

# Challenges and Opportunities for Further Nuclear Cooperation Between the U.S. and ROK

International Workshop on Prospects for the Trump Administration's  
Nuclear Energy Policies and the U.S.-ROK Nuclear Cooperation

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# US & ROK: A 55-year Partnership

- 1962 first research reactor KRR-1 (TRIGA II) built by General Atomics
- The US-ROK Joint Standing Committee on Nuclear Energy Cooperation— Over 30 years of collaboration:
  - Nuclear Safety and Regulations
  - Safeguards and Export Control
  - Non-Proliferation and Nuclear Security
  - Emergency Preparedness
  - Waste Management
  - Nuclear materials and Medical Isotopes
- Collaboration on SFR prototype is one of many on-going US-ROK nuclear cooperative projects.
- **ROK nuclear engineering and science community is world class**



# Challenges



# US-ROK Nuclear Fuel Cycle Cooperation Limited by Global Effort to Constrain DPRK Aggression

- October 1994, “Agreed Framework” signed by US and DPRK viewed as a key achievement of the Clinton Administration non-proliferation experts.
- Many non-proliferation experts remain committed to seeing the goals of Agreed Framework brought back into force as a diplomatic solution to dealing with DPRK aggression.
- Two of the key provision of the Agreed Framework are:
  - “The DPRK will consistently take steps to implement the North-South Joint Declaration on the **Denuclearization** of the Korean Peninsula.”
  - “The DPRK will engage in North-South dialogue, as this Agreed Framework will help create an atmosphere that promotes such dialogue.”



# 1992 ROK-DPRK Joint Declaration is Still Seen as Important by US

- US views Joint Declaration is a valid basis for nuclear policy on the Korea Peninsula and purpose for continuing the Six-Party Talks.
- US, Japan & China: As long as “denuclearization” is goal, then no need to acknowledge DPRK as a weapons state.
- US, Japan, and ROK expect assistance from China in pressuring DPRK, but no one wants a long-term role for Beijing on the peninsula.
- The Six-Party Talks keeps Chinese engagement within a multi-lateral framework.



# Bottom Line

- US-ROK fuel cycle agreement is a hostage to a failed US-DPRK agreement.
- Unlikely Trump administration will see benefit to providing advanced consent rights given the complex international diplomatic framework of DPRK containment.
- Many US policy makers strongly support “Gold Standard” which restricts cooperation in reprocessing and enrichment.
- Until issue of “denuclearization” is addressed, little progress expected.





# Opportunity



# Setting for Future Cooperation

- Toshiba-Westinghouse bankruptcy and interest in acquisition by China is changing political dynamics for nuclear new build.
- ROK is expected to be a full fuel cycle state in 30 years but still lacks robust policy and technical measures to fully address cradle to grave.
- The nuclear technology sector has not been innovative.
  - SMR's are 60 years old
  - GEN IV technology is 50 year old
  - Fuel cycle solutions are 40 years old
- Innovation drives IP and is key to new economy that will be facing the ROK.





# New Nuclear Build: Competition or Collaboration?

- With Toshiba & Hitachi withdrawal from nuclear construction, **Korea is only country building US based technology meeting US safety standards.**
- ROK-- limited expansion of new domestic nuclear
- ROK needs exports to sustain domestic supply chain to support domestic fleet.
- ROK aggressive reverse-engineering to minimize foreign content will result in less cooperation on new build contracts.
- **Better to pursue new build opportunities with US and others than try to go it alone. 70% is better than 0%.**



# Fuel Cycle Technology Development and Deployment

- Pyroprocessing superior to PUREX for SNF treatment
- ROK correctly focused on backend treatment for volume/toxicity reduction.
- However!
  - World has over 200 metric tons of excess plutonium, creating more cannot be justified
  - Pyroprocessing not a priority
- Aggressive reduction of stockpiles of Pu through deployment of SFR and other “burner reactors” should be **multi-national** goal.
- Deployment of solutions for spent fuel treatment are limited until Pu disposition pathways created.



# Innovate Disposal Solutions

- Innovate repository and waste form designs
  - Massive geologic underground repositories are norm. Why?
  - Repositories are designed to fit the waste, why not design the waste to fit the repository?
  - Smaller specialized disposal systems?:
    - Deep Borehole,
    - Seabed Mines (Finland and Sweden),
    - Seabed Boreholes
- Can we innovate direct disposal together?



# Innovate Decommissioning Technology

- Within the next 40 years over 100 reactors will likely be decommissioned.
- Growing demand for decommissioning tools and treatment/storage/disposal
- US significantly more advanced in decommissioning technology and **management** than ROK.
- Joint ventures difficult but not impossible.
- Development and deployment of specially modified large industrial robots will dramatically reduce time and cost for decommissioning.

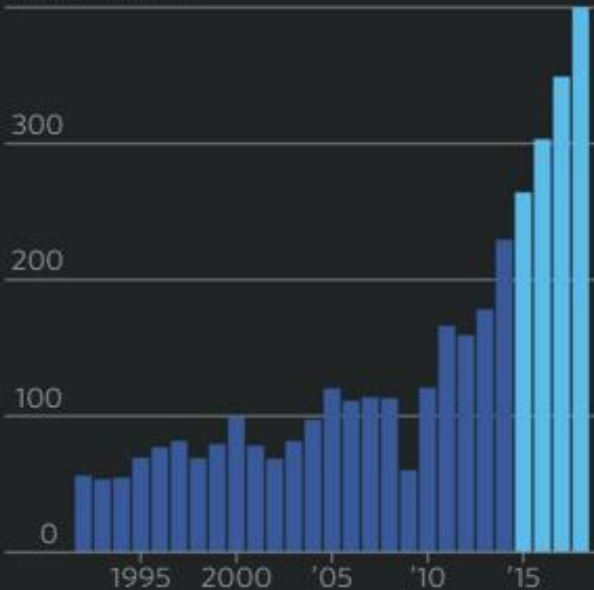


# Robotics and Automation: The Future of the Nuclear Industry—and *All Industries!*

## Adding Machines

World-wide industrial robot shipments

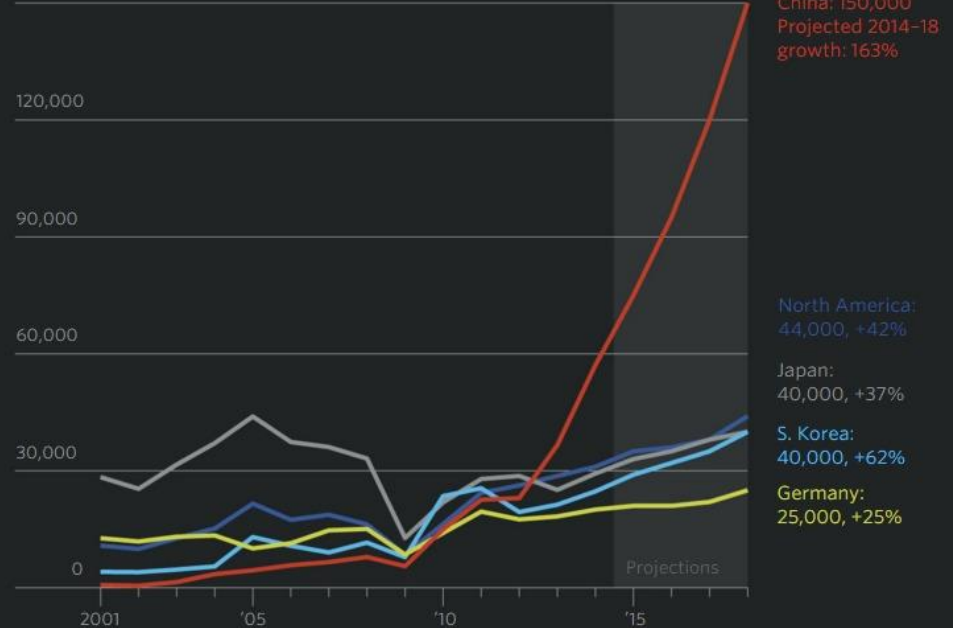
400 thousand



## Automation Nation

Top five markets for industrial robot sales

150,000 robots

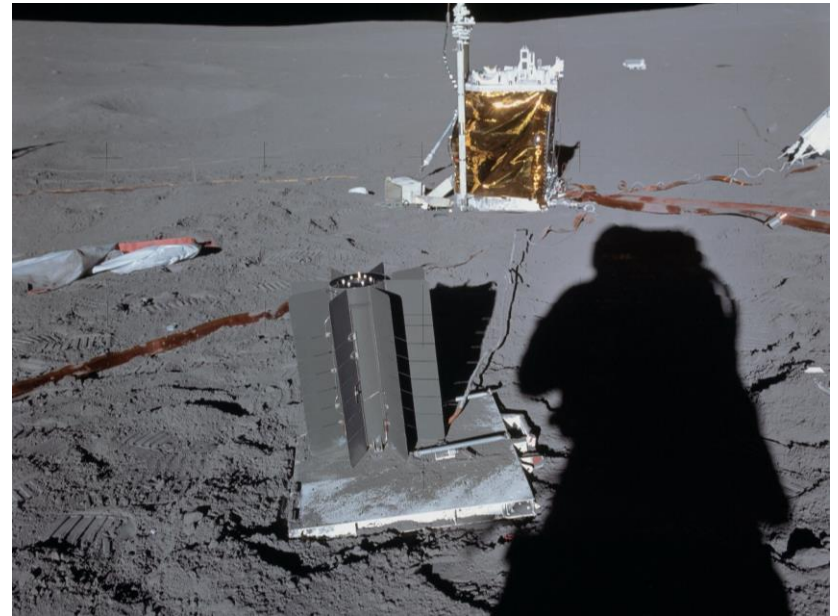


Source: International Federation of Robotics



# Next Generation Power Source?

- Smaller, higher density energy sources
- Intrinsically safe, low maintenance
- Near zero releases under accident conditions
- Highly efficient energy conversion:
  - Brayton Cycle
  - Stirling Engine
  - Direct conversion



SNAP-21 RTG on Moon





# End with the Start

## Last Thoughts

How to advance the Fuel Cycle  
Discussions



# Redefine “Denuclearization”?

- 1994 denuclearization applied to nuclear weapons development and dual use facilities and technology. Assumes civilian and defense nuclear programs cannot be separated.
- Changes since 1994:
  - DPRK willfully violates every provision of 1994 and IAEA develops and implements Additional Protocol
  - ROK becomes a major global nuclear supplier of nuclear technology
  - DPRK nuclear weapons program becomes vital means of propping up DPRK regime, unlikely to abandon.
  - Joint Comprehensive Plan of Action (JCPOA) or “Iran Deal”
- **New definition??– “Denuclearization does not include programs and facilities under IAEA Safeguards and with Additional Protocol.”**



**Thank You for Your Attention**

