Hong Kong Academy of Engineering Sciences Forum

WORLD ENERGY DEMAND AND ENERGY SECURITY FOR HONG KONG

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18 June 2011

Myth

- Energy crisis in 1973.

Truth

- There has never been an energy crisis in the history of the human race.
- There was an oil crisis in 1973.

Why should we be concerned with energy demand and energy security?

- Environmental security
- Economic security
- National security

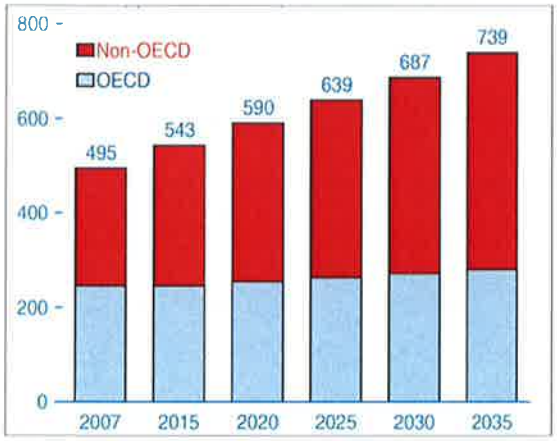
Outline

- Overview of World Energy Demand
- Technology Options for Generating Electric Power
- Energy Security for Hong Kong

Overview of World Energy Demand

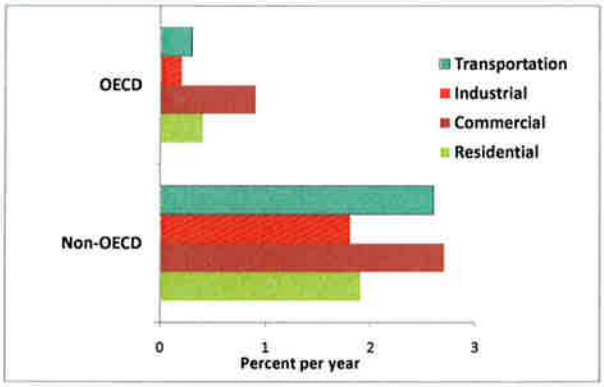
World Total Energy Consumption (2007-2035)

(quad) **(1 quad ≈ 172 million barrels of oil)**



Source: Energy Information Administration / International Energy Outlook 2010, figure 1, pg. 1

Average Annual Growth in Delivered Energy Consumption by Region and End-Use Sector



Source: Energy Information Administration / International Energy Outlook 2010, figure 1, pg. 1 ; Appendix F, Table F2 & Table F10

World Total Energy Consumption

	Quad (1 quad ≈ 172 million barrels of oil)	
Fuel	2007	2035
Liquids (Oil)	174.7 (35.3%)	223.6 (30.3%)
Natural Gas	112.1 (22.6%)	162.0 (21.9%)
Coal	132.4 (26.7%)	206.3 (27.9%)
Nuclear	27.1 (5.5%)	47.1 (6.4%)
Hydro & other renewables	48.8 (9.9%)	99.8 (13.5%)
Total	495.2	738.7

FOSSIL

Source: Energy Information Administration / International Energy Outlook 2010, Appendix A, Table A2, reference case.

World Fossil Fuel Use & Reserves

	1990	2006	2007	2035
Oil (million barrels per day)	66.5	85.2	86.1	110.6
Natural Gas (trillion cubic feet)	73.4	104.6	108.5	156.3
Coal (million short tons)	4,307.6	6,090.3	6,379.4	9,940.2

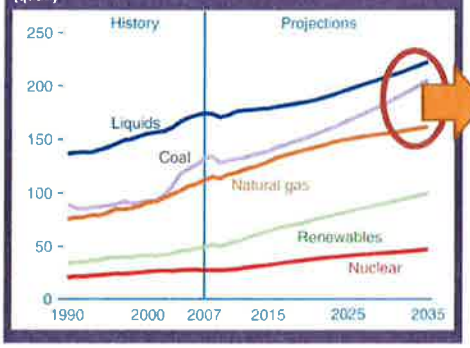
Source: Energy Information Administration / International Energy Outlook 2007 & 2010, appendix A, tables A5-7.

Proven reserves: Oil and natural gas as of 1 Jan 2010 Coal as of 1 Jan 2008	Reserves available at present	Estimated # of years remaining @ 2007 consumption rates
Oil (million barrels)	1,353,700	43.1
Natural Gas (trillion cubic feet)	6,609	60.9
Coal (million short tons)	909,400	142.6

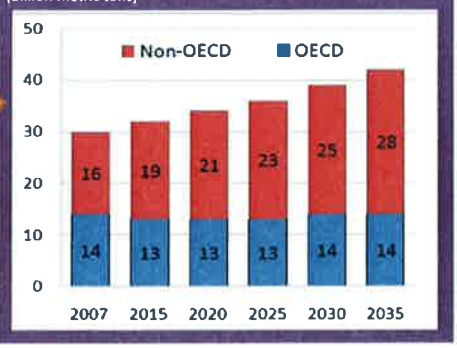
Source: Energy Information Administration / International Energy Outlook 2010, table 5, pg. 37; table 7, pg. 57; table 10, pg. 73.

World Total Energy Consumption and Carbon Emissions

World Total Energy Use by Fuel Type (1990 – 2035)



World Energy-related Carbon Dioxide Emissions by Region (2007 – 2035)

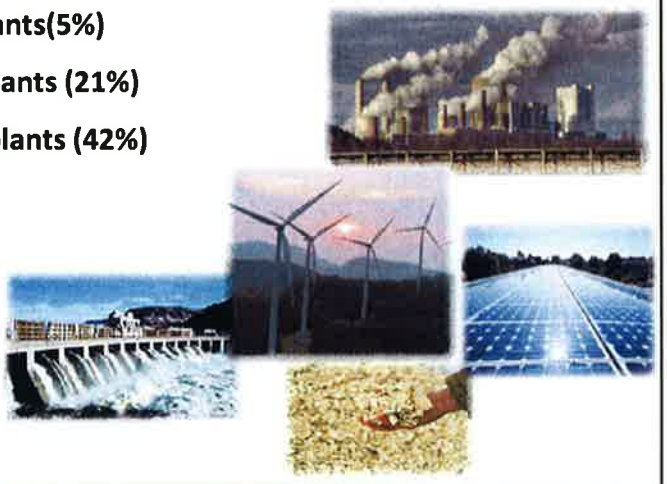


Source: Energy Information Administration / International Energy Outlook 2010, figure 16 &103, pgs. 11 & 123.

Technology Options for Generating Electric Power

World Electric Power Generation by Source (2007)

- Oil-fired power plants(5%)
- Gas-fired power plants (21%)
- Coal-fired power plants (42%)
- Nuclear (14%)
- Renewables (18%)
  - Hydro
  - Wind
  - Solar PV
  - Biomass
  - Geothermal



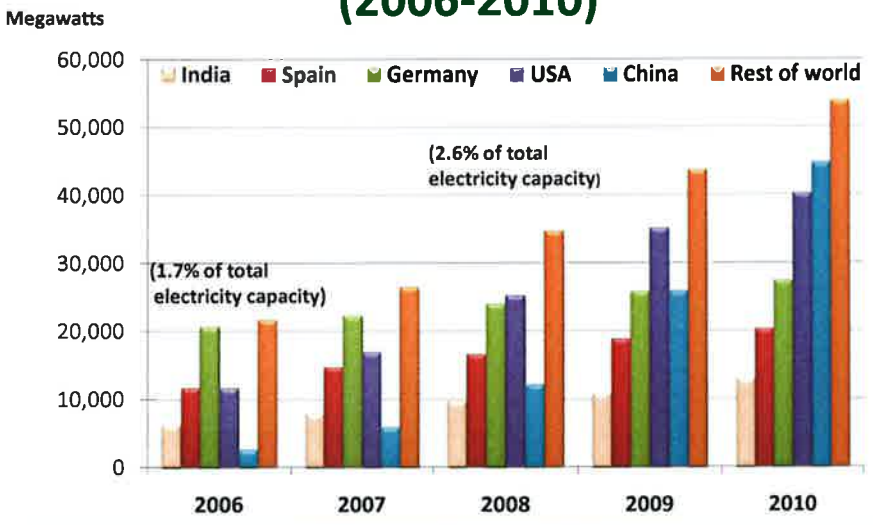
Wind Energy

- Conversion of wind to mechanical energy and then into electric energy
- Global wind power capacity has grown at an average cumulative rate of over 30% from 1998 to 2008
- Total worldwide installed capacity of nearly 200,000 megawatts at the end of 2010

- The cost of electricity generated from wind is now at record lows, with several projects in US Brazil, Sweden, Mexico display a cost of energy below $68/MWh
- China is now the world's leading wind power country, accounted for nearly half of the new global installations in 2010

Source: Global Wind Energy Council /Global Wind Report 2010, p.10 ; BP Statistical Review of World Energy June 2011 ; Bloomberg New Energy Finance , 7 Feb 2011 http://bnef.com/PressReleases/view/139
Image : Global Wind Report 2010

Worldwide Installed Wind Capacity (2006-2010)



Source: BP Statistical Review of World Energy June 2011 ; http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=7, accessed on 17 Jun 2011

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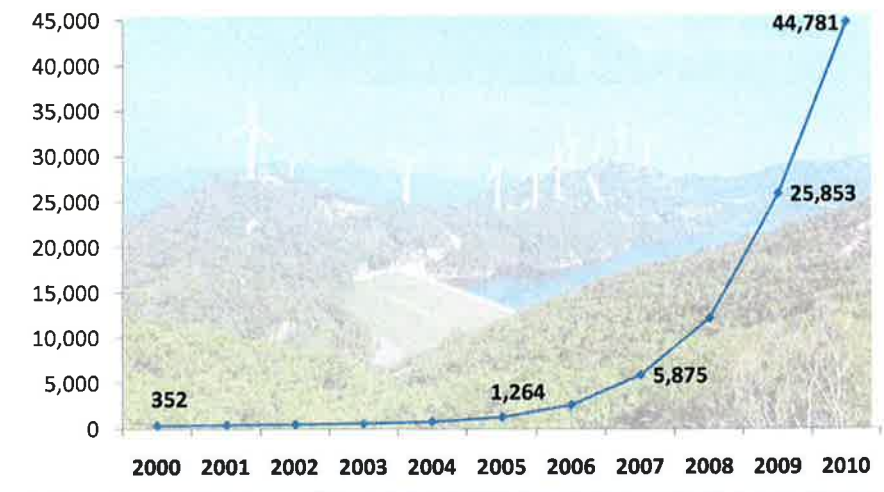
China's Wind Capacity (2000-2010)



Source: BP Statistical Review of World Energy June 2011

Image : Nanao wind farm, Guangdong, © *Greenpeace*

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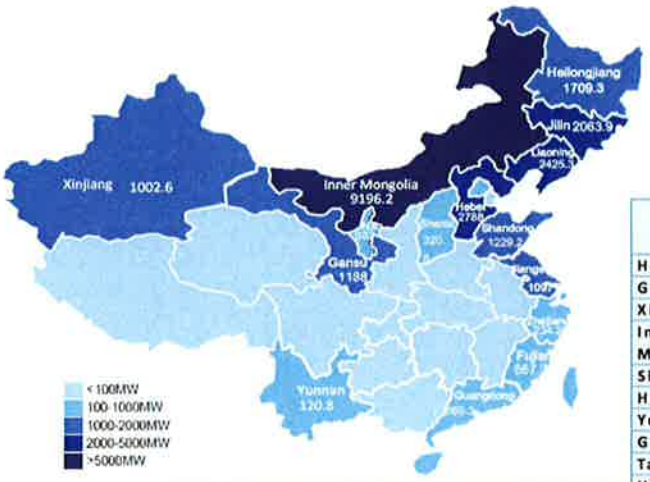
China's Wind Capacity

- Current installed wind capacity by province 2009 (MW)



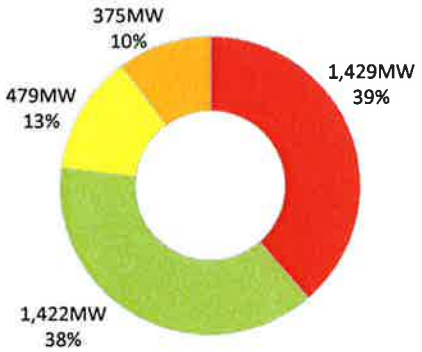
	Population density (persons/sq.km)
Hong Kong	6,480
Guangdong	486
Xinjiang	12
Inner Mongolia	20
Shandong	579
Hainan	232
Yunnan	109
Gansu	56
Taiwan	639
Heilongjiang	81

Source: CWEA, 2010.

Solar PV- Installed Capacity

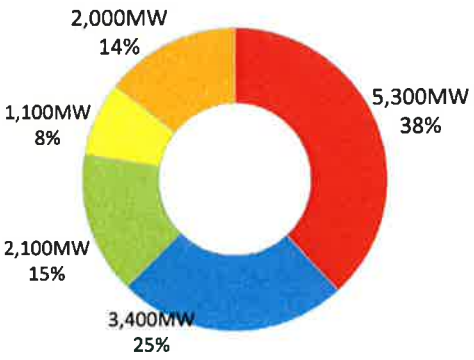
2005

(0.09% of total electricity capacity)



2008

(0.3% of total electricity capacity)



Germany Spain Japan USA Rest of world

Nuclear Power

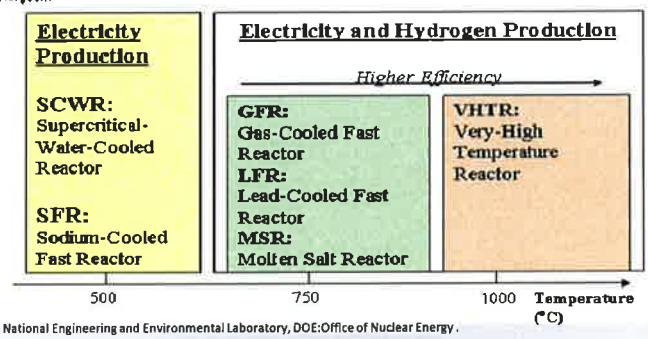
- Over 440 commercial nuclear power reactors operating in some 30 countries
- Providing about 14% of the world's electricity
- As of end of 2010, more than 60 International Atomic Energy Agency member states were considering introducing nuclear power programmes. Almost all of the 29 countries which already had such programmes planned to expand them
- China has six nuclear power plants, with 13 nuclear power reactors in operation, and more than 25 reactors under construction

Sources: World Nuclear Association, IAEA

Next Generation Nuclear Power Plants

NGNP- Very High Temperature Reactor (VHTR)

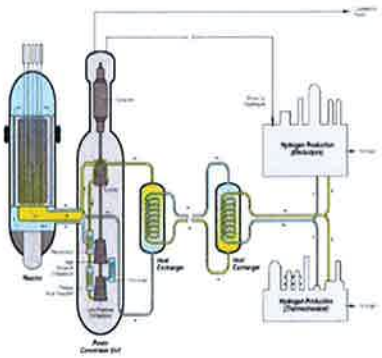
- **Countries working together**



Source: Idaho National Engineering and Environmental Laboratory, DOE:Office of Nuclear Energy.

NGNP- Mission Objectives

- Demonstrate a full-scale prototype NGNP by year 2017
- Demonstrate high temperature Brayton cycle electric power production at or near full scale
- Demonstrate hydrogen production
- Demonstrate by test the exceptional safety capabilities



High Temperature Reactor

- **China has built a small (10MW) advanced high-temperature gas-cooled demonstration reactor with pebble bed fuel, which successfully generated electric power since 2003.**
- **A commercial prototype high-temperature reactor is expected to start up in 2013.**

Source: http://www.world-nuclear.org/info/

China Energy Policy

- Medium-to-Long Term Development Plan of Nuclear Power (2005-2020)
  - Increase nuclear generating capacity to 40 Gwe by 2020
  - Meet 4% of China's electricity demand
- 12th Five-Year Plan (2011-2015)
  - Non-fossil fuel to account for 11.4 % of primary energy consumption
  - Energy consumption per unit of GDP to be cut by 16 %
  - Carbon dioxide emission per unit of GDP to be cut by 17 %
- China's nuclear energy policy has the following key elements :
  - Pressurised Water Reactors will be the mainstream but not sole reactor type
  - Nuclear fuel assemblies are fabricated and supplied indigenously
  - Domestic manufacturing of plant and equipment will be maximised, with self-reliance in design and project management
  - International cooperation is encouraged
- State Council suspended the approval process for new nuclear power stations so as to revise safety standards after the Fukushima crisis

Source: http://news.xinhuanet.com/english2010/china/2011-03/16/c_13782113.htm ; http://news.xinhuanet.com/politics/2007-11/02/content_6998061.htm ; World Nuclear Association

Nuclear Power

Benefits :

- No carbon dioxide or other greenhouse gas emissions
- Produces clean electricity on a global scale

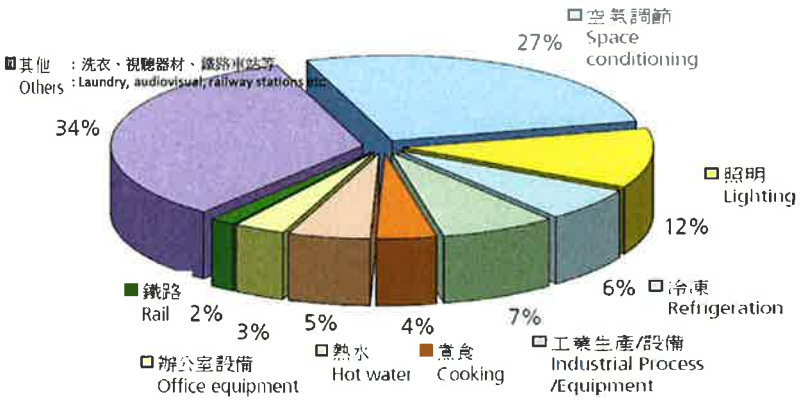
Public concerns :

- Radioactive waste disposal
- Plant safety
- Disaster preparedness
- Nuclear material proliferation
- Public outcry against use of nuclear power after Fukushima crisis
  - Germany to scrap nuclear power by 2022

Sources: World Nuclear Association, IAEA

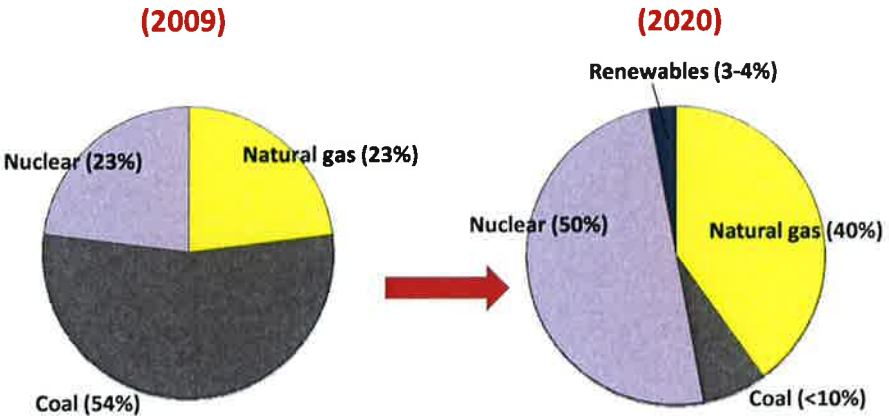
Energy Security for Hong Kong

Hong Kong Electricity End-uses (2008)



Source : Hong Kong Energy End-use Data 2010, Electrical & Mechanical Services Department, HKSAR

Hong Kong Proposed Fuel Mix Revamp



Total electricity consumption:
162,799 TJ (0.15 quad) in 2009 and 200,399 TJ (0.19 quad) in 2020

Source :Hong Kong's Climate Change Strategy and Action Agenda, HKSAR Government

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What Is the Future Environment That We Want?

- Clean environment
  - minimize use of fossil fuels
- Same level of living standard
  - convenient
  - comfortable
  - efficient

How Do We Meet These Requirements?

- Coal power is on the way out
- Nuclear power is not welcome
- Choices available:
  - reduce electricity consumption
  - increase use of renewable energy

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Vision for 2050

- Reduce electricity consumption by 50%
- Increase use of renewable energy to 80%

Germany's targets

Energy Experts at PolyU

Department	Name	Expertise
Department of Applied Biology and Chemical Technology	Prof WT Wong Prof Sam Lo Dr Joseph Yung	Biofuel production from Algae
Department of Building Services Engineering	Prof. YANG Hongxing	Renewable energy (solar energy and wind energy)
	Dr LU Lin, Vivien	Renewable energy (solar energy and wind energy)
	Prof. NIU Jianlei	Energy consumption/demand modelling and simulation in the building sector
	Dr CHEN Ting-yao	Building energy analysis and conservation
	Prof. WANG Shengwei	Energy efficiency in building through optimized controls
	Prof. DENG Shi-Ming	Air Conditioning and Refrigeration System energy consumption, Building Energy Audit
Department of Electrical Engineering	Dr NGAN Hon-wing	Power market reform, Energy Policy
Department of Electronic & Information Engineering	Prof. WOO Chung-ho	Nuclear energy


Thank You!
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