安源易如国际科技发展(北京)有限公司

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Sustainable Energy in China: Status and Prospects

Azure International

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Note: This presentation would not have been possible without the generous support of Jean Ku of NREL who provided much of the material and useful background information

Presentation outline

- Status of ‘sustainable’ energy in China
- Renewables
  - Solar PV for rural electrification
  - Wind for grid-connected use
  - Biomass
- Other Alternatives
  - Hydrogen, Fuel Cells
  - Distributed Power
  - Energy Efficiency
  - Coal Gasification

China's Energy Situation

- China second largest consumer of energy globally
  - China now second largest importer of oil (41% projected for 2004)
- Demand growth well above expectations
  - Shortage in generation capacity and transportation bottlenecks
  - Massive capacity expansion program announced
  - Energy consumption to double by 2020
- China still highly dependent on coal >70%, mining costs increasing
- Oil and gas resources are limited
- Transportation market exploding
- Energy intensity per unit of GDP (PPP basis) very high
  - Efficiency improving but not fast enough

China's Energy Situation (cont'd)

- Environmental degradation is becoming a national priority
  - China has 9 out of the 10 top most polluted cities in the world
  - International commitments – China 2nd largest GHG emitter
  - UNEP Director: "China's economic goals 'environmentally unachievable'" due to resource constraints
  - Fuel efficiency standards, emissions standards, LNG buses and taxis
- Government looking to diversify energy supply for economic, environmental and security reasons
  - LNG, purchasing of overseas assets
  - Renewables, other alternatives
  - Intermittent focus on CDM

Renewable energy in China

- Rapid growth from a very low base
- False starts in the past
- Energy bureau created in NDRC - Renewable energy has been put into the national energy strategy
- Goal of 100GW of renewable energy capacity by 2020 - 10% of total capacity
- 20 GW of wind, 50 GW small hydro, 1-2 GW solar PV, 15 GW of biomass, and 14GW of others
- Large hydro well developed, continuing growth
- The National's People Congress has agreed to issue a renewable energy promotion law – draft being developed by CRED, Tsinghua University, and other partners under NDRC leadership

Barriers to Commercialization of Renewables in China

- Higher upfront cost, subsidization of traditional energy (same as in developed countries)
- Marketing
- Awareness
- Incomplete assessment of renewable resources
- Lack of domestic suppliers
- Standards and testing facilities problem for equipment
- Poor linkages from R&D to commercialization
- Lack of coherent and clear policy incentives
- Restructuring of power industry – local versus national differences

Current Policies Framework

- Overall
  - National development program (1996 - 2010) issued by SDPC, SSTC and SETC in 1995
  - New incentives proposed by SDPC and SSTC approved by State council
  - SETC recommendations (in a research stage)
  - Wind concessions program by NDRC
- Taxation
  - Low value added tax rate (17% normal): 6% for hydro, 8.5% for wind, 13% for biogas
  - Duty free for equipment import for renewable energy technologies in joint venture case
  - Low duty rate for domestic investment: normal 23% in 1997 and wind is 6% for example
- Power purchase agreement (PPA)
  - Grid must buy the power generation from renewable technologies
- Price
  - Pay back price system applied for power generation by renewable technologies
- R & D
  - Government supports R&D program for renewable energy

Source: Li Junfeng, CREIA

Commercialization Activities

- **“Brightness”** program
  - launched by SDPC (NDRC)
  - target to supply power by renewable energy for remote areas
- **“Ride the Wind”** program
  - large wind turbine commercialization program supported by NDRC
  - two joint ventures have been developed for 300 and 600 kW turbine manufacturers
  - bilateral investment introduced for wind
- Rural electrification program for small hydro
  - organized by Ministry of Water Resources and SPC
  - started in middle of 1980s and three phase have been finished
  - 800 counties supply power by small hydro
- Rural energy integrated planning program
  - organized by Ministry of Agriculture and other 7 major commission and ministries
  - demonstrated in middle of 1980s and developed in 1990
- Double push program by SETC
  - 100 MW wind farms being established by this program

Source: Li Junfeng, CREIA

Renewable energy law

- “Renewable Energy Development and Utilization Promotion Law” in NPC legislative plan for 2004
- June 2004 – final draft for discussion
- June – Dec 2004 – revise draft
- Support for renewable energy from highest level of government
- Unclear whether if MMS, a Renewables Portfolio Standard (RPS), a feed in tariff or perhaps a combination

Source: Jean Ku, NREL

Key players

- SDPC – Now the National Development and Reform Commission
- Beijing Jikedian Renewable Energy Development Center
- CREIA

- Local provincial planning commissions

- DOE/NREL
- UNDP
- UNEP (New office in Beijing)
- WB/GEF
- GTZ
- Energy Foundation

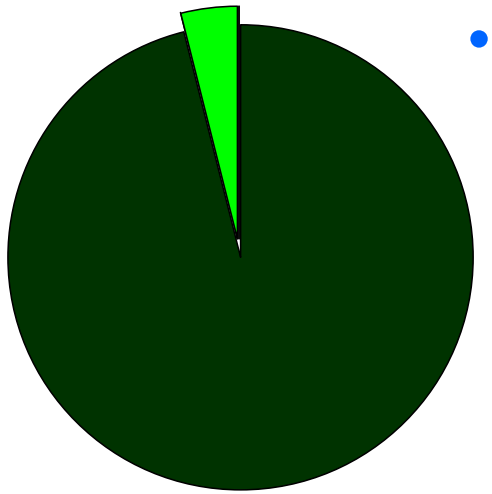
Solar PV in China

- Focus on rural electrification
- Manufacturing – *3MW in 2001, 40MW of 2003 capacity in 8 enterprises*
- Strong government support
- International programs – *$20M for WB/GEF; $25M for UNDP; new funding each year from US bilateral agreements*
- BP Solar and Shell active

Source: Jean Ku, NREL

A large percentage of Chinese households have electricity

5% Unelectrified



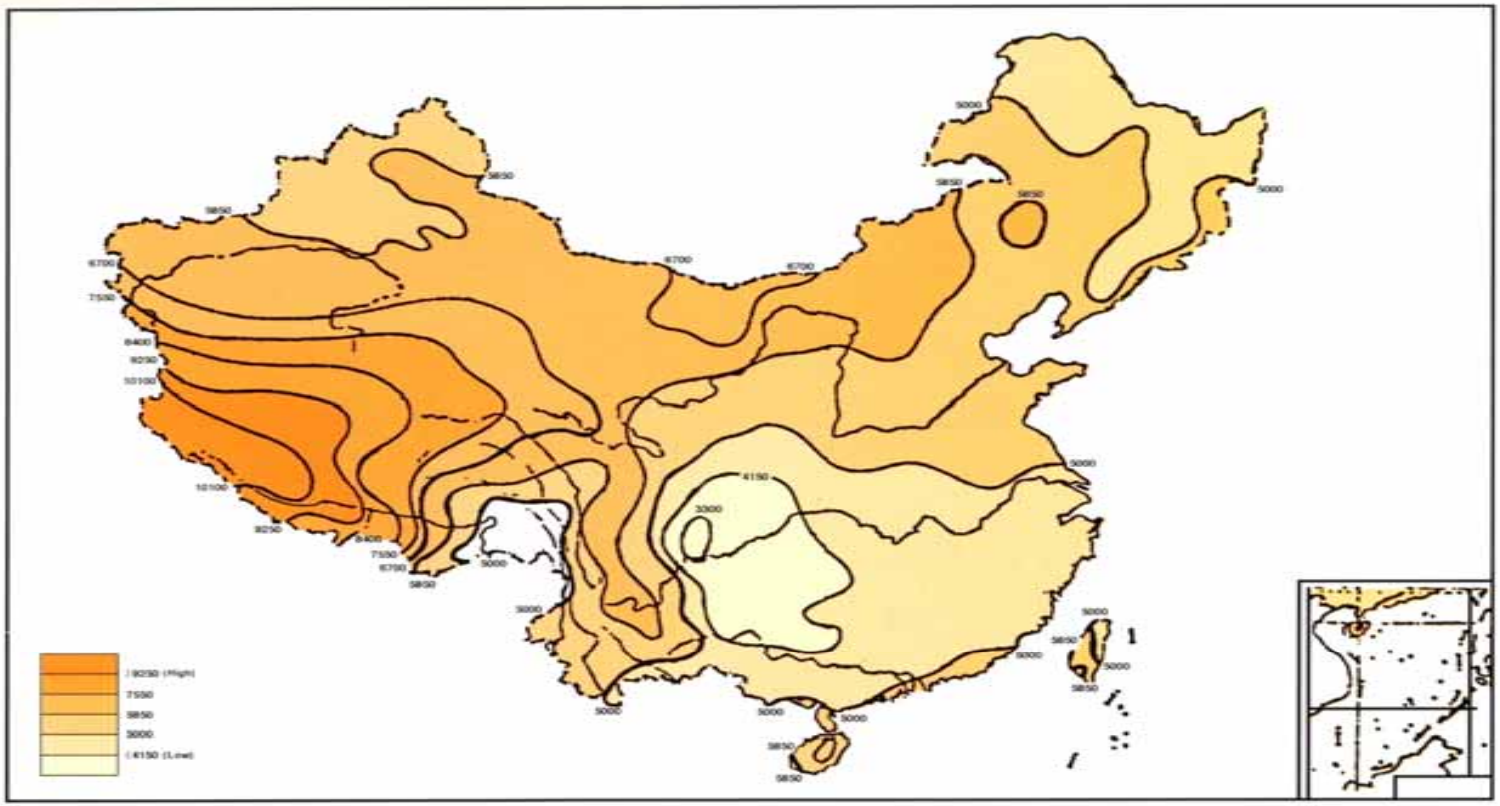
95% Electrified

- Total Unelectrified population in China – *60 million people*

Most village systems installed in the west

Source: Jean Ku, NREL

The west has good resources



注：1MJ/m²=2.78 × 10⁻¹kw · h/m²

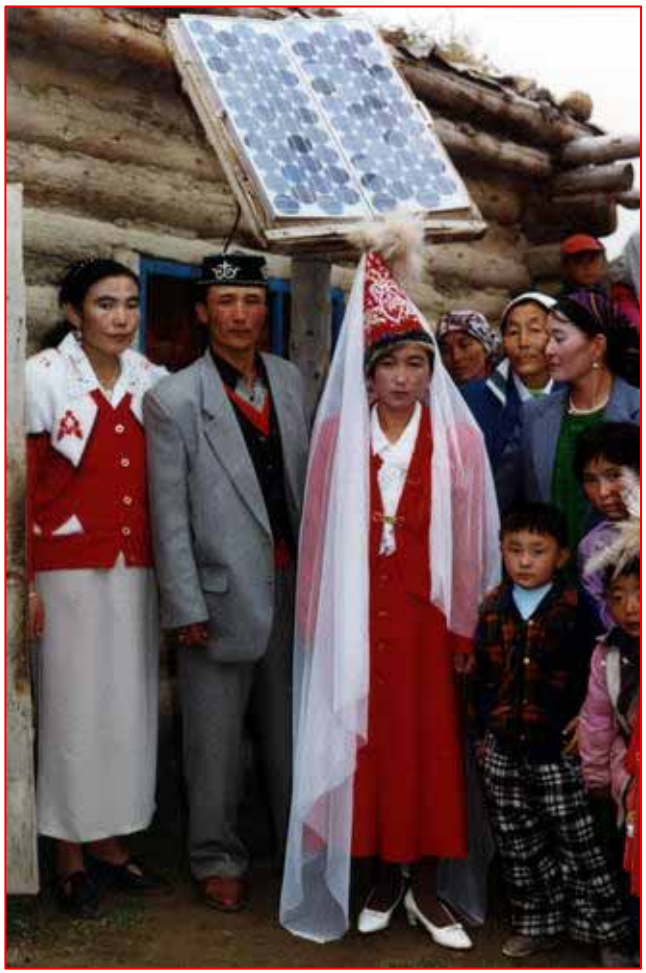
图 1. 中国年太阳能分布图(单位：兆焦／米².年)

Figure1. Distribution of solar energy in China(MJ/m²)

中国气象科学研究院

Chinese academy of meteorological science

The Township Electrification Program is ambitious in size and scope

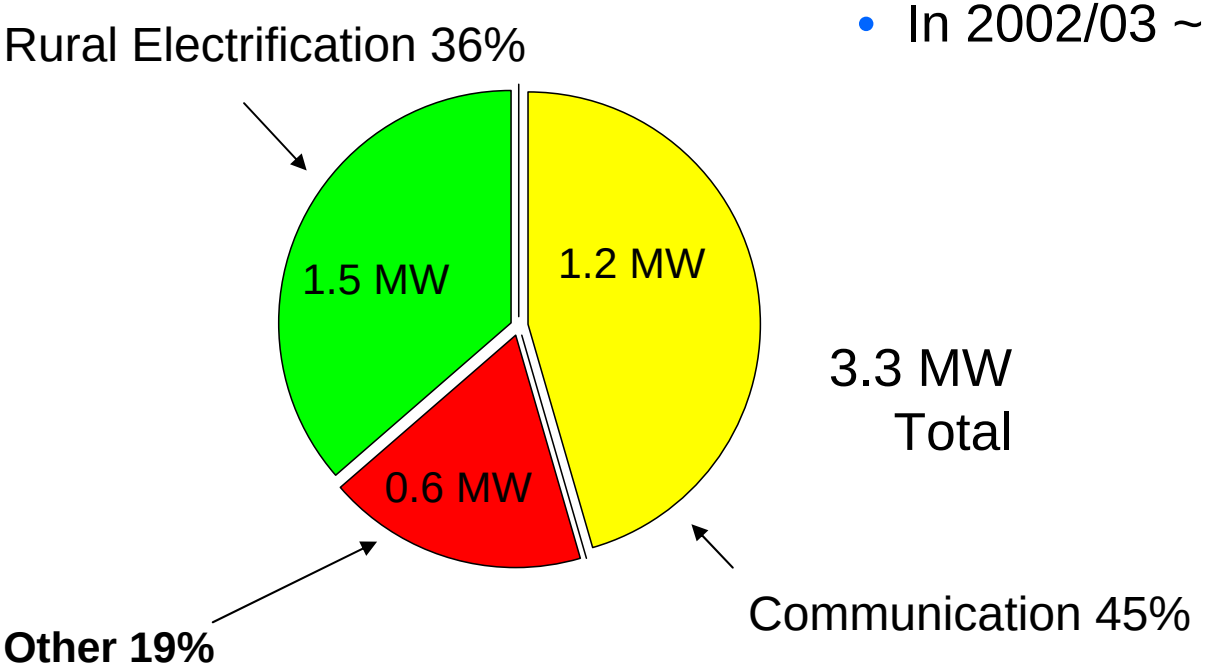


- 220MW total; 20MW PV
- 1 million people; 1061 townships
- $240M from government
- Goal - *15 years of system operation*

Source: Jean Ku, NREL

Pre-TEP PV Sales in China were moderate

PV Sales in China by Market Sector, 2000



PV Sales in China for Rural Electrification

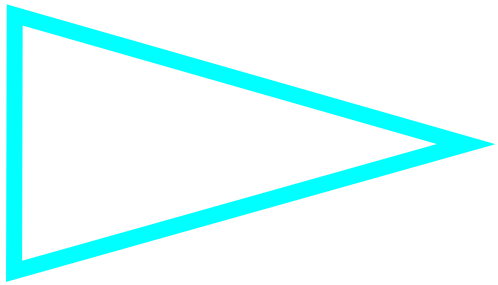
- In 2000 – *1.2MW*
- In 2002/03 ~ *20MW*

3.3 MW Total

Source: Jean Ku, NREL

The key to success is infrastructure

Technology
- 25 years of research
- manufacturing expansion



Financing
- IFC
- WB country loans
- UNDP development assistance
- GEF environmental buy-downs
- Foundations
- Private Investo
- Country $$

INFRASTRUCTURE

Marketing
Distribution
Sales
Service
Maintenance
Revenue collection
Joint Ventures

Integrated Applications
Products

Training

Cost-effective and sustainable applications

A large enough quantity of equipment, in a geographically tight enough area, to reach the critical mass needed for local business viability.

Source: Jean Ku, NREL

Training - 40,000 will ultimately be trained

- March 2003 training regulation
  - Local Master Trainers (general knowledge of PV hybrids and PV/wind hybrids)
  - Rural electric workers (basic knowledge)
  - Village Operators (specific systems)
- Accredited training center, certified workers
- Village power handbook
- Training courses

Source: Jean Ku, NREL

China is “leapfrogging”

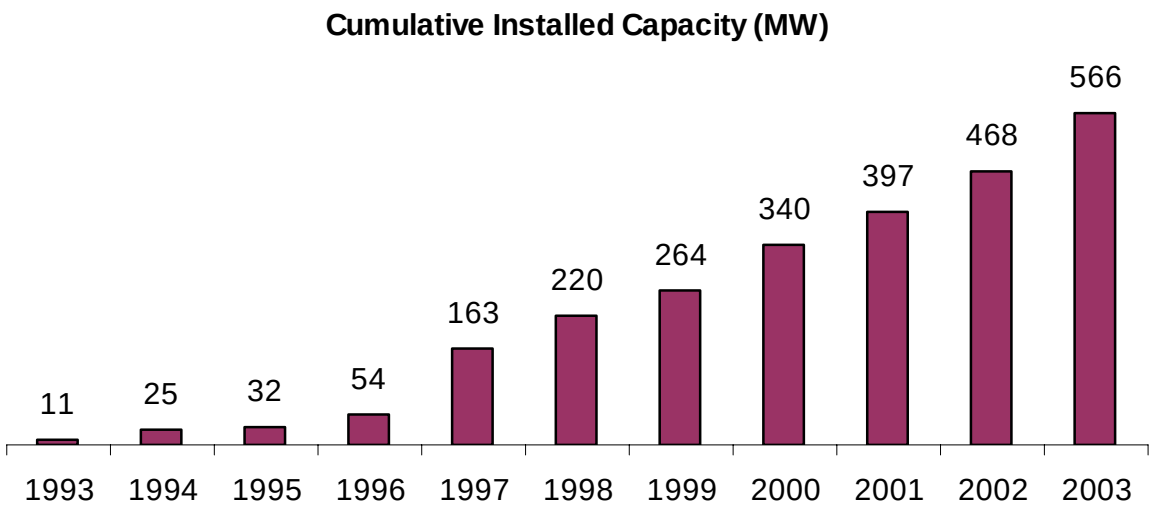
- Ambitious program with great potential
- Could become model for renewables-based rural electrification
- Numerous hurdles
- Great market for PV – Village Electrification Program
- Government commitment to universal electrification by 2010

Source: Jean Ku, NREL

Grid-connected wind power

China has vast wind resources

- World class wind resources estimated at 250 GW
- 40 wind farms, 566 MW installed capacity (by end of 2003). 98 MW added in 2003.
- Market share of pure Chinese manufacturers still small, but growing



Climate ripe for wind power

- Political climate attractive for large-scale wind development
- In the past, wind farms were tied-aid or small additions
- Restructuring of power sector in Spring 2003
- Demand and policy changes
  - Electricity shortages
  - NDRC goal of 20 sites by 2005; 10 GW goal by 2010; 20 GW goal by 2020
  - Wind concessions – pilot for long-term PPA and large-scale wind farms
- Wind offers global and local environmental benefits
  - Green tags – potential for Beijing and Shanghai

Source: Jean Ku, NREL

Wind concessions add capacity

- Goal – Develop wind market in China
- Long-term PPA – lower cost of wind, more favorable price for wind due to competitive bidding
- Large-scale wind farms (100-200MW) – economies of scale in construction, boost local manufacturing
- Bidding documents for first 2 concessions issued in Mar 03; Winning bids selected Sept 03.

Source: Jean Ku, NREL

Wind concession terms

- 20 year concession agreement
- BOT
- 40% of equipment must be locally-manufactured
- bidders will have 6 months to prepare their proposal, and will allowed to make wind measurements at the site
- bid assessment committee will be made up of at least 2/3 technical and economic specialists
- electricity price will be a major factor in choosing a developer
- PPA will be signed
- 15% income tax
- government will assign a representative to oversee the project (likely a state-owned enterprise)
- any disputes will be arbitrated by SDPC/NDRC

Source: Jean Ku, NREL

First 2 concessions in progress

- Jiangsu Rudong site - Hua Rui Group won bid to develop the site; bid price of 0.436 yuan/kWh (5.70 yen/kWh) using GE Wind turbines
- Guangdong Shi Bei Shan site - Guangdong Yuedian Company won bid to develop site; bid price of 0.501 yuan/kWh (6.55 yen.kWh) using Goldwind turbines
- 25+ potential sites being investigated.
- 2 new concessions sites under preparation for bids - Huitengxile, IM and Rudong, JS

Source: Jean Ku, NREL

Wind resource assessment

- NREL (DOE/EPA) – wind atlas of SE China identified 50 GW of available wind within 10 km of coastline of Fujian and eastern Guangdong

(http://www.nrel.gov/china/pdfs/wind_atlas_china.pdf)

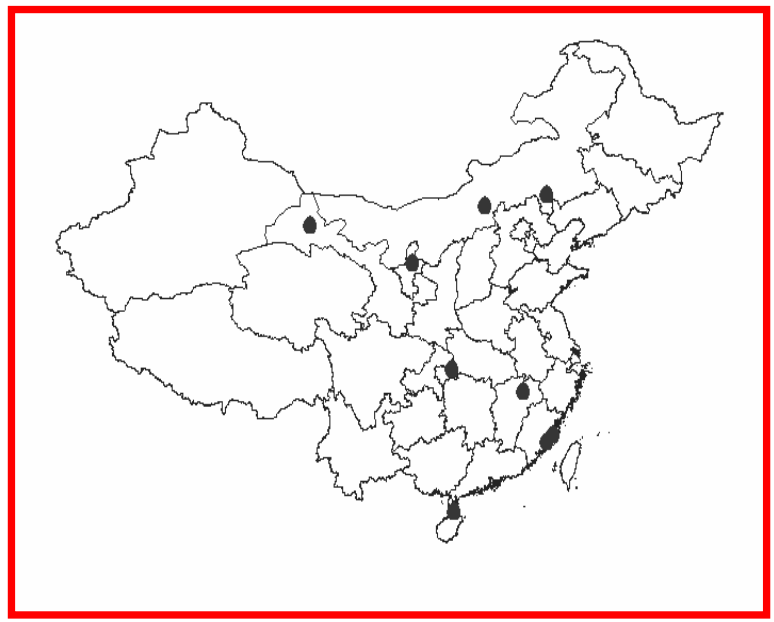
- UNEP – wind resource assessment

of key areas in China by Fall 2004

- UNDP/China – 10 sites being

monitored for potential concessions

- Poyang Lake, Jiangxi
- Lichuan, Hubei
- Huitengxile, IMAR
- Dali, IMAR
- Yumen, Gansu
- Helan Mountain, Ningxia
- Datong, Jilin
- Chongwu, Fujian
- Putian, Fujian
- Xuwen, Guangdong



Source: Jean Ku, NREL

Wind: Key conclusions

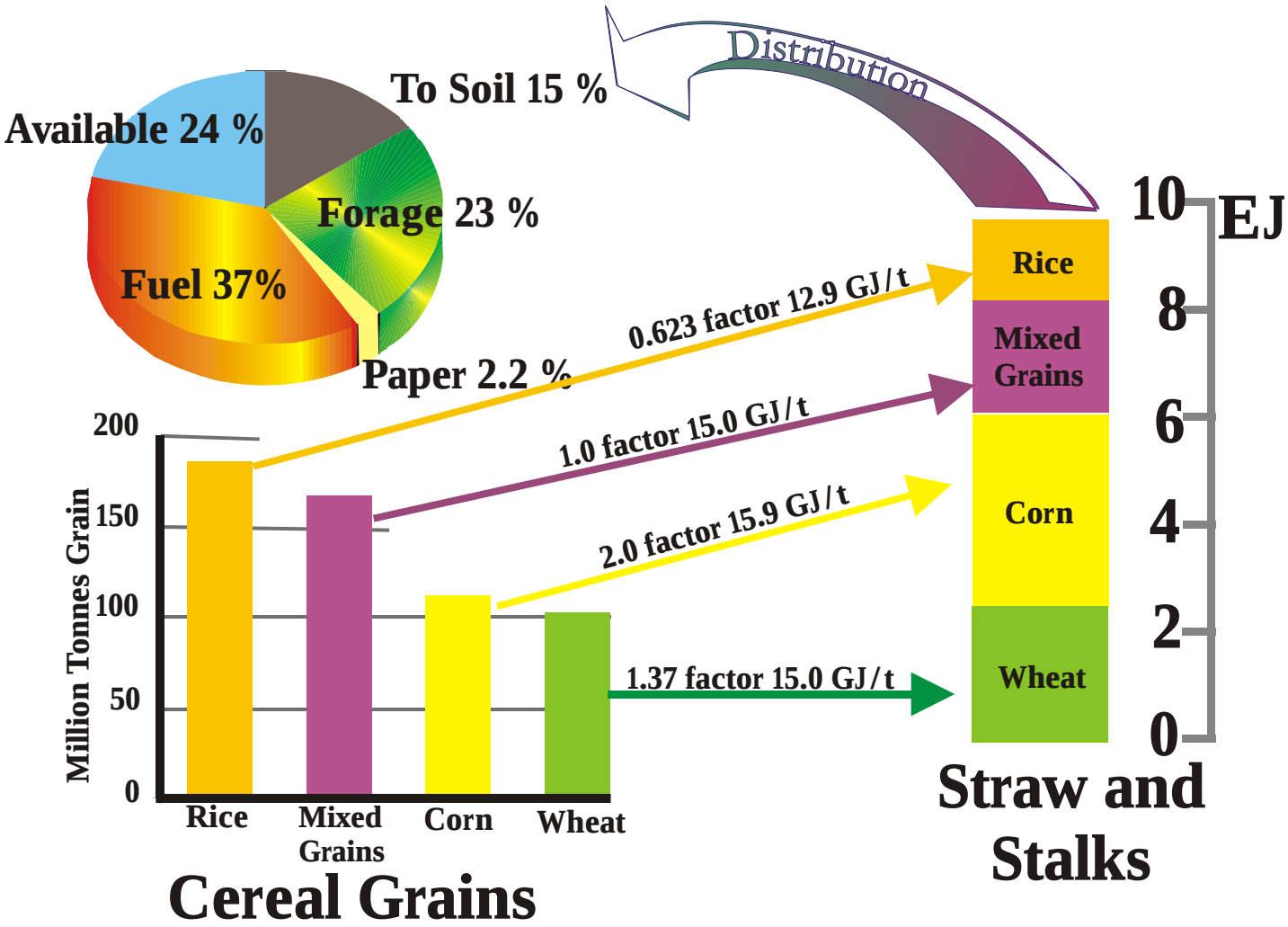
- Huge potential
- Meets growing demand for power quickly (while meeting air pollution requirements)
- Critical policy support is imminent
- Localization of technology necessary

Biomass

- **Resources – estimated total 50 GW potential but fragmented, diverse**
  - Combustion, Co-firing with coal and Gasification technologies
    - Straws and stalks –150 Mtce
    - Forestry – 200 Mtce
    - Urban residues (garbage) – 20 Mtce
  - Anaerobic Technologies (Biogas)
    - CAFO (large scale livestock production) 60 Mtce
    - Industrial organic waste waters + sewage treatment 150 Mtce
  - More than 9 million small digesters used for rural household
  - More than 2000 large and middle sized digesters for industrial application
  - Total yield of biogas was over 2 billion cubic meters by the end of 2002
- Technologies
  - Advanced technologies are needed to achieve environmental performance
- Displacement of agriculture?

Source: Jean Ku, NREL

Availability of agricultural residues - China 1995



Source: Jean Ku, NREL

Other ‘Sustainables’

- Renewables
  - Geothermal
  - Wave Energy
  - Small hydro
  - Solar thermal
- Hydrogen, Fuel Cells
- Distributed Power
- Energy Efficiency
- Coal Gasification

Fuel Cells

- Immense potential in urban transportation to mitigate GHGs
  - Major markets: FCBs, electric bikes, hybrids?
  - FCB costs too high to be competitive with diesel buses
  - Weak policy & planning capacity in public transport sector
- There is a lack of awareness and acceptance of FCB technology among key actors
  - From standing start in 1999, significant government investment
  - 863 Program focus on vehicles, PEM, hydrogen storage
  - 973 Program focus on basic research: materials, chemistries
  - Almost no private investment
  - Lack of key partnerships seen in US and Europe
- Pilot programs
  - FCBs for Beijing (Olympics) and Shanghai (World Expo)

Distributed Power

- A “novel” concept internationally; infrastructure costs seen as key barrier
  - Not a primary commercial interest in China
  - Lack of awareness
- Huge opportunity
  - With need to double TPES, China can make an “easy” jump to DG systems and be a world leader
  - Waiting for capable leader to set course and examples

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