Biofuels and Sustainability

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Materials online at: http://rael.berkeley.edu

Global Sustainability: A Nobel Cause
Potsdam, Germany, **October 9, 2007**

Overview

- **<u>Feedstock-to-fuel</u> choices have profound impacts far beyond the energy sector**
- **Carbon is a start, but *sustainable fuel* standards are needed**

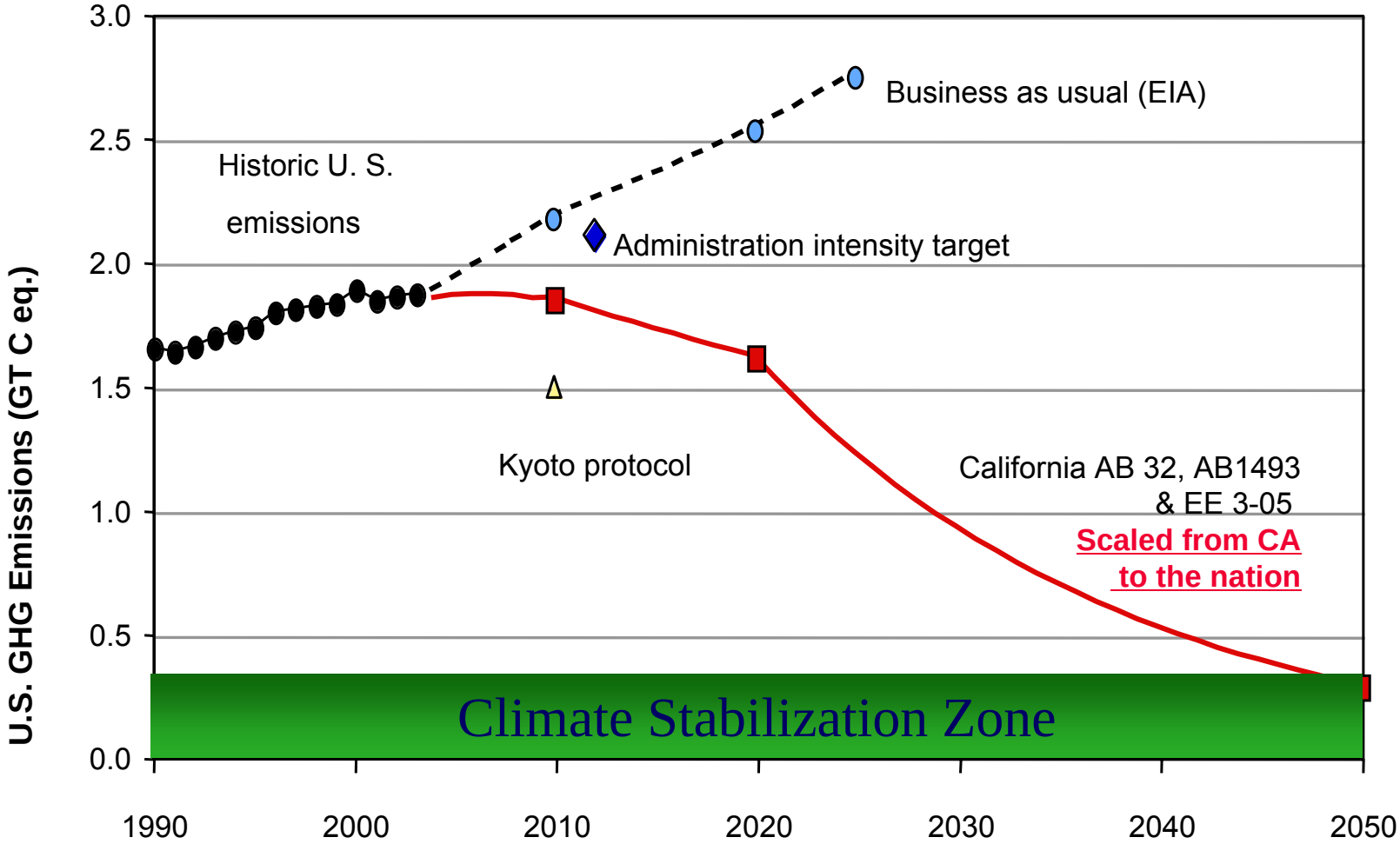
- **Markets provide a key tool**

- **The poor are the most at risk, but have much to gain if biofuels are made tools to achieve sustainable societies**

- **Biofuel research and demonstration must be integrated with policy development**
- **Biofuels link energy and globalization**

Energy Biosciences Institute

The California commitment - scaled to the nation



Kammen, "September 27, 2006 – A day to remember", *San Francisco Chronicle*, September 27,

SCIENCE'S COMPASS

POLICY FORUM: CLIMATE CHANGE

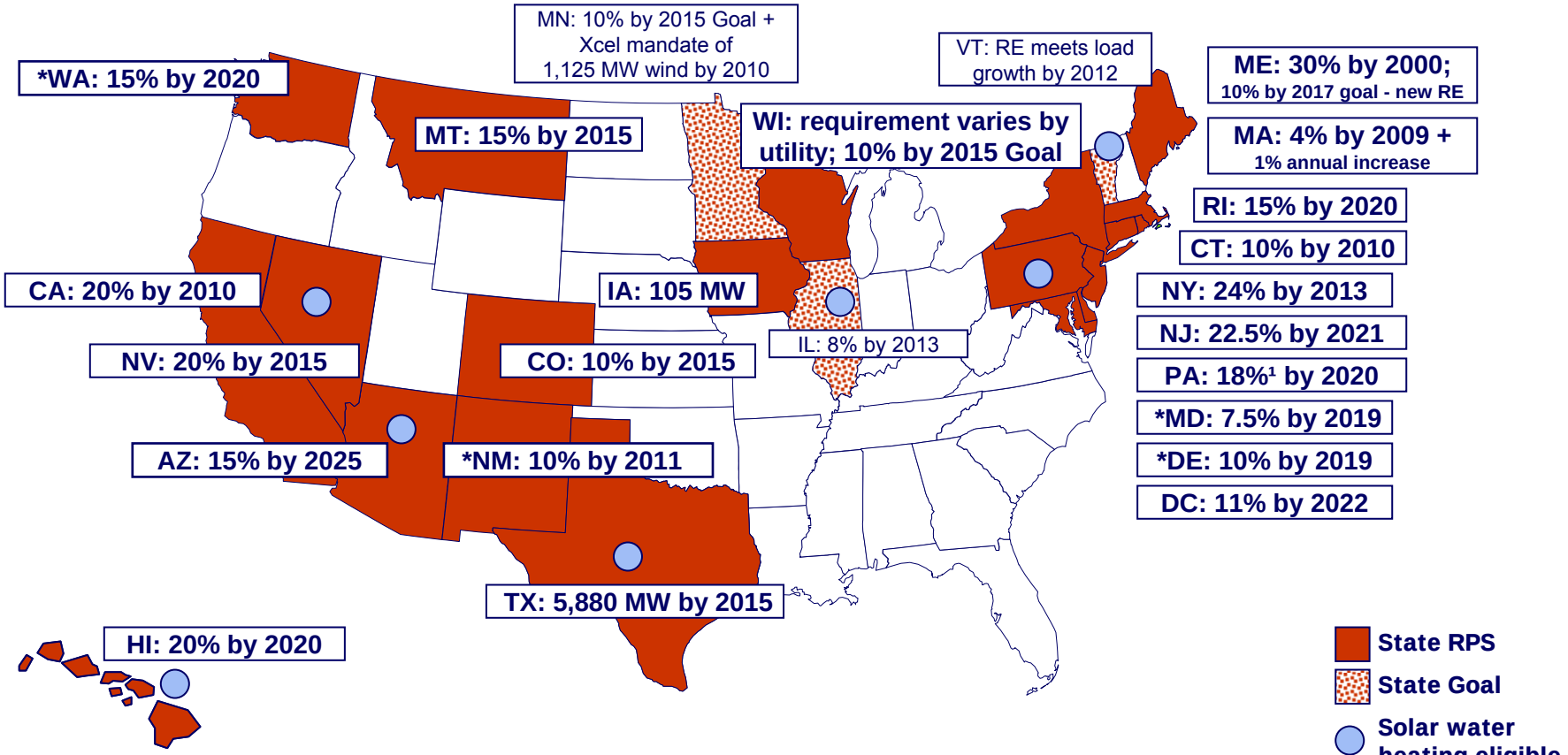
Equity and Greenhouse Gas Responsibility

Paul Baer, John Harte, Barbara Haya, Antonia V. Herzog, John Holdren, Nathan E. Hultman, Daniel M. Kammen,* Richard B. Norgaard, Leigh Raymond

www.sciencemag.org SCIENCE VOL 289 29 SEPTEMBER 2000

Renewable Energy Portfolio Standards

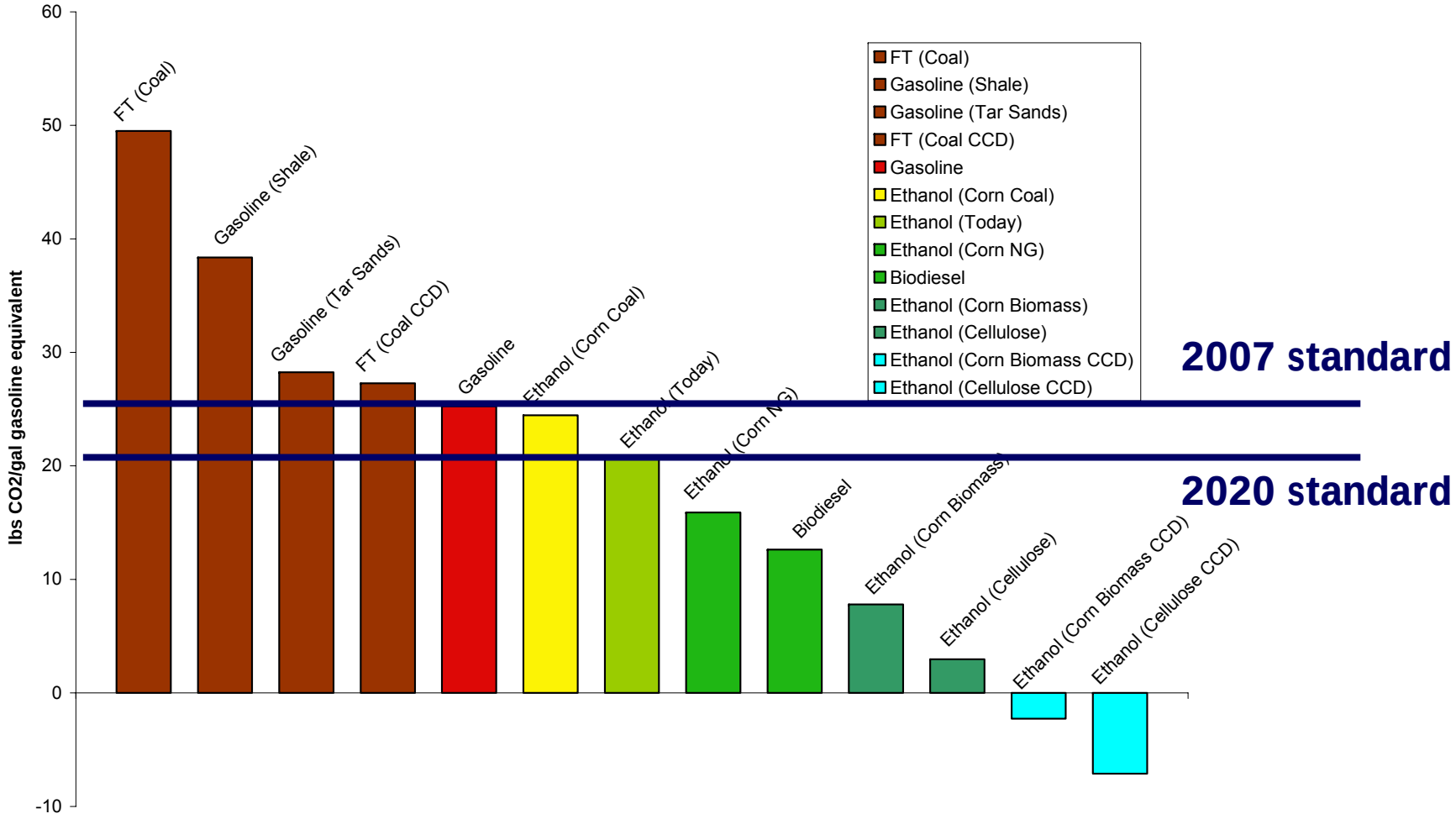
23 states + DC, and counting



*** Increased credit for solar or other customer-sited renewables**

PA: 8% Tier I (renewables)

An Alternative Fuel is Not Necessarily a Low-Carbon Fuel, but it can be



Forest Resources Under Stress

(Bailis, Ezzati and Kammen, *Science*, *2005)*

COOKSTOVE SMOKE is ubiquitous in Kenya, where wood, charcoal and other biomass fuels are used for cooking and heating. Particulates in smoke are a major contributor to respiratory disease, the leading cause of illness in developing nations.

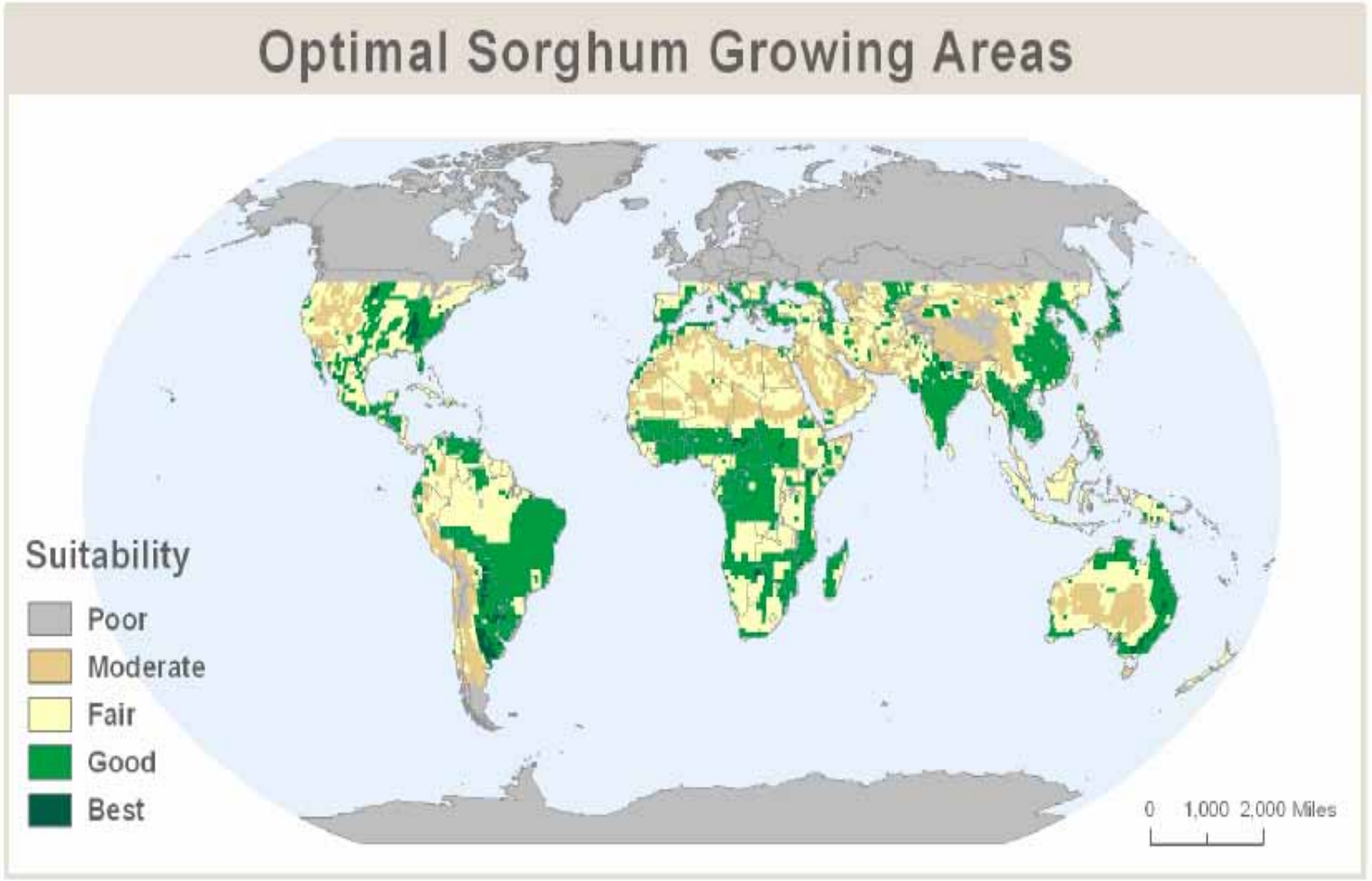
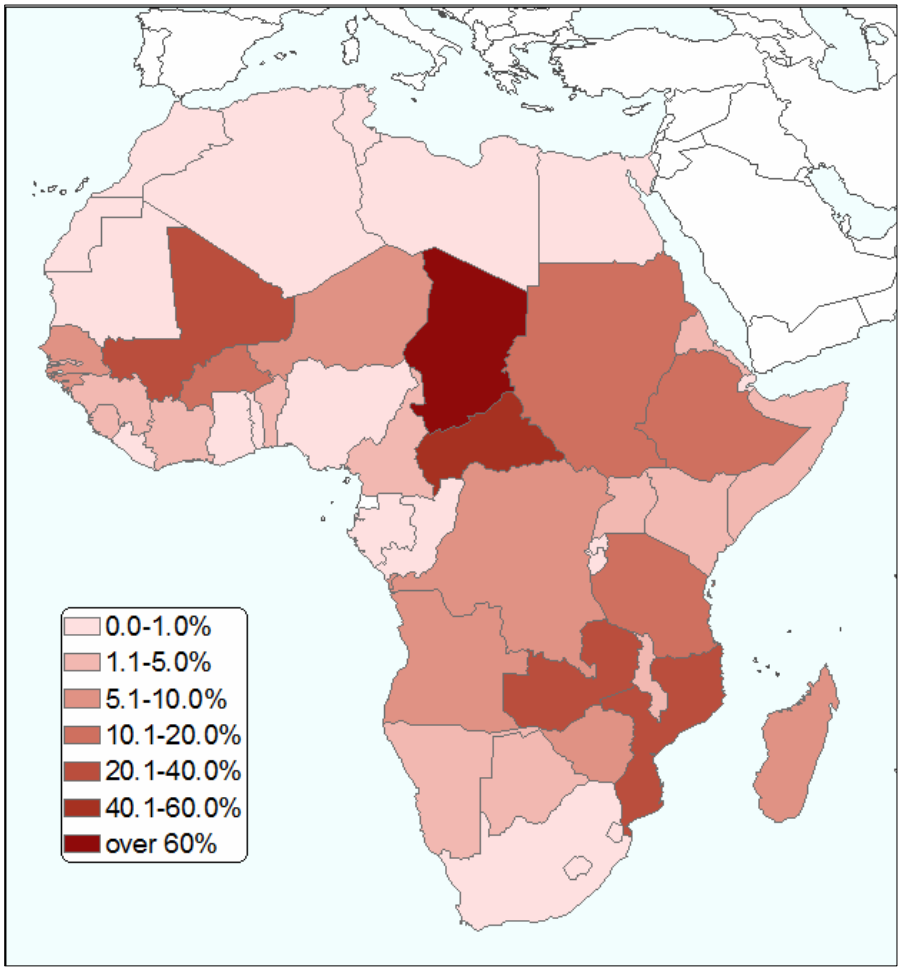


Figure 1. Optimal sorghum growing areas are based on solar radiation, minimum, maximum, and monthly temperature, annual precipitation, and soil texture. Produced by the UC-Berkeley Geospatial Imaging and Informatics Facility (GIIF) as an early demonstration of the data methods available for this study.

William Collins, LBNL

Ethanol can Displace Gasoline Consumption in Africa

- Using only post-harvest crop losses as inputs (up to 50 percent of yields), biofuels can play a significant role
- Implications for poverty alleviation, job creation, urban health, and foreign currency savings
- Metrics for ecological and cultural sustainability must be part of the planning process



Source: FAO/IIASA 2002, EIA 2007, ICRISAT 2007

A promising crop: *Miscanthus X Giganticus*

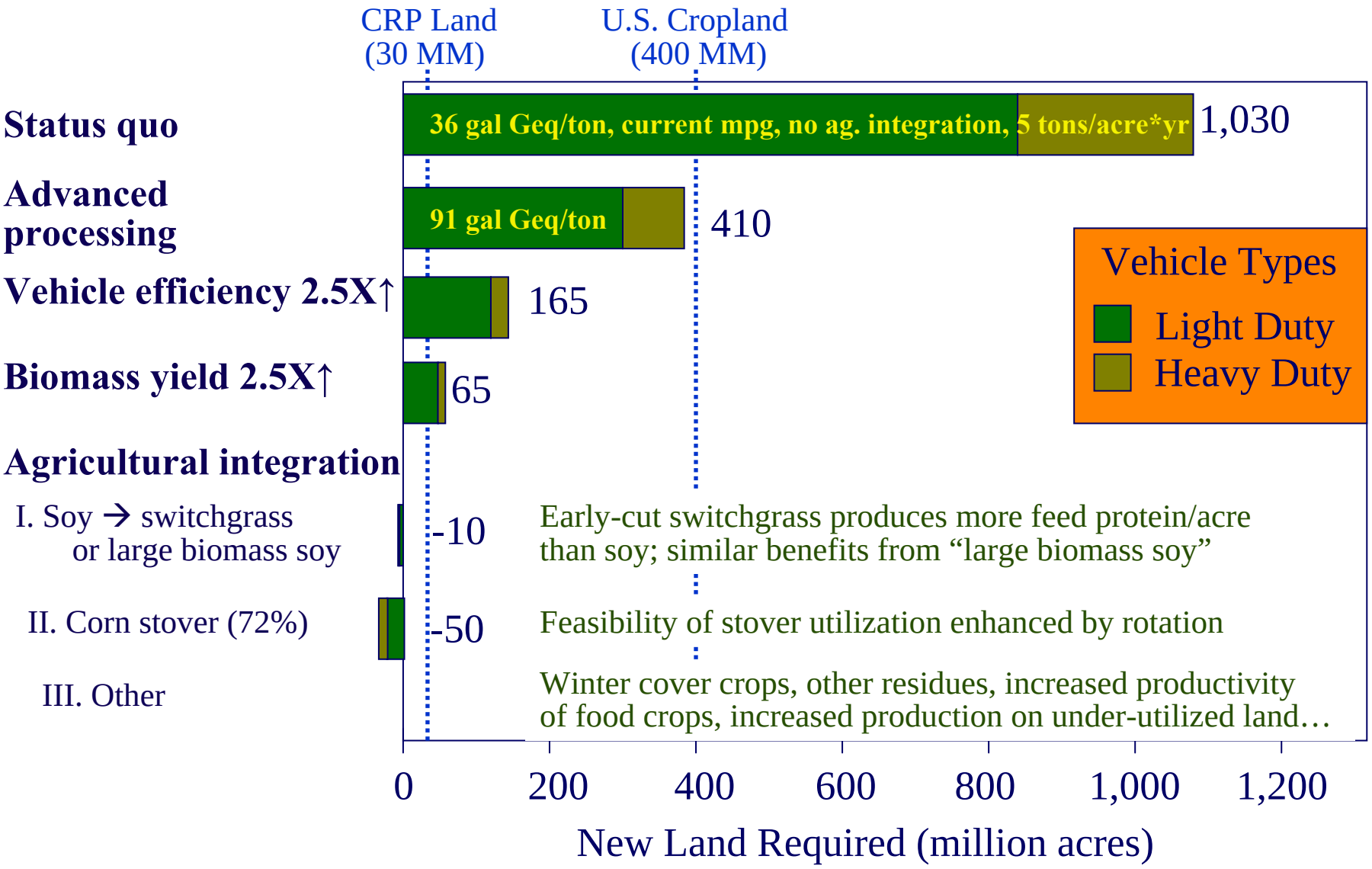
Top left: summer Miscanthus growth (sterile)

Top right: Miscanthus stands (UK)

Right: winter harvest of the C4 plant, Miscanthus after growing season and nutrients and water returned to the soil

Photo credits: S. Long (U. of Illinois/EBI)

Land Required to Satisfy Current U.S. Mobility Demand



U.S. mobility demand, the largest per capita in the world, could be met from land now used for agriculture while maintaining food production (L. Lynd)

UNIVERSITY OF CALIFORNIA
BERKELEY

REPORT OF THE
RENEWABLE AND APPROPRIATE ENERGY
LABORATORY

Putting Renewables to Work:
How Many Jobs Can the
Clean Energy Industry
Generate?

by

Daniel M. Kammen
Kamal Kapadia
Matthias Fripp

of the
Energy and Resources Group &
the Goldman School of Public Policy

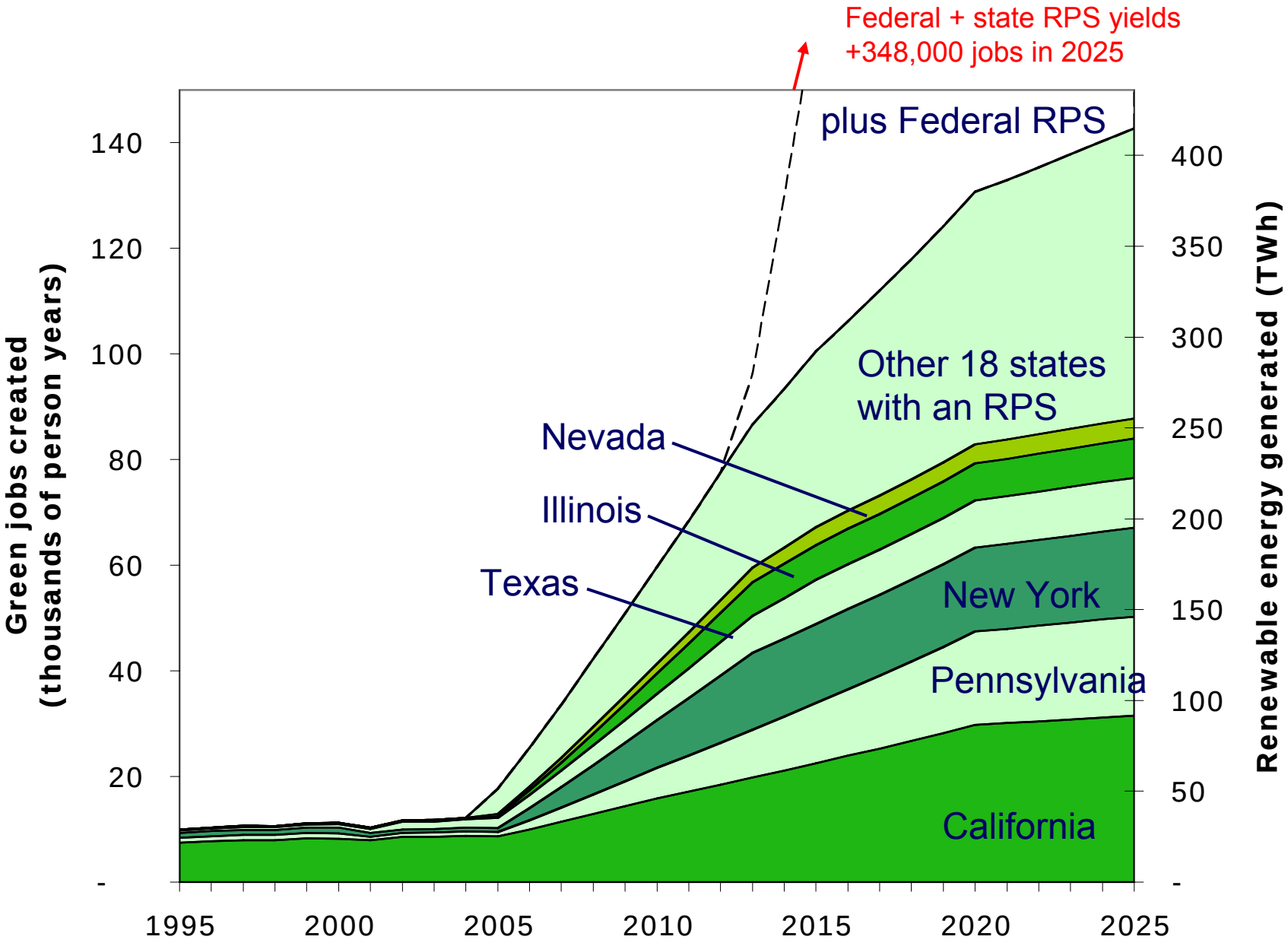
APRIL 13, 2004

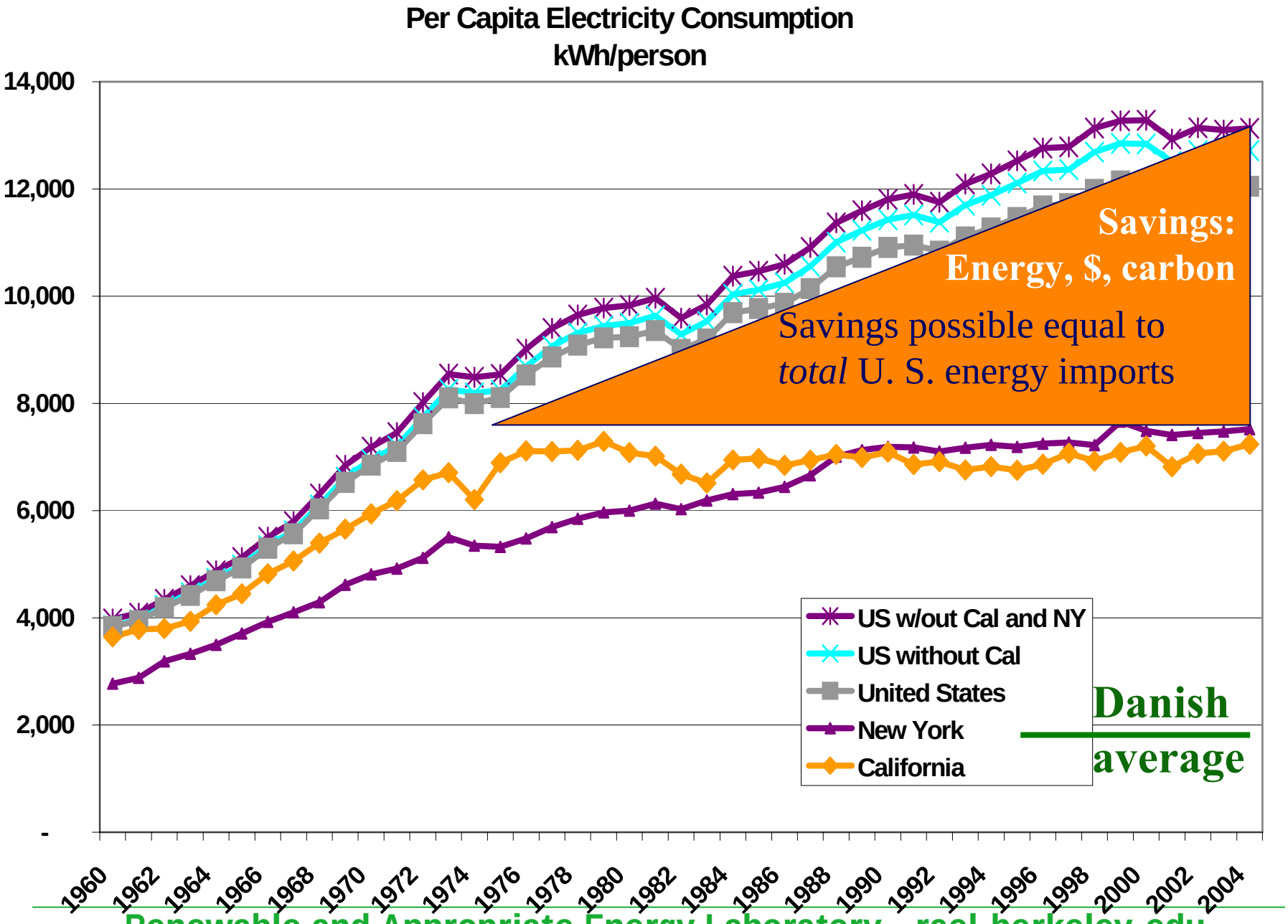
Study reviews:

- 13 studies of job creation

- 3 - 5 *times* More jobs per dollar invested in the renewables sector than in fossil fuels

Green Collar Job Creation




Per Capita Electricity Consumption
kWh/person
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Savings:
Energy, $, carbon
Savings possible equal to
total U. S. energy imports
US w/out Cal and NY
US without Cal
United States
New York
California
Danish
average

Solar Energy for Many Applications

Moscone Center, SF: 675,000 W

Residential Solar: 1000 - 4000 Watts/home

CA Solar Initiative/Million Solar Roofs:

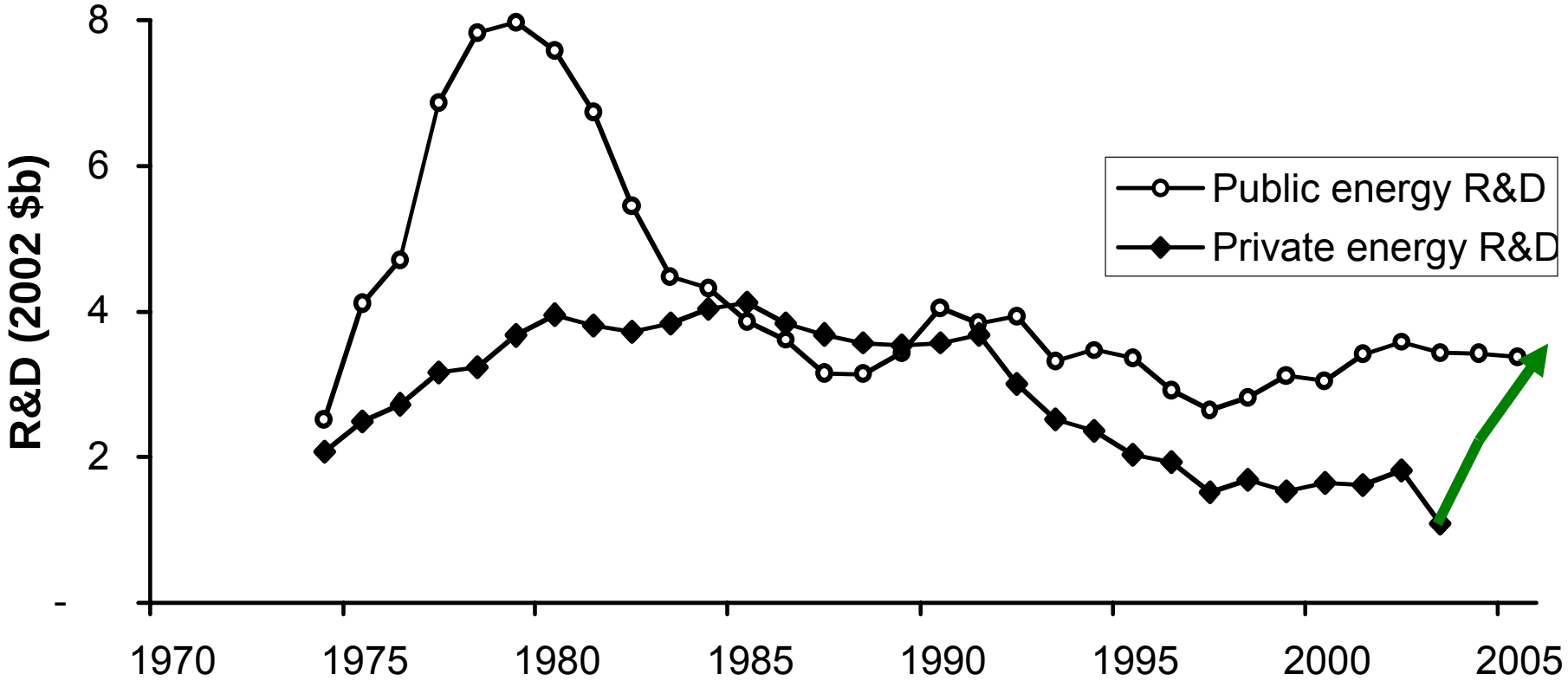
3,000 - 10,000 MW of solar to be built

Kenyan PV market: Average system: 18W

Largest penetration rate of any nation

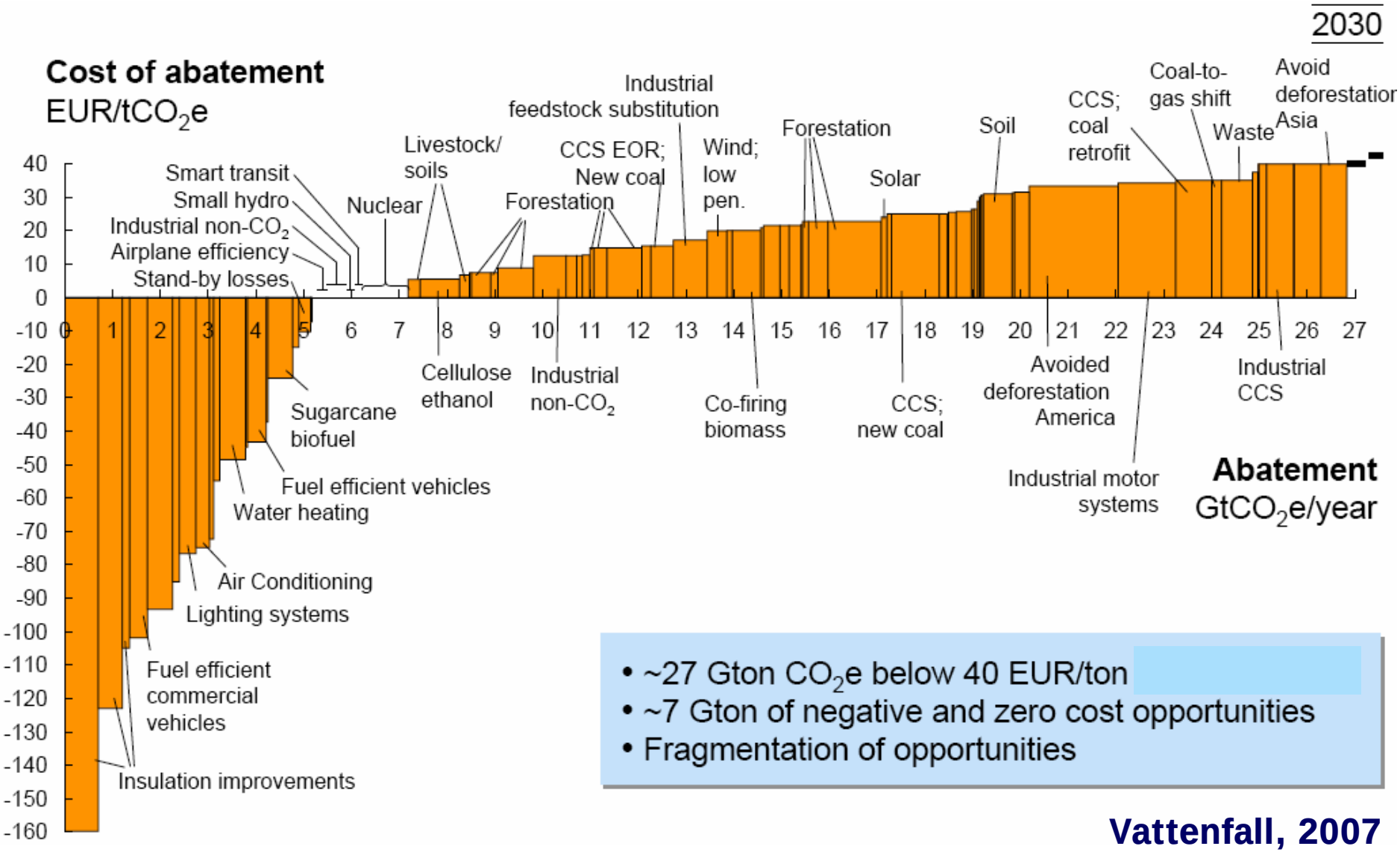
	California	Japan
2005 Annual PV Installations	50 MW	290 MW
Average Cost for Residential System	$8.8/Wac	$7.4/Wac
Average Cost Reduction from 99-04	5.2%/year	8.9%/year

United States' Public and Private Sector Energy Research and Development Spending



Kammen and Nemet (2005)
"Reversing the incredible shrinking energy R&D budget," *Issues in Science & Technology,* **Fall**, 84 – 88.

Global CO_2 Abatement Opportunities



- ~27 Gton CO_2e below 40 EUR/ton
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities

Vattenfall, 2007

California Public Utilities Commission
505 Van Ness Ave., San Francisco, CA

PRESS RELEASE

PROPOSAL: $620 MILLION, 10 YEAR PROGRAM
THE INSTITUTE WILL BE A HUB FOR GLOBAL PARTNERSHIPS

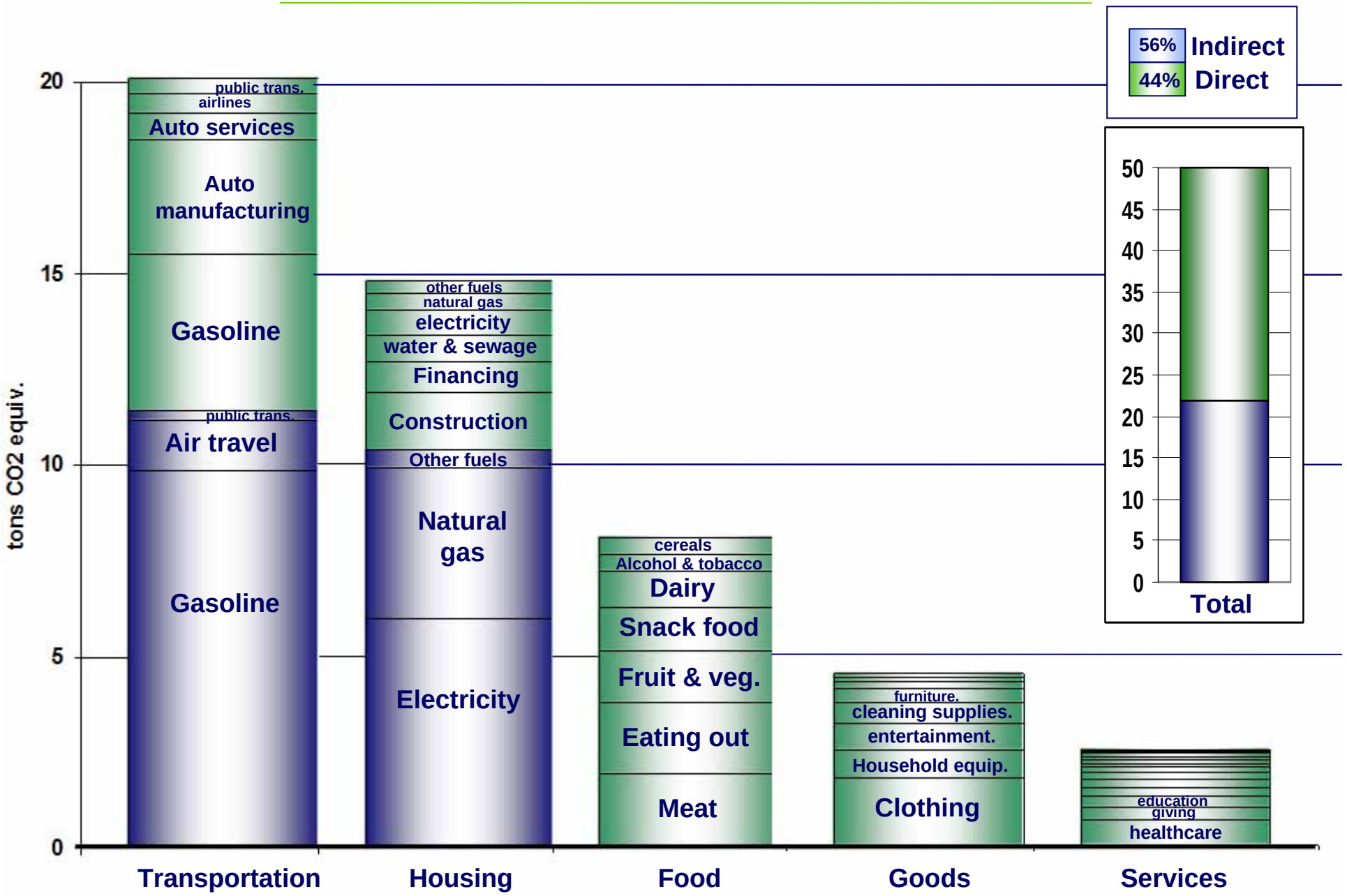
FOR IMMEDIATE RELEASE

Media Contact: Terrie Prosper, 415.703.1366, news@cpuc.ca.gov

PUC CONSIDERS UC PROPOSAL CREATING CLIMATE SOLUTION INSTITUTE

SAN FRANCISCO, September 20, 2007 - The California Public Utilities Commission (PUC), as part of its continuing effort to aggressively pursue ways for California to reduce greenhouse gas emissions, today said it will analyze and act upon a proposal by the University of California to create the California Institute for Climate Solutions.

Summary of GHG Emissions for Typical U.S. Household (LEAPS Results) 50 Metric tons of CO_2 equivalent gases



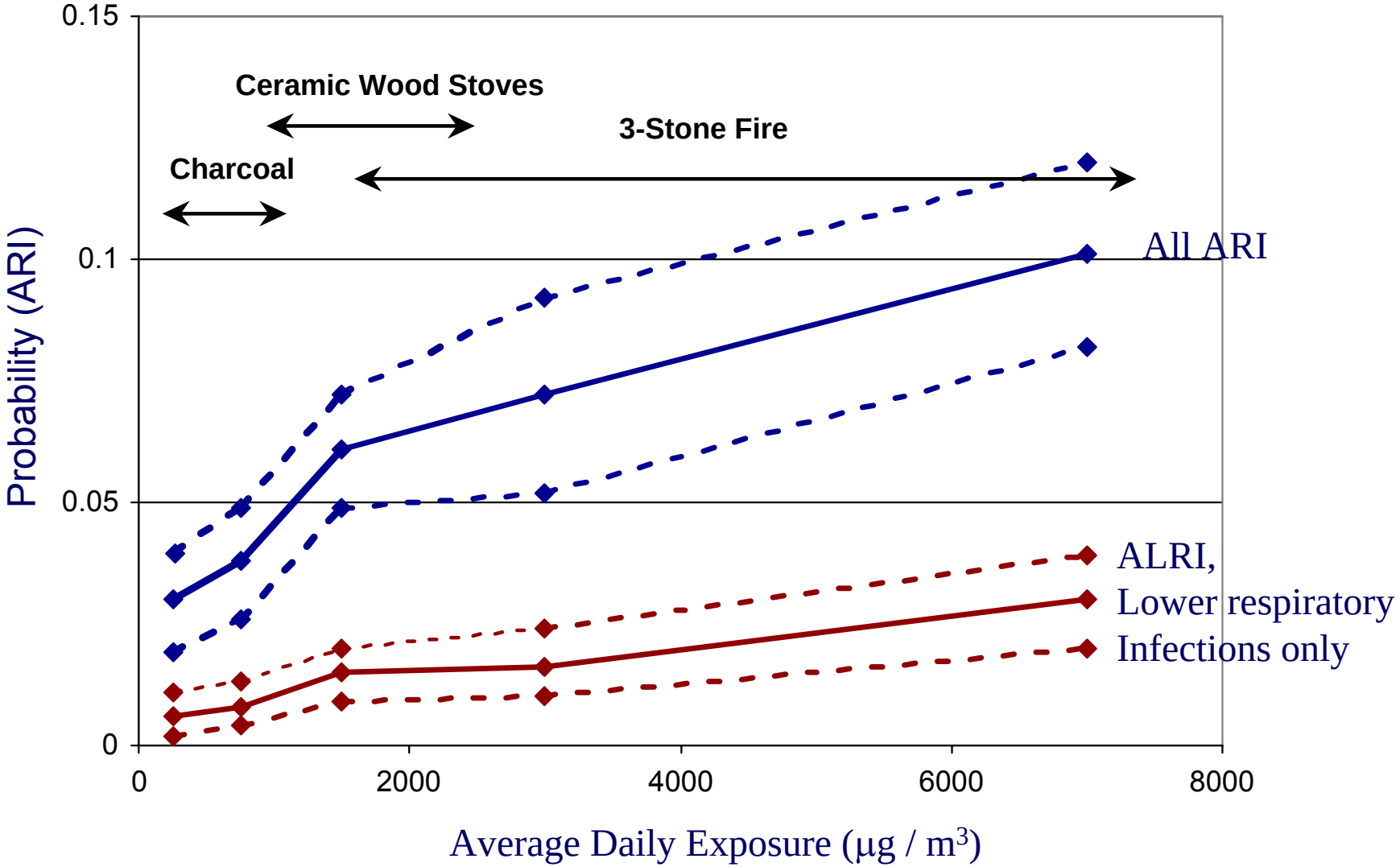
Effective Soil Organic Matter Input

Crop	Avg. Annual OM input (t/acre)
Sugar beet, potato	0.3
Corn	0.5
Cereals, oilseed crops	0.7
Alfalfa	1.0
Miscanthus	4.2 (2.0 t[C])

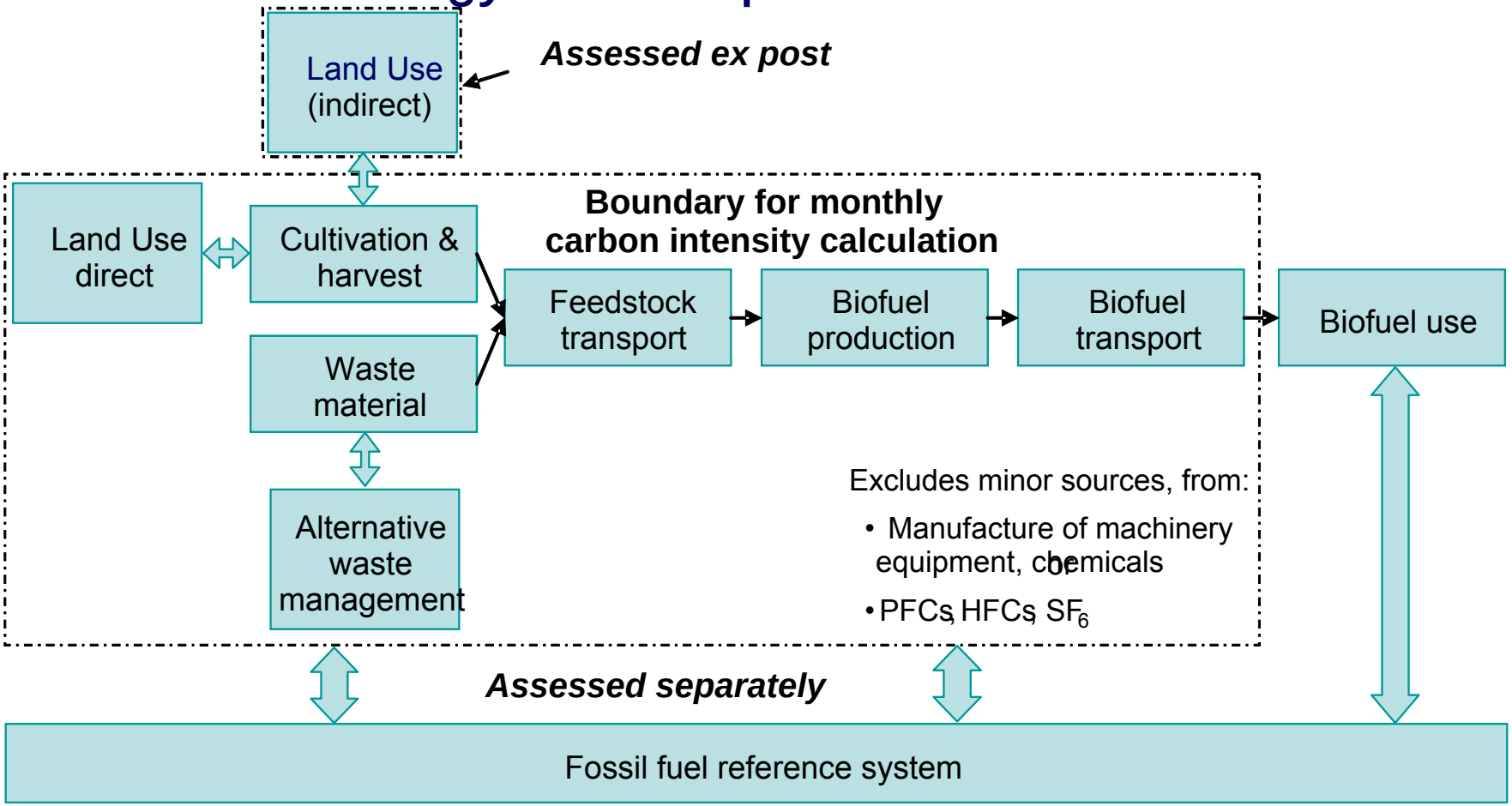
Adapted from Korschens 1992, Korschens et al. 1998, Beuch et al. 2000)

OM to the soil - not necessarily final state

Illness Reduction Observed in Kenya
(ARI = acute respiratory infection)



UK approach may become an internationally agreed methodology in compliance with WTO rules



Maximize the use of waste

Standardize system boundaries

Recognize previous land use

Co-product allocation

Move to 'sustainable fuel' standard to benefit the poor and ecosystems

Look-up table for simple estimating: Jobs per MW

Energy Technology	Source of Estimate	Average Employment Over Life of Facility (jobs/MWa)		
		Construction, Manufacturing, Installation	O&M and fuel processing	Total Employment
PV 1	REPP, 2001	6.21	1.20	7.41
PV 2	Greenpeace, 2001	5.76	4.80	10.56
Wind 1	REPP, 2001	0.43	0.27	0.71
Wind 2	EWEA/Greenpeace, 2003	2.51	0.27	2.79
Biomass Ğ high estimate	REPP, 2001	0.40	2.44	2.84
Biomass Ğ low estimate	REPP, 2001	0.40	0.38	0.78
Coal	REPP, 2001	0.27	0.74	1.01
Gas	Kammen, from REPP, 2001; CALPIRG, 2003; BLS, 2004	0.25	0.70	0.95

Kapadia, Fripp and Kammen (2004)
"Putting renewables to work"

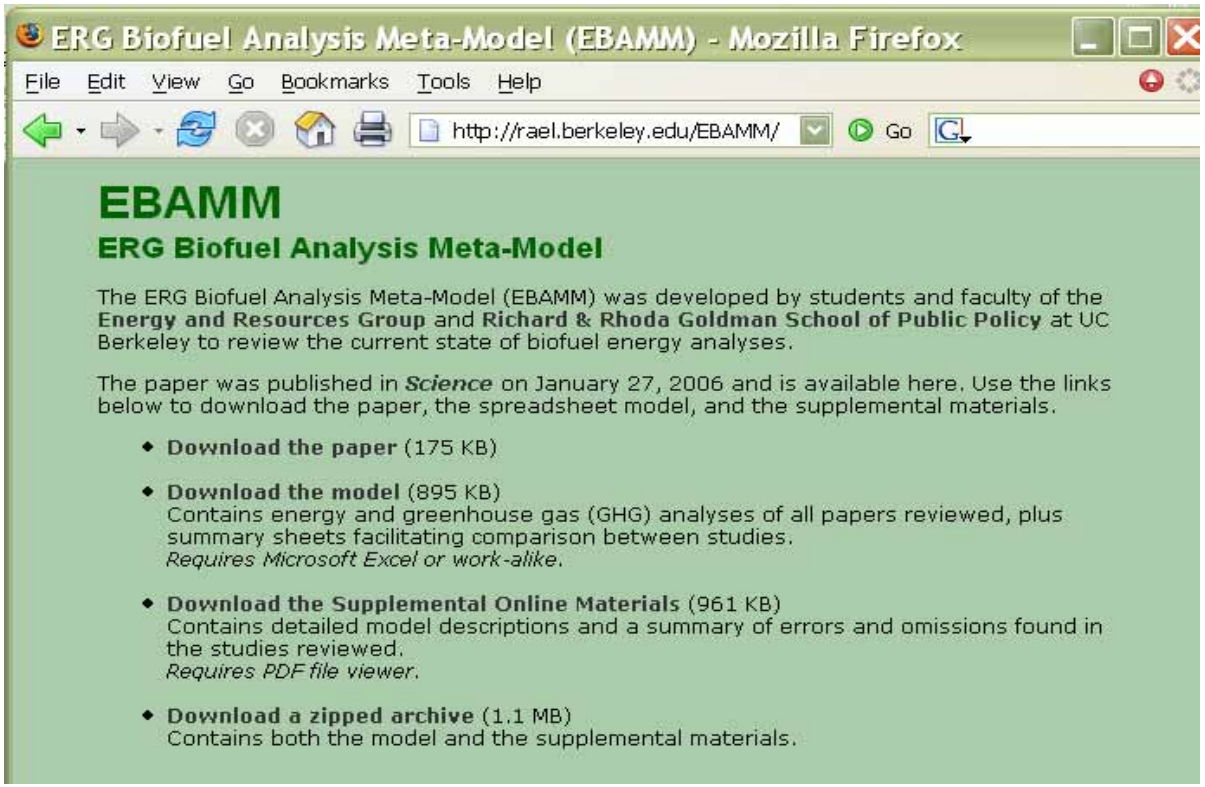
REPORTS

27 JANUARY 2006 VOL 311 SCIENCE www.sciencemag.org

Ethanol Can Contribute to Energy and Environmental Goals

Alexander E. Farrell,[1*] Richard J. Plevin,[1] Brian T. Turner,[1,2] Andrew D. Jones,[1] Michael O'Hare,[2] Daniel M. Kammen[1,2,3]

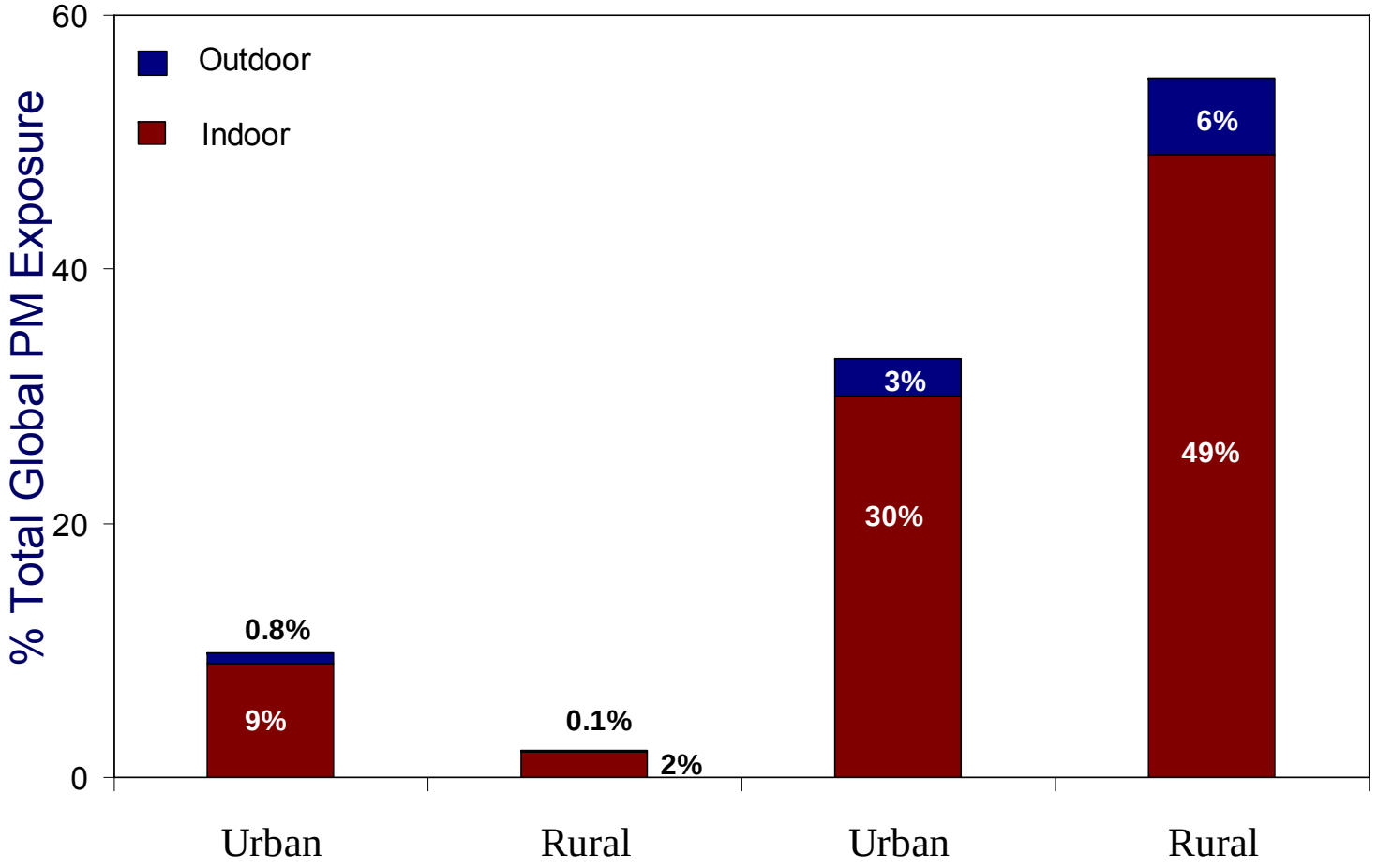
Open access, online, biofuel calculator tools: http://rael.berkeley.edu/ebamm



CROP	Harvest-able Biomass (tons/ acre)	Ethanol (gal/t)	Million acres needed for 35 billion gallons of ethanol	% 2006 harvested US cropland needed
Corn grain	4	500	70	25.3
Corn stover	3	300	105	38.5
Corn Total	7	800	40	15.3
Prairie	2	200	210	75.1
Sorghum	2	200	210	75.1
Switch-grass	6	600	60	20.7
Miscanthus	17	1700	18	5.8
Tank Algae*	80+	600+	< 10	< 2
*assumes CO_2 input				

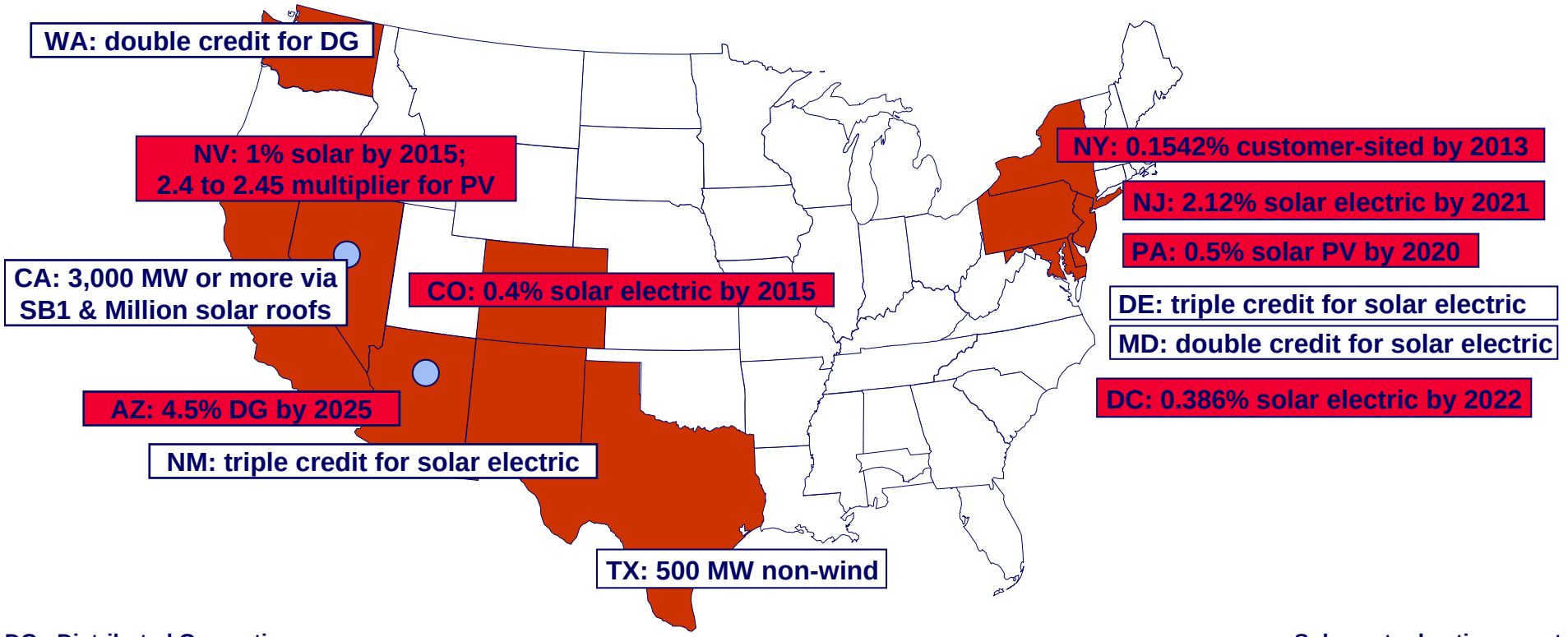
Global Exposure to Air Pollution

Exposure = Population • Time • Pollution



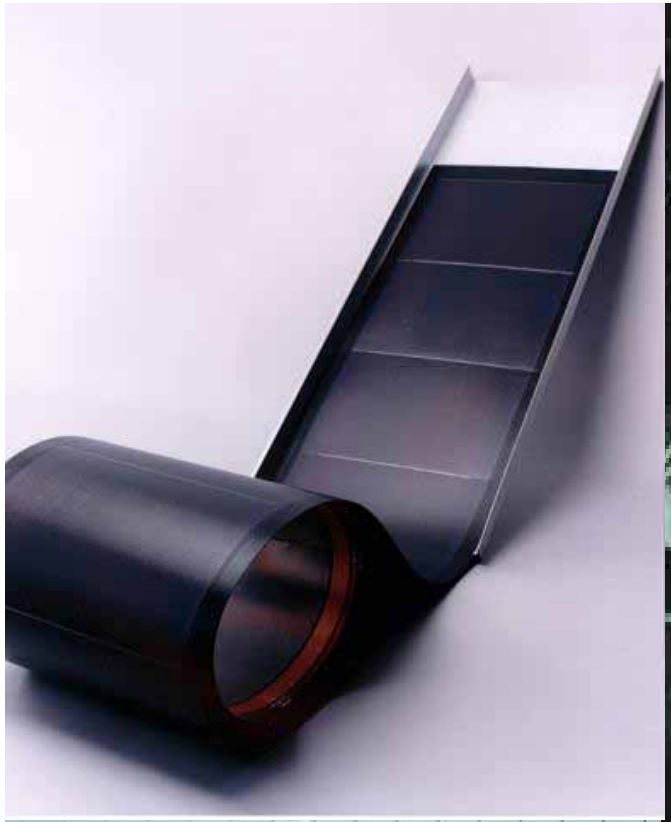
Smith, 1988

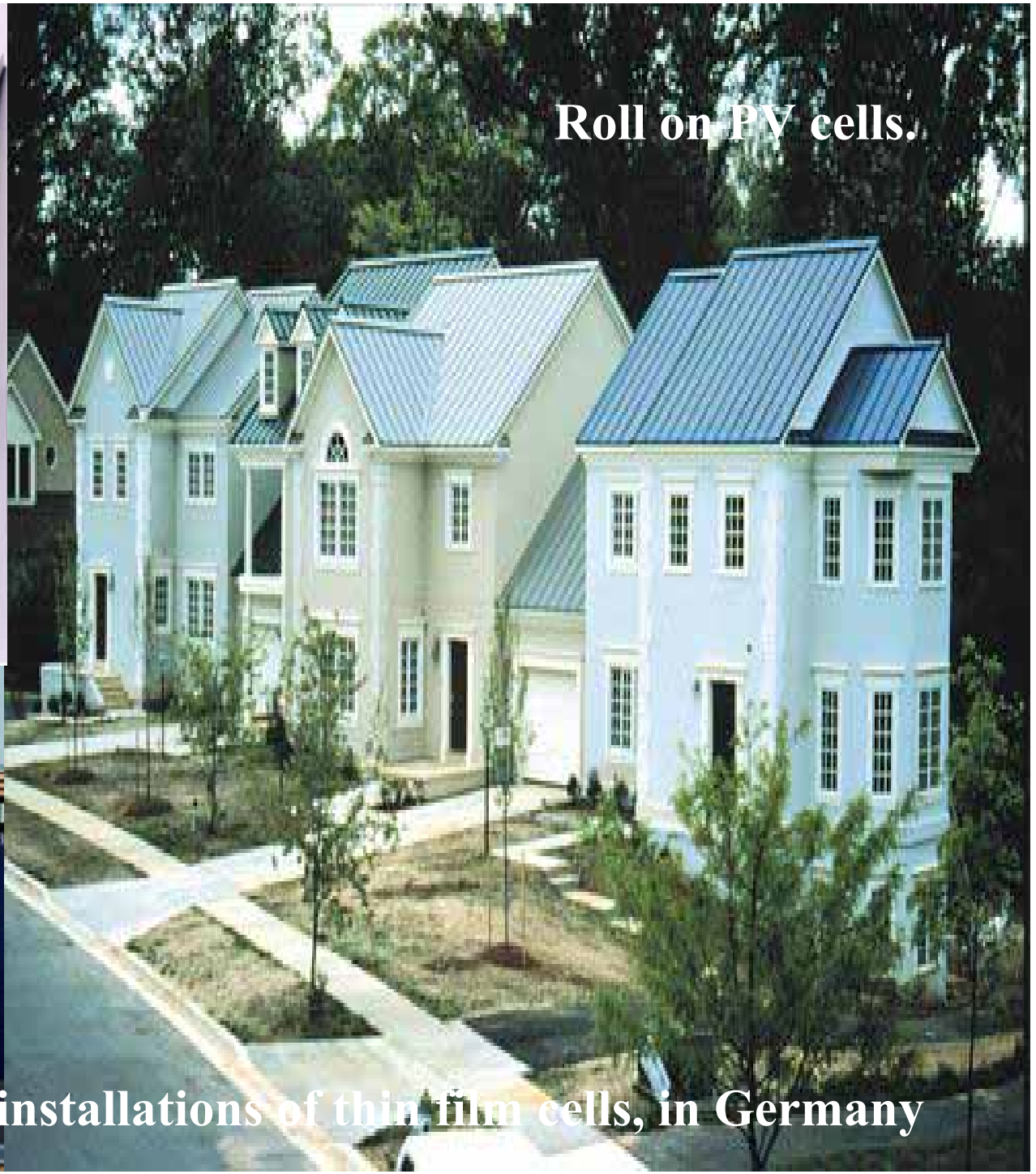
Solar & Distributed Generation Provisions in RPS Policies



DG: Distributed Generation

Solar water heating counts towards solar set-aside

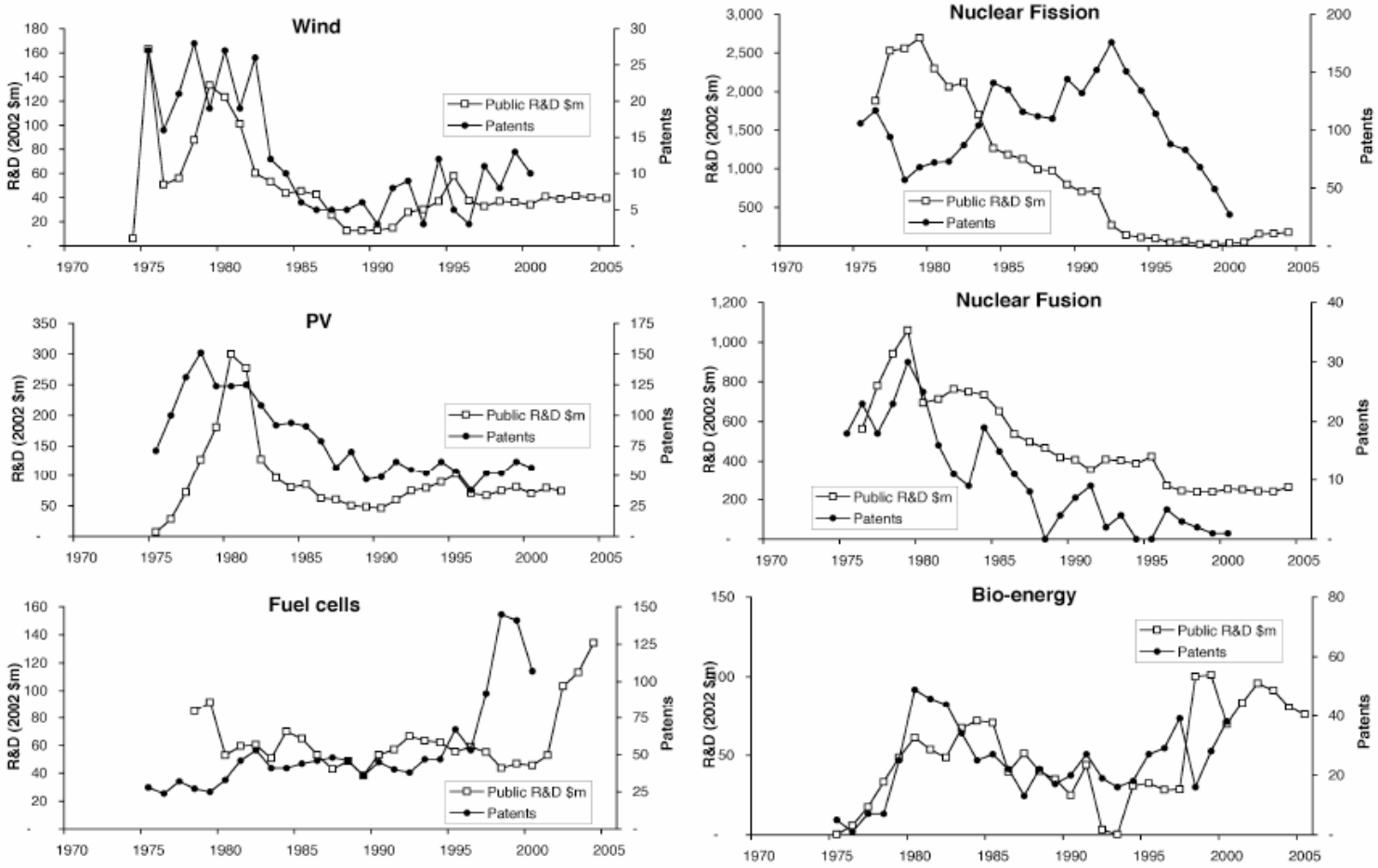




Roll on PV cells.

Solar photovoltaic installations of thin film cells, in Germany

Patents and R&D Funding Correlated



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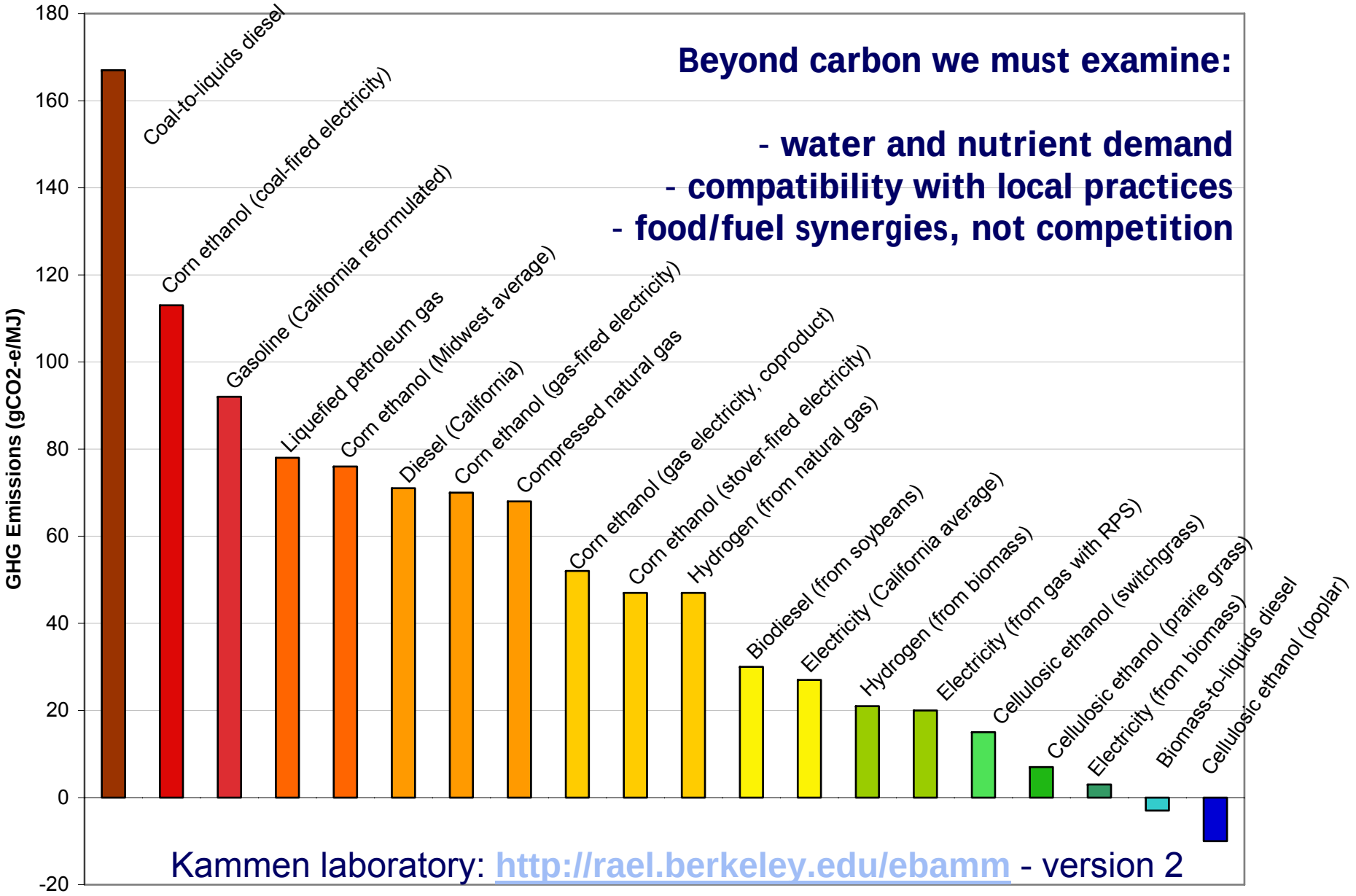
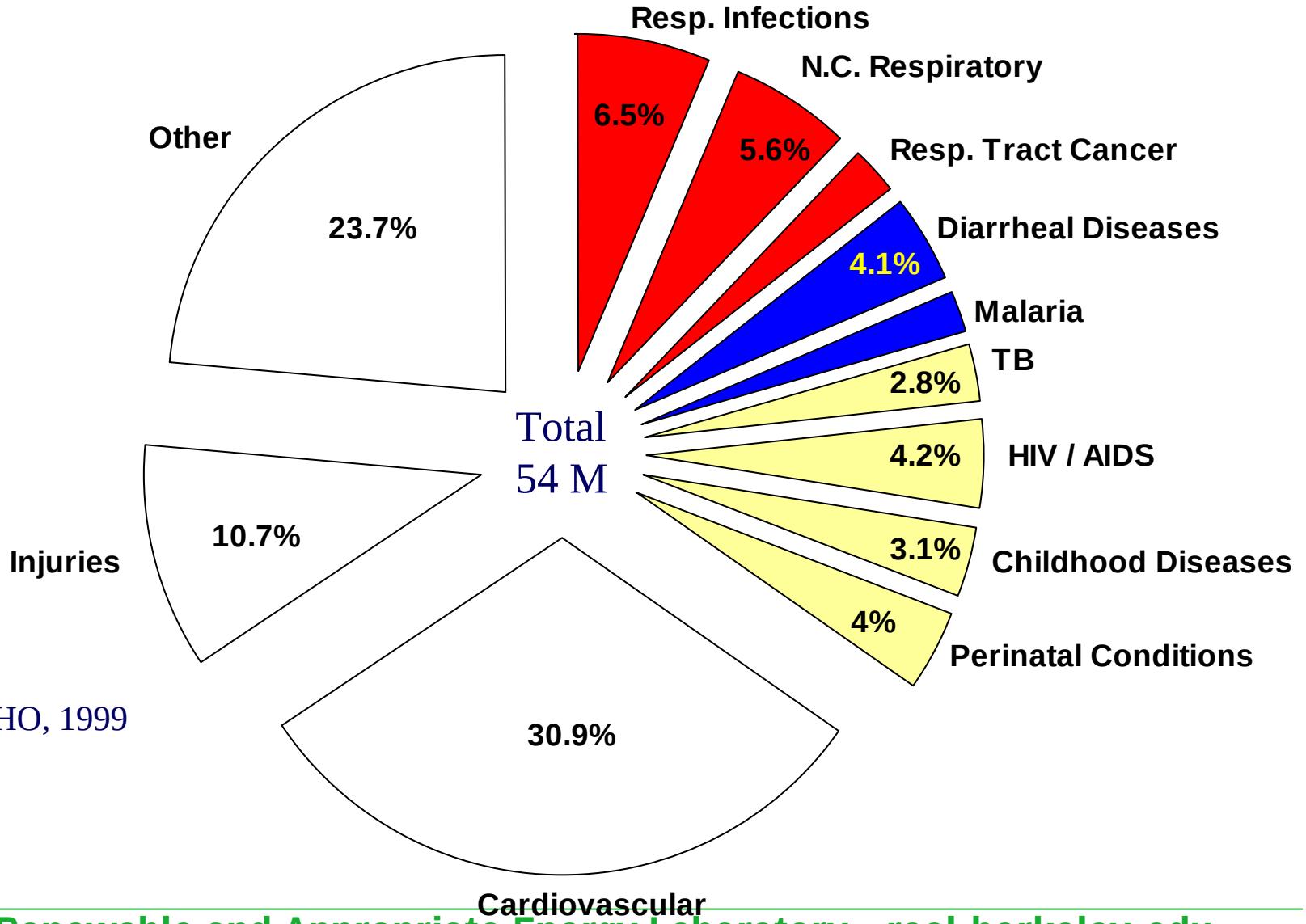
And Nemet, dissertation, 2007

From a Low Carbon Fuel Standard to a Sustainable Fuel Standard

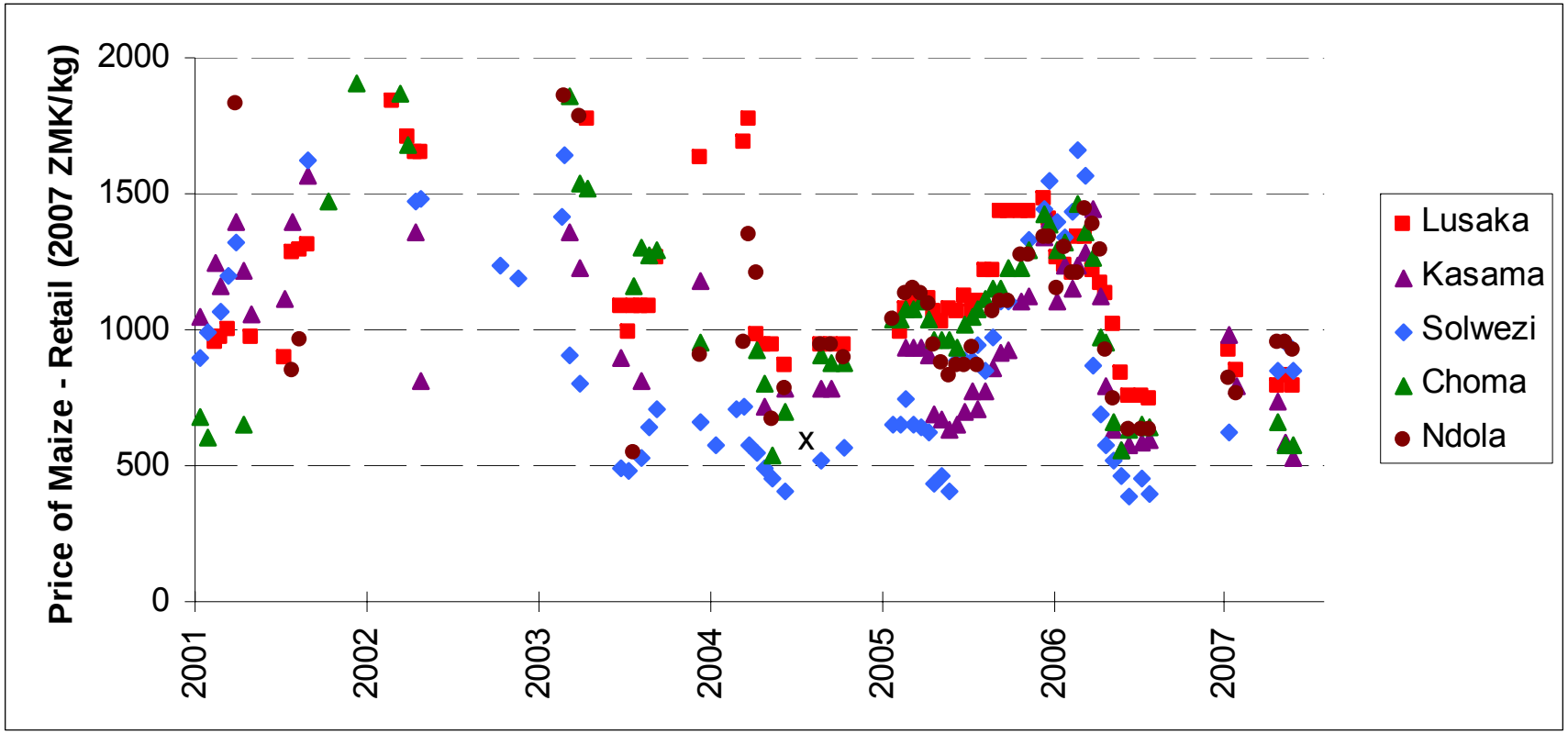


The Global Distribution of Disease (Mortality)



source: WHO, 1999

Food Prices are Volatile Today – without biofuels (example: 5 Zambian markets)



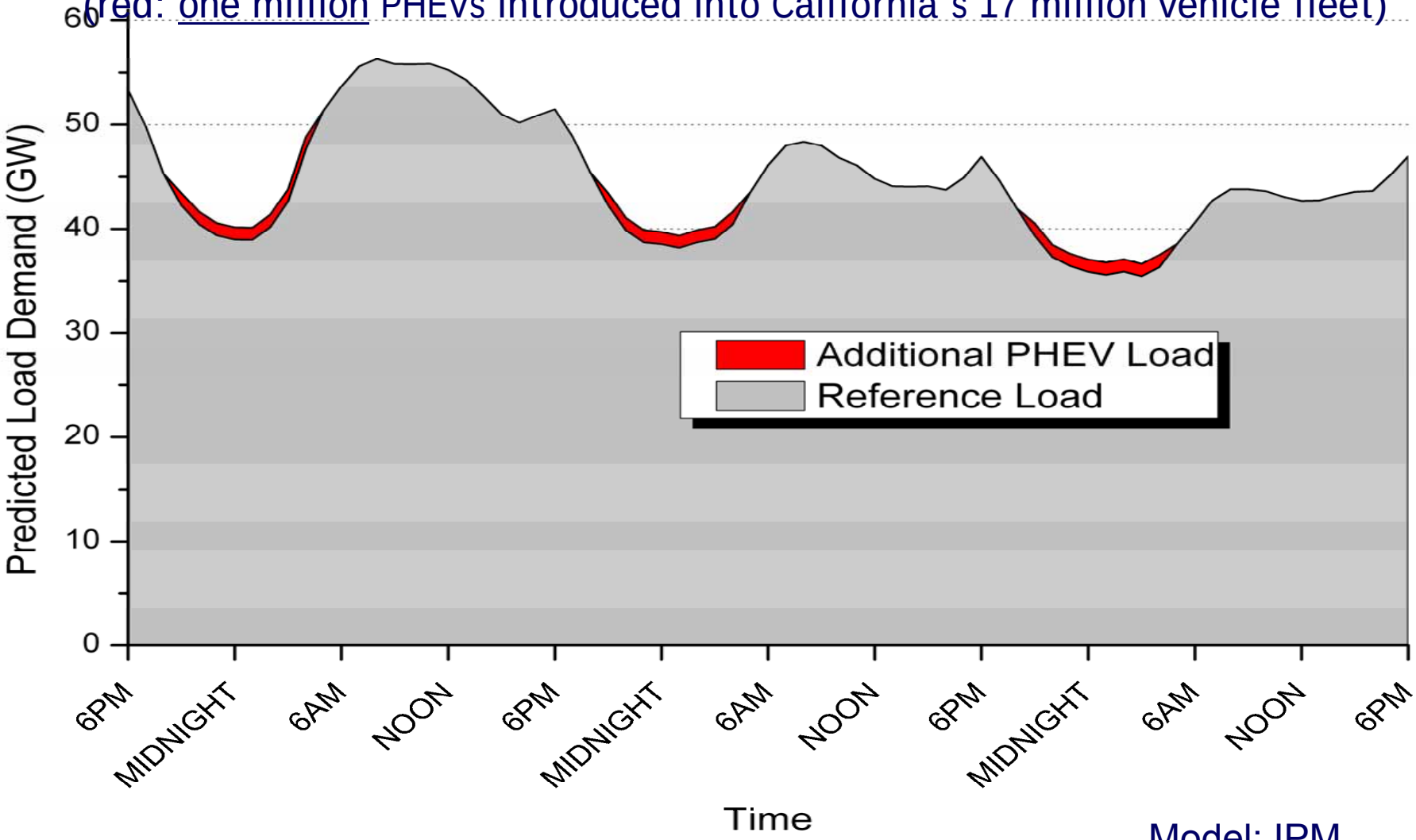
Source: Zambia Ministry of Agriculture and Co-operatives, 2007.

Zambia food prices are volatile due to pressures from climate and policy.

Plug In Partners / e.g. CalCars.org

Plug-in Hybrid (PHEV) Off-Peak Electricity Demand

(red: one million PHEVs introduced into California's 17 million vehicle fleet)



Model: IPM

- Additional load from PHEVs is small
- PHEVs could be charged mostly via base-load filling during evenings and nights, when electricity costs are low