21st Century Coal: Energy Access, Clean Coal Technologies and Sustainable Mining

Presentation to Expert Group: Norwegian Government Pension Fund Global

June 2014

Peabody ENERGY

The Investment Thesis for 21st Century Coal

- The world is engaged in a rich dialogue about energy, the economy and the environment
- Investment officers also face choices as they consider types of energy investments
- This presentation is meant to facilitate a deeper understanding of what we call 21st Century coal
- Peabody Energy is the world's largest private sector coal company and a global leader in sustainable mining, energy access and clean coal solutions

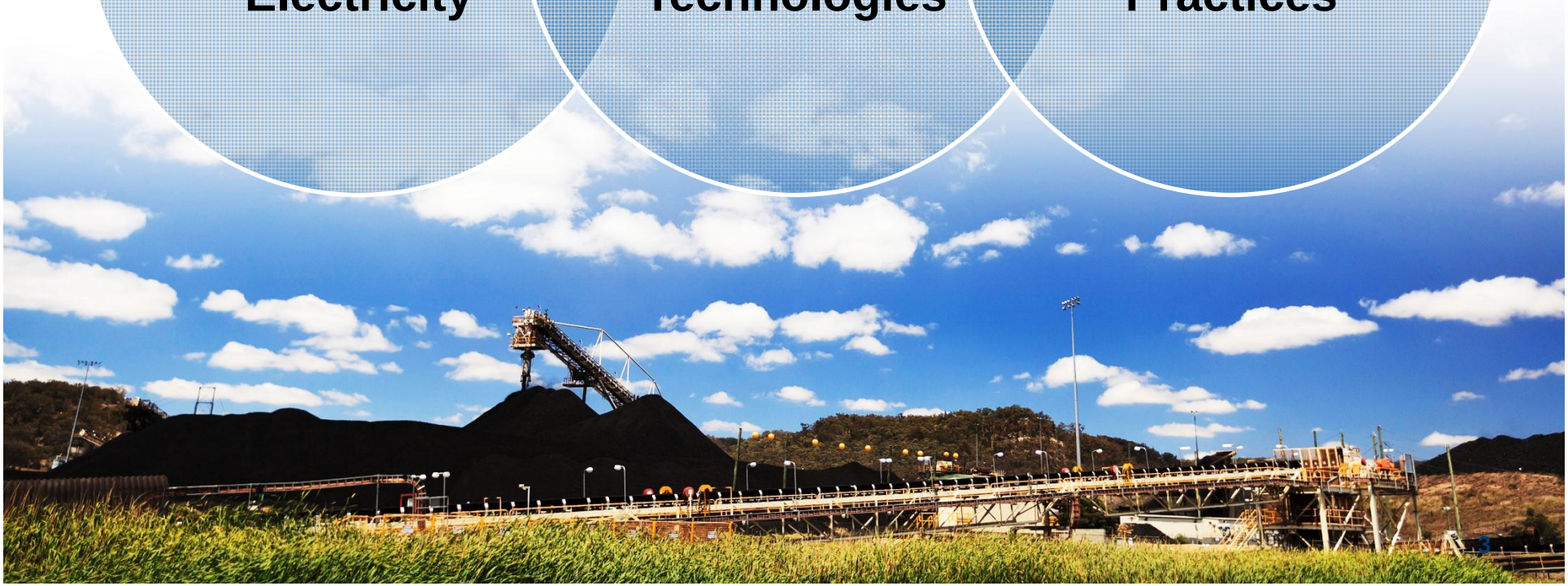
Peabody Energy (NYSE: BTU) is a Fortune 500 and S&P 500 company repeatedly recognized for excellence in leadership in coal mining and coal use

21st Century Coal Requires Leadership Across Several Dimensions

1) Increased Access to Low-Cost Electricity

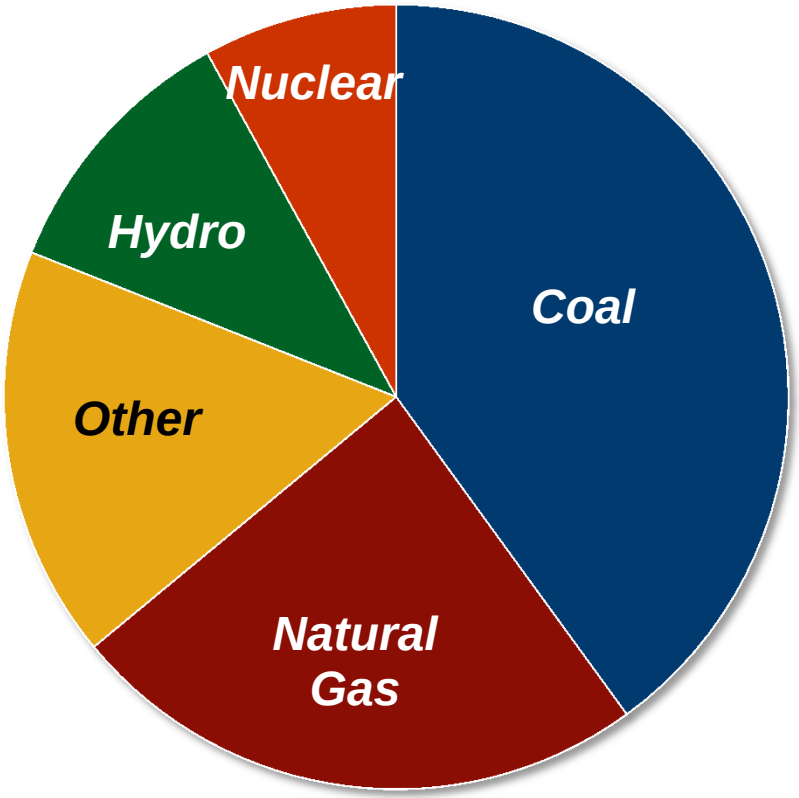
2) Continued Advancement of Clean Coal Technologies

3) Excellence in Sustainable Mining Practices



Coal: The World's Fastest Growing Major Fuel

Expected Electricity Growth (2011 – 2035)

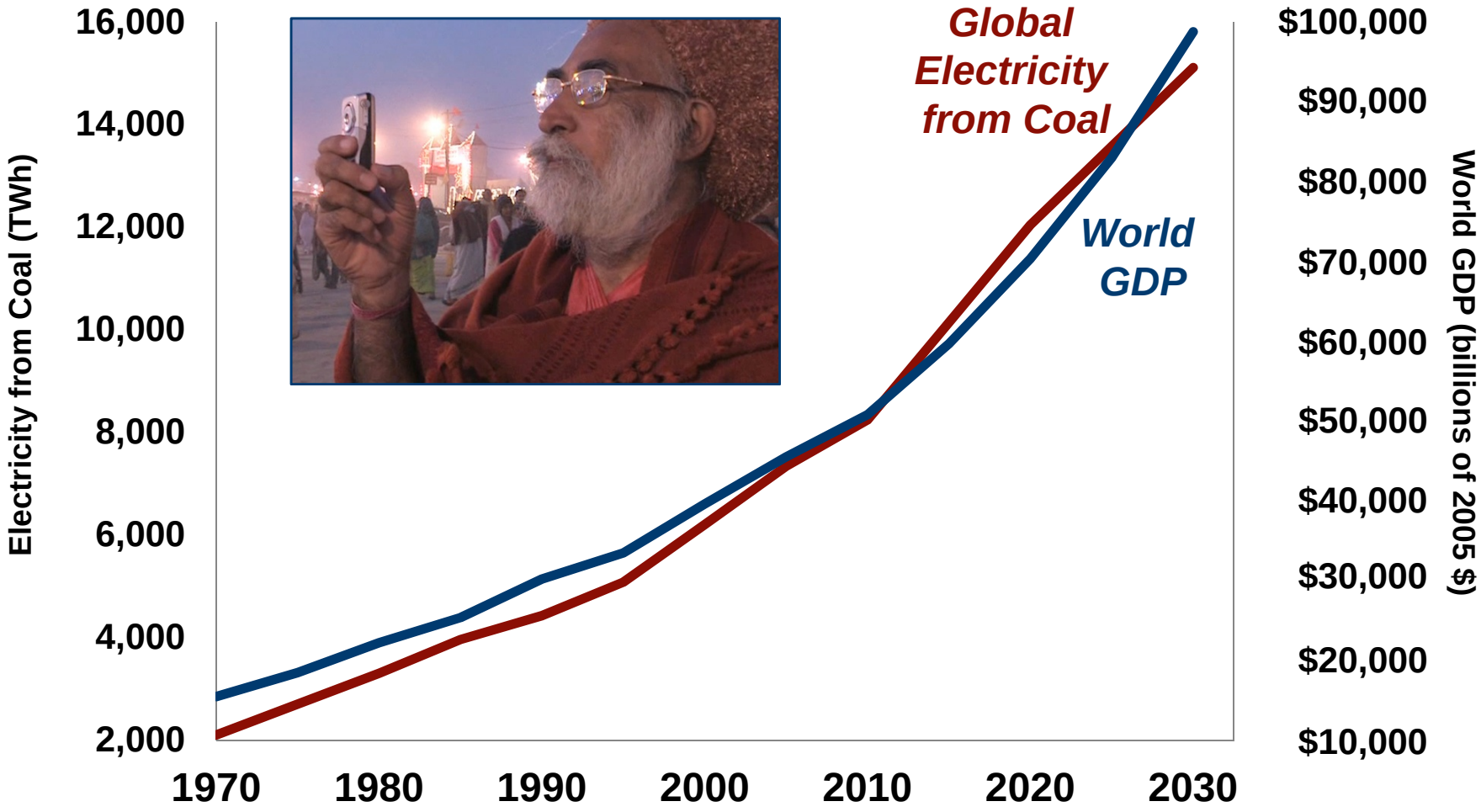


- Coal projected to account for largest percentage of global electricity generation growth
- Coal grew dramatically faster than all other major fuels in past decade
- Wood Mackenzie and other observers project that coal will overtake oil as world's largest energy source in coming years

Source: Peabody Energy Analytics, BP Statistical Review of World Energy 2013; Wood Mackenzie; International Energy Agency (IEA), World Energy Outlook Current Policies Scenario.

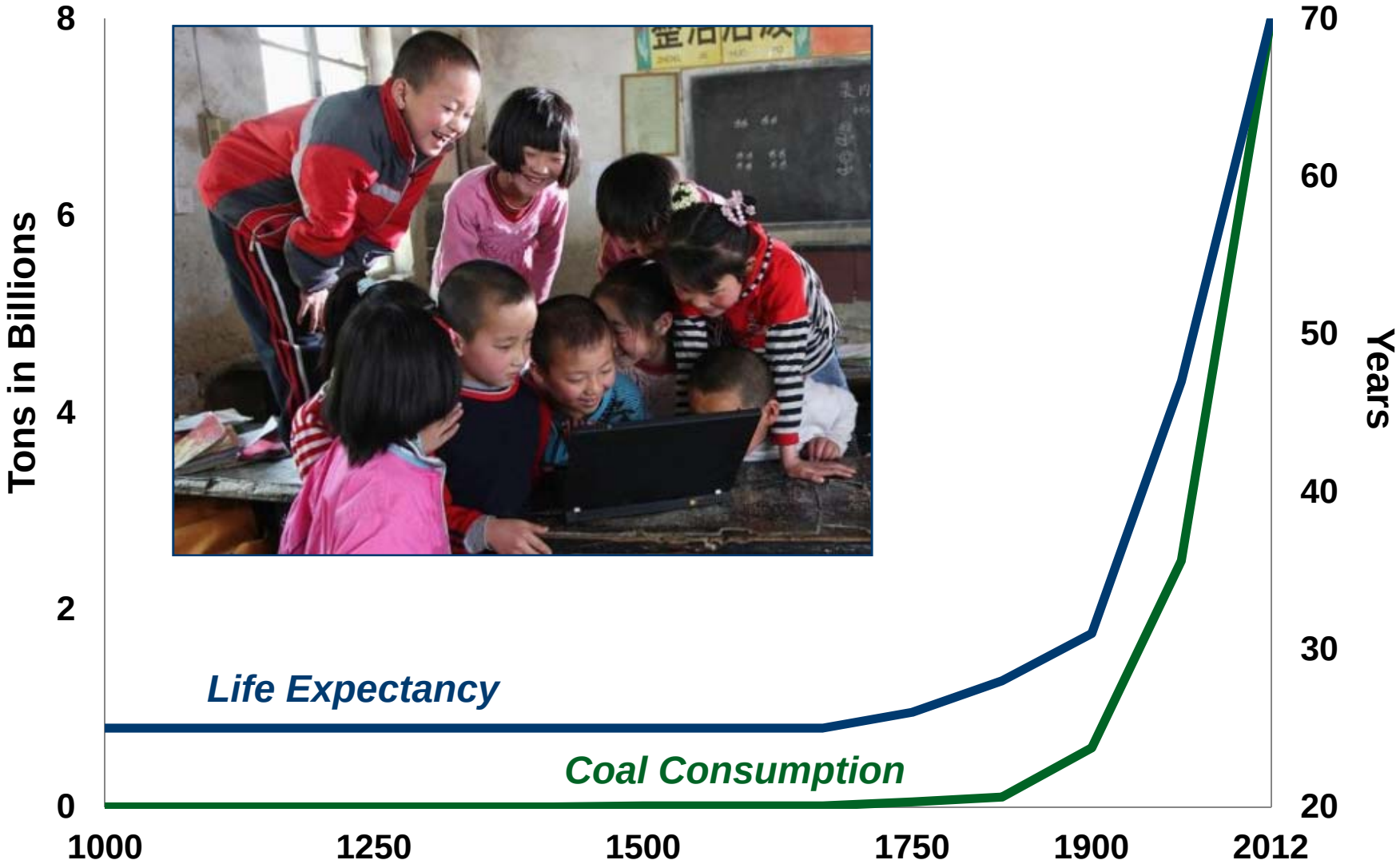
Coal-Fueled Electricity Increases Correspond to Rise in Economic Growth

Near-Perfect Correlation Between Coal Use and Global GDP



Source: Developed from International Energy Agency World Energy Outlook (1995-2013); USDA 2011.

World Turns to Coal to Improve Quality of Life for Millions of People



Source: UN; Yale Environnent 360 Blog.

Digital Lifestyles Create Enormous Demand for Energy

Coal is the power energizing the world

Our energy needs in perspective: In just one day…

Global population will increase by **210,000**

85,000+ People will move to cities in **China** and **India**

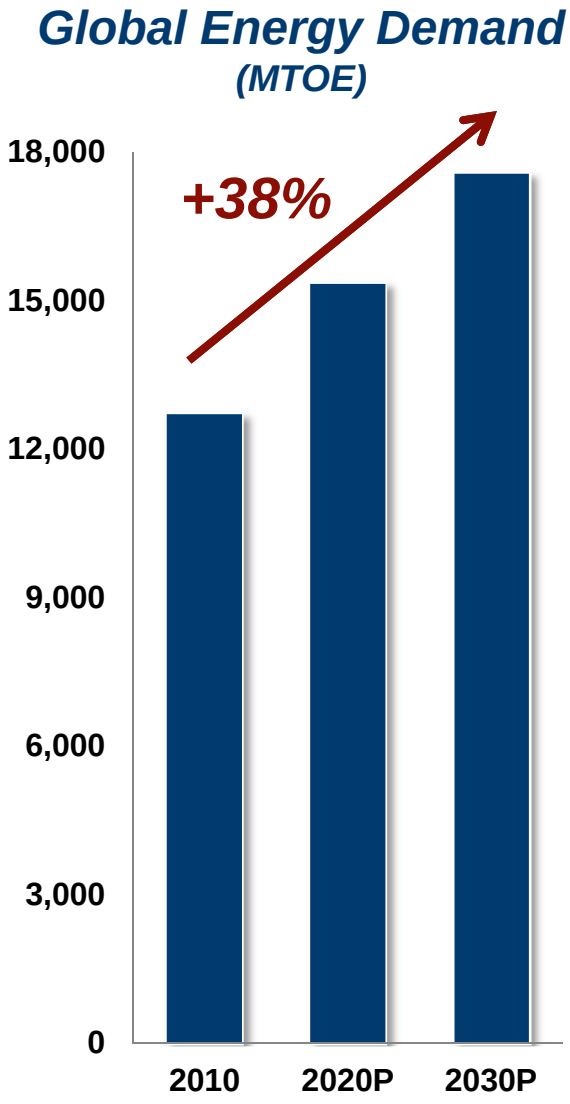
1,100,000 People open an internet account

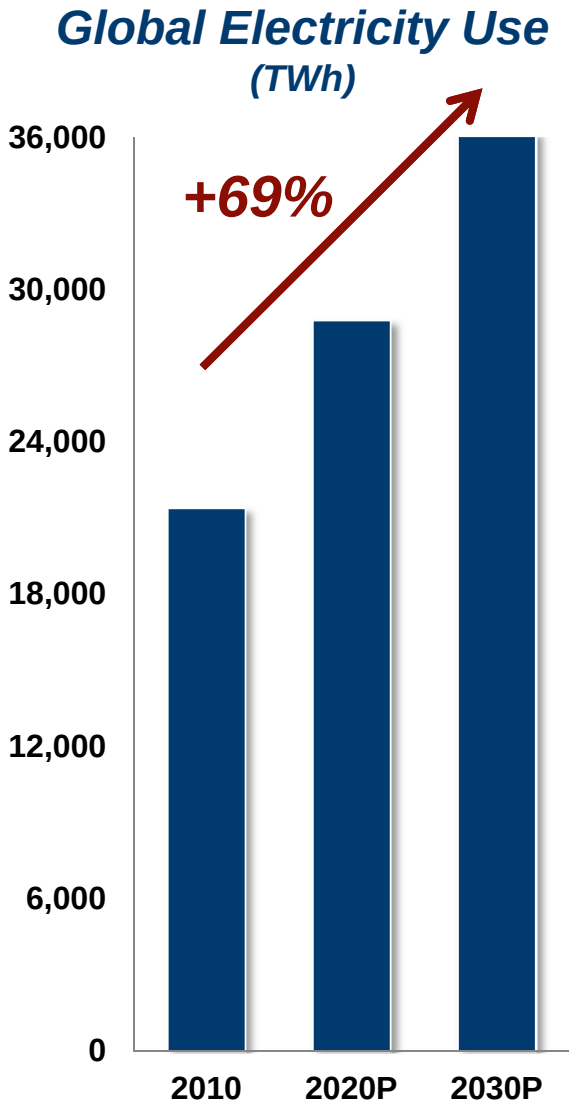
225,000 New cars will be sold

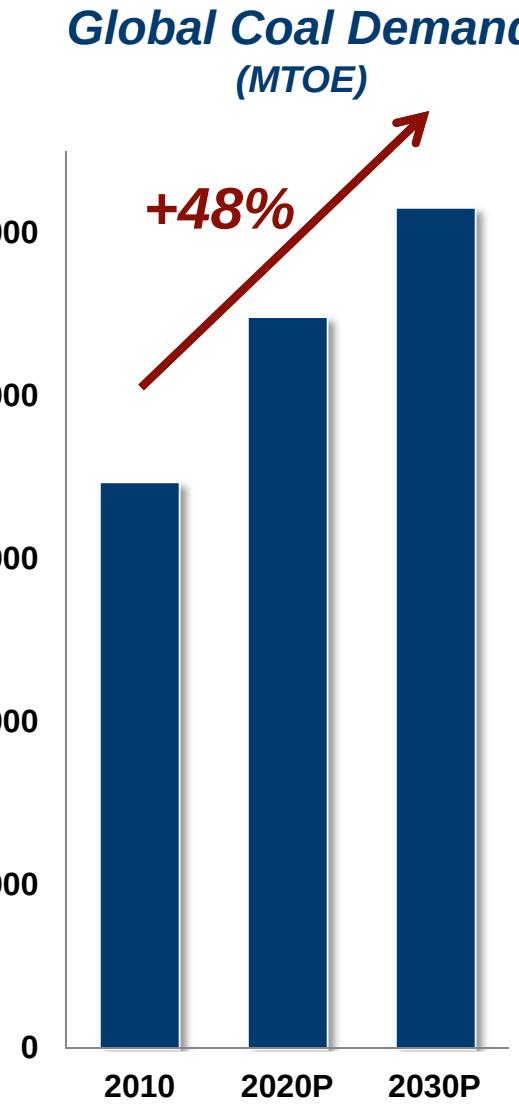
21 million metric tons of coal will be used

950,000 Twitter accounts will be opened

Expanding Global Energy Needs Lead to Rising Coal Demand







Source: Peabody Energy Analytics; International Energy Agency (IEA), 2013 World Energy Outlook.

ENERGY POVERTY IS A GLOBAL CRISIS

Energy Poverty: The World's Number One Human and Environmental Crisis

Global Energy Poverty Effects are Devastating	Half the world's population lacks proper energy access; Energy poverty is fourth leading cause of death globally, killing 4 million per year
Energy Essential for Health and Longevity	One billion people receive substandard care in health facilities from lack of electricity; 2.5 billion people lack improved water sanitation facilities
Energy Access Linked to Educational Attainment	In developing world, half of children attend primary schools with no electricity
Coal Key to Solution for Energy Access	Coal is abundant, reliable and low cost; fuels nearly 30% of global energy use and is the fastest growing major fuel in the world

Energy Impoverishment Takes a Mighty Toll

"It's a story about cookstoves, but its so much more than that. It's about energy impoverishment. A 'complex and wicked problem' with staggering consequences" Mark Wrighton, Chancellor, Washington University of Saint Louis, in Foreword to Yamada (2013)

From *Foreword* to *Fires, Fuel, and the Fate of 3 Billion: The State of the Energy Impoverished* (by Gautam Yadama, 2013)

The Human Face of Energy Poverty

1.3 Billion people have no electricity

2.4 Billion live on less than $2 a day

4 Million die annually from household air pollution

Land degradation, erosion from gathering fuel wood

Sources: *Foreword* to *Fires, Fuel, and the Fate of 3 Billion: The State of the Energy Impoverished* (Gautam Yadama, 2013); IEA, WEO 2013; The World Bank, Poverty Overview

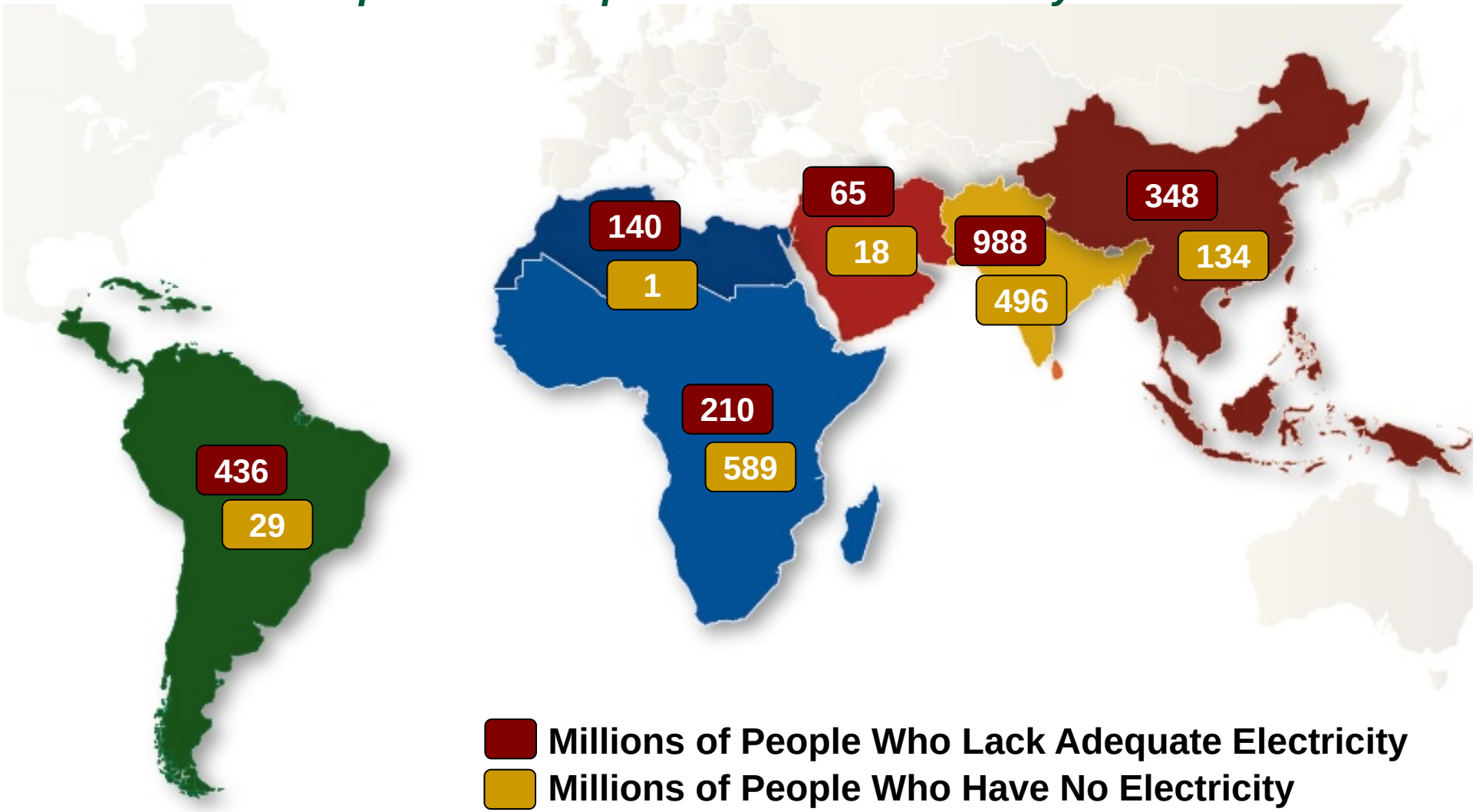
The Effects of Global Energy Poverty are Devastating

- Nearly 3 billion people use primitive stoves to burn wood or biomass to cook and heat homes
- Rudimentary cook stove smoke exposure is equivalent to inhaling 400 cigarettes per hour
- 4 million people die each year from household air pollution

Sources: *Foreword* to *Fires, Fuel, and the Fate of 3 Billion: The State of the Energy Impoverished* (by GautamYadama, 2013); IEA, WEO 2013; The World Bank, Poverty Overview

Energy Access is a Human Right and a Rapidly Rising Need

3.5 Billion People Lack Proper Access to Electricity



Source: International Energy Agency World Energy Outlook 2012, The World Bank World Development Indicators 2014, CIA World Factbook 2013-14

A Chronology

International Action on Energy Poverty

- 2010: Gregory Boyce, Chairman and CEO Peabody Energy, raises the issue of energy poverty at the World Energy Congress and increases global awareness of the crisis

- 2011: International Energy Agency produces a Special Report – “Energy for all: Financing access for the poor”

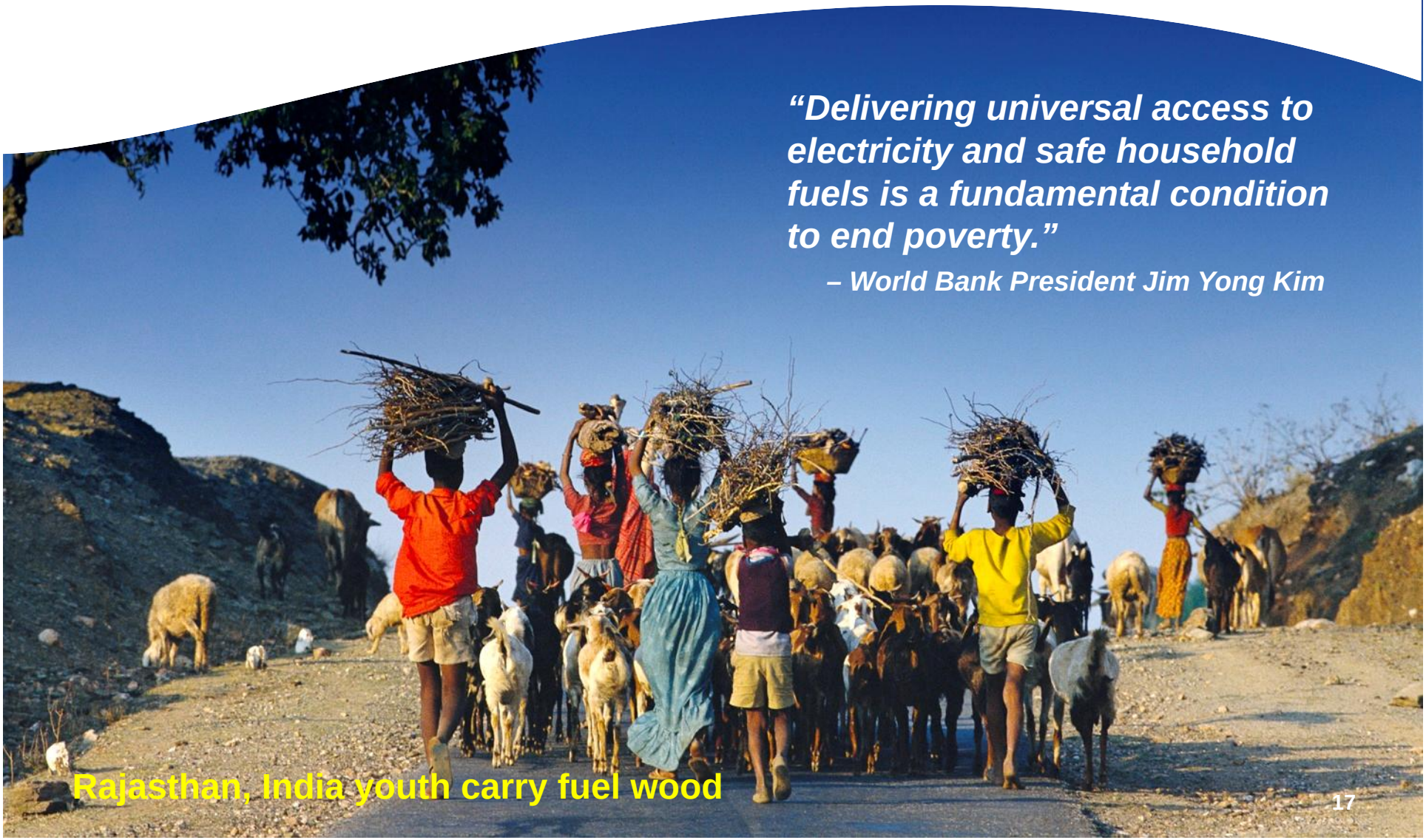
- 2012: United Nations declares the year of “Sustainable Energy for All”

SUSTAINABLE ENERGY FOR ALL

- 2013: International Energy Agency and World Bank publish the “Global Tracking Framework” as part of the Sustainable Energy for All initiative

WHAT WILL IT TAKE TO SOLVE THE WORLD'S ENERGY POVERTY CRISIS?

Energy Access



"Delivering universal access to electricity and safe household fuels is a fundamental condition to end poverty."

– World Bank President Jim Yong Kim

Rajasthan, India youth carry fuel wood

Access to Electricity

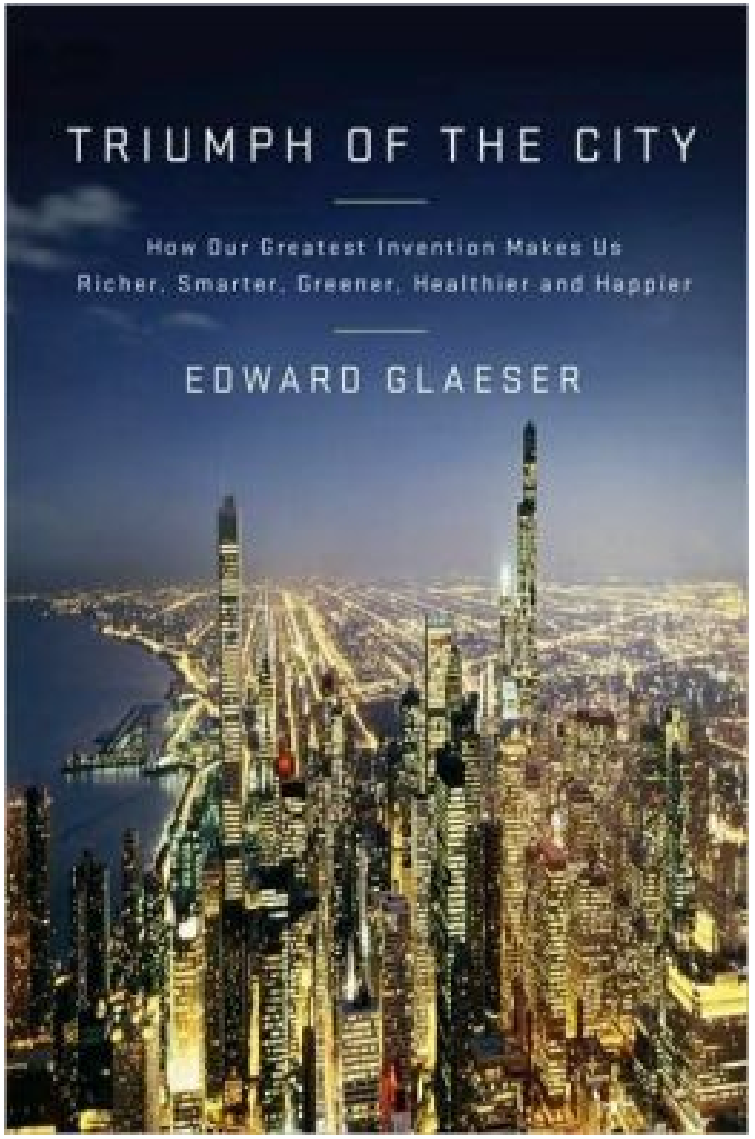
Alleviating Energy Poverty is a Common Goal

- "We believe that nations must have the power to connect their people to the promise of the 21st Century. Access to electricity is fundamental to opportunity in this age." President Barack Obama, 2013
- "The 'Sustainable Energy for All' initiative was created to help end energy poverty. By 2030, it aims to achieve universal access to energy, including electricity." World Bank, 2012
- "Modern energy sources provide people with lighting, heating, refrigeration, cooking, water pumping and other services that are essential for reducing poverty." Worldwatch Institute, 2013
- "Eliminate Energy Poverty as priority one: create energy access for all by 2050; advance all energy forms for long term access." Gregory Boyce, Chairman & CEO, Peabody Energy 2010

Coal is the Solution at Scale

- Coal is the only energy source that can provide modern access at scale
- Clean coal technologies provide the method to address access as well as environmental concerns
- Urbanization is the pathway to eradicating global poverty and energy deprivation
- Coal is the base fuel for power and steel to urbanize a world of over 9 billion people by 2050

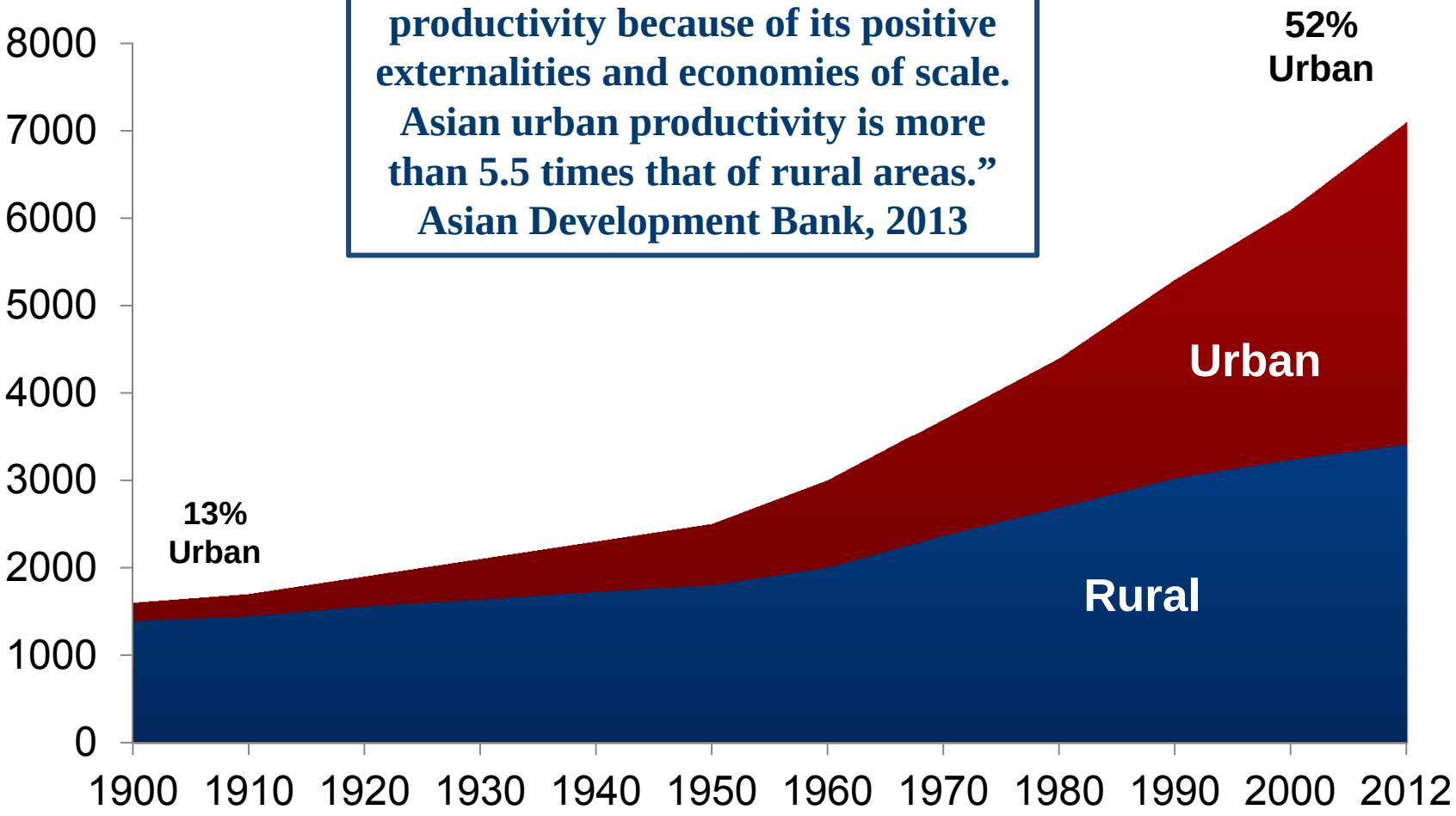
Coal and Urbanization Lead the Pathway Out of Poverty



The Rise of Cities

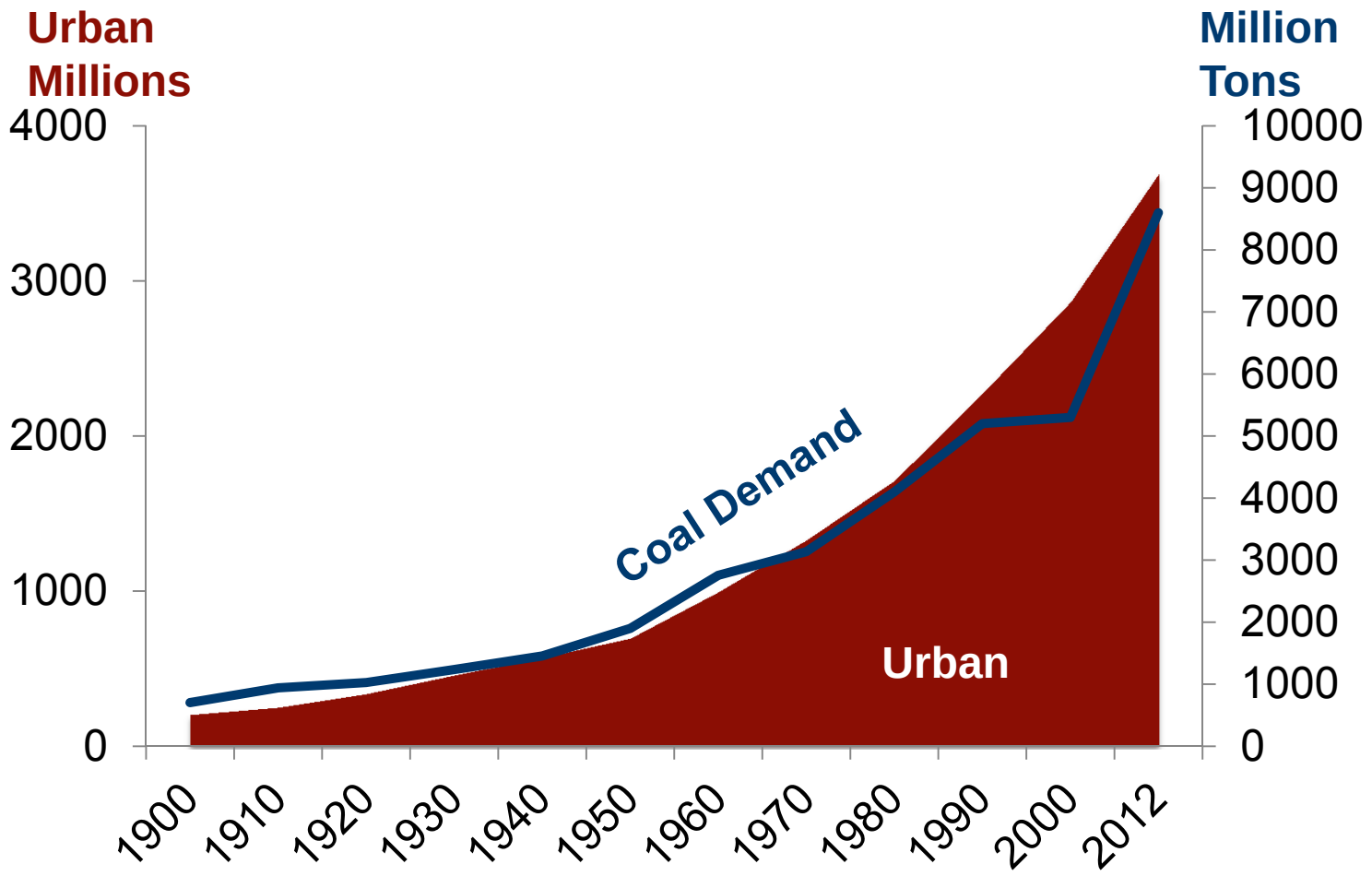
Global Population
in Millions

"Urbanization brings higher productivity because of its positive externalities and economies of scale. Asian urban productivity is more than 5.5 times that of rural areas."
Asian Development Bank, 2013



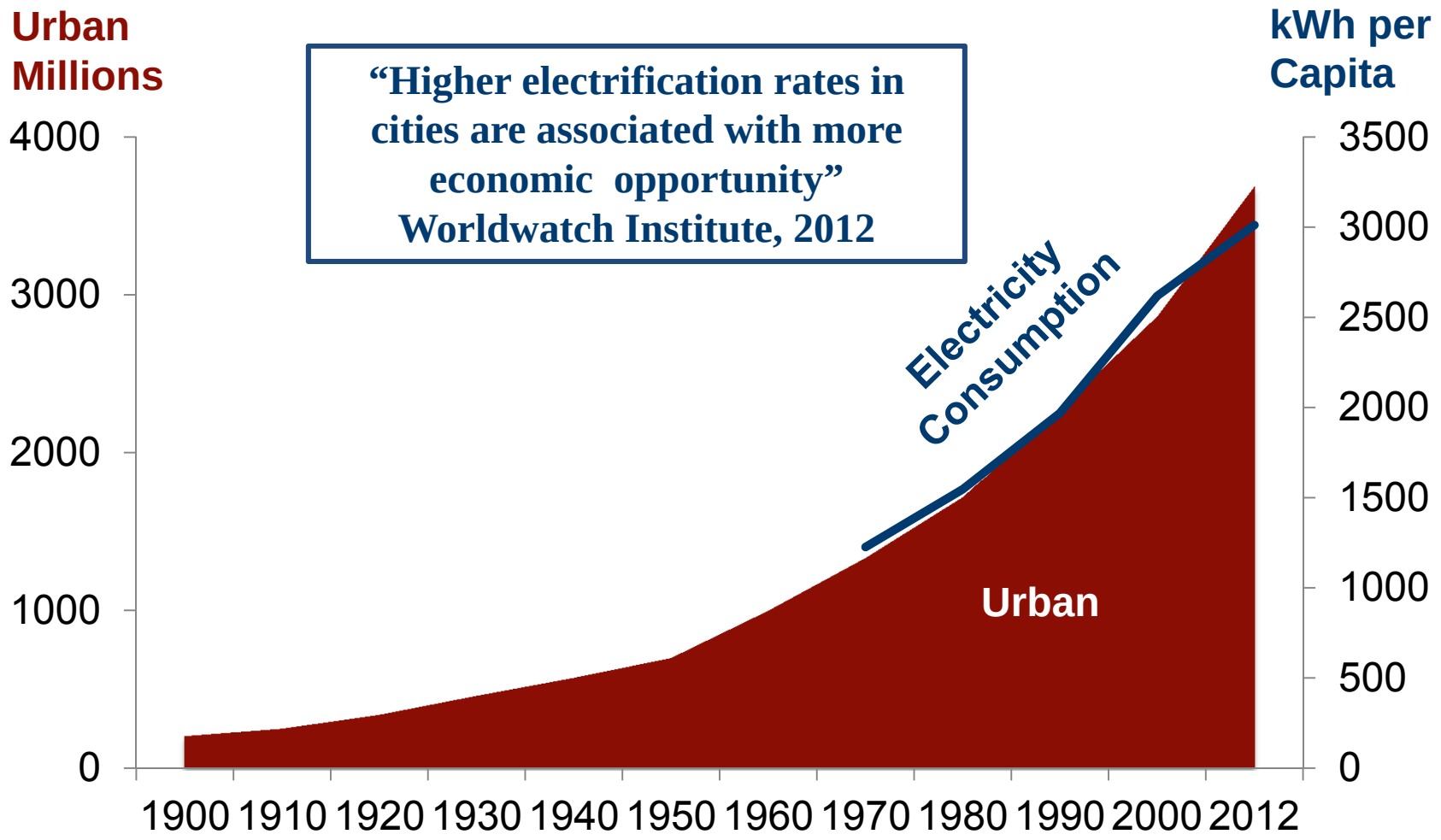
Sources: UN; US Census Bureau; World Population Prospects; World Urbanization Prospects

Global Urbanization and Coal Demand



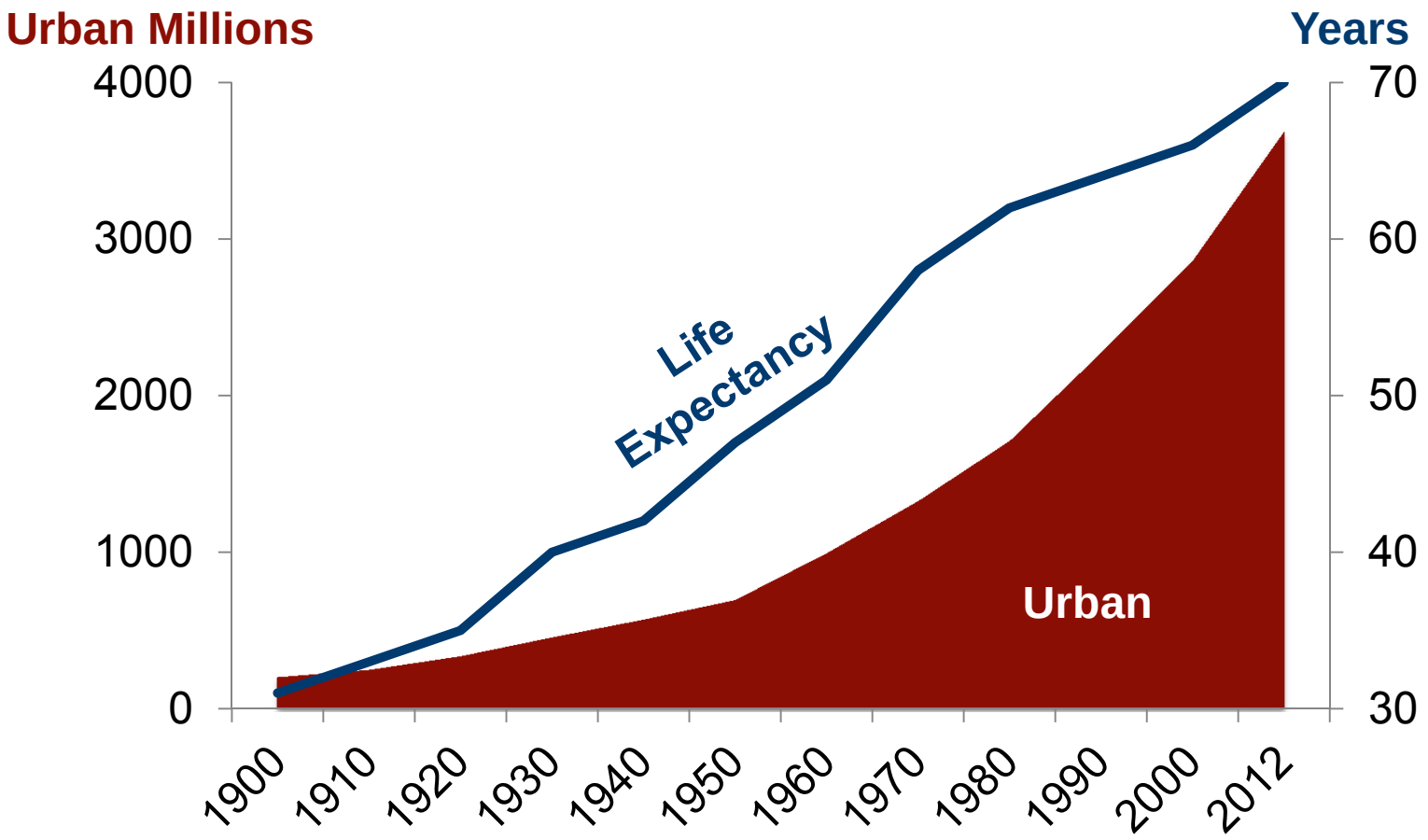
Sources: UN; IEA; EIA; Hook, Zittel, Schindler, Aleklett; Dorf

Global Urbanization and Electricity Consumption



Sources: United Nations, World Bank

Global Urbanization and Life Expectancy



Sources: United Nations

3 Billion New Urbanites in 30 Years

"In all human history we have reached 3.5 billion of urban settlers, and in the next 30 years we are going to have 3 billion more…Imagine the changing rate — what we have done in all human history, we nearly will do in the next 30 to 40 years."
Joan Clos, Direct UN Settlement Program, 2013

Equivalent to adding **7.7 Tokyos** or **12 New Yorks**

to the globe each year

Sources: UN; US Census Bureau; Tokyo Metropolitan Government

The Last Time We Added 3 Billion People to Cities (1950-2010)

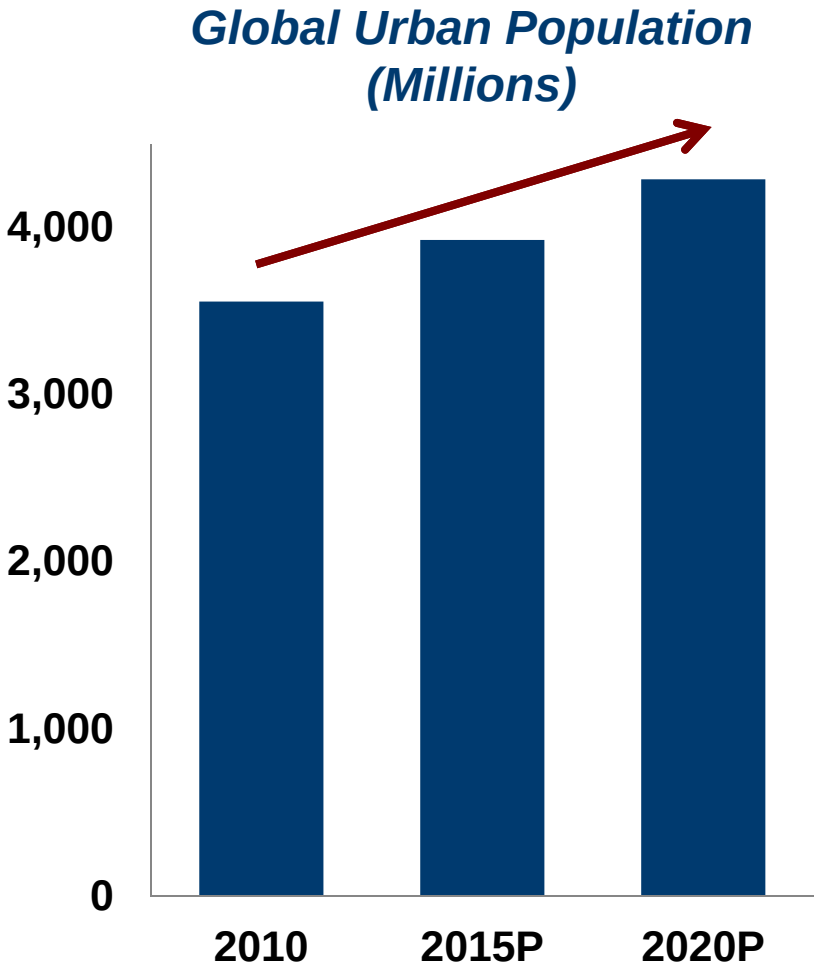
Cities Will Grow by 3 Billion by 2050

- Oil demand grew from 10 million b/d to 88 million b/d
- Natural gas use rose from 8 Tcf to 113 Tcf
- **Coal demand increased from 2 billion tonnes to 7.1 billion tonnes**
- Cement use rose over 3 billion tonnes
- Steel consumption increased from 200 million tonnes to 1,400 million tonnes.
- Nuclear power rose from nil to 2,500 TWh

Sources: EIA; IEA; Worldwatch Institute; World Steel Association

Urbanization Drives Greater Coal Use to Fuel Growing Electricity Demand

200,000 People Added to Cities Each Day



- World needs more energy as populations migrate to urban centers and embrace modern living
- More than 70 million people expected to be added to cities each year through 2020
- Coal is the only affordable fuel, at scale, to meet rising energy needs

Source: United Nations, Department of Economic and Social Affairs, Population Division "World Urbanization Prospects: The 2011 Revision".

Electricity Provides the Mechanism

- Beneficial electrification – improving the quality of life through electricity
- Ecowatts – using more kilowatts for economic growth and a cleaner environment
- Electrotechnologies – applications which avoid emissions by replacing biomass, oil and gas with clean coal-based electricity

1930s – The New York Times: "Nothing in modern life so raises the standard of living of high and low income groups as the use of electricity."

Coal: Least Expensive and Most Reliable Form of Electricity Generation

Coal Supplies Over 40% of the World's Power Generation

	Coal	Oil	Natural Gas	Nuclear	Solar/ Wind
Low Cost	●	○	◑	◔	○
Baseload Capacity	●	○	◑	●	○
Safe to Transport	●	◑	◑	○	●
Energy Dense	●	◑	◑	●	○
Widely Available	●	◕	◕	○	◔
Technology Based	●	●	●	●	●

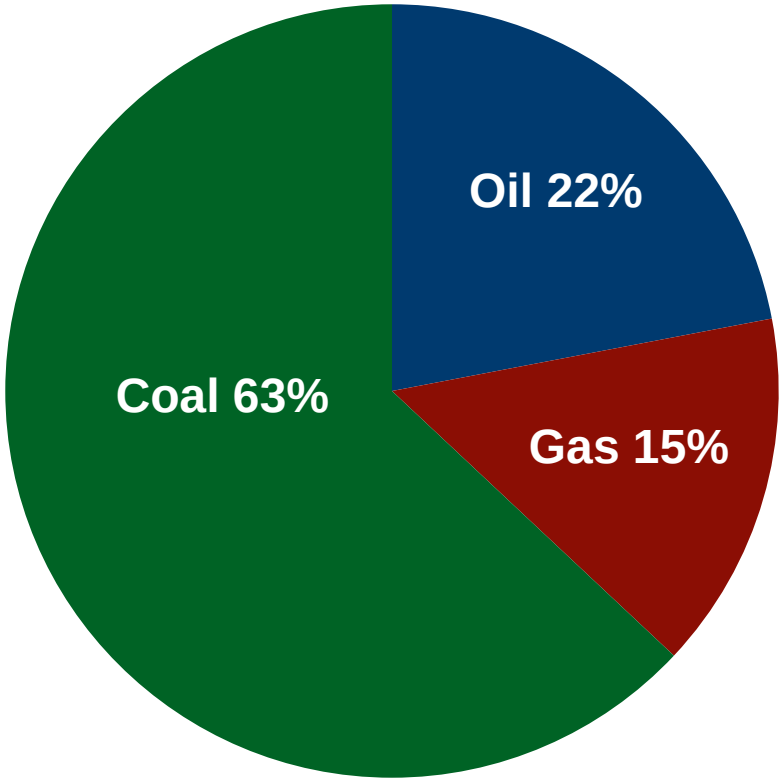
Coal:

- Only a fraction of other fuels' costs
- Provides baseload power; easily transported
- Energy dense, abundant and increasingly uses advanced technologies

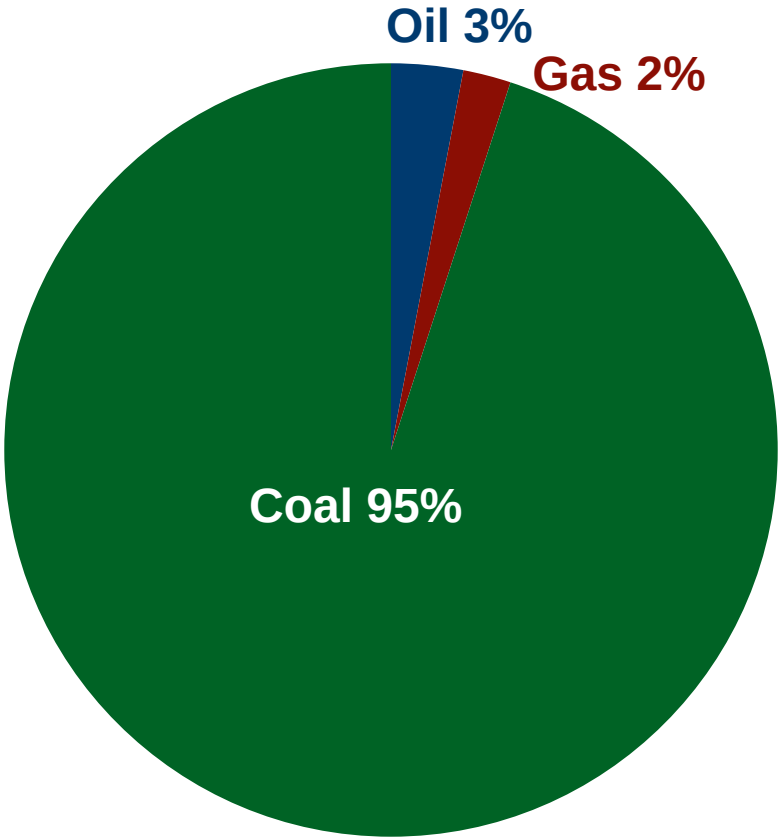
Source: IEA World Energy Outlook 2013; Peabody Energy Analytics.

Coal is Our Most Abundant Energy Resource

Global Reserves (economically recoverable)



Global Resources



Sources: Developed from IEA; EIA; BP

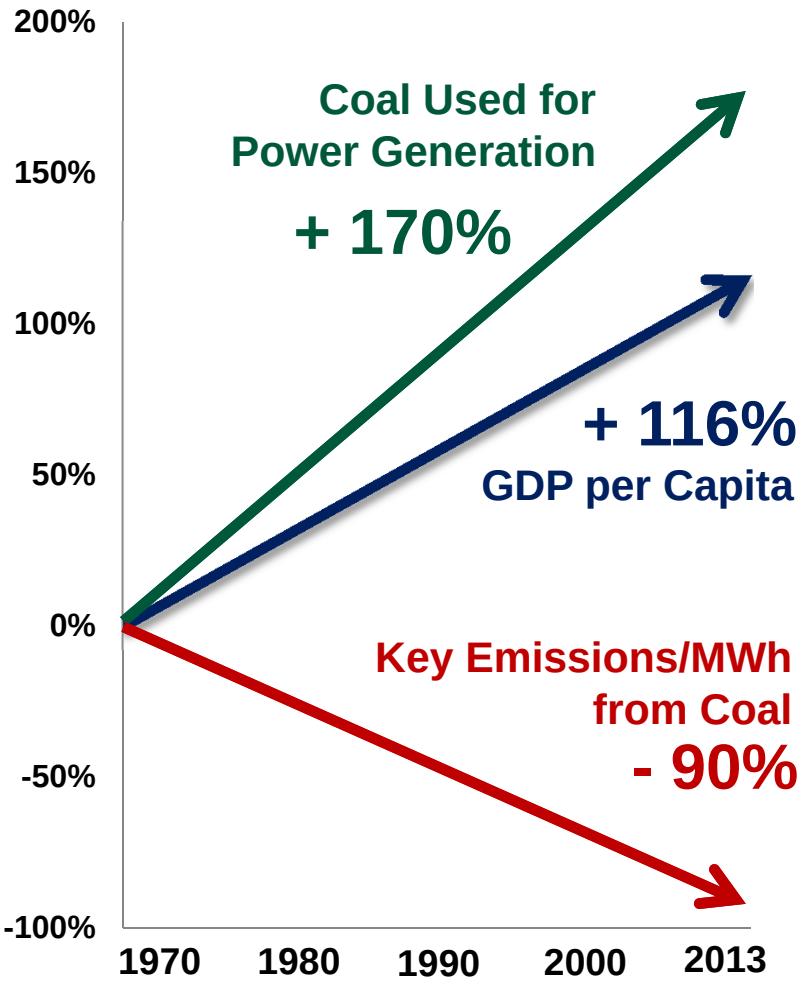
Clean Coal Solutions

21st Century Coal: The Power Fueling Advanced Energy for Life

Advanced Coal Technologies Lower Emissions	Advanced generation and control technologies drive improved efficiency and lower emissions; Large suite of technologies available today
Proven Results Show Path Forward	U.S. experience demonstrates tremendous environmental results while increasing coal use using today's advanced coal technologies
Next-Generation Technologies to Further Progress	Research and development underway to advance goal of coal-fueled power virtually free of emissions, including carbon capture technologies

Advanced Coal Technologies: U.S. Environmental Success Story

U.S. Emissions Rate Declines 90% Since 1970; Coal Use Rises 170%



Source: USDA 2011; Energy Information Administration 2013; U.S. EPA Air Trends Data, 2013

Advanced Coal Provides the Best Path for Achieving Environmental Goals

Peabody ENERGY

Innovative Technologies Build on Progress for Sustainable Future

Higher temperatures and pressures drive efficiency in advanced "supercritical" coal plants

High efficiency advanced plants produce more electricity per ton of coal

Every 1% efficiency gain reduces lifetime emissions by 2,000 tons of nitrogen oxide and sulfur dioxide and 2.5 million tons of CO_2

Today's Advanced Coal Technologies Remove Majority of Localized Emissions

Low-NO_X Boiler Technology

Today's super-critical power plants are highly efficient, creating more energy per ton of coal used. Within the boiler, NO_X levels are reduced by lowering the temperature of the flame.

Selective Catalytic Reduction (SCR)

An SCR further controls NO_X emissions by injecting product into the air stream as it passes over a catalyst, converting the NO_X to nitrogen and water. The SCR also helps control mercury.

Dry Electrostatic Precipitator (ESP)

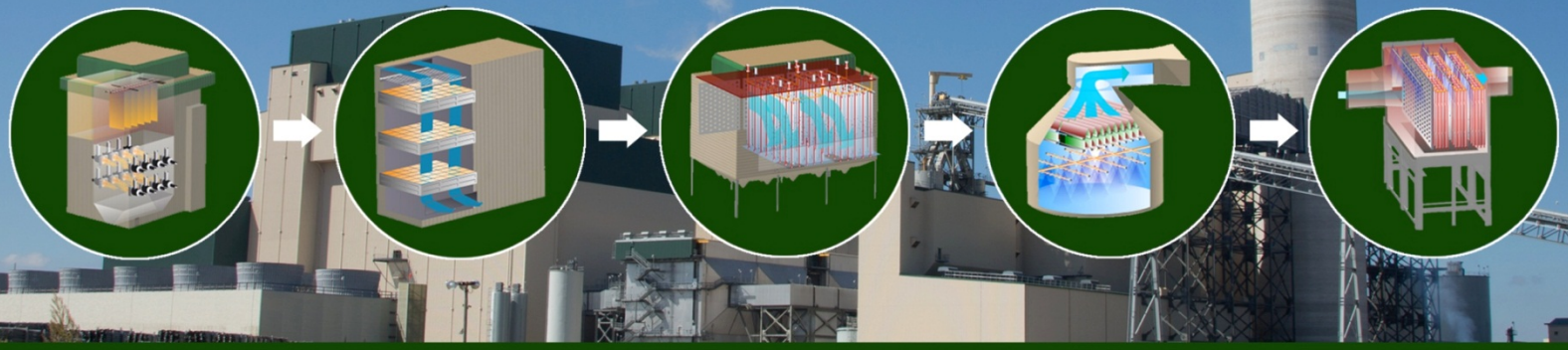
The dry ESP removes virtually all particulates from the air stream in addition to some mercury. The dry ESP uses electrodes to place an electric charge on the particles, which are captured on an oppositely charged plate. The particles are then shaken from the plates and collected.

Sulfur Dioxide (SO_2) Scrubber

SO_2 is dramatically reduced by injecting a lime-stone and water mixture into the air stream, where it reacts to capture or "scrub" the SO_2. Scrubbers also help control mercury.

Wet Electrostatic Precipitator (ESP)

The air stream passes through the scrubber into a wet ESP, which will remove fine particulates and other constituents. Wet ESPs use multiple high-voltage fields to attract the particles to an electrode, which is then washed with water to capture the constituents, including some mercury.



Supercritical coal plants operate at high efficiencies that significantly reduce emissions on a per kilowatt hour basis. In the United States, these plants achieve carbon dioxide emissions that are as much as 25 percent lower than the oldest coal plants.

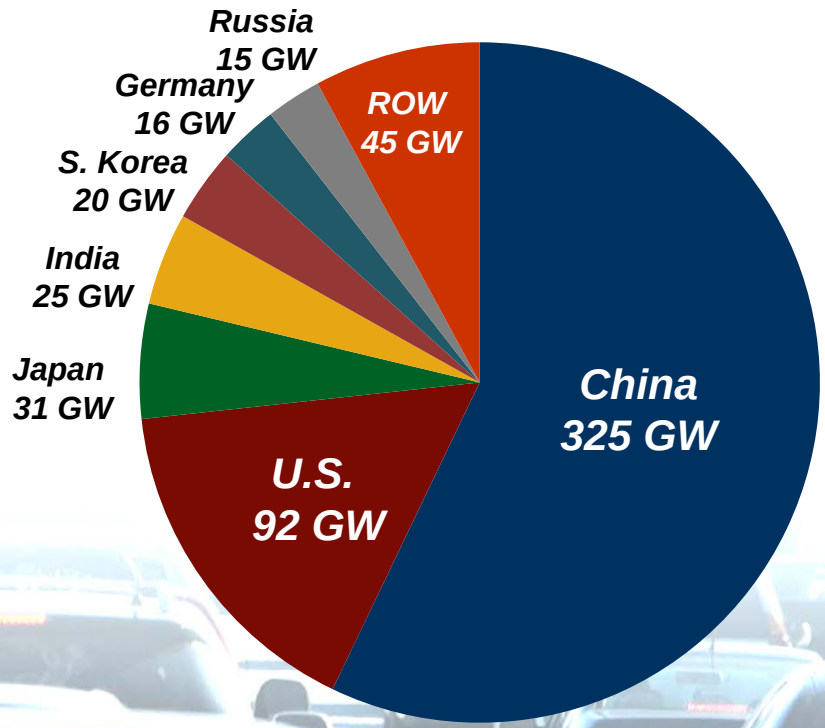
Source: U.S. Energy Information Administration.

Every Advanced Coal Plant Equal to Taking 'A Million Cars Off the Road'

"A single, large coal plant, if built with the best-available technology, can reduce emissions by the annual equivalent of taking a million cars off the road…"

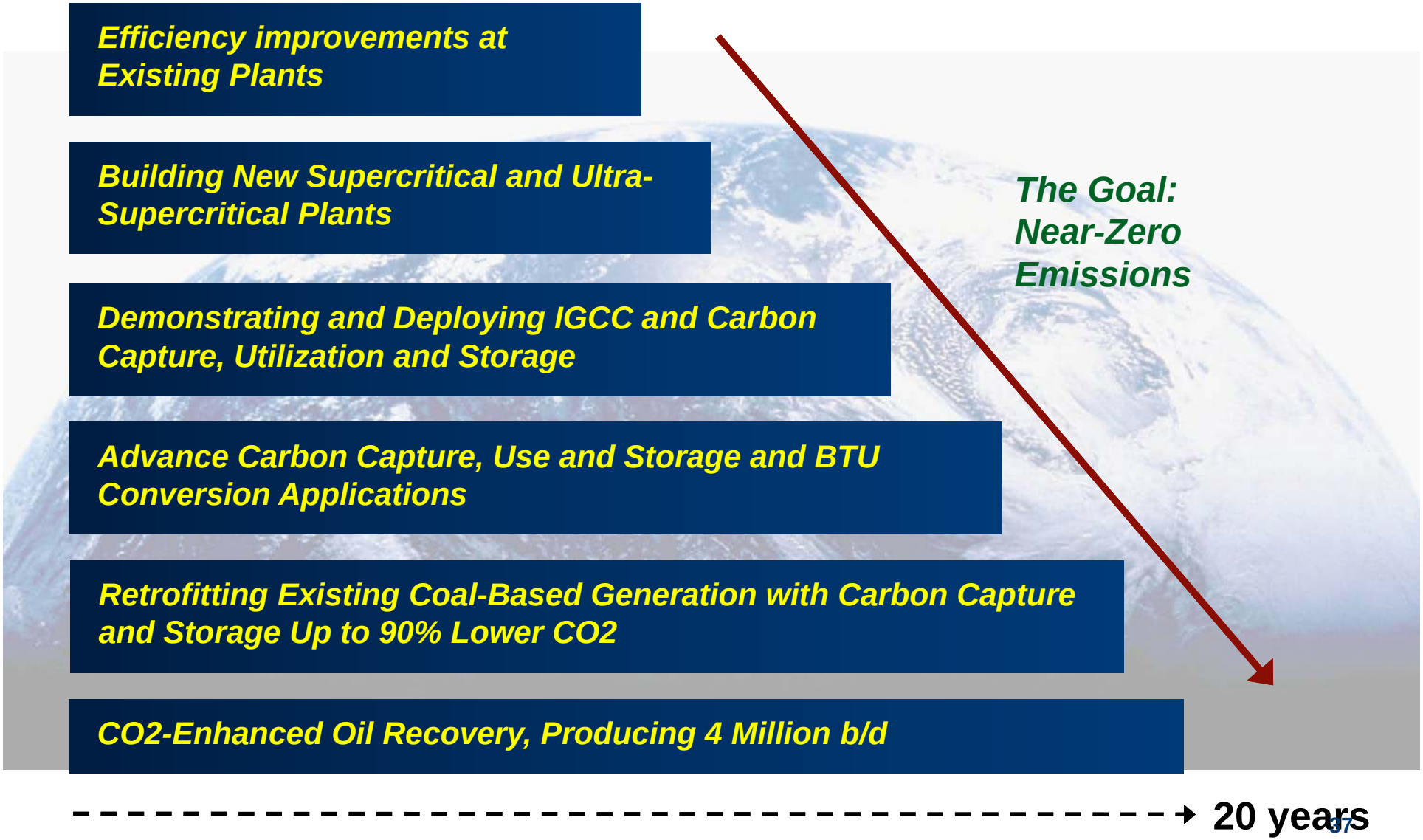
Maria van der Hoeven
Executive Director
International Energy Agency
December 2012

Advanced Coal Generation
569 GW On Line and Under Construction



Supercritical and ultrasupercritical operating plants and plants under construction.
Source: Platts World Electric Power Plant Database. December 2013.

Next Generation Technologies: Continuous Path Forward



Research and Development Underway to Advance Next-Generation Technologies

GreenGen: Among World's Largest Near-Zero Emissions Coal Plants

Control Room at the GreenGen Plant Tianjin, China

- Peabody is the only non-Chinese partner
- Designed to be the world's largest near-zero emissions power plants and global model
- Multi-phase power project with carbon capture and carbon research center
- First 250 MW unit commissioned in 2012

Source: China Huaneng Group news release, Dec. 12, 2012.

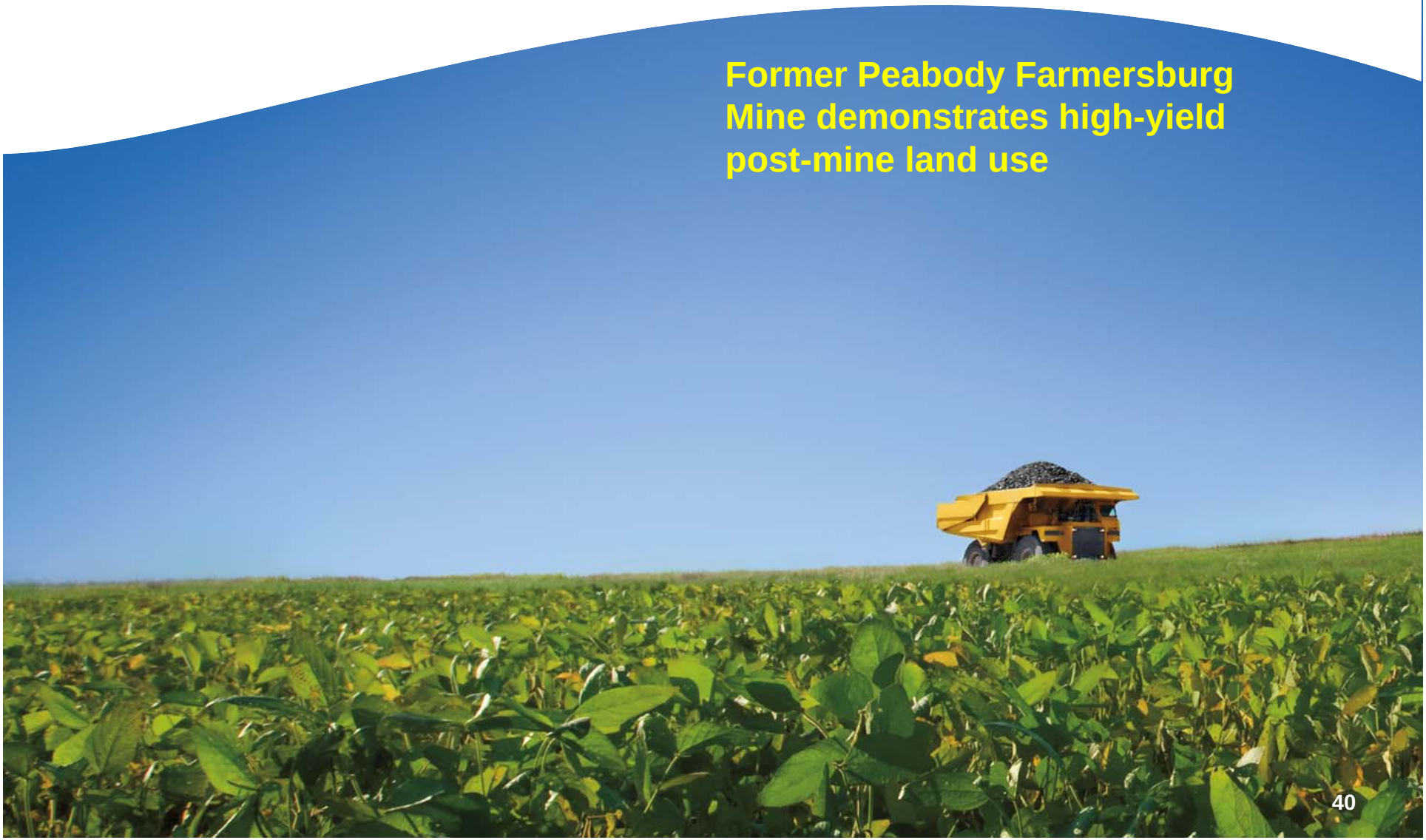
World Can Use Far More Coal, While Achieving Environmental Results

Peabody Plan Advances Technology Solutions to Achieve 3Es

- Ensure at least half of new generation from coal
- Replace older coal plants with ultra-supercritical plants
- Deploy coal-to-gas, coal-to-chemicals, coal-to-liquids
- Develop 100 CCS projects in a decade
- Commercialize near-zero emissions technology

GreenGen Power Plant, Tianjin

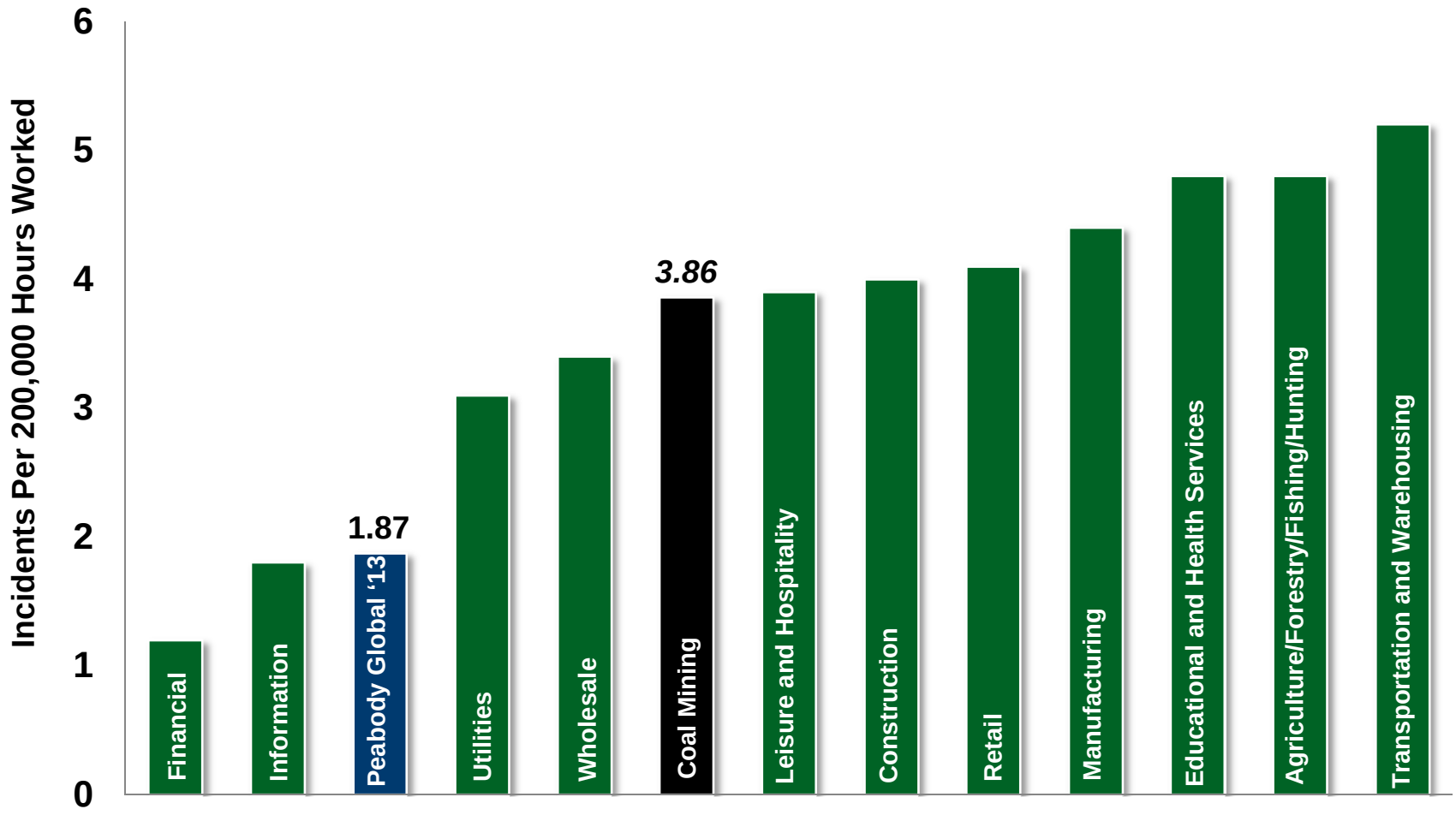
Sustainable Mining



Peabody Strives for Model of Best-in-Class Sustainable Mining

Safety	Communications, training and prevention initiatives aimed at goal of zero incidents
Productivity	Continuous improvement in operational efficiencies through enhanced mining methods
Resource Recovery	Optimal reserve recovery using advanced extraction methods
Land Restoration	Longstanding commitment to restore lands to condition equal to or better than before mining
Economic Benefits	Good corporate and social responsibility; focus on creating thriving communities where we operate

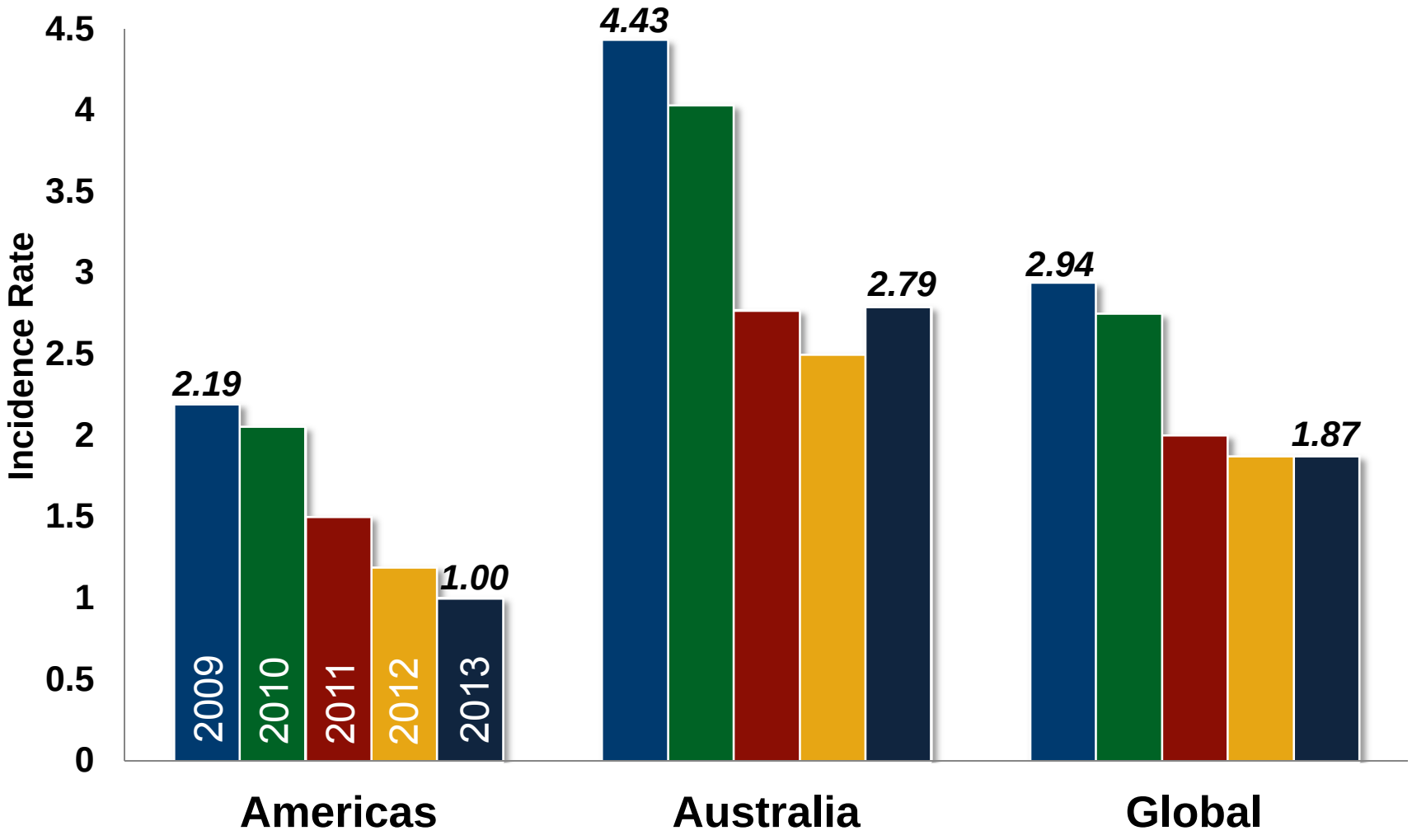
Peabody and U.S. Industry Far Safer than Majority of U.S. Business Sectors



Source: Peabody 2013 data; U.S. Department of Labor, Occupational Safety and Health Administration, 2012 data; Mine Safety and Health Administration, January – September 2013 (Preliminary) data.

Peabody Focused on Continuous Improvement in Safety Performance

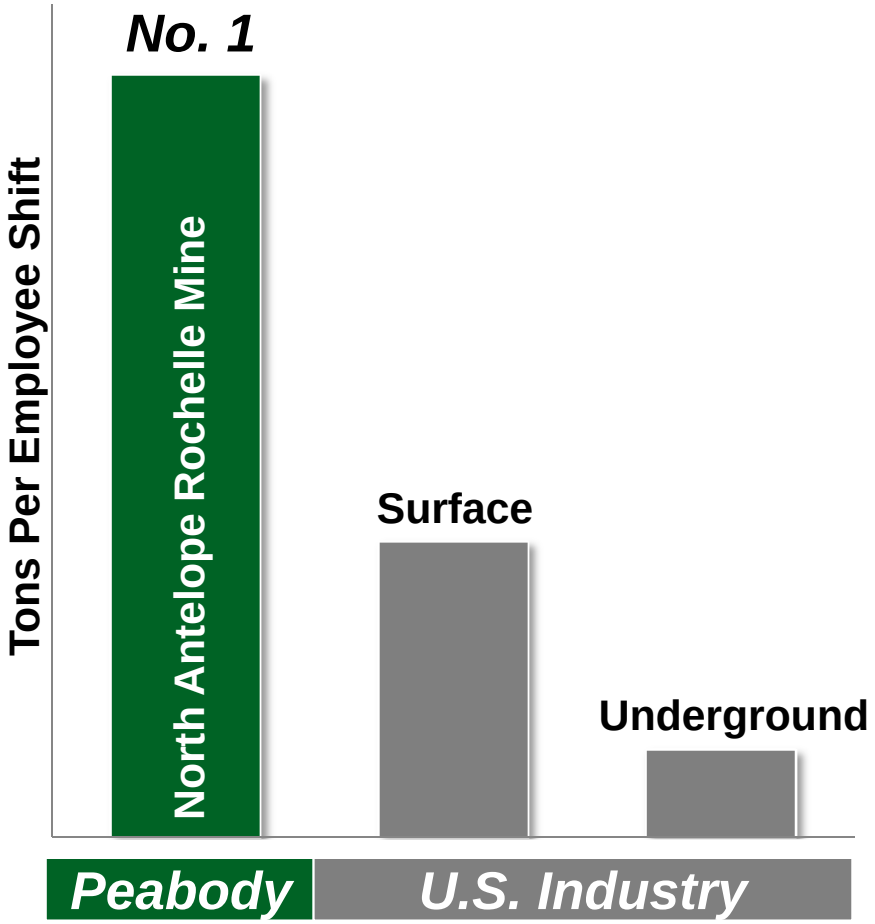
2013 Global Incidence Rate of 1.87



Incidence rate per 200,000 hours worked. 2012 Actual as of January 21, 2013.
All values are for a calendar year basis.

Enhanced Mining Methods Drive Further Improvement in Operational Efficiencies

North Antelope Rochelle Mine: Most Productive U.S. Coal Mine



21st Century Coal Mining:

- Uses efficiencies of scale to drive productivity, including larger trucks, shovels and draglines
- Implements best-in-class technologies, such as GPS and monitoring systems
- Requires extensive high-tech training for operators

Peabody and industry data for 2013. Data reflects all activities at the mining complex.
Source: U.S. Department of Labor Mine Safety and Health Administration and Ventyx.

Efficient Resource Recovery Essential to Modern Coal Mining

- World has nearly 1 trillion tons of coal; makes up 60% of global resources
- In-depth mine planning and state-of-the-art technology ensure effective recovery of available resources
- Water conservation is a priority and coal mining uses tiny fraction of water consumed in the U.S.
  - Agricultural irrigation consumes two-thirds of all fresh groundwater
- Peabody does not participate in mountain top removal


North Antelope Rochelle Mine

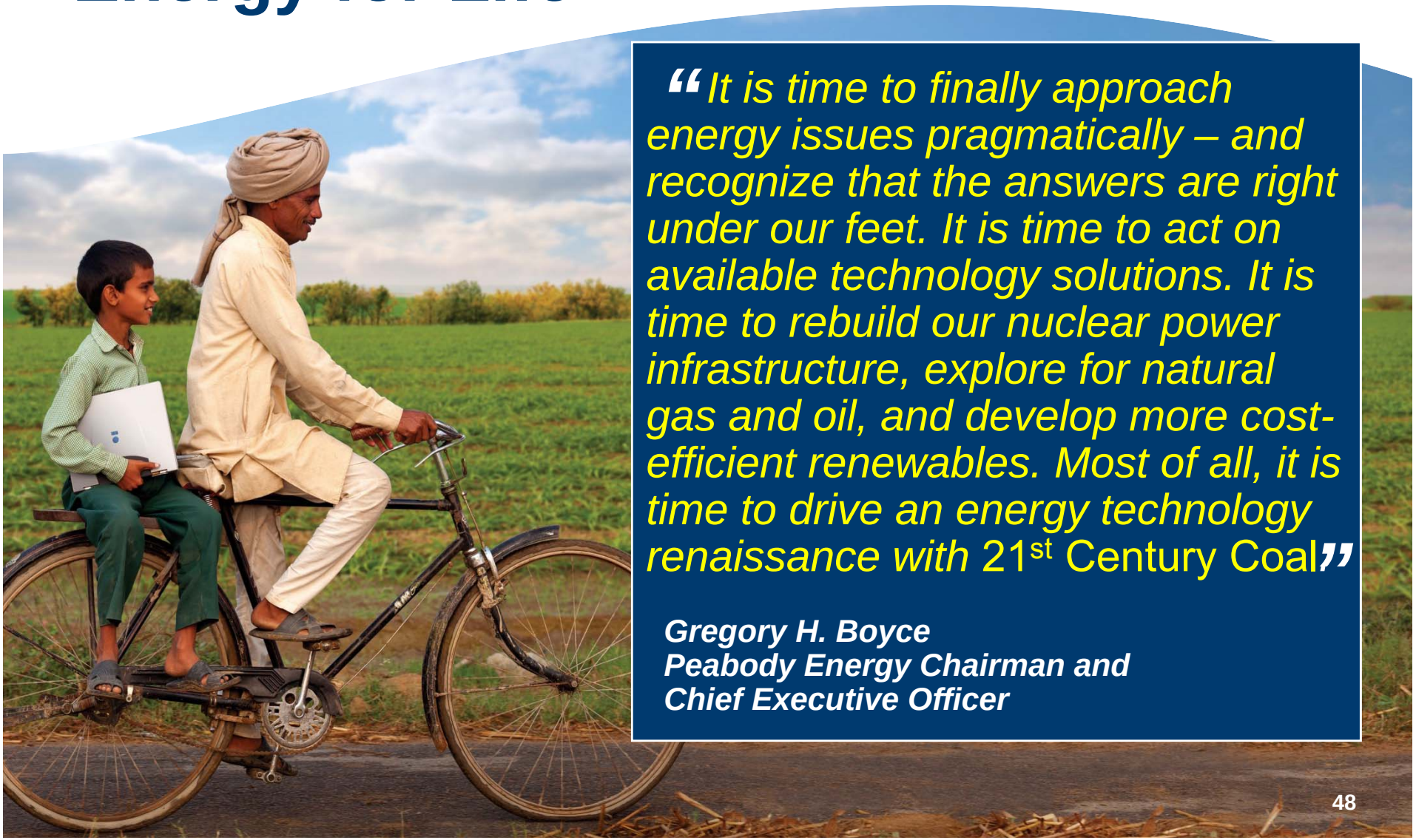
Reclaimed Mining Lands Sustain Farmland, Wildlife and Communities

- Extensive planning in advance of mining activity
- Contemporaneous land restoration ensures smallest active area for mining operations
- Peabody has pioneered agricultural practices to return mined land to highly productive farmland in U.S. and Australia
- Created 1,300+ acres of wildlife habitat, established 300 acres of pristine ponds and lakes in 2013

Coal Mining and Use Fuel Economies and Power Social Progress

- Coal mining and coal use directly provide more than 7 million jobs and indirectly support hundreds of million more
- Peabody contributed $22 billion in economic benefits worldwide in 2013
  - $5.6 billion in direct contributions that create jobs and fuel prosperity
- Peabody provided nearly $5 million in charitable funding aimed to enhance health and welfare, education and environment

21st Century Coal is Advanced Energy for Life



"It is time to finally approach energy issues pragmatically – and recognize that the answers are right under our feet. It is time to act on available technology solutions. It is time to rebuild our nuclear power infrastructure, explore for natural gas and oil, and develop more cost-efficient renewables. Most of all, it is time to drive an energy technology renaissance with 21st Century Coal"

Gregory H. Boyce
Peabody Energy Chairman and
Chief Executive Officer

Peabody Energy is 21st Century Coal

- The world uses substantial energy and those needs are rapidly rising
- Even today, too many people in the world lack access to low-cost electricity
- Coal is uniquely capable of providing that energy, with a scale and cost profile that is unmatched in the world
- Peabody believes that mining must be safe and productive, with high resource recovery and advanced land restoration
- We also believe in continuous emission improvement leading to the ultimate goal of near-zero emissions
- Peabody is pleased to be a global leader in sustainable mining, energy access and clean coal solutions

21st Century Coal: Investing in the Future

- Investors can make a difference for people and for the environment
- Continued investment in coal is required to lift billions out of energy poverty
- Investment in world-class, environmentally responsible companies drives technological innovation
- Improved technology continues to deliver on environmental goals

Peabody ENERGY

Advanced Energy

PeabodyEnergy.com
AdvancedEnergyForLife.com