

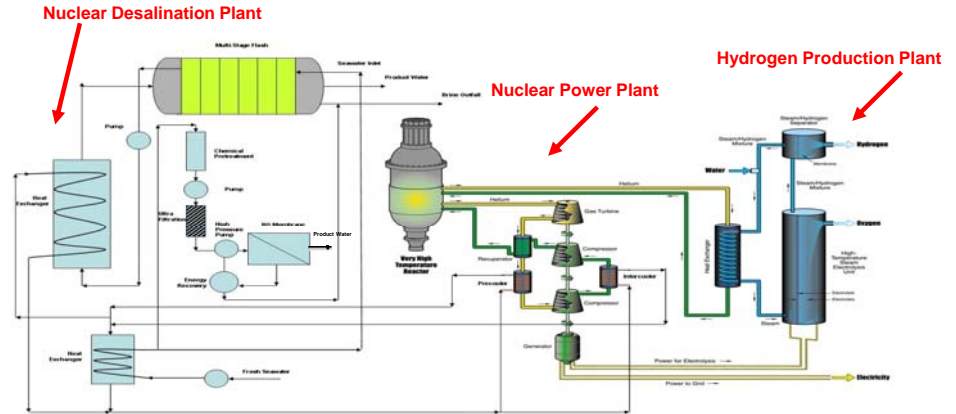
# A High Efficiency and Environmentally Friendly Nuclear Reactor (HEER) for Electricity, Hydrogen, and Desalination

Youssef Shatilla<sup>1</sup>, Mujid Kazim<sup>2</sup>, and Pavel Hejzlar<sup>2</sup>  
<sup>1</sup>Masdar Institute of Science and Technology, <sup>2</sup>Massachusetts Institute of Technology

## Motivation

Three of the major problems facing human development are the scarcity of energy resources, and potent water and rising levels of environment pollution. This is especially true for countries in the Gulf region where natural potent water sources are practically non-existent and the only fully developed energy sources are oil and natural gas.

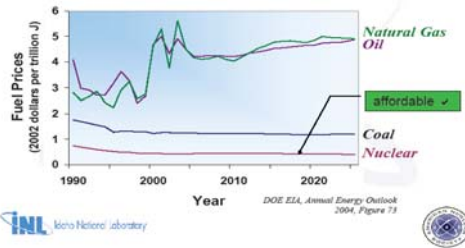
Scientific research, like that envisioned to be performed at MIST, can help go long way on the road of finding solutions to these two complicated problems. Recently, nuclear energy has been regaining grounds in the competition for meeting the most advanced countries' (like USA and France) energy demand with virtually zero greenhouse gas emissions. However, some of the major obstacles against the deployment and use of nuclear energy as an alternative energy source in the Middle East are building the technical capacity to operate the reactors, storage and disposal of the spent fuel, and the requirements to secure the fuel material to avoid the diversion of its fissionable content for use as weapon materials.



## Available energy resources:

- Oil
    - Limited and polluting
    - Future price stability?
  - Natural gas
    - Today's fuel of choice but polluting
    - Future price stability?
  - Coal
    - Plentiful but polluting
  - Renewable (Solar and Wind)
    - Capacity to meet demand?
    - Still expensive
  - Nuclear
    - Proven technology
- Let's go Nuclear...!!!!

## U.S. fuel prices to electricity generators



*I have a dream ...!!!!<sub>MLK</sub>*

Build a Nuclear Self-Sustainable Special Free Zone (N3SFZ) at MIST powered by a nuclear reactor (HEER) that:

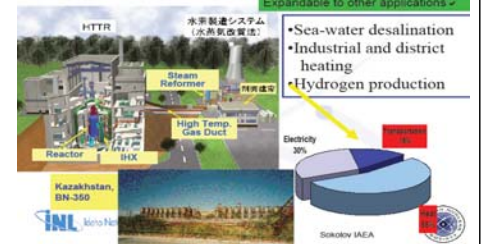
- Generates electricity for MIST and surroundings
- Produces potent water through Gulf water desalination
- Generates hydrogen to fuel Abu Dhabi future hydrogen cars
- And it will do all that with 3Z's - Zero emission, Zero waste, and Zero proliferation

The development of advanced nuclear power reactor designs that minimize these challenges is underway in different parts of the world including at MIT. One approach is to design a power reactor that minimizes, and perhaps eliminates, the need for refueling throughout the reactor lifetime (thirty or more years). This eliminates the need by the host country to get direct access to the nuclear fuel, which will be supplied and later retrieved by the vendor country making that reactor design proliferation-resistant. This also minimizes any required shipments of spent fuel to international storage installations, or even national ones. While ordinary reactors are refueled every 12 to 24 months, it is possible to stretch the operation to a minimum of 48 months, and with a higher initial enrichment in uranium or thorium fissile isotope even to 10 or 15 years. However, the required inspection and maintenance needs of the reactor without opening during the fuel cycle may need revisited and investigated.

## Uranium resources are ample



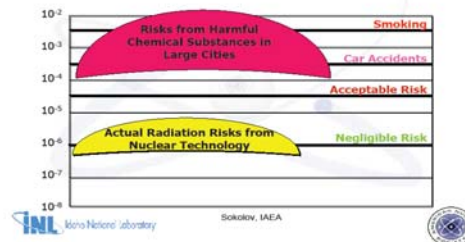
## Non-electricity applications of nuclear energy



## Why Nuclear Energy? Because:

- Low carbon emission technology
- Affordable
- Sustainable
- Safe
- Accepted
- Doesn't leave a mess
- Consistent with international policy
- Expandable

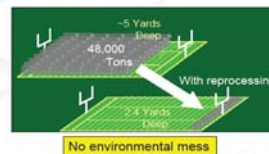
## Nuclear technology has low risk



## Total amount of used fuel generated is relatively small and readily manageable

Current high-level waste volume after 40 years of operations would fill an area about the size of a football field five yards deep

- ~48,000 metric tons
- ~1/2 ton per fuel assembly
- ~ 100,000 assemblies
- Only ~5% is waste



## N3SFZ Components

### Reactor:

- Produces net electric power of 100 MW<sub>e</sub> for the grid
- Advanced design; long refueling cycle which means no access to nuclear fuel (i.e. proliferation-resistant)

### Hydrogen Production Plant (HPP)

- Uses ~146 MW<sub>e</sub> from reactor to produce hydrogen through High Temperature Electrolysis of Steam (HTES) – fuel for 280,000 light vehicles

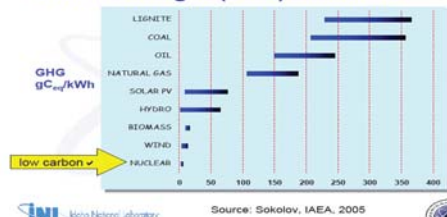
### Desalination Plant (DP)

- Uses ~76 MW<sub>e</sub> from reactor to produce potent water through Hybrid Multi Stage Flash and Reverse Osmosis (MSF-RO) – 182,400 m<sup>3</sup>/d

*The dream is here .....*

*.... Let's make it a reality !!!!*

## Greenhouse gas (GHG) emissions



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Source: Sokolov, IAEA, 2005

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