Disaggregation of the SRES Scenarios

China Buildings Sector Example

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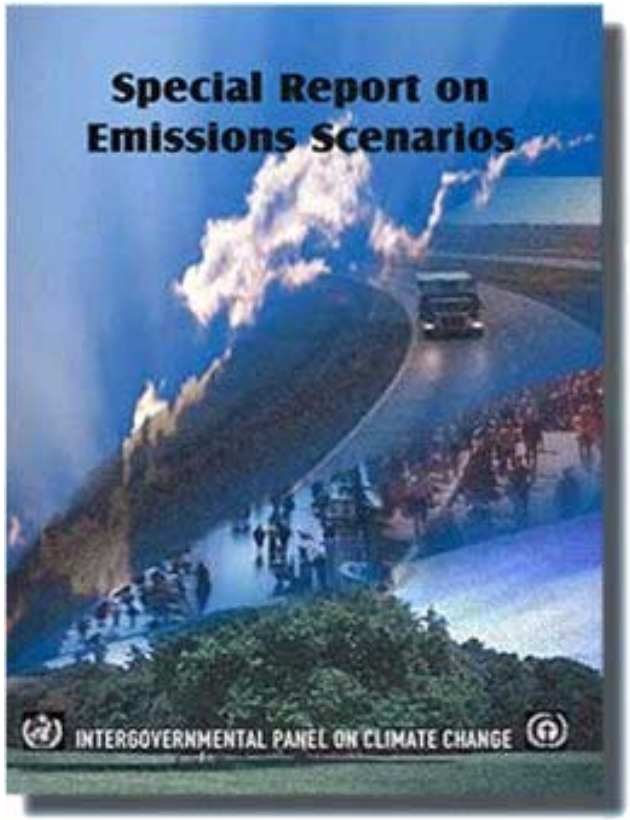
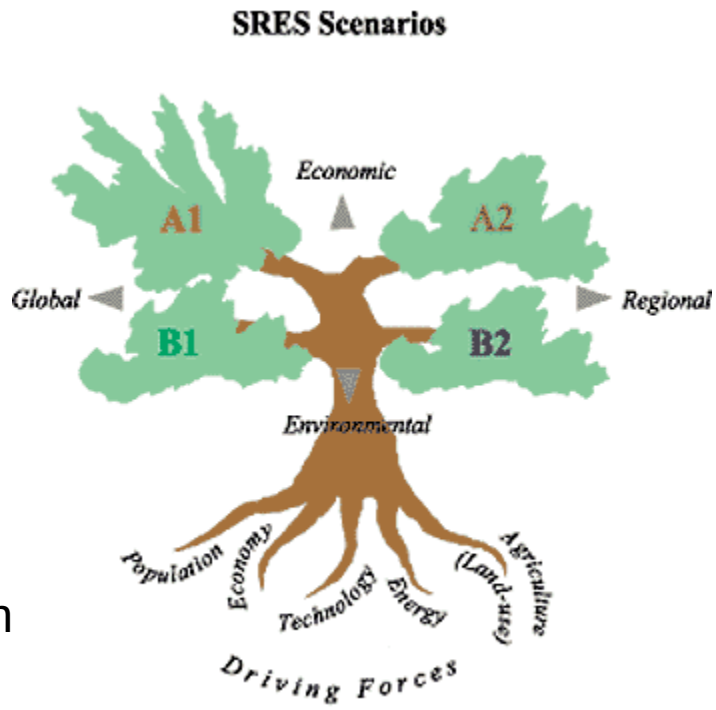
Special Report on Emissions Scenarios (SRES)



- Produced baseline scenarios to 2100
- Four major storylines: A1, A2, B1, B2
- Four world regions: OECD90, REF, ASIA, ALM
- Four marker scenarios
- Energy use, fossil-fuel CO2 emissions

SRES Storylines

A1: Rapid economic growth, low population growth, rapid introduction of new and more efficient technologies



A2: Slower economic and technological growth, high population growth

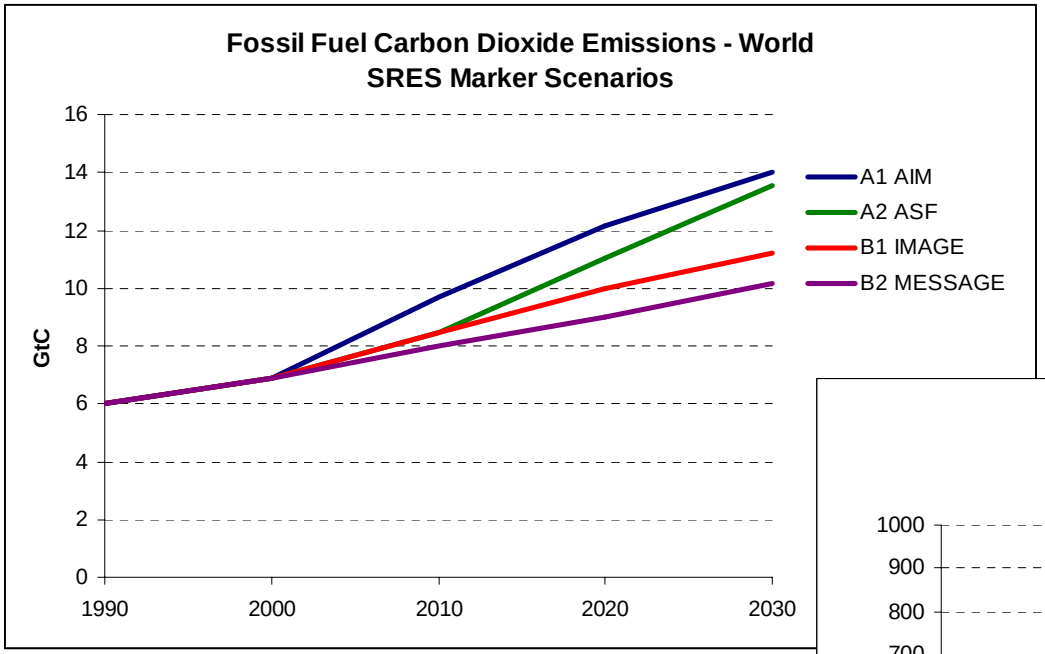
B1: Transition to a service-oriented economy with clean and efficient technologies, low population growth

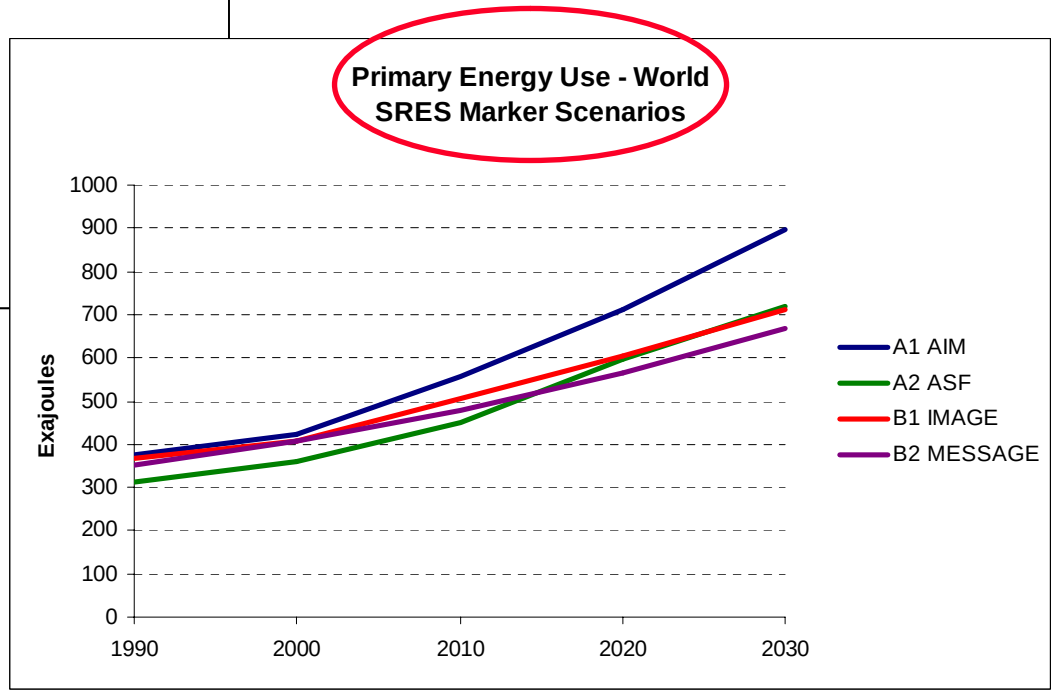
B2: Intermediate economic growth, moderate population growth, and less rapid but more diverse technological change

SRES Modeling Teams

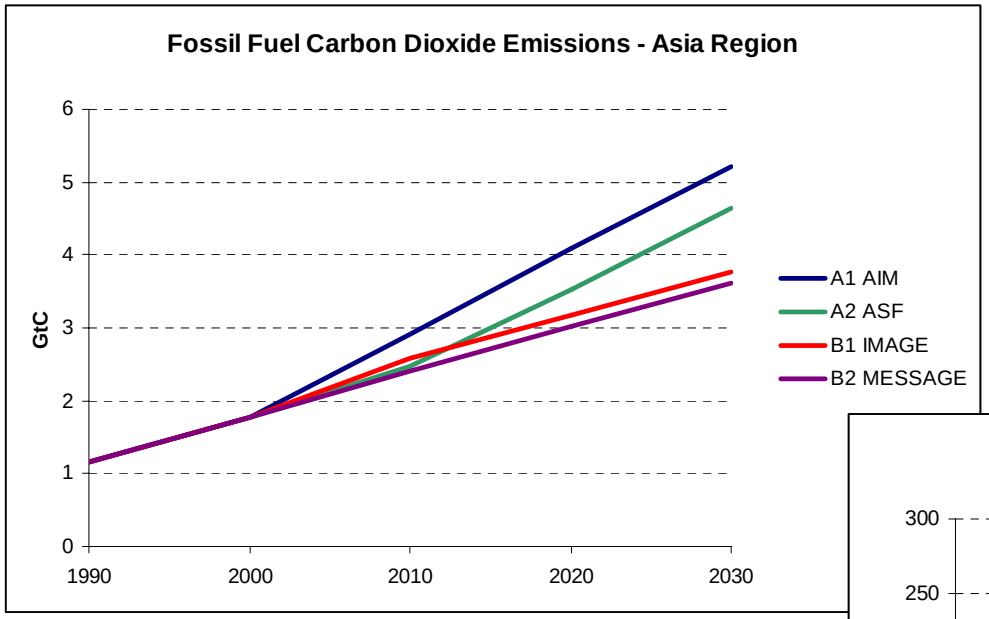
Marker Scenario	Model	Institutional Affiliation
A1 AIM	Asia Pacific Model	National Institute of Environmental Studies, Japan
A2 ASF	Atmospheric Stabilization Framework	ICF Consulting/US EPA, U.S.
B1 IMAGE	Integrated Model to Assess the Greenhouse Effect	National Institute for Public Health and Environmental Hygiene (RIVM), Netherlands
B2 MESSAGE	Model for Energy Supply Strategy Alternatives and their General Environmental Impact	International Institute of Applied System Analysis (IIASA), Austria
Other Models		
MARIA	Multiregional Approach for Resource and Industry Allocation	Science University of Tokyo, Japan
Mini-CAM	Mini Climate Assessment Model	Pacific Northwest National Laboratory, U.S.

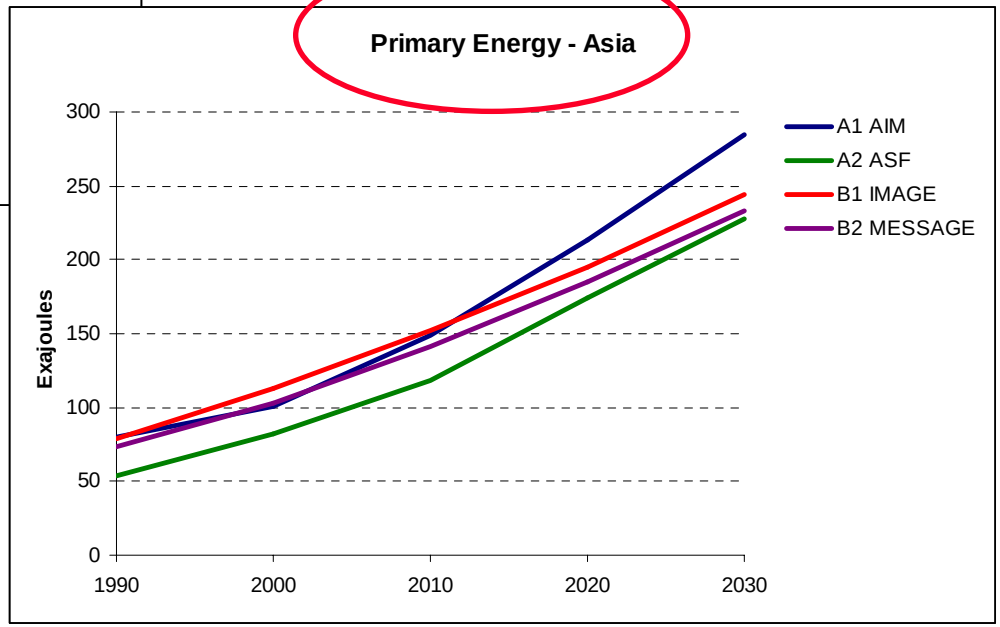
World Fossil Fuel CO2 Emissions and Primary Energy Use, 1990-2030



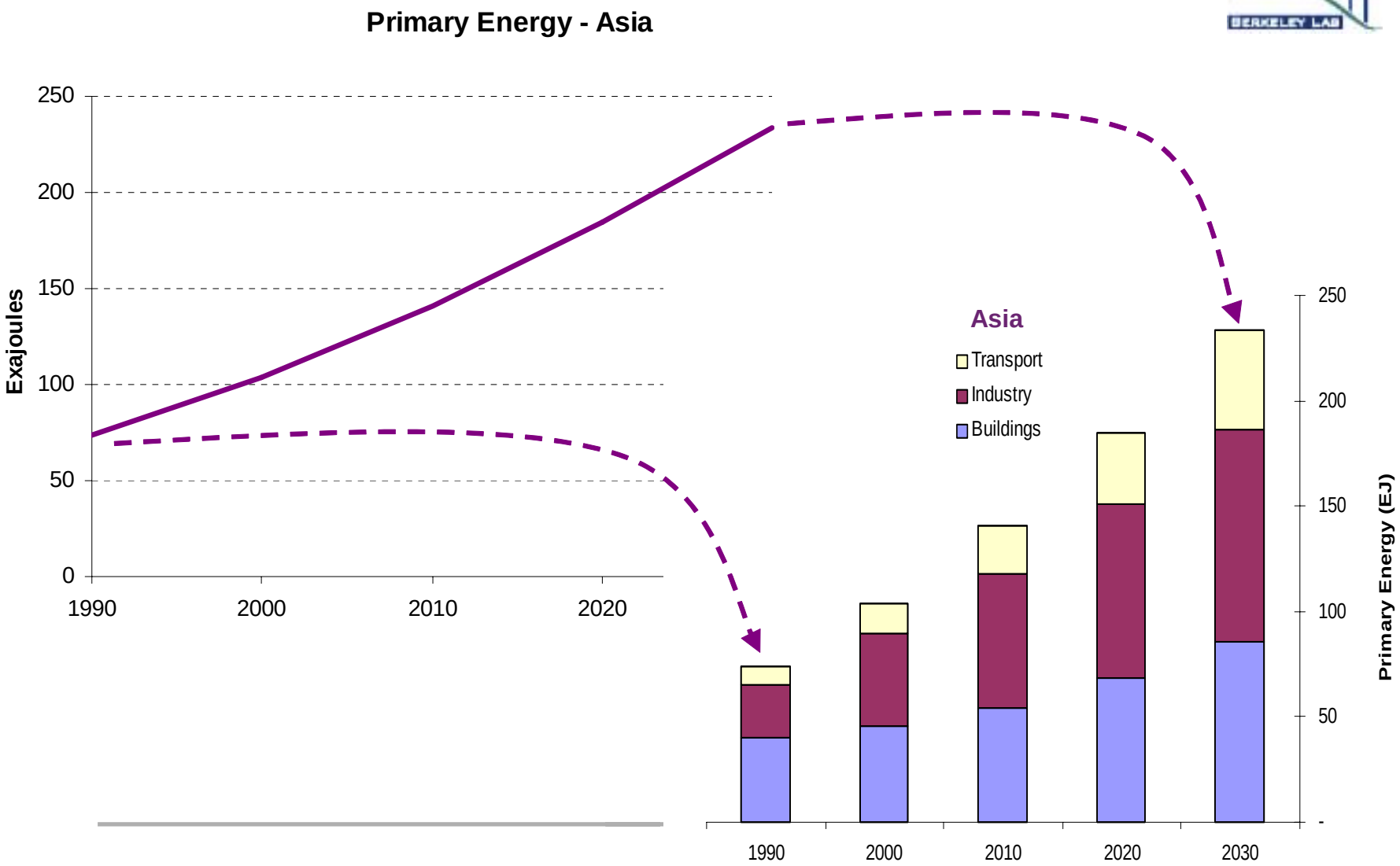


Asia Fossil Fuel CO2 Emissions and Primary Energy Use, 1990-2030

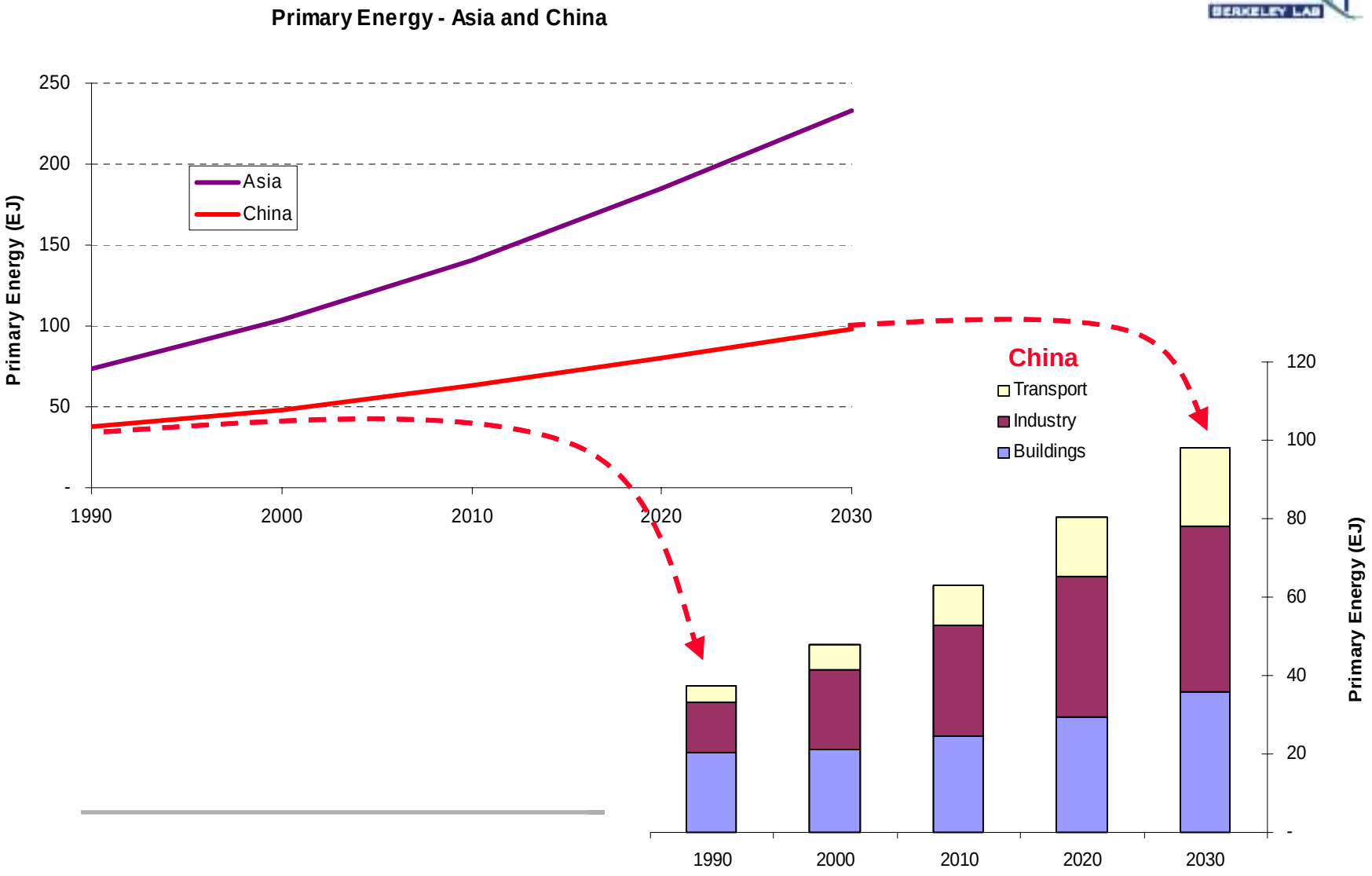




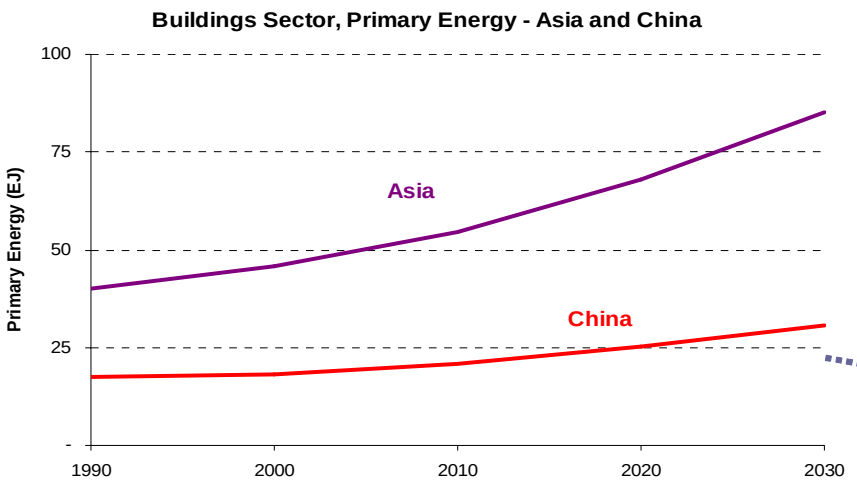
SRES B2 Marker Scenario - Asia Sector Disaggregation

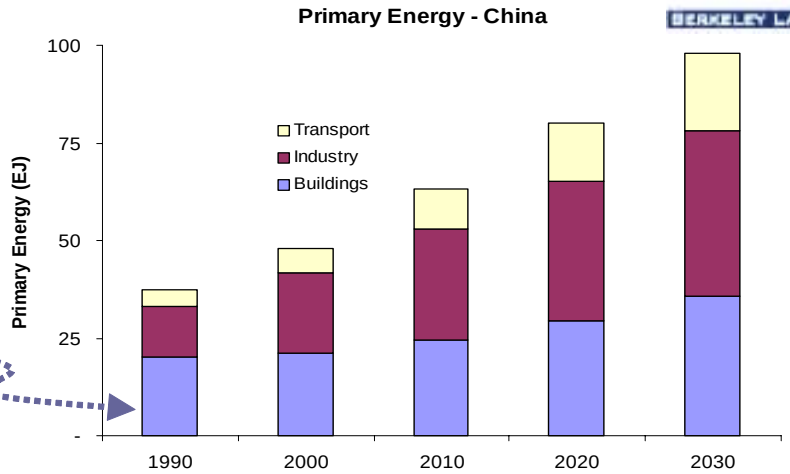


SRES B2 Marker Scenario - China Sector Disaggregation



China (B2 Marker Scenario) Driver variables for bottom-up characterization of buildings sector





Driver Variables	*2000*	*2030*	*AAGR*
GDP (trillion yuan)	9.1	58.7	6.4%
Population (millions)	1,268	1,451	0.5%
Share urban population	33%	61%	2.1%
Commercial building area (billion m2)	8.7	36.9	4.9%
Per capita living space--urban (m2/person)	19.9	36.7	2.1%
Per capita living space--rural (m2/person)	24.9	39.0	1.5%
Household size--urban (persons)	3.2	3.1	-0.1%
Household size--rural (persons)	4.4	3.9	-0.4%
Building Energy Demand (EJ)	21.2	35.8	1.8%

China Buildings Sector (B2 Marker Scenario)
Variables for *Residential Buildings*

Drivers

- population
- household sizes
- GDP, income
- household area per capita
- heating/cooling loads per m^2 (*including infiltration*)
- lighting loads
- urbanization rates
- rural/urban splits
- heating/non-heating region splits

Technical characteristics

- saturation levels of alternative devices for each end use
  - cooking
  - appliances (refrigerator, washing machine, TV, other)
  - lighting (traditional, efficient)
  - space heating
  - space cooling
- energy types for devices
  - electricity
  - fossil fuels
  - biofuels
- energy & emissions intensities
  - by device, over time

China Buildings Sector (B2 Marker Scenario) Variables for *Commercial Buildings*

Drivers

- population, GDP, income
- commercial area per capita
- heating/cooling loads per m^2
- lighting loads per m^2
- heating/non-heating region splits

Building types

- hotel
- office
- hospital
- school
- other

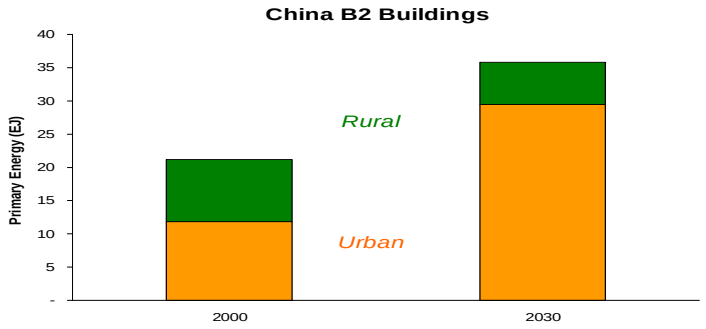
Technical characteristics

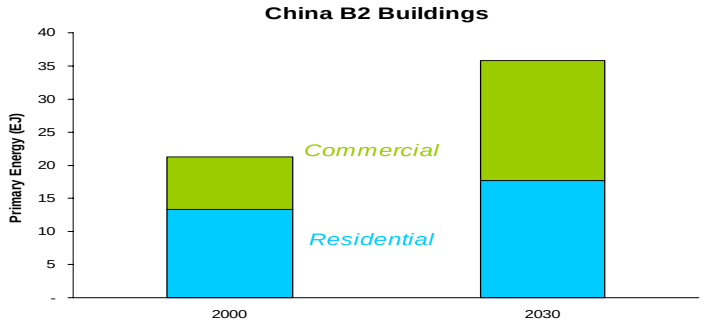
- shares or saturation levels of alternative devices for each end use
  - space heating
  - space cooling
  - lighting
  - other
- energy types for devices
  - electricity
  - fossil fuels
- energy & emissions intensities
  - by device
  - over time

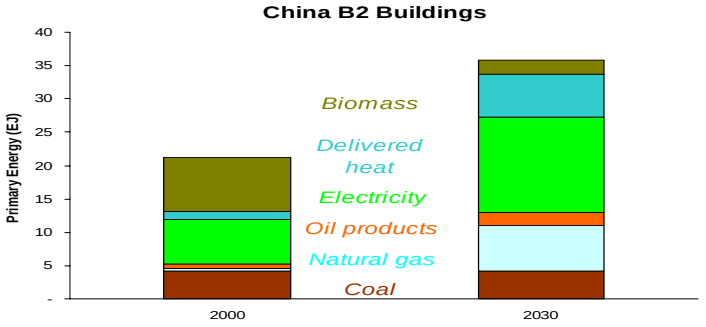
China Buildings Sector (B2 Marker Scenario)

Bottom-up modeling results (primary energy)

	EJ		Share		
Energy Demand	*2000*	*2030*	*2000*	*2030*	*AAGR*
Residential buildings	13.4	17.6	63%	49%	0.9%
Commercial buildings	7.8	18.2	37%	51%	2.9%
Urban buildings	11.8	29.5	56%	82%	3.1%
Rural buildings	9.4	6.3	44%	18%	-1.3%
Coal	4.3	4.1	20%	12%	-0.1%
Natural gas	0.3	6.9	1%	19%	11.1%
Oil products	0.7	1.9	3%	5%	3.5%
Electricity	6.8	14.4	32%	40%	2.6%
Delivered heat	1.1	6.4	5%	18%	6.0%
Biomass	8.1	2.2	38%	6%	-4.3%







Example: Urban Residential Refrigerators

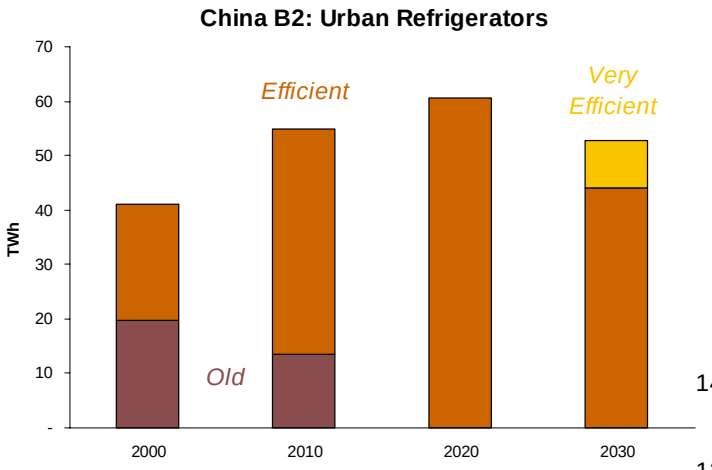
Energy demand function

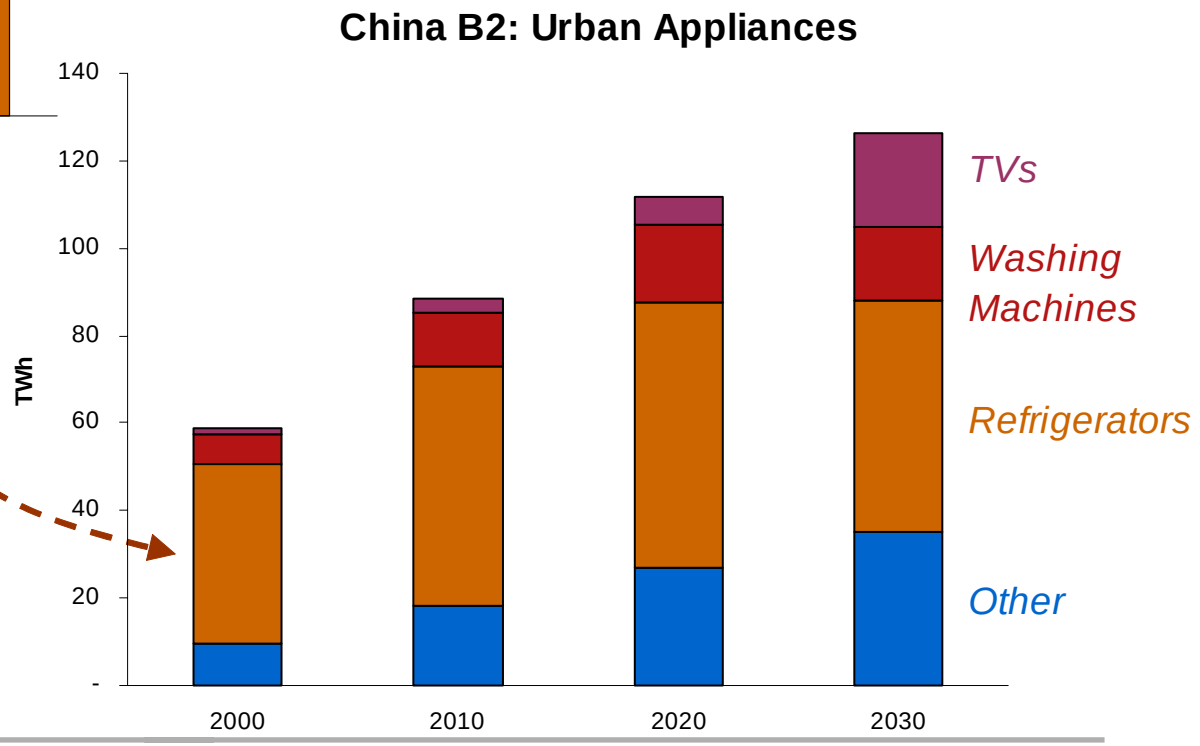
$$E_{urbref} = households_{urb} \times saturation_{urbref} \sum_i share_{ref_i} \times UEC_{ref_i}$$

Indicator	*Units*	*2000*	*2010*	*2020*	*2030*
Urban households	millions	131	193	240	284
Saturation of refrigerators	%	79%	90%	100%	100%
Shares:					
old	%	46%	23%	0%	
efficient	%	55%	77%	100%	75%
very efficient	%			0%	25%
Unit energy consumption:					
old	kWh/yr	421	344	281	
efficient	kWh/yr	379	309	253	207
very efficient	kWh/yr			146	124

Example: Urban Residential Refrigerators

B2 simulation results



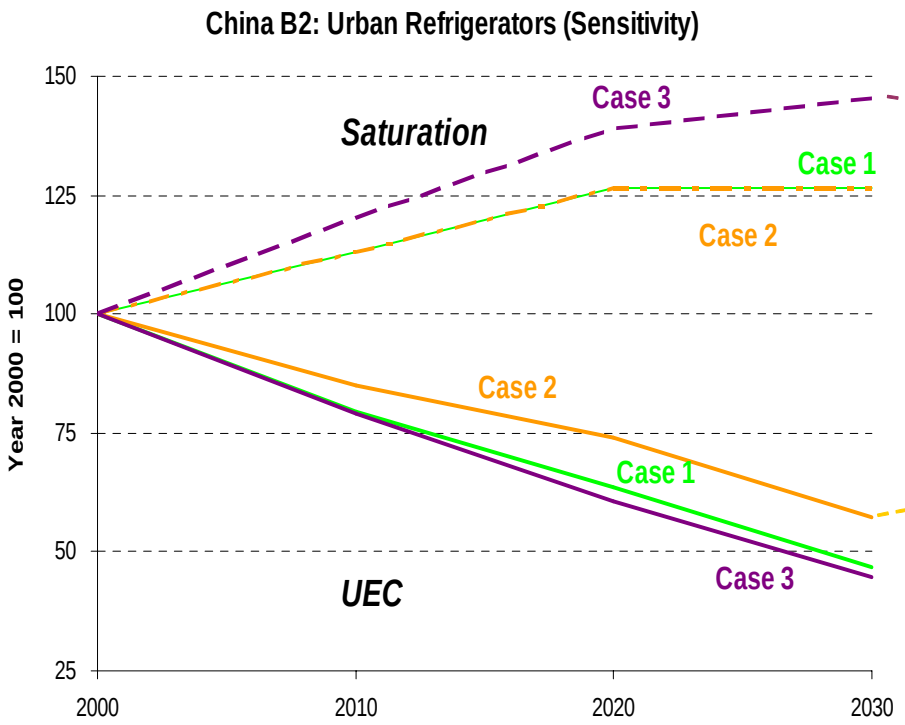


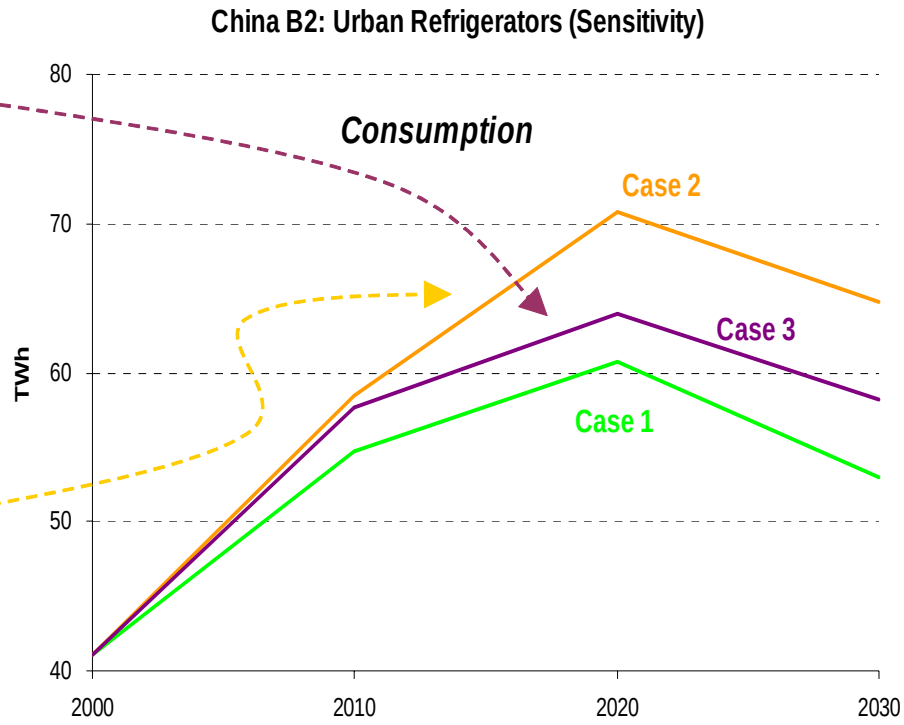
Example: Urban Residential Refrigerators
Sensitivity

Case 1: Build to fit B2

Case 2: Larger refrigerators, weaker standards

Case 3: Deeper saturation, higher turnover





Such end-use analysis supplies policy-relevant detail to overall mitigation paths.

- The preceding example demonstrates how a database and model rich in end use detail can flesh out mitigation scenarios.
- Mitigation activities—and policies—depend on specific attributes of sectors, regions, and end-use technologies.
- End-use data are difficult to collect, evaluate and assemble.
  - "Good" data (on end use and their drivers) exist for some regions.
  - "Preliminary" data exist for all regions, but the data need to be assembled.
  - In many cases, the data exist at the subregional level (i.e., individual countries). It is necessary to compile and establish uniform definitions among the country data and then aggregate to the regional level.
- As Ernst Worrell and Lynn Price will discuss, this project will provide technical support and co-ordination to leading groups who can contribute to the assembly of a consistent, well-documented database that covers:
  - 10 regions and 3 sectors at the end use level (energy service demand, end-use technology, energy efficiency, usage, saturation) and
  - the drivers of energy demand (by sector).

The Global Energy Demand Database will be a shared resource for modelers worldwide

Vision: The GED Database will be a collaboratively designed and created resource, maintained by LBNL for the use of all contributors. It will be ***a shared resource*** for project participants and collaborators.

- ***Ability of participating groups to provide data and documentation*** will determine GED database content.
- Each sector in each region will be built up from ***detailed data*** on energy consumption, technology, and drivers.
- ***Users are free to determine applications.***
  - For example, GED database used in the LBNL GED Model will allow ***simulation*** of demand consistent with existing scenarios as well as ***creation*** of new scenarios.