

# **ASEAN ACADEMY OF ENGINEERING AND TECHNOLOGY (AAET)**

## **2006 INTERNATIONAL CONFERENCE FOR A SUSTAINABLE ASIA Session 6 – New and Renewable Energy**

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## **Sustainable Energy Systems in Developing Economies**

### **The Opportunities and Challenges**

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# Structure of Presentation

- **Introduction and overview**
- **Sustainable scenarios in a fast developing world**
- **Sustainable technology drivers**
- **Sustainable technology options**
- **Market development and growth mechanisms**
- **Funding and resources**
- **Conclusion**

# World Energy Outlook

- Electricity demand is increasing faster than energy use
  - ◆ from 1980 to 2020 energy use doubles
  - ◆ electricity triples due to per capita increase and population growth
- New 10M+ megacities will add dramatically to electricity demand and urban pollution
- But – there is still no reliable affordable energy supply for a third of world's people!
- In developing countries, focus will be on energy access, not sustainability

**Is this sustainable?**

**No!**

# World Energy Scenarios 1990 – 2050 - 2100

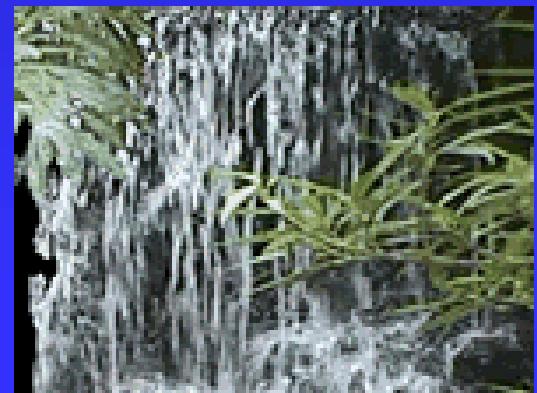
- A - High growth scenarios
  - ◆ A1 - Ample oil and gas
  - ◆ A2 - Return to coal
  - ◆ A3 - Non fossil fuel future
- B - Medium growth scenarios
- C - Ecologically driven scenarios
  - ◆ C1 - New renewables
  - ◆ C2 - Renewables and new nuclear

# Energy Scenarios 1990 - 2050 - 2100

Scenario		Units	A - High Growth	B - Medium Growth	C - Ecological Growth
Population	1990	BN	5.3	5.3	5.3
	2050		10.1	10.1	10.1
	2100		11.7	11.7	11.7
Gross World Product	1990	\$TN	20	20	20
	2050		100	75	75
	2100		300	200	220
Primary Energy Intensity	1990	MJ/\$GWP	19.0	19.0	19.0
	2050		10.4	11.2	8.0
	2100		6.1	7.3	4.0
Primary Energy Consumption	1990	EJ/a	379	379	379
	2050		1041	837	601
	2100		1859	1464	880
Cumulative CO2	1990-2100	Gt	910 - 1450	1000	540
Energy Sector Investment	1990-2020	\$TN	15.7	12.4	9.4
	2020-2050		24.7	22.3	14.1
	2050-2100		93.7	82.3	43.3

# Humanitarian Drivers

- Strongly held but seemingly impotent humanitarian concerns for the world's deprived
  - ◆ especially remote communities in developing countries
- 1.6 – 2 BN people lack adequate electricity or clean water
  - ◆ number not falling as populations grow
- Increasing equity imbalance between world's 'haves' and 'have nots'



# Commercial Drivers

- Developed world is technology rich
  - ◆ new technologies in all energy resources offer solutions
- “Internalising externalities” favours development of sustainable technologies
  - ◆ carbon pricing?
- Developed nations compete to support new sustainable industries
  - ◆ range of powerful market mechanisms (carrots) and regulatory regimes (sticks)
- Export potential with global allies is vast

# Scientific Drivers

## Greenhouse effect and global warming

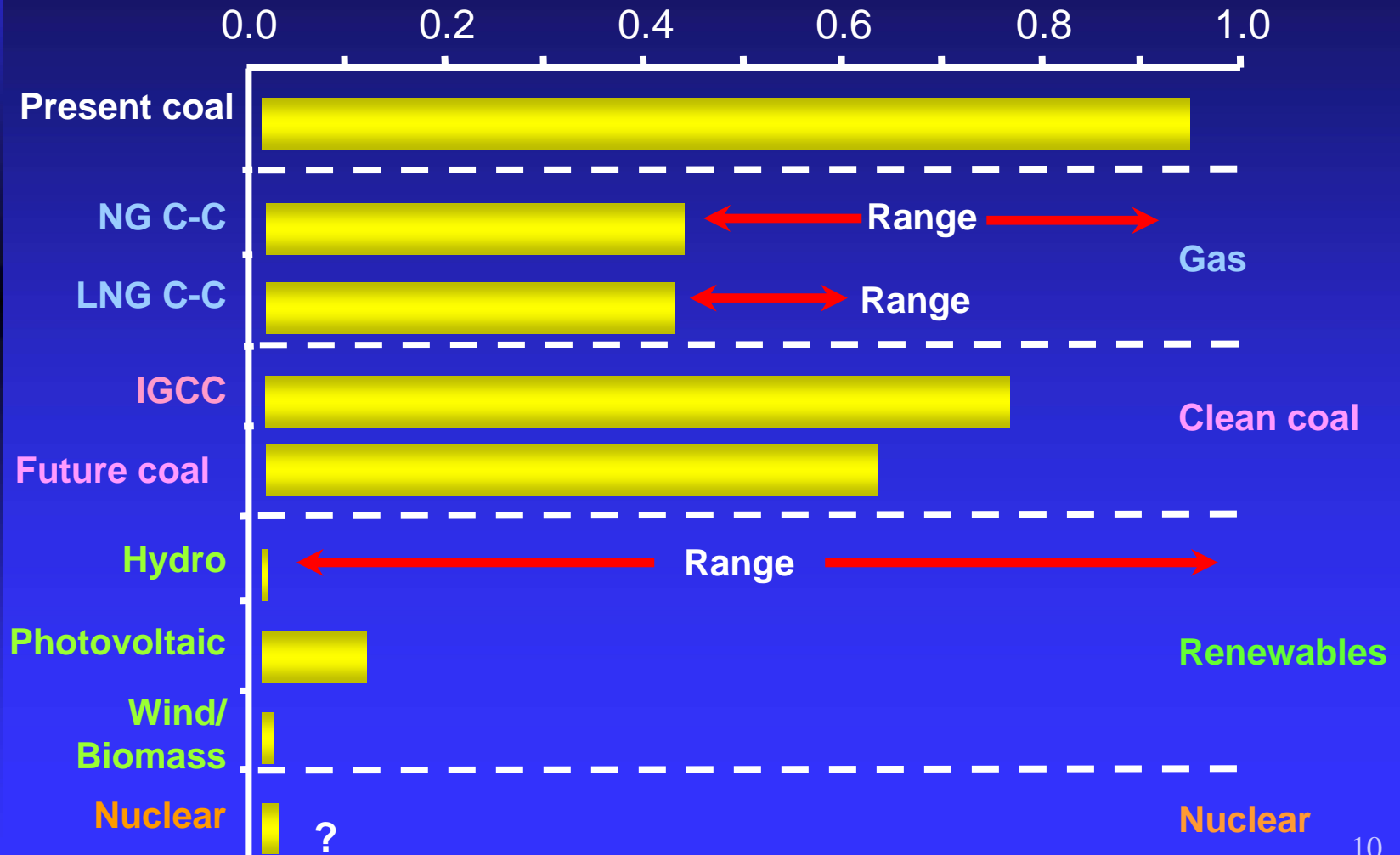
- IPCC Third assessment Report (2001)

*“There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities”*

- Strong demands from underwriters for low greenhouse gas emission technologies

- Public debate often strident, generally lacking in scientific knowledge and objectivity

# Electricity GGE (t CO<sub>2</sub> - e/MWh)



# Renewables

- Hydro, solar thermal and photovoltaic, wind, biomass, tides, waves and geothermal hot dry rocks
  - ◆ virtually unlimited, carbon free and sustainable
  - ◆ very diffuse
- Expensive, but under intense development
- Fast gaining market share from low base
  - ◆ small scale distributed applications
  - ◆ suited to remote off grid regions and developing communities
- Will benefit from 'internalisation of externalities'
  - ◆ carbon pricing and trading



# Nuclear

- Supplies 15% of world's electricity and 25% of base load
  - ◆ high fixed and low variable costs stabilise future prices and add to energy security
  - ◆ safety proven with over 10 000 reactor years operating experience in 440+ reactors over five decades
  - ◆ safer, cheaper, modular GIII, GIII+ and GIV reactors promise new nuclear era
- Problems of high level waste disposal resolvable
- Public acceptance is now the major challenge



# Hydrogen

## Vision of hydrogen economy

- Ideal for fuel cells for distributed energy and power
- Long term replacement for oil in land transport
- Sourced from;
  - ◆ electrolysis/photolysis of water,
  - ◆ natural gas reforming, and
  - ◆ coal gasification
- Easy to transport by pipeline, but hard to store
  - ◆ experimenting with hydrides, and
  - ◆ nanomaterials

# Distributed Energy and Power

- Distributed energy and power:
  - ◆ closer to city and regional consumers
  - ◆ uses gas microturbines, fuel cells, renewables and related technologies
  - ◆ combined power, heating and cooling at high efficiency
  - ◆ flexible, reliable, cheap - reduces GHGs
- Diminishing significance of large centralised power plants
  - ◆ increasing significance of small localised site specific solutions



# Energy Efficiency

- Potential to reduce energy intensity 15% - 25% per unit of GDP
  - ◆ universal, disaggregated and hard to capture
  - ◆ low cost reduction of GHG emissions
- Technologies to be targeted include:
  - ◆ high efficiency variable speed electric drives,
  - ◆ high temperature combustion and smelting,
  - ◆ water and process heating,
  - ◆ lighting, heating, cooling and air conditioning,
  - ◆ recovery and reuse of heat and materials

# New Generation Transport

- Hybrid cars offer <50% fuel consumption and <35% pollution using:
  - ◆ Smaller petrol or diesel engines – for base load
  - ◆ Supercapacitors – for acceleration
  - ◆ Advanced batteries – for energy storage and levelling
  - ◆ Regenerative braking – for energy recovery
- Longer term technologies will include:
  - ◆ Fuel cells - gas then hydrogen – to replace IC engine
  - ◆ Supercapacitors and hydrogen storage devices improved
  - ◆ Drive train and braking advances
  - ◆ Optimised intelligent transport systems (ITS) improve traffic and route management



# Social Implications of Change

- Changes in employment
  - ◆ losses in regional areas, eg, from reducing coal based generation, but gains from biomass, etc
  - ◆ impacts on social cohesion, skill base
- Changes in economics
  - ◆ cost of electricity has a major impact on industry and community
  - ◆ externalities have to be factored into costs/pricing
- Is this a field for study between AAET and ATSE?

# Challenges and Opportunities

- Maintain international competitiveness
- Use coal, gas, hydro, oil shale, geothermal, solar, wind, biomass and uranium resources sustainably
- Respond to declining oil self sufficiency
- Improve urban air quality
- Meet agreed greenhouse gas and global warming targets
- Create new businesses - export Australian energy resources and technologies
- Maximise value of energy science and technology base - universities and private enterprise

# What are the market drivers for sustainable energy systems?

- **International cooperative R & D**
- **Reducing technology costs**
- **Growing international technology relationships**
- **Unserved off-grid demands**
- **Increased distributed generation**
- **Deregulation freeing private capital**
- **Increasing venture capital for innovation**
- **Internalisation of externalities favours sustainable technologies**
- **Increasing industry cohesion - free trade agreements**
- **More favourable policy environments**

# International collaboration - the potential

- **Can support appropriate financial structuring of projects if risks are shared, including taking a role in ownership**
- **Can assist in community involvement and related industry development**
- **Can help to develop long term supportive counterpart industrial relationships**
- **Can contribute to education and training – and ‘training the trainers’ for ongoing sustainability**
- **Can provide remote monitoring and control support**

# Financial structuring for sustainable technologies

- **Grants and soft loans (at worst!)**
  - ◆ huge competition and heavy bureaucracy
  - ◆ focus on lender kudos, not recipient need
  - ◆ limited community involvement
  - ◆ often indifferent follow up, inadequate training and lack of 'ownership', leading to
  - ◆ project failure!
  
- **Grants and soft loans (at best!)**
  - ◆ support project equity (ie owner stake)
  - ◆ provide for local 'buy in' with financial discipline
  - ◆ strong community involvement
  - ◆ support local management with business and operational training
  - ◆ project success!

# International funding and support agencies

- **The World Bank (IBRD)**
- **The Asian Development Bank (ADB)**
- **The Solar Development Corporation (SDC)**
- **The Energy Sector Management Assistance Program (ESMAP)**

# Conclusions



- The choice of energy future is ours - remembering that:
  - ◆ technology can provide the solutions, and
  - ◆ technology must empower the unempowered
- For development pathways, we must understand:
  - ◆ which energy pathways are sustainable
  - ◆ which technology options to pursue, and
  - ◆ the full social, economic and environmental consequences of each
- ASEAN will undoubtedly develop an integrated regional energy policy