



Iran's Nuclear Fuel Cycle Facilities: A Pattern of Peaceful Intent?

OVERVIEW:

Nuclear Energy or Nuclear Weapons?

- Confirmed record of hiding sensitive nuclear fuel cycle activities from the IAEA.
- Iran's rationale for "peaceful" nuclear fuel cycle does not hold up under scrutiny.
 - Given Iran's insufficient uranium reserves, Iran cannot achieve its goal of nuclear energy independence.
 - Moreover, indigenous fuel cycle costs are substantially greater than importing nuclear fuel at market prices...or taking full advantage of its current wasted hydrocarbon resources.
- But Iran's uranium reserves could give Iran a significant number of nuclear weapons. In fact, Iran's facilities are scaled exactly like another state's facilities that were designed to produce fissile material for nuclear weapons.



Fuel Cycle Rationalization

Senior Iranian officials have stressed **two themes** to rationalize Iran's extensive nuclear fuel cycle expenditures in support of plans to build 7000 Megawatts of nuclear power by 2020:

1. **"Iran cannot rely on energy from fossil fuels for the following reason: resources are limited...and the local use of these resources will drastically affect foreign exchange earnings."**
-- Iranian Vice-President and Atomic Energy Minister
Aghazadeh, May 2003
2. **"The best use that a country like mine can make out of its uranium ores is to replace oil as a primary source of energy...within two decades most of our oil production will be consumed internally, leaving nothing tangible for export."**
-- Iranian Representative to the IAEA, Ambassador Salehi, March 2003

The background features a stylized, light-colored atomic symbol (resembling a Bohr model) overlaid on a teal-to-white gradient. The symbol consists of several elliptical orbits and a central nucleus, rendered in a light beige or off-white color.

Iran's Nuclear Fuel Cycle Facilities: Concealment & Deception

A History of Concealment & Deception

Long-standing IAEA safeguards violations show that Iran kept its nuclear activities hidden until they were first revealed by others.

Iran's provision of "changing or contradictory information," as described by the Director General, leaves major issues remain unresolved:

- Apart from "contamination," the full extent of centrifuge research and development;
- The full extent of plutonium experimentation;
- Military involvement in any nuclear activity.

300 miles
500 km

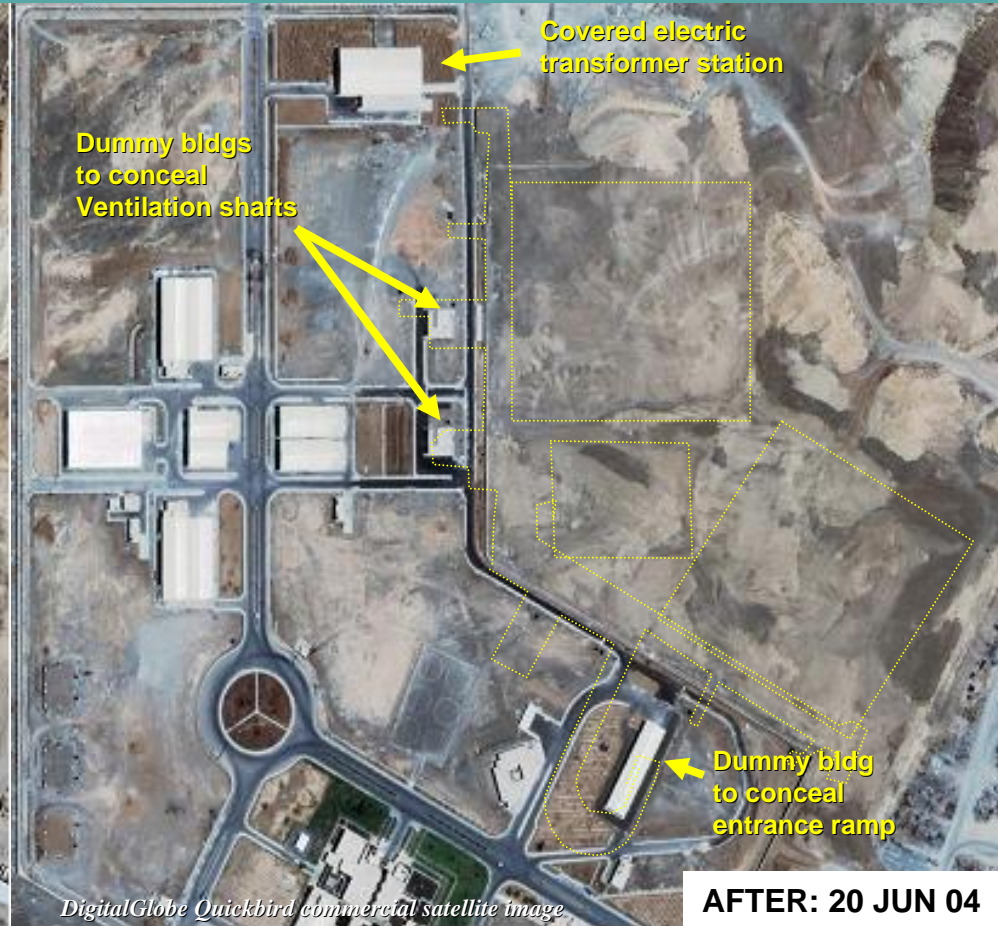


**Sites circled in red
unknown pre-mid 2002**

- MW** Megawatts
- Uranium processing facility
- Uranium mines
- Heavy-water facility
- Research reactors / research facilities
- Uranium enrichment facility
- Light-water reactor (under construction)

Source: IISMaps

Natanz Gas Centrifuge Uranium Enrichment Complex



- Covert facility in remote location, could enrich uranium for weapons
- Dummy structures to prevent detection and identification
- Concealed underground, hardened, well defended

Vehicle Entrance Ramp
(before burial)

Bunkered underground
production halls

Admin/engineering
office area

DigitalGlobe Quickbird commercial satellite image

20 SEP 02

Vehicle Entrance Ramp
(after burial)

Bunkered underground
Centrifuge cascade halls

Helicopter
pads

New security
wall

Dummy building
concealing tunnel
entrance ramp

Admin/engineering
office area

Concealment Effectiveness

**Buried Centrifuge
Cascade Halls**

**Dummy Bldg Located Over
Vehicle Entrance Ramp**



Arak Heavy Water Reactor Complex: Reactor could produce...

~1-3 Bombs worth of Pu/yr

June 2004-March 2005, significant progress on Heavy Water plant construction

- Full production of primary line planned for 2005

Despite IAEA Board request to forgo construction,

- Reactor is well underway and progressing rapidly

Iran says reactor needed for medical and industrial isotopes...A capability already inherent in Iran's 10 Megawatt Tehran Research Reactor.

Arak Heavy Water Reactor Complex



40 MWth reactor UIC

Heavy Water plant

22 MAR 05

DigitalGlobe Quickbird commercial satellite image

Arak 40 MWth Heavy Water Reactor

Foundation for reactor and containment structure

Foundation for reactor ventilation stack

Auxiliary building foundation (for Laboratory/Hot cells?)

Arak 40 MWth Heavy Water Reactor

Foundation for reactor and containment structure

New excavation

Foundation for reactor ventilation stack

Auxiliary building foundation (for Laboratory/Hot cells?)

One Uranium Mine public, One clandestine...Why?

Saghand
Uranium Mine

Uranium mining and
pre-processing
support facility

Uranium mining
shaft headframe

From AEOL website

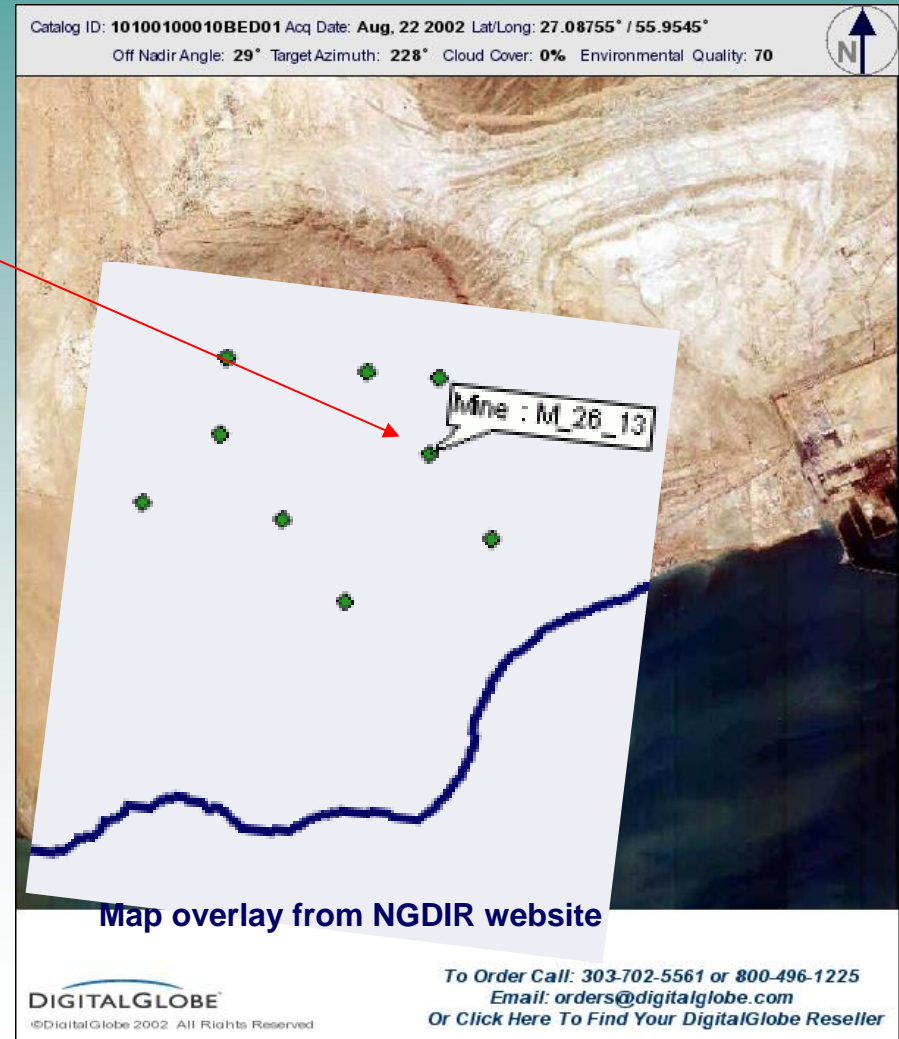


Clandestine Uranium Mine & Mill Still Under IAEA Investigation

- Iran omitted from national websites, pre-2004 declarations to IAEA, and OECD/IAEA “Red Book” reporting... any indication of Gachin, while regularly citing Saghand
- DDG’s June Oral Statement reiterated that the Agency seeks to *“better understand the complex arrangements governing the current and past administration of the mine.”* *Possible Military Involvement?*
- IAEA investigating *“why the work on the very promising [Gachin] project was suspended by the AEOL from 1994 to 2000”* while Iran focused on the *“much less promising ore deposit at Saghand.”*

Iranian Government Misrepresented Uranium Mine

Mine M_26_13 is located at the Gachin Uranium Mill but is listed only as the Sandrasang mine near the village of Gachin for "building stone."



Gachin Uranium Production Plant

(Undeclared prior to
May 2004)



Reagent storage area

Production Area
(leaching/ion exchange/precipitation
/drying/packaging)

Entrance/security
gate

Ore receiving area

Tailings pipeline

Crushing / grinding circuit
(Later modified)

Waste Tailings pond



DigitalGlobe Quickbird commercial satellite image

22 AUG 02

Gachin Uranium Production Plant

(Undeclared prior to
May 2004)

**“Hot-test”
operations
indicated**

Reagent storage area

Production Area
(leaching/ion exchange/precipitation
/drying/packageing)

Entrance/security
gate

Ore receiving area

Tailings pipeline

Crushing / grinding circuit
(heavily discolored from dust from
recently crushed ore)

Discoloration from
acids, wash &
sludge from initial
trial operations

Waste Tailings pond

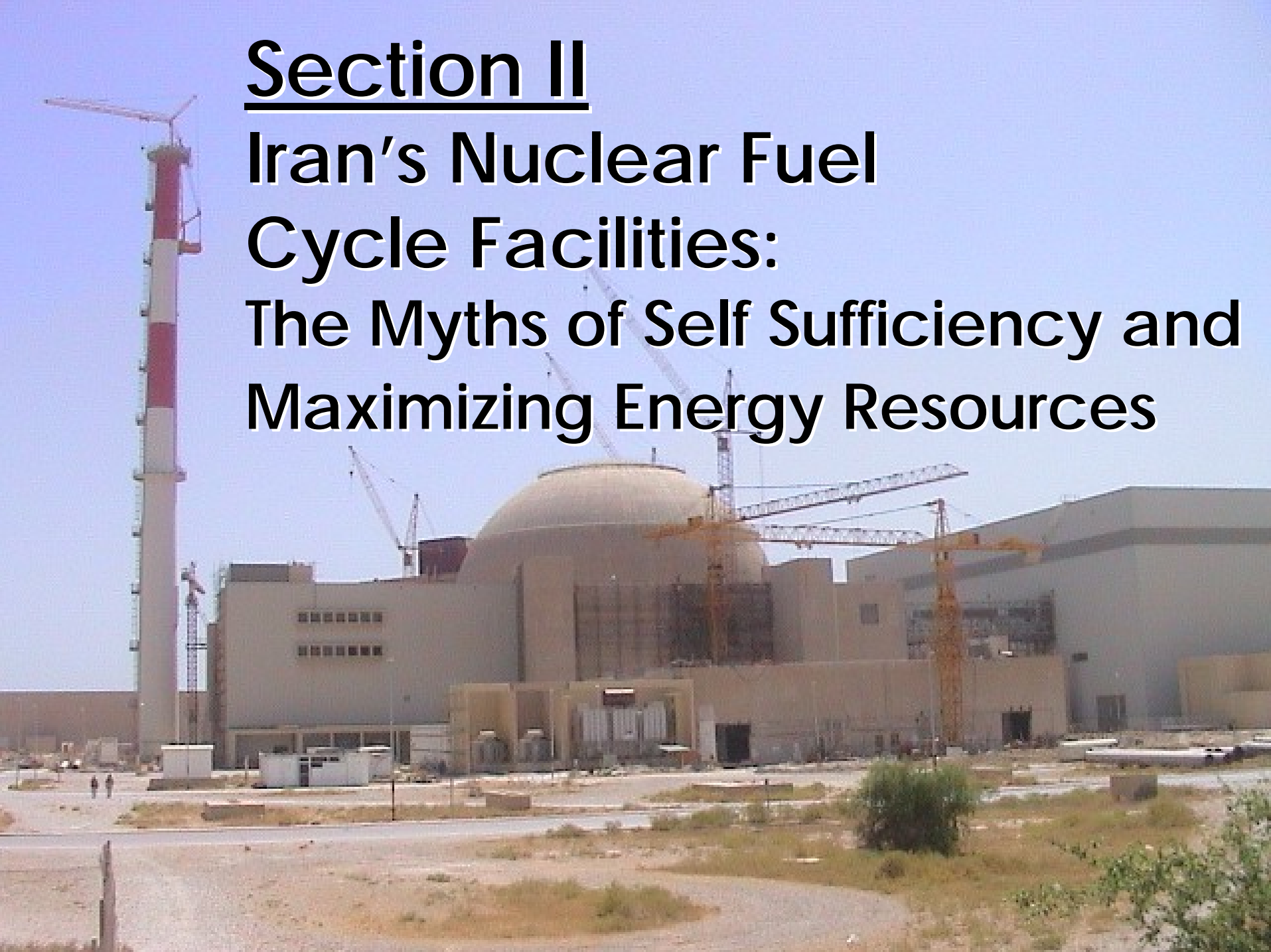


Section II

Iran's Nuclear Fuel

Cycle Facilities:

The Myths of Self Sufficiency and Maximizing Energy Resources





• Why Iran's Large Nuclear Fuel Cycle Investment Makes No Sense Economically

- **Alternate investments** in natural gas or oil refining would be more attractive.
- Iran **lacks adequate deposits of natural uranium** to be self sufficient for civil nuclear power.
- Iran's supply of other **energy resources far from depleted**.



Estimated Fuel Cycle Costs

Capital costs of selected nuclear facilities (Arak, Esfahan, Saghand, Gchine, Natanz) **approximately \$600 million - \$1 billion.**

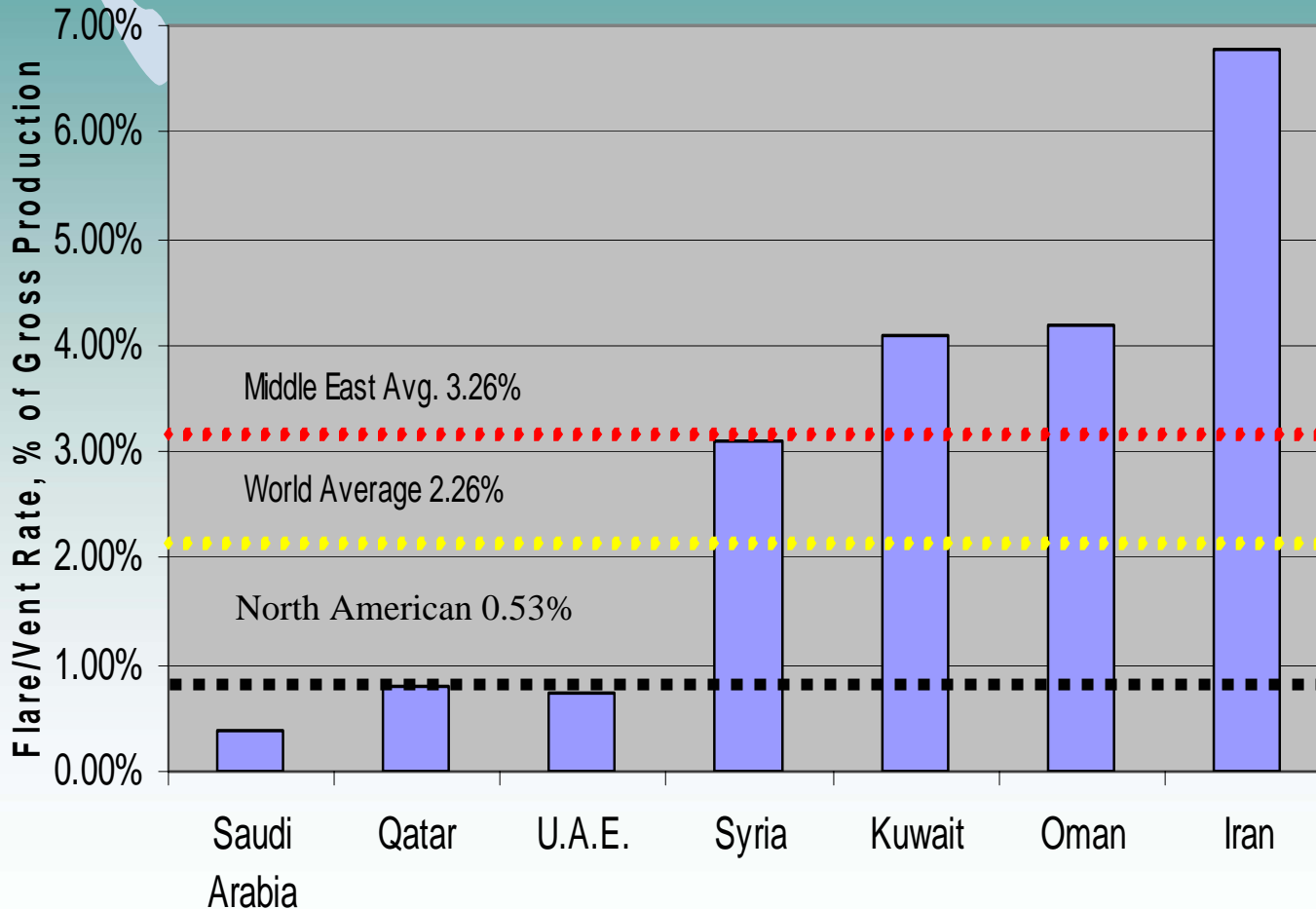
For seven planned reactors, Iran would need to invest **at least another \$6.0 billion.**

- The role of economies of scale not clear in the Iranian nuclear program.
- Additional developmental hurdles unclear, such as with the fuel fabrication plant.

Attractive Alternatives to Investing in the Nuclear Fuel Cycle

- If Iran invested \$2.5 – \$3.2 billion to upgrade its natural gas infrastructure rather than to construct a nuclear fuel cycle infrastructure, **Iran could save, at current market prices, \$1.6 – \$2.2 billion worth of natural gas annually.**
- Were Iran to invest \$5.5 billion in oil refinery projects to upgrade its gasoline refinery capacity, **Iran could increase the annual net revenue for its petrochemical sector \$982 million.**

Alternative Investment Example: Recovering Natural Gas





Benefit of Recovering Wasted Gas

In 2002, Iran wasted 6.78% of natural gas gross production equal to 290 billion ft³.

- Assume Iran moved to world average (2.26%)
 - Approximate investment = \$2.5 billion
 - Savings equivalent to:
 - \$1.6 billion (Market price 7.78\$/MMBtu)³
 - 2.8 Bushehr Nuclear Power Plant equivalents⁴
- Assume Iran moved to N. American Average (0.53%)
 - Approximate investment = \$3.2 billion
 - Savings equivalent to:
 - \$2.22 billion (Market price 7.78\$/MMBtu)³
 - 3.9 Bushehr Nuclear Power Plant equivalents⁴

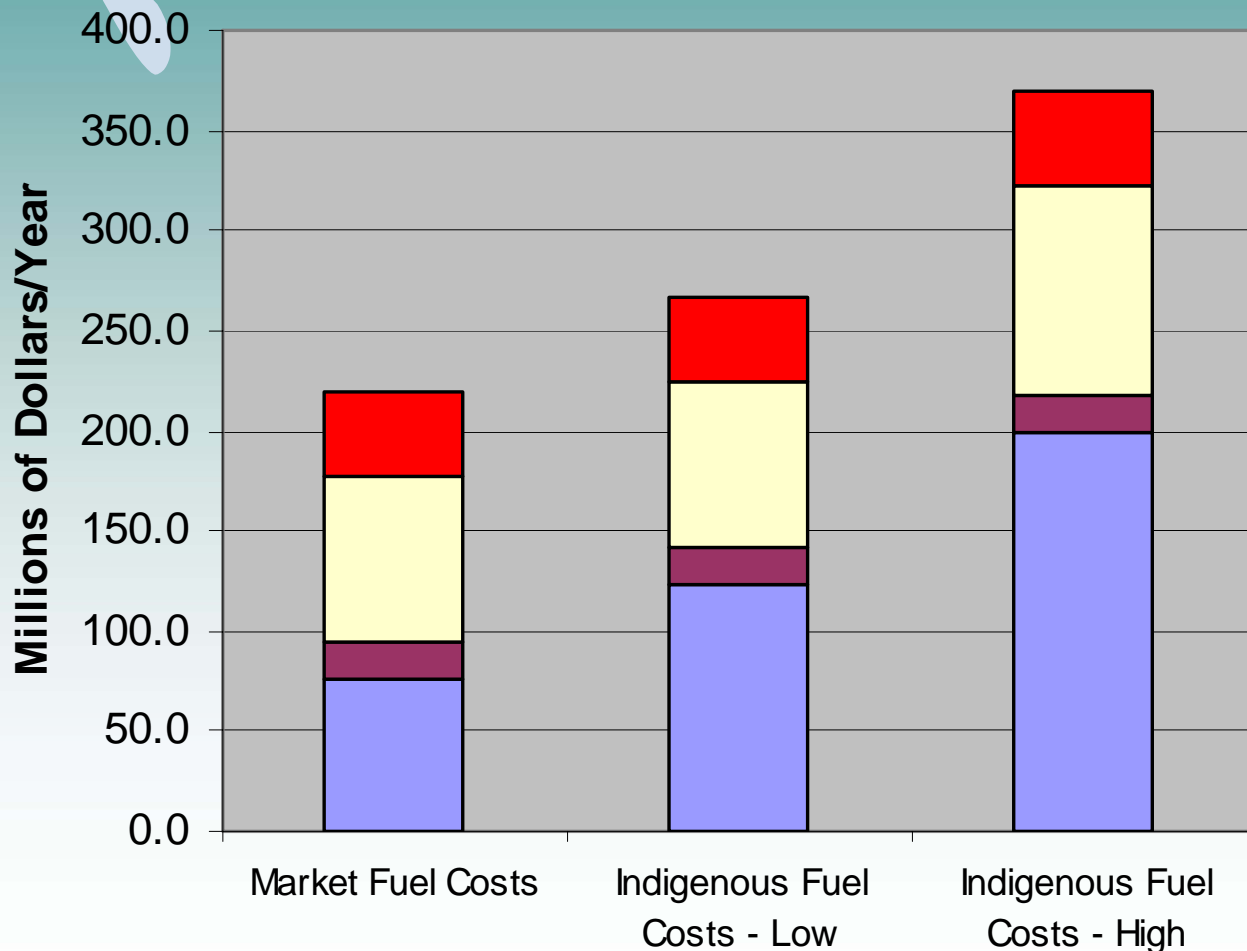
Alternative Investment Example: Reducing Gasoline Imports

- In 2001, Iran was importing 8.5 million liters of gasoline per day
- In 2004, Iran was importing 40% of their daily gasoline needs, or 22 million liters of gasoline per day¹ valued at **\$2.5 – \$3.0 billion²**.
- Annual demand increasing at around 9% per year²
- Gasoline imports could potentially cost **Iran \$4.5 billion for 2005³**

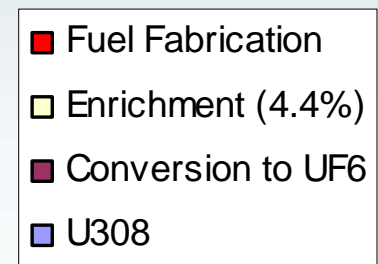
Benefits of Gasoline Production Upgrade

- If Iran were to invest \$5.6 billion in a **high gasoline yield Western-type refinery**, it could eliminate its dependence on imported gasoline and increase its annual net oil-related revenue by approximately \$982 million.

Comparative Nuclear Fuel Costs for 7000 Megawatts: Indigenous Vs. Market



- Iran could save \$59 - \$161 million per year by purchasing fuel from abroad.



The Myth of Nuclear Fuel Self Sufficiency

- Setting economics aside, even if speculative uranium deposits in Iran are assumed and included, Iran is not close to possessing sufficient uranium to fuel seven 1000 MWe for their lifetime. **It is thus impossible for Iran to avoid dependence on a foreign supplier for its uranium fuel.**

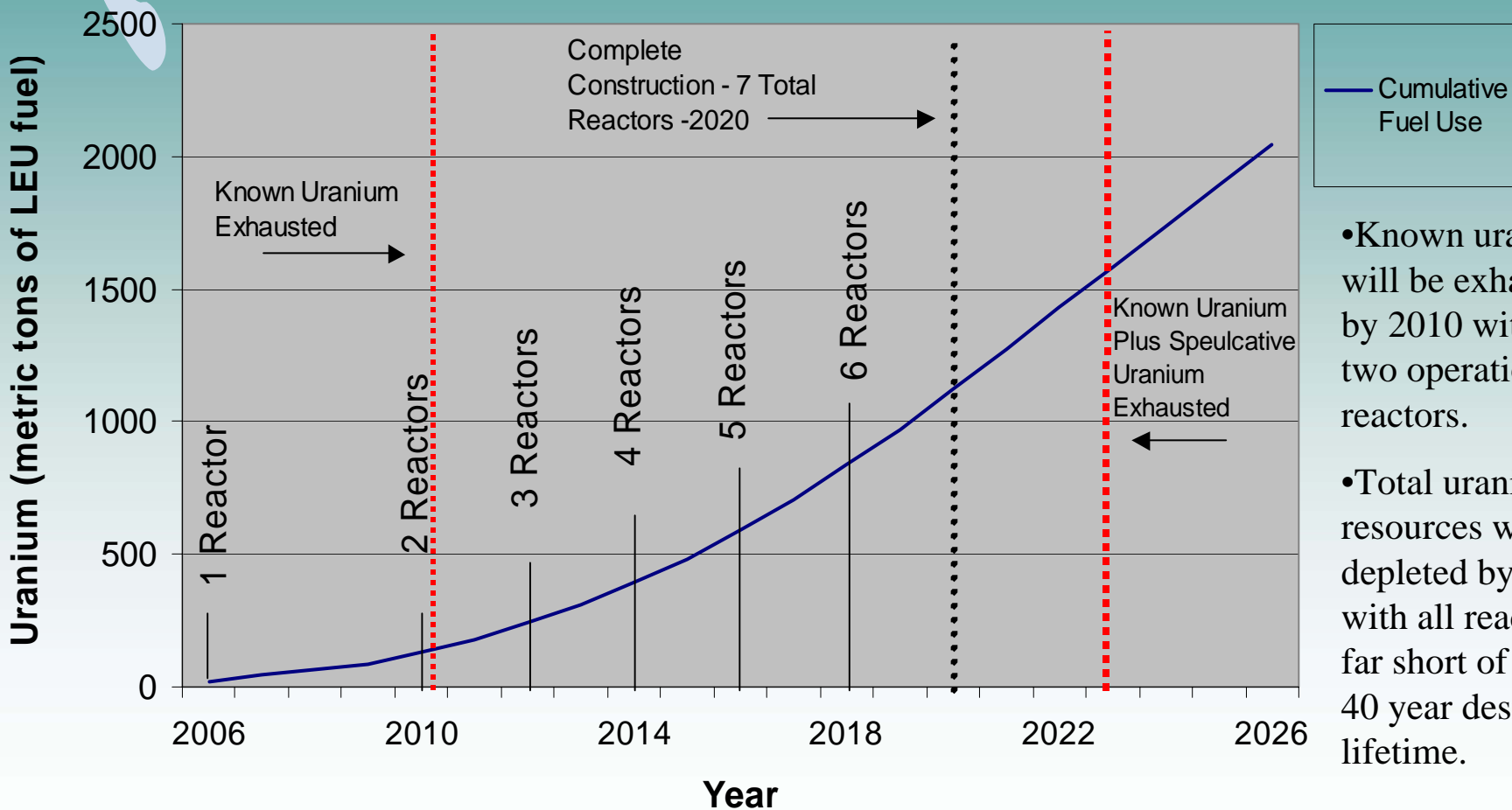
Limited Uranium Resources

Iran does not have enough uranium to fuel its planned reactors

- Known uranium (1,427) + speculative (13,850) = 15,277 tons U
- Assume Bushehr burns 22 tons of LEU annually

	Known Uranium	Known + Speculative Uranium
Number of Operational Reactors	Years of Operation	Years of Operation
1	6.5	69.4
2	3.2	34.7
3	2.3	23.2
4	1.6	17.4
5	1.3	13.9
6	1.1	11.6
7	0.9	9.9

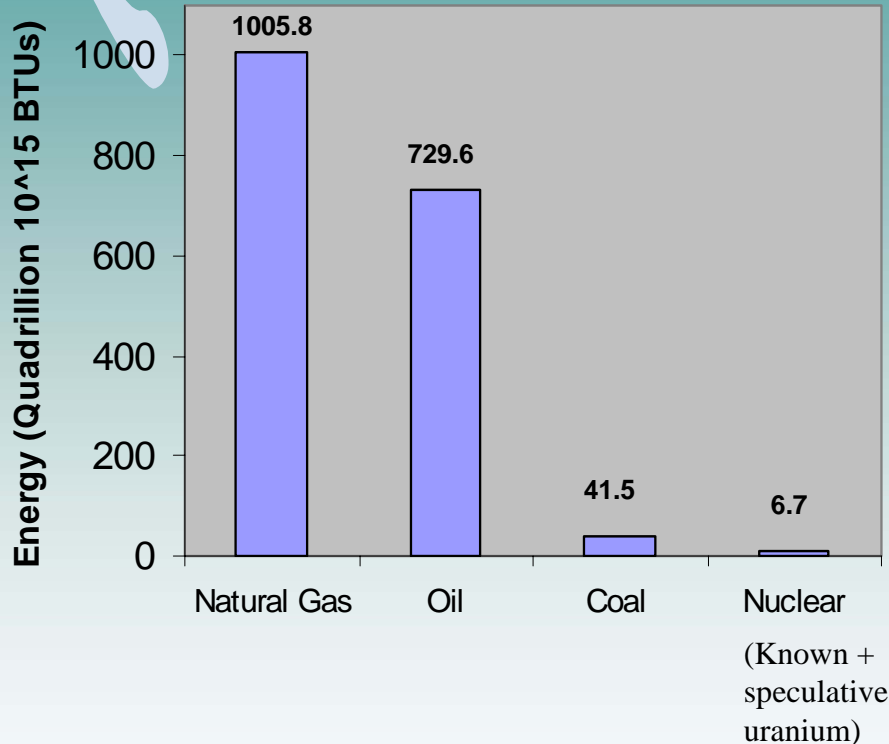
Fuel Resource Constraints 2006-2026



- Known uranium will be exhausted by 2010 with only two operational reactors.

- Total uranium resources will be depleted by 2023 with all reactors far short of their 40 year design lifetime.

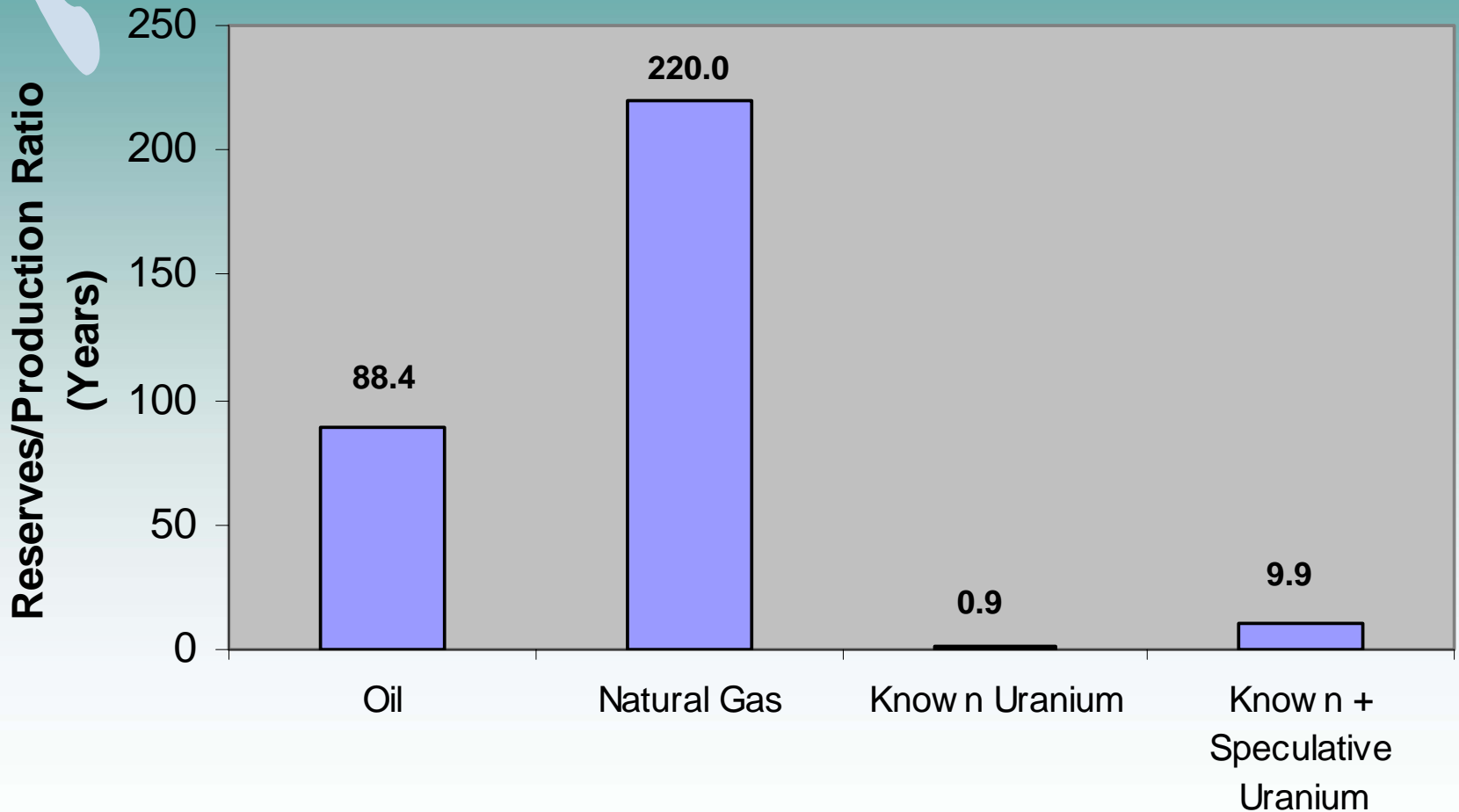
Which Resource Truly Scarce?



- Oil
 - 125.8 billion barrels proven reserves
 - Roughly 10% of world total
- Natural Gas
 - 940 trillion cubic feet proven reserves
 - World's 2nd largest supply, 15.5% world total

Energy equivalence used = 1070 BTU/ft³ natural gas, 5.8e6 BTU/barrel oil, 11,000 BTU/lb. coal, 4.41e11 BTU/mton U-235. Source *Nuclear Engineering: Theory and Technology of Commercial Nuclear Power* – Knief. Energy data from March 2005 U.S. EIA Iran Country Analysis Brief.

Duration of Energy Resources Under Current Production and Consumption



Note 1 - Oil production 2004, gross natural gas production 2002 from EIA

Note 2 - Nuclear fuel production based on requirements of 7000 MW nuclear with a once through fuel cycle

A stylized, light-colored atomic symbol is centered on the left side of the slide. It features a central nucleus with three elliptical orbits around it. The background is a teal-to-white gradient.

Section III

- **Iran's Nuclear Fuel Cycle Facilities:
To What End?**



Iran's Program Makes Sense for Nuclear Weapons

Iran's nuclear program is well-scaled for a weapons capability, as a comparison to another state's nuclear weapons infrastructure shows.

When one also considers Iran's concealment and deception activities...

...it is difficult to escape the conclusion that Iran is pursuing nuclear weapons.



Uranium Reserves: Only Enough for Weapons

As noted, Iran's uranium resources cannot support the peaceful program Iran says it is pursuing.

However, Iran's uranium resources are more than sufficient to support a nuclear weapons capability.

- The Gachin mine's output (~21 tonnes/yr) alone could supply enough uranium, if enriched, to produce ~4 nuclear weapons/yr.

Comparing Nuclear Infrastructures Another State Iran

Gas Centrifuge Plant



Gas Centrifuge Plant at Natanz



Comparing Nuclear Infrastructures

Another State

~13 Tonne/yr
Heavy Water Plant



Iran

~16 Tonne/yr
Heavy Water Plant



Comparing Nuclear Infrastructures

Another State

~40 Megawatt Heavy Water Reactor For Plutonium production



Iran

40 Megawatt Heavy Water Reactor at Arak



Comparing Nuclear Infrastructures

Iran's program is strikingly similar to Another State's Program in other ways:

- Uranium mining – Both States have limited known domestic reserves (Iran ~ 71 tons/year versus ~ 23 tons/year)
- UF₆ Conversion – Both state's seek a 200 ton/year production capacity

Comparing Delivery Capabilities

Iran's Shahab III and Another State's Variant Intermediate-range ballistic missile (IRBM) derived from the DPRK's No Dong



System	Range (km.)	Payload (kg.)	CEP
Shahab III	1,300	~1,000	~250 m
Variant	~2,000	700	~250 m
No Dong	1,300	700-1,000	~250 m



Nuclear Energy or Nuclear Weapons?

- Extensive Concealment and Deception Record
- Once revealed, Iran offered rationale for “peaceful” nuclear fuel cycle.....However:
 - Nuclear energy independence not feasible given ore reserves
 - Iran could maximize its earnings and energy by:
 - Importing nuclear fuel
 - Reducing waste of natural gas currently flared
 - Increasing gasoline production for domestic energy independence
- Iran’s uranium reserves cannot support planned nuclear power plants, but are well-scaled to give Iran a significant number of nuclear weapons.
- Iran’s nuclear program is very similar to another state’s nuclear weapons program.

CONCLUSION:

Iran's past history of concealment and deception and nuclear fuel cycle infrastructure are most consistent with an intent to acquire nuclear weapons.