

# **THE FUTURE OF ELECTRICITY GENERATON**

**Presented at the  
Mid-America Regulatory Conference  
Rapid City, South Dakota, June 2011**

**Roger H. Bezdek, Ph.D., President  
Management Information Services, Inc.  
Washington, D.C., [rbezdek@misi-net.com](mailto:rbezdek@misi-net.com)**



# INTRODUCTION

- What will the electric industry look like 20 or 30 years from now?
  - Worldwide?
  - In the U.S.?
- What is the likely trajectory of the electric industry over the next several decades?
  - Worldwide?
  - In the U.S.?
- Will we still be using fossil fuels?
- Which ones and how much?
- Lessons from Colorado – is mandated fuel switching desirable?

# ELECTRICITY HAS CREATED, SHAPED, & DEFINED MODERN WORLD

Economic growth and electricity usage are closely correlated, & electricity has enabled virtually every technological achievement of the past 100 years, transforming:

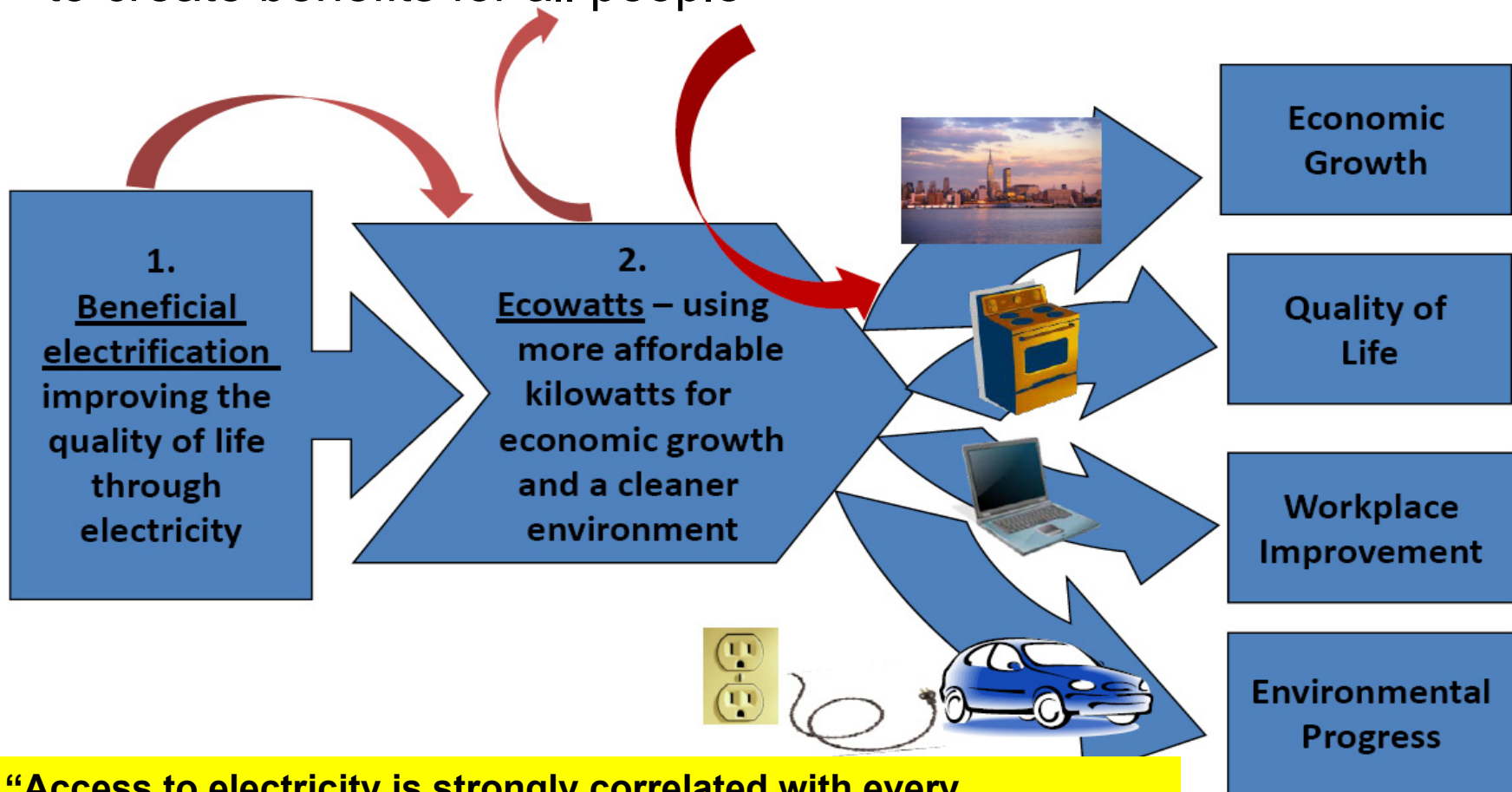
- Industry
- Commerce
- Agriculture
- Transportation
- Medicine
- Communications



**National Academy of Engineering:  
Electrification is “most significant  
engineering achievement of the  
20th Century”**

# ELECTRIFICATION: IMMENSE BENEFITS FOR ALL

**Electro technologies** -- driving the application of ecowatts to create benefits for all people



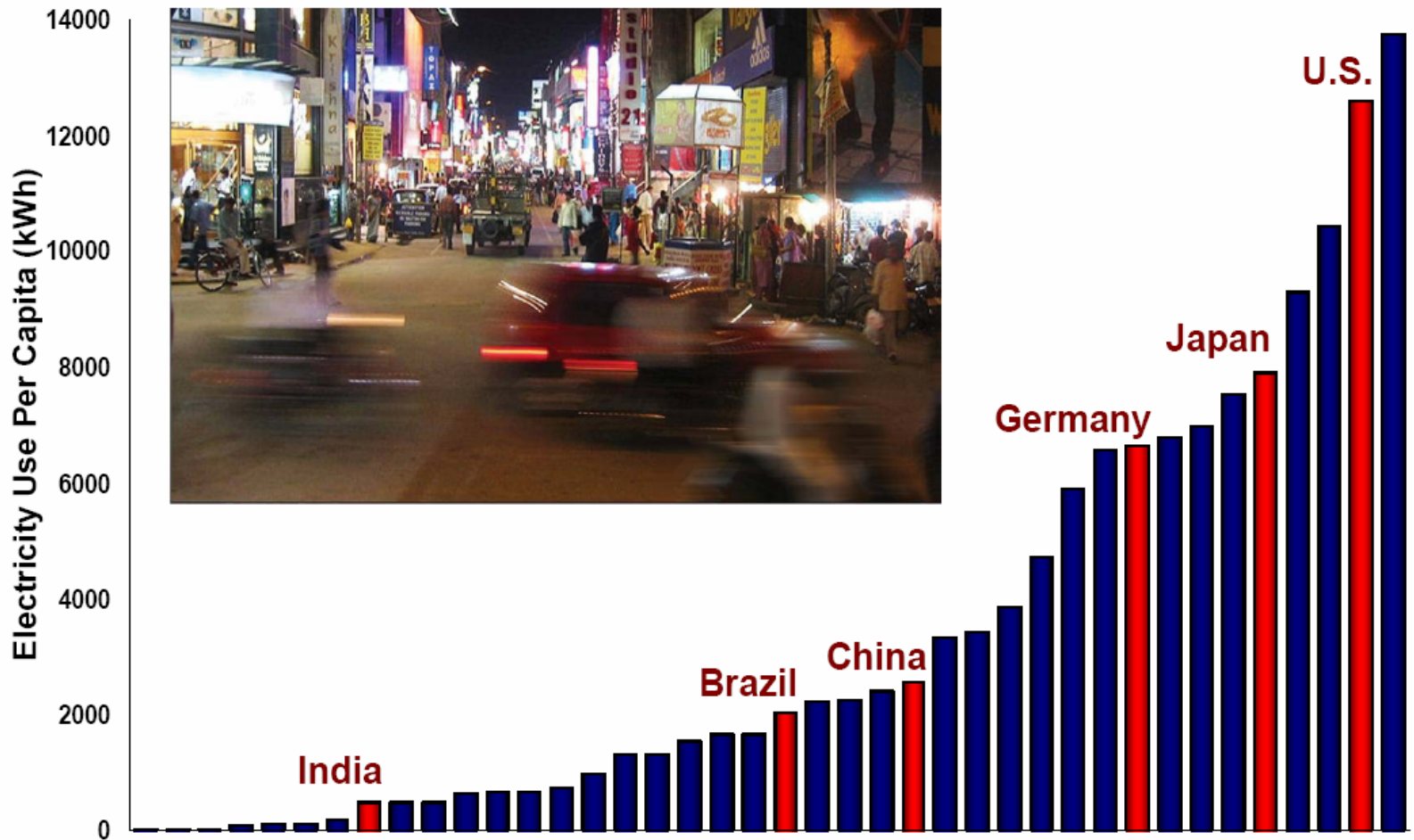
**“Access to electricity is strongly correlated with every measurable indicator of human development” -- *Berkeley Science Review*, 2008**

# ELECTRICITY ESSENTIAL TO WORLD ECONOMY

- **Electricity created modern cities:** Climate control, lighting, elevators, subways, etc.
- **Air conditioning** led to huge geographic population shifts
- Electricity made the **assembly line and mass production** possible
- **Refrigeration & sanitation** technologies made the modern food industries possible – & vastly increased human health and safety
- Electricity revolutionized **transportation:** Vehicles, airlines, mass transit, telecommuting
- Electricity revolutionized **medicine** & greatly increased human health & life spans
- Electricity revolutionized **agriculture**, reducing the required agricultural labor force by 95%
- Electricity created the “**global village:**” Telephone, radio, TV, FAX, cell phones, computers, Internet, IT, satellites, email, social networks, etc.

# ECONOMIC DEVELOPMENT STRONGLY LINKED TO HIGHER ELECTRICITY USE

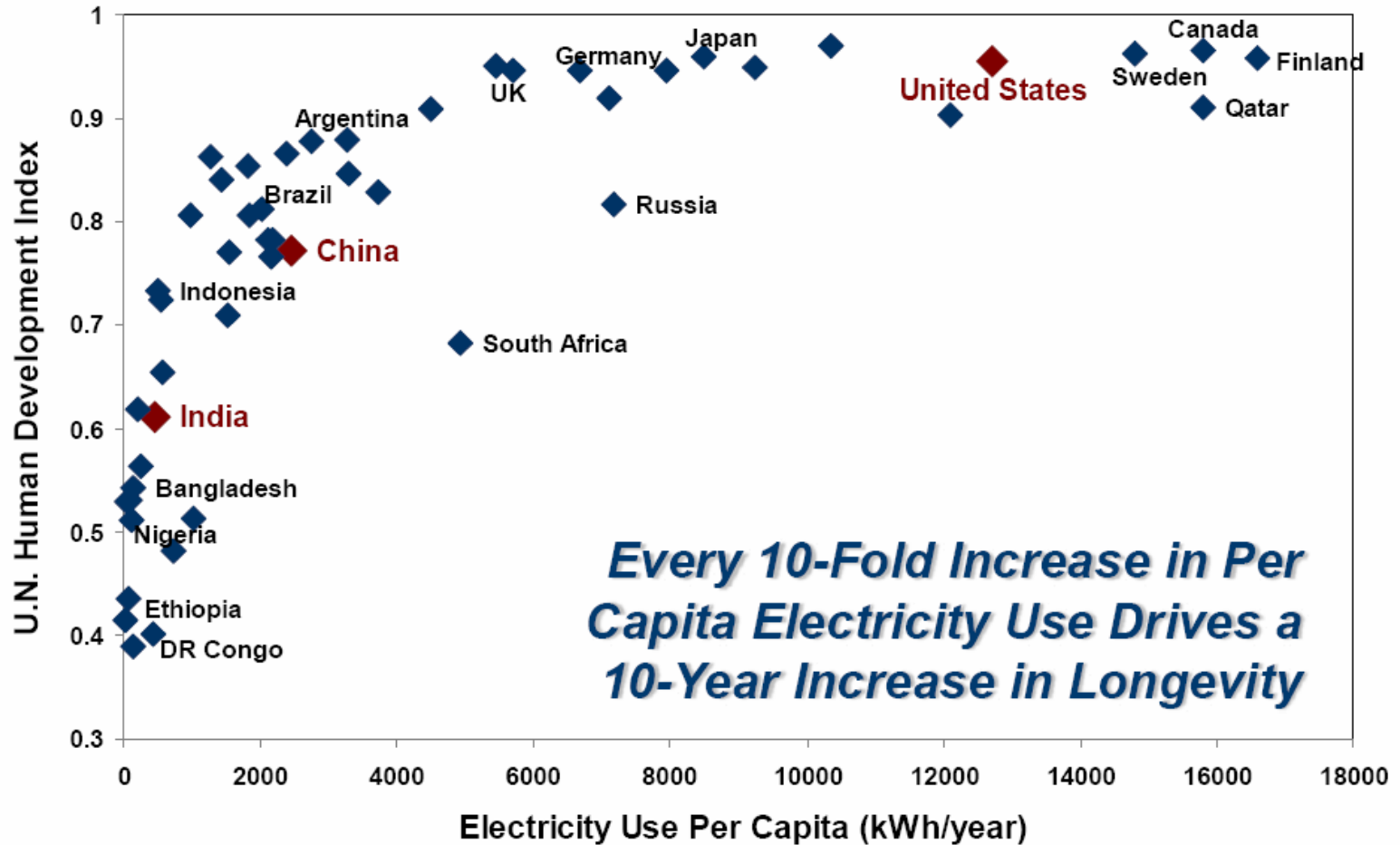
Most Nations Use Less Electricity Than Developed Economies



Source: CIA World Fact Book 2009.

# ELECTRICITY ENABLES PEOPLE TO LIVE LONGER & BETTER

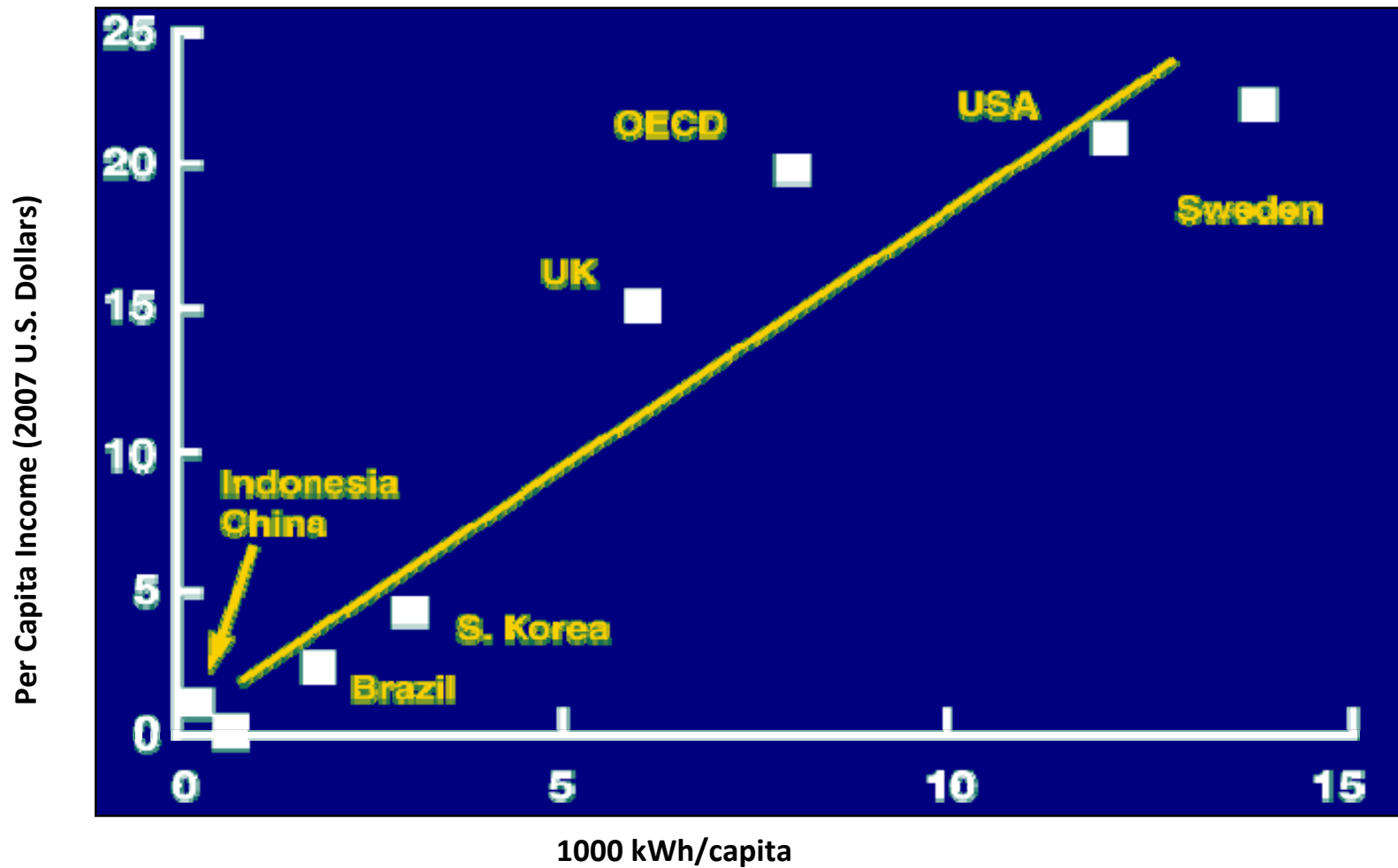
## UN Links Affordable Energy to Quality of Life



Source: CIA World Fact Book 2009, United Nations Development Program's Human Development Report, 2009.

# ELECTRICITY FUELS & SUSTAINS PROSPERITY

## Wealth Expands With Greater Electricity Use

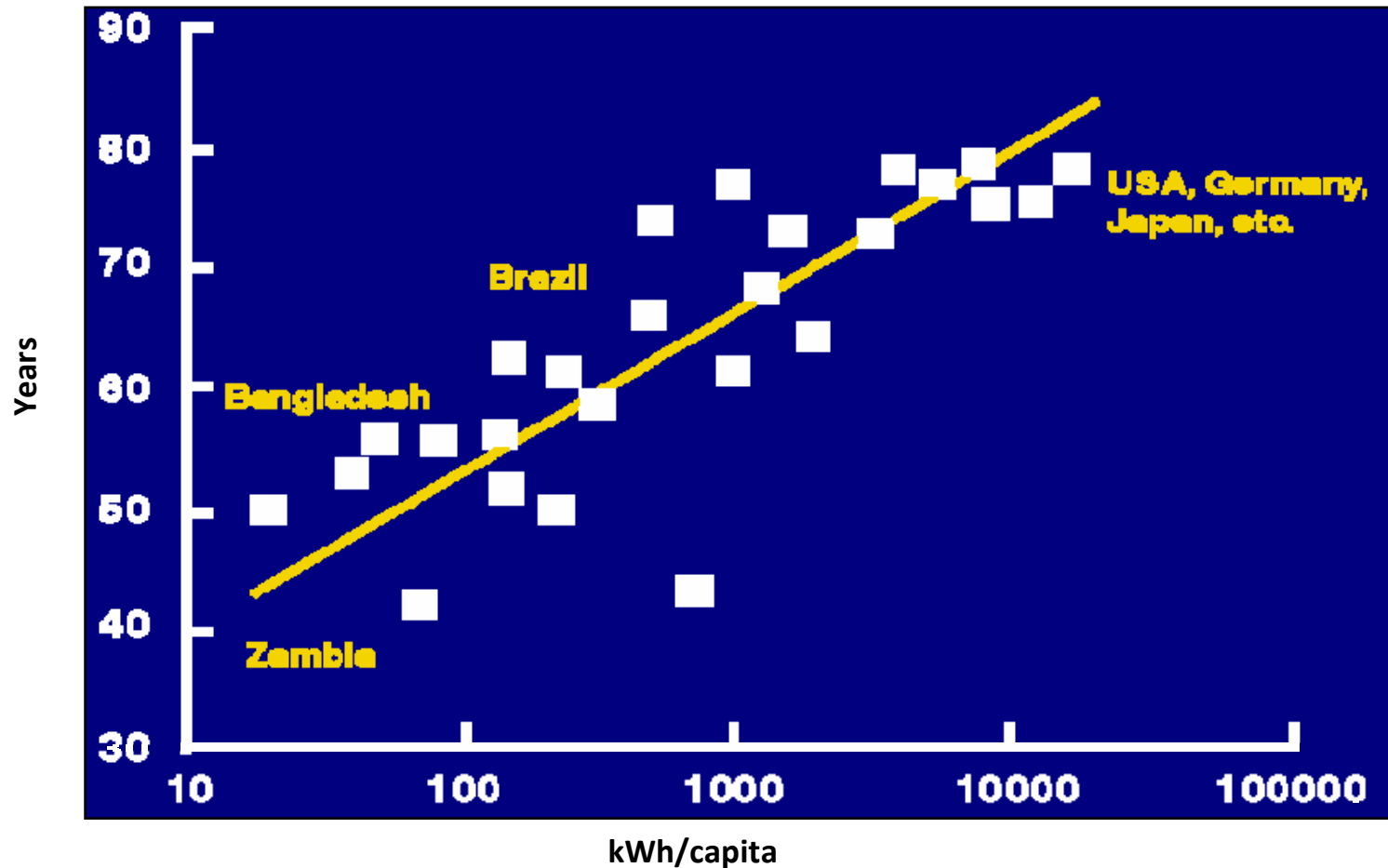


Source: World Resources Institute, IEEE Spectrum



# ELECTRICITY FACILITATES INCREASED HEALTH & WELL-BEING

## Longevity Expands With Greater Electricity Use

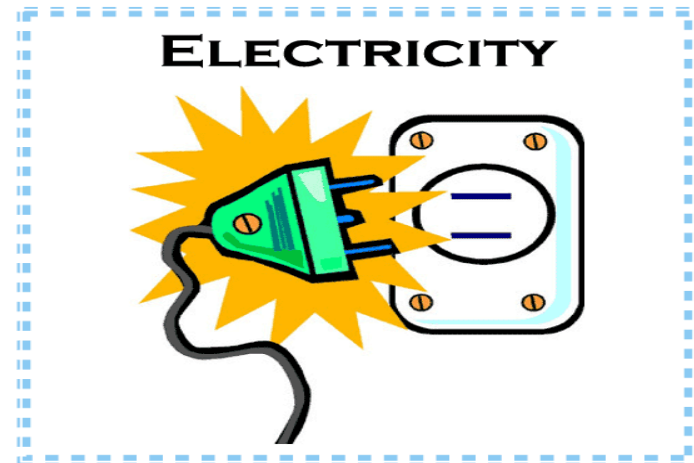


Source: World Resources Institute, IEEE Spectrum

# ELECTRICITY INCREASINGLY IMPORTANT IN 21ST CENTURY

Examples of **electricity's potential this century** to address:

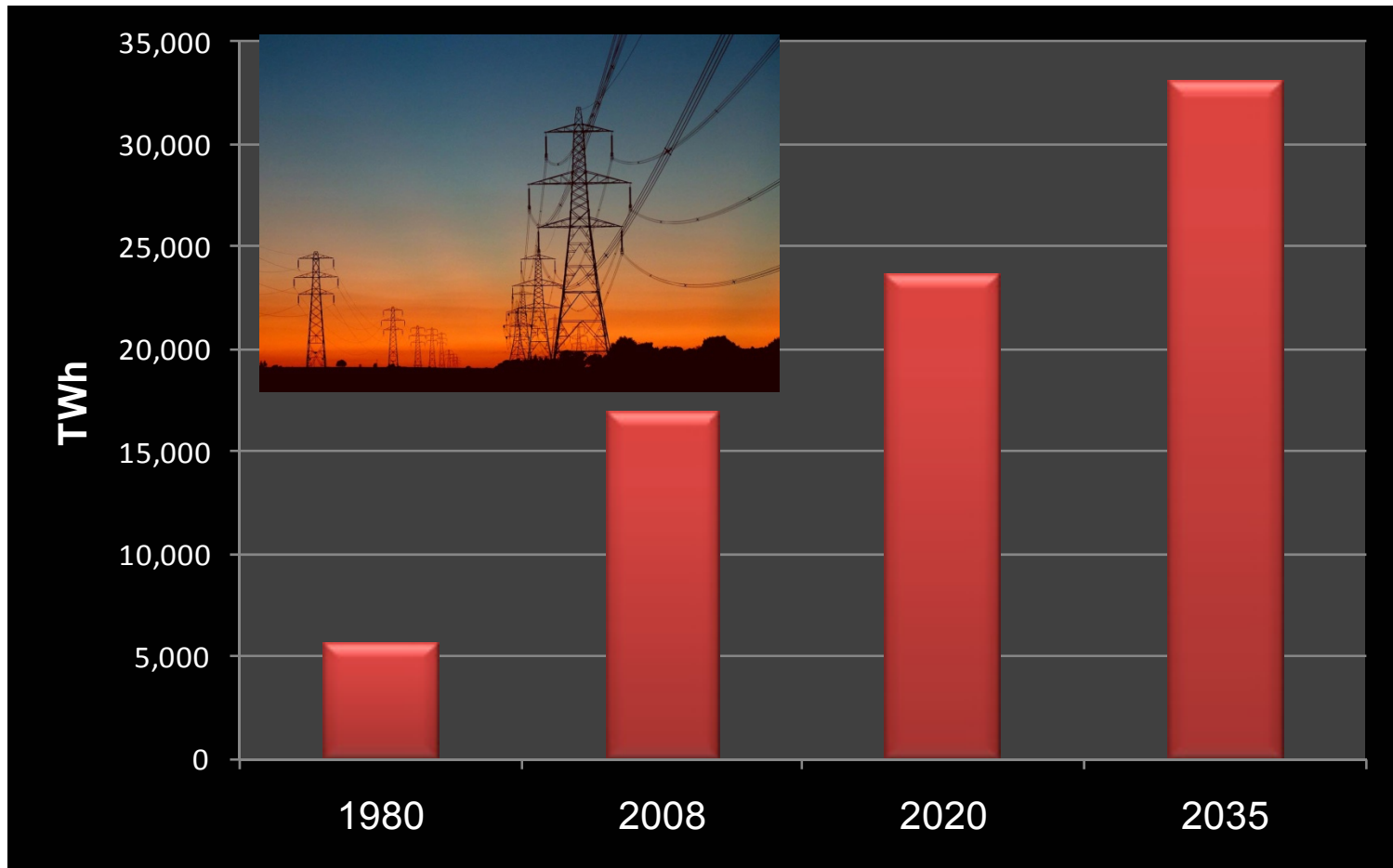
- Energy challenges, electricity use, and energy conservation
- Environmental, sustainability, & climate issues
- Economic development
- Transportation issues
- Improving people's standard of living
- Health, medicine, and bio-tech
- Continuing developments in communications, IT, etc.
- The productivity challenge, electricity use, and productivity growth
- Others: Emerging electro-technologies, new industries, nanotechnology, robotics, superconductivity, space exploration, etc.



**However, Adequate, Reliable, Affordable Electricity Supply is Essential**

# WORLD ELECTRICITY CONSUMPTION WILL DOUBLE BY 2035

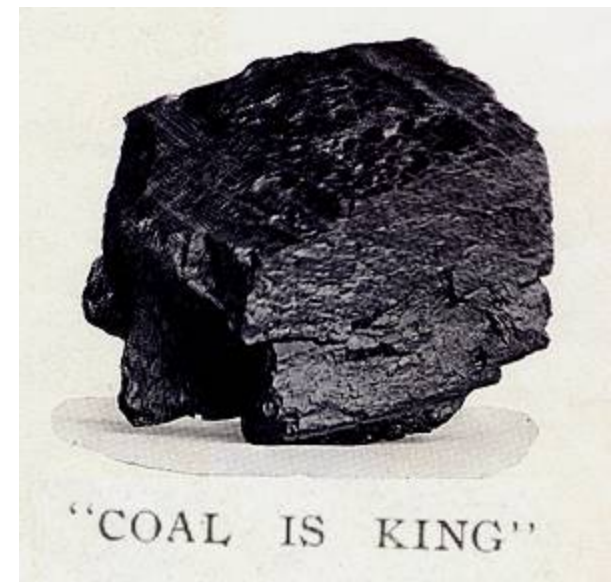
## World Electricity Consumption (Terawatt Hours)



Source: International Energy Agency, 2010.

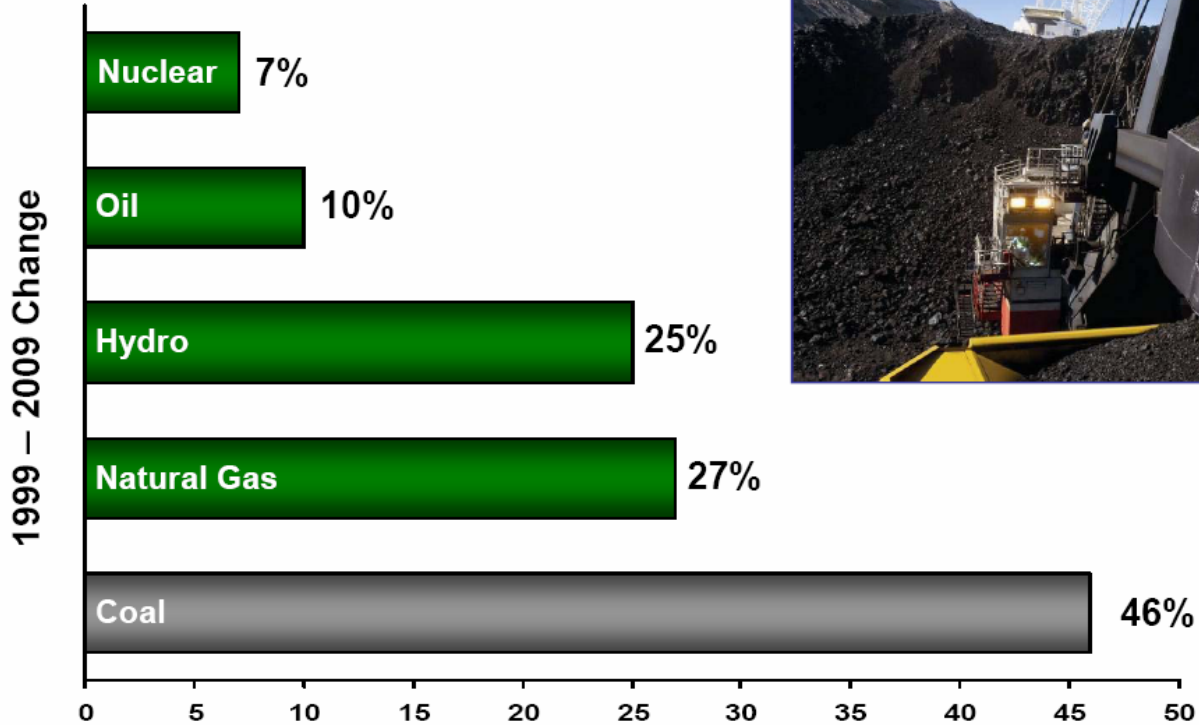
# COAL: PRIMARY WORLD ENERGY SOURCE OF THE PAST, PRESENT, AND FUTURE

- Coal was the world's dominant energy source in the 19<sup>th</sup> century
- Coal was the world's major energy source in the 20<sup>th</sup> century:
  - More energy was obtained from coal than from oil
  - Thus, contrary to common perception, 20<sup>th</sup> century was really the “coal century,” not the “oil century”
- Coal is the world's most rapidly growing energy source in the 21<sup>th</sup> century:
  - Coal use grew twice as fast as any other energy source over past decade
  - Coal's dominance is forecast to continually increase
- ***Coal is the only fuel that can meet world's rising energy demand***



# COAL: WORLD'S FASTEST GROWING FUEL FOR PAST DECADE

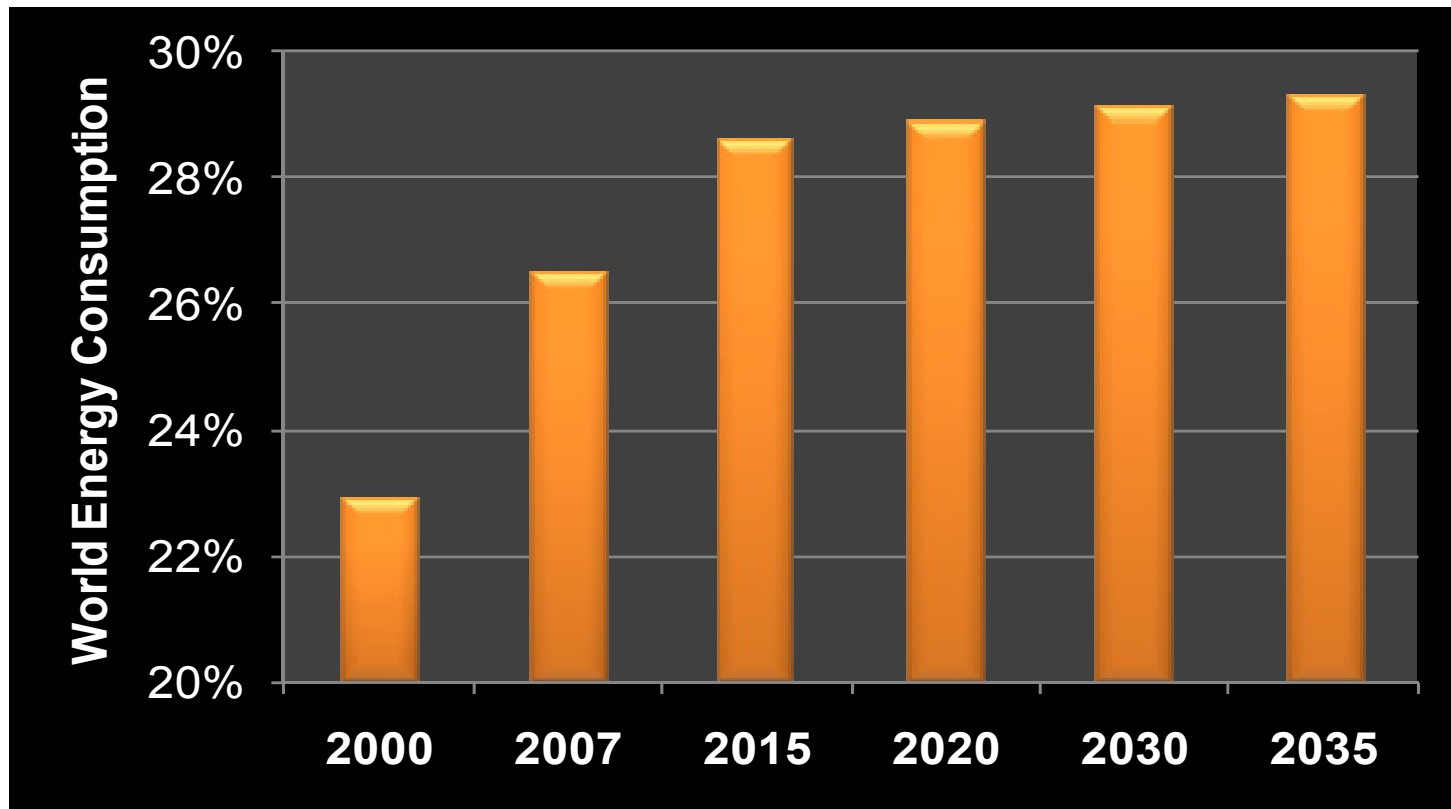
## *Change in Global Energy Consumption*



Source: BP Statistical Review of World Energy, June 2010.

# COAL WILL PROVIDE CONTINUALLY INCREASING SHARE OF WORLD ENERGY

Coal Share of Total World Energy Consumption: 2000 - 2035

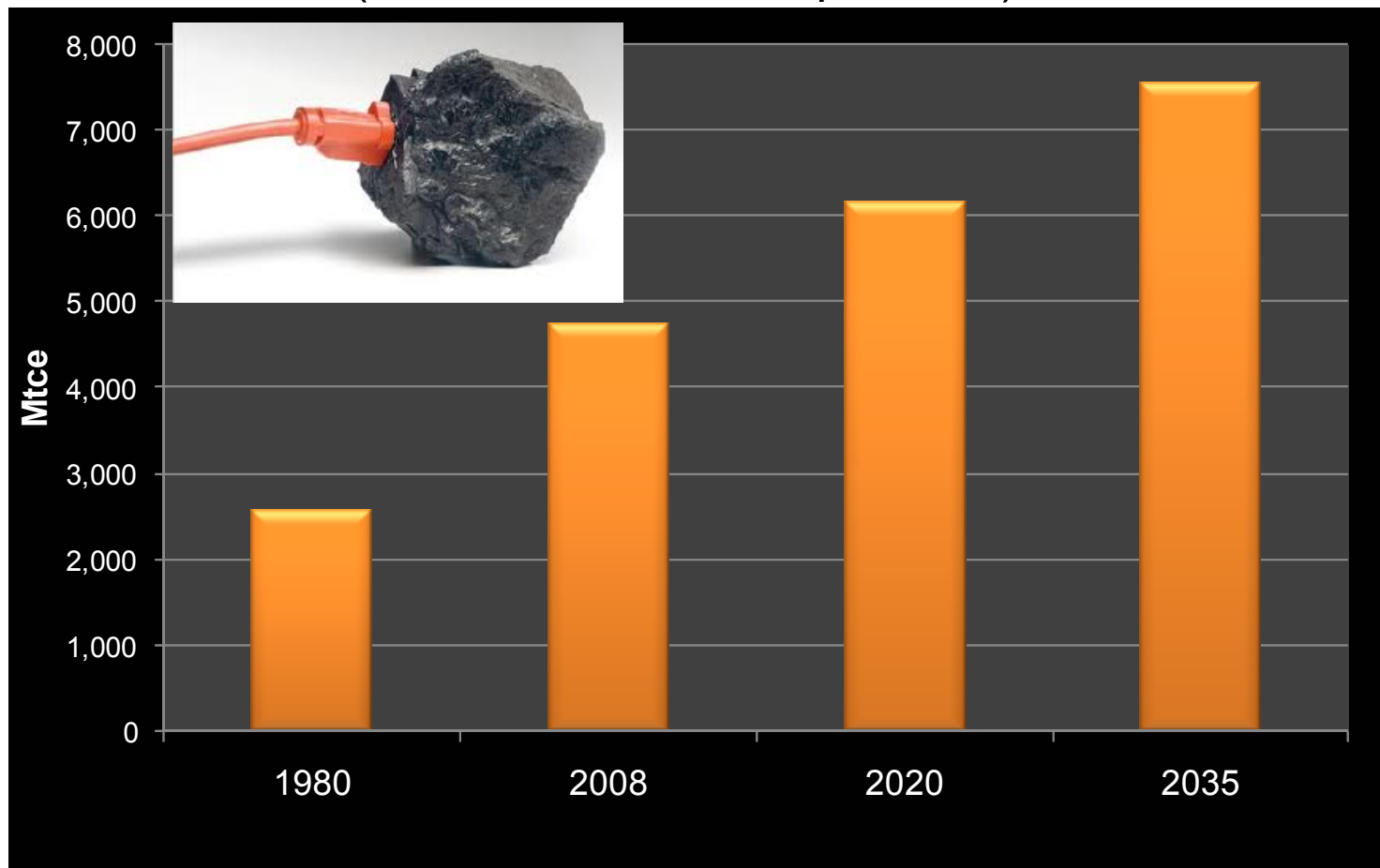


Source: International Energy Agency, 2010.

**Coal's share of total world energy consumption forecast to increase by > 1/4: From < 23% in 2000 to > 29% in 2035.**

# WORLD COAL CONSUMPTION WILL INCREASE 60% BY 2035

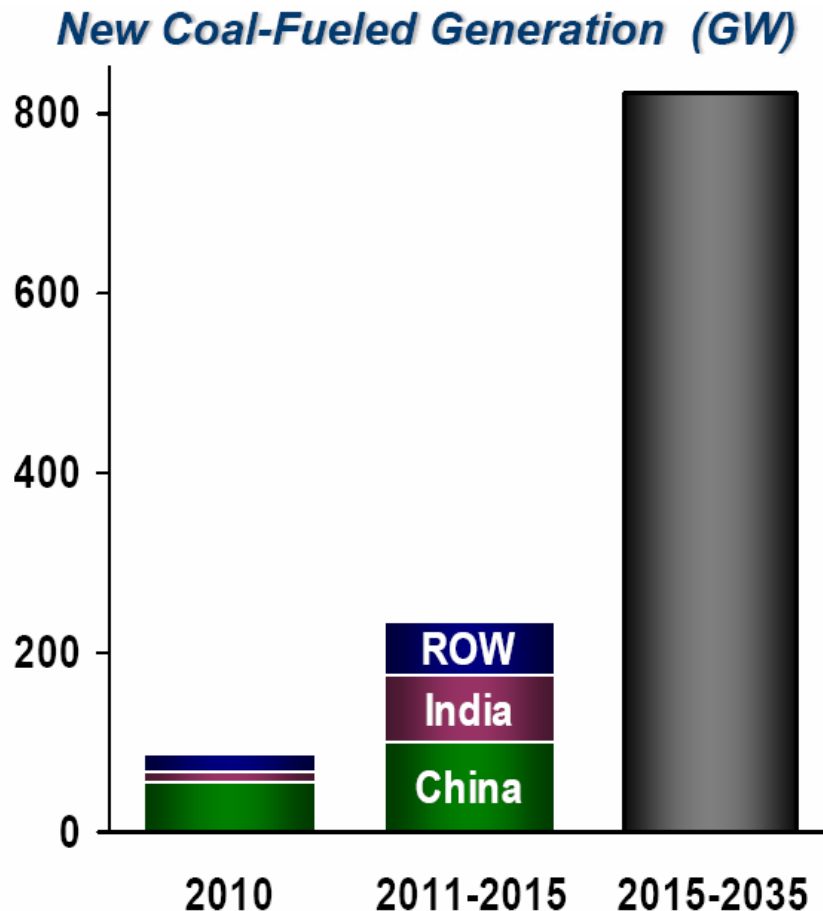
## World Primary Coal Consumption (Million Tons Coal Equivalent)



Source: International Energy Agency, 2010.

# MAJOR NEW GLOBAL BUILD OUT OF COAL GENERATION UNDER WAY

Generation Demand Driven by Asia & Growing Share of Electricity



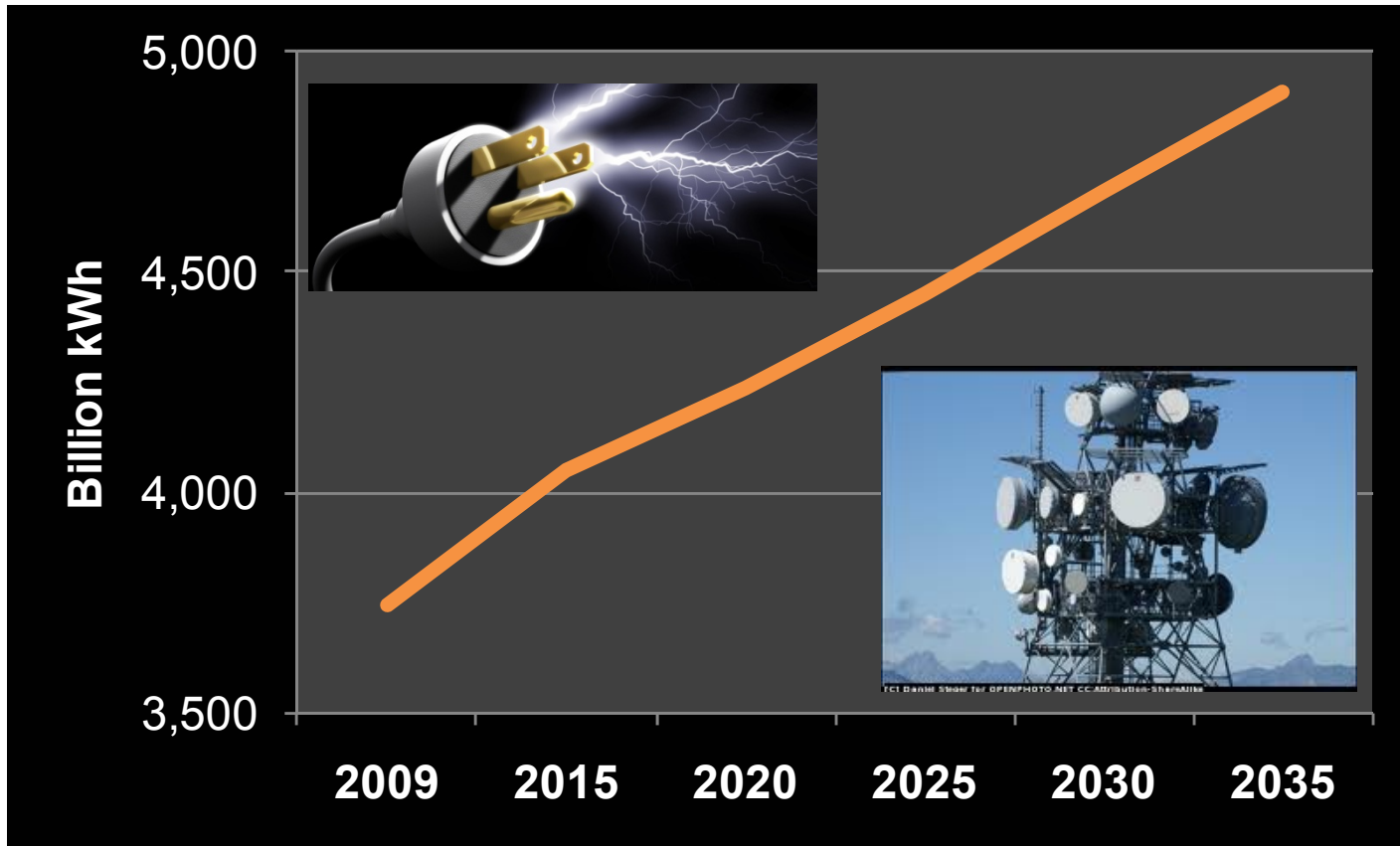
- Global coal-fueled generation expected to grow 90% by 2035
- 340 MTPA coal growth just in new plants starting up in 2010
- 2010 rate equates to ~1 billion tonnes of new demand every three years

Source: Platts Worldwide Power Plant Database and EIA. Global coal-based generation growth based on 2007 –2035.



# U.S. ELECTRICITY USE GROWING RAPIDLY

## U.S. Electricity Consumption, 2009 - 2035

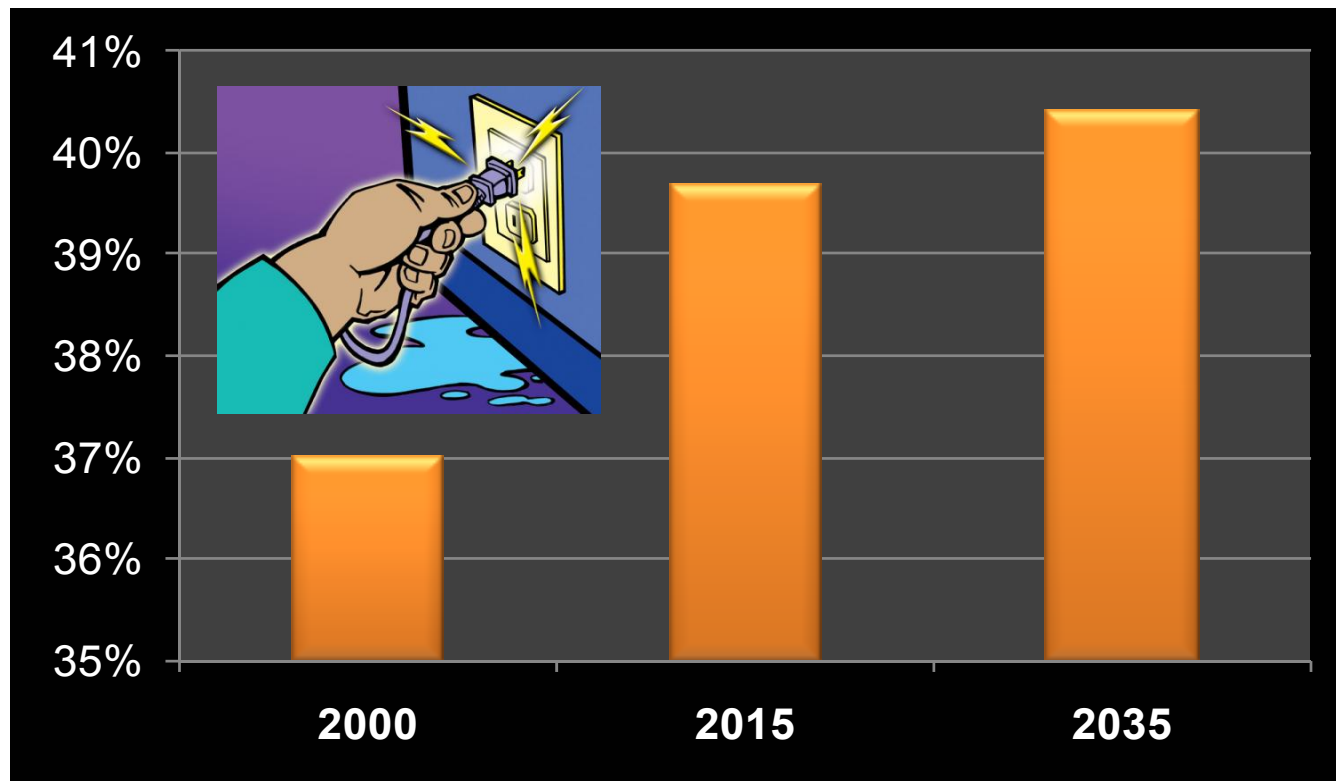


Source: U.S. Energy Information Administration, 2011.

**U.S. electricity consumption will increase > 30% by 2035**

# ELECTRICITY INCREASING IN IMPORTANCE IN U.S. ECONOMY

## Electricity as a Percent of Total U.S. Energy Consumption

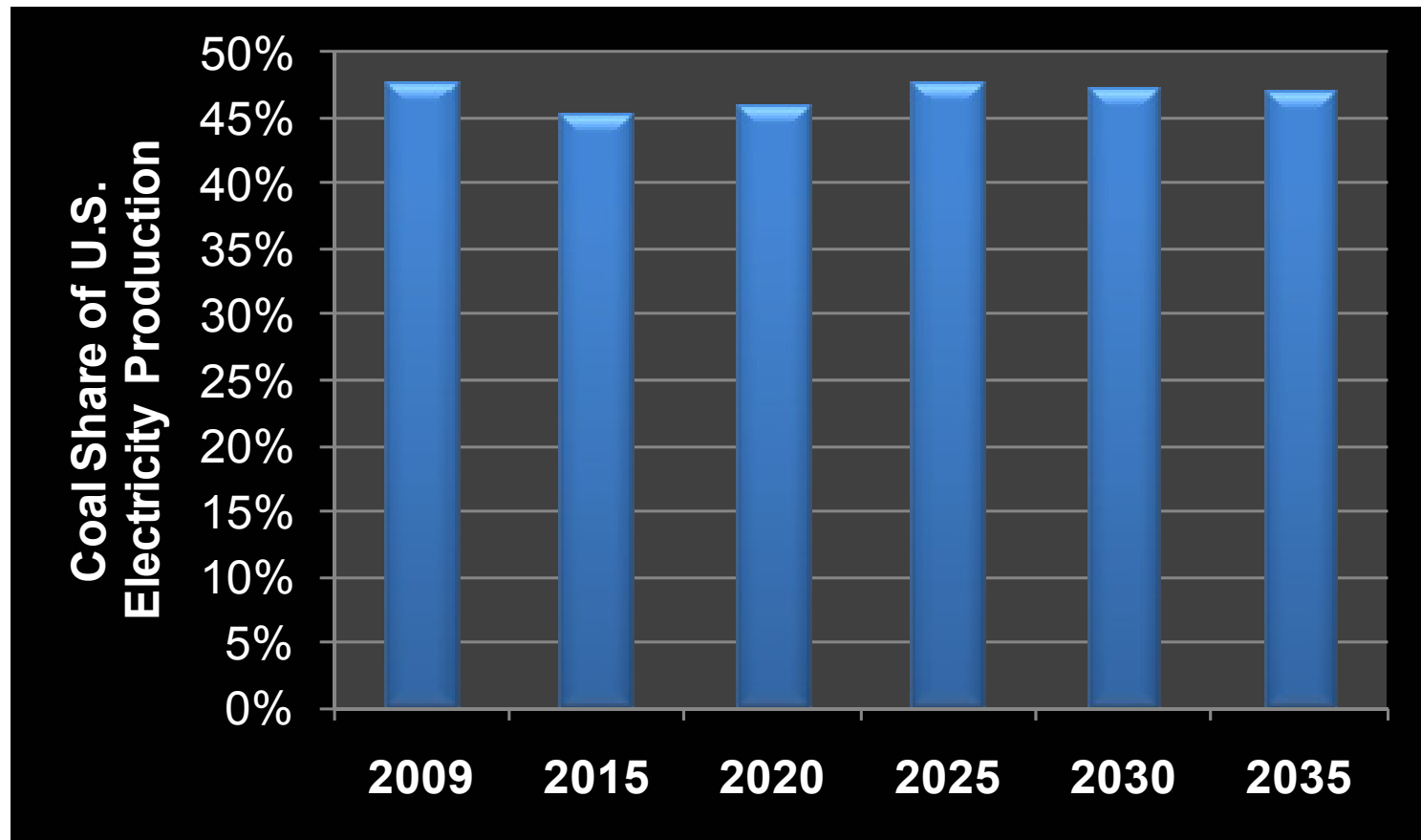


Source: U.S. Energy Information Administration, 2011.

**Share of U.S. energy provided by electricity increases by 10%, as U.S. energy consumption increases 20%**

# COAL WILL REMAIN MAINSTAY OF U.S. ELECTRICITY PRODUCTION

Coal Share of U.S. Electricity Production, 2009 - 2035

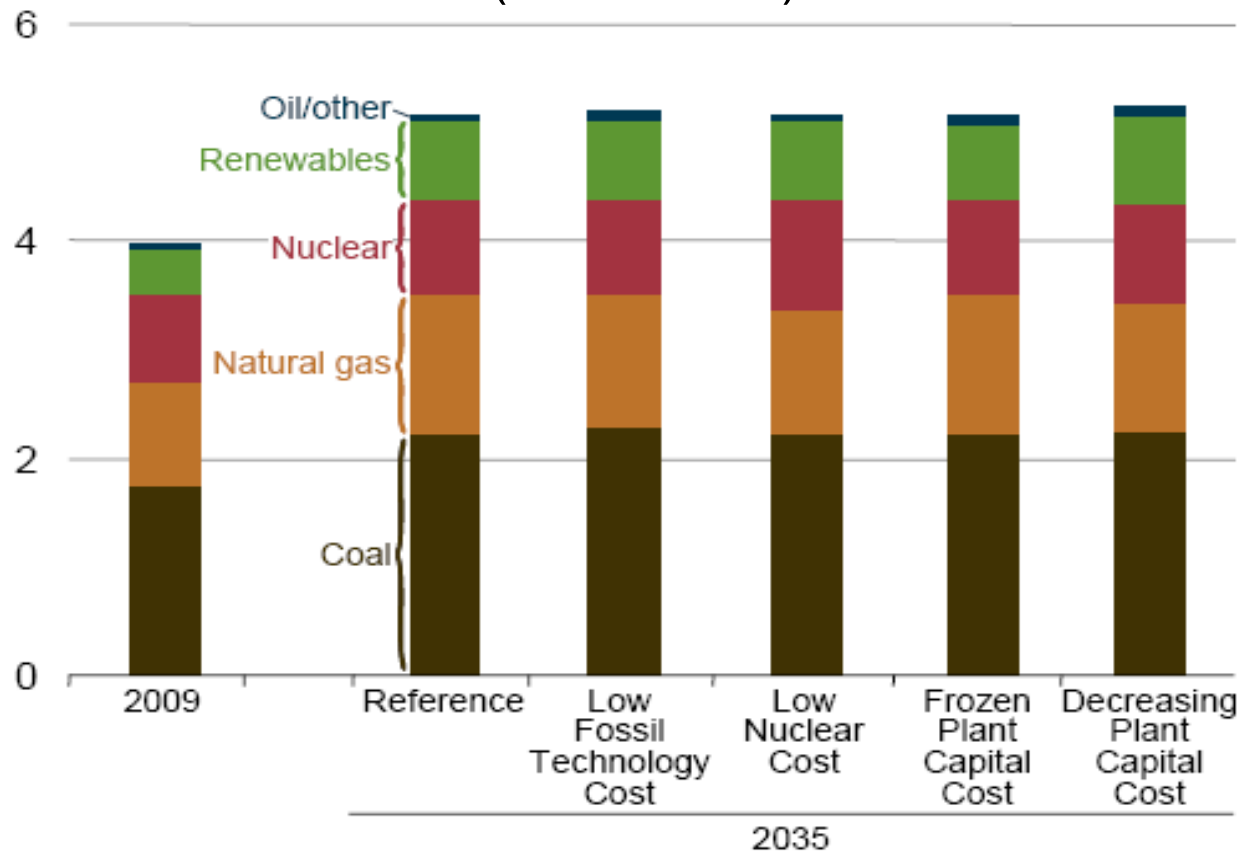


Source: U.S. Energy Information Administration, 2011.

**Coal Will Continue to Produce ~ 45% - 50% of U.S. Electricity**

# COAL REMAINS PRIMARY U.S. ELECTRICITY FUEL ACROSS ALL EIA SCENARIOS

U.S. Electricity Generation in all 5 EIA Scenarios, 2009 & 2035  
(billion kWh)



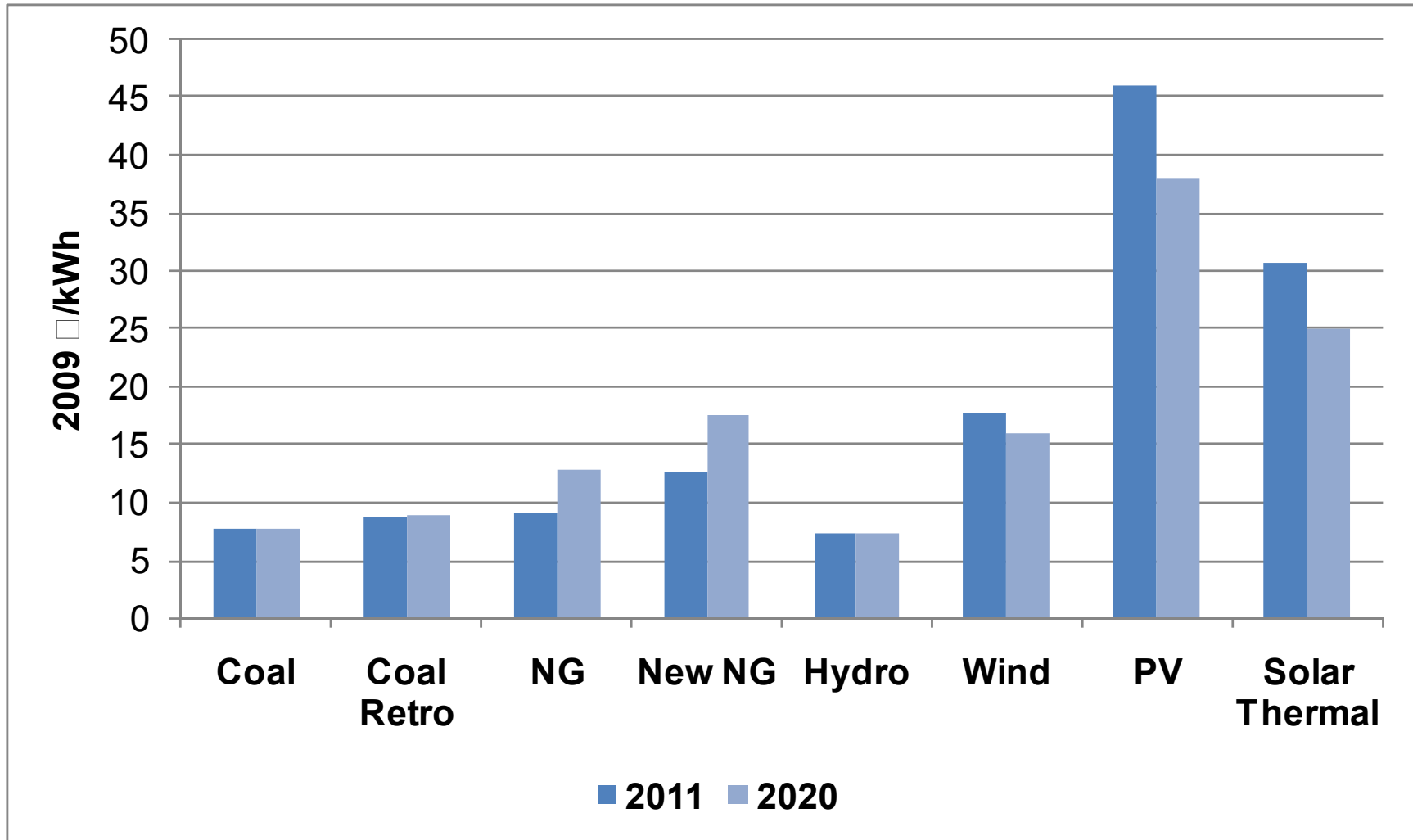
Source: U.S. Energy Information Administration, 2011.

**Coal is largest share of 2035 generation in all scenarios, varying ~ 42% - 44%**

# IS MANDATED FUEL SWITCHING DESIRABLE? THE COLORADO EXPERIENCE

- In 2010, **Colorado enacted Clean Air-Clean Jobs Act (CACJA)**
- Requires PUC to evaluate plan for fuel options & emissions reductions from electricity generation
- Public Service Company of Colorado (PSCo) Plan recommends:
  - Massive shifting of electric generation from coal to natural gas (NG)
  - Retirement of coal power plants
  - Building new NG power plants & pipelines
- Under plan, **20% of state coal-fired generation would be retired & NG-fired generation would increase 50%**
- **We analyze likely energy & economic impacts on Colorado of this fuel switching**

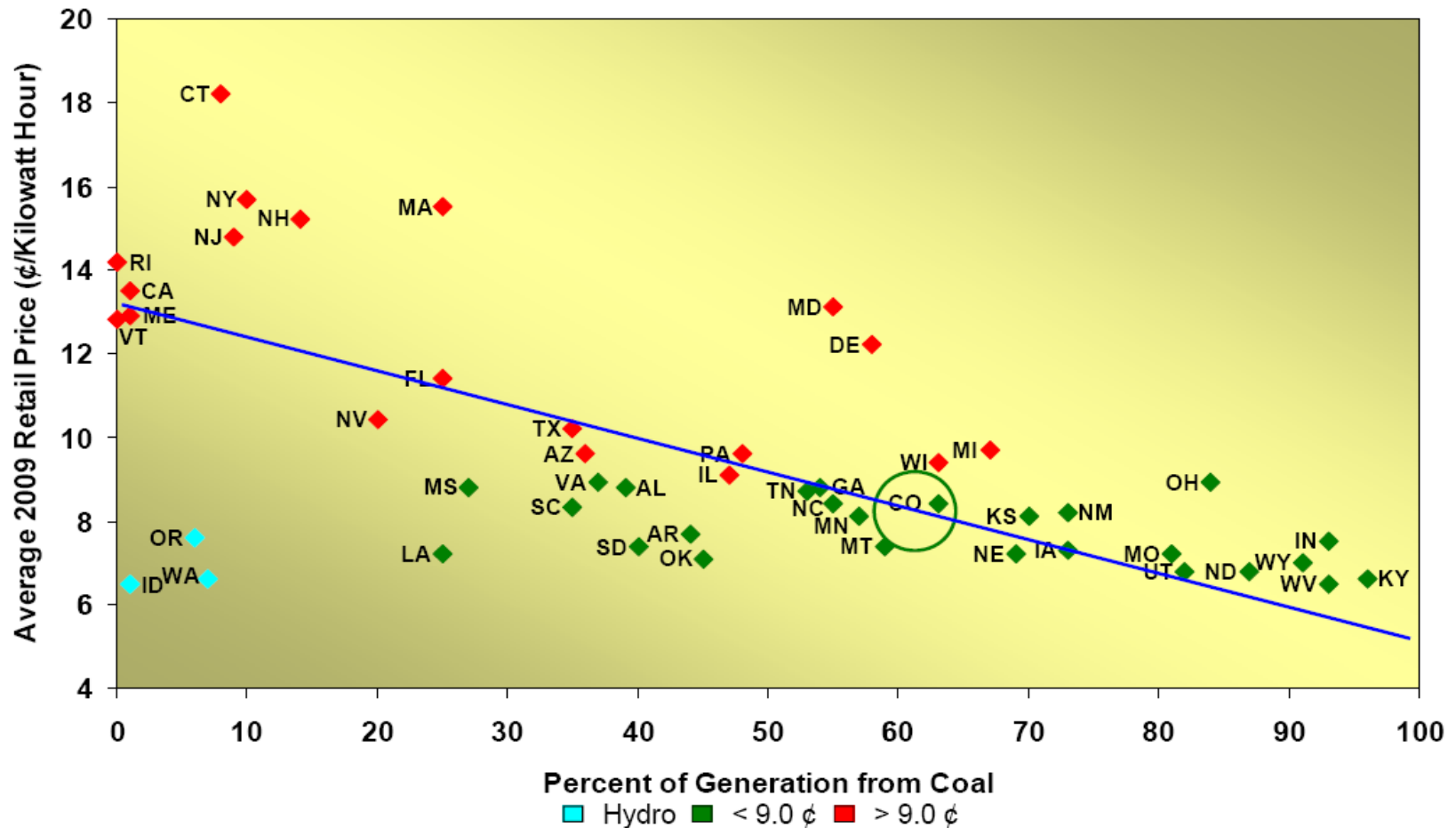
# COLORADO LCOEs



**Coal much less expensive than alternatives (ex. large hydro)**

# COAL GENERATES INEXPENSIVE ELECTRICITY

## Relationship Between Coal Generation & Electricity Prices by State

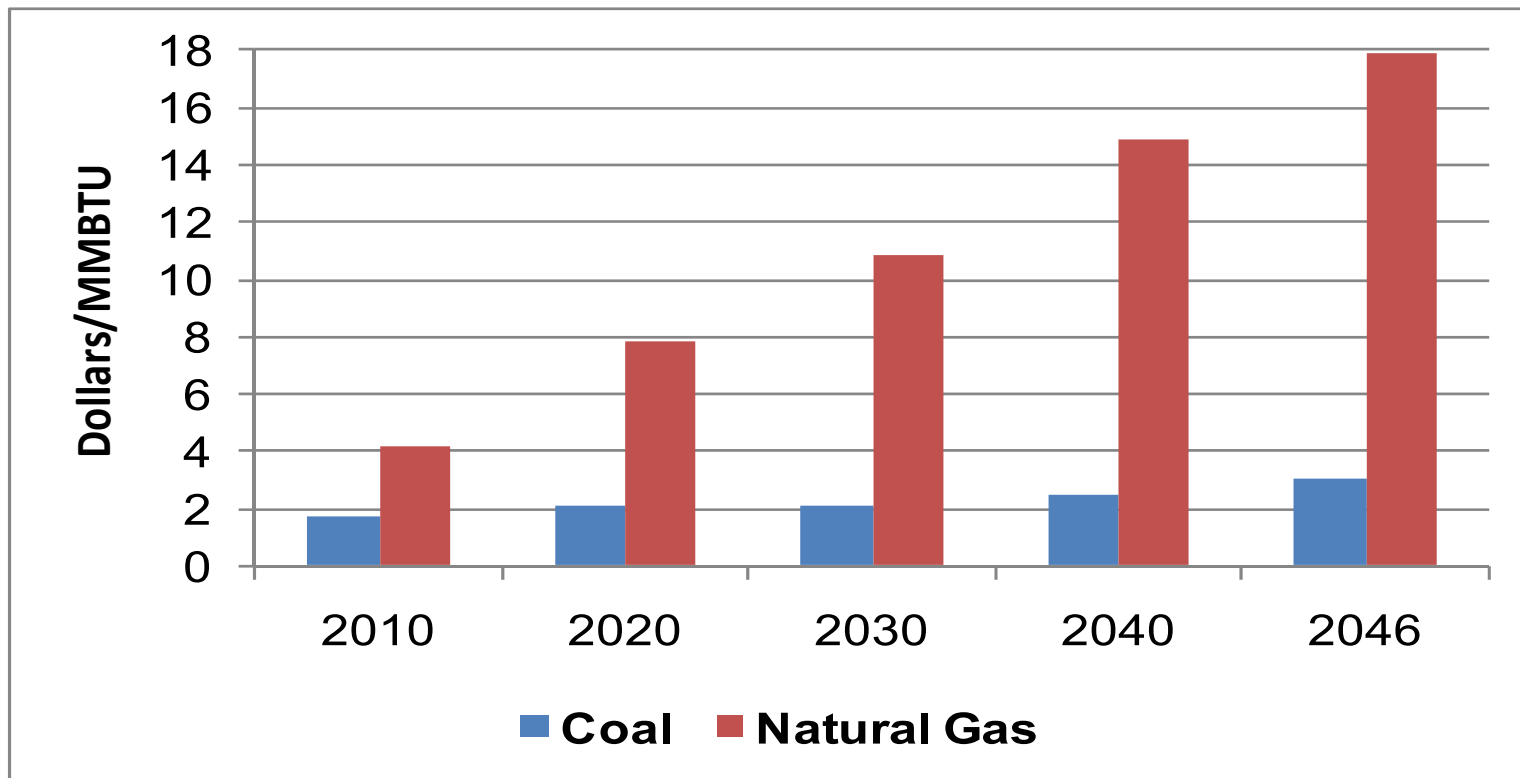


Source: Energy Information Administration, March 2010.

# PSCo FORECASTS HUGE INCREASES IN NG COSTS

NG goes from being twice as expensive as coal to 6  
times as expensive

## PSCo Fuel Cost Forecasts

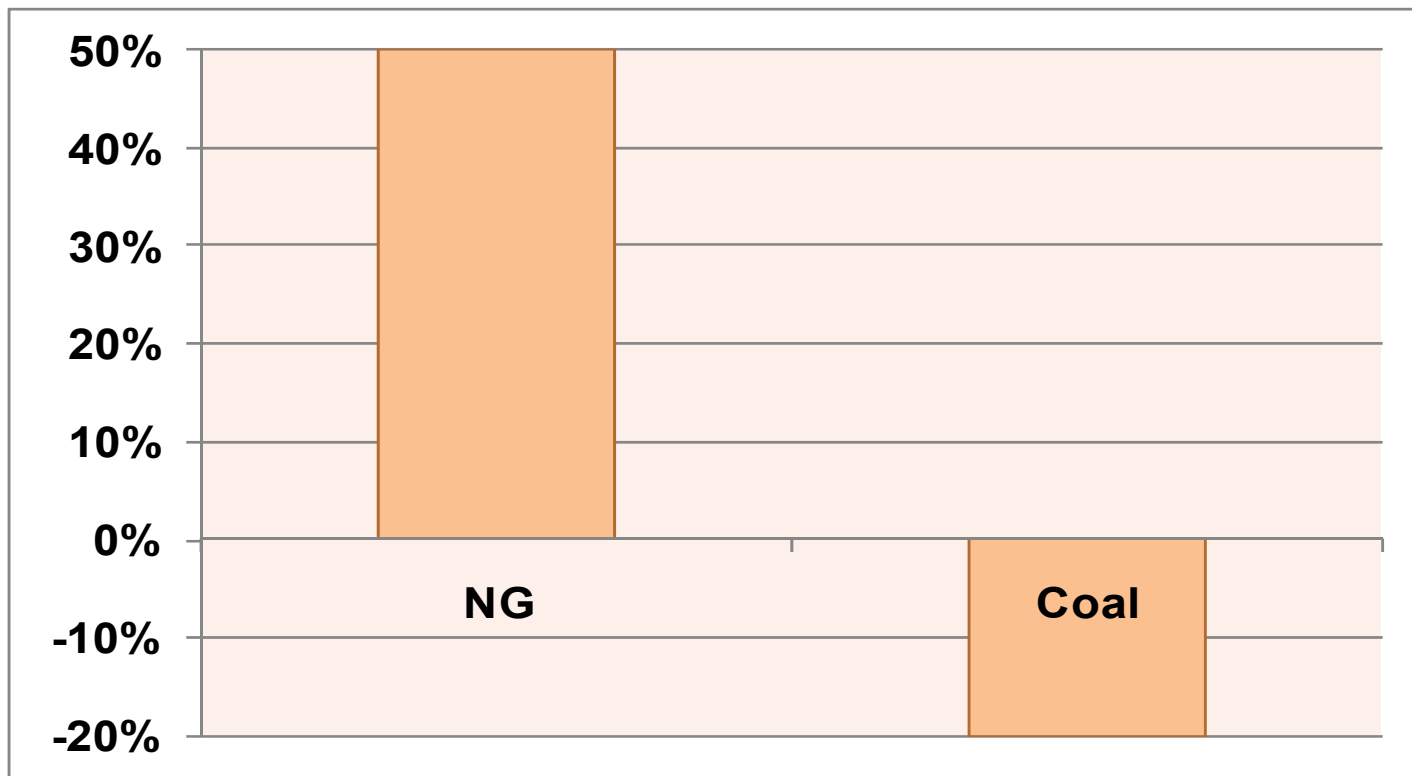


Source: PSCo Filing 6-30-10 and Management Information Services, Inc., 2011.



# PSCo FUEL INPUTS CHANGE DRAMATICALLY

## Change in PSCo Generation Mix, 2011 - 2020



**Requires equivalent of NG consumed annually by > 1/2 of Colorado residences**

## 3 SCENARIOS

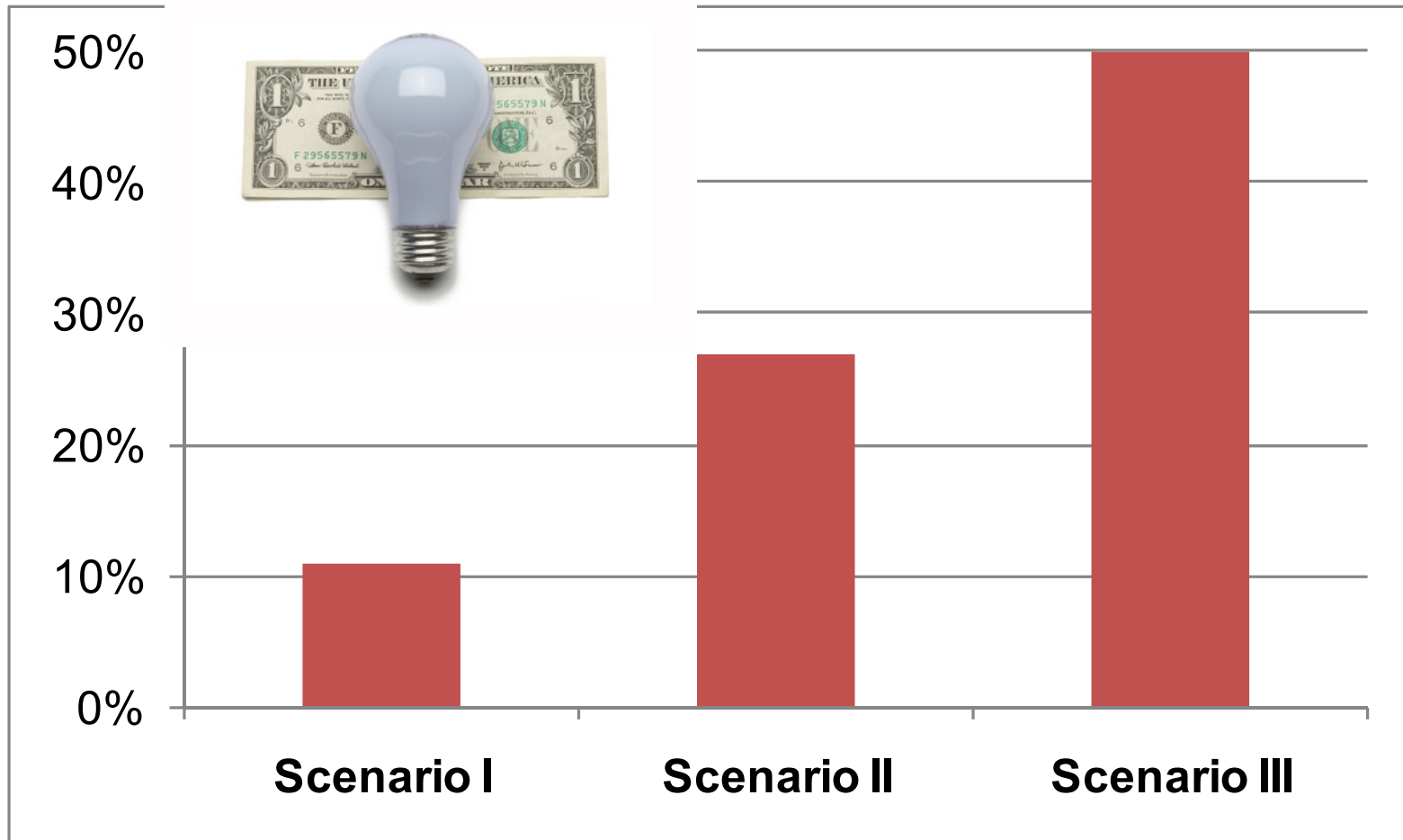
- **Scenario I:**
  - Entire 20% reduction in coal use made up by NG
  - NG generation increases > 50%
- **Scenario II:**
  - Entire 20% reduction in coal use made up by NG
  - NG electricity increases > 50%
  - NG LCOEs increase due to increased use of NG (based on econometric studies of relationship between increased NG use & NG prices)
- **Scenario III:**
  - NG generation increases 24%, & NG LCOEs increase
  - Increased generation also from wind & renewables
  - Renewable LCOEs increase due to large % increase in utilization over short time

## RESULTS ARE INEVITABLE AND OMINOUS

- **It ain't rocket science!**
- PSCo Plan implies large reduction in use of least expensive fuel – coal
- Plan implies huge increase in use of more expensive fuels: NG & renewables
- According to PSCo forecasts, NG goes from being twice as expensive as coal in 2010 to 4 times as expensive in 2020
- **Plan thus uses more & more of more expensive fuel**
- NG fuel cost ~ 70% of NG LCOE
- **Very large increases in PSCo costs are inevitable**

# ELECTRICITY COSTS WILL INCREASE

## Electricity Cost Increases



Source: Management Information Services, Inc., 2011.

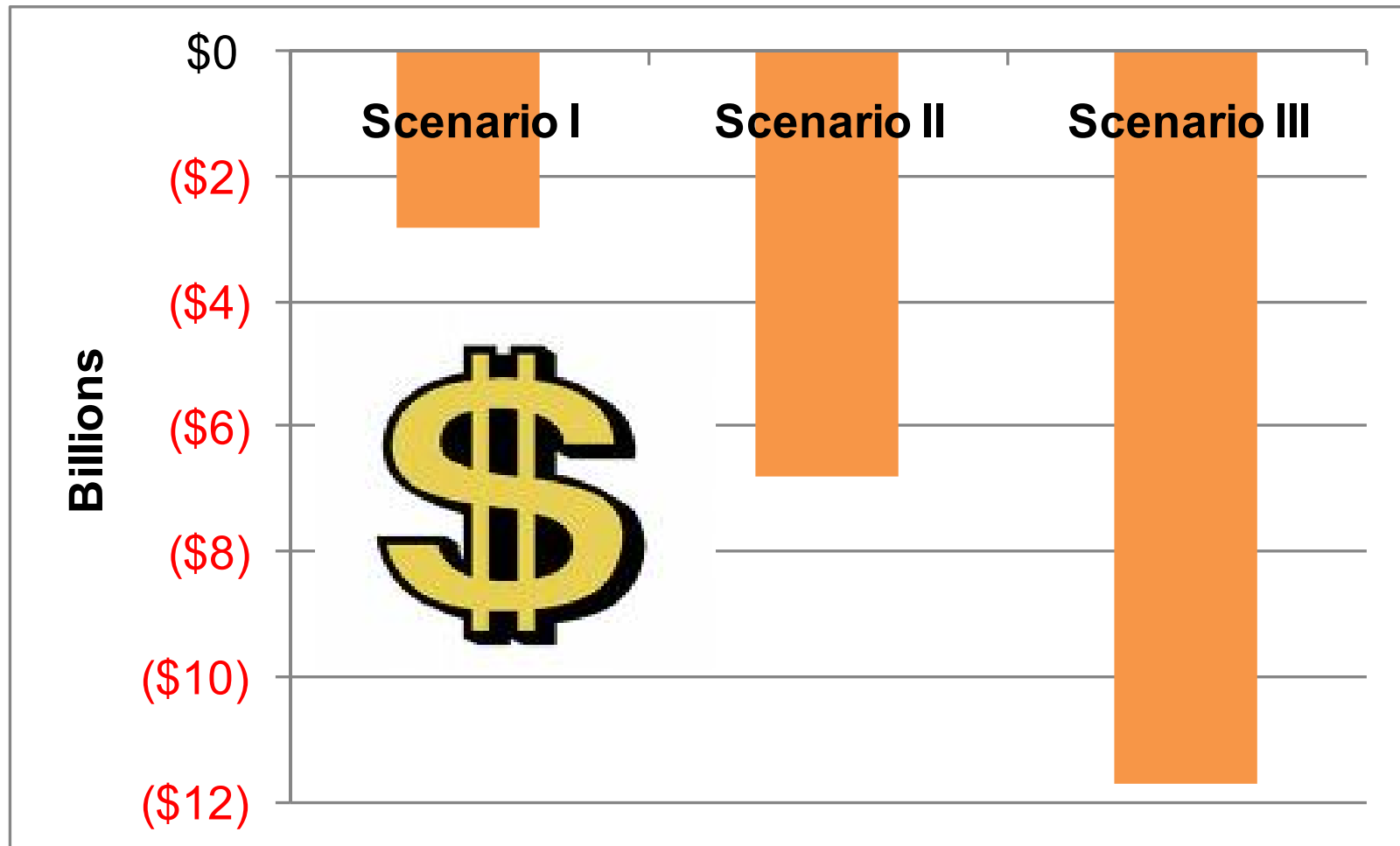
# ELECTRICITY COSTS ARE IMPORTANT

- **Electricity price increases act like a tax increase**, reducing incomes of energy consumers and ratepayers
- Supply-side impacts from price increases depress business development & economic output
- Adverse affects on Colorado economy and jobs:
  - 1<sup>st</sup>, businesses in Colorado will face increased competitive disadvantages
  - 2<sup>nd</sup>, some businesses in Colorado will leave the state
  - 3<sup>rd</sup>, new businesses will not locate in Colorado
  - 4<sup>th</sup>, electric customers will have less \$ to spend



# COLORADO GSP WILL BE REDUCED

## Annual Reduction in Colorado GSP (Constant 2008 dollars)

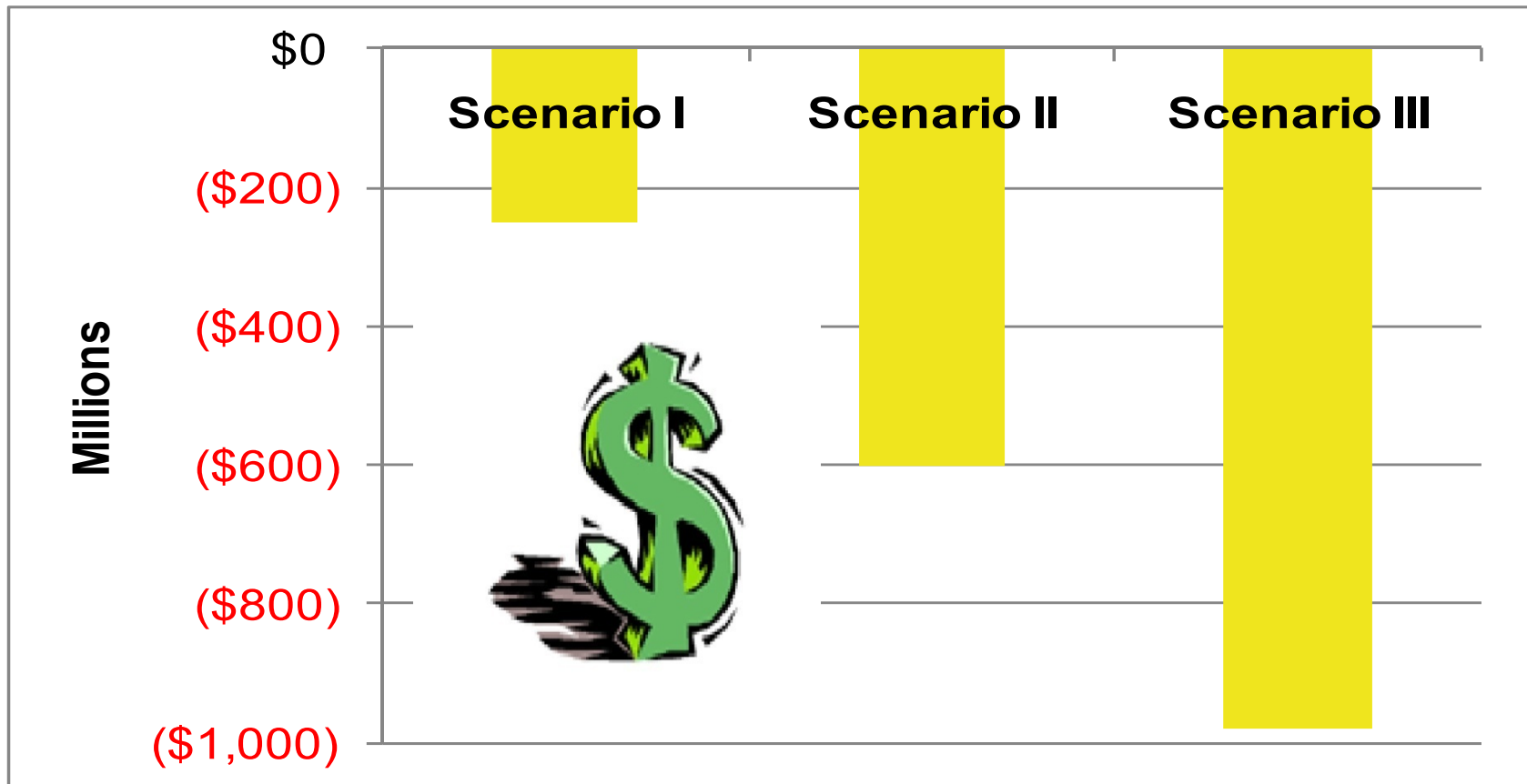


Source: Management Information Services, Inc., 2011.

# GOVT. TAX REVENUES WILL FALL

## Annual Losses in Tax Revenues to Colorado State & Local Governments

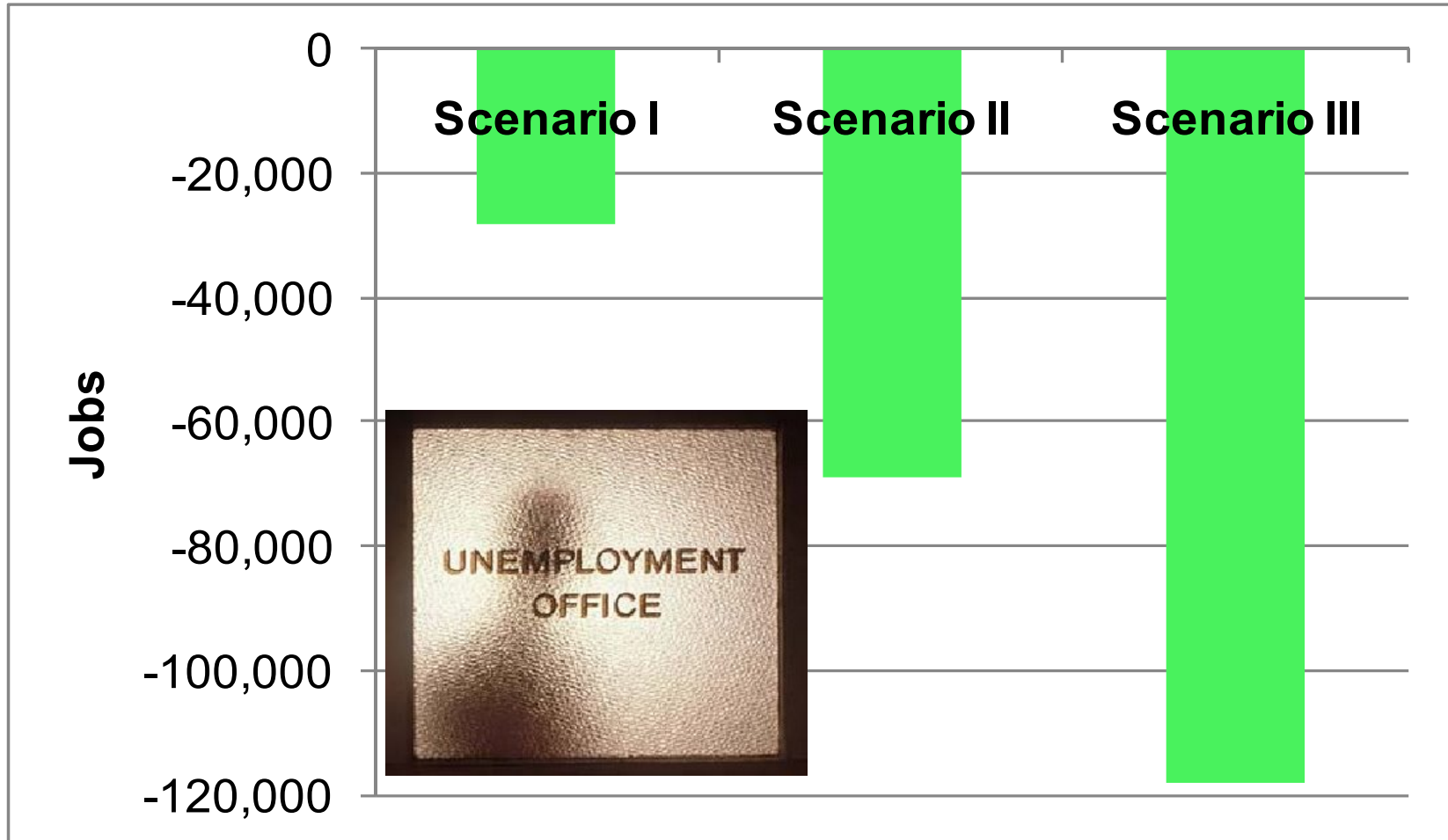
(Constant 2008 dollars)



Source: Management Information Services, Inc., 2011.

# MANY JOBS WILL BE LOST

## Annual Colorado Job Losses



Source: Management Information Services, Inc., 2011.

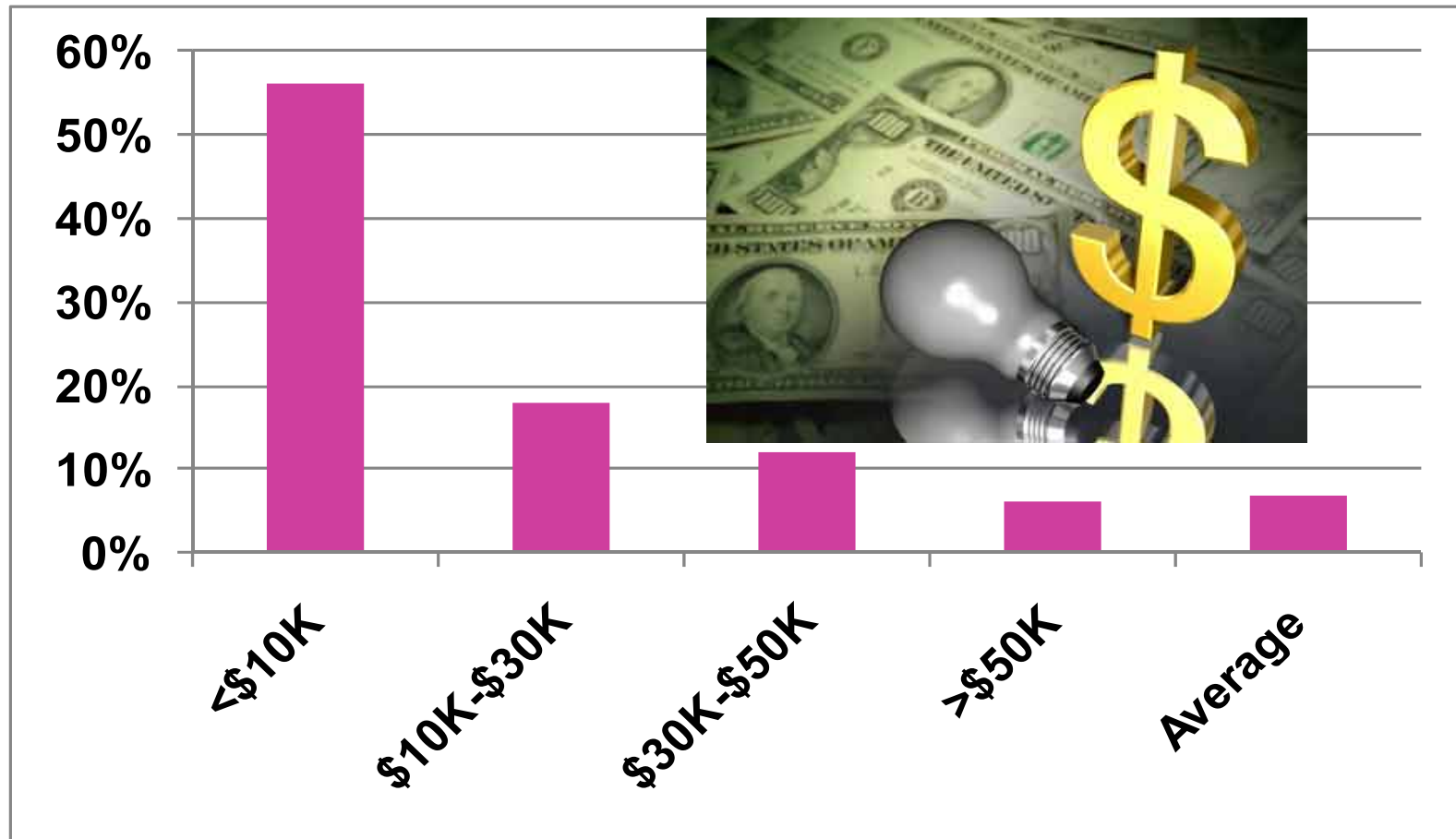


## IMPACT ON LOW INCOME PERSONS

- CACJA requires that “in evaluating the rate impacts of the plan, the commission shall examine the impact of the rates on low-income customers.”
- **Energy price increases are highly regressive:**
  - > 800,000 low income persons in Colorado
  - > 80% receive no energy \$ assistance
- Numerous studies indicate energy bills crowd out food, health, clothing, & other basic necessities
- Problem acute in Colorado: For example, Energy Outreach Colorado & U. of Colorado find that energy costs are 2<sup>nd</sup> most prevalent cause of homelessness in state (after domestic abuse)
- **Electricity price increases from PSCo plan would greatly harm low income persons**

# COLORADO ENERGY BURDEN

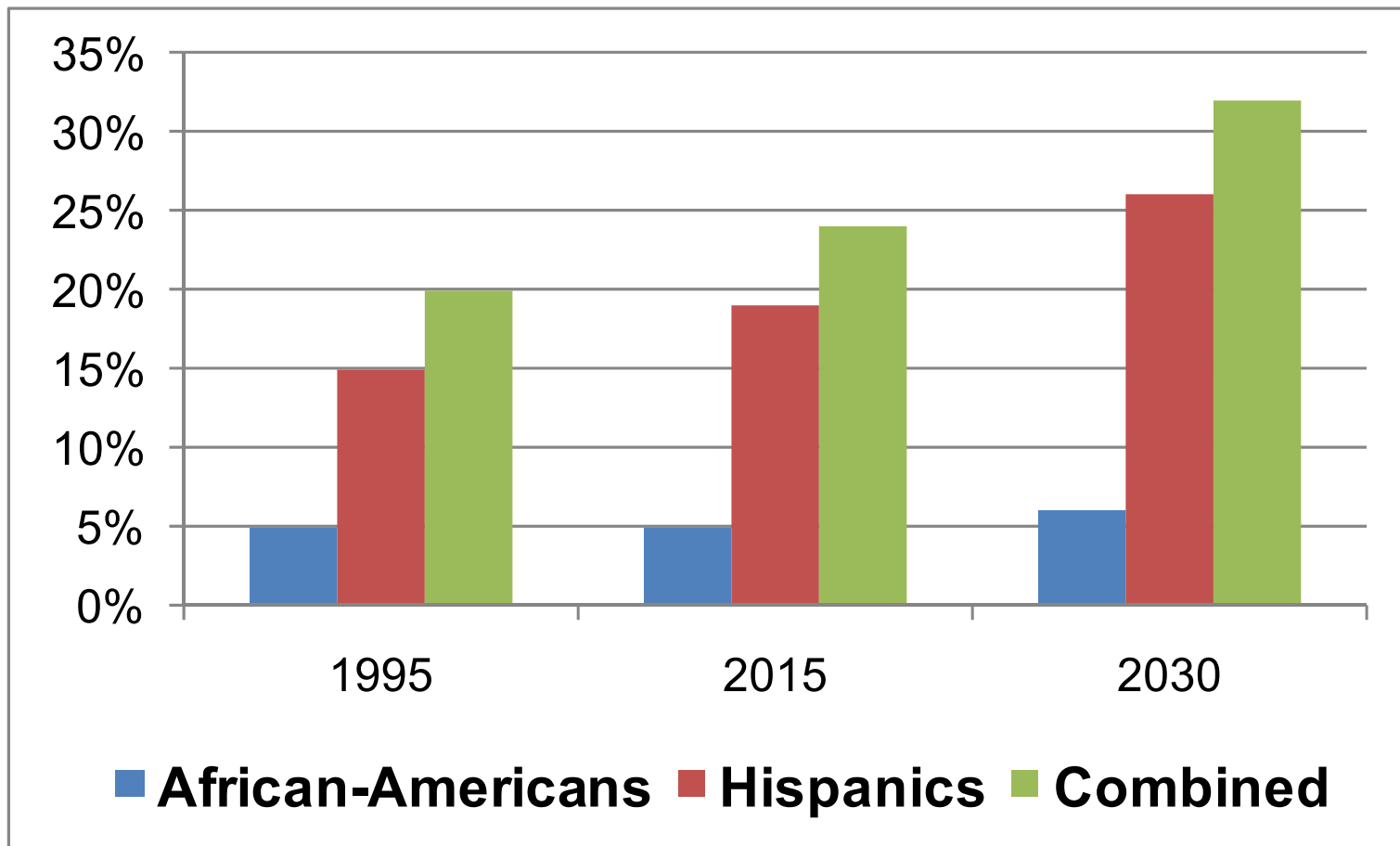
Colorado Household Energy Costs by Income Category, 2009  
(pre tax annual income)



Sources: U.S. Energy Information Administration and U.S. Census Bureau.

# HIGH ENERGY BURDEN FOR MINORITIES

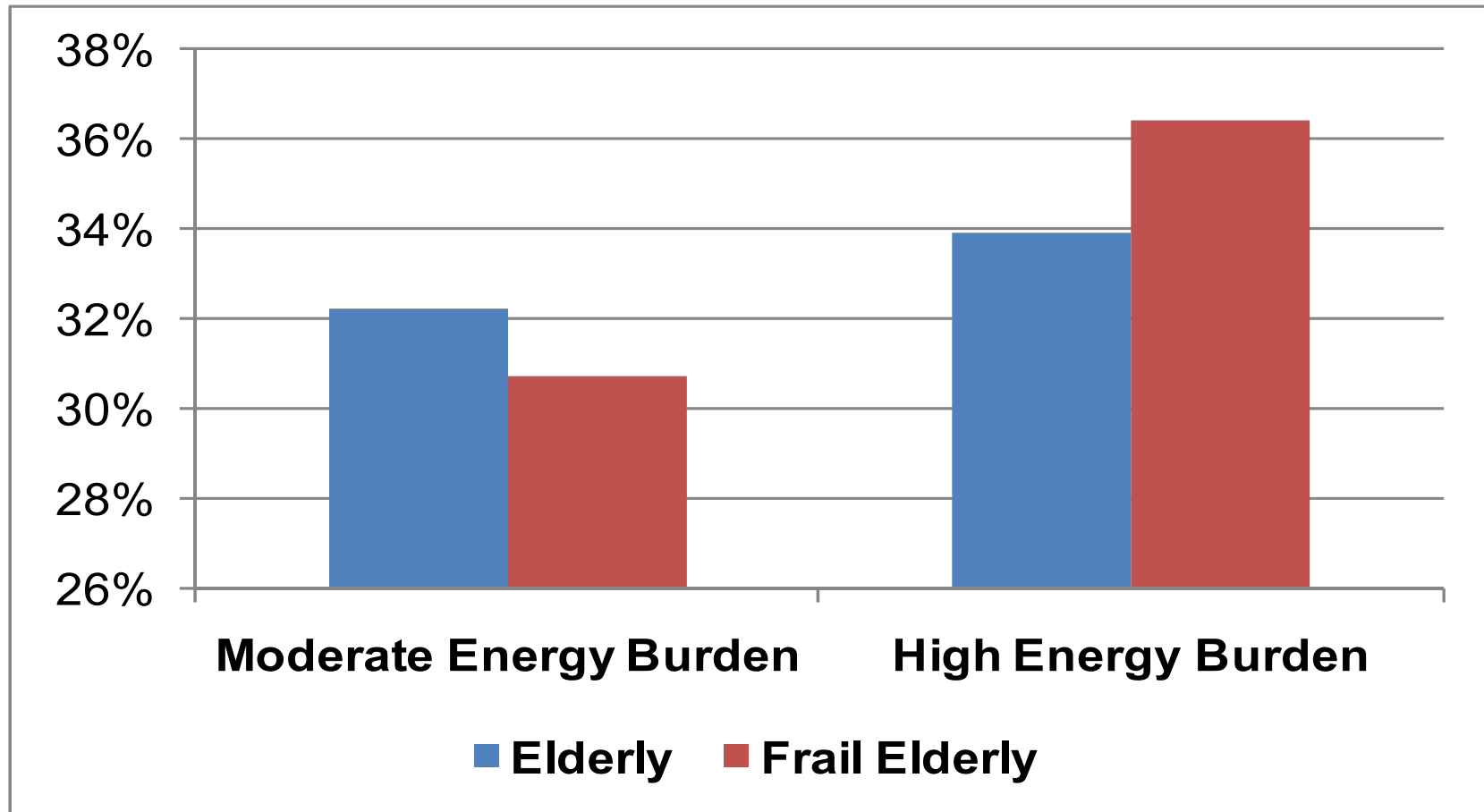
## Changing Demographics in Colorado (percent of state population)



Source: U.S. Census Bureau, 2011

# HIGH ENERGY BURDEN FOR ELDERLY

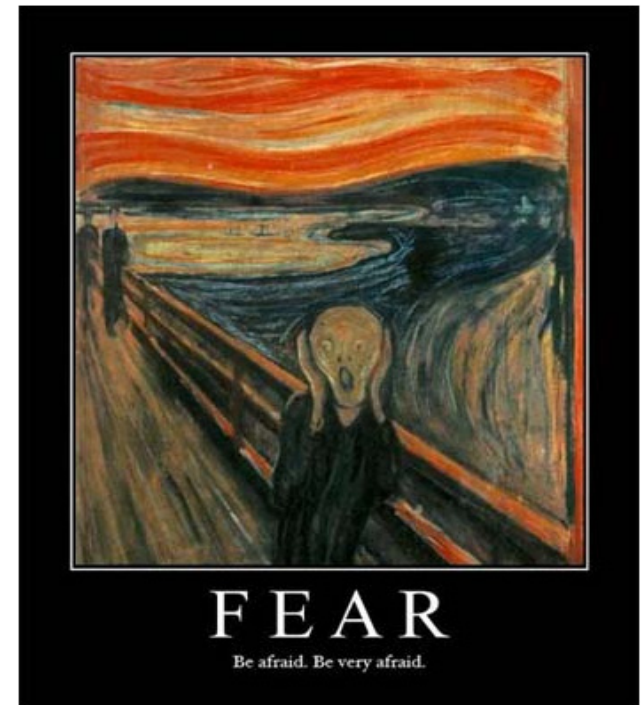
## Energy Burdens of the Elderly



Source: Division of Energy Assistance, U.S. Department of Health and Human Services.

# FINDINGS: PSCO PLAN WILL DO GREAT HARM TO COLORADO

- Electricity prices would increase >30%
- Ratepayers bills would increase >\$1 billion annually
- Colorado GSP would decrease > \$7 billion annually
- St. & local tax revenues would decrease > \$600 million
- 70,000 or more jobs lost every year
- Low income persons, minorities, & elderly would especially suffer
- Some businesses would leave; others would not locate in Colorado
- Plan equivalent to large tax increase
- **All Coloradans would suffer**



# CONCLUSIONS

- **Electricity essential to world economy**
- Necessary for economic development, poverty relief, & increased human health, safety, & well-being
- **Future electric generation will be increasingly coal-based**
- Coal is the world's primary energy source of the future
- U.S. electricity consumption will increase significantly
- U.S. economy will become increasingly "electrified"
- **Coal will remain primary U.S. electricity fuel**
- **Forced fuel-switching away from coal will have serious economic and job consequences**
- In Colorado, mandated fuel-switching away from coal will:
  - Increase electricity rates
  - Depress the state economy
  - Destroy jobs
  - Increase energy poverty among low income groups & the elderly