A FIRST WAVE CASE SERIES

RISE3D

A NICE FUTURE INITIATIVE PROJECT SPONSORED BY THE U.S. DEPARTMENT OF ENERGY.

RISE3 AND RISE3D

THE NUCLEAR INNOVATION: Clean Energy Future (NICE Future) Initiative has developed a new campaign focusing on community impacts to build on the success of the Flexible Nuclear Campaign for Nuclear-Renewables Integration (FNC).

While the FNC established a clear role for flexible nuclear energy to support a clean energy transition alongside deployment of renewable energy resources, the new Campaign to Research Impacts on Social Equity and Economic Empowerment (RISE3) will e-publish a community-focused case series organized and managed by the United States NICE Future Team.

This RISE3D case series has been developed from submissions by participating countries and partner organizations, demonstrating how advanced and innovative nuclear energy technologies, such as small modular reactors, will support the clean energy transition in a variety of community contexts.

Partnerships with Indigenous, Underserved, or Remote Communities

Flexible and Integrated Systems Utilizing Both Nuclear and Renewable Energy

Evaluation of Transition Options for Unabated Coal Sites

Economic Empowerment Opportunities & Workforce Development

Benefits of Electric and Non-Electric Applications

TABLE OF CONTENTS

COMMUNITIES RISE ON THE FOUNDATIONS OF THE FNC

As the world springs to action to address twin climate change and energy security imperatives, this is a pivotal global moment to bring innovative solutions to people in communities around the globe. As the sole nuclear energy-focused initiative of the Clean Energy Ministerial (CEM), the Nuclear Innovation: Clean Energy Future (NICE Future) initiative is advancing a vision of the world in which nuclear innovations are integrated with other non-emitting technologies to accelerate progress toward clean energy and climate goals.

The Global Clean Energy Action Forum (GCEAF), hosted this year in Pittsburgh, Pennsylvania, marks the successful completion of the Flexible Nuclear Campaign for Nuclear-Renewables Integration (FNC), a three-year NICE Future initiative that has contributed ground-breaking analyses by the world's leading experts in integrated systems. While highlighting nuclear energy as a clean, integrated, flexible, and secure solution in tandem with renewable energy, FNC work has informed global research and development programs as well as technology investment decisions.

With the sunsetting of the FNC at the GCEAF, campaign co-leads Canada, Japan, the United Kingdom, and the United States are proud to launch the new Campaign to Research the Impacts on Social Equity and Economic Empowerment (RISE3). The RISE3 campaign will provide expert resources and create a blueprint for countries transitioning to a clean and just energy economy with nuclear innovation as a key pillar. As a complement to this work, and a method to promote the vision and success of RISE3 participants and partners, the U.S. Department of Energy is sponsoring the RISE3D Case Series. Intended to span the course of the three-year campaign, with rolling admissions to the project, the case studies in this e-publication are intended to be the first wave of efforts to drive the conversation on how nuclear energy can uplift communities and economies. Successes, updates, and new case studies will be promoted on the NICE Future website, just like this initial e-publication.

I could not be prouder and more excited for the efforts you will read about in this case study series, as well as the future efforts our partners are preparing for submission to RISE3D. They represent some of the very best work that has been accomplished through the NICE Future initiative, with an eye toward a future where nuclear energy provides key solutions to our climate and energy challenges. I hope that you are as inspired as I am as you explore the first issue of RISE3D.

Dr. Kathryn Huff

Assistant Secretary for Nuclear Energy
U.S. Department of Energy

MUNICIPALITY OF PINAWA

Natural Resources Canada

The Local Government District (LGD) of Pinawa is the host municipality of the Atomic Energy of Canada Limited-owned, Canadian Nuclear Laboratories-managed Whiteshell Laboratories (WL), a nuclear Research and Development site that is currently being decommissioned. Pinawa is a community of 1,500 people located in Manitoba. Pinawa was built in 1963, at the same time as the WL site, to provide a community for WL employees to live in. The site has also provided jobs to residents from all over Eastern Manitoba, including Winnipeg. WL employed over 1,000 employees at its peak.

FIGURE 1: The Whiteshell Laboratories site where the demonstration SMR in Pinawa would be hosted.

The WL site is the best location in Canada for the demonstration of Small Modular Reactors, and the residents of Pinawa desire a nuclear future. First Nations neighbours have been engaged in the idea of hosting a demonstration reactor and are supportive. We also have support from elected provincial and federal representatives, educational institutions, trade organizations, and others. There is a strong social license for demonstration of SMRs at the WL site, and a huge advantage of the WL site is the capacity to connect to the Manitoba Hydro grid utilizing existing infrastructure.

SMRs may potentially play a significant role in providing affordable, reliable, clean, greenhouse gas-free electricity and heat for both on-grid and off-grid applications. Pinawa's focus has been on smaller SMRs (5 to 20 MWe) for off-grid remote communities and industrial operations such as mining. Off-grid communities or mine sites are typically in remote locations with a significant component of First Nations residents. It is essential that SMR technology be successfully demonstrated before any remote off-grid community and/or mine site will adopt an SMR as a solution for their energy needs. It is Pinawa's vision to not only demonstrate SMR technologies, but to also show how

FIGURE 2: An aerial view of the community of Pinawa.

FIGURE 3: A hydroponic facility that has been developed for the Arctic environment.

an SMR can change their quality of life for the better.

Another key advantage of the WL site is that Pinawa can be set up as a microgrid, be powered by the demonstration SMR (confirmed with Manitoba Hydro), and become the Demonstration Remote Community. The SMR would decrease the cost of electricity in a remote, off-grid community by a factor of three to five (or maybe more) and eliminate the reliance on burning diesel fuel and the environmental harm that it causes.

There are many ways that the surplus power can change lives:

1. Ability to grow fresh fruit and vegetables in a harsh climate year round. Hydroponic facilities are being developed to operate in arctic climates, with some units already deployed in remote communities. These can be combined with greenhouse facilities using electricity and waste heat from the SMR. Having affordable fresh fruit and vegetables year round will lead to a healthier diet and better health outcomes.
2. District heating, which will further reduce reliance on fossil fuels, and therefore, further reduce cost of living.
3. Improved access to internet, electrification of vehicles, and purification/desalination of water.
4. Integration with renewable sources of energy.
5. Since Energy Poverty is reduced or eliminated, new economic development is enabled.

THE CASE FOR ADVANCED NUCLEAR REACTORS FOR PUERTO RICO

North American Young Generation in Nuclear & Nuclear Alternative Project Puerto Rico

Puerto Rico is an unincorporated U.S. territory with 3.2 million residents. Puerto Rico's history with nuclear energy started in the late 1950s with the experimental reactor BONUS – short for Boiling Nuclear Superheat reactor – which was cancelled in 1968. In May 1970 the government of Puerto Rico ordered a 583 MWe two-loop Westinghouse pressurized water reactor plant for a site in the north coast of the island. This project was also cancelled in 1978. Since then, nuclear energy has been proposed for Puerto Rico several times, but a lack of public knowledge and local technical expertise halted any progress for the idea.

Our organization, The Nuclear Alternative Project (NAP), is educating communities in Puerto Rico about advanced nuclear reactors before the consideration of any construction project. The goal of our organization is to provide the community of Puerto Rico the knowledge to make an informed decision about advanced nuclear reactors when these are commercialized in a near future.

PUBLIC HEARINGS AT HOUSE OF REPRESENTATIVES: Four (4) organizations were invited to present motions at public hearings regarding Resolution 1189: The Puerto Rico Electric Power Authority (PREPA), The Puerto Rico Energy Bureau (PREB), the College of Engineers and Surveyors of Puerto Rico (CIAPR) and The Nuclear Alternative Project (NAP). Resolution 1189 was passed to evaluated advanced nuclear in Puerto Rico.

The public wants to know and understand more about advanced nuclear power, and if feasible, they want to be involved and "in-the-know." This finding contradicts the historical view that people in Puerto Rico are afraid of nuclear power or oppose it. To the contrary, people want to learn more about it. NAP has successfully engaged with communities in need and has been able to continue the communication with such communities since 2015. Since then, NAP has also engaged with community leaders, local government officials and has been able to transform the public perception about nuclear energy.

An educational and community engagement campaign is proposed to demystify misconceptions about nuclear power and disseminate the information gathered, mainly the benefits and challenges for advanced reactors. Special emphasis will be given to history of nuclear power in the U.S., severe weather and seismic resiliency of advanced reactors, and the economic impact of nuclear power projects to communities. A systematic approach will be taken to capture the progress on public perception towards advanced reactors.

The Nuclear Alternative Project (NAP) performed a public outreach campaign to gather the perception and sentiment of the public in Puerto Rico towards advanced reactors. The major findings of this effort indicate that the top three priorities residents have for an energy portfolio are:

1. good for health and the environment,

2. lower electricity bills and,

3. resist natural disasters.

Most residents are interested in learning more about potential nuclear energy deployment Puerto Rico. 93% of the interviewed residents were curious about the possible benefits of this option. This appears inconsistent with media reports about people not wanting to "talk about"nuclear power in Puerto Rico.

There is no education and age difference between those who support more studies on nuclear power plants for Puerto Rico and those who do not. Their opinions on nuclear power were not based on demographics but rather on their degree of exposure to information on the subject.

Puerto Ricans seem very cautious on who they would trust to perform more research on nuclear power for Puerto Rico. They trust NAP, the University of Puerto Rico, or a collaboration between both to perform these studies. They trust the Puerto Rico Electric Power Authority the least to perform any research regarding nuclear power.

MEDIA INVOLVEMENT: Radio, TV, and podcast platforms appearances in Puerto Rico informing the public about the advances in nuclear energy.

SIGNING CEREMONY OF PUBLIC ENERGY POLICY: NAP was the only nuclear energy representative invited to the signage of Puerto Rico's energy public policy.

The best method to educate the population regarding nuclear energy is television (i.e., news, advertisement, educational segments, etc.). There is a clear need for public education on the economic impact of nuclear power to communities. Residents are not aware that nuclear power is more than just reliable and clean electricity, and that its economic potential on communities and the population in general is significant.

The estimated time for the proposed project plan is 3 years. This time will allow for additional surveys to be completed, data gathering, evaluation and analysis and development of educational material to be presented to key stakeholders.

The primary challenges will be that a first-of-its-kind reactor will have strong opposition from antinuclear groups in Puerto Rico, and that public perception still needs to change. A solution could come from a nuclear engineering program at public and private universities in Puerto Rico, and from continued engagement. We will also face political and spent nuclear fuel challenges.

NUCLEAR AT THE ENDS OF THE EARTH: SMR DEMONSTRATION AT MCMURDO STATION, ANTARCTICA

U.S. Department of Energy Office of International Nuclear Energy Policy & Cooperation

SARAH MCPHEE, STRATEGIC ADVISOR

The United States maintains three year-round scientific base stations in Antarctica, with more U.S. personnel on the continent than from any other country. The largest South Pole scientific community is McMurdo Station on Ross Island, a research community operated by the U.S. National Science Foundation consisting of up to 1250 residents.

The environment at McMurdo is pristine and punishing, with average temperatures in January reaching 28 degrees Fahrenheit (-2 degrees Celsius) and average lows plummeting to -15 degrees Fahrenheit (-26 degrees Celsius) with 24 hours of sunshine or darkness, depending upon the season. The community is exceptionally remote. Once a year—usually around the last two weeks in January—a vessel from Port Hueneme, California, delivers enough food, supplies and equipment for the entire year, and removes trash and unused or broken equipment. According to international treaty, nothing native to the continent may be consumed and nothing left behind, especially waste. However, necessity has thus far dictated that energy for the community is supplied primarily via diesel generators. The fuel must be delivered at great expense while generating emissions and waste.

FIGURE 1: McMurdo Station, courtesy of the National Science Foundation

There is a precedent for nuclear energy at McMurdo Station, but the experimental reactor was decommissioned in 1972 due to design flaws which resulted in unsafe

conditions. As the world moves toward a clean and sustainable future, U.S. facilities in the South Pole must also consider a future without fossil fuels. Small Modular Reactors (SMRs), integrated with previously existing wind energy, provide the best solution for ending emissions and waste, reducing fuel shipments, and scaling up capacity for back-logged research requests while demonstrating the efficacy of nuclear integration with renewables in remote, underserved communities.

ENERGY PROFILE

Roughly 90% of McMurdo's energy needs are satisfied by fossil energy (including water desalination). In 2015, McMurdo station consumed roughly 60 gallons of diesel per hour; at this rate, the largest Antarctic community consumed about 12,515 barrels annually, which is the equivalent of about 21,275 MW a year. More recent data indicates that McMurdo's energy requirements may have doubled in the last seven years, with a reported back-log of requests for scientific expeditions due to shortages related to infrastructure.

Efforts to decrease McMurdo's carbon footprint include the installation of three Enercon E-33 (330 kW each) wind turbines in 2009, which help power McMurdo and New Zealand's Scott Base. The windmills have reportedly reduced diesel consumption by 11% or 463,000 litres per year.

FIGURE 2: The tanker ship USNS Maersk Peary docked at McMurdo Station's ice pier is covered by a late season snowfall. Photo Credit: Laura Gerwin, The Antarctic Sun

THE CASE STUDY

The McMurdo RISE3D Case Study is part of a three-year campaign to demonstrate how nuclear energy can transform communities, advance environmental justice & equity, uplift economies and improve quality of life for remote, off-grid, or island communities. The U.S. is responsible for environmental stewardship of three large bases in Antarctica, a continent which all nations have an interest in protecting and where all territorial claims are on hold per international treaty. Furthermore, the conditions at McMurdo are absolutely the most extreme on the planet – bringing nuclear energy to McMurdo Station via SMR (a location where a previous reactor failed) will demonstrate how nuclear energy can uplift remote, islanded communities and integrate with renewables to address emissions in the last pristine place on the planet.

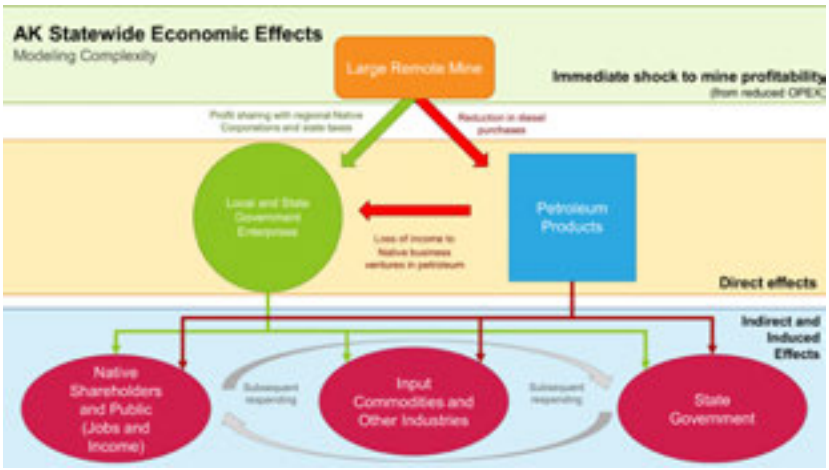
McMurdo shares a grid with New Zealand's Scott Base; the benefits of re-introducing nuclear energy will need to be advocated. A proposed schedule includes a needs assessment in FY23, feasibility/economic impact study in FY24, and an Environmental Impact Study and potentially a draft proposal for SMR procurement in FY25.

ECONOMICS OF NUCLEAR MICROREACTOR DEPLOYMENT FOR LARGE ISOLATED ENERGY USERS

Idaho National Laboratory

HAYDN C. BRYAN AND ANNA M. WROBEL, NUCLEAR ENERGY ECONOMISTS

Many industries are economic cornerstones of a region, providing employment and economic activity to communities. Should these industries struggle economically, these areas could suffer from job loss and outmigration. Variable fuel costs, carbon emissions, and reliability issues are forcing some companies to reconsider diesel as an energy generation technology – as such, carbon-neutral, reliable nuclear microreactors are receiving attention as an alternative. Funded under the Emerging Market Analysis Initiative, this research examines the cost competitiveness and regional economic impacts of replacing diesel generation with nuclear microreactors at a hypothetical, large, off-grid mine in Alaska.

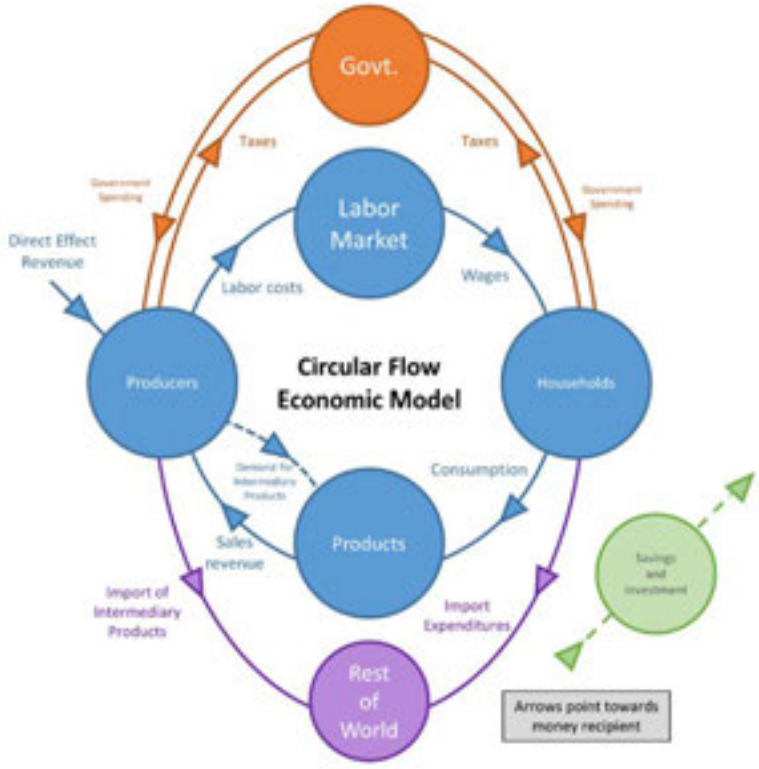


Economic interrelationships between the hypothetical mine and other economic sectors

Our research utilizes a two-part methodology to assess the economic impact of replacing diesel with a microreactor at a remote mine: 1) a comparative cost analysis and 2) an economic impact analysis (EIA). Part One determines microreactor financial competitiveness against existing diesel generators and estimates the changes in mine revenue and the accompanying changes in community and state tax revenues. For Part Two, we collaborated with the University of Alaska Center for Economic Development (UACED) to conduct an EIA estimating project effects on regional employment and GDP – using the results from Part One and the input-output model tool IMPLAN.

Financial competitiveness against alternatives is a primary consideration for energy projects. Part One utilizes Monte Carlo analysis to assess the financial competitiveness of microreactors and diesel, finding microreactors competitive under expected parameter ranges. The analysis also finds diesel and microreactor competitiveness are highly sensitive to fuel costs and capital expenditures, respectively.

An example of how positive and negative shocks create direct, indirect, and induced effects



A circular flow model of the economy

A project's impact on a region's economy is important for political and public acceptance. Our analysis assumes that the microreactor concept meets the installed and unattended attributes of fission batteries, meaning minimal employment is required to start and operate the reactor. Based on the results from the financial analysis, a microreactor reduces mine expenses over its lifetime. Some of these additional profits are assumed to be shared with the regional Native Corporation, which shares mine ownership. The mine also pays additional taxes and increases regional investment following the current behaviors of regional mines.

These initial "shocks" were run through an IMPLAN input-output model to assess direct, indirect, and induced economic impact on the studied region. Alternative tools include IAEA's EMPOWER and NREL's I-JEDI, which could be used for future research.

Overall, the model results show introducing nuclear microreactor energy reduces total regional employment due to job reductions in the petroleum industry. However, the project results in increased economic activity in the area due to the financial interrelationships between the mine, the regional Native Corporation, and the region's government. As such, the economic results of the study are mixed.

Microreactors are a promising alternative to diesel power in the studied use case, given its technological compatibility with mine needs, expected financial competitiveness, and carbon neutrality. However, it is important to consider the job losses that microreactors could create within a host community. Future research will expand this analysis as more information on microreactors becomes available.

SMR DEPLOYMENT IN DOICESTI, ROMANIA

Nuclearelectrica

Romania plans to deploy a NuScale technology, VOYGR-6™ Small Modular Reactor (SMR) type, by the end of this decade. The project enjoys the support of the Romanian Government through Romania's sole nuclear power company, Nuclearelectrica, in partnership with the U.S. company NuScale.

As a result of a comprehensive study funded by an $1.2 million United States Trade and Development Agency grant to identify potential locations for a SMR plant in Romania, a site was identified on a retired coal-fired power plant location at Doicesti, Dambovita County.

The Project will contribute to Romania's energy security and decarbonation targets, as 4.59 GWe of coal fired plants will be retired by 2032. By reusing the site of the former Doicești thermal power plant and increasing the workforce demand, the new nuclear capacity will bring economic benefits, including new jobs for the community.

It is expected as the first VOYGR-6™ power plant of 462 MWe to generate approximately 200 permanent jobs, 1,500 jobs in construction, and 2,300 jobs in fabrication, also helping Romania to avoid the generation of about 4 million tons of CO_2 equivalent per year. The project also represents an opportunity for the Romanian nuclear supply chain to prove its skills gained with the Romanian Nuclear Program.

Rendering of NuScale plant layout

One major advantage of the NuScale SMR technology is that the modules are factory-manufactured and carried to the site as large oversized components, significantly reducing the time and cost of construction activities. This brings a reduced financial risk for investors, as well as for customers. The increased flexibility versus large

NuScale and Nuclearelectrica Team Agreement Signing at COP26, by Cosmin Ghita, CEO Nuclearelectrica and John Hopkins, NuScale Power Chairman

nuclear plants make this concept a good partner for renewable technologies.

The result is a safer and economical nuclear power plant!

Nuclearelectrica and NuScale will also develop a NuScale Energy Exploration (E2) Center, a dedicated Control Room that will be installed at the University Politehnica of Bucharest to support the training of Romania's next generation of nuclear experts, operators and maintenance staff.

Nuclearelectrica, with its more than 40 years of experience operating two of the most performant nuclear units among the 400+ nuclear units in the world at excellent standards, has a strategy to further develop its civil nuclear program in order to reach the country's energy stability and decarbonation targets. Based on the Integrated National Plan in the field of Energy and Climate Change (PNIESC), Romania plans to reduce CO_2 emissions by 55% by 2030 and its import dependency from 20,8% today to 17,8% in 2030.

Nuclearelectrica's progress in the implementation of the SMR technology developed by the NuScale company, together with the existing and new large nuclear units and continuing with renewable sources, represents a new challenge for the Romanian vision to build a sustainable future for tomorrow's generation and an enhanced security of supply.

THE REFURBISHMENT AND ADDITIONS OF NUCLEAR REACTORS IN CERNAVODA, ROMANIA

Nuclearelectrica

Romania, with its more than 40 of experience operating two CANDU 6™ reactors placed among the most performant nuclear units through the 400+ nuclear units in the world at standards of excellence, has a strategy to further develop its civil nuclear program, in order to reach the country's energy stability and decarbonation targets. Romania plans to reduce CO_2 emissions by 55% by 2030 and its import dependency from 20.8% today to 17.8% in 2030. Meanwhile, up to 4.59GWe of coal capacities will be retired by 2032. Currently, Nuclearelectrica is contributing 33% to the total CO_2-free electricity production in Romania. Also, nuclear energy provides 11,000 jobs, including within the local supply chain, achieving a cumulative turnover of approx. €590 m Euros, with a development program until 2030 of approximately € 8-9 bn.

Cernavoda Units 1 and 2 general view

To achieve its ambitious targets, Romania, through Nuclearelectrica, the sole nuclear power producer of the country, is developing strategic projects like the Refurbishment of Unit 1, development of two more CANDU™ Units (Cernavoda Units 3 and 4), and plans to be the first country in Europe to deploy a NuScale small modular reactor (SMR) of Voyger 6™ type. Those projects, the will increase the nuclear energy contribution to 66% of the clean electricity in Romania.

CANDU reactors have an initial lifecycle of 30 years, which can be extended by another 30 years, following a refurbishment process, and this is what Nuclearelectrica is currently doing for Unit 1, which was put into commercial operation in 1996. Initiated in 2017, the Refurbishment project is implemented in three stages, in accordance with the experience and international practice in the field and is now in phase 2. The last phase, which will be carried out in the period 2027-2029, starts with the shutdown of Unit 1 and consists of the

actual performance of the works in the Unit 1 Refurbishment Project within the facilities of the unit, and its recommissioning.

Among the benefits of the Unit 1 Refurbishment project could be another 30 years of operation as of 2029, at a significantly lower cost among all sources of electricity[1] and more than 5 million tons of CO_2 to be avoided annually.

The CANDU Units 3 & 4 Project in Cernavoda, Romania, is included in the Romania's Energy Strategy, 2019-2030, as well as in the National Integrated Plan in the field of Energy and Climate Change, as a pillar of Romania's energy independence and reaching its decarbonization targets as an EU Member State. Started in 2021 and currently in the preparatory stage, it is estimated that Unit 3 will be put in operation in 2030 and Unit 4 in 2031. The project is developed under a Nord Atlantic cooperation, mentioning the strategic partnership with USA and Canada, following Romania's more than 40 years of partnership with US and more than 70 with Canada in the field of nuclear energy. An EU partnership is also expected.

1 Projected Costs of Generating Electricity 2020 Report by the International Energy Agency and the OECD Nuclear Energy Agency, https://www.iea.org/reports/projected-costs-of-generating-electricity-2020

IMPACTS OF YOUNG PROFESSIONALS ON NUCLEAR ENERGY ADOPTION

International Youth Nuclear Congress (IYNC)

T.M. KELSY GREEN, LENA ANDRIOLO

The roles nuclear power currently plays and will play in future clean energy transitions are important: it is a necessary part of a balanced energy mix, its peaceful uses benefit the welfare of humankind, and it works as a conduit to transfer knowledge from the current generation of leading scientists to the next generation across international boundaries. Young professionals and students play a critical role in energy transitions, and this case study focuses on how youth in the nuclear energy industry are currently engaging their local communities and the global society to galvanize the next steps in clean energy transitions. By studying this topic, countries interested in nuclear energy and nuclear energy adjacent organizations can better meaningfully engage young people.

This case study will leverage the global youth network of the International Youth Nuclear Congress (IYNC) and its member countries (representing Young Generation Networks, or YGNs) to discuss how youth involvement in nuclear energy has a positive impact on local and global communities, ranging from locally

IYNC brought together young professionals and students for a workshop at the University of Michigan in 2019 to discuss how nuclear energy can be part of a low-carbon, balanced energy mix.

organized grassroots events to participation in the most important climate- and energy-related international conferences. Hence, this case study will engage a diverse set of youth from countries with differing stages of nuclear energy infrastructure. Youth activities in countries with developed nuclear power plants, in newcomer countries, and in global contexts will be discussed. Particularly, youth activities related to workforce development, knowledge transfer, educational opportunities, peer mentoring, and community involvement will be presented.

Specifically, this case study will discuss examples of nuclear energy-related, country-level policies and ascertain their effects on youth in relation to education and professional development opportunities (i.e., nuclear workforce development and local business development due to economic benefits of nuclear power) and improvement in environmental outcomes (i.e., air and water quality). The four countries to be studied are the United Arab Emirates, the Philippines, Morocco, and France.

This case study will also include results from a global survey called "The World Young Generation in Nuclear Thermometer," which seeks to understand how young professionals already in the nuclear industry and youth about to enter the nuclear workforce view the nuclear energy industry. Geared with this knowledge, IYNC will suggest strategies and policies to help young professionals and students navigate the industry. Importantly, the case study will provide ways to be involved in the described youth-led initiatives.

NUCLEAR ENERGY IN THE UAE: PROMOTING HIGH-VALUE CAREERS AND INDUSTRIALIZATION

Emirates Nuclear Energy Corporation, United Arab Emirates

The UAE Peaceful Nuclear Energy Program was launched in 2008 and its flagship project – the Barakah Nuclear Energy Plant – began construction in 2012. Since the start, ENEC focused on developing the country's most talented science students, engineering graduates and experienced professionals and providing them with an opportunity to become pioneers of the emerging nuclear energy sector.

Since 2009, ENEC has worked with local educational institutions to develop dedicated training programs for the development of a local nuclear workforce. For example, Abu Dhabi's Khalifa University established the first university-level program in Nuclear Engineering in the region, while Abu Dhabi Polytechnic introduced a Higher Diploma in Nuclear Technology for the training of engineers and technicians.

To support students, ENEC's Energy Pioneers scholarship program offers talented students to develop the specialized knowledge and practical experience to join the industry as a qualified technician,

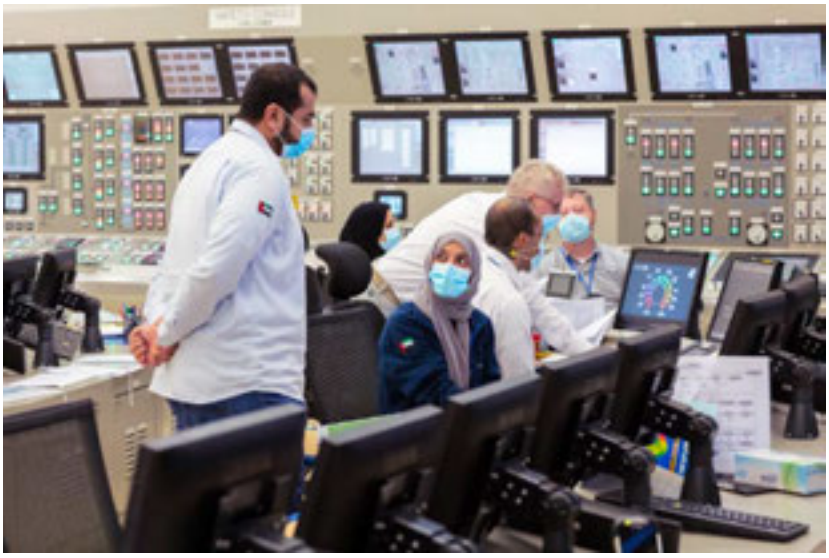


FIGURE 1: Eight certified female reactor operators work at Barakah, all UAE nationals.

FIGURE 2: Reactor operators in the Main Control Room of one of the Units at Barakah.

engineer or operator. To promote the training of nuclear professionals, ENEC also built dedicated training facilities at the Barakah Plant, including four full-scope simulators replicating the main control room of the reactors at Barakah.

The program promotes equity, diversity and youth development by creating high-value career opportunities for UAE nationals to support the UAE's clean energy transition. Working with local educational institutions, ENEC continues to provide training to the future leaders of the UAE Program, as well as build a culture of innovation, research and development. The recent establishment of the Emirates Nuclear Technology Center at Khalifa University provides a platform for stimulating and growing nuclear research and development in the UAE.

ENEC recognizes the importance of investing in people and promoting diversity. With over 3,000 employees from more than 50 nationalities, it is one of the most multinational nuclear energy programs in the world. Approximately 20% of the staff are female, including eight Reactor Operators (out of 157 in total), which is significant for a typically male-dominated industry. ENEC also promotes the role of young people, with more than 40% of staff being under the age of 35 years old. To ensure youth have a voice in the organization, the Barakah Youth Council was established as a committee that engages the youth and acts as a channel of communication between young employees and senior management.

The Barakah Plant will operate for 60 or more years and will continue to provide high value job opportunities for UAE Nationals in various fields, contributing to a knowledge-based economy. ENEC's annual participation in student's forums and career fairs aims to attract more young people to join the country's growing nuclear industry and ensure a sustainable pipeline of talent for the UAE Program for decades to come.

NUCLEAR ENERGY: POWERING THE UAE'S NET ZERO ECONOMY

Emirates Nuclear Energy Corporation, United Arab Emirates

The UAE Peaceful Nuclear Energy Program was launched in 2009 with the objective of delivering clean nuclear energy to the UAE. Prior to this, the country had no existing nuclear infrastructure. Leveraging the nation's experience in delivering large scale construction projects, ENEC promoted the development of a local nuclear supply chain to support the delivery and operation of the Barakah Nuclear Energy Plant.

ENEC continues to work to establish a nuclear supply chain in the UAE. The development of this new economic sector directly supports the nation's economic growth and diversification strategy. ENEC's Industrial Development Team has been supporting UAE companies to ensure they meet the strict quality and technical standards required to tender for contracts for the country's nuclear energy program. Also, in 2021, Abu Dhabi became the first market to offer clean energy certificates (CECs) for nuclear energy, allowing companies to purchase through a quarterly auction to demonstrate their green credentials.

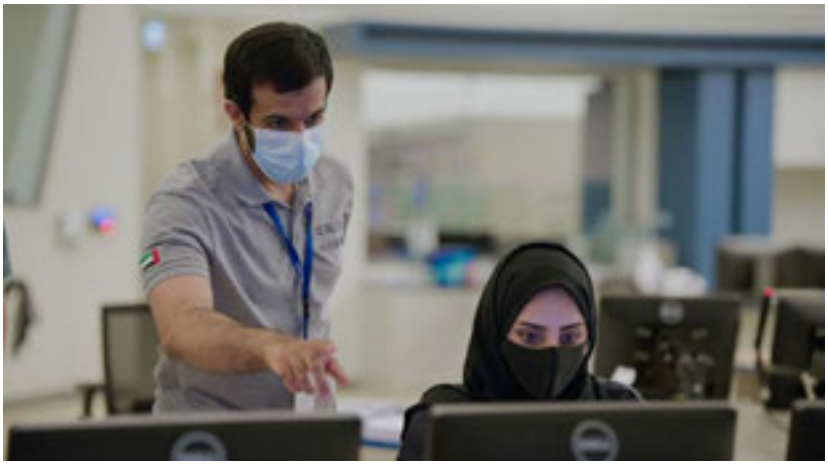


FIGURE 1: Reactor operators in the Main Control Room of one of the Units at Barakah.

Nuclear energy in the UAE presents unique opportunities for local companies to become suppliers to the Barakah Project for its 60 or more years of operations. These companies become nuclear-qualified suppliers, opening them up to deliver goods and services to the international nuclear industry market. ENEC provides support by organizing Supplier Forums, organizing awareness and training sessions, as well as facilitating the signing of Joint Ventures.

Additionally, the CECs allow companies to access ESG funding and grow the net zero economy by further investing in clean energy technologies. The Barakah Plant is the largest source of electricity for the CECs, allowing companies to demonstrate their sustainability credentials by decarbonizing their operations.

UAE companies have been part of the local supply chain since the project's inception. For example, Emirates Steel supplied nuclear-quality rebar to the plant and is the only qualified supplier of nuclear-grade steel products in the Middle East. Also, Ducab manufactures high-quality cables for the Barakah Plant and was awarded a contract for the supply of cables to Shin Hanul-1 and -2 in South Korea.

Up to 2022, ENEC has awarded contracts to local companies worth more than $6.7 billion for the delivery of goods and services to the Barakah project. By mid-2022, three CEC auctions had been held with companies like the Abu Dhabi National Oil Company, Aldar Properties and Emirates Steel purchasing certificates to demonstrate their sustainability credentials. These companies are decarbonizing their operations and gaining access to ESG funding.

Sufficient incentive is required for local companies to qualify their products and services to meet the high standards of the nuclear industry. While the construction and operation of four Units at Barakah is enough for some types of suppliers, others do not find it viable to make the necessary investment. This can be addressed by opening up to other nuclear markets in the region.

FIGURE 2: A school engagement session for young women.

For CECs the challenge will be creating incentives for companies to accept this 'green premium'. Demand from end consumers for green products and services and access to ESG funding create a strong motivation.

QUANTIFYING THE ECONOMIC IMPACT ASSOCIATED WITH INVESTMENTS IN SMR NEWBUILDS IN NUCLEAR NEWCOMER COUNTRIES USING THE IAEA EMPOWER TOOL

International Atomic Energy Agency and Member States

SAIED DARDOUR

Investments in energy infrastructures stimulate construction, manufacturing and engineering services, generating economic growth across a wide range of economic sectors beyond the energy sector. The labor market is also impacted by direct and indirect (or "spillover") effects, which can be estimated and quantified, as illustrated in the joint report of the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), [2] and a recent study of the International Monetary Fund (IMF) [3].

The IAEA developed the EMPOWER (Extended Input-Output Model for Sustainable Power Generation) tool to support the evaluation of the economic impacts associated with such investments [4]. EMPOWER belongs to the class of Input-Output (IO) models [5], commonly used to evaluate the impact of investments in large infrastructure projects, which offer the ability to analyze the effects of exogenous shocks in a relatively simple way (Figure 1).

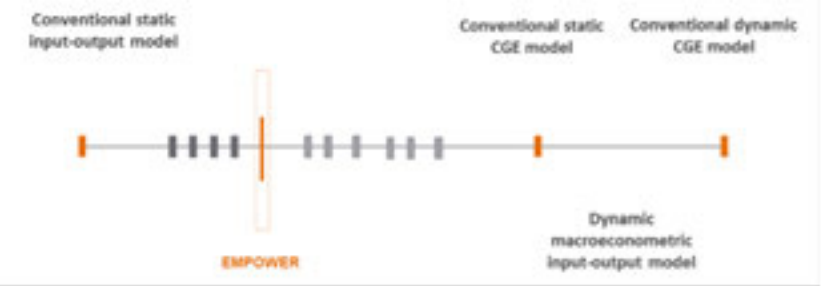


FIGURE 1: EMPOWER vs other macroeconomic impact assessment tools

The IO model was designed to allow the evaluation of macroeconomic impacts during construction and operation. In each of these phases, and depending on data availability and user interest, it is possible to represent four consecutive levels of economic feedback:

- Indirect effects related to the impacts of upstream production.
- Induced effects that consider the response of households to changes in disposable income.
- The response of the labor market.
- Feedback related to options retained for investment financing.

EMPOWER has been applied during the Coordinated Research Project (CRP) [4] to quantify the economic impacts of GW-scale nuclear new build projects in several countries.

Many countries are considering the introduction of Small Modular Reactors (SMR) as part of a robust, cost-efficient, environmentally friendly and low-carbon energy mix that would fulfil the increasing

FIGURE 2: Many countries are considering the introduction of nuclear power to boost reliable and clean energy production and are looking into both SMR and conventional nuclear power reactors. In this photo: construction of Rooppur nuclear power plant in Bangladesh, 2019. (Photo: IAEA)

demand for electricity over the next decades while generating positive social and economic impact.

Tunisia is one of these countries.

The electricity production in Tunisia is almost entirely based on burning natural gas, with a share in the generation mix exceeding 90%. In 2021, nearly 45% of Tunisia's natural gas needs were met through imports, mainly from Algeria [5].

To meet the rising electricity demand (expected to double by 2030) while decreasing the carbon intensity of the produced electricity, Tunisia is considering an increasing reliance on variable renewables (in 2021, only 3% of Tunisia's electricity was generated from hydroelectric, solar and wind [6]) and the introduction of nuclear power.

A preliminary study conducted by Tunisian Utility STEG using EMPOWER [4, 7, 8] suggested that investment in GW-scale nuclear power reactors could add up to 0.2% to the GDP growth rate, and create up to 11,000 jobs during construction, compared to a business-as-usual scenario.

The direct and indirect impact on GDP is even higher during operation - an additional 0.5% GDP growth rate.

In the context of the IAEA Coordinated Research Project on "Economic Appraisal of SMR projects," [1] a Methodological Working Group was set up to explore the applicability of macroeconomic impact assessment tools - including EMPOWER - to SMR projects and to provide a canvas and a framework supporting investigations to be carried out by participating institutions.

For the purpose of this research, generic input-output tables - representing developed and developing economies - will be considered. The simulations will cover both the construction and operation phases for different technologies. Finally, sensitivity analyses will be carried out assuming varying degrees of "localization" (proportion of products and services provided domestically) and sensitive parameters in private consumption.

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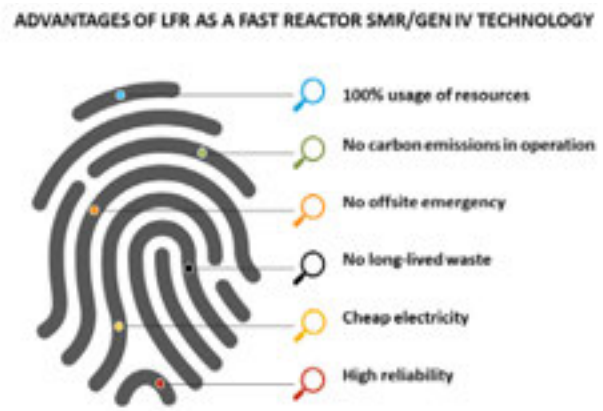
THE ALFRED PROJECT

Nuclear Research Institute, a subsidiary of Technologies for Nuclear Energy, Romania

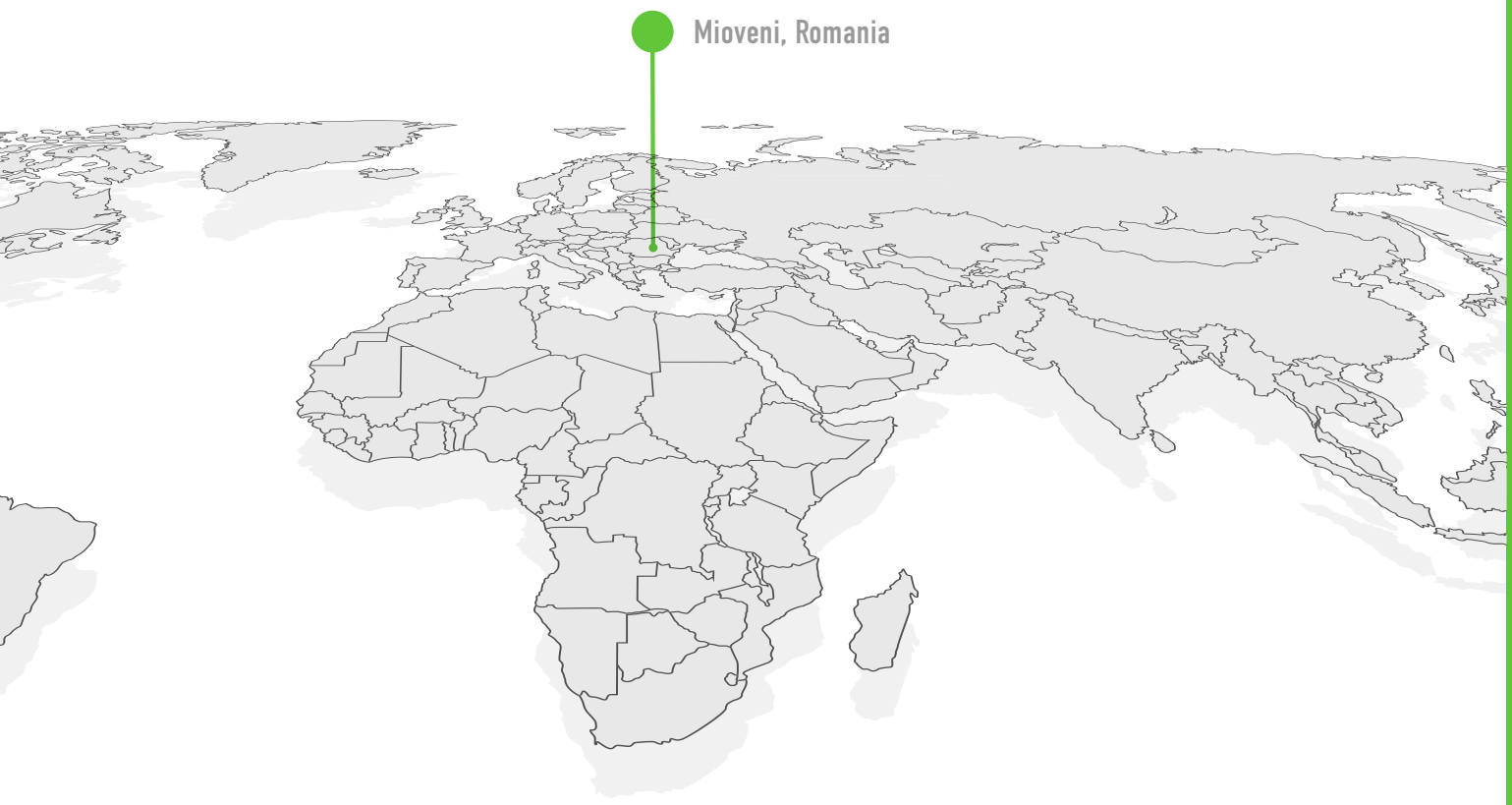
In Romania the energy mix is balanced and dominated by low-carbon energies (hydro, nuclear, renewable), with a share of about 70%. However, many of the classic power plants are at the end of their life and require replacement or upgrading. In the current context, nuclear energy is a stable component, offering a competitive price, zero CO_2 emissions, and the advantage of independence from external resources.

The Advanced Lead Fast Reactor European Demonstrator (ALFRED) project is devoted to the development of new nuclear systems. It is approaching:

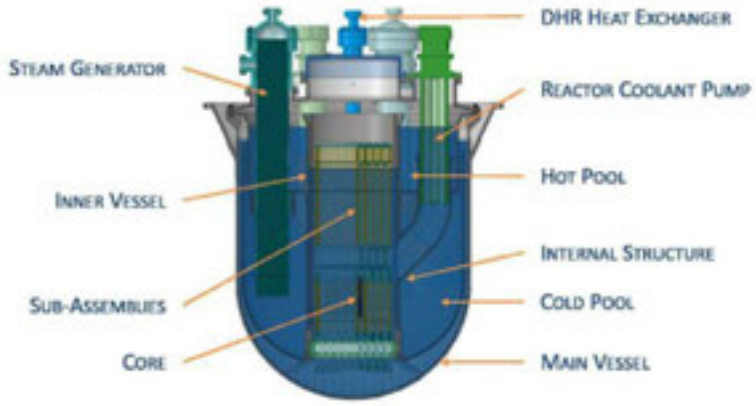
1. The scientific community, with the aim of keeping young talent in the country and in the nuclear field by creating more than 380 new jobs, most of them with high technical specialization. Also, an important increase in R&D activity is expected through the development of the experimental infrastructure.
2. Industry, through the significant demand for components, equipment or services generated by the implementation of the ALFRED project and the commercial development of Lead-cooled Fast Reactor (LFR) technology, which will contribute to the consolidation of the nuclear energy industry on a sustainable trajectory. It is estimated that the construction of the ALFRED reactor and the supporting infrastructure will create over 1000 jobs.
3. The local community of Mioveni, through the impact on the local economy. Considering the aspect of public acceptance, the implementation of the ALFRED project is supported by the community of Mioveni. A Local Dialogue Group was created in the early phase of the project and acts as an interface between the public, local authorities and developers.



The LFR GEN IV technology will provide solutions with additional important advantages related to the nuclear fuel utilization (significant extension of available resources), advanced safety characteristics (no need for offsite emergency response), significant radioactive waste reduction (improved protection for the public health and the environment) or proliferation resistance features. The longer refueling periods and simplified operation and



ALFRED REACTOR VESSEL – COMPACT SMR DESIGN
STEAM GENERATORS INSTALLED INSIDE THE VESSEL



maintenance will be an attractive feature especially for the isolated communities.

By providing a reliable and flexible power generation in a hybrid system with the renewables and a broad range of non-electrical applications, this technology may have an essential contribution to assure a high quality of life and economic development in an environmental justice and equity dimensions.

During this phase the financial scheme of the project is based mainly on the national and European public funds. The progress of present R&D activities and construction of facilities will allow for the development of public/private partnerships as well. The interest in the ALFRED project is reflected by the cooperation agreement concluded by the FALCON consortium with the Romanian nuclear industry represented by ROMATOM.

SMALL REACTORS WITH BIG IMPACT: HOW SMRS CAN BE A SOLUTION FOR TRANSITIONING COAL COMMUNITIES

Nuclear Energy Institute

	Coal Site				NuScale SMR			
Job Type	On-Site Coal FTEs	Total Hourly Wages	Median Hourly Wage	Total Hourly Wages per MWe	On-Site SMR FTEs	Total Hourly Wages	Median Hourly Wage	Total Hourly Wages per MWe
Craft	34	$1,272.73	$37.36	$0.91	64	$2,810.65	$42.64	$3.04
Operators	25	$976.85	$37.19	$0.70	40	$1,846.60	$43.45	$2.00
Laborer	27	$681.25	$24.63	$0.49	55	$1,552.73	$25.35	$1.68
O&M Support	3	$104.09	$36.53	$0.07	49	$1,956.95	$41.74	$2.12
Supervisory	8	$403.20	$50.78	$0.29	10	$551.20	$55.12	$0.60
Professional	6	$280.25	$49.74	$0.20	14	$753.18	$52.96	$0.82
Senior Leadership	4	$263.42	$64.43	$0.19	5	$380.76	$75.62	$0.41
Total	**107**	**$3,981.79**	**$37.19**	**$2.84**	**237**	**$9,852.07**	**$43.45**	**$10.66**

While coal plants face a challenging future, the announced closure of a coal plant does not have to mean "devastation to the local economy." There is an alternative—new nuclear power plants, including small modular reactors (SMRs). SMRs can replace the electricity production from a coal plant with:

- Economical, carbon-free electricity;
- Jobs—more jobs and better-paying jobs;
- Similar performance on the grid, leveraging existing site assets and workforce.

All with benefits concentrated in the local community losing the coal plant.

Like-for-Like Replacement – SMRs are close to a "drop-in replacement," providing a similar profile to the coal plant being replaced.

- **Makes use of the current site location and assets** – A SMR could leverage the existing infrastructure and site assets, ensuring they are not squandered. The interconnection to the electricity grid, switchyard, and access to river/lake as cooling water will be available for use by a SMR. While light water SMRs will have very similar equipment like those used by the coal plant (pumps, turbine generators, etc.), these will likely not be salvageable for the water-cooled SMR.
- **Serves a similar role on the electricity grid** – SMRs provide baseload, dispatchable power with a high-capacity factor. Like the NuScale 12-pack, a SMR would also be large enough (~1,000 MWe) to serve a role on the electricity grid similar to a large coal plant. Therefore, deployment of a SMR would not require a major reconfiguration of the electric grid.

Coal Plant Position	# Dedicated Coal Positions	SMR Position	# Dedicated SMR Positions	Position Type	Degree of Retraining Required
Operations Supervisor	5	Senior Reactor Operator	5	Supervisor	High
Control Room Operator	10	Reactor Operator	15	Operator	High
Field Operator	15	Non-Licensed Operator	25	Operator	Low
Lab Operator/Chemistry/Scrubber	4	Chem Tech	14	Craft	Medium
Maintenance Supervisor	2	Maintenance Supervisor	3	Supervisor	Medium
Mechanical Craft	12	Mechanical Craft	21	Craft	Low
I&C Craft	9	I&C Craft	10	Craft	Medium
Electrician Craft	5	Electrician Craft	11	Craft	Low
Technician	11	Technician	13	Laborer	Low
Security Officer	20	Security Officer	48	Laborer	Low
Sub-Total	**93**		**165**		
All Other Positions	14		72	42 are O&M Support (Planners, Outage, etc.)	Medium
Total On-Site Positions	**107**		**237**		
Possible Centralized Positions			33		
Total Positions			**270**		

Sources: NuScale; ScottMadden analysis

Number of Jobs – According to NuScale, its 12-module configuration with 924 MWe would provide 270 jobs, of which approximately 237 would be on-site jobs, well in excess of a typical 1,000-MWe coal plant. These jobs would exist throughout the life of the plant, for more than 40 years. Focusing only on the on-site jobs (vs. industry-wide USEER data) and using U.S. Bureau of Labor Statistics (BLS) data, the median hourly wages for on-site SMR jobs would pay a premium of approximately 17% and, accounting for the greater number of jobs, yield more than double the annual labor spend of a comparable coal plant.

Similar Jobs and Limited Retraining – Many of the SMR jobs, particularly craft jobs, require similar skills to those of typical coal plant staff. Like coal plants, SMRs require operation and maintenance of plant equipment (pumps, valves, welding, etc.). These jobs would require some retraining, but they would not require wholesale repurposing of the workforce to a totally different job type (e.g., information technology sector). The vast majority of jobs in a SMR have coal plant equivalents that would likely require low to medium levels of retraining.

SMR deployment is not certain. To achieve these benefits, some action will be needed:

- Nuclear in general and SMRs specifically must be acknowledged as a zero-carbon solution.
- SMRs will need federal and state policy support to get beyond first-of-a-kind challenges.
- Clean energy incentives should be targeted to solutions that re-employ people.
- Local communities should receive support and funding to assess SMRs as an option.

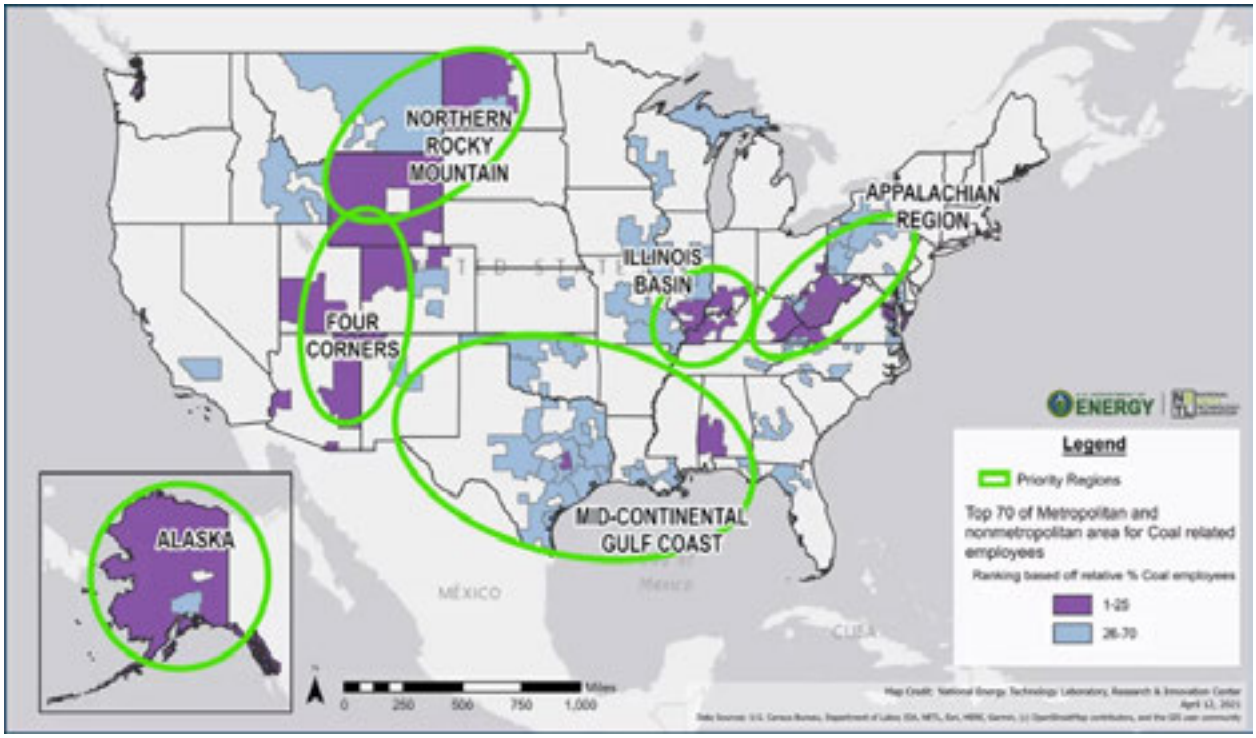
RURAL TWO-UNIT COAL STATION LOCATED ADJACENT TO TRIBAL LANDS

Gateway for Accelerated Innovation in Nuclear (GAIN)

Close to 100,000 MW of coal-fired electric generating capacity in the United States will retire over the next decade as the industry moves to achieve carbon emission reduction goals and shift to a clean energy economy. Retirements can introduce unintended and undesired effects on the electrical grid, regional economics, and negative impacts to local communities. GAIN is working with utilities and communities to consider and evaluate opportunities to utilize past investments in the facilities, supporting infrastructure and local staff. Efforts have been focused on the communities identified in the chart from Interagency Working Group on Coal Communities. An especially attractive option is to look forward, deploy innovative technology, and repurpose these coal plants with advanced nuclear power plants including small modular reactors (SMR). These advanced reactor designs can utilize some existing infrastructure, maintain many similar high paying jobs, contribute to a greener energy portfolio, and reduce carbon emissions. These advanced nuclear power plants also will contribute to resiliency of the electric grid through the distributed siting of "always on" sources of electricity generation.

Station A, owned and operated by Utility A, is a two-unit coal plant located in a small rural town (Town A) with a population of approximately 3500 people. To reduce carbon emissions, Station A is scheduled to shift to seasonal operations by 2025 and retire in 2030. Town A is currently reliant on Station A as a source of jobs and economic stability. Station A currently employs approximately 130 personnel (mix of Town A residents and residents from surrounding areas).

To reduce impacts of Station A retirement, Utility A and Town A are investigating potential replacement technologies/ infrastructure. GAIN partnered with Utility A and Town A to conduct a coal to nuclear repurposing study in parallel with Utility A's assessment of non-nuclear replacement technologies.

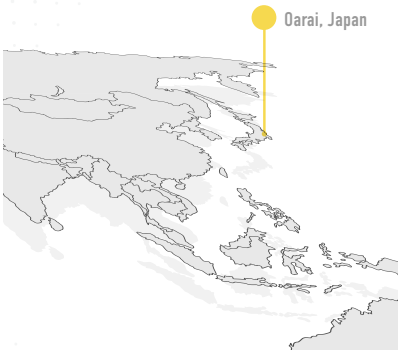


The GAIN coal to nuclear repurposing study consists of a detailed siting assessment, a nuclear technology assessment, and an economic impact analysis. In addition, together with Utility A and Town A, GAIN is also supporting conversations with the local community, the state, and nearby tribal nations to address questions related to nuclear. The objectives of the study are summarized below. The GAIN team is actively working on the assessment and plans to complete the work this calendar year (by the end of 2022).

- Understand if the Station A site is suitable for coal to nuclear repurposing. Determine if there are any fatal flaws/major roadblocks.
- Increase Utility A's and Town A's familiarity/understanding of the candidate nuclear technologies being considered for coal to nuclear repurposing.
- Identify the potential economic benefits associated with Station A coal to nuclear repurposing. Identify beneficial activities that could occur/take place during a potential time gap. Identify companion industries/opportunities that could help support economic stability/development.
- Understand what is being done to advance nuclear technologies, supporting infrastructure, supply chain, the grid, etc.
- Promote sharing of lessons learned and establish a connection with utilities/plants/communities impacted by coal plant retirements and/or considering coal to nuclear repurposing.
- Identify preferred nuclear technologies and related projects to start monitoring.

THE HTTR: THE WORLD'S FIRST HTGR TEST REACTOR FOR HYDROGEN COGENERATION

Ministry of Economy, Trade and Industry, Japan



The Ministry of Economy, Trade and Industry (METI), in collaboration with other ministries and agencies, formulated the "Green Growth Strategy" to achieve a carbon-neutral, decarbonized society by 2050.

In the process of heat production, for instance, burning fossil fuels should be substituted for alternatives with low-carbon emission. Hydrogen will play a dominant role in the decarbonization of the field. Particularly, the use of hydrogen as a substitute for coke as a reducing agent is considered to be promising to reduce CO_2 emissions in the steel making sector. To realize the "zero-carbon steel" technology, a stable supply of a large amount of carbon-free hydrogen with a competitive cost is necessary.

Towards the decarbonization, the Green Growth Strategy sets a target of increasing renewables' share of power generation from 50% to 60% in 2050. To enable such high renewable penetration levels on the electric grid, the imbalance between the generation of the intermittent renewable sources and demands have to be managed.

The High Temperature Gas-cooled Reactor (HTGR) is expected to take an important role in attaining carbon neutrality by 2050 due to its inherent safety characteristics and high temperature heat supply capability. Because of such unique features, HTGR can produce 80,000 tons of hydrogen per year, and the expected production cost in 2050 is $1 U.S./kg with a combined use for power generation and heat supply.

An HTGR cogeneration plant has the potential to supply large-scale, stable and cost-competitive carbon-free hydrogen. A previous study showed that five units of HTGR cogeneration plants can meet hydrogen demand in a standard steel plant in Japan, and CO_2 emissions from the steel plant can be eliminated.

Furthermore, an HTGR cogeneration plant that consists of an HTGR, helium gas turbine and hydrogen production plant can be used to compensate for the intermittent and perturbating performance

FIGURE 1: An HTTR inspection.

FIGURE 2: The local community participating in a cleanup activity.

of the renewable resources on power system stability. The plant can follow the daily and hourly load variations of the renewable energy with constant reactor power and power generation efficiency by allocating heat generated in the reactor to gas turbines and hydrogen production plants upon request, depending on the power generation rate.

Moving toward the commercial deployment of HTGR cogeneration plants, a safety design of an HTGR for the coupling of hydrogen production plants which allows hydrogen production plants to be constructed under conventional chemical plant regulations should be established from an economical point of view. However, chemical plants have never been coupled to nuclear reactors directly so far.

In order to establish the safety design, Japan Atomic Energy Agency has started the world's first nuclear hydrogen demonstration project using the High-Temperature Test Reactor, an HTGR test reactor located in Oarai, Japan. It is expected that the safety design will be established through reviews of changes to the reactor installation of the HTTR in conformity to the New Regulatory Requirements. Finally, this project will demonstrate the performance of components required for coupling between HTGR and hydrogen production plants, such as high temperature isolation valves, hot gas duct, etc.

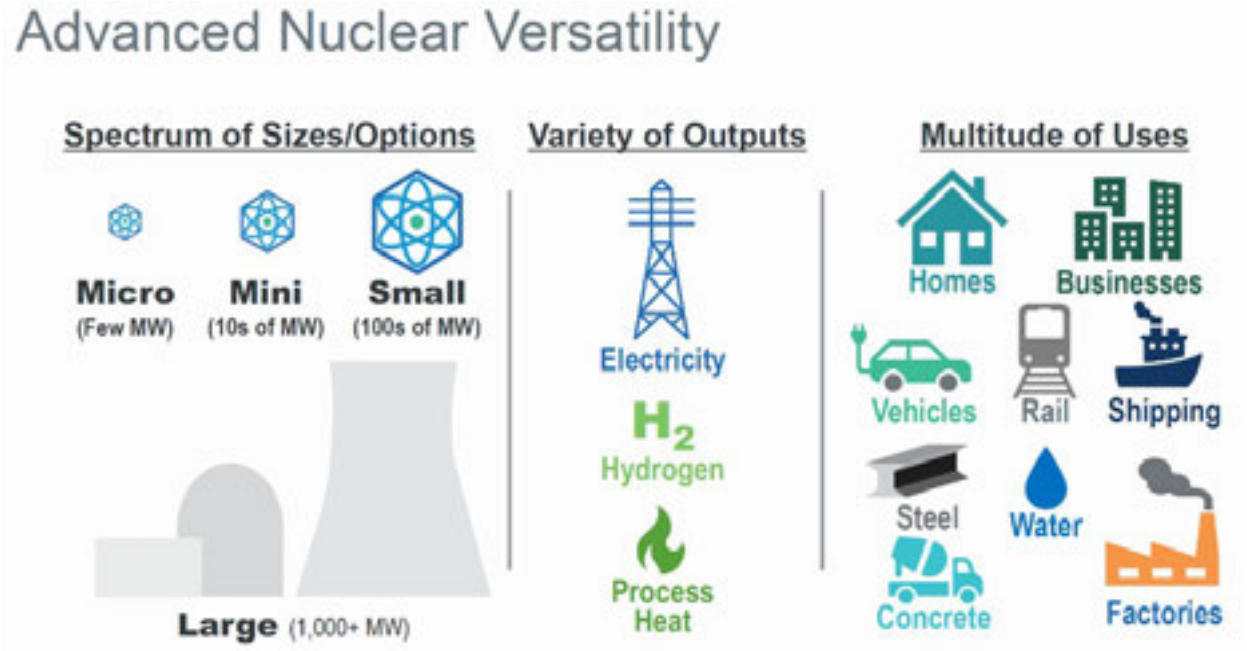
BENEFITS BEYOND ELECTRICITY: FOUR-UNIT STATION IN COAL DEPENDENT STATE

Gateway for Accelerated Innovation in Nuclear (GAIN)

The GAIN Coal to Nuclear Transition project is completing several specific coal to nuclear transition project evaluations, working closely with community and utility participants. Evaluating, planning for, and completing the deployment of an advanced nuclear power plant is a complex task for a power company and a new undertaking for most of the impacted coal communities. These projects require need specialized knowledge, expertise, and capability. Critical to the evaluation and planning is engagement with the community to understand and incorporate their vision for a successful transition of the coal station.

These evaluations are intended to serve as a catalyst and integrator for the related efforts to support and enable successful repurposing, actively working to stimulate, accelerate, and optimize potential coal to nuclear repurposing projects. GAIN's efforts are intended to:

- Enable local communities and entities to capture the important economic benefits of a coal to nuclear conversion (including benefits beyond electricity)
- Enable potential owner/operators to select the appropriate sites for a coal to nuclear conversion that provides the best return on investment
- Enable and accelerate the transition to a new and greener energy future



Station B, owned and operated by Utility B, is a four-unit coal site located in an industrial area (i.e., Community B) in a state that is currently dependent on coal generation (i.e., State B). Station B operates in a competitive market and is responsible for providing reliable, safe, and low-cost electricity to Utility B customers. Station B also provides byproducts (i.e., fly ash and gypsum) to local industries/manufacturers.

Station B is scheduled to retire within the next 20 years, and the surrounding area has no capacity for natural gas. Repurposing the coal site for advanced nuclear technology appears to be a viable option that could meet generation requirements and provide benefits beyond electricity (i.e., heat, steam, hydrogen). However, additional investigation/evaluation is required to confirm feasibility.

GAIN is supporting Utility B to finalize the scope of the GAIN coal to nuclear repurposing study. However, the scope of work is intended to include a feasibility assessment (that builds off a fatal flaw analysis conducted by Utility B) and a detailed assessment of advanced nuclear technologies' benefits beyond electricity to help inform a path forward/identify actions that Utility B, State B, and/or Community B can take now to reduce risk.

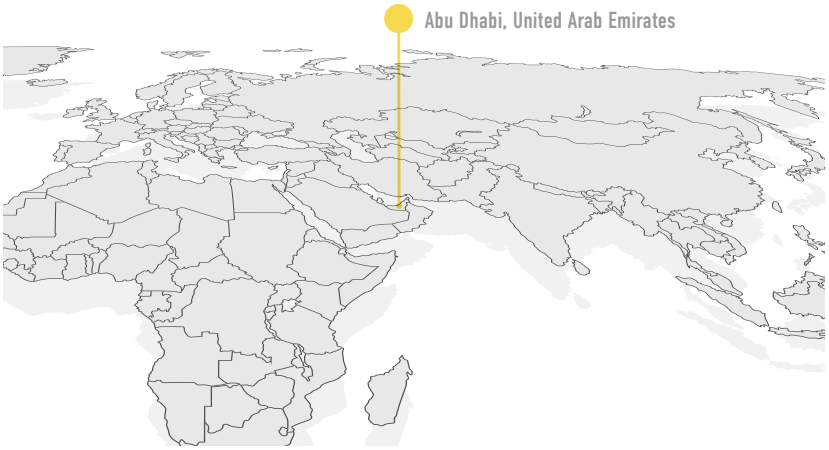
THE UAE'S BARAKAH PLANT IS A REGIONAL GREEN POWERHOUSE

Emirates Nuclear Energy Corporation, United Arab Emirates

The UAE Peaceful Nuclear Energy Program was launched in 2009 with the objective of delivering clean nuclear energy to the UAE. Its flagship project, the Barakah Nuclear Energy Plant, is already operational and generating abundant electricity to meet the country's growing demand while reducing greenhouse gas emissions.

The Barakah Plant is just the beginning – nuclear energy has a greater role to play in the UAE's Net Zero future. ENEC's wider mission is to explore and incubate strategic investments in nuclear energy that support the growth and development of the country.

The UAE is transitioning from a petroleum-based economy to one based on knowledge and innovation. Nuclear science and technology present the UAE with numerous opportunities for research and development activities to support both the UAE nuclear program, international initiatives and research needs as well as non-energy sector nuclear research.



To continue advancing innovation in the nuclear energy sector, ENEC is promoting an R&D program which seeks to capitalize on the aspects of nuclear science that create high-value jobs and a knowledge-based economy. As part of the Program, ENEC is exploring long-term investments for energy portfolio diversification through clean hydrogen generation, small modular reactor technology and next generation reactors as well as non-energy applications of nuclear technology.

For example, the four Units of the Barakah Plant have the potential to generate up to 1 million tons of hydrogen per year, contributing significantly to the nation's Net Zero 2050 targets.

These initiatives will establish new areas of innovation for the UAE to further develop its expertise as a regional pioneer of nuclear science and technology. It will also generate further career and investment opportunities at home and abroad.

FIGURE 1: Outreach at the Al Dhafra Dates Festival, located in the region of the Barakah Plant.

FIGURE 2: Reactor operators in the Main Control Room of one of the Units at Barakah.

The development of nuclear energy in the UAE creates opportunities that have been included as part of ENEC's R&D Program. The Barakah Plant acts as a bridge to other clean energy technologies and is a catalyst for innovation.

ENEC is seeking to promote innovation in nuclear energy and non-energy applications. The generation of clean hydrogen, research into small modular reactors and next generation reactors, as well as other applications of nuclear science, offer significant potential to secure the UAE's continued energy leadership, promote further decarbonization and create additional economic value.

Furthermore, the use of nuclear technology in sectors such as agriculture, space exploration and medicine directly support the UAE's goals and targets. ENEC's R&D Program includes these as research focus areas to ensure maximization of value and nuclear expertise in the country.

Challenges include the fact that research and development programs into new and innovative technologies require large up-front investments without an immediate benefit, though they do produce results further down the road. This can be addressed by dedicating a portion of the revenue from the electricity generated at Barakah for specific R&D initiatives to ensure funding in available.

R&D Programs also require the development of expert staff and seeking inputs from expert team members across the organization. This challenge can be addressed through advanced planning and human capacity building.

The NICE Future initiative provides a valuable platform for exchanging experiences in energy transitions that can make policymakers around the world more comfortable, and thereby help accelerate action. The purposes of this initiative also aligns well with recommendations from IEA's recent work, including the 'Global Commission on People-Centred Clean Energy Transition' and the key messages of our newly released 'Nuclear Power and Secure Energy Transitions' and 'IEA World Energy Employment' reports.

Dr. Fatih Birol

Executive Director of the International Energy Agency

As a partner organization, the IAEA is supporting the Nuclear Innovation Clean Energy (NICE) Future initiative under the CEM as it offers a forum to discuss the benefits of nuclear power in the transitions towards clean energy systems. After contributing to the Flexible Nuclear Campaign, the IAEA is going to contribute to the campaign Research Impacts on Social Equity and Economic Empowerment (RISE3), by sharing the Agency's work on the macroeconomic impacts of nuclear investments, in terms of economic growth and job creation. The contribution will focus on the analyses of the impact of investments in innovative reactor technologies such as Small Modular Reactors, to demonstrate their contribution to a Just Transition for communities that are dependent on fossil fuel activities. The IAEA is ready to provide more case studies to this campaign.

Rafael Grossi

Director General, International Atomic Energy Agency

All technological development takes place in societal contexts. In the case of nuclear technology, these contexts are interwoven with the prospects for success of new and innovative technologies. Small modular reactors and Generation IV systems may prove to be game changers that enable economic growth while protecting the environment, but they cannot succeed unless they fit the societal needs and expectations. Understanding the social and economic impact of new nuclear technologies will help put these innovations into a complete context, highlighting the value they can bring to communities and everyday life. Innovative nuclear technologies can replace fossil fuels, creating far more healthy air for the women, men, and children who live nearby. They can provide clean, reliable and cost-effective heat and electricity to remote communities, opening to them new economic opportunities.

The case studies assembled by Nuclear Innovation: Clean Energy Future (NICE Future) under the aegis of the Research Impacts on Social Equity & Economic Empowerment Demonstration (RISE3D) will help gather experience and perspectives. The insights this work will provide will give us a more complete picture of the potential of nuclear innovation to improve the quality of life for people and communities around the world.

William D. Magwood, IV

Director-General, OECD Nuclear Energy Agency

On behalf of the members of the International Framework for Nuclear Energy Cooperation (IFNEC) I am pleased to celebrate the inception of RISE3D, which will provide an action-oriented opportunity for countries to work together to provide the tools and innovation needed to support underserved communities aspiring to change the trajectory of the quality of life, energy diversity and energy security for generations to come. This aligns well with IFNEC's values, priorities and mission while contributing to a broader partnership that will indeed benefit all of us as citizens of the world. Now more than ever, we need to make sure that we support each other as we deploy advanced reactor technologies, leverage them in integrated systems and ensure that the use of nuclear energy for peaceful purposes meets the highest standards of safety, security and nonproliferation.

I am excited about the case studies that will kick off the RISE3D project and look forward to supporting this living body of insights, experiences and lessons learned. I am grateful that RISE3D is a creative mechanism for countries and organizations to contribute. We look forward to supporting this engaging and important campaign!

Aleshia Duncan

International Framework for Nuclear Energy Cooperation Chair and Deputy Assistant Secretary for International Nuclear Energy Policy and Cooperation

NICE Future NUCLEAR INNOVATION: CLEAN ENERGY

AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

GLOBAL CLEAN ENERGY ACTION FORUM

CEM13/MI-7 USA 2022

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