




→ Nuclear Power in Turkey, Egypt, and Saudi Arabia – how cost effective?

Nonproliferation Policy Education Center
Carnegie Endowment for International Peace

Washington, DC

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Interest in nuclear energy widespread throughout the Middle East / North Africa

-  **PROPOSED:** Expressions of interest have been made and/or studies have been carried out with an eye toward future development.
-  **PLANNED:** Agreements/contracts have been signed and operations are going ahead.
-  **UNDER CONSTRUCTION**



Economic reasons cited to support nuclear power development in the Middle East

*“Although a major oil producer, the UAE argues that it **needs nuclear energy to satisfy soaring demand for power and desalinated water**. With electricity demand soaring by 10 per cent a year, the UAE is expected to double its power capacity over the next decade to supply the rapidly-growing population and many industrial ventures. Officials say that **faster growth** as a result of economic diversification could **eat away at hydrocarbons exports**.”*

Financial Times January 21, 2008

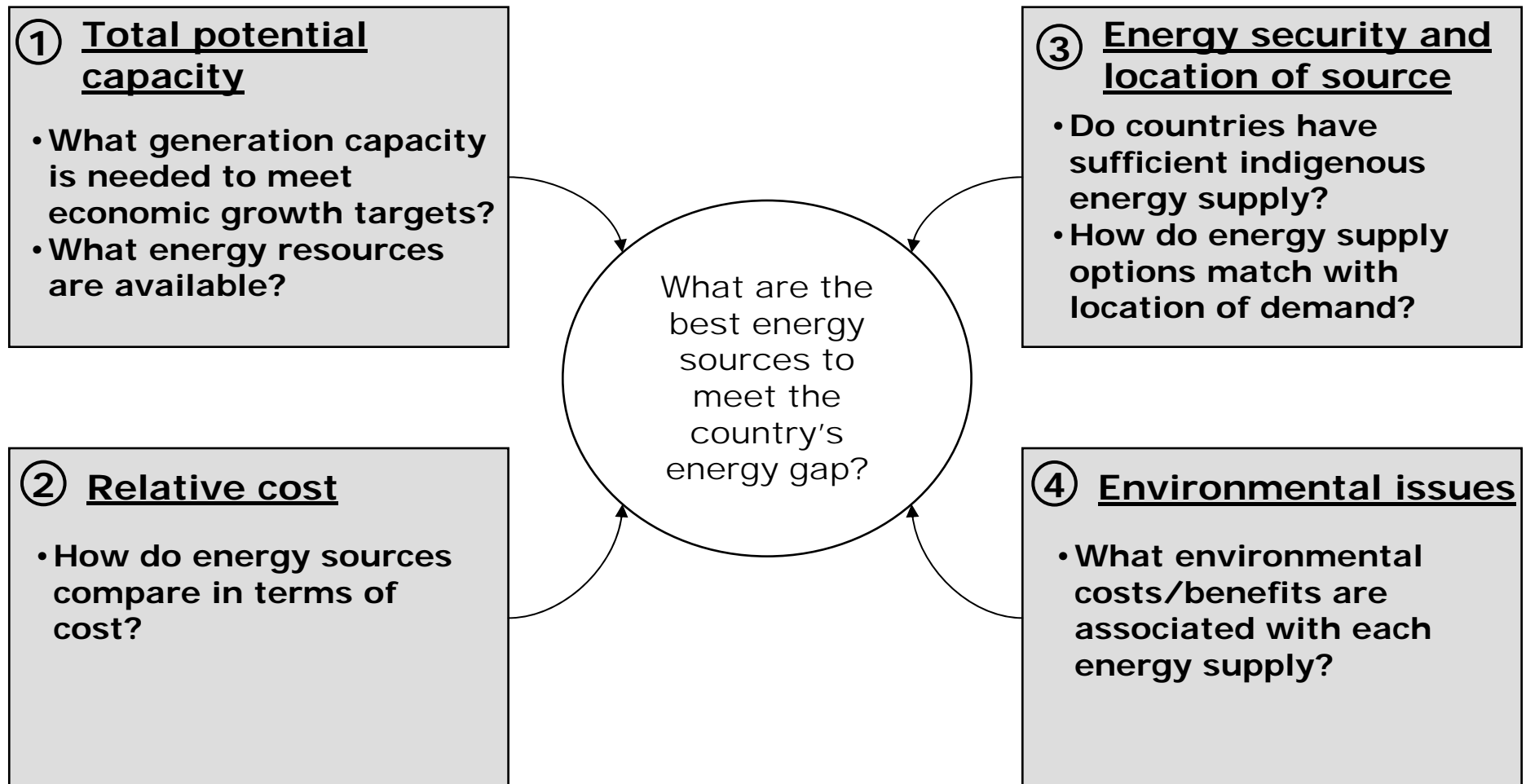
*“But economics are also behind this new push to explore nuclear power, at least for some of the aspirants. Egypt's oil **reserves are dwindling**, Jordan has no natural resources to speak of at all, and **power from oil and gas has grown much more expensive for everyone**. Though the day has not arrived, it's conceivable that **nuclear power will be a cheaper option than traditional plants**.”*

Christian Science monitor, November 1, 2007

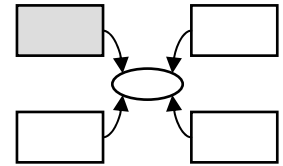
*“Demand for electricity is growing at more than 6 per cent annually, something which dictates doubling the capacity for electrical power generation in the GCC nations over the next 10 years. The **GCC members also wish to diversify the sources of energy** by adopting technically and **economically feasible technologies for power generation and water desalination**. This takes into consideration that the alternatives to oil and gas in the long run are nuclear energy, wind power, and solar energy, especially when we note the expected increases in oil and gas prices and rising demand, especially from the Asian region.”*

Abd-al-Rahman Bin Hamad al-Atiyyah,
Secretary General of the Gulf Cooperation Council

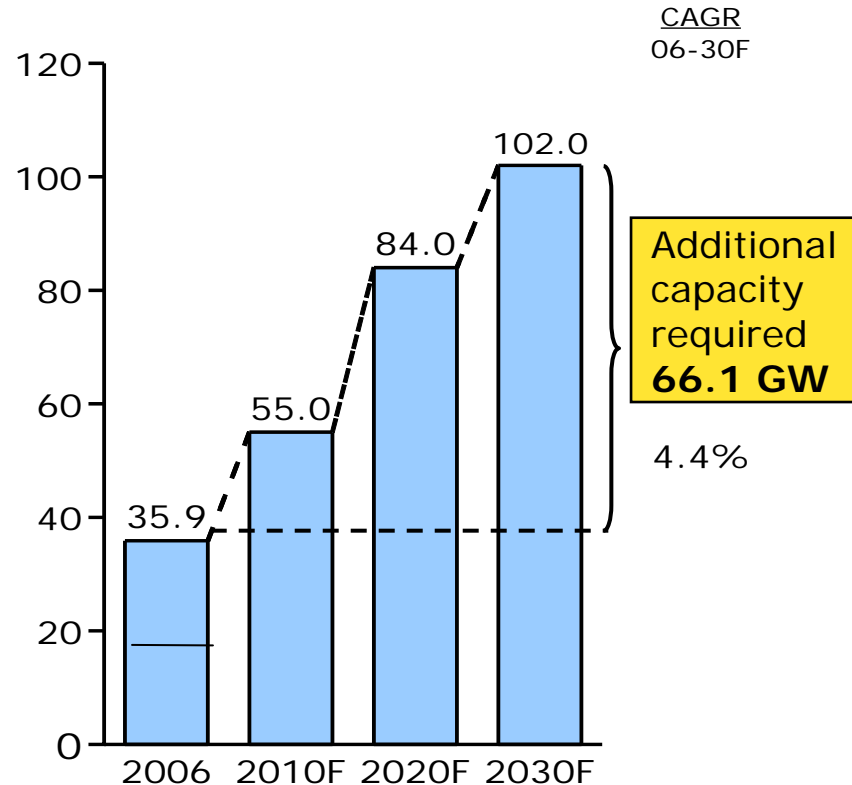
A framework for policy analysis for national energy strategies focuses on total potential capacity, relative costs, locations of sources, and environmental issues



Saudi electricity generation dominated by oil and gas; need to almost triple by 2030 to meet demand



Generating capacity required (GW)



Drivers of demand growth

- 3.5% GDP growth **
- Large demand for water desalination

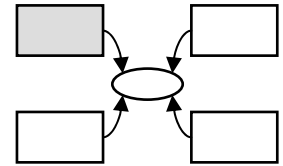
*Gas and Oil generation capacity split based on 2005 proportions

**GDP growth rate from 2003-2030

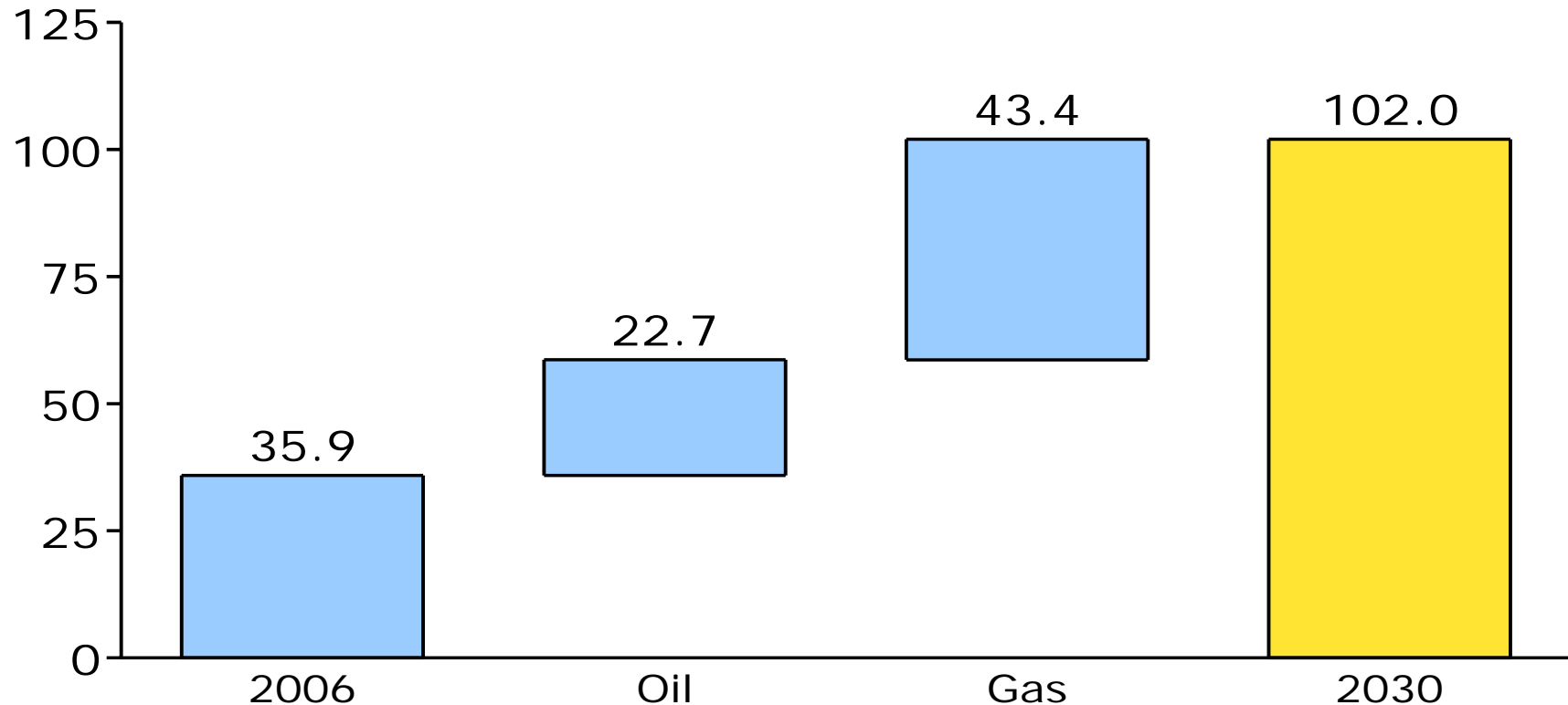
Source: Saudi Arabia Electricity and Cogeneration Regulatory Authority Annual Report 2006; International Energy Agency Statistics; World Energy Outlook 2005 – International Energy Agency



Oil and gas generators projected to fulfill the bulk of Saudi's future generation needs

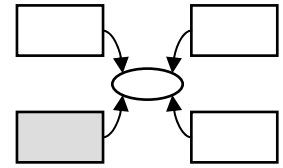


Generating capacity (GW)*

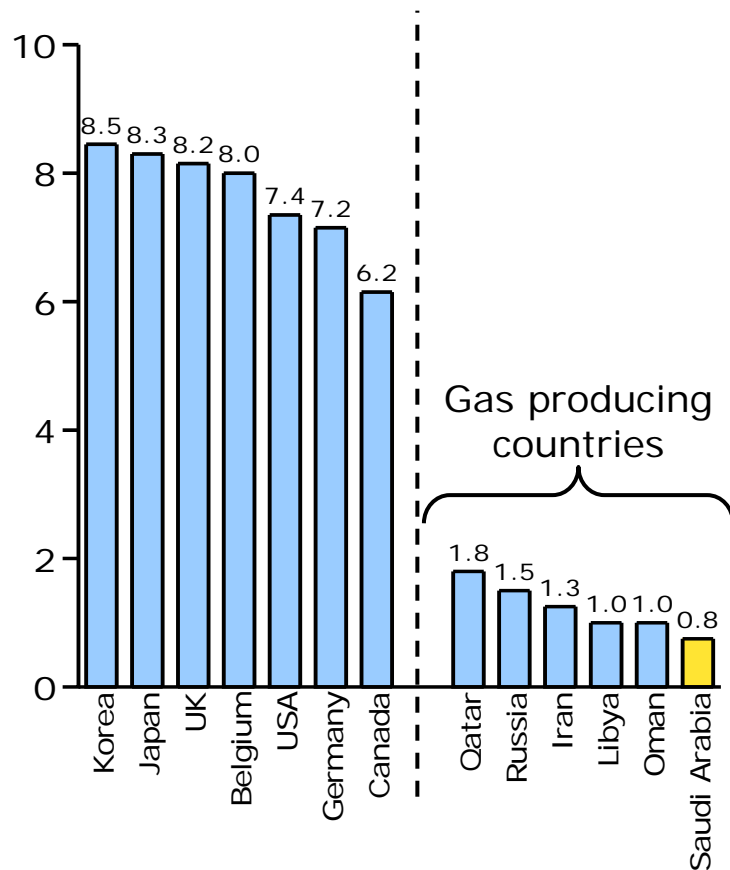


*“The Saudi government has **not seriously considered electricity generation from any source other than gas, supplemented by crude oil.** The abundance of the resource just means that there’s less economic need for anything else.”*

Saudi's extremely low gas "cost" significantly reduces the cost of gas plants compared to nuclear

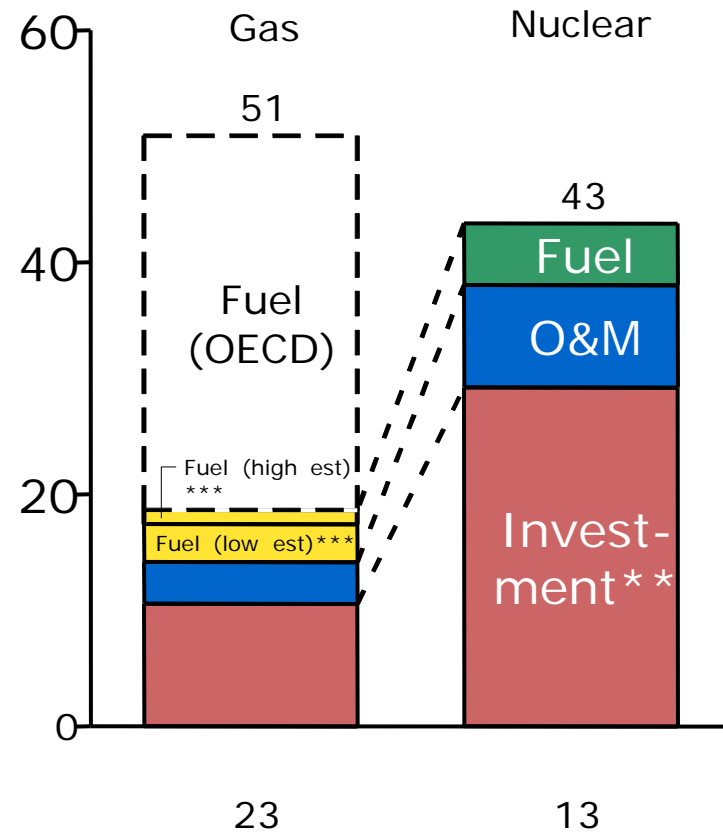


Natural Gas cost
(US\$ per million BTUs, 2007 Q2)



10% Discount Rate

Average Levelized cost*
(US\$/MWh)



*Average of data from survey of new facilities in 21 countries, mostly OECD but also include 4 developing countries. Levelized generation cost include initial investment cost, Operation and Maintenance cost, Fuel cost, and in the case of nuclear; main assumptions – 85% capacity factor for plants, 40 year lifetime for coal and nuclear plants, for other plants lifetime come from country level responses, fuel price projection based on each country's models

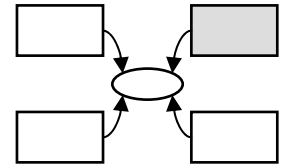
** Investment cost for nuclear power includes decommission cost

***calculated as Saudi's gas price as % of the lowest and highest price in the OECD gas price data available

Source: American Chemistry council; Projected Cost of Generating Electricity 2005 Update – Nuclear Energy Agency / IEA

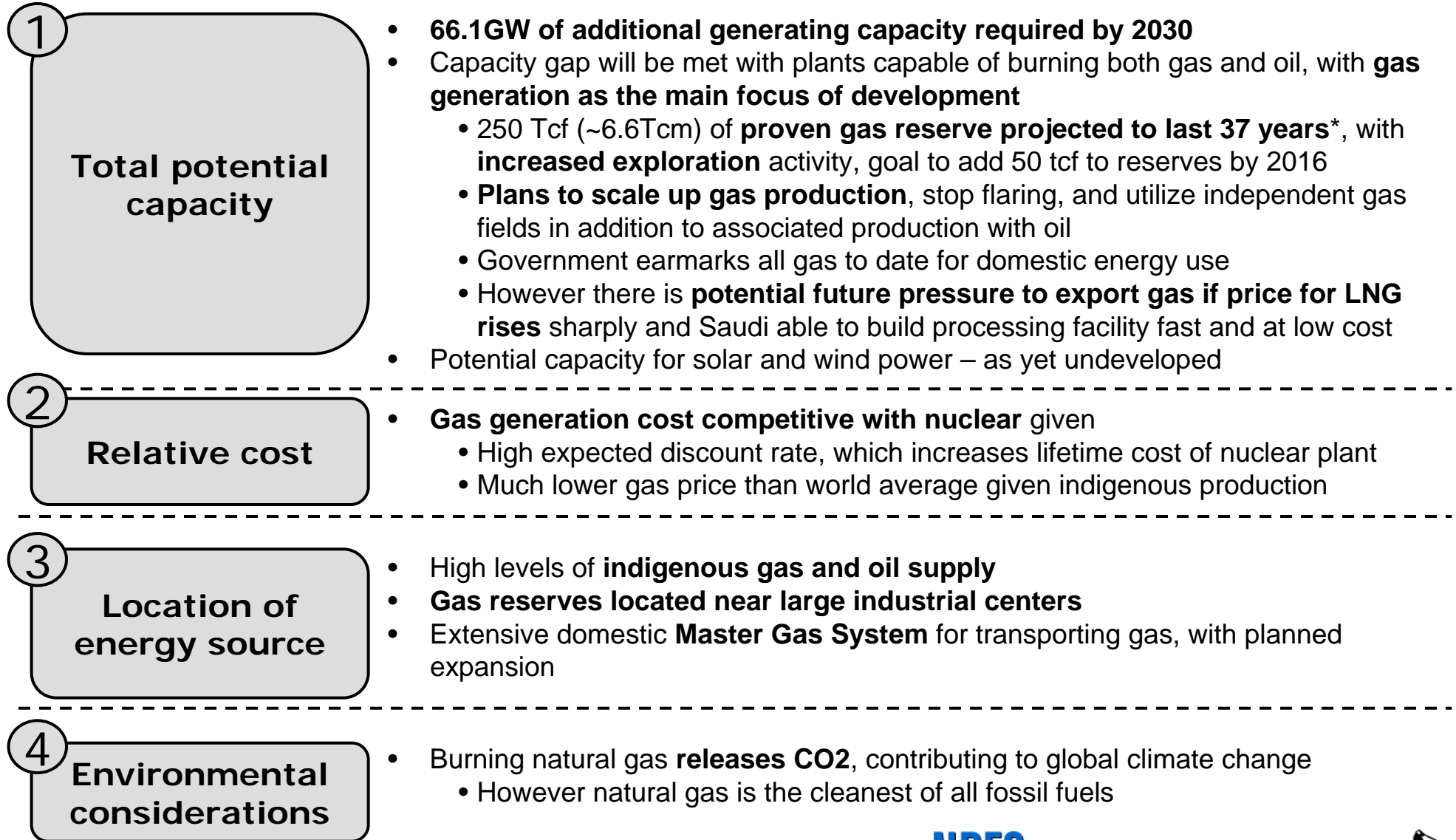


Saudi Arabia has an extensive fuel supply and infrastructure

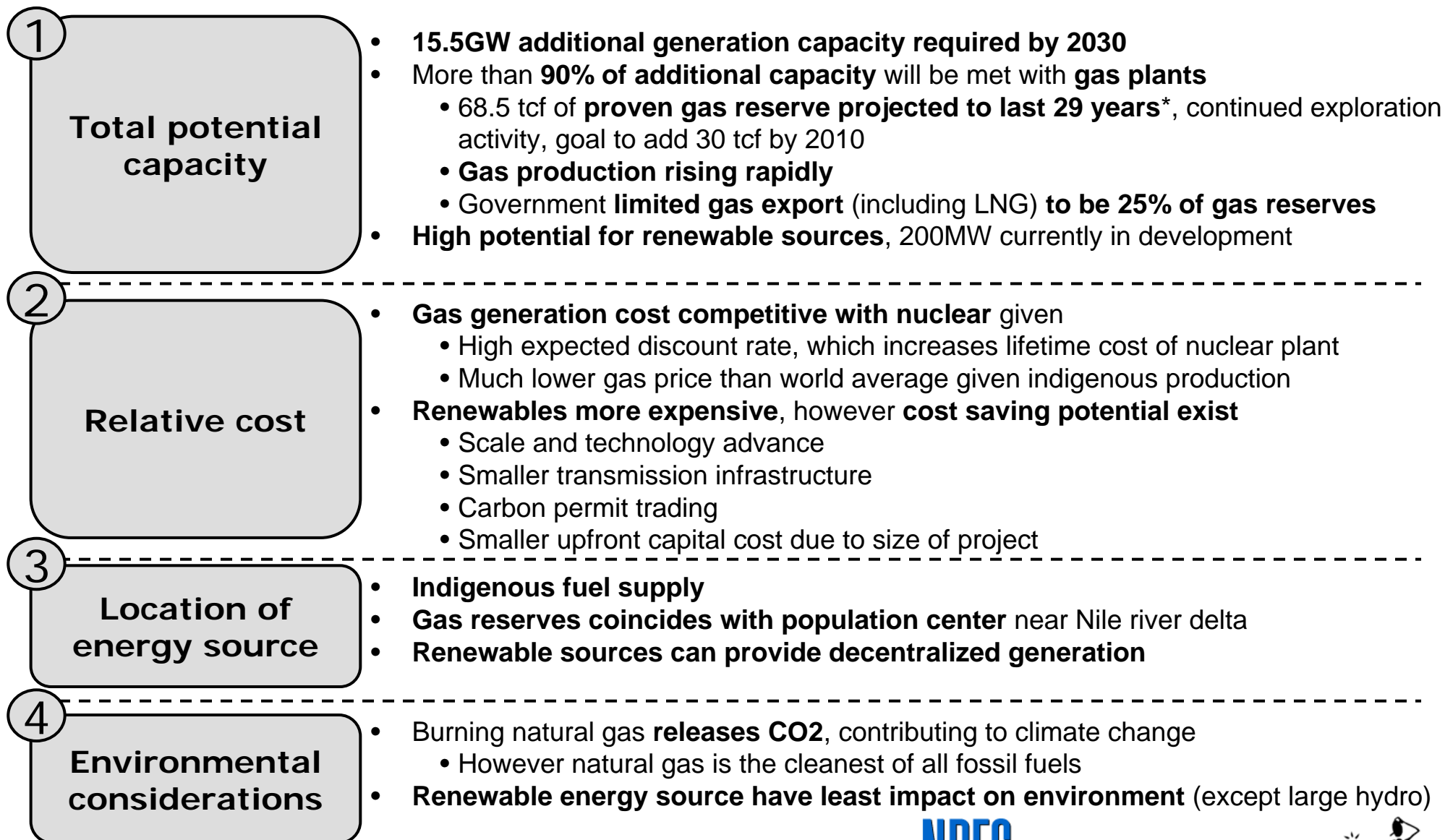


Indigenous fuel supply and infrastructure for transporting fuel ensures energy security

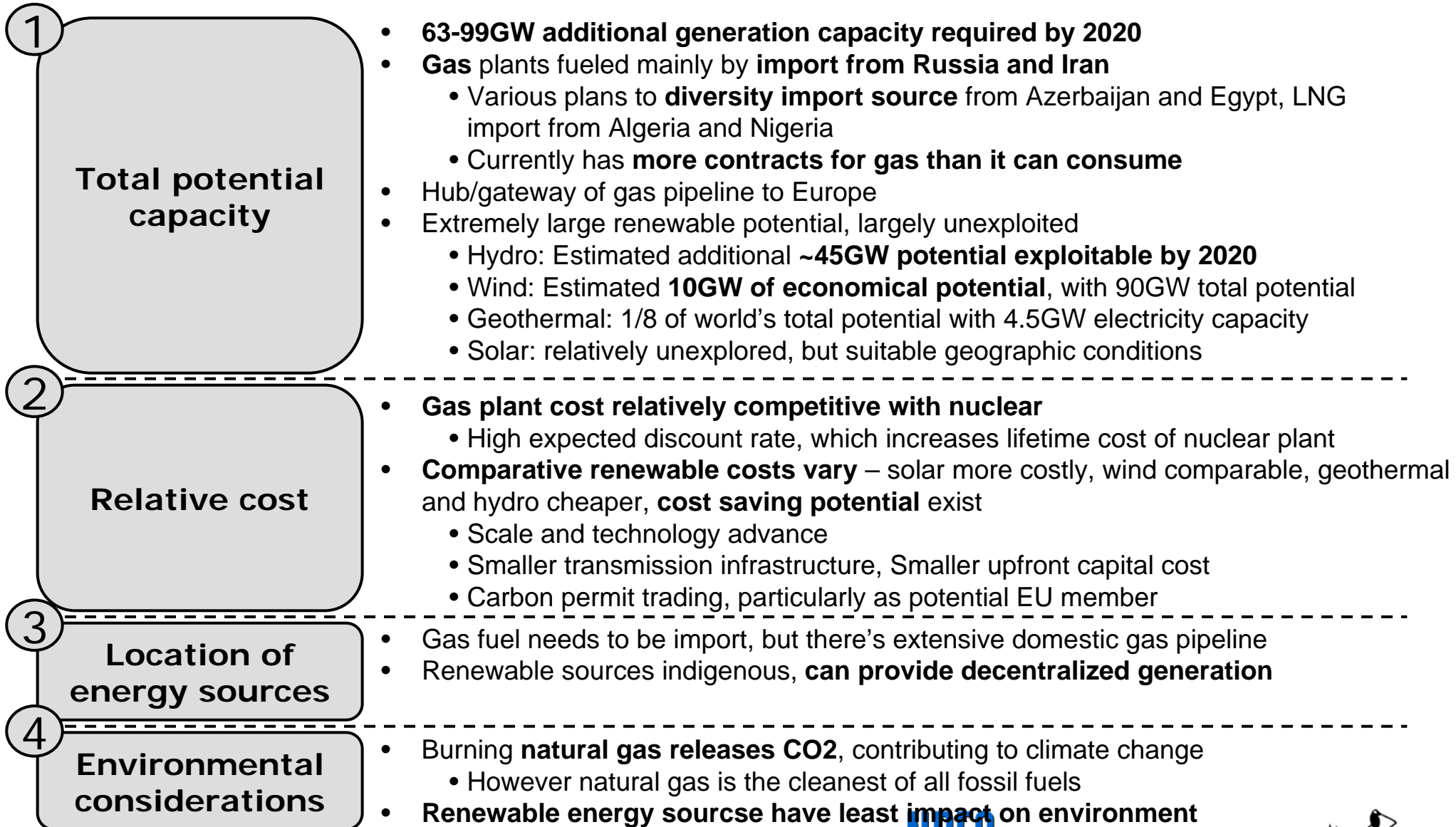
Saudi can meet its electricity demand effectively through developing gas generation



Egypt can meet its electricity demand effectively through development of gas and renewable fuels



Turkey has a myriad of alternative fuels feasible to meet demand, pace of development uncertain



Preliminary conclusions

- Neither Saudi Arabia nor Egypt require nuclear power to meet their growing electricity demand in the medium term
 - **Indigenous supply of natural gas** as fuel that is **abundant, cost-effective**, with **established delivery infrastructure**
 - Government set aside significant quantities for domestic consumption, will only come under pressure if incentive to export gas rises significantly with LNG price and large reduction in cost of LNG infrastructure
 - **Underdeveloped / unexplored potential for renewable power sources**
 - Higher cost but potential savings in transmission infrastructure, upfront investment, and added benefits of environmental protection and meeting decentralized electricity needs
 - Hydro, wind, and solar for Egypt, wind and solar for Saudi
- Turkey can meet its growing electricity demand with a myriad of energy sources, need for nuclear power depends on natural gas negotiations and the pace of renewable energy development
 - **Gap in energy can be met with imported gas**
 - Current gas contracts ensures medium term supply security
 - Position as hub for pipelines and plans to diversify gas sources
 - Optimum geographic location for **hydro and wind potential**
 - Hydro most cost effective energy source
 - Development encouraged by Renewable Energy Law, pace uncertain
 - Nuclear could contribute to electricity portfolio if development of other sources hits barriers