapted from National Geographic, September 2005 and "Earth at Night" NASA/GSFC, NOAA/ NGDC, November 2000

# A Quarter Century of Energy R&D Contributions

Total U.S. Energy R&D = \$100B

Renewable Energy R&D = \$14B



Created a commercial nuclear power option



Reduced emissions from coal-fired power plants



Enhanced oil recovery from wells



Enabled hybrid vehicles to enter the market



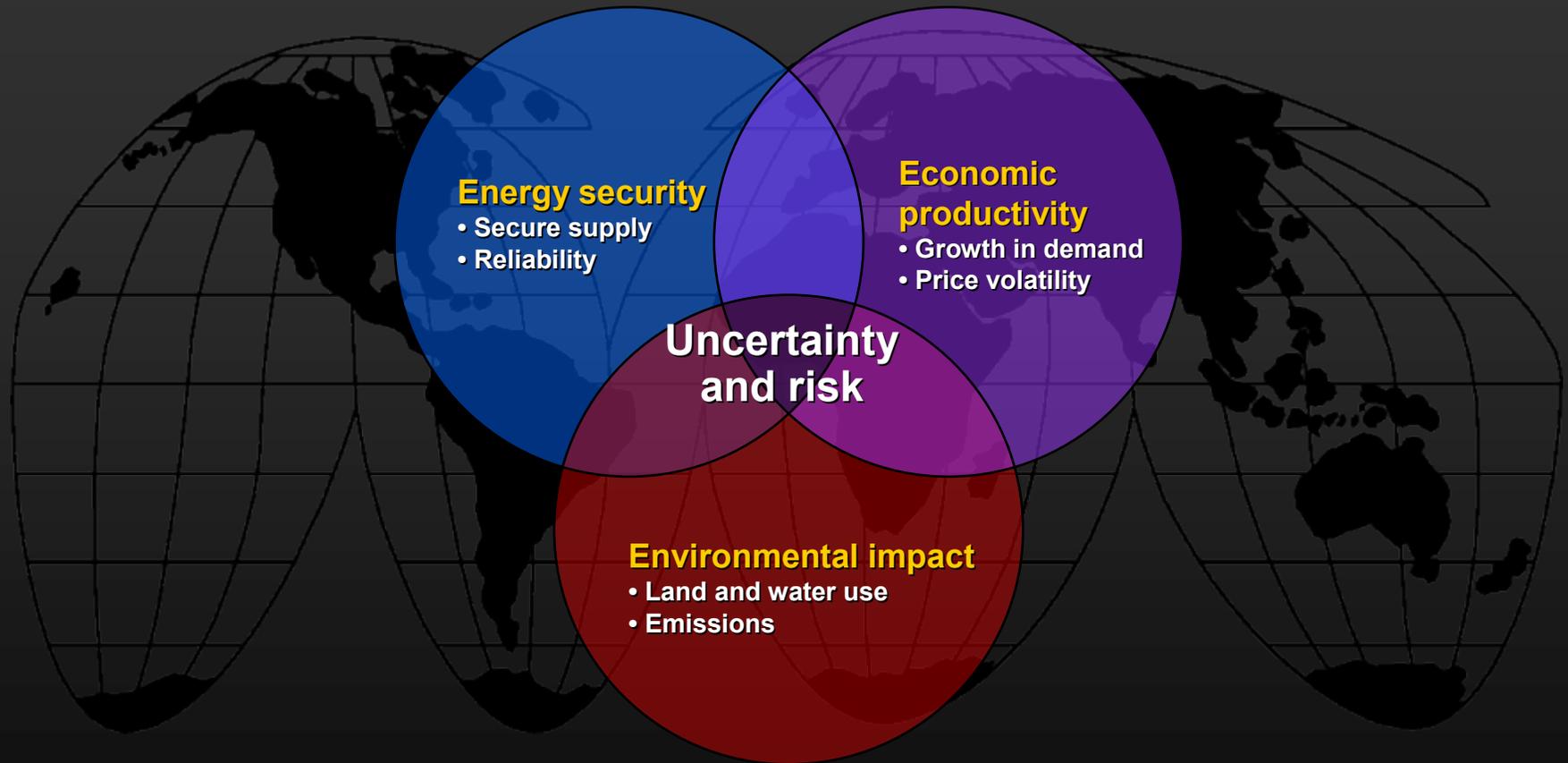
Brought utility-scale wind into our generation mix



Improved energy productivity

***Technology innovations have had a significant impact, but...***

# Energy Solutions are Enormously Challenging



***We need a balanced portfolio of options***

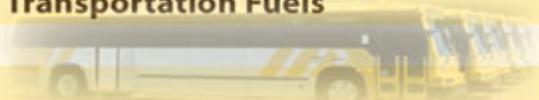
# Technology-based Solutions:

There is no single nor simple answer

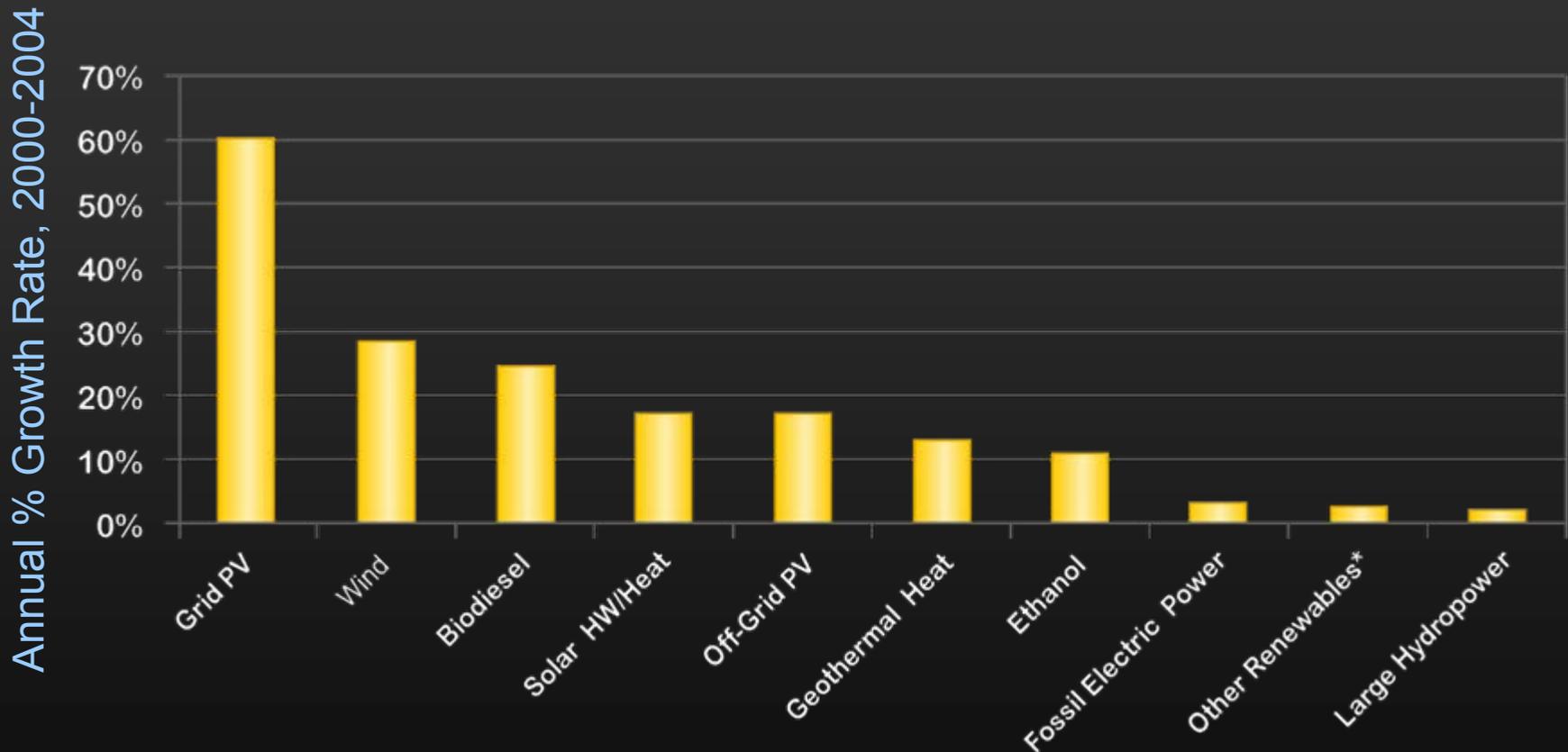
- Energy efficiency
- Renewable energy
- Non-polluting transportation fuels
- Separation and capture of CO<sub>2</sub> from fossil fuels
- Next generation of nuclear fission and fusion technology
- Transition to smart, resilient, distributed energy systems coupled with pollution-free energy carriers, e.g. hydrogen and electricity



# Global Renewable Energy Applications

Renewable Energy Market	Renewable Energy Technology/Application
<b>Power Generation (grid-scale)</b> 	Solar PV Wind turbines Large and small hydropower Geothermal Solar Thermal Power Biomass power Combined heat and power Tidal and wave power
<b>Rural Energy (off-grid)</b> 	Solar PV, Solar Home Systems Small Wind Turbines Small Hydro Solar PV Water Pumps Solar Crop Dryers
<b>Cooking, Heating, and Lighting</b> 	Solar Water Heaters Solar cookers Solid biomass Geothermal heat pumps
<b>Transportation Fuels</b> 	Ethanol Biodiesel

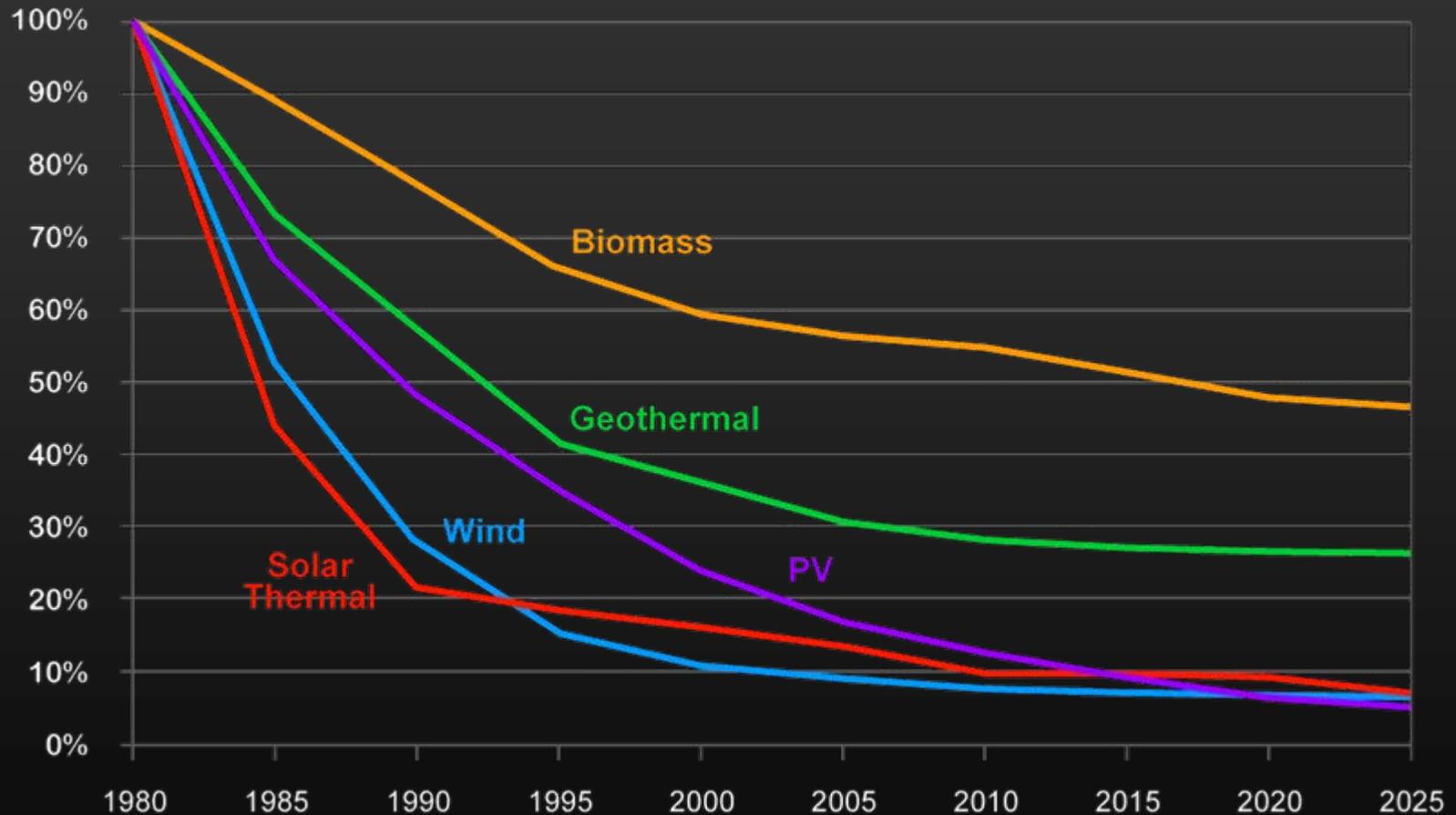
# Growth in Renewable Energy Outpaces all Fuels



\*biomass, geothermal and small hydropower

Source: REN21 2005 and OECD/IEA 2004

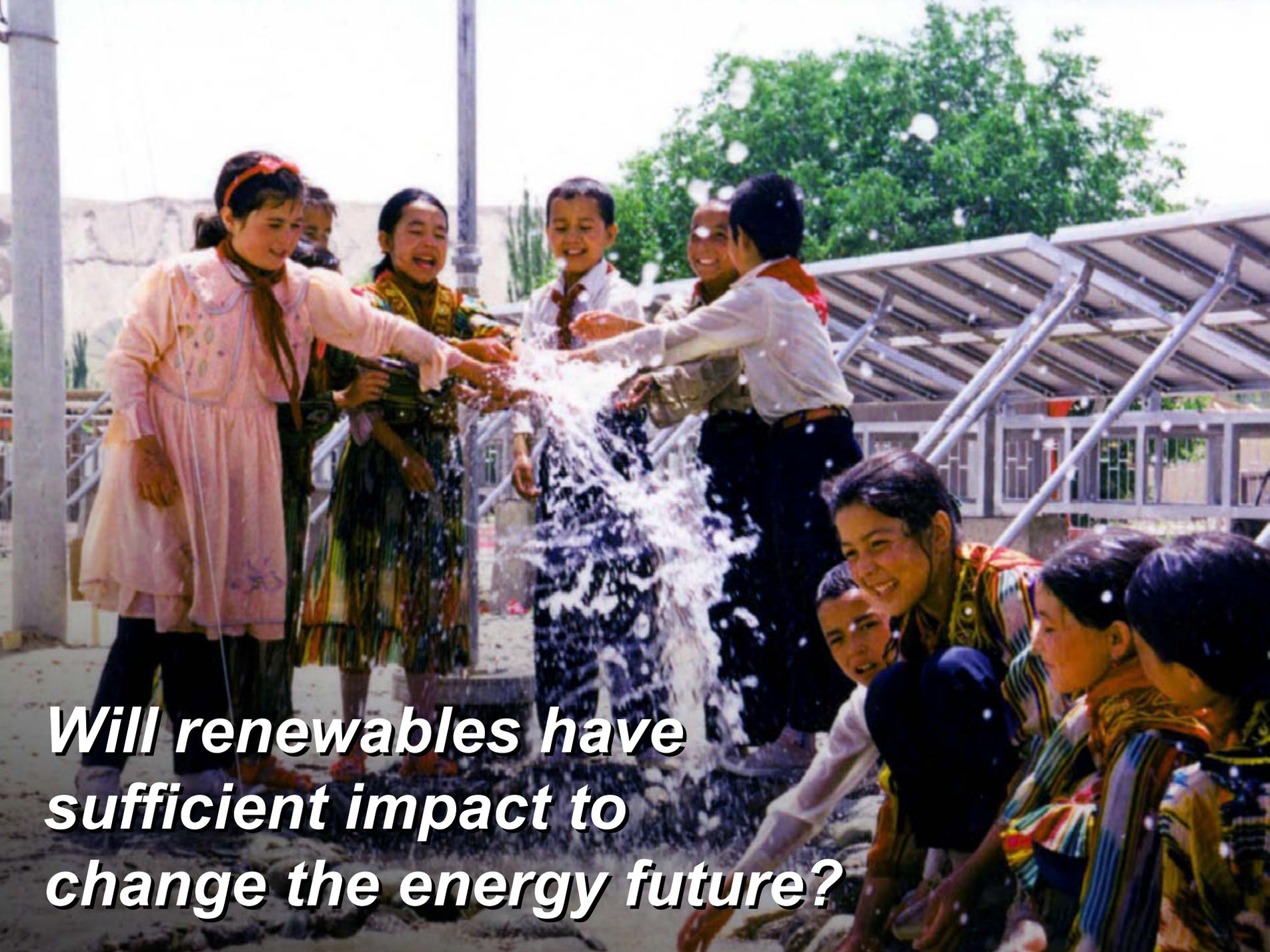
# Renewable Energy Electricity Generation Costs as Percentage of 1980 Levels: Historical and Projected



Source: NREL 2005, 2002

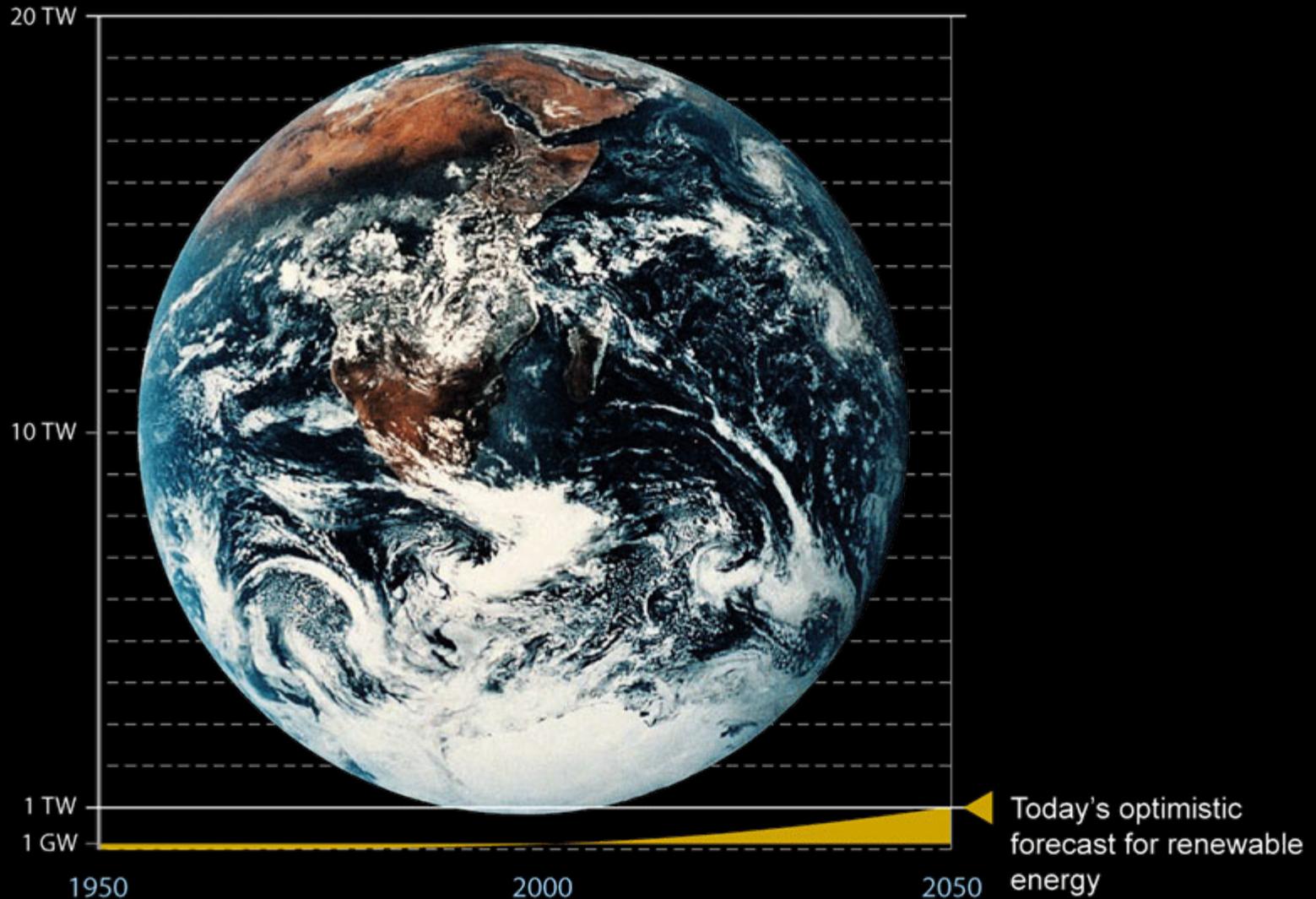
A world map where the landmasses are dark blue and the oceans are a lighter blue. The map is illuminated with a dense pattern of small, bright yellow and white dots, representing city lights or population density. The text is overlaid in the center of the map.

**However, we need terawatts,  
not just gigawatts...**

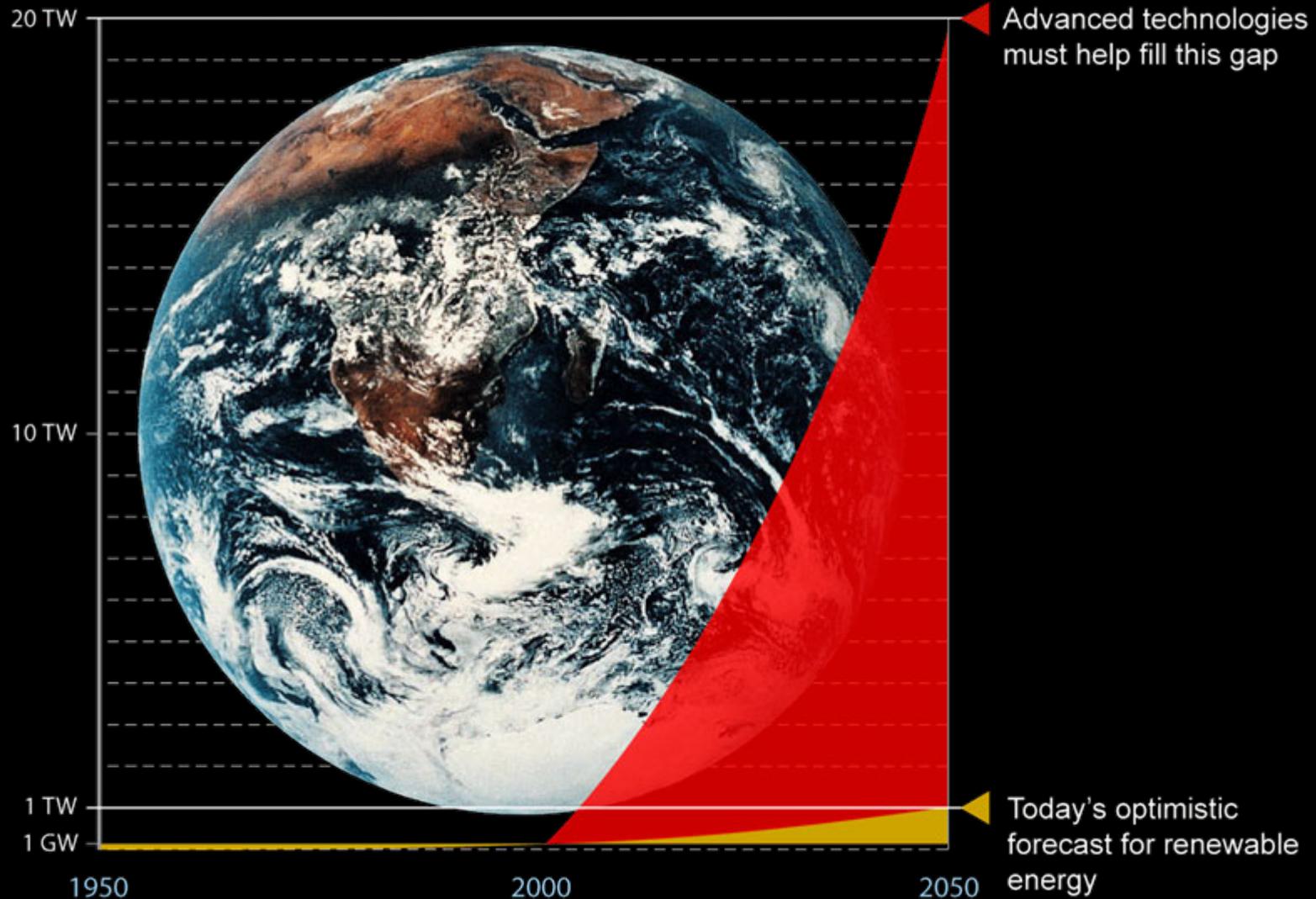


***Will renewables have sufficient impact to change the energy future?***

# Magnitude of Challenge Requires Global Action and a Change in Trajectory



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# Getting There Involves...

**Reducing  
Risk**

**Technologies**

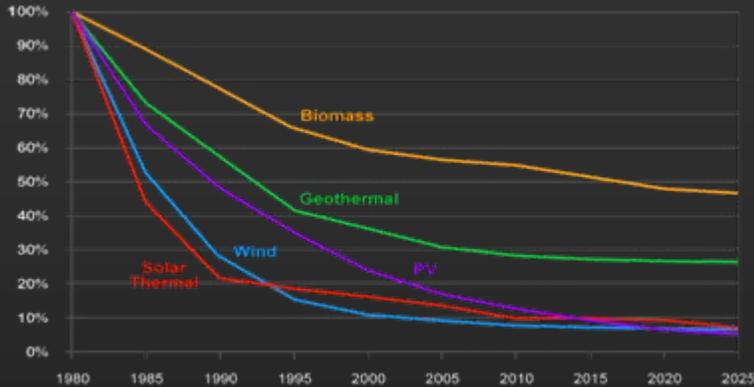
**Capital  
Mobilization**



**Policies**

**Markets**

# The U.S. Government – Like Many Others – Is Making Strong Commitments to Expanding Renewable Energy Use



**Reducing Costs via R&D**

**International Technical Assistance**



**CSD Energy Theme**

**MDG**

**Supporting International Partnerships & Processes**

# Expert Paper Section on Renewable Energy Status and Prospects

- Organized by technology with an overview section
  - Biomass
  - Geothermal
  - Hydropower
  - Solar – CSP, PV, and SHW
  - Wind
- Synthesis by Technology of:
  - Applications
  - Status and trends
  - Technical issues
  - Opportunities

# Biopower/Biofuels



Biopower costs = \$0.08-0.12/kWh : Projected costs = \$0.06-0.07/kWh by 2020  
Current bioethanol costs = \$1.5-5/GGE : Projected costs = \$1-2/GGE by 2025

# Geothermal



Photos courtesy ORMAT



Current costs = \$0.03-0.05/kWh  
Projected costs = \$0.02-0.04/kWh by 2025

# Hydropower



Photos courtesy of UNIDO  
Regional Centre for Small Hydro  
Power



## Current costs

Large Hydropower (over 10MW) \$0.03-0.04/kWh

Small (1-10MW) \$0.04-0.07/kWh

Mini (100-1000kW) \$0.05- 0.10/kWh

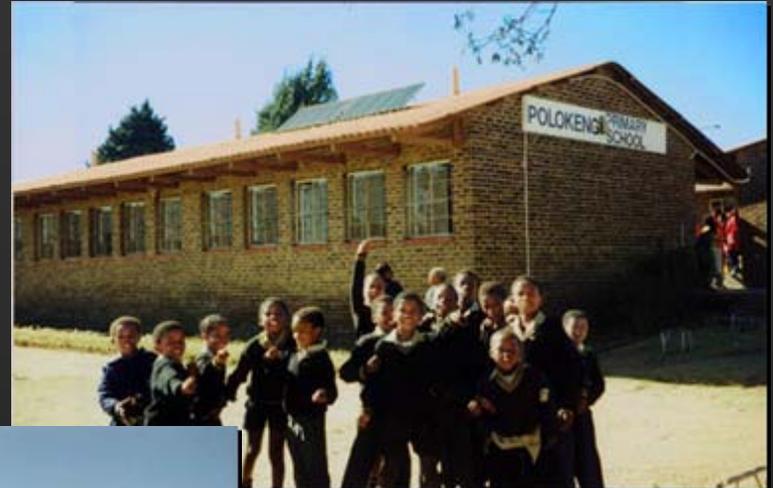
Micro (1-100kW) \$0.07-0.20/kWh

# Concentrating Solar Power



Current costs = \$0.12-0.15/kWh  
Projected costs = \$0.05/kWh by 2025

# Photovoltaics



Current costs = \$0.17-0.32/kWh  
Projected costs = \$0.05-0.07/kWh by 2025

# Solar Hot Water



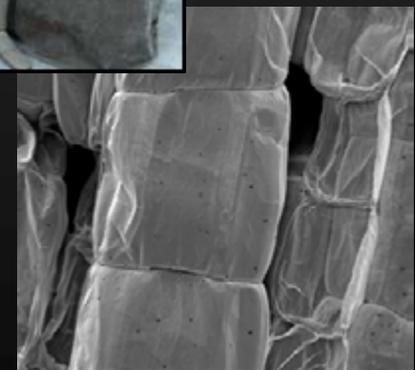
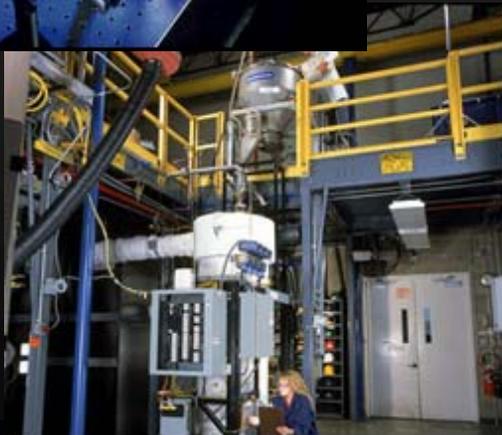
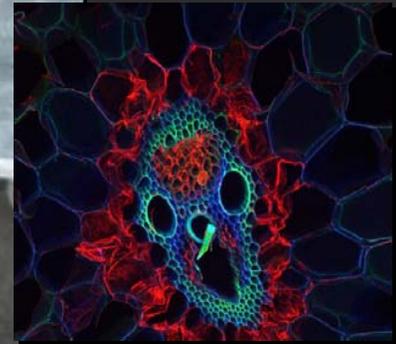
Current costs = \$0.08-0.12/kWh  
Projected costs = \$0.04-0.06/kWh by 2011

# Wind



Current costs = \$0.04-0.06/kWh  
Projected = \$0.03 by 2025

# New Discoveries in Science and Engineering are Helping to Fulfill the Promise of Renewable Energy



# Conclusions

- Renewable Energy has Great Potential
  - Fastest growing energy source as costs decrease and recognition of benefits increases
- Global Action Required to Accelerate Renewable Energy Growth
  - Continued RD&D
  - Capacity building at all levels
  - Sound policies to establish stable markets
  - Mobilization of private investment
- Enhanced International Collaboration is a Key to Success

# The U.S. Department of Energy's National Renewable Energy Laboratory

[www.nrel.gov](http://www.nrel.gov)



**Golden, Colorado**