Beyond energy: Nuclear innovations in medicine, agriculture, and more

Chair:
Tim Yeo
Chairman
New Nuclear Watch Institute

Speakers:

Ben Holtzman
Program Advisor, New Reactors & Advanced Technology, Nuclear Energy Institute

Simon Wakter,
Senior Advisor, Nuclear Technology - Nuclear Safety & Licensing, AFRY

Ryan Collyer
Chief Executive Officer, Rosatom Central and South Africa

Qu Liang
Director, Department of Nuclear Sciences and Applications, Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture

8 December 2021

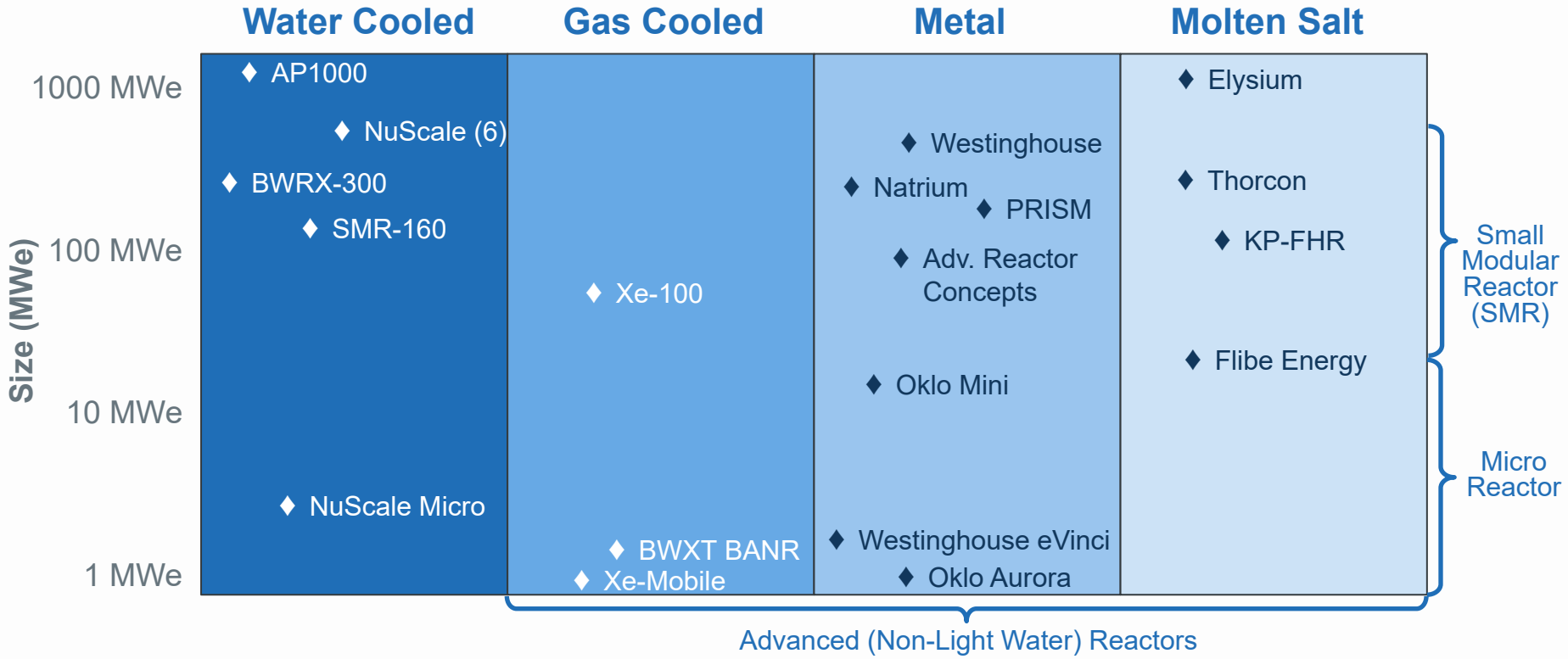
BEYOND ENERGY: NUCLEAR ENERGY IN A ZERO CARBON WORLD

Ben Holtzman
NEI

December 8, 2021

NUCLEAR ENERGY INSTITUTE

Advanced Nuclear Technologies*

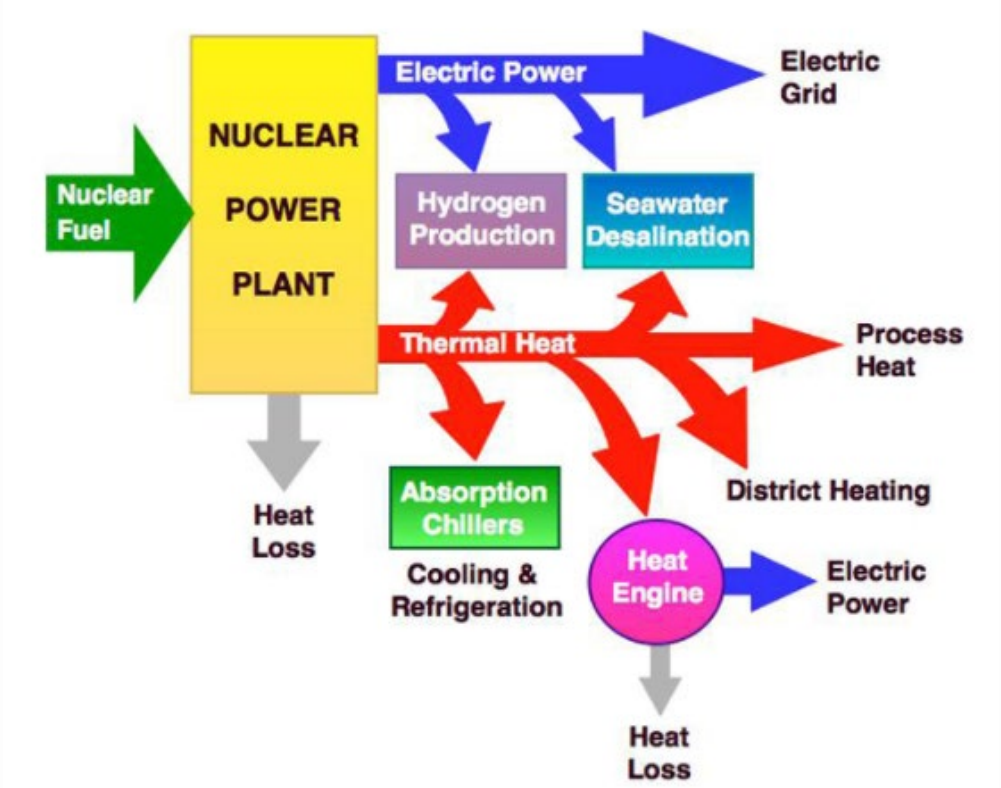


* - partial list of technologies

Nuclear Cogeneration Opportunities

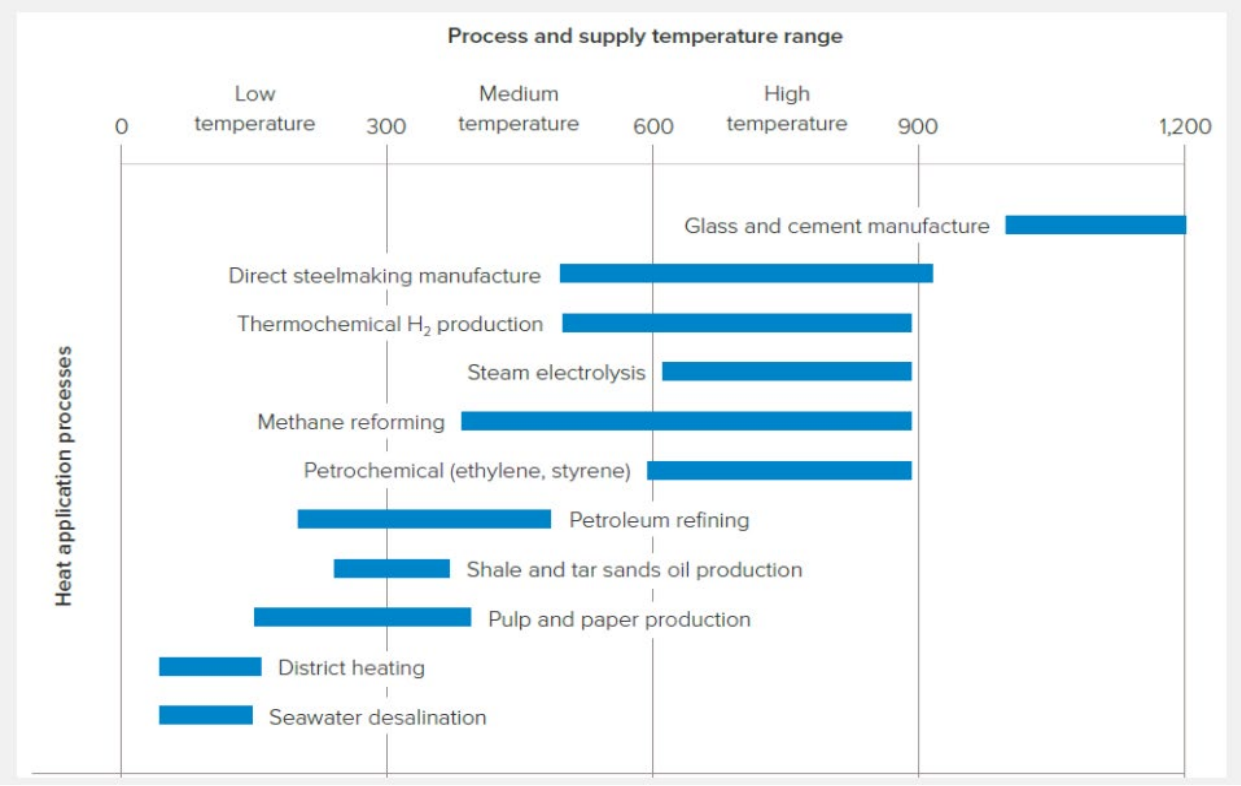
Sample Applications

1. Desalination
2. Hydrogen production
3. Synthetic fuel production for transportation systems
4. Production of heat and hydrogen for industrial processes
5. Fertilizer production for the agricultural sector
6. Production of medical isotopes



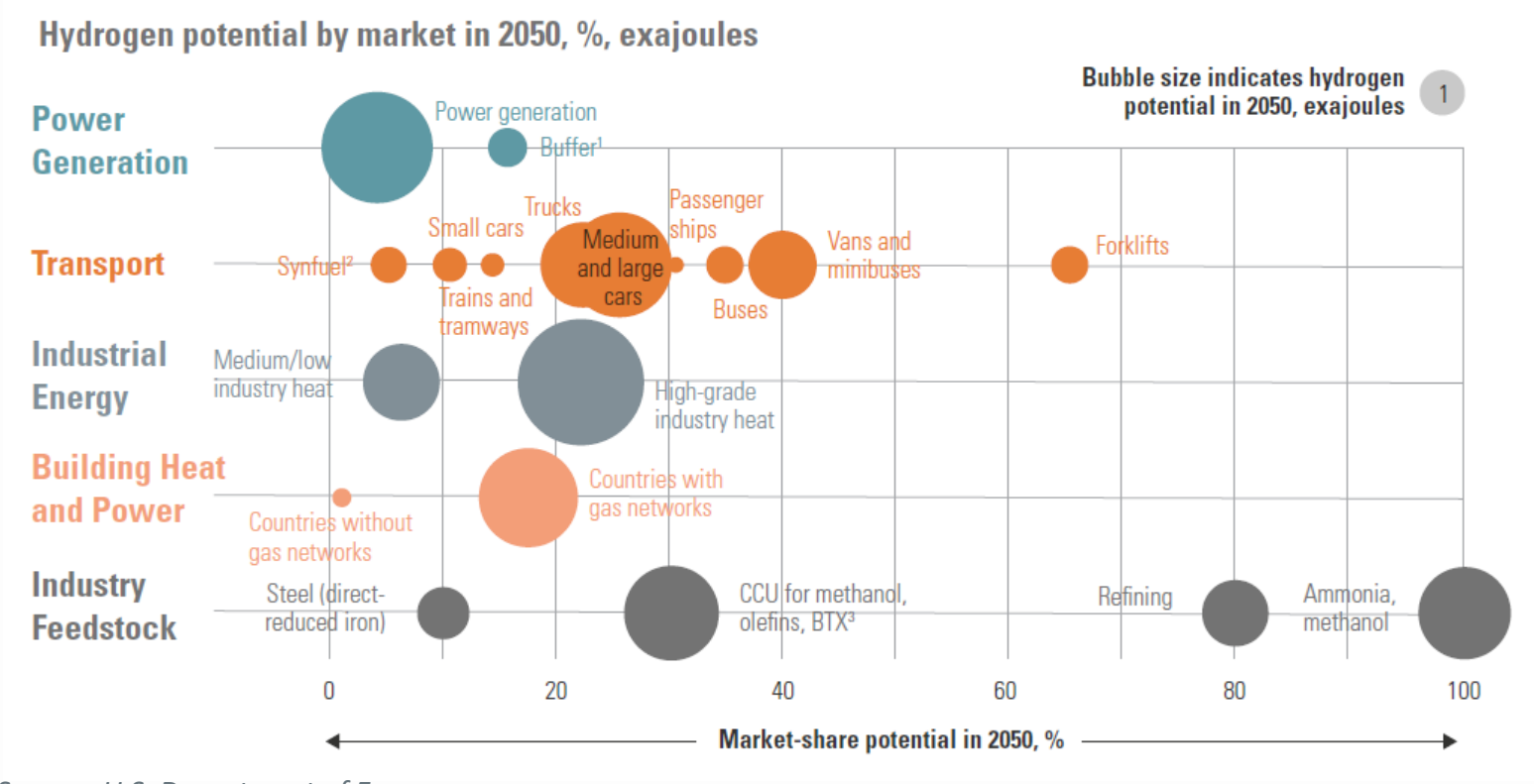
Source: *International Atomic Energy Agency*

Commercial Market Applications



Source: *Nuclear Cogeneration, civil nuclear energy in a low-carbon future*, The Royal Society, October 2020

Hydrogen Market Potential



Source: *U.S. Department of Energy*

Advanced Nuclear Versatility

Spectrum of Sizes/Options

Micro (Few MW)

Mini (10s of MW)

Small (100s of MW)

Large (1,000+ MW)

Variety of Outputs

Electricity

H_2 Hydrogen

Process Heat

Multitude of Uses

Homes

Businesses

Vehicles

Rail

Shipping

Steel

Water

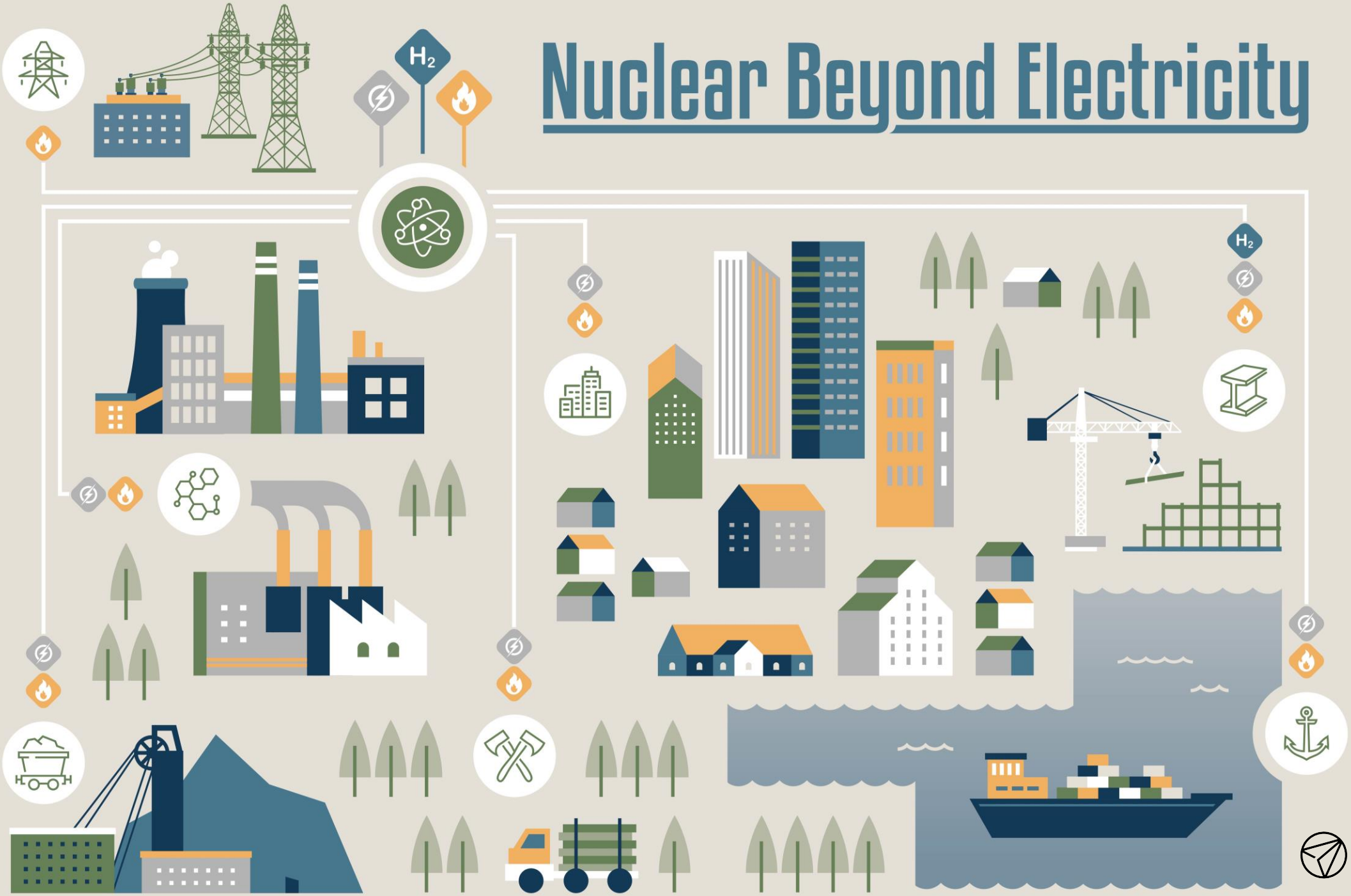
Concrete

Factories

THANK YOU

By Third Way, GENSLER

Nuclear Beyond Electricity



AFRY
ÅF PÖYRY

DISCLAIMERS AND RIGHTS

NOTHING IN THIS REPORT IS OR SHALL BE RELIED UPON AS A PROMISE OR REPRESENTATION OF FUTURE EVENTS OR RESULTS. AFRY HAS PREPARED THIS REPORT BASED ON INFORMATION AVAILABLE TO IT AT THE TIME OF ITS PREPARATION AND HAS NO DUTY TO UPDATE THIS REPORT.

AFRY makes no representation or warranty, expressed or implied, as to the accuracy or completeness of the information provided in this report or any other representation or warranty whatsoever concerning this report. This report is partly based on information that is not within AFRY's control. Statements in this report involving estimates are subject to change and actual amounts may differ materially from those described in this report depending on a variety of factors. AFRY hereby expressly disclaims any and all liability based, in whole or in part, on any inaccurate or incomplete information given to AFRY or arising out of the negligence, errors or omissions of AFRY or any of its officers, directors, employees or agents. Recipients' use of this report and any of the estimates contained herein shall be at Recipients' sole risk.

AFRY expressly disclaims any and all liability arising out of or relating to the use of this report except to the extent that a court of competent jurisdiction shall have determined by final judgment (not subject to further appeal) that any such liability is the result of the wilful misconduct or gross negligence of AFRY. AFRY also hereby disclaims any and all liability for special, economic, incidental, punitive, indirect, or consequential damages. **Under no circumstances shall AFRY have any liability relating to the use of this report.**

All information contained in this report is confidential and intended for the exclusive use of the Recipient. The Recipient may transmit the information contained in this report to its directors, officers, employees or professional advisors provided that such individuals are informed by the Recipient of the confidential nature of this report. All other use is strictly prohibited.

Presenter

SIMON WAKTER

Senior Advisor, Nuclear Energy
simon.wakter@afry.com
+46 10 5051594

INDUSTRIAL & DIGITAL SOLUTIONS

Advanced Automation
Connected Products
Automotive Design & Engineering
Food & Pharma
IT Solutions
Specialized Technical Services
Systems Management

ENERGY

Renewable Energy & Thermal Power
Hydro
Transmission & Distribution
Nuclear
Contracting

INFRASTRUCTURE

Transportation
Buildings
Project Management
Water
Environment
Architecture & Design

PROCESS INDUSTRIES

Bioindustries
Chemicals
Pulp, board, paper & tissue
Mining & Metals
Smart solutions:
– Health & Safety
– Sustainability
– AFRY Smart Site & digitalisation

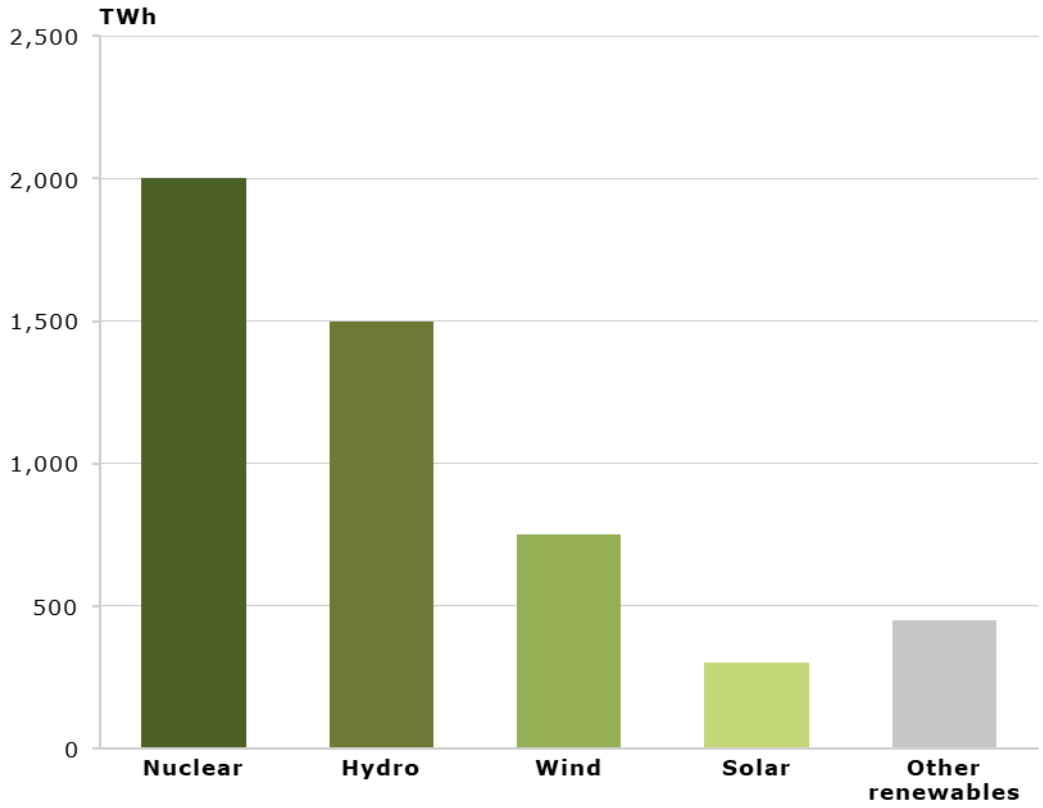
MANAGEMENT CONSULTING

Energy Sector
Bioindustry Sector
Market Analysis
Strategic Advice
Operational Excellence
M&A and Transactions

AFRY
ÅF PÖYRY

Nuclear renaissance 2.0?

LOW CARBON ELECTRICITY GEN. IN ADVANCED ECONOMIES



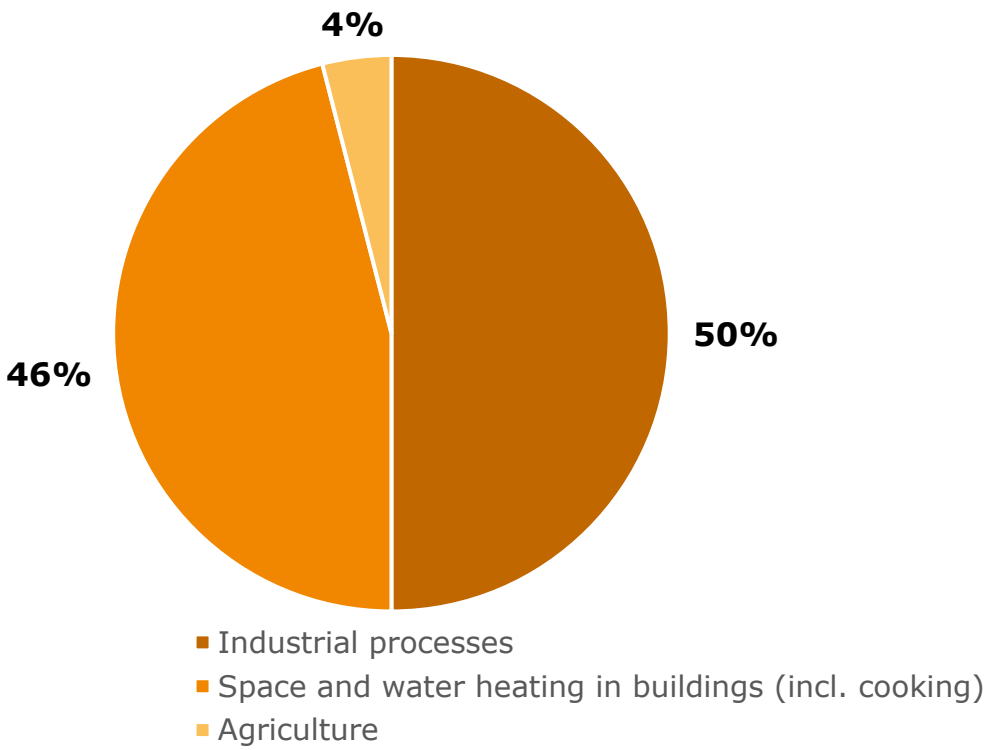
AN IMPORTANT ROLE IN GLOBAL ELECTRICIY PRODUCTION

- Nuclear energy currently produces 10 % of global electricity.
- Nuclear is the main source of fossil free electricity in advanced economies
  - providing 40 % of fossil free electricity in advanced economies overall and approximately 50 % in the EU and the USA
- There is a strong and growing interest in new reactors as a way to decarbonise electricity and energy supply
- Upwards of 100 different reactors with a wide variety of designs and technologies have been developed in both emerging and mature nuclear markets

AFRY
ÅF PÖYRY

Heat is the largest energy end-use

- Heating for our homes, industry and other applications accounts for half of our total energy consumption.
- Heating contributes 40 % of global carbon dioxide emissions.
- More than anything else, the real strength of nuclear energy is providing large amounts of low-carbon heat at very competitive prices.



AFRY
ÅF PÖYRY

Three reasons to care and to pay attention

1

PLANNED DEPLOYMENT OF SMRs

Several small modular reactors (SMRs), both conventional and advanced reactors, have planned deployment of FOAK units before or around 2030. Smaller reactors with higher temperatures are well suited for a range of industrial applications, both financially and technically.

2

DE-RISKING DECARBONISATION

Countries and companies face a serious challenge decarbonising, and especially heat. The scale and challenge is immense and for many industrial applications nuclear may be only credible non-carbon option.

De-risking the decarbonisation journey – both for countries and companies.

3

REALISING THE POTENTIAL OF NUCLEAR ENERGY

I – Different set of solutions depending on whether the goal is to definitely quickly reduce emissions short term or to definitely reach zero emissions.

II – Different solutions depending on whether you hope to maybe reach net zero or if you can't afford not to.

III – How can we work to realise this potential? Largely demonstrated technologies – both on their own and in full-scale applications since several decades – which now need to be enabled and implemented in reality.

AFRY
ÅF PÖYRY

Nuclear Beyond Electricity

- Initiative by research organisation Energiforsk
  - Technical report and popular science brochure
  - Conference theme, January 25-26th

  https://energiforsk.se/konferenser/kommande/nuclear-beyond-electricity/

1. Background
   - Initiatives and activities
2. Exploring three applications
   - Hydrogen production
   - Integration of SMRs in steel production
   - Opportunities for existing nuclear power plants

AFRY

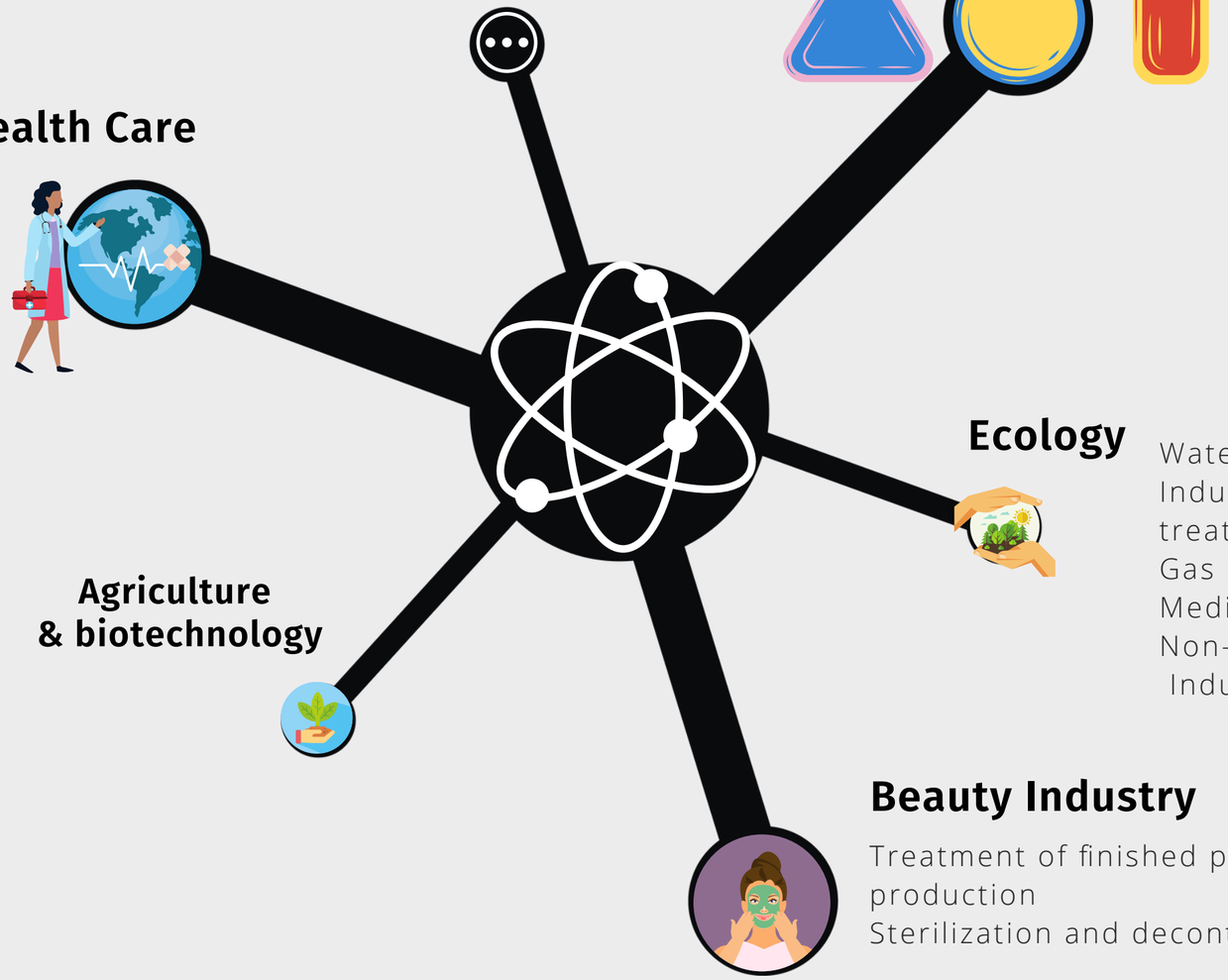
ÅF PÖYRY

NUCLEAR INNOVATIONS IN MEDICINE, AGRICULTURE, AND MORE

Ryan Collyer, CEO Rosatom
Central and Southern Africa

ROSATOM

BROAD FIELD OF APPLICATION



Other

Products irradiation for long - team storage
Strategic deposits (skin, textile, food products)
Archive documents, museum artefacts
Books processing

Chemistry

Oil cracking
Biofuel production
Composite materials production
Modification of polymers and polymeric products

Health Care

Sterilization and decontamination
Pharmaceuticals and components
Hygiene products
Biologically active supplements
Medical products
Implants and transplants
Blood and its components

Ecology

Water treatment
Industrial plants sewage treatment
Gas purification
Medical wastes disinfection
Non-destructive testing
Industrial radiography

Agriculture & biotechnology

Crop yield and planting
Material enhancement
Grain disinfection
Decontamination:
Food products
Animal feed
Enhancement of slow processing food industry

Beauty Industry

Treatment of finished products and raw materials for makeup production
Sterilization and decontamina- tion of perfumery products

ROSATOM

Agriculture and food industry

Plants

- Improved germination
- Increased yield
- Accelerated maturation

Animals

- Survive better
- Grow faster
- Have higher productivity

ROSATOM

DELAY SPROUTING

- Uniformity of treatment
- Long-term effect
- Single treatment
- Cost effective
- Environmentally sound

- Potato
- Onion
- Garlic
- Carrot
- Jerusalem artichoke
- Sweet potato

DISINFESTATION WITH RADIATION

- No adaptation
- Full extermination
- Uniformity of treatment
- Single treatment
- Cost effective
- No harm to human and environment
- Dried fruits can be treated

- Grain
- Beans
- Flour
- Cereals
- Dried fruits

Extend Shelf Life and Delay Ripening

Does radiation destroy beneficial nutrients and create toxic compounds?

No, it doesn't. With doses used the nutritive value of food is not affected. Food is completely safe to eat.

Does the irradiation process make food radioactive?

No, it doesn’t. Irradiation passes through substance, nothing remains inside.

ROSATOM

SIT – Sterile Insect Technique

Pest Control

1. **Specially reared or captured insects are irradiated**
2. **Males become sterile**
3. **Sterile insects are released into the wild**
4. **Rates of reproduction effectively reduced**

Screw-worm fly
Florida, 1962
Venezuela, 1964

Tsetse fly
Zanzibar, 1997
Ethiopia, 2012

Mosquito vector
for Zika virus
(under development)

ROSATOM

Healthcare

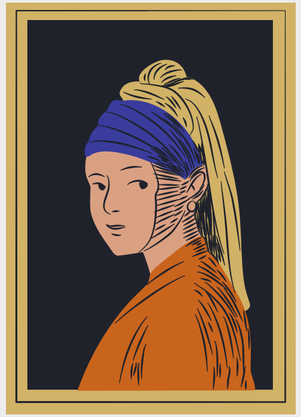
Diagnostic (Radiography, Computed Tomography)
Non-invasive treatment
Therapeutic nuclear medicine

Used in:

- *oncology*
- *cardiology*
- *neurology*
- *pneumology*
- *pediatrics*

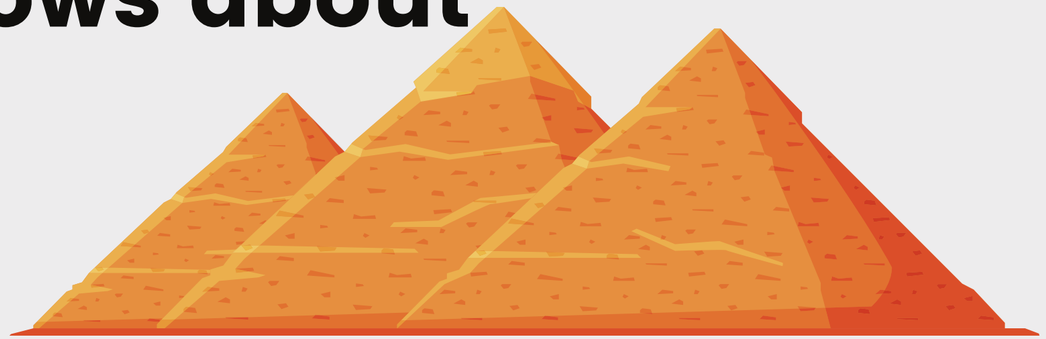
ROSATOM

Other areas you might not knows about



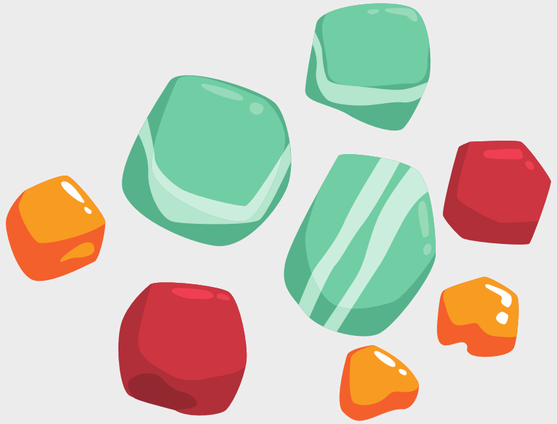
Restoration of masterpieces

X-ray fluorescence spectrometry makes it possible to determine the chemical composition of an item



Conservation and consolidation of cultural heritage

Radiation techniques have demonstrated significant success in the disinfestation and preservation of cultural heritage artefacts, and national and international research programmes have developed harmonized methodologies for such radiation treatment.



Neutron Activation Analysis

Used to accurately determine the concentrations of elements in a sample (determine the amount of a particular metal its tissues contain).

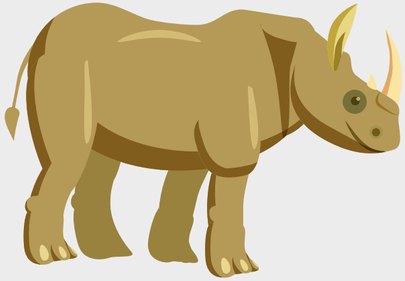
Monitoring of butterfly migration

Hydrogen and carbon isotopes have been used for decades to trace the natal origins of monarch butterflies.

Rhisotope Project

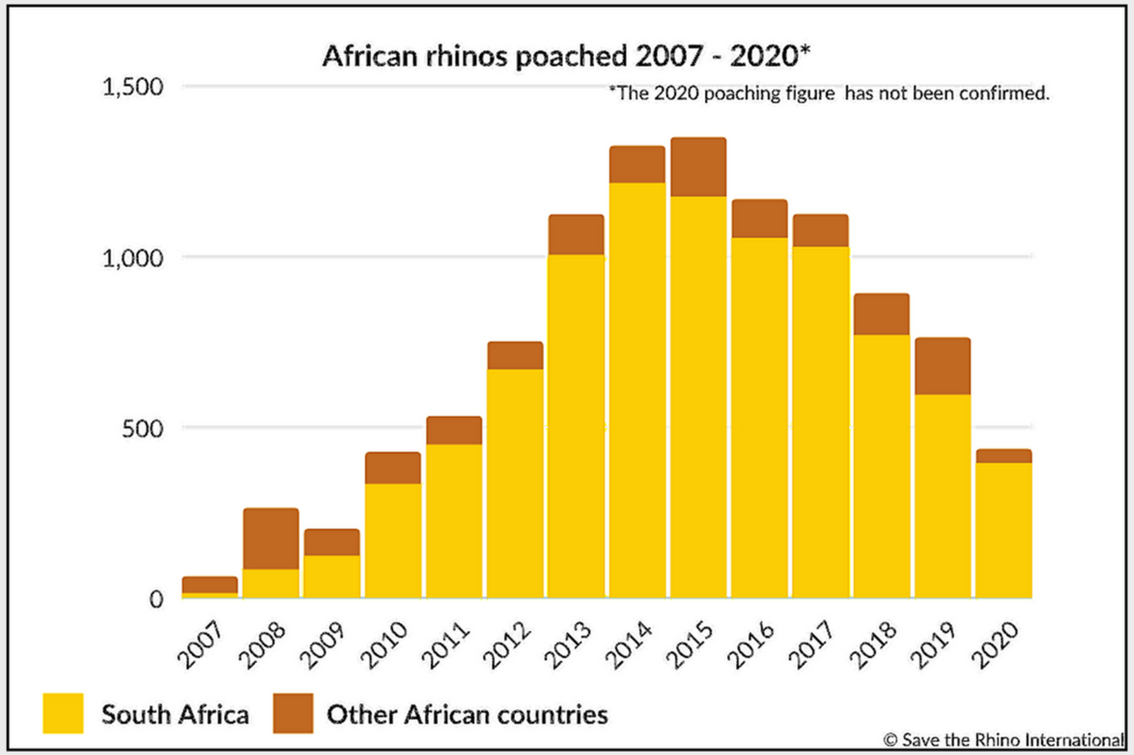
Using nuclear science techniques to devalue rhinoceros horn, and fight rhinoceros poaching

ROSATOM



Rhisotope Project. Why?

- South Africa is home to 90% of the world's rhino population. From 2010 to 2019 over 9600 rhinos were killed in poaching attacks.
- Rhino horn sold for $50 000 a kg (an average horn weighs about 3kg) on the black market.
- Even with all the preventative methods, rhinos are dying daily at the hands of poachers.
- At the current rate of loss, wild rhino will be extinct in less than 8 to 10 years.
- Most often, horns are transported across borders using various known channels which are not subject to inspection due to international legislations. It is only require opening if the sensors at the airport have picked up radioactivity



ROSATOM

Rhino Project is an initiative between the top global nuclear company and scientists, researchers, South African rhino owners and the best wildlife veterinarians to significantly reduce rhino poaching. The purpose of the project is to create a lasting and effective means of significantly lowering the amount of rhino being poached and killed for their horns.

James Larkin
Rhisotope Project
founder

ROSATOM

Project goals:

By placing radioactive material in rhino's horn, we aim to reduce demand for rhino horn globally, limit its export potential and thereby create a very effective rhino protection system.

Use of stable isotopes to better understand the physiology of the rhino and rhino horn, to ensure there is no movement of material from the horn back into the animal.

This work is necessary to demonstrate to rhino owners that any Planned Exposures to the animals are Justified, and any harm will be kept to an absolute minimum.

The consequences of being caught in possession of illicit radioactivity are significantly greater than for illegal possession of rhino horn

ROSATOM

Stages of the project

May 2021

The first phase of the project began on 13 May. Trace amounts of harmless, stable isotopes introduced into the horns of two rhinos - named Igor, after Soviet nuclear physicist Igor Kurchatov, and Denver, after the state capital of Colorado - in the Buffalo Kloof Private Game Reserve.

September 2021

Animas were carefully monitored for 4 months. In September Phase 1 of the Rhisotope Project demonstrated that radioisotopes deposited into the horn of the rhino remain in the horn and do not move back into the animal.

January 2022

Phase 2 of the innovative project is planned to commence in January 2022

ROSATOM

Contact Us

Please contact us if you have any questions, proposals or enquiries.

---

polyakovskaya@rosatom.com
Evdokia Polyakovskaya, PR manager

info_csa@rosatom.com

https://www.facebook.com/Rhisotope

https://www.facebook.com/rosatominafrica

ROSATOM

Joint FAO/IAEA Centre
Nuclear Techniques in Food and Agriculture

Beyond energy:
Nuclear innovations for food and agriculture

Qu Liang, Director
The Joint FAO/IAEA Centre of
Nuclear Techniques in Food and Agriculture

57-year Longstanding Strategic Partnership

through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture

IAEA

Atomic energy for peace, health and prosperity

Achieving food security for all

Joint FAO/IAEA Centre
Nuclear Techniques in Food and Agriculture

To contribute to food security and sustainable agricultural development by use of nuclear techniques and biotechnology

Competitive advantages of nuclear techniques

Traceability: *Isotopic tracers as marker*

Radioactivity: *Induced genetic variation, sterility, sterilization*

Measurability: *Radio and stable isotope measurable*

Accuracy: *More accurate than conventional methods*

Specificity: *Unique sensitivity and specificity*

Core Areas for Nuclear Application in Food and Agriculture

- Animal Production and Health

- Food Quality and Food Safety

- Soil and Water Management & Crop Nutrition

- Plant Breeding and Genetics

- Insect Pest Control

Animal Production and Health

- **Early and rapid diagnostic technologies**

  Transboundary animal and zoonotic diseases (ZODIAC)

- **Tracing of transboundary animals and their diseases**

  Monitoring and tracing migratory pathways of transboundary animal diseases

- **Development/evaluation/validation of irradiated vaccines**

  More effective and broad spectrum of protection

- **Improving animal nutrition and local breeds**

  Increasing animal nutrition by using local animal breeds improving production traits (more and better milk and meat)







Plant Breeding and Genetics

- Improving crop cultivars by using mutation breeding techniques
- Increasing efficiency of mutation breeding through application of modern biotechnology
- Developing mutant varieties with better adaptation to climate change
- Enhancing biodiversity for crop improvement

Soil and Water Management & Crop Nutrition

- **Monitoring and measuring climate change**
  - *Measuring greenhouse gas emissions from agriculture*
  - *Monitoring the impact of climate change on agriculture*
- **Climate smart soil/water management for a better production**
  - *Measuring soil erosion and degradation and their controls*
  - *Water saving agriculture*
- **Contamination control for a better environment**
  - *Tracing and managing antimicrobial residues through soil and water*
  - *Assessing and mitigating the impact of micro-plastics on land*
- **Response to nuclear emergencies affecting food and agriculture**

Food and Environmental Protection

- **Monitoring and tracing technology**
  - Food forensics --- **'finger printing' techniques**
  - Traceability --- **tracing contaminants techniques**
  - Authenticity --- **food origin determination**
- **Analytical technology**
  - Agrochemical residues analysis
  - Contaminant analysis
- **Food irradiation**
  - Food Processing
  - Phytosanitary Treatments

Insect Pest Control

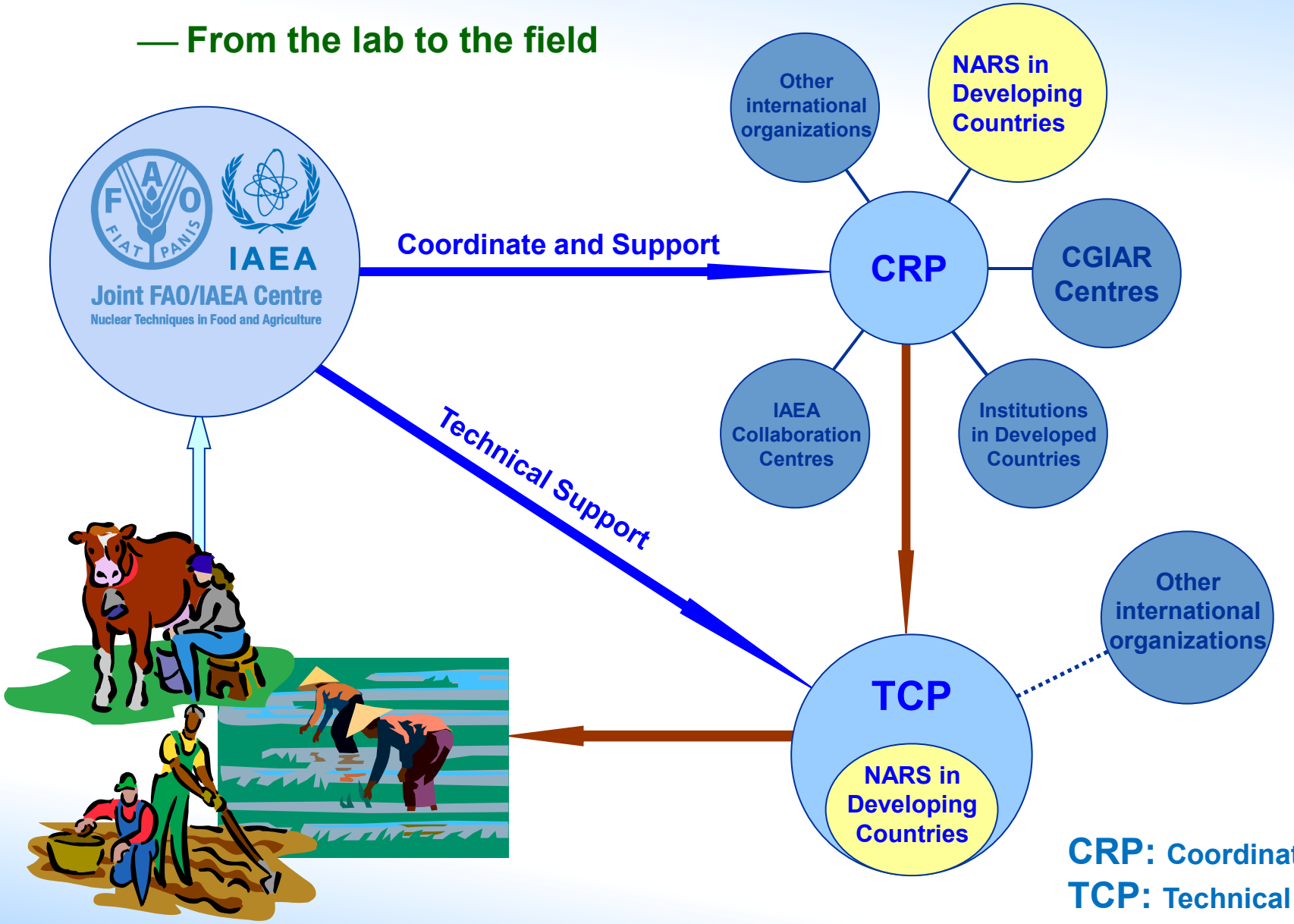
Joint FAO/IAEA Centre
Nuclear Techniques in Food and Agriculture

Using the Sterile Insect Technique (SIT)

- *Control of major plant pest*
- *Control of livestock pest*
- *Control of mosquitoes*
- *Development of genetic sexing and other methodologies*

Programme Delivery

— From the lab to the field



CRP: Coordinated Research Project

TCP: Technical Cooperation Project

IAEA Seibersdorf Laboratories

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

FAO/IAEA Agriculture and Biotechnology Laboratories

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Thank You

Beyond energy: Nuclear innovations in medicine, agriculture, and more

Chair:
Tim Yeo
Chairman
New Nuclear Watch Institute

Speakers:

Ben Holtzman
Program Advisor, New Reactors & Advanced Technology, Nuclear Energy Institute

Simon Wakter,
Senior Advisor, Nuclear Technology - Nuclear Safety & Licensing, AFRY

Ryan Collyer
Chief Executive Officer, Rosatom Central and South Africa

Qu Liang
Director, Department of Nuclear Sciences and Applications, Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture

8 December 2021