

China's Green Revolution: Prioritizing Technologies to Achieve Energy and Environmental Sustainability

McKinsey & Company February 2009

PROJECT BACKGROUND

Objective: Develop a comprehensive, objective, and consistent fact base to inform economically sensible and environmentally sustainable approaches for meeting China's energy and resource growth requirements

Not intended to advocate specific policies or approaches. All content and conclusions remain solely the responsibility of McKinsey & Company

ABOUT THIS REPORT

What it does...

- Evaluate the technical potential of 200+ energy efficiency, clean energy and carbon management technologies
- Evaluate and prioritize abatement measures in 5 sectors – buildings, power, transportation, emissionintensive industries, agriculture/ forestry
- Consider ONLY technology-related costs
- Incorporate input from several leading authorities

What it does NOT do...

- Provide a realistic forecast
- Lay out specific action plans for China
- Recommend specific abatement targets

- Consider social costs (e.g., unemployment), taxes, transaction costs, etc.
- Draw only from McKinsey sources

CHINA IS EXPECTED TO SEE STRONG GDP GROWTH AND CONTINUED URBANIZATION IN THE NEXT TWO DECADES...

China GDP*

EUR Billions, 2005 real



China population

Billions



* Exchange rate in 2005 EUR1 = RMB10.1953 Source: Expert interview; McKinsey analysis

DRIVING UP DEMAND FOR BUILDING FLOOR SPACE, VEHICLES AND BASIC MATERIALS

Billion sq. m 2.9% 3.3% 91 24 Commercial 68 14 42 5 Residential 66 55 37

Steel demand Megatons

Total floor space



Source: China industry year books; McKinsey analysis



Cement demand Megatons





THE CHINESE GOVERNMENT HAS RECOGNIZED THE CHALLENGES ... AND IS TAKING ACTIONS

Recent energy efficiency policies in China

- Target 20% reduction in energy intensity per unit of GDP in 2006-2010
- Initiated "1000 Top Enterprise Energy Saving Project" to monitor energy efficiency performance of the most energy intensive enterprises
- Shut-down and consolidated sub-scale, inefficient capacity in energy-intensive industries
- Implemented energy efficiency standards for automobiles, buildings, and appliances
- Cut taxes on small cars
- Invested in grid efficiency and efficient power plants
- Invested in renewable energy
- Enacted Renewable Energy Law

• Enacted Recycling Economy Law to encourage recycling of industrial waste Source: McKinsey analysis

CURRENT POLICIES AND PLANS EXPECTED TO SUSTAIN 5% ANNUAL CARBON EFFICIENCY IMPROVEMENT IN THE "BASELINE SCENARIO"...



...DRIVING "BASELINE EMISSIONS" 40% LOWER THAN THE "FROZEN TECHNOLOGY" SCENARIO, A BIGGER REDUCTION THAN IN NORTH AMERICA

Baseline emissions reduction -China

Giga tons of CO₂e



Baseline emissions reduction -North America* Giga tons of CO₂e



BEYOND THE BASELINE, WE IDENTIFIED 5 AREAS WHERE CHINA CAN LAUNCH A "GREEN REVOLUTION"

Major technologies in baseline Major technologies in abatement • Super-and ultra super-critical • Wind: off-shore Power • Wind: onshore • Solar Conventional fuel efficiency • Hybrid and pure electric vehicle marginal improvement measures Mature efficiency improvement Waste recovery and utilization in technologies industry, agriculture and urban



 Current efficiency building codes 	 Passive design with higher building energy savings
 Conservatory tillage 	 Grassland restoration and management

Source: McKinsey analysis

1. GREEN POWER IN CHINA: COAL COULD BE REPLACED BY NUCLEAR, HYDRO AND RENEWABLES AS THE PRIMARY SOURCE OF POWER



* Including geothermal, CBM, MSW, LFG and biomass Source: Expert interview; literature research; McKinsey analysis

1. US CASE: SIMILAR TREND IN THE US POWER MIX

Generation Projection

TWh, per cent



* Includes oil, geothermal, municipal solid waste, and pumped storage Source: U.S. EIA Annual Energy Outlook (2007), McKinsey analysis

1. GREEN POWER IN CHINA: GENERATION COST FOR CLEAN TECHNOLOGIES COULD DROP TO COMPARABLE LEVELS OF COAL



* Generation cost includes amortized capital at 4% risk free discount rate, OPEX and fuel expenses, and excludes tax, subsidy, etc.

** Learning rate is applied to global capacity built-up, as China is likely to be the world exporter for wind and solar equipments

Source: China solar association; Huangneng Group; Tsinghua Univ; SERC; McKinsey analysis

2. GREEN FLEET IN CHINA: EV TECHNOLOGIES CAN BREAK THE RELIANCE ON IMPORTED OIL

	Well-to-wheel emission* Kg CO ₂ e/100 Km	Gasoline consumption Liter/100 Km	Additional investment EUR/vehicle	Country technology leadership
Base vehicle	20	7.4	0	• Europe, US, Japan
Max ICE improvement bundle	14	5.2	950	
Full hybrid	13	4.8	1,500	• Japan
Plug-in hybrid	9	1.6	1,600	1,6001,6003,6003,600
Pure electric vehicle	7	0	3,600	

* Emission is calculated based on 2030 power mix assumed in our baseline, where coal power share is 65 percent

** Pure electric vehicle electricity consumption 9 KWh/100 Km, plant to battery efficiency 85%; Battery-to-wheel efficiency 81%; hybrid car with 66 percent electric share

Source: DRIVE; expert interview; McKinsey analysis

2. GREEN FLEET IN CHINA: OIL SAVINGS DEPENDS ON HOW FAST EVS ROLL OUT

Total gasoline consumption in 2030

Megatons, assuming EV penetration in new cars reach 100% in 5 years after starting point Percent



in passenger

car fleet

3. GREEN BUILDING IN CHINA: INSULATION, HVAC SYSTEM AND LIGHTING OFFER SUBSTANTIAL ENERGY SAVINGS WITH GOOD ECONOMICS

Abatement volume

Gigatons CO₂e

Average abatement cost EUR/ton CO₂e, 2030



3. GREEN BUILDING IN CHINA: ENERGY EFFICIENT BUILDING INSULATION COULD BE APPLIED TO 2/3 OF FLOOR SPACE BY 2030

Penetration of energy efficient building insulation technologies, abatement scenario



* Majority will be floor space in rural areas Source: McKinsey analysis

4. GREEN INDUSTRY IN CHINA: ON TOP OF ENERGY EFFICIENCY, WASTE RECOVERY PRESENTS A SIZEABLE ABATEMENT OPPORTUNITY



5. GREEN ECO-SYSTEM IN CHINA: RESTORING AND EXPANDING FORESTS AND GRASSLANDS



GREEN MINDSET IN CHINA: SMALL CHANGES TO CONSUMER BEHAVIOR + DENSER URBAN PLANNING = ADDITIONAL ABATEMENT

Abatement potential

Gigatons CO₂e



Source: China Building Energy Efficiency Annual Report; NSB; expert interview; McKinsey analysis

FULL APPLICATION OF THESE TECHNOLOGIES COULD BRING A "GREEN REVOLUTION" FOR BOTH CHINA AND NORTH AMERICA

Abatement potential of China

vs. baseline

Giga tons CO₂e



Abatement potential of North America vs. baseline Giga tons CO₂e



Source: McKinsey analysis

THIS GREEN REVOLUTION COULD SIGNIFICANTLY IMPROVE CHINA'S ENERGY SECURITY

China crude oil demand and supply* Million tons



China coal demand and supply Million tons



* 2030 crude oil demand is based on demand forecast of gasoline, diesel and other oil products Source: EIA; IEA; expert interview; McKinsey analysis

ON AVERAGE EUR 150-200 BILLION WILL BE NEEDED IN ADDITIONAL ANNUAL INVESTMENT TO COMPREHENSIVELY IMPLEMENT THE TECHNOLOGIES

Incremental capital needed to capture the technical potential

Real 2005 EUR billions, annual average of each 5-year period



JUST A FIVE-YEAR DELAY COULD REDUCE ABATEMENT POTENTIAL BY ONE-THIRD

Building
Power

Loss of abatement potential due to 5-year delay of technology implementation Gigatons CO₂e



Loss of abatement due to 5-year implementation delay

IN SUM...

- Current policies will deliver real impact
- Additional reductions are possible and significant...
- ...which will deliver both environmental and energy security benefits
- However, investments needed are very large
- And decisions need to be made soon