Base Case Co-benefits: Coordinating and Systemizing Evaluation Methods with Examples from China

Professor Kirk R. Smith
University of California, Berkeley CA
Visiting Senior Scientist
Woods Hole Research Center, Falmouth MA

Presentation at the IGES Scoping Consultation
The Developmental Co-Benefits of Climate Policies in Asia
Bangkok, Aug 3, 2007

Major Co-benefits Questions

1. Is it possible to simultaneously achieve both significant carbon credits as well as progress toward development goals?
   i. “Significant” statistically
   ii. “Significant” substantively

2. What methods are available to estimate, measure, and confirm these benefits?
   i. Should be robust and easy to apply
   ii. Should be traceable to international norms

And,

- How does one handle trade-offs between the two, that is,
  - Make a decision to go with a project that achieves more progress toward development goals, but costs more per ton of carbon?

- Context: Scoping methods for UNDP MDG-Carbon Facilities (Beijing/New York)

Background to Central Premise

- Methods for determining benefits in terms of carbon credits, health improvements, economic development, etc. are complex and in flux, and vary according to a range of explicit and implicit assumptions made by the analyst. e.g.:
  - Basic metrics for health, economic development, etc.
  - Economic valuation approaches
  - Discount rates
- Nevertheless, there has been much progress in recent years within the context of major international collaborative assessments for some of the benefits being considered

International Collaborative Assessments

- IPCC/UNFCCC: Metrics and procedures for calculating carbon credits
- Millennium Development Goals: 8 MDGs with ~30 explicit indicators and metrics
- Commission on Macro-economics and Health: established health burden metrics and standard methods for cost-effectiveness analysis
- WHO Comparative Risk Assessment: Metrics of exposure and health burden with estimated exposure –response relationships and uncertainties

Premise

- The first scoping of benefits should use the methods and metrics established by the international collaborative assessments –base case

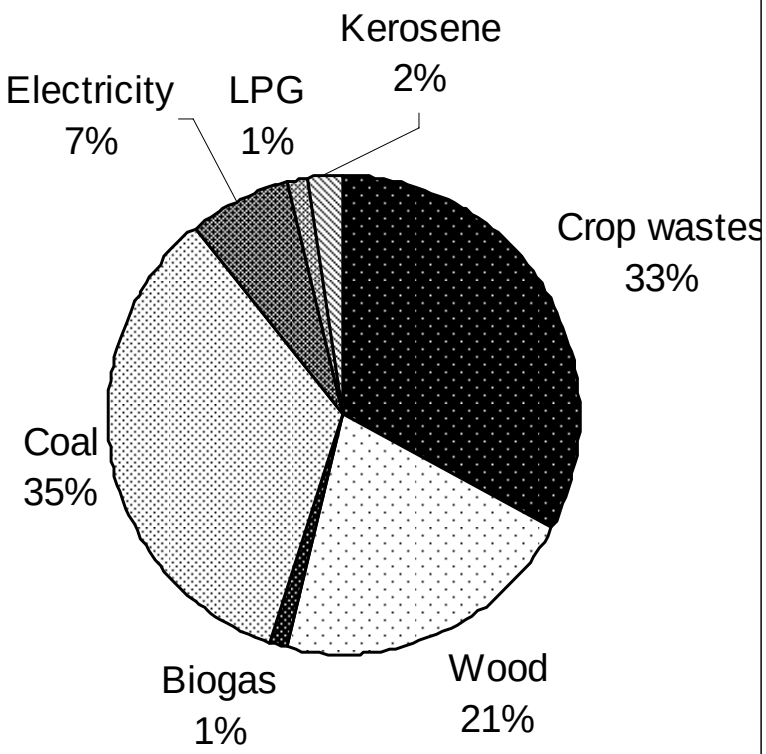
- Elaboration can be made in additional analyses (cases) based on particular needs or local conditions

Examples will be drawn from the rural energy sector in China

- The energy sector is where most GHG emissions derive
- Rural areas are where energy is most closely tied to household health and development
- China is in a position to implement a range of projects soon

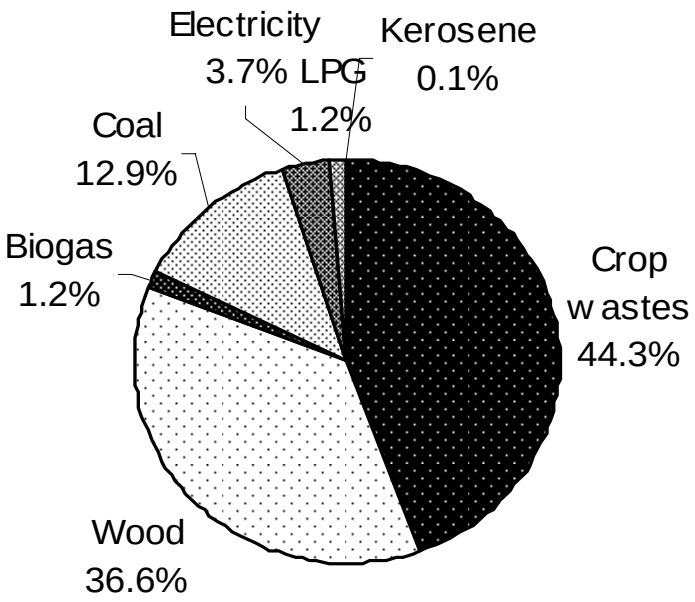
Rural Energy in China: 2004

Total



Ministry of Agriculture

Households



70% of total

National Bureau of Statistics

Comparative Risk Assessment (CRA)
2-year 30-institution project organized by the World Health Organization

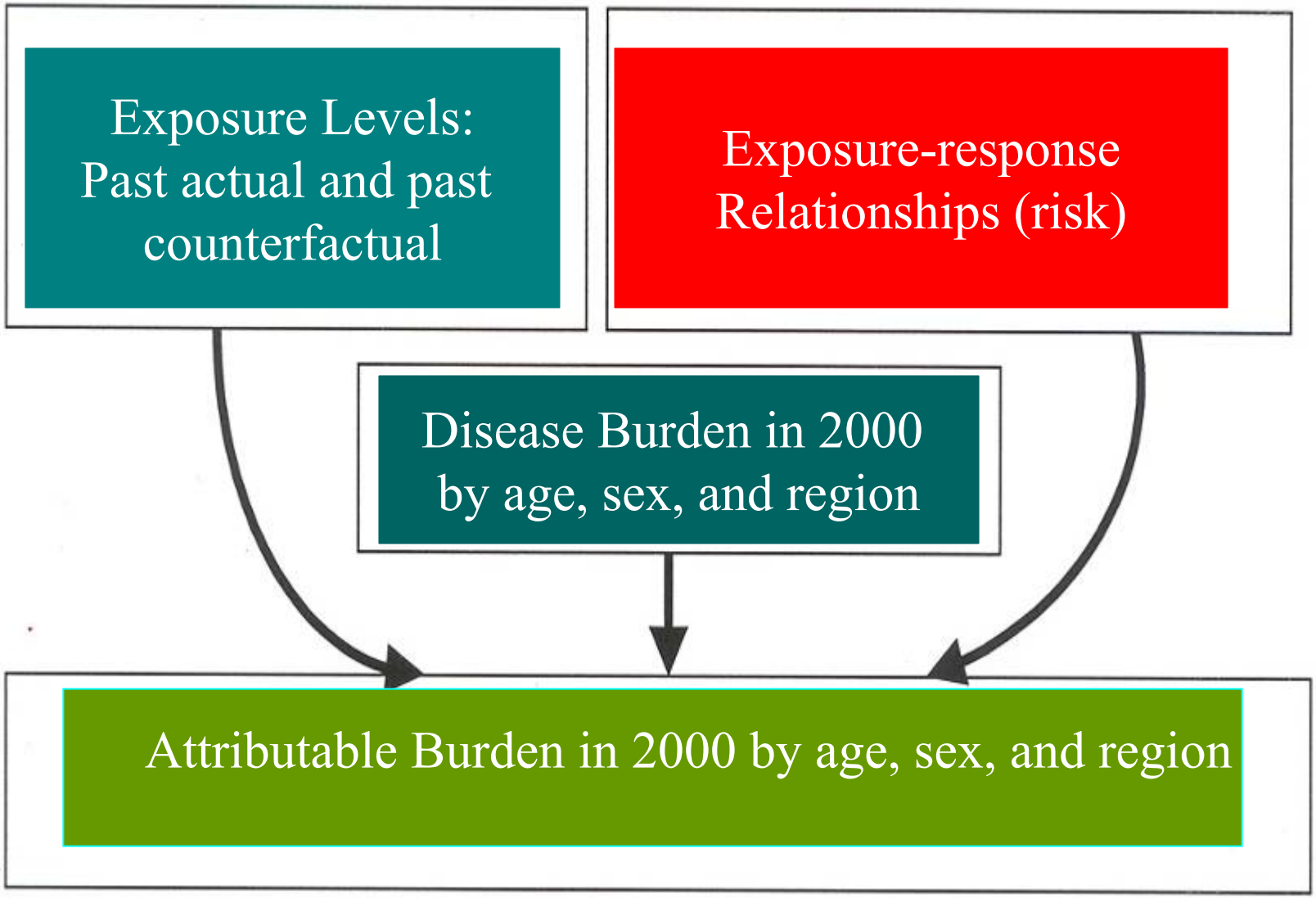
Disease, injury, and death due to 26 major risk factors calculated by age, sex, and 14 global regions.

Fully published in late 2004 in two volumes by WHO

WHO CRA

- Standard methods and metrics
- Common databases
- “Consensual Discipline”
- Uncertainty explicitly ascertained
- Heavily peer-reviewed
- Published in detail
- Regular update
  - Next update starting Sep 2007

Comparative Risk Assessment Method



Health Effects of Indoor Solid Fuel Combustion*

Use of biomass fuels in households increases risk of

- Chronic Obstructive Pulmonary Disease in adult women by a factor of 3.2 (95% CI: 2.3-4.8) .
- Pneumonia in children under 5 years old by a factor of 2.0 (95% CI: 1.7-2.5).
- Lung cancer in women, coal only

***Review of many dozen studies worldwide by World Health Organization (WHO, 2002,2004)**

Health Benefits of Fuel/stove Intervention

Best published studies in the world were done by examining introduction of improved coal stoves in China

Improved Stoves Brought to Xuanwei County in early 1980s

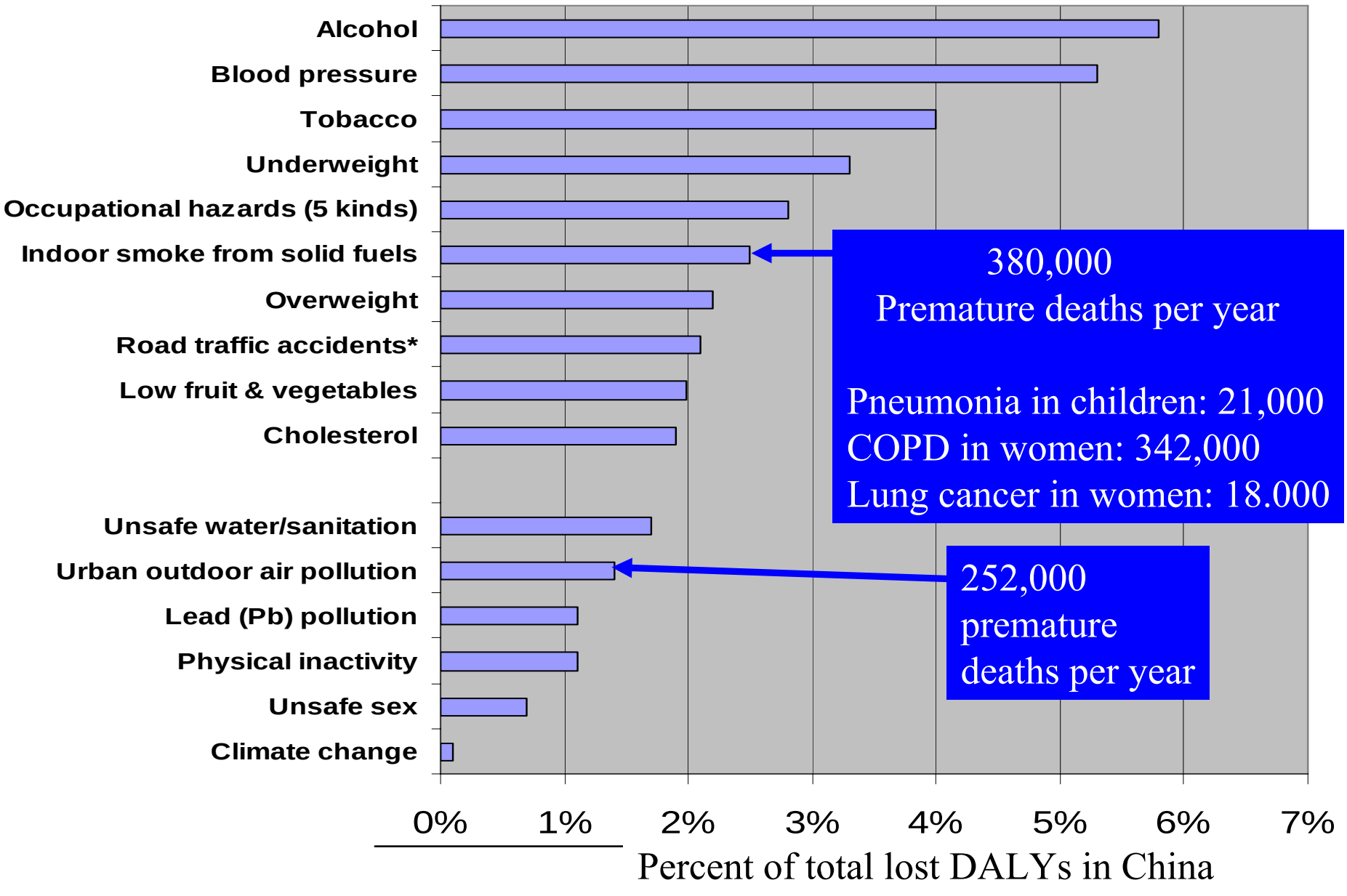
- The reduction in particle levels was ~a factor of about three.
- Reduction in lung cancer was ~40% in men and ~45% in women. (*Journal of the National Cancer Institute)*
- Reduction in COPD rates was also significant at about 50% in both men and women (*British Medical Journal*)
- Reduction in lung cancer and COPD took 10 years to fully develop after IAQ improvement.

Metric Used for Comparative Risk Assessment

- Lost life years only type of unit ever proposed that systematically includes premature mortality and morbidity
- And puts everyone on Earth on an equal basis, i.e., we all share the right and capability of the same length of healthy life
- The Disability Adjusted Life Year, DALY, one such metric, is the only one with systematic, worldwide databases that allow consistent comparisons across age, sex, disease, risk factor, and region the world.

Chinese Burden of Disease from Top 10 Risk Factors

Plus Selected Other Risk Factors



MDG 4. Reduce child mortality.

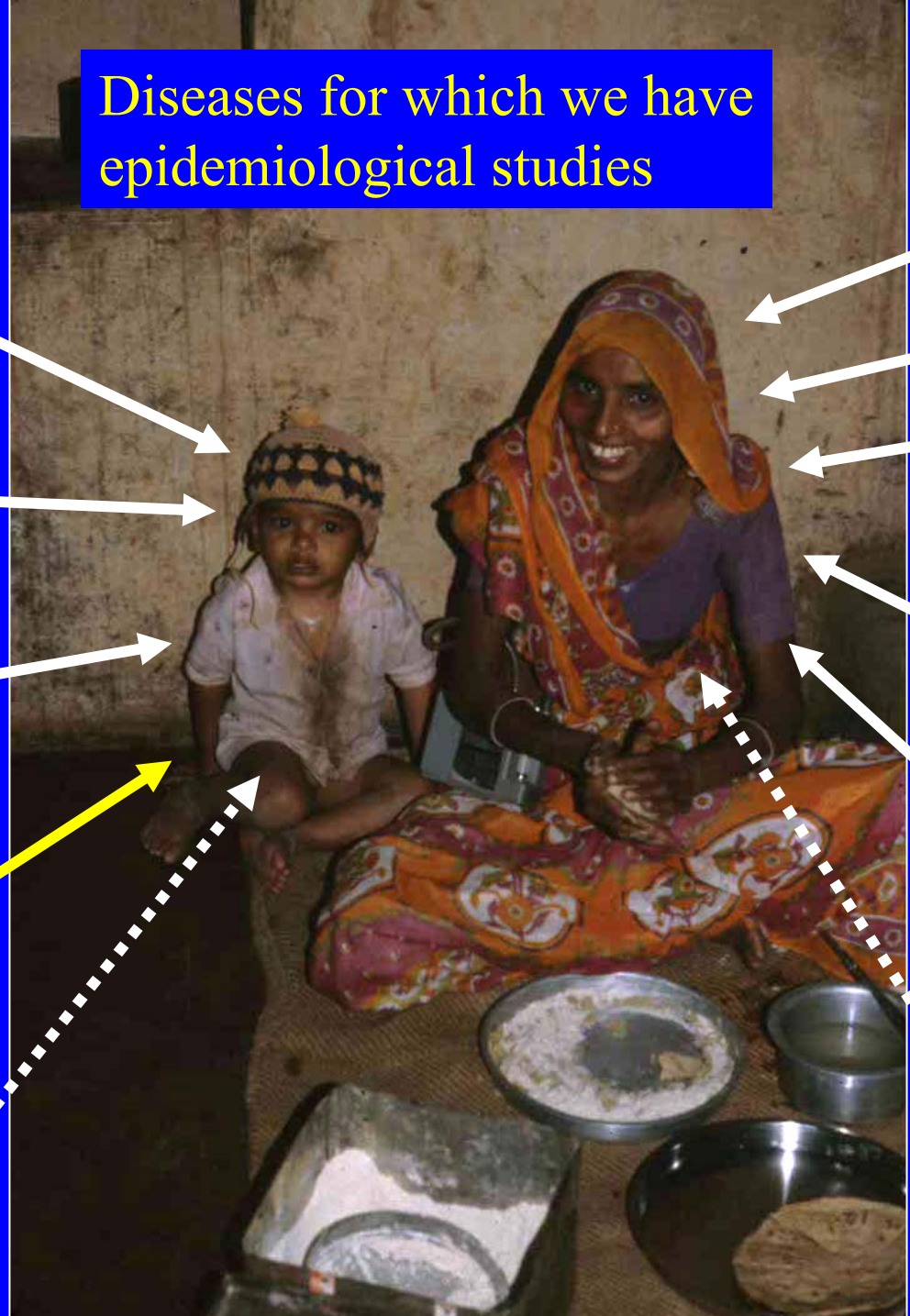
- **Official Indicators**
  - 13. Under-five mortality rate
  - 14. Infant mortality rate
- **Rural Energy – closely related indicators**
  - **Mortality/morbidity from pneumonia**
  - **Incidence of low birth weight**

MDG 5. Improve maternal health.

- **Official Indicators**
  - 16. Maternal mortality ratio
- **Rural Energy – related indicators**
  - Mortality/morbidity from chronic obstructive pulmonary disease (COPD) and lung cancer in women
  - TB, cataracts and heart disease in women

MDG 6: Reduce TB, HIV, Malaria

- Official indicator
  - 23. Prevalence and Death Rates Associated with Tuberculosis
- **Rural Energy – related indicators**
  - **Pneumonia as chief fatal outcome of HIV in children**
  - **TB as chief fatal outcome of HIV in adults**



Diseases for which we have epidemiological studies

ALRI/ Pneumonia (meningitis)

Asthma

Low birth weight & stillbirth

Early infant death

Cognitive Effects?

Chronic obstructive lung disease

Interstitial LD

Cancer (lung, NP, cervical, aero-digestive)

Blindness (cataracts, trachoma)

Tuberculosis

Heart disease

Absolute impact depends on

1. Exposure difference
2. Risk (exposure-response relationship)
3. Background disease rate

As all depend on local conditions, the impact of a risk factor, such as air pollution, will not be the same in different populations

Indoor and Outdoor Air Pollution Risk Factors in China

	Population	Exposure Metric	Relative risk per unit	DALYs/ exposurea
Outdoor		1000 people		3% DALY
Cardiovascular	Adults>30	10 µg/m3 PM2.5	1.059	1.56E-01
Lung Cancer	Adults>30	10 µg/m3 PM2.5	1.082	2.26E-02
ALRI	Children<5	10 µg/m3 PM10	1.01	1.64E-02
Indoor		Household (HH)		
COPD	Adults>30	Solid fuel use	3.2	1.17E-02
Lung Cancer	Adults>30	Solid fuel use	1.9	5.03E-03
ALRI	Children<5	Solid fuel use	2.3	7.58 E-03

WHO CRA, 2004

How to quantify, verify, and value? Mothers' and Children's Health

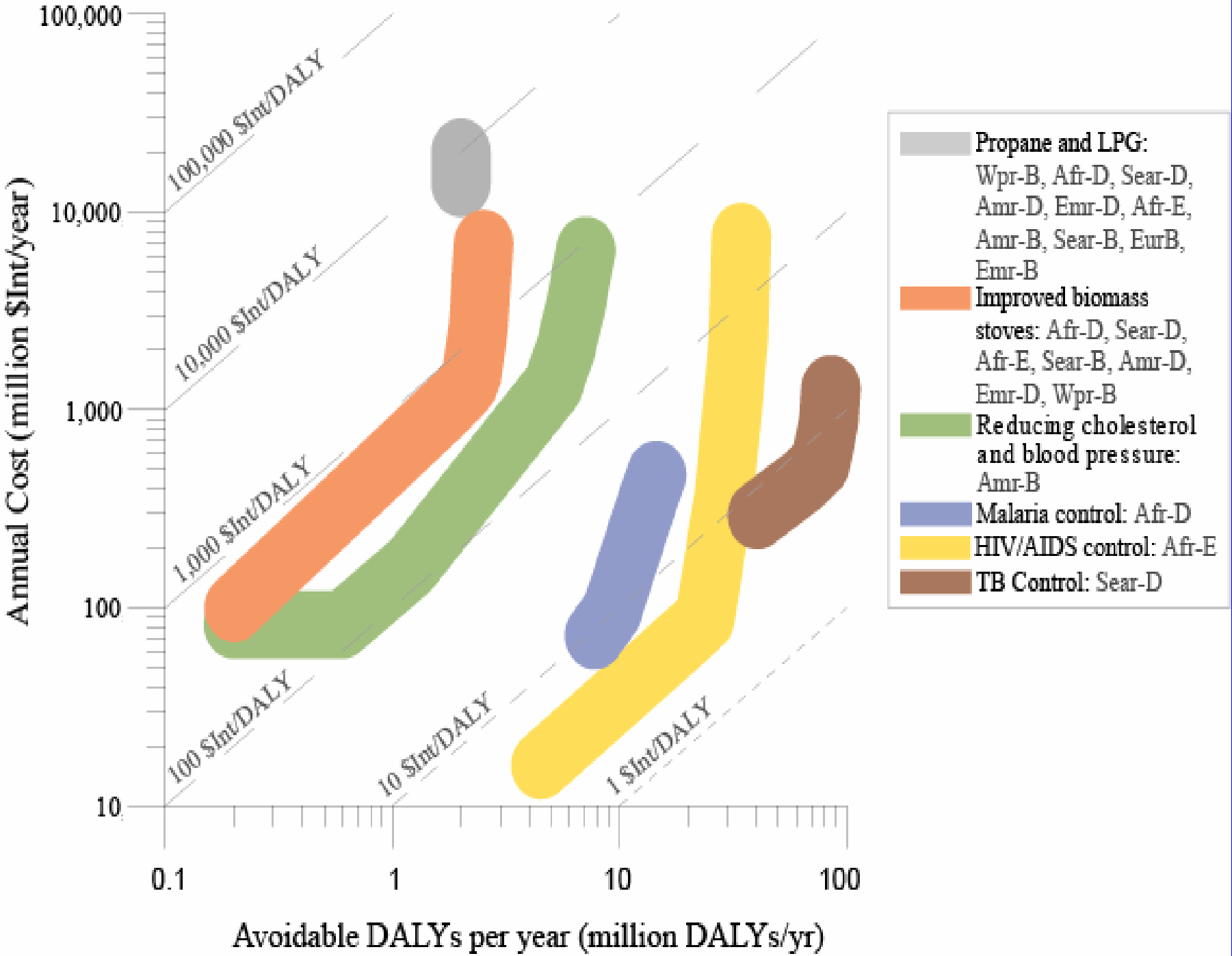
- Apply peer-reviewed results of meta-analyses of health benefits from household energy improvements using standard epidemiologic risk techniques in the WHO CRA to estimate DALYs for each population group
- How to determine economic value? WHO/IBRD has developed methods and recommendations

Commission on Macro-economics and Health, 2001

- Recommended methods and criteria for setting priorities among health interventions based on
  - DALYs: saved healthy life years
  - Cost: in terms of local income levels
- Adopted by World Health Organization and World Bank

Recommendations

- **"Very Cost-Effective":** Less than the local $GDP/capita per DALY should be considered part of primary health promotion and be undertaken as quickly and widely as possible.
- **"Cost-Effective" :** Between one and three times the local $GDP/capita-DALY, interventions should be seriously considered and with appropriate attention to the needs of special populations, regions, etc; the cheaper ones should generally be undertaken first.
- **"Not Cost-Effective" :** More than three times the local $GDP/capita-DALY, interventions should be left to private markets and not be part of government or donor activities.


100,000
10,000
1,000
100
10
Annual Cost (million $Int/year)
100,000 $Int/DALY
10,000 $Int/DALY
1,000 $Int/DALY
100 $Int/DALY
10 $Int/DALY
1 $Int/DALY
0.1
1
10
100
Avoidable DALYs per year (million DALYs/yr)
Propane and LPG: Wpr-B, Afr-D, Sear-D, Amr-D, Emr-D, Afr-E, Amr-B, Sear-B, EurB, Emr-B
Improved biomass stoves: Afr-D, Sear-D, Afr-E, Sear-B, Amr-D, Emr-D, Wpr-B
Reducing cholesterol and blood pressure: Amr-B
Malaria control: Afr-D
HIV/AIDS control: Afr-E
TB Control: Sear-D

Cost-Effectiveness Analyses

- Need to apply consistent criteria
- Need to stick to UNFCCC rules for CDM
- No need to depart from recommendations by WHO/IBRD for health analyses
- Need to reflect standard financial analysis methods
- Is need to adjust discount rates and other protocols to bring the three types of analysis together
    - DALYs - health
    - Global Warming Commitments – climate change – including use of GWPs for combining GHGs
    - Costs – financial analysis

Summary metrics for use in co-benefits scoping.

	Health	**Climate Change**	**Money**	
Metric	DALYs (Disability-Adjusted Life Years)	GWC (Global Warming Commitment)	International Dollars	
Unit	Years	Tons CO_2 equivalent	US Dollars	
Formulation	Years lost from premature death plus weighted years lost to disability	Tons CO_2 plus tons other GHGs multiplied by their global warming potentials (GWPs)	Local currency adjusted by its capability to buy standard market basket of purchases	
Discount Rates	DALYs	GWPs	Benefits	Costs
Kyoto Case	0%	100-year ~ 0.7%	1%	3%
Base Case	3%	20-year ~ 4.3%	3%	3%
Financial Case	3%	20-year ~ 4.3%	3%	6%

Health Impact in China

- Indoor air pollution from household solid fuel use – 2002 (WHO)
  - Children: 21,000 deaths from pneumonia
  - Women: 342,000 from COPD
    18,000 from lung cancer
  - Burden = 3.2 million DALYs
- If half reduced, at $4500/DALY (3x GDP/cap) = $7.2 billion/yr
- Without credit for poisonous coal

Carbon from Rural Coal

- Ministry of Agriculture: 167 million tons coal used in 2005
- If half could be saved: 260 million tCO2 at $15 = $3.9 billion/yr
- If combustion efficiency could be increased so that the methane emissions are reduced from the remainder, depending on GWP, perhaps an additional $2 billion/yr could be had

A Chinese Biomass Gasifier Stove

Tests show PIC emissions nearly at LPG levels.

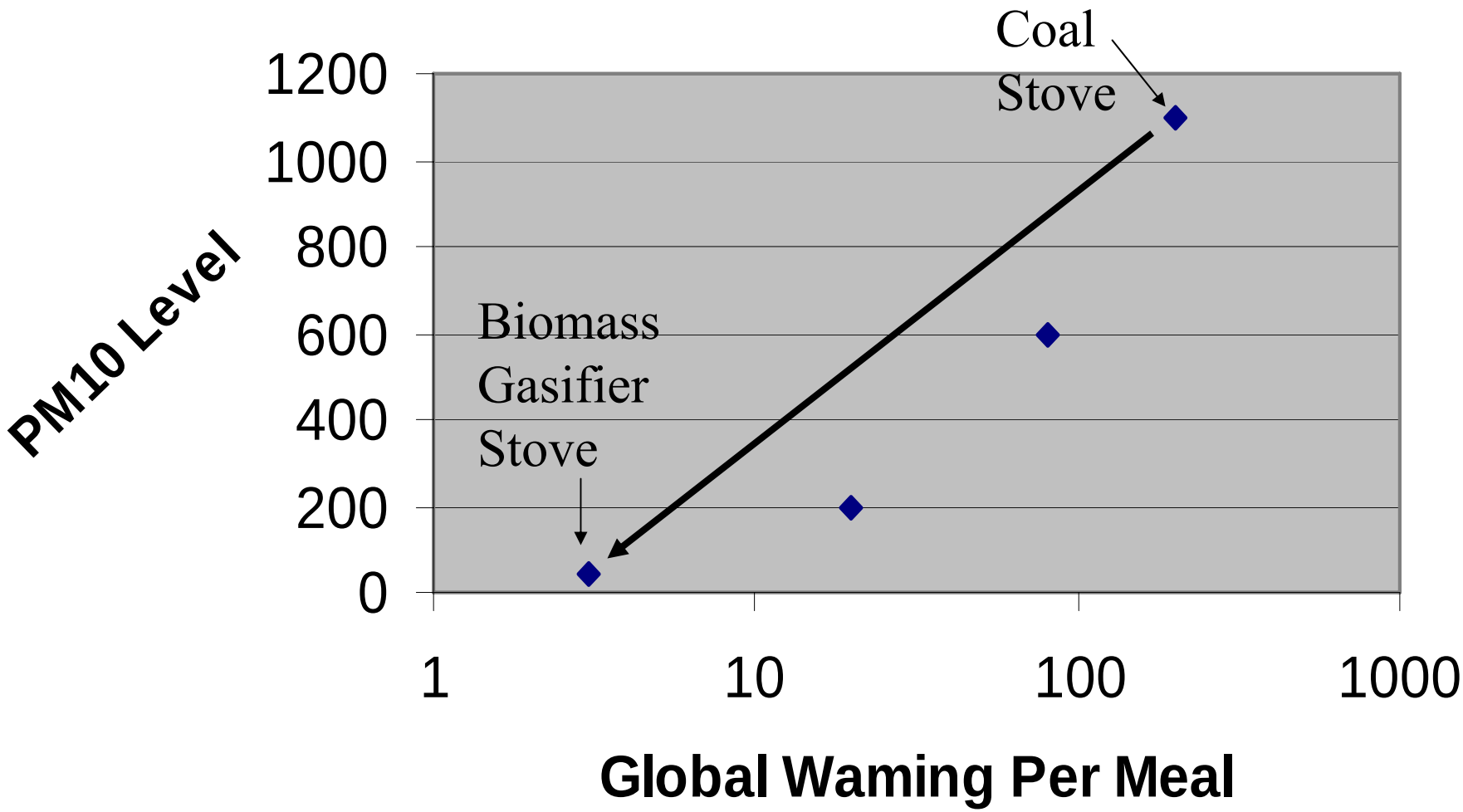
Winner of Chinese national contest
announced March 2007 for best stove meeting
emissions and reliability criteria: cost 300Y

Three Co-benefits Cases for Chinese Rural Energy Sector: Substitution of Biomass Gasifier Stoves for Coal Stoves

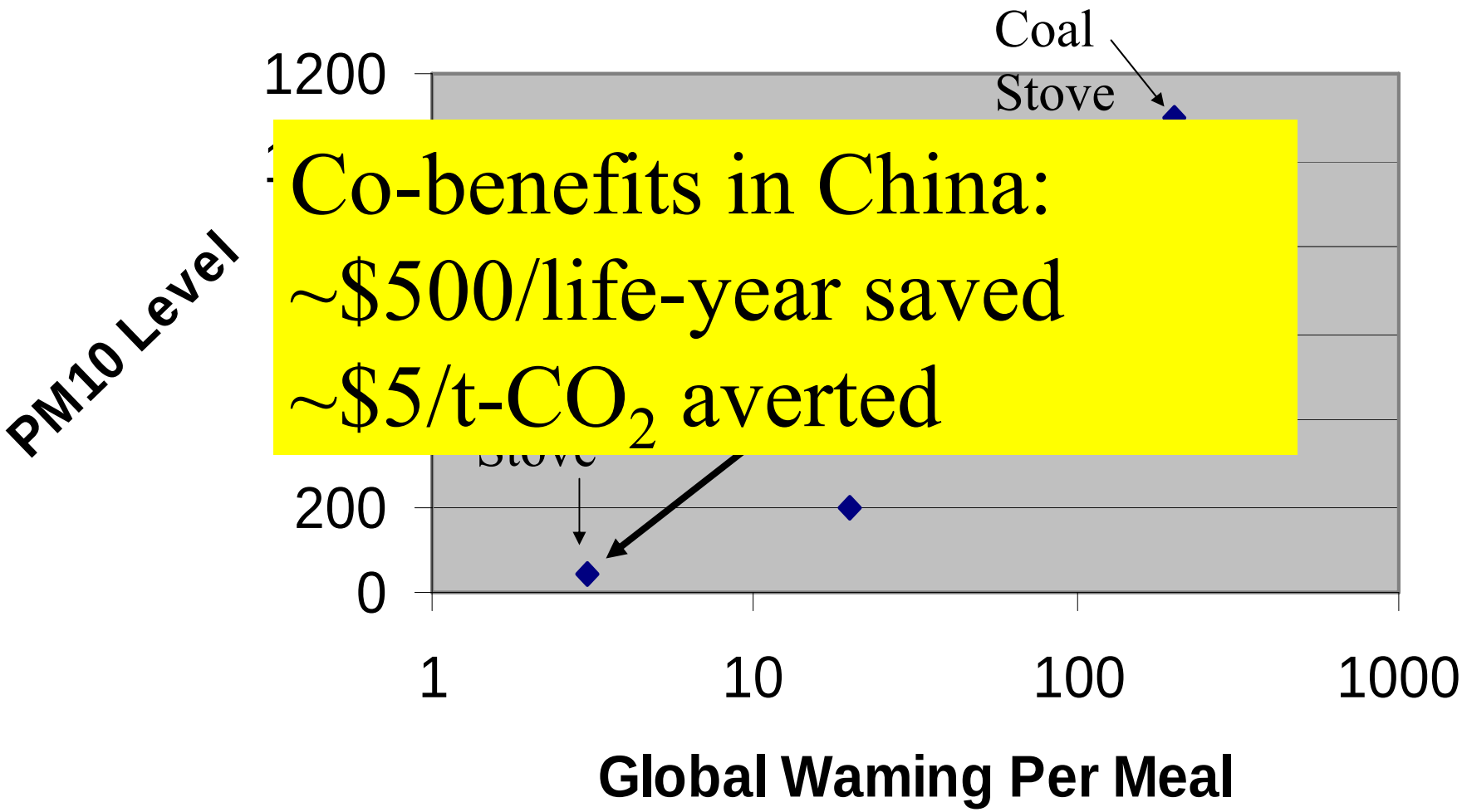
Case	$/DALY	$/tCO2e	Health (at $1500/DALY)	Carbon (at $10/tCO2e)	Total ($/stove)	% Health
Kyoto	$374	$5.64	$205	$91	$295	69%
Base	$479	$4.93	$160	$104	$264	61%
Financial	$411	$4.23	na	na	na	na

Source: Smith & Haigler, in press

Health and Greenhouse Gas Benefits of Biomass Stove Options



Health and Greenhouse Gas Benefits of Biomass Stove Options

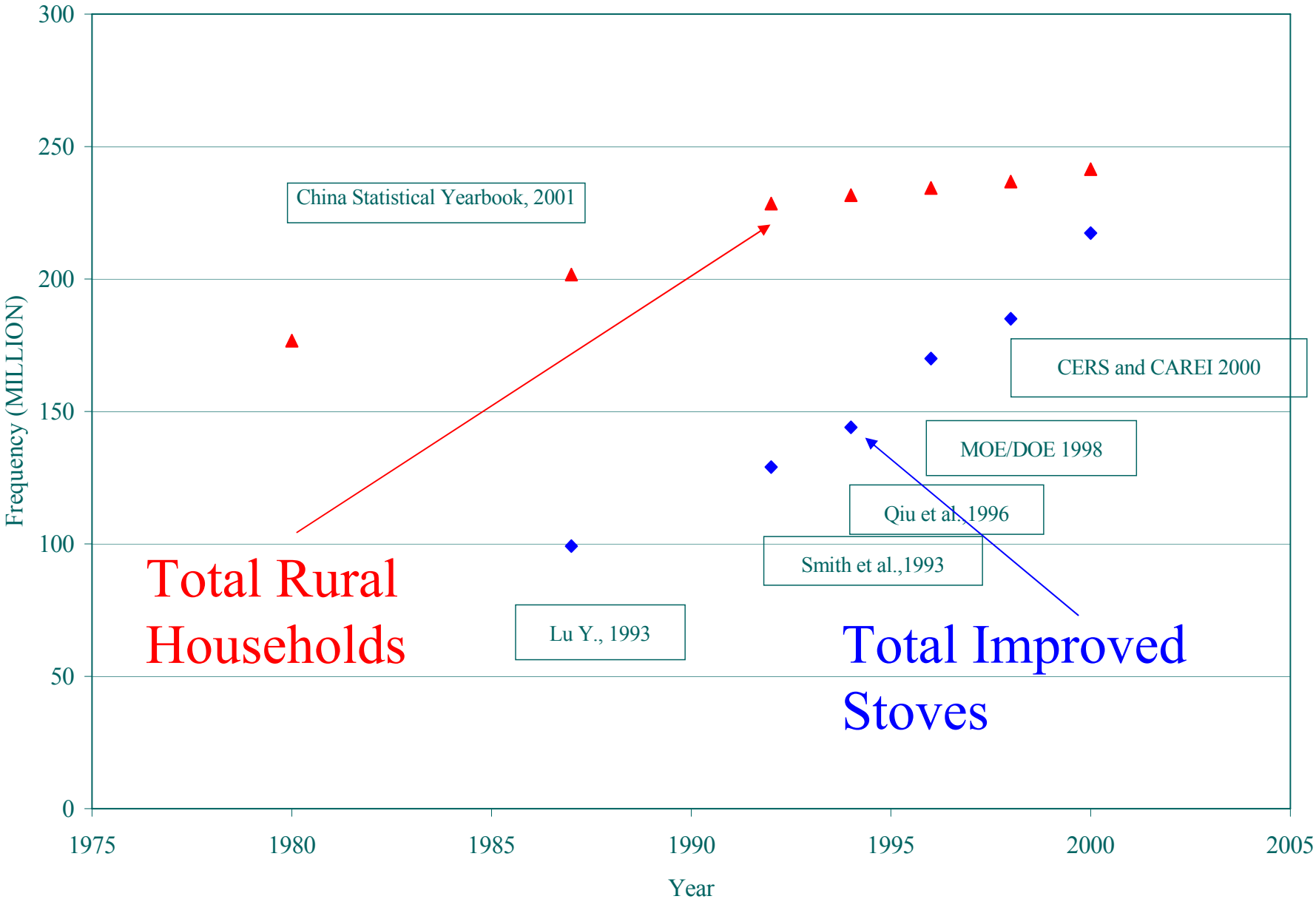


China has shown itself capable of major achievement in rural energy, including one of the largest rural development Programs in human history and, purportedly, the most cost-effective Energy efficiency measure undertaken in China.

Improved Biomass Stoves in China

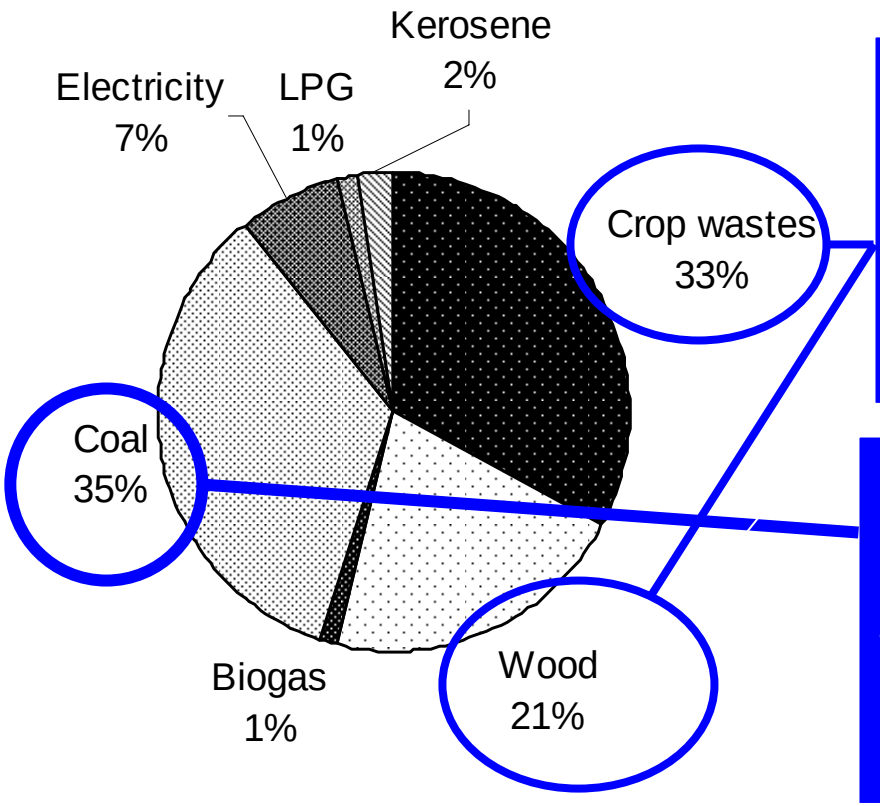
More than 180 million introduced 1981-1998

China's National Improved Stove Program (NISP)



Rural Energy in China: 2004

Total

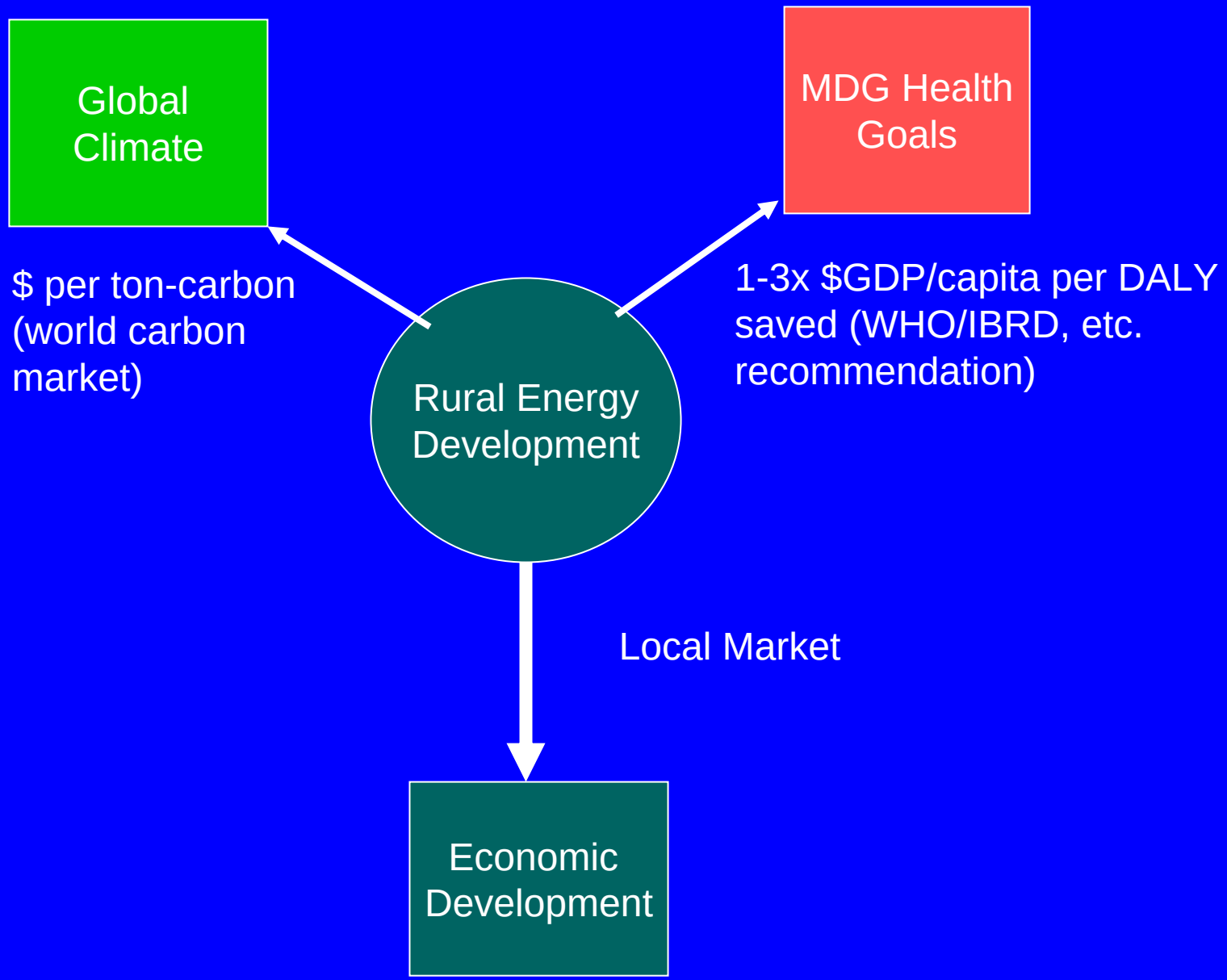


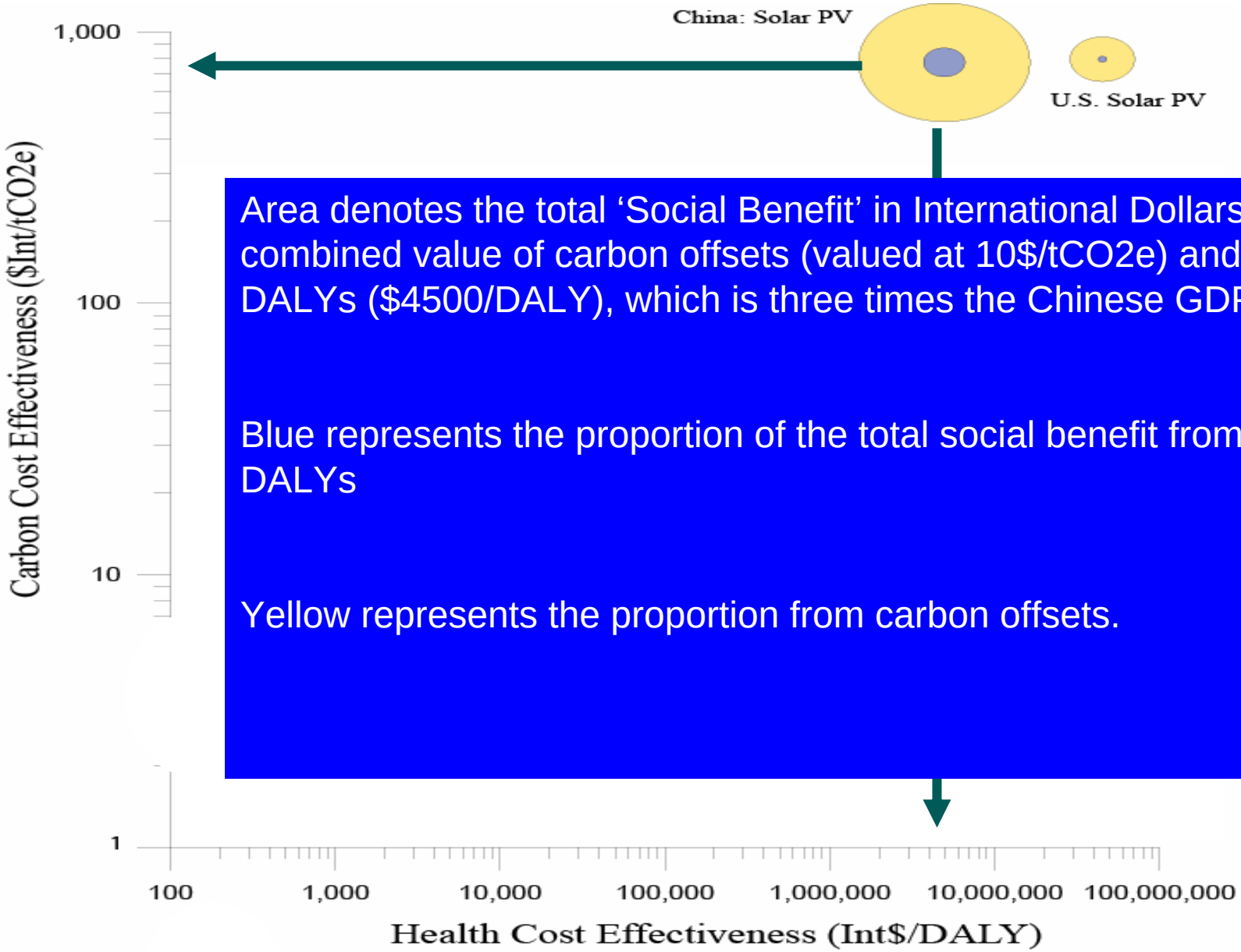
Rural biomass ~15% of all Chinese energy use

167 million tons ~10% Chinese CO_2 emissions

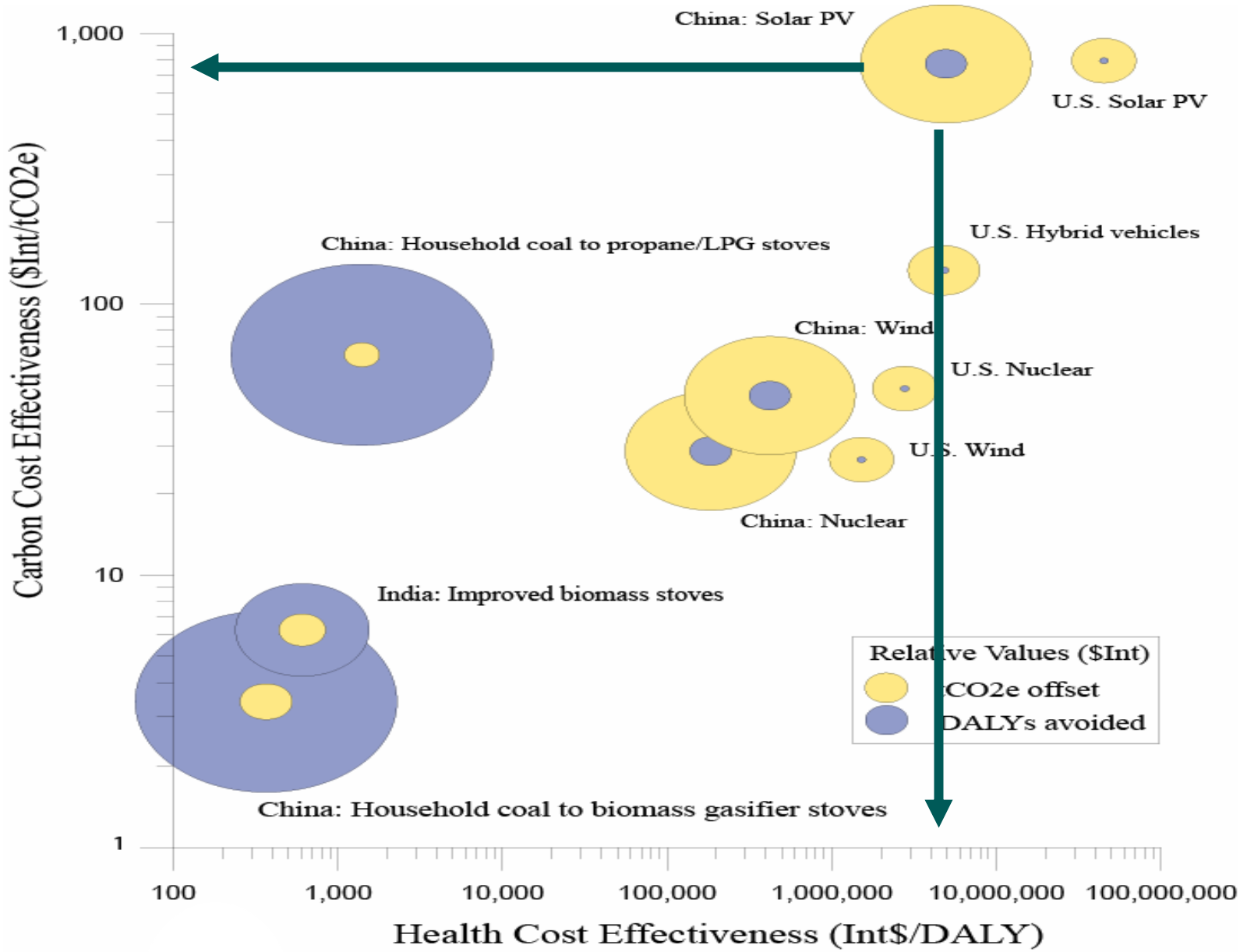
Ministry of Agriculture

How Much to Spend to Support RED?





Source: Smith & Haigler, in press



Source: Smith & Haigler, in press

What about non-health co-benefits?

- Several of the other MDG goals offer indicators that could serve in base case analyses for other development co-benefits
- Two examples follow

MDG 1. Eradicate extreme poverty and hunger.

- **Official Indicators**
  - 1. Proportion of population below $1 (PPP) per day
  - 2. Poverty gap ratio [incidence x depth of poverty]
  - 3. Share of poorest quintile in national consumption
  - 4. Prevalence of underweight children under-five years of age
  - 5. Proportion of population below minimum level of dietary energy consumption
- **Rural Energy – other possibilities as well**
  - Fuel costs per person-meal.
  - Time spent cooking.
  - Time spent obtaining and preparing fuel
  - Economic modeling of the effects of expanding rural energy activities

MDG 7.Environmental Sustainability

- **Official Indicators**
  - 25. Forested land as percentage of land area;
  - 27. Kg oil equivalent per $1,000 (PPP) GDP;
  - 28. Carbon Dioxide Emissions (per capita)
  - 29. Proportion of population using solid fuels
  - 30. Proportion of the Population with Access to Improved Water Source;
- **Rural Energy – other possibilities as well**
  - **Carbon storage;**
  - **CO2-equivalent GHG emissions;**
  - **biodiversity preservation;**
  - **fraction of renewable energy;**
  - **reduction of diarrhea rates**

Conclusion

- The first scoping of benefits should use the methods and metrics established by the international collaborative assessments
  - they represent a consensus of world expert opinion on how best to navigate through the complexity of such analyses
  - This would represent in all analyses, the **Base Case**
- Elaboration can be made in additional analyses (cases) based on particular needs or local conditions
  - Departures from Base Case to be clearly stated
  - Restricted, however, to peer-reviewed methods in published literature

Need, however

- To slightly adjust the methods proposed by the different groups to be consistent with one another, e.g.
  - Discount rates
  - Valuation techniques
  - Time periods
- Must be verifiable at reasonable cost
  - “You don’t get what you expect, you get what you inspect”

The presentation based on

Smith KR and Haigler E, "Co-benefits of climate mitigation and health protection in energy systems: Scoping methods"

Symposium on Climate Change and Health
Ed, KR Smith

***Annual Review of Public Health*, in press .**

Full list of CO-benefits publications since 1992:

http://ehs.sph.berkeley.edu/krsmith/page.asp?id=5

Thank you