Introducing Nuclear Power:
The Rationale and Challenges

by

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Discussion Outline

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I. The Environment and Development

- The relationship between environment and nuclear energy development can be considered from the broader perspective of sustainable development, which the Brundtland Commission, also known as the World Commission on Environment and Development, defined in 1987 as “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.
- This definition attempts to emphasize the importance of economic development to meet human needs, and the importance of the sustenance of the natural environment as both a resource provider and waste absorber.
- Since the Brundtland Commission, the United Nations has through various organs and instruments made efforts to translate the Brundtland Commission's definition of sustainable development into specific policy directions.
- The Commission on Sustainable Development (CSD) addressed the issue of Energy for the first time at its ninth session in 2001. CSD-9's decision on energy is thus the first dedicated effort by the CSD to further translate the Brundtland Commission's definition of sustainable development into specific policy directions with respect to energy.

- The discussion on nuclear power at CSD-9 led to two main conclusions:
  i. Countries agreed to disagree on the role of nuclear power in sustainable development, and
  ii. Countries agreed that "The choice of nuclear energy rests with countries."

- The Johannesburg Plan of Implementation (JPOI) which resulted from the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in 2002, called on governments, as well as relevant regional and international organizations, to implement the recommendations and conclusions of CSD-9.

- The JPOI also included a 'positive list' of technologies and called for a series of actions to promote the widespread availability of clean and affordable energy, specifically the promotion of renewable energy resources, efficiency improvements, and advanced energy technologies, including cleaner fossil fuel technologies. Nuclear power is included in the category of advanced energy technologies.

- Energy and nuclear power have also been part of the CSD agenda during its fourteenth and fifteenth sessions in 2006 and 2007 on energy for sustainable development, industrial development, air pollution/atmosphere and climate change.

II. Energy as a Driver of the Developmental Process

The Nexus between Energy Consumption and Gross Domestic Product.

- The productivity of any physical system is intrinsically linked to its driving force.
- The gross domestic product (GDP) of country, the measure of the aggregate monetary worth of the total goods and services produced within the country, is a fair indication of its productivity.
- The GDP, though dependent on a number of macroeconomic factors, is also principally dependent on a driving force.
- Empirical evidence that the driving force could be energy may be deduced from correlation between the per capita GDP and energy usage of some countries:
  - In the developed countries;
  - In the emerging and developing countries; and
- Table 1(a-c) gives some insight to this correlation

NAME OF COUNTRY	PER CAPITA GDP IN US$	PER CAPITA ENERGY USAGE IN MILLION BTU	ELECTRICITY GENERATION IN BILLION KWH	POPULATION	PER CAPITA ELEC. GEN IN KWH
Luxembourg	**65,630**	**431**	**278.6**	**448,569**	**620,975**
Norway	**59,590**	**455**	**135.8**	**4,525,116**	**30,010**
Switzerland	**54,930**	**169.7**	**56.1**	**7,301,994**	**7,683**
Denmark	**47,390**	**153**	**34.2**	**5,368,854**	**6,372**
France	**34,810**	**181.5**	**543.6**	**60,765,983**	**8,945**
United Kingdom	**37,600**	**165.7**	**372.6**	**60,587,000**	**6,150**
Germany	**34,580**	**176**	**579.0**	**83,251,851**	**6,955**
Czech Republic	**10,710**	**173.7**	**77.4**	**10,256,760**	**7,544**
Slovenia	**17,350**	**157.3**	**14.3**	**1,932,917**	**7,377**
Spain	**25,360**	**163**	**270.3**	**45,061,274**	**5,999**
Netherlands	**36,620**	**258**	**94.3**	**16,491,461**	**5,721**

Table 1b: Correlation between GDP and Energy for some European Countries

Sources: 2005 and 2006 capacity and projected planned additions: Energy Information Administration (EIA), Form EIA-860, "Annual Electric Generator Report" (preliminary); International Energy Annual 2005.

NAME OF COUNTRY	PER CAPITA GDP IN US$	PER CAPITA ENERGY USAGE IN MILLION BTU	ELECTRICITY GENERATION IN BILLION KWH	POPULATION	PER CAPITA ELEC. GEN IN KWH
United States	**43,740**	**340.5**	**4062.0**	**302,200,000**	**13,441**
Canada	**32,600**	**436.2**	**609.6**	**32,900,000**	**18,529**
Mexico	**7,310**	**64.8**	**222.4**	**106,500,000**	**2,088**
Argentina	**4,470**	**74.2**	**101.1**	**39,400,000**	**2,565**
Brazil	**3,460**	**50.1**	**396.4**	**189,300,000**	**2,094**
Russia	**4,460**	**212.2**	**904.4**	**144,978,573**	**6,238**
India	**720**	**14.8**	**661.6**	**1,131,900,000**	**585**
Korea, South	**15,830**	**190.7**	**366.2**	**48,500,000**	**7,551**
Indonesia	**1,280**	**23.4**	**120.3**	**231,600,000**	**520**
Australia	**32,220**	**273.4**	**236.7**	**48,500,000**	**4,880**

Table 1c: Correlation between GDP and Energy for some American, Asian and Pacific-rim Countries

Sources: 2005 and 2006 capacity and projected planned additions: Energy Information Administration (EIA), Form EIA-860, "Annual Electric Generator Report" (preliminary); International Energy Annual 2005.

- As can be observed, the highly developed and industrialized countries with concomitant high per capita GDPs are also heavy consumers of primary energy. This even becomes more obvious from the Figure 2.1.
- Generally, about 40% of all primary energy consumed is in the form of electricity, and modern manufacturing processes depend principally on electricity.
- It is thus expected that there could be even a higher level of correlation between GDP and per capita electricity generation. This relationship is shown in Figure 2.2.
- Both figures show that there is a clear one-to-one correspondence between productivity measured by way of the GDP and the energy consumption within the country.
- It could also be observed that the data for the undeveloped countries of Africa are clustered at the origin of the charts, while the industrialized and emerging countries are in the upper sections.

Figure 2.1: Interrelationship btw GDP and Energy usage

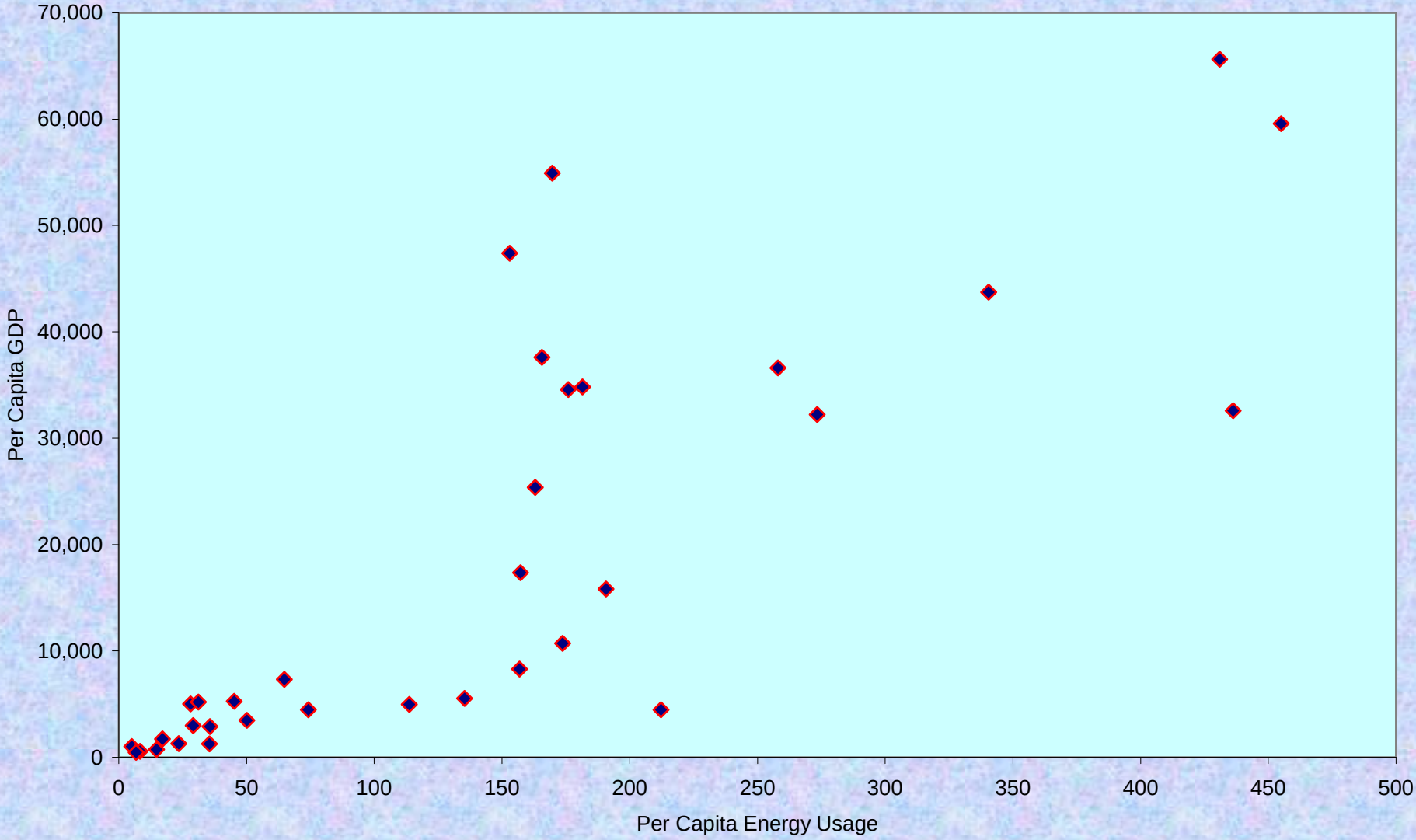
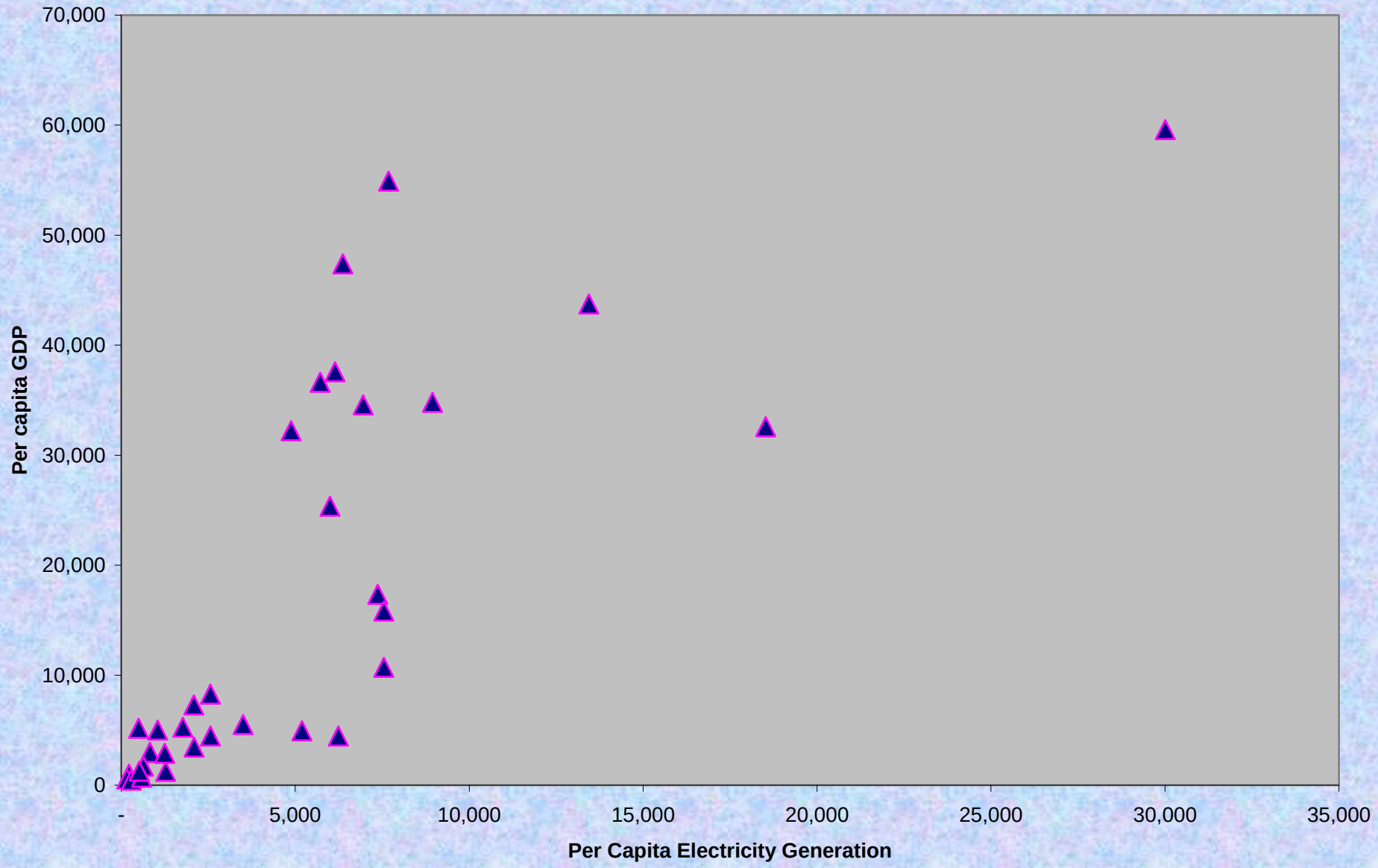
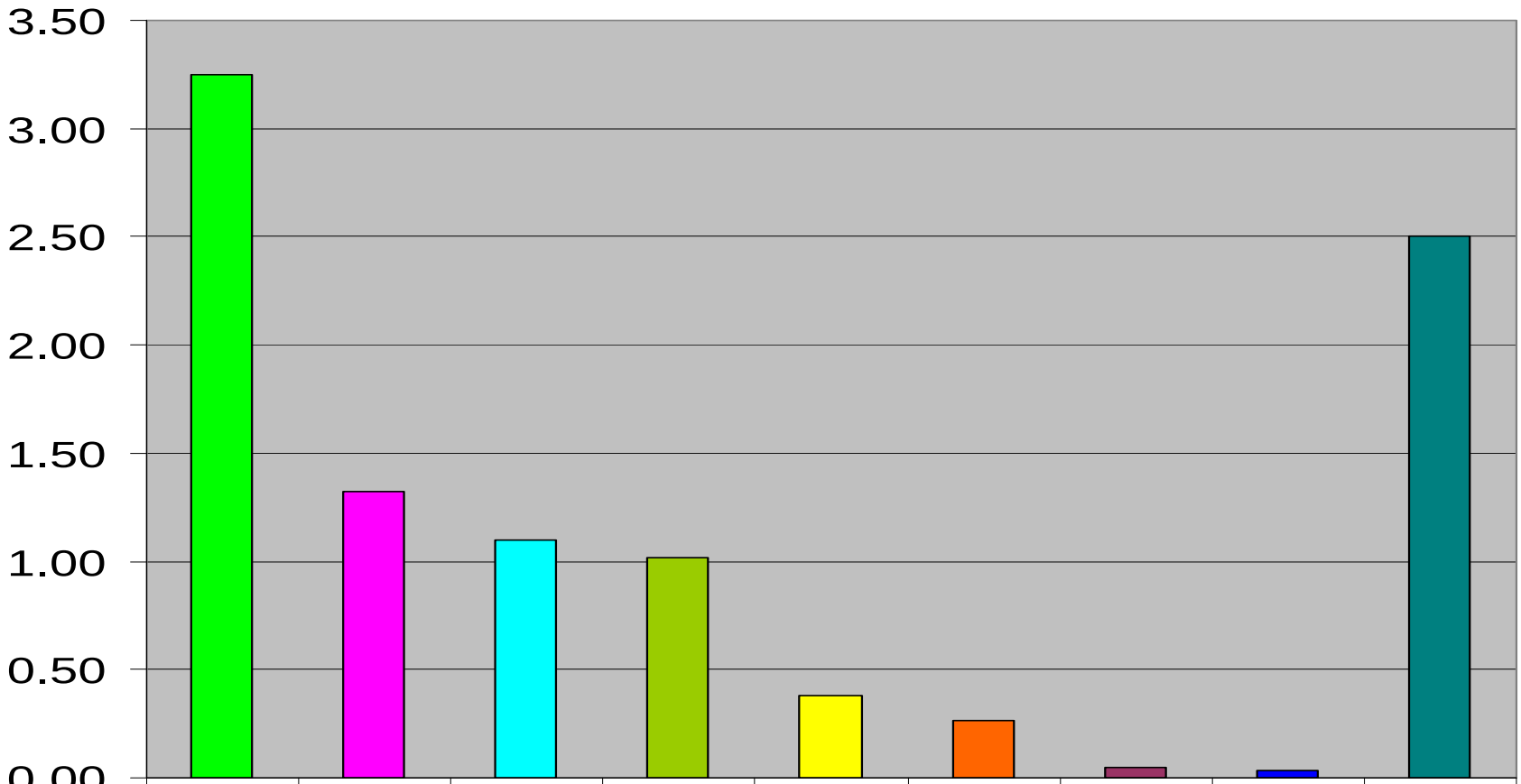


Figure 2.2: Interrelationship btw GDP and Electricity Generation



Per Capita Generation (kWe) : Source: PHCN

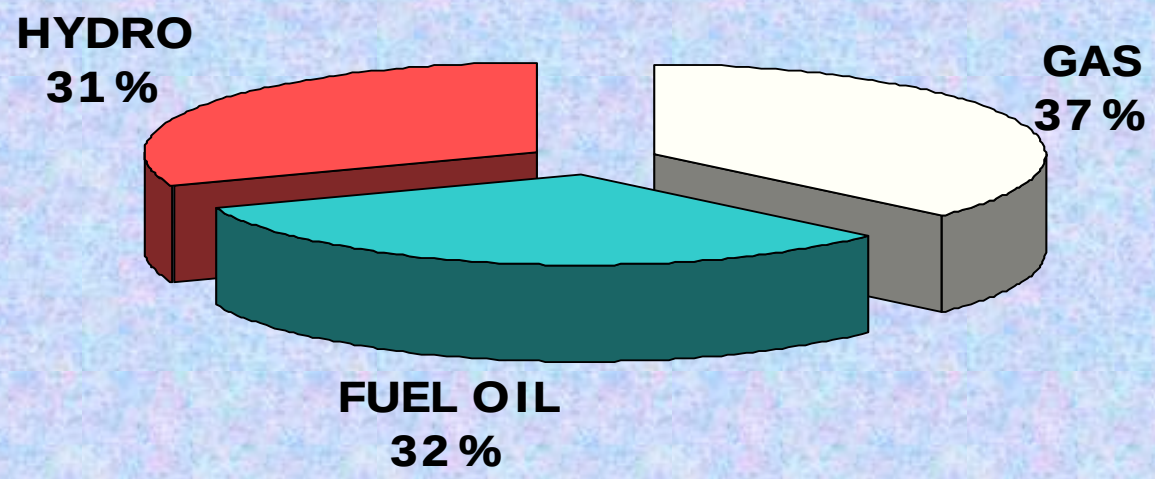


	United States of America	United Kingdom	Ukraine	South Africa	Cuba	Egypt	Ghana	Nigeria	Bench Mark
Per Capita Generation (kWe)	3.25	1.32	1.10	1.02	0.38	0.27	0.05	0.03	2.5

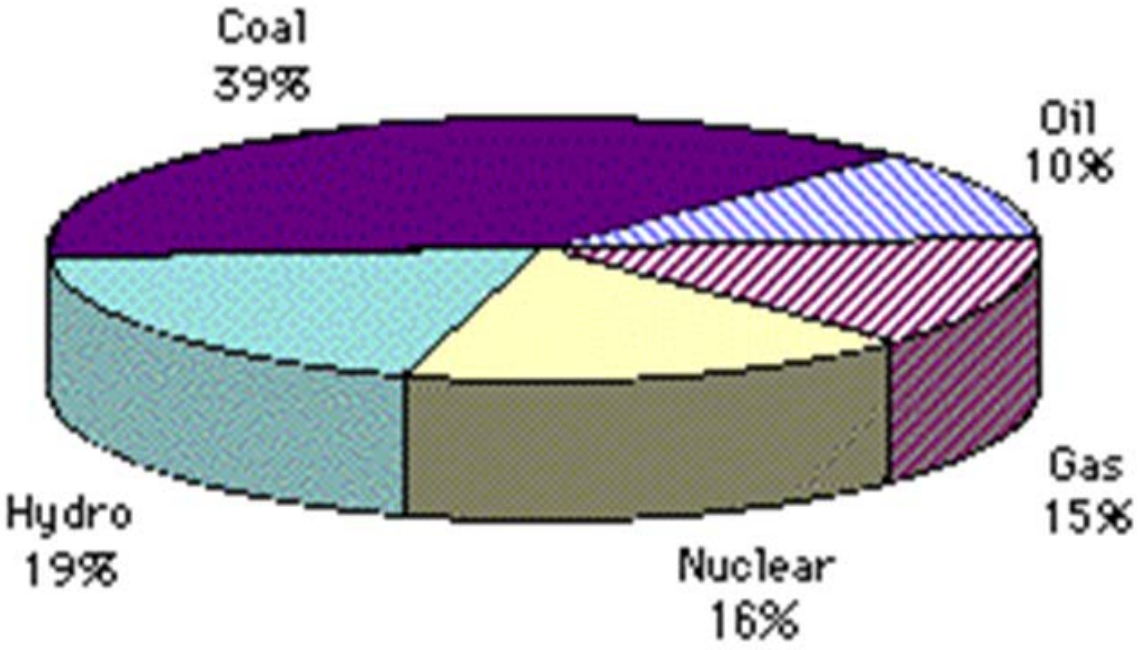
III. Long-term Energy Security and Need for Diversification

- Long-term national energy security is imperative for sustainable development in any country.
- Quite a number of countries, particularly African countries, depend on fossil fuels and hydropower for their national energy needs.
- It should be noted that fossil fuels are finite and will be depleted over time, and also that there are physical and technical limitations to the harnessing of hydropower.
- Conservation of resources and resource exploitation in harmony with the environment have effectively become the key elements and indicators for effective development planning for sustainability.
- Thus, long-tern energy security must take into account the dilemma of global warming and climate change. This would entail optimization of the available energy mix.
- Consequently, it could be inferred that sustainable socioeconomic development, and preservation of the environment are dependent on access to a diversified basket of energy options.

Electricity Generation by Source in Nigeria: Source: PHCN.



World Electricity Generation



- Energy policies should therefore be formulated such that the exploitation and utilization of finite assets such as fossil fuels are optimally managed.
- For instance, resources such as oil and gas may also be put to other lucrative uses, as they possess high utility values in other sectors of the economy, such as in the petrochemical industry and the agricultural sector.
- It is also important to note that proper management of these resources must also include the essential element of conservation for future generations.
- A proactive and sustainable national electricity generation policy should therefore be futuristic in content, and have as an important component, resource conservation and management in order not to mortgage the welfare of future generations.

IV. Why Consider Nuclear as an Option

- The exploitation of any energy resource in any country depends on a number of factors, chiefly among which are: natural availability, economic viability, utilization base of the energy form, technology infrastructure, strategic considerations and environmental impact, among others.
- It is unlikely that in any given circumstance, all of the above identified factors will be positive.
- Policy decisions will therefore be based on optimizing all the contributing factors, bearing in mind the overriding national interests.
- However, in today's global environment, with a fundamental drift towards free market economy, the investment climate and energy market dynamics also play major roles
- Nevertheless, consistent with the studies earlier cited considerations for environmental preservation and mitigation of global climate change are also paramount.

The inherent features of a nuclear power programme entail:

- High initial capital cost
- Low maintenance and Operating cost
- Long construction period compared to other technologies
- Higher availability and capacity factors
- Longer lifetime (50-60 years)
- Delayed investment returns
- Predisposed to cost overruns and construction delays in an environment of regulatory uncertainties.
- Long term government commitment and public support
- Need for technical and human resource underpinning
- Need to secure nuclear material and thus, need for high safety standards, insurance and physical security.
- Must be committed to an international regime of oversight governed by one standard of safety, security and safeguards and international treaties and conventions.

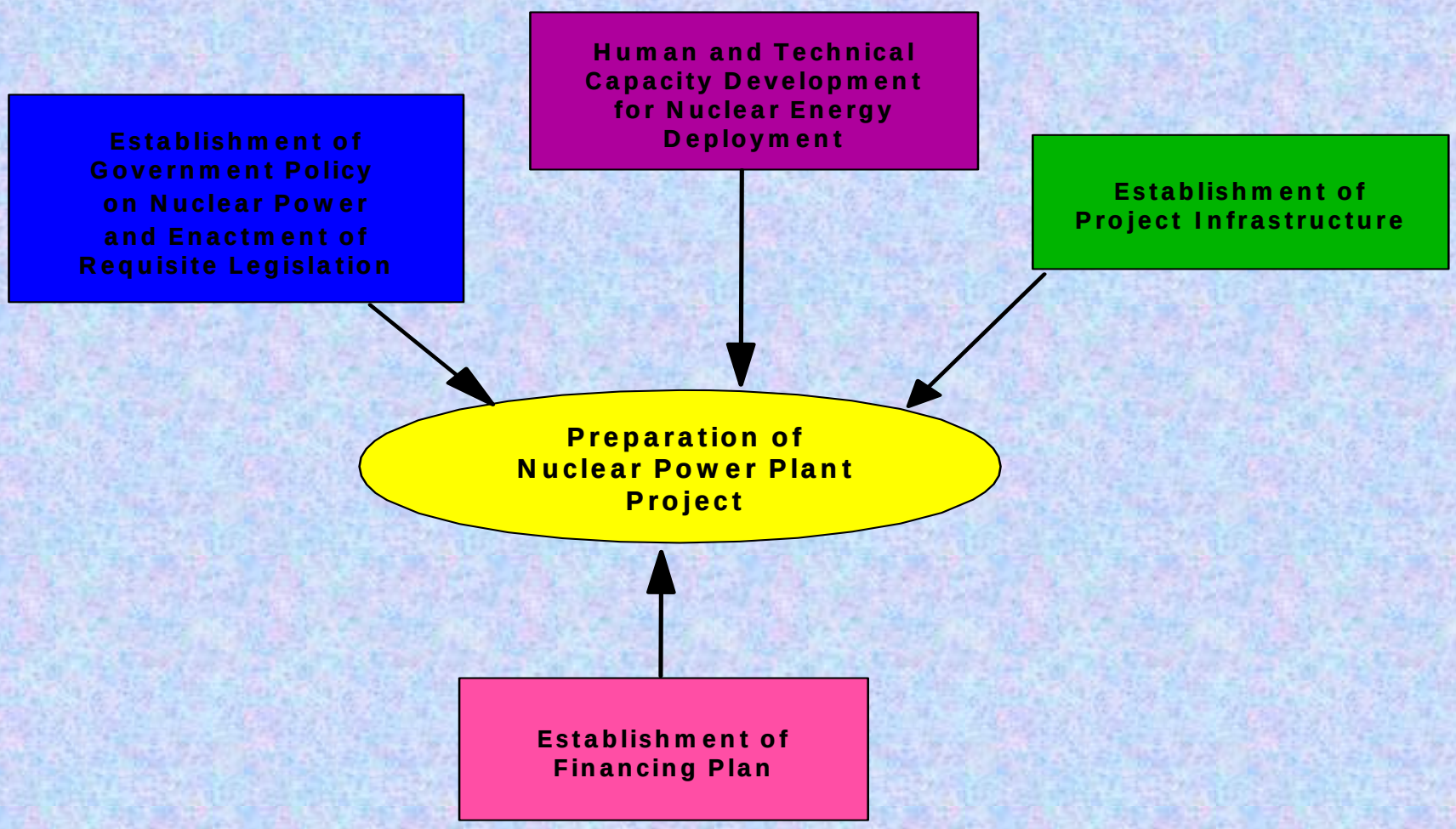
- On the overall, considering economic competitiveness, mitigation of climate change, long-term energy security, nuclear appears attractive.
- Furthermore, introduction of nuclear energy comes with significant spin-off benefits due to application of nuclear technology in many other sectors, such as:
  - Medicine and human health
  - Food and agriculture
  - Capacity building in heavy industries, transportation, etc
  - Water resources management
  - Mineral exploration and extraction
  - Environmental management
- The introduction of nuclear power programme in a country and its successful execution is largely dependent on the network of national infrastructure, covering a wide range of activities and capabilities.
- Introduction of nuclear power may also facilitate regional integration. For instance, small contiguous countries with limited resources could form sharing partnerships at the regional or multinational level for the development of common physical facilities, common programmes, industrial capabilities and knowledge in the deployment of nuclear electricity, which will result in mutual economic benefits.

v: The Extractive Industries and Financing of Energy Projects

Consider the following rhetorical but fundamental questions:

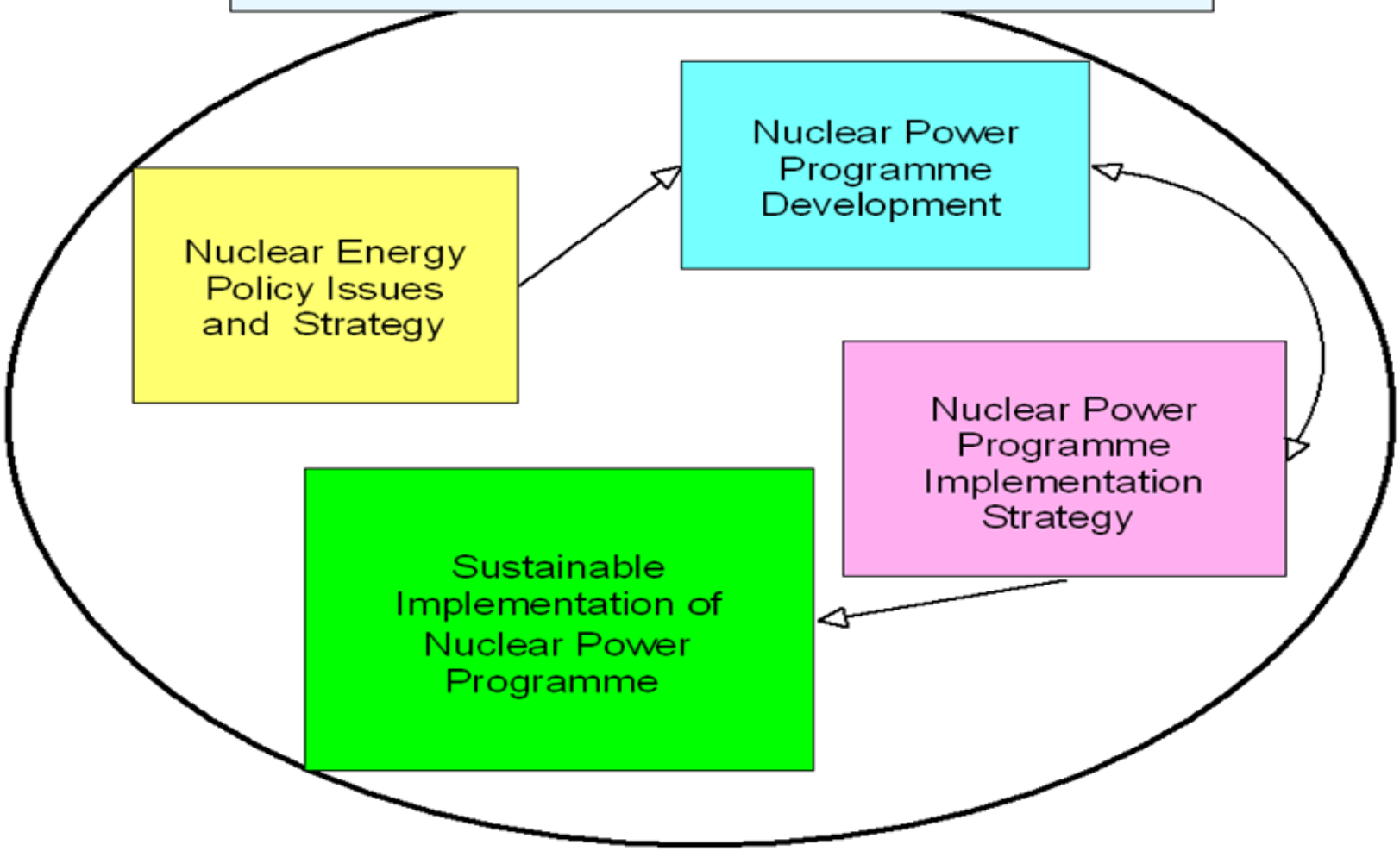
- How do developing countries with monocultural economies dependent mainly on ***petroleum resources or some other mineral resource*** survive on depletion of the available reserves?
- How would they meet their energy needs for industrial and domestic applications in the future?
- How could these countries generate the requisite finances to embark on new power projects when their primary resources are depleted?
- Is it an appropriate and reasonable developmental objective to invest the revenues accruing from the extraction of the currently available primary resources to ensure some long-term energy security and create the enabling environment for sustainable development in the future?
- Should mitigation of environmental degradation form an essential plank of energy planning, exploration, extraction and usage?

VI: Starting a New Nuclear Power Programme: The Expected Challenges.



Preparatory Steps for Introducing NPP.

Basic Elements of the Nuclear Power Programme



Likely National Challenges Inherent in Implementing an NPP Programme

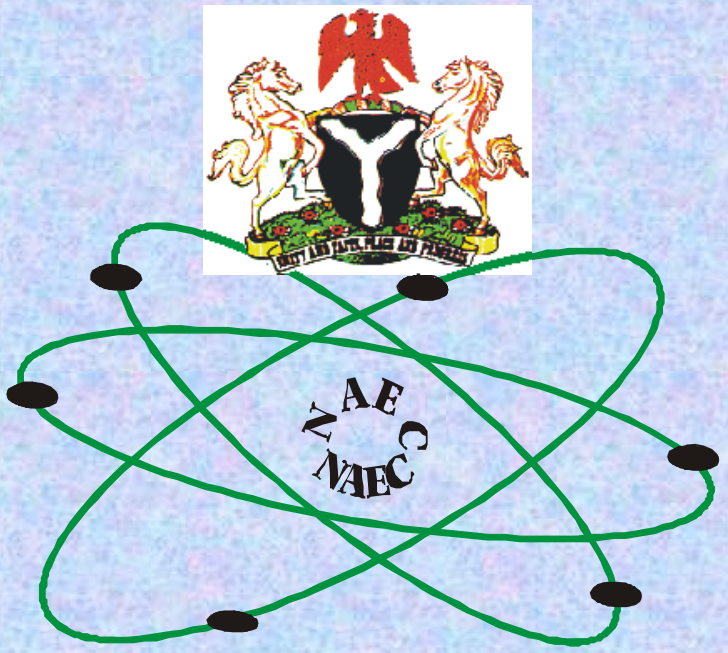
- Long-term national (political) commitment to, and sustainability of programme over gestation period of at least 20-30 years;
- Training of requisite restrictive manpower and long lead-time required to build a critical mass of human resource base;
- Development of appropriate infrastructure needed to support the implementation of the programme;
- Development of requisite industrial capacity to gradually domesticate nuclear technology;
- Development of the requisite financing plan, catalyzed by government, with the private sector as a partner; and
- Motivating and sustaining a positive attitude in all sectors of the citizenry, as well as adhering to a clearly defined policy of openness and transparency in programme implementation.

VI: Concluding Remarks

- The deployment of nuclear power for electricity generation globally has achieved good degree of success. This is mainly due to established records of economic competitiveness, safety and environmental friendliness.
- The lessons learned from the over 50 years of NPP operation has led to significant improvements in technology and design; with the concomitant attainment of higher safety margins;
- Long-term energy security and assurance of sustainable development entail optimal exploitation of a diversified basket of energy options, with clearly defined objectives for mitigation of climate change. In this regard, nuclear power offers a suitable option.
- For countries with finite fossil energy resources, investment in nuclear power with available revenues may be prudent. However, due cognizance should be given to building a reasonable national consensus, which must be informed by a realistic roadmap and implementation strategy.
- The requisite structure for the prosecution of the national nuclear power programmes should be such that would enthrone a high degree of openness and transparency, ensuring strict compliance with international standards and adherence to an established regime of safety, security and safeguards.

Concluding Remarks contd.

- Governments of countries introducing nuclear power should demonstrate commitment by taking on the responsibility for infrastructure and manpower development to create the requisite enabling environment for the successful implementation of the programme in partnership with the private sector;
- Availability of the requisite human resource base is paramount. Thus, through an appropriate mechanism for training, mentoring, motivating, and retraining of a dedicated corps of nuclear energy professionals; scientists, engineers, technologists and technicians, a solid foundation should be laid to implement the programmes in a sustainable manner;
- For effective participation, the industrial sector must be engaged and challenged to be a worthy partner in the implementation of the national nuclear power programmes; and
- The financial sector and the investing community should be sensitized to see the business opportunities offered by a long-term commitment in the implementation of national nuclear power programmes.



Thank you for your attention.