



# Enhancing the Utility System Resiliency

## Nuclear Power Resiliency

*Shah Nawaz Ahmad*  
*Senior Advisor*  
*India Middle East & South East Asia*



# *Nuclear Power : Resilience*



- *Shah Nawaz Ahmad*  
*Senior Advisor*  
*India Middle East & South East Asia*

- **World Utility Summit**  
February 20 -21, 2023
  - Delhi , India

# World Nuclear Association

- **International Atomic Energy Agency (IAEA)**  
= UN Organization **175 member states** are its members as of March 2022.  
Most UN members and the Holy See are members
- **World Nuclear Association**  
= Association of the global nuclear industry.  
= Membership (World-Wide): 180+ members from 35 countries
- *Association members are responsible for virtually all of world uranium mining, conversion, enrichment and fuel fabrication; all reactor vendors; major nuclear engineering, construction, and waste management companies; and most of the world's nuclear generation. Other members provide international services in nuclear transport, law, insurance, brokerage, industry analysis and finance.*
- **World Association of Nuclear Operators (WANO)**.  
= Membership (world-wide) consists of civil nuclear power plant operators

## Resilience\*\*

- Resilient infrastructure can anticipate, absorb, adapt to, and/or rapidly recover from a disruptive event Best when all-hazard “disruptive events” include the unenvisioned
- All hazards span naturally occurring events, such as storms or earthquakes, and also include malicious human actions
- A well-designed resilient system will ***either maintain maximum practicable functionality, or enable rapid restoration with minimum downtime***, regardless of whether or not that particular event or scenario had been anticipated in the design and planning phase

\*\* ( Jeff Dagle Electricity Infrastructure Resilience Pacific Northwest National Laboratory )



# Performance

- High Availability & Capacity Factors
- Av capacity factor 80% + world-wide: Very high availability factors
- ***Kaiga 1 NPP in India worked continuously for 962 days setting a world record***  
(Current record:- 1,110 days by Darlington NPP in Canada)
- Conservative design, use of assured quality equipment and procedures make this possible



FOUNDING PARTNERS



20 - 21 February 2023

Sustainable Transformation of Utilities



## Economics

- High upfront costs USD/MWe, but long life of 60-80 years, gives stable revenue
- Competitive at 3-10% discount rates
- Low fuel costs, so many years' worth can be stocked (more resilient to supply disruptions & logistics issues)
- Resource Adequacy Less volatile market or chances of supply disruption.
- For every €1 invested, the nuclear industry indirectly contributes €4 in GDP, and every direct job creates 3.2 jobs in the EU as a whole
- Included in EU Taxonomy as a transition technology



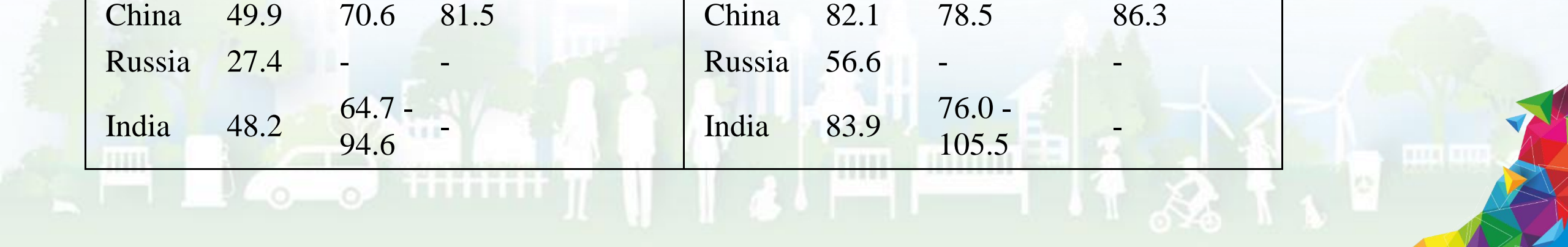


**OECD electricity generating cost projections for year 2020 on – 3% discount rate, ¢/kWh**

country	nuclear	coal	Gas CCGT
France	45.3	-	-
Japan	61.2	87.6	87.6
Korea	39.4	69.8	83.0 - 91.0
Slovakia	57.6	-	-
USA	43.9	75.1 - 116.2	59.6
China	49.9	70.6	81.5
Russia	27.4	-	-
India	48.2	64.7 - 94.6	-

**OECD electricity generating cost projections for 2020 on – 10% discount rate, ¢/kWh**

country	nuclear	coal	Gas CCGT
France	96.9	-	-
Japan	112.1	111.3	97.1
Korea	67.2	81.0	90.2 - 00.4
Slovakia	146.1	-	-
USA	98.6	100.2 - 174.9	80.2
China	82.1	78.5	86.3
Russia	56.6	-	-
India	83.9	76.0 - 105.5	-





# Nuclear for economic development

**International Monetary Fund (IMF) found nuclear energy investment spending has a large economic output multiplier effect.**



Horizon	Nuclear Energy Investments Multiplier	Renewable Energy Investments Multiplier	Fossil Fuel Energy Investments Multiplier
Impact	4.11	1.19	0.65
1 Year	3.97	1.20	0.64
2 Years	3.88	1.19	0.62
3 Years	3.83	1.17	0.59
4 Years	3.80	1.14	0.55
5 Years	3.78	1.11	0.52

**Source:** IMF Working Paper, 2021, Building Back Better: How Big Are Green Spending Multipliers? by Nicoletta Batini, Mario Di Serio, Matteo Fragetta, Giovanni Melina, and Anthony Waldron



# Environmental Resilience

- Onagawa @ 160 km from Fukushima survived a higher earthquake & similar tsunami.
- Nuclear Power Plants have continued to supply power even under unusually severe weather conditions  
(Moral: More effective sharing of Industry-wide Best Practices can avert many incidents)







**ieema**  
your link to electricity

FOUNDING PARTNERS

**IEEE**  
Advancing Technology  
for Humanity

**IEEE PES**  
Power & Energy Society®

15th Edition  
**ELECRAMA**  
Powering the Future of Energy

4th Edition  
**World Utility Summit**

20 - 21 February 2023

Sustainable Transformation of Utilities

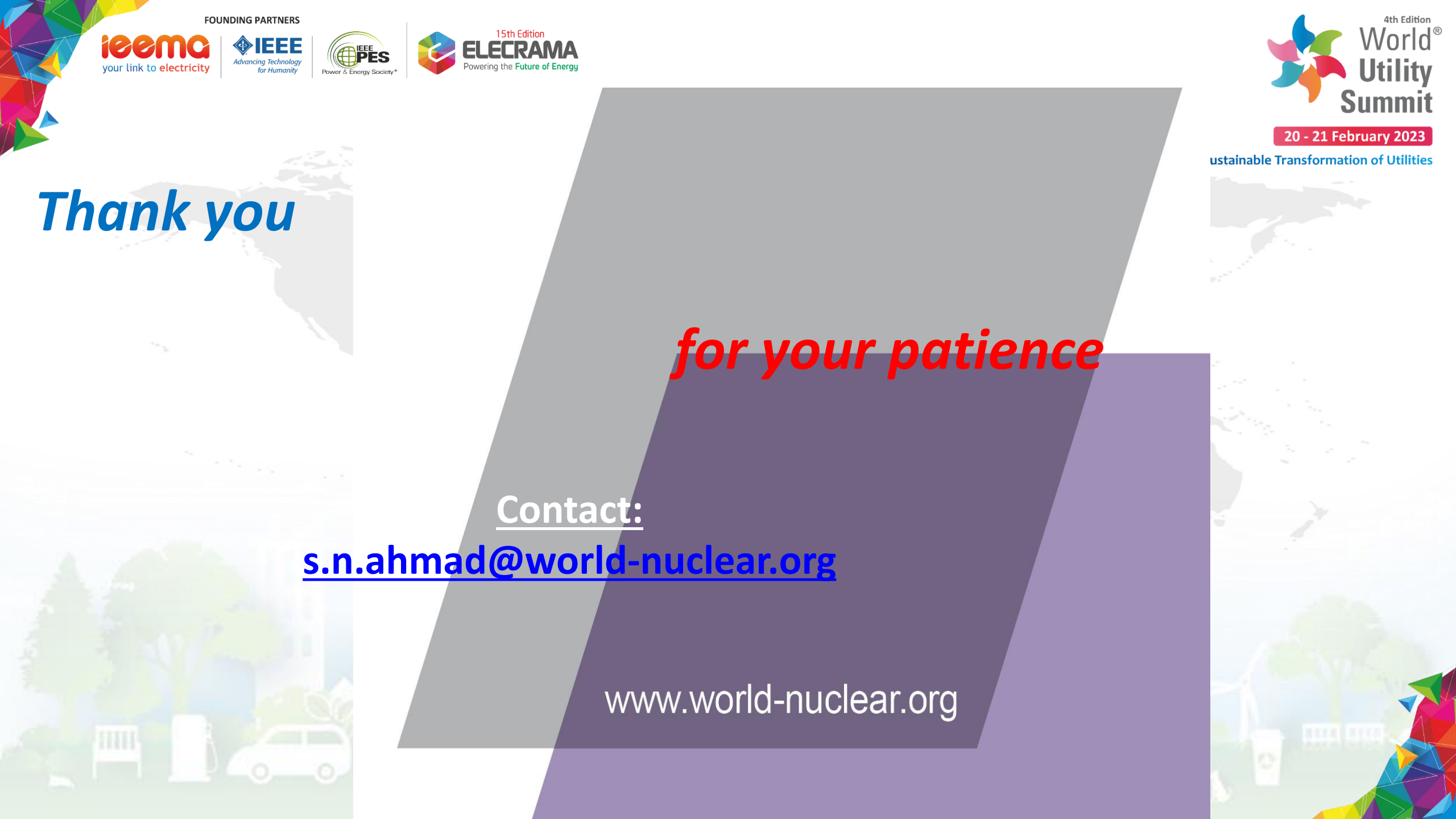






<b>ENVIRONMENT</b>	<b>Impact of nuclear in comparison with other generation technologies</b>
<b>Climate Change</b>	On a life-cycle basis-median value of <b>12g CO<sub>2</sub> equivalent/kWh</b> has been estimated for nuclear – similar to wind, and lower than all types of solar
<b>Ecosystem Protection</b>	Acidification and eutrophication lowest of all generation technologies
<b>Land use</b>	Lowest: A large two-unit nuclear power plant can provide electricity for 4-5 million people from a generating footprint of just <b>2 square Km.</b>
<b>Water Use</b>	At the higher end (comparable to oil)
<b>Waste</b>	Uranium- high energy density-less fuel reqd- less waste & is fully contained
<b>HUMAN HEALTH</b>	
<b>Air Pollution</b>	Causes virtually no air pollution Many applications of nuclear technology in the service of human health
<b>Radiation</b>	Only technology that measures and accounts for radioactive emissions
<b>ECONOMICS</b>	
<b>Resource adequacy,</b>	Uranium- only use power production – small amount needed. Widely distributed
<b>Resource efficiency</b>	Lowest material requirement
<b>Affordability</b>	Cost-competitive (LCOE). Improves markedly when system costs/externalities accounted for.





FOUNDING PARTNERS

**ieema**  
your link to electricity

**IEEE**  
Advancing Technology  
for Humanity

**IEEE PES**  
Power & Energy Society\*

**ELECRAMA**  
15th Edition  
Powering the Future of Energy

4th Edition  
**World  
Utility  
Summit**

20 - 21 February 2023

ustainable Transformation of Utilities

*Thank you*

*for your patience*

Contact:

[s.n.ahmad@world-nuclear.org](mailto:s.n.ahmad@world-nuclear.org)

[www.world-nuclear.org](http://www.world-nuclear.org)