IMPACT OF IAEA COORDINATED RESEARCH PROJECTS ON TECHNOLOGY ADVANCES

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eBeam Technology for Cleaning, Healing, Feeding, and Shaping this World and Beyond…

an International Atomic Energy Agency Collaborating Centre for Electron Beam Technology


Environmental Health
One Health
Human Health
Animal Health

Over-Arching Topics in Environmental Health

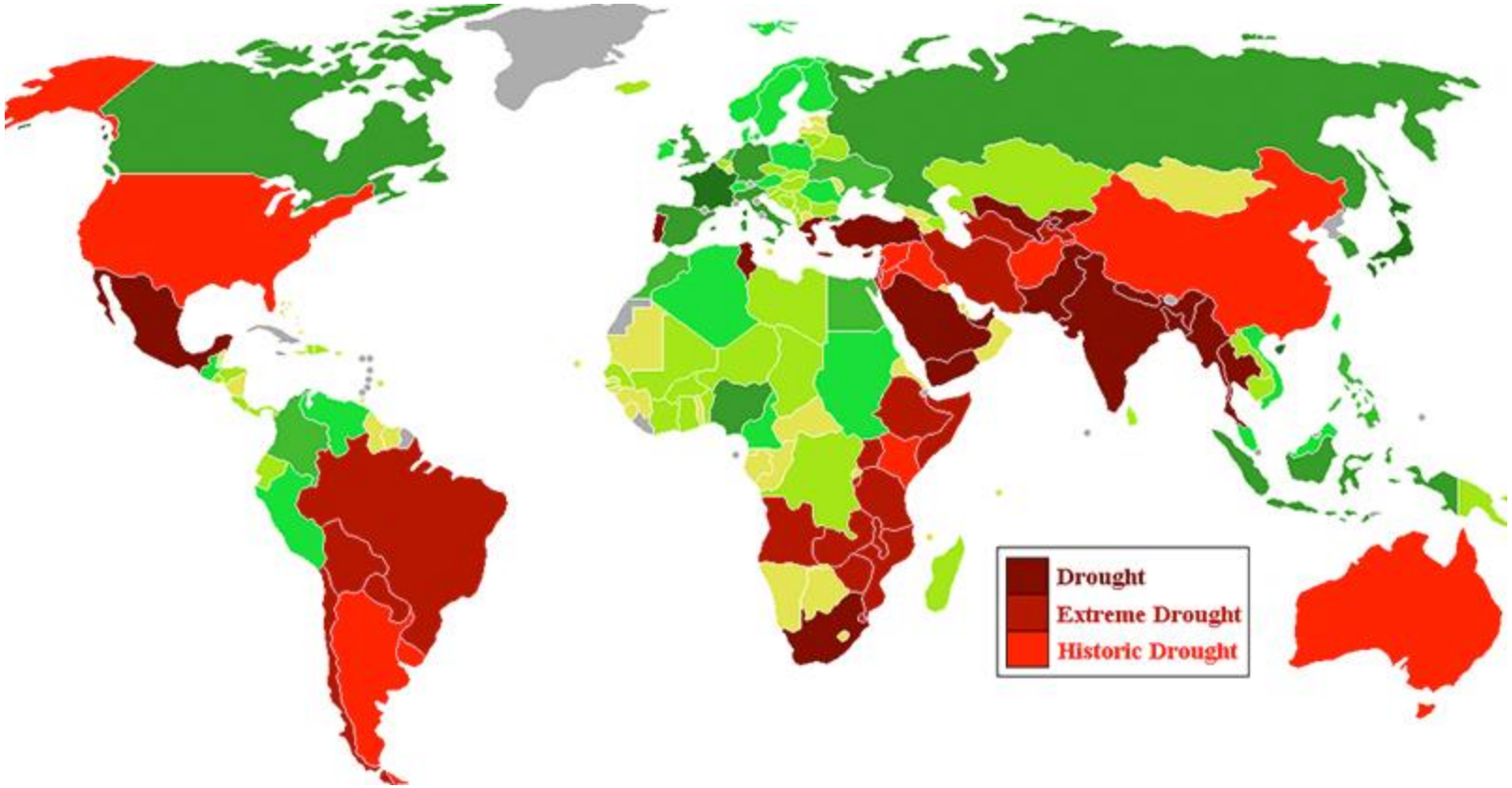
- Municipal Drinking water
- Industrial and Domestic Wastewater
- Organic Pollutants
  - Microbial Pathogens
    - Bacterial, viral and protozoan pathogens
  - Organic Chemical Pollutants
    - Pesticide residues
    - Pharmaceutical industry wastewater
    - Municipal solid and liquid wastes

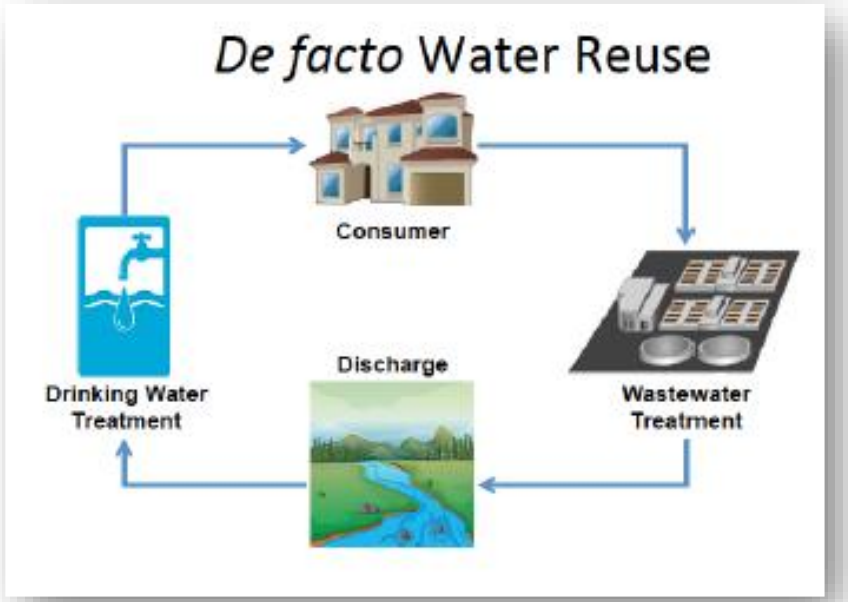
IAEA Coordinated Research Projects to Address Grand Challenges

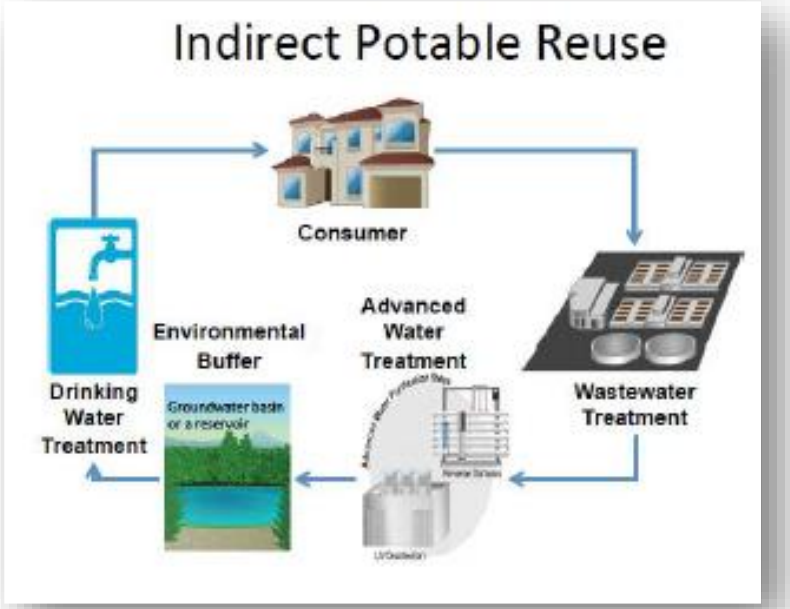
Example Projects focused on environmental contaminants

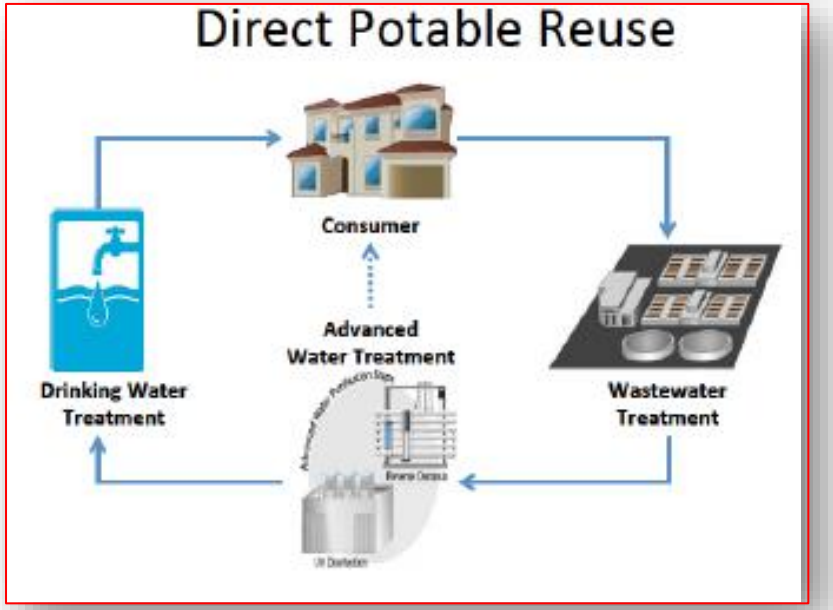
- Use of irradiation for chemical and microbial decontamination of water, wastewater and slduge. 1995-2001
- F23024- Electron Beam Treatment of Organic Pollutants Contained in Gaseous Streams- 2004 - 2009
- F23029- Radiation Treatment of wastewater for reuse with particular focus on wastewaters containing organic pollutants –2010-2016
- F2303- Radiation inactivation of biohazards using high powered electron beam accelerators –*Nov 2017*
- F23034- Radiation based technologies for treatment of emerging organic pollutants – 2019-2024

Grand Challenges









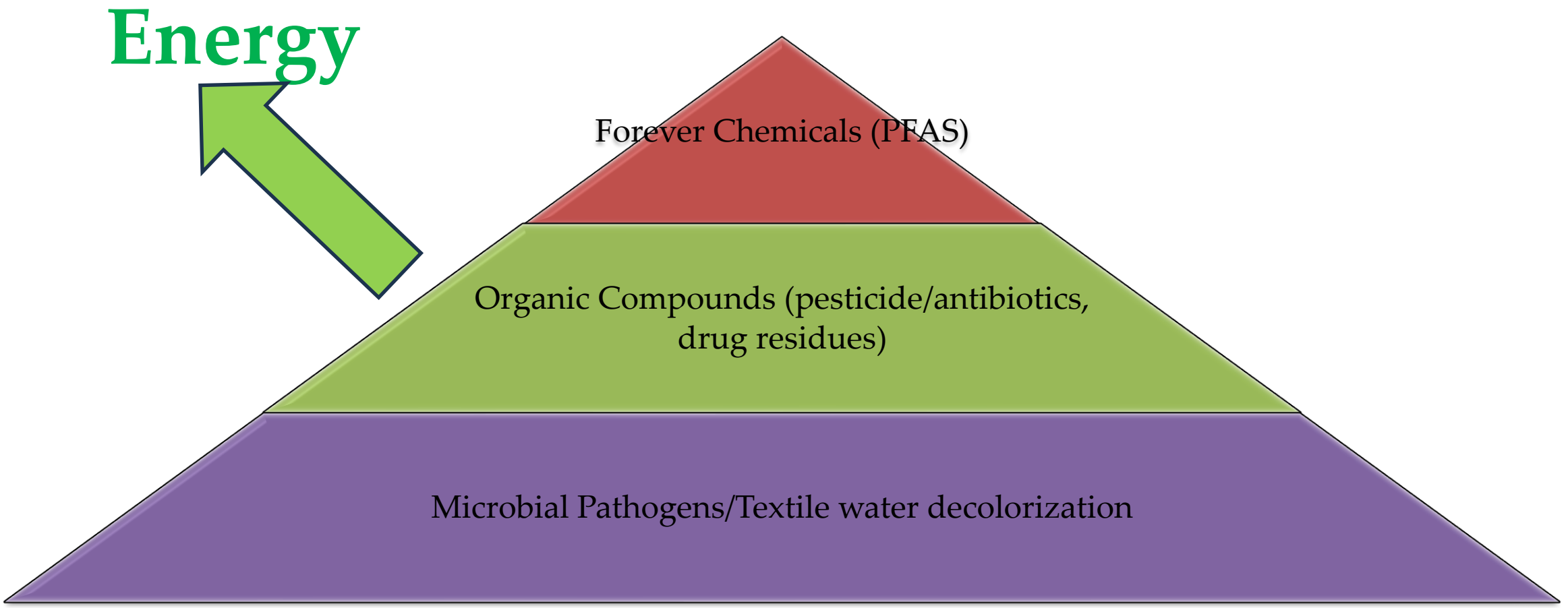
TWDB/WateReuse Foundation.2016

nrdc.org; miamiherald.com

Contemporary View

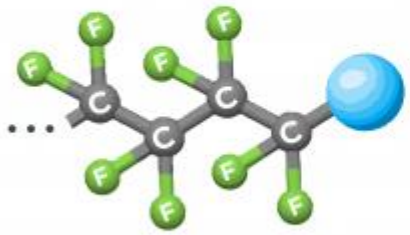
- Sewage sludges are significant pools of energy substrates and nutrients
- Wastewater Treatment Plants
- **Sustainable Resource Recovery Facilities**
  - Compelling need to exploit different technologies to extract as much of the energy and nutrients as possible from different waste-streams

Contemporary Challenges



Per and polyfluorinated chemical compounds (PFAS)

PFAS are short for per- and polyfluoroalkyl substances, meaning that they **contain a chain of carbon atoms** (alkyl) **bonded to fluorine atoms** (fluoro).



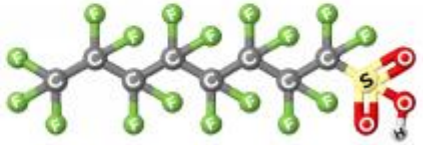
C: Carbon; F: Fluorine; O: Oxygen; H: Hydrogen; S: Sulfur

PFOA and **PFOS** are the most studied, and they both have an **8-carbon chain**. They differ in their terminal groups:

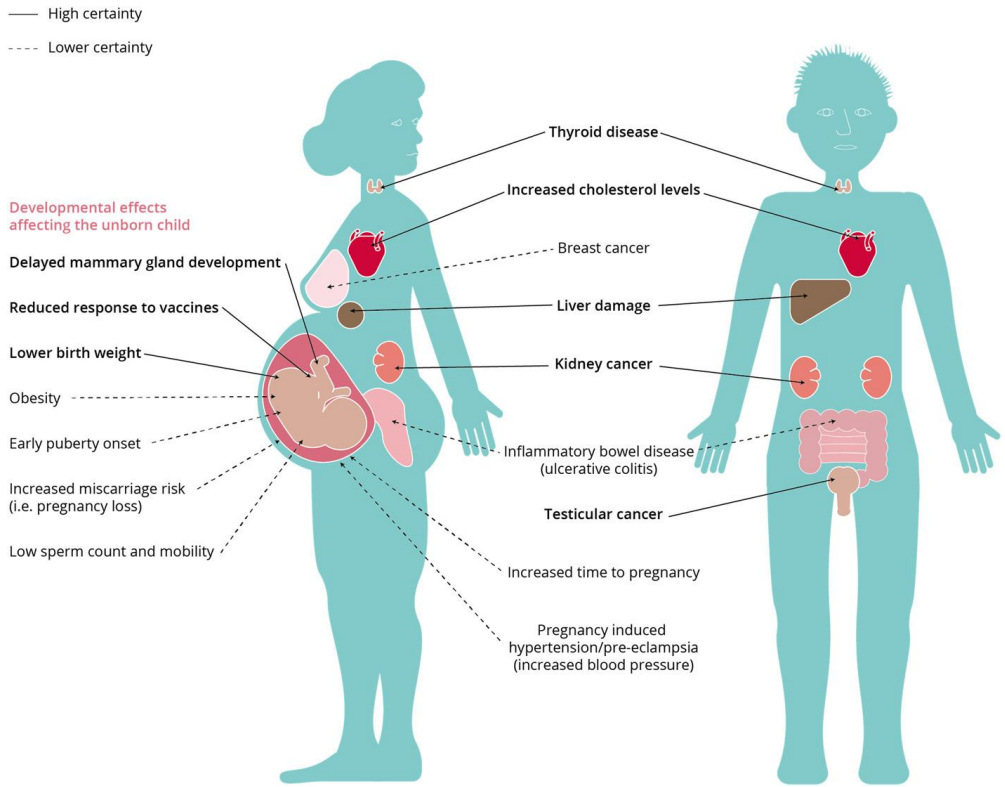
PFOA has a **carboxylic group (-COOH)**,

Perfluorooctanoic acid (PFOA)

while **PFOS** terminal group is a **sulfonic acid ($-SO_3H$)**



Perfluorooctane sulfonic acid (PFOS)



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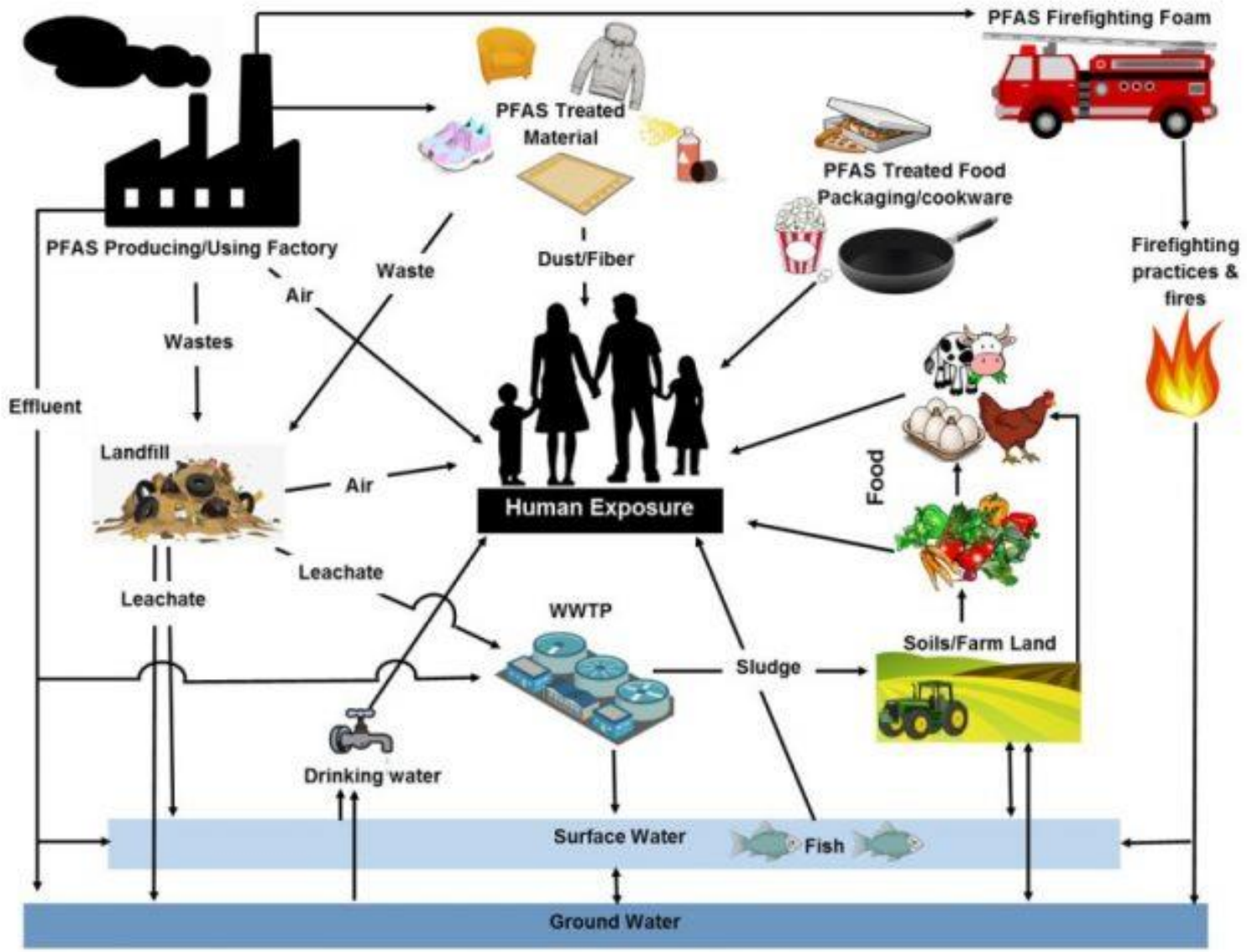
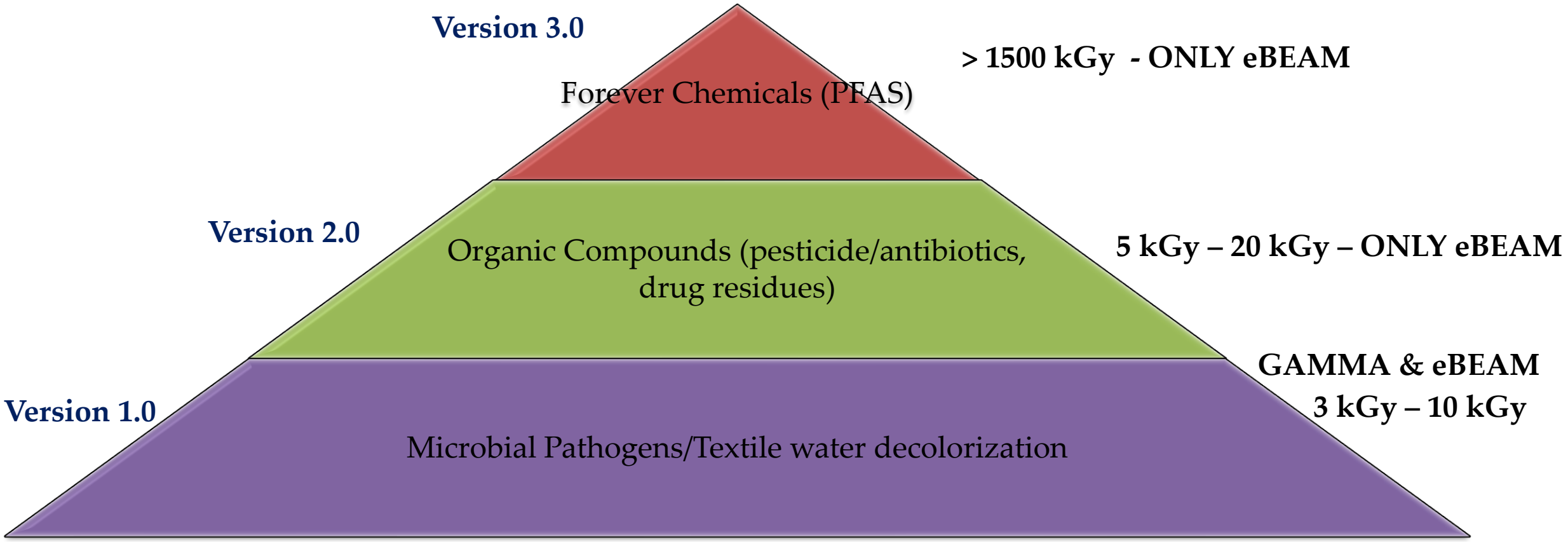


Human Exposure and sources of PFAS
Image: DWP, adapted from Oliaei et al. 2013.

Current Situation – Environmental landscape is quickly changing

- PFAS remediation
- Energy recovery from municipal sludges
  - Waste valorization
  - Circular economy
  - Sustainable Development Goals
- Water Reuse

Technology Options

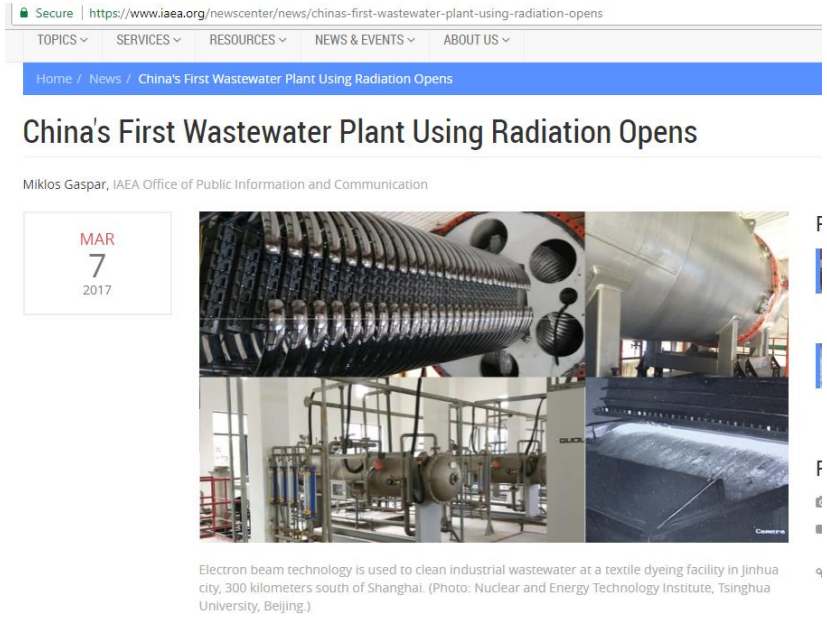


Current State of the Science-Its not a question whether the technology will work..

Project	Location	Technology	Year
Deer Island Wastewater Treatment Plant -400m^3/day	Boston, Massachusetts, USA	eBeam	1980's
Impela Project 2454 dry tons/year	Ontario, Canada	eBeam	1980's
Virginia Key Project 645 m^3/day	Miami, Florida, USA	eBeam	1990's
Mobile eBeam Demonstration Project	Daejeon, S. Korea	eBeam	2011
Dyeing Wastewater Treatment Project (2000 m^3/day)	Jinhua City, China	eBeam	2016
Dyeing Wastewater Treatment Project (30,000 m^3/day)	Jiangmen City, Guangdong Province, China	eBeam	2020
Hospital wastewater Treatment Project (400 m^3/day)	Shiyan City, Hubei Province, China	eBeam	2021
Antibiotic Fermentation Residues Treatment Project (200 dry tons /day)	Yining City, Xinjiang, China	eBeam	2021
Dyeing Wastewater Treatment Project (5000 m^3/day)	Xiangyang City, Hubei Provinve, China	eBeam	2022
Landfill Leachate Treatment Project (300 m^3/day)	Mianyang City, Sichuan Province, China	eBeam	2022

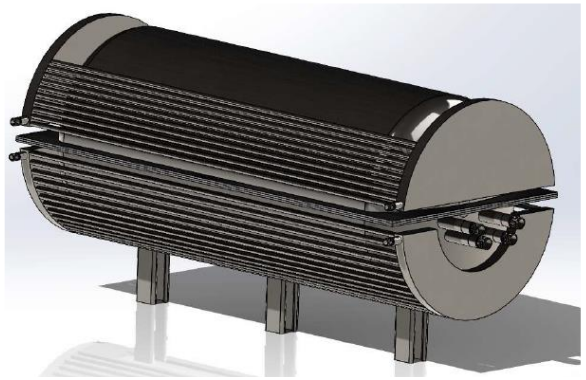
Electron Beam Technology for Water Treatment

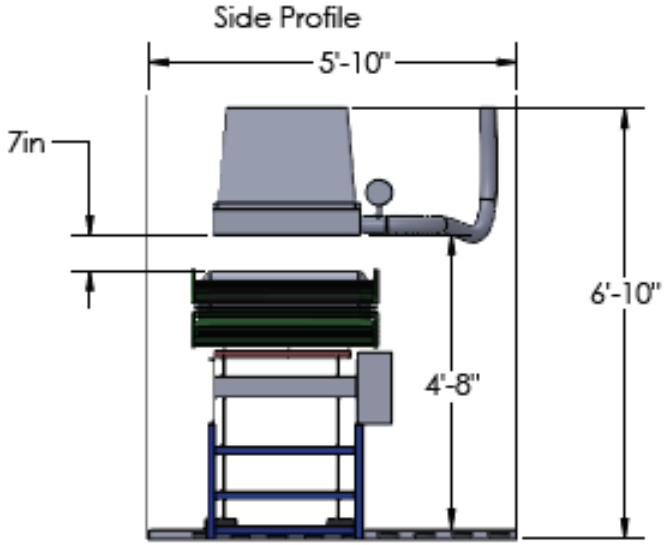
- China – pilot scale eBeam facility for treating wastewater from the dyeing industry 2017

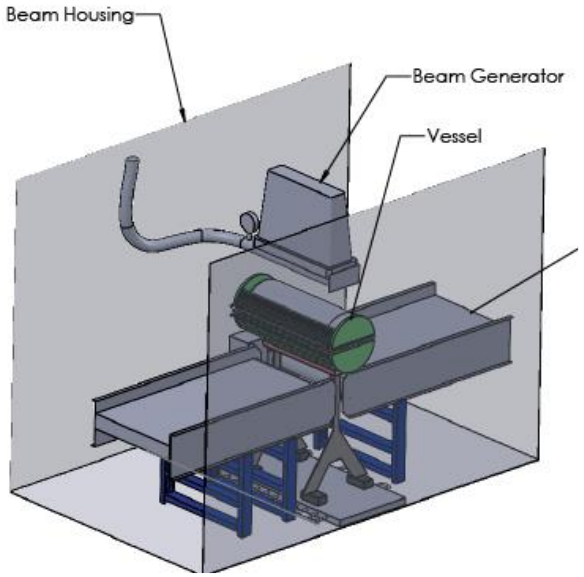


China’s example investment in eBeam technology

Texas A&M University - eBeam Technology for PFAS Remediation







International Water Association-*Source Water*

Harnessing Electrons to Clean and Power the World

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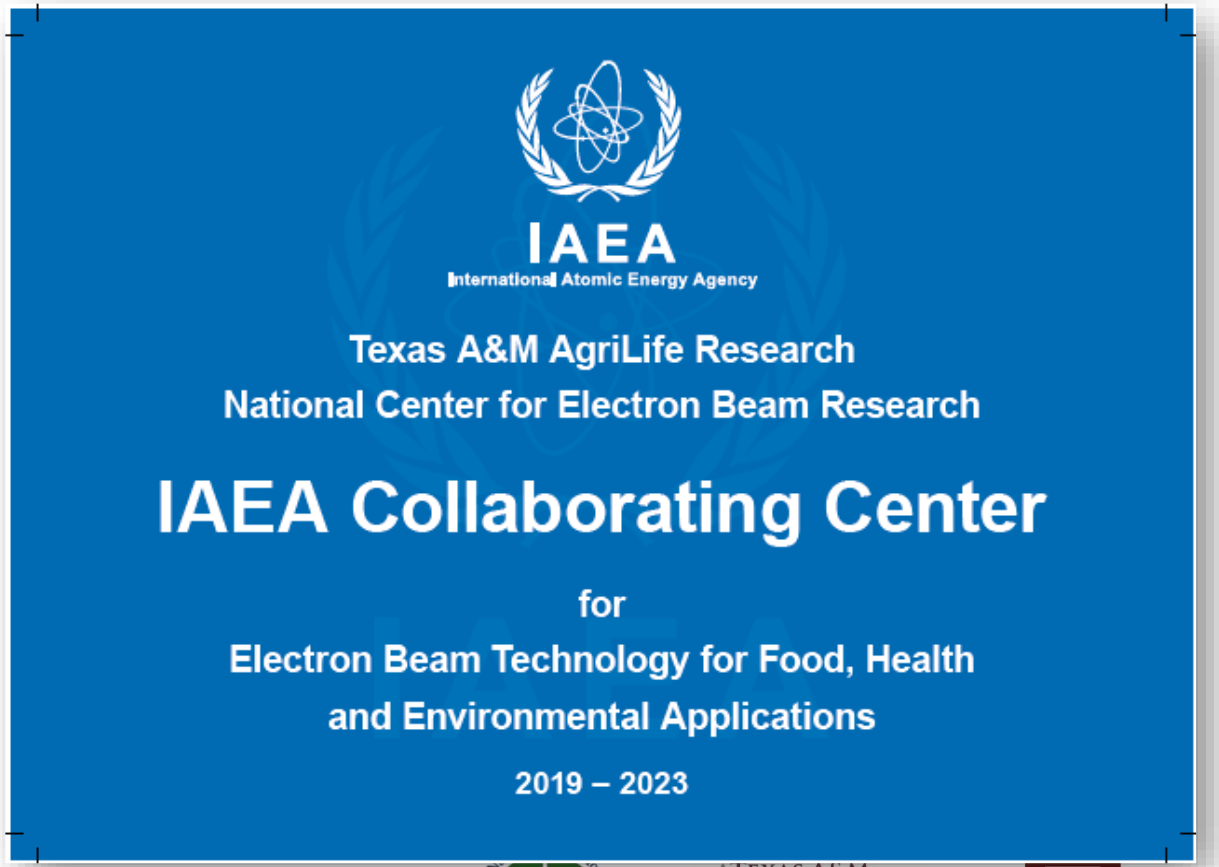
International Atomic Energy Agency (IAEA) – Collaborating Center



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Electron Beam Research

TEXAS A&M AGRILIFE RESEARCH

A&M

Strategic Partnership Between Texas A&M University and US Government

National Nuclear Security Administration

ORS Office of Radiological Security
Protect · Remove · Reduce

Accelerate the transition from the use of radioactive sources to machine sources all around the world

- *Unleash private investments in the technology*
- *Sustainable economic prosperity*
- *Safe, secure access to nuclear technologies*

National Center for Electron Beam Research

Texas A&M AgriLife Research

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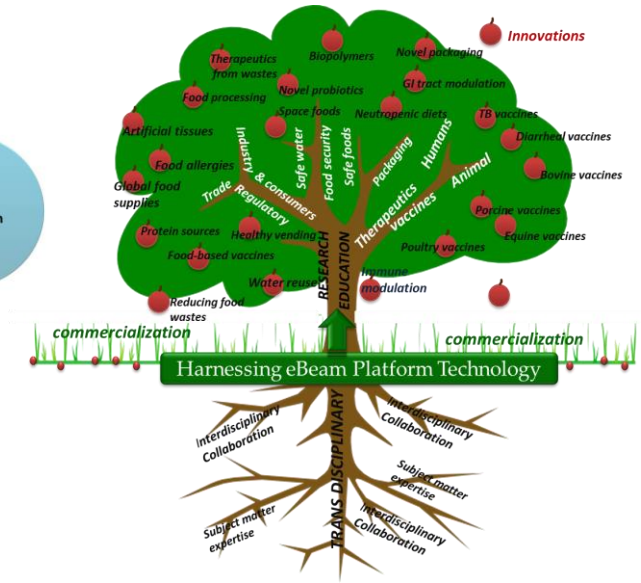
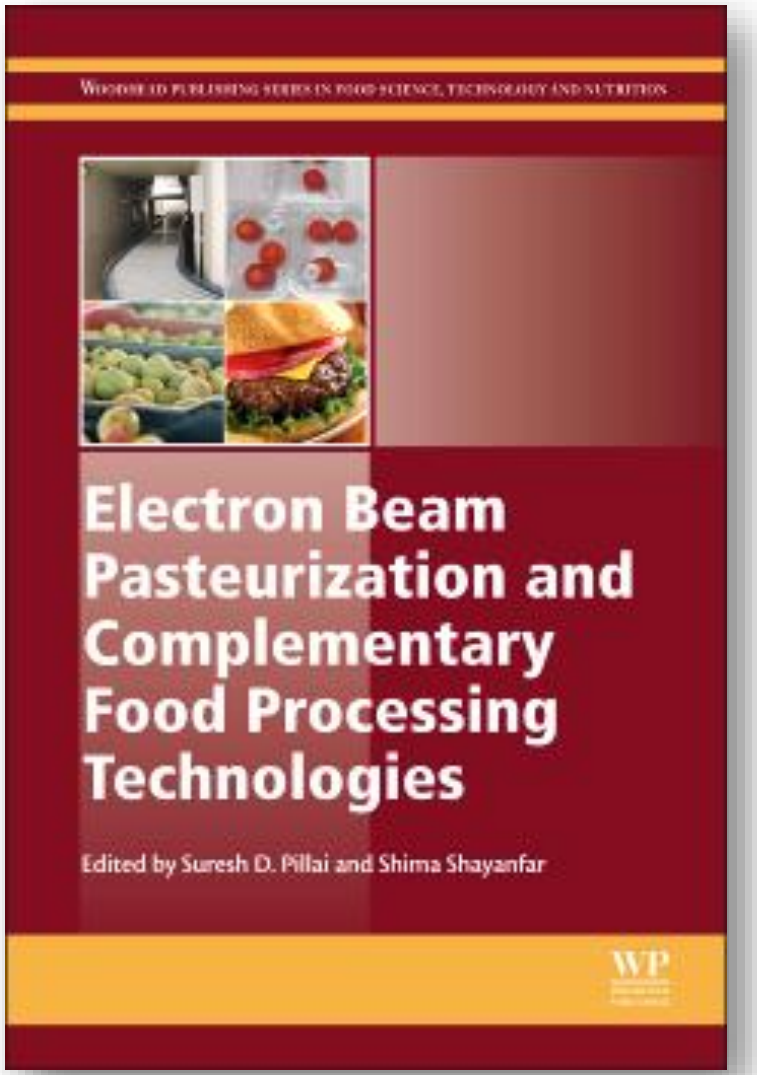
NCEBR's Global Vision

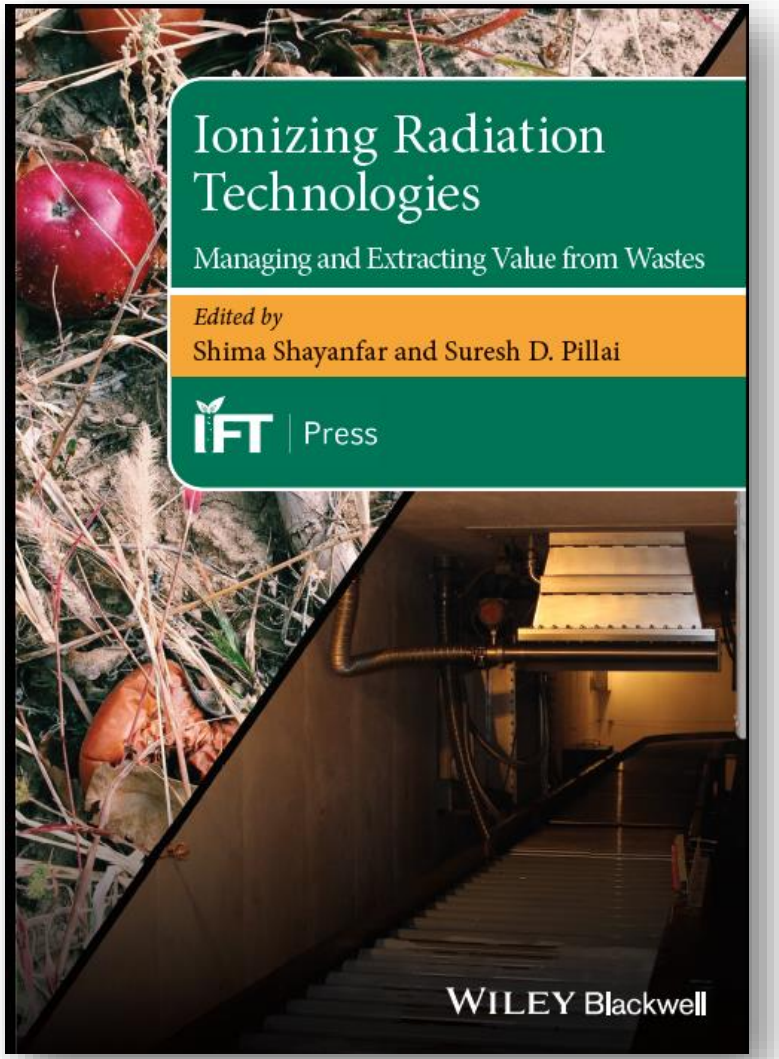


Help Educate, Support Research, Help Design and Empower Commercially Viable eBeam Facilities and Businesses worldwide

- ✓ Mexico
- ✓ Pakistan

Peru
Uruguay
Argentina
Sri Lanka
Bangladesh
Kuwait
Jordan
Morocco
Botswana


Woodhead Publishing Series in Food Science, Technology and Nutrition
Electron Beam Pasteurization and Complementary Food Processing Technologies
Edited by Suresh D. Pillai and Shima Shayanfar
WP


Ionizing Radiation Technologies
Managing and Extracting Value from Wastes
Edited by
Shima Shayanfar and Suresh D. Pillai
IFT | Press
WILEY Blackwell

Remember

eBeam Technology can *Clean, Heal, Feed, and Shape* this World and *Beyond*……

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