Implementing the 2030 Agenda for Sustainable Development – What is the Role of Nuclear Science and Technology?

H-Holger Rogner
International Institute for Applied Systems Analysis (IIASA)
Royal Institute of Technology (KTH), Stockholm

06 June 2017 – International Atomic Energy Agency (IAEA)
Current development challenges

- 850 million people are under nourished
- 2 billion people lack food security
- 1.1 billion people without access to electricity
- Almost 3 billion people without access to modern fuels or technologies for cooking/heating
- 660 million people lack access to safe water
- 2.4 billion do not have adequate sanitation
- 250 million children not learning basic skills
- Anthropogenic interference with the climate system
- Adaptation to the degree of climate change that can no longer be avoided
Current development challenges

- Mounting concerns over climate change
- 2015 Paris Agreements

Pollution related health and environmental hazards

Source: IPCC AR5

Source: OECD Environmental Outlook Baseline; output from IMAGE suite of models.
Planetary boundaries

- Beyond zone of uncertainty (high risk)
- In zone of uncertainty (increasing risk)
- Below boundary (safe)
- Boundary not yet quantified

Source: J Rockström, 2016
Sustainable development on the international agenda

1972 - Club of Rome “Limits to Growth”
1972 - The United Nations Conference on the Human Environment
1987 - Brundtland Commission on Environment and Development “Our Common Future”
2000 - Millennium Development Goals (MDGs)
Millennium Development Goals

2000 - UN Millennium Development Goals (MDGs)
- The largest-ever gathering of world leaders agrees eight time-bound and measurable development goal to be achieved by 2015

- **Halve, between by 2015 the proportion of people whose income is less than $1.25/ day**
- Halve by 2015, the proportion of people who suffer from hunger

- **Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015**

- **Reduce maternal mortality ratio by 75%**
- Achieve universal access to reproductive health

- Mainstream sustainable development
- Reverse the loss of environ. resources
- Halve the proportion people without access to safe drinking water and basic sanitation
- Achieve significant improvement in the lives of at least 100 million slum dwellers

- **Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling**

- Reduce by two thirds the under-five mortality rate

- Have halted & begun to reverse the spread of HIV/AIDS
- Have halted & begun to reverse the incidence of malaria & other major diseases

- Develop a non-discriminatory trading and financial system
- Address the special needs of the LDCs, especially the debt problem
Isn’t there something missing among the MDGs?

Energy is not on the MDG list!

- Without access to modern forms of energy it will be virtually impossible to achieve any of the MDGs.
- Clean and affordable energy services are key enablers for meeting the MDG to achieve broader societal objectives.
- It touches upon every facet of life → numerous stakeholders.
Sustainable development on the international agenda

1972 - Club of Rome “Limits to Growth”
1972 - The United Nations Conference on the Human Environment
1987 - Brundtland Commission on Environment and Development “Our Common Future”
2000 - Millennium Development Goals (MDGs)
2001 - CSD 9 on Energy
2002 - World Summit for Sustainable Development
2011 - SE4All
2012 - Rio Plus 20 “The Future We Want”
2015 - UNGA “2030 Agenda for Sustainable Development”
2015 - CoP 21 “Paris Agreement”
Sustainable development at a crossroads

- 2012 - 2015 Preparing an Agenda for Development
  - As the 2015 deadline approached it became clear that not all MDGs would be met
  - Sustainable Development Goals (SDGs)
  - SDGs incorporated the pillars of development and a much wider ranging and ambitious set of goals
  - Unlike the MDGs, the SDGs adopted a bottom up approach that involved all 193 UN member states in the consultation and development of the goals and a fundamental shift from us/them to inclusive global cooperation
  - They are “action-oriented, concise and easy to communicate, limited in number, aspirational, global in nature and universally applicable to all countries”, while “taking into account different national realities, capacities and levels of development and respecting national policies and priorities”.
The Sustainable Development Goals (SDGs), officially known as *Transforming our world: the 2030 Agenda for Sustainable Development* is a set of seventeen aspirational "Global Goals" with 169 targets between them.

More comprehensive in scope than the previous eight Millennium Development Goals (MDGs).

- Cover the MDGs plus additional economic, social (incl. human rights), and environment issues: the full sustainable development agenda
- *Includes a SDG for Energy*
- Universal goals that will apply to every nation (not just developing countries)
- A plan of action for All
- Inclusive “no one left behind”
- Zero targets instead of halves
- Runs from 2016 to 2030
Agenda 2030 for Sustainable Development

- 17 Sustainable Development Goals (SDGs) with altogether 169 targets, policy recommendations for implementation and performance indicators
Parts of the Agenda

VISION
&
PRINCIPLES
Reflected in declaration

RESULTS FRAMEWORK
Sustainable Development Goals

Global Partnership
Means of Implementation (Mols)

IMPLEMENTATION

FOLLOW-UP & REVIEW
Structure of 17 SDGs

GOAL

Targets on Ends
1.1
1.2
...

Targets on Means
1.a
1.b
...

Indicators
Under development

Under development
2030 Agenda: SDGs are integrated and indivisible

- Not 17 separate ambitions with altogether 169 targets, but highly interlinked challenges requiring coordinated action

- SDGs are *global in nature and universally applicable, taking into account different national realities, capacities and levels of development and respecting national policies and priorities*

- Interlinkages and national priorities ➔ Trade-offs

- Successful implementation of one SDG can adversely impact the implementation of another SDG or harvest synergies
SDGs as a network of targets

(Source: LeBlanc 2015)
Examples of SDG 7 and SDG 2 interlinkages

**Goal 7:** Ensure access to affordable, reliable, sustainable and modern energy for all

- **7.1 By 2030,** ensure universal access to affordable, reliable and modern energy services
- **7.2 By 2030,** increase substantially the share of renewable energy in the global energy mix
- **7.3 By 2030,** double the global rate of improvement in energy efficiency

**End hunger, achieve food security and improved nutrition and promote sustainable agriculture**

- **2.1 By 2030,** end hunger and ensure access by all people, in particular the poor, to safe, nutritious and sufficient food all year round
- **2.3 By 2030,** double the agricultural productivity & incomes of small-scale food producers, esp. women through secure & equal access to land, other productive resources and inputs, knowledge, financial services & markets
- **2.4 By 2030,** ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

Indirect via SDG 2: SDG 1; 3.1, 3.2, 3.8; 4.2, 4.3; 5.4, 5.5; 6.4, 6.5; 8.1, 8.2, 8.3; 10.1; 12.1; 13.1; 15.1, 15.2; 16.1; 17.13
Examples of SDG 7 and SDG 6 interlinkages

**Goal 7:** Ensure access to affordable, reliable, sustainable and modern energy for all

- **7.1 By 2030,** ensure universal access to affordable, reliable and modern energy services
- **7.2 By 2030,** increase substantially the share of renewable energy in the global energy mix
- **7.3 By 2030,** double the global rate of improvement in energy efficiency
- **7.a - By 2030,** enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and clean fossil fuel technology, and promote investment in energy infrastructure and clean energy technology
- **7.b - By 2030,** expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support

**6. CLEAN WATER AND SANITATION**

Ensure availability & sustainable management of water & sanitation for all

- Fossil fuel extraction, biofuel production & hydropower are water-intensive processes
- Water supply, pumping and treatment are energy-intensive activities
- Energy sector activities generate large quantities of wastewater (thermal and chemical pollution released into aquatic ecosystems)
- Desalination is on the rise in the world’s water-stressed regions and increases energy demand
- Wind and PV replacing thermal generation reduce water requirements
- Water can store off-peak energy
**Examples of SDG 7 and SDG 13 interlinkages**

**Goal 7:** Ensure access to affordable, reliable, sustainable and modern energy for all

- **7.1 By 2030,** ensure universal access to affordable, reliable and modern energy services
- **7.2 By 2030,** increase substantially the share of renewable energy in the global energy mix
- **7.3 By 2030,** double the global rate of improvement in energy efficiency

**7.a - By 2030,** enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and clean fossil fuel technology, and promote investment in energy infrastructure and clean energy technology

**7.b - By 2030,** expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support

**Take urgent action to combat climate change and its impacts***

- Mitigation affects all of SDG 13 and adaptation needs
- SDG 13 impacts all other SDGs
- Water availability for energy & agriculture (e.g., SDG 1, SDG 2)
- Severe weather events (e.g., SDG 3, SDG 11, SDG 15)
- Migration, Reduced inequality, Peace (e.g., SDG 10, SDG 16)

* The 2030 Agenda explicitly acknowledges the lead of UNFCCC in the implementation of SDG 13
The Climate, Land-use, Energy, Water Nexus

- Food, water and energy security are the key policy concerns in most countries
- Food (land-use), energy and water systems are highly interlinked
- All interact with the climate system and the environment
- All are highly relevant for the analysis of Nationally Determined Contributions (NDCs)
What about nuclear science & technology?

- No mentioning in the PA or SDG documents
  - If mentioned in the climate negotiations or SD debates then almost exclusively negative
  - Delegations are afraid of instigating an intense debate
- Nuclear energy is a potent climate mitigation technology and largely consistent with SD principles
- Nuclear science & technology can contribute to the implementation of quasi all SDGs
Zero Hunger

Plant mutation breeding

- Develop hundreds of varieties of hardier, more disease-resistant crops (SDG 1, SDG 2)
- Increased yields per ha and multiple cropping (SDG 2)
- Improved nutritional value of some crops (SDG 3)
- Lower water requirements (SDG 6, SDG 7)
- Optimal fertilizer application (SDG 12)
- Shorter growing times allowing extra days to grow other crops and vegetables (SDG 2)
- Plants tolerant to high salt levels in soil or resistant to certain pests (SDG 2)
- Adapting to climate change (SDG 13):
  - increased frequency of severe weather events plus shifting precipitation patterns increase the number of area with floods and saline water contaminating normal soils
  - increased number of areas with severe droughts
Radioisotopes

- Over 10,000 hospitals worldwide use radioisotopes in medicine, and about 90 percent of the procedures are for diagnosis.
- Radioisotope imaging techniques like SPECT, PET/CT and conventional imaging such as MRI and CT are instrumental in fighting modern diseases like cardiovascular disease and cancer.
  - SPECT is an imaging technique that generates several image ‘slices’ of an organ by detection of gamma rays emitted by a radioactive substance given to the patient.
Radiation fighting cancer

Radiotherapy is designed to use radiation to target and kill cells

- External beam radiation therapy
  - A beam, or multiple beams, of radiation to target specific areas of a patient’s body. The beam is designed to minimize radiation exposure to healthy cells, while controlling or killing the cancer cells. The beams can consist of electrons and/or X-rays, gamma rays or, in the case of particle therapy, protons or carbon ions

- Brachytherapy
  - Radiation sources are placed inside of or next to an area of a patient’s body that requires treatment. It exposes a tumor with higher doses of localized radiation at lower risk of damaging surrounding healthy tissue

- Radionuclide therapy
  - Usually administered orally, radionuclides are applied to treat cancer, blood disorder or thyroid gland diseases. The radioactive material is chosen for its isotope properties, or chemical properties, as certain body parts can absorb certain isotopes significantly more effectively than other body parts, which allows to target those specific areas requiring treatment.
Good Health, Well-Being & Zero Hunger

Sterile Insect Technique (SIT)

- improves food security and agricultural productivity by using nuclear and isotopic techniques to protect
  - plants from insect pests such as the fruit flies, Tsetse fly, moths, screwworms
  - the health of livestock and enhances reproduction, e.g., eradicating tsetse flies which decimates livestock
- reduces the use of pesticides and chemicals
- improves farming income and export revenues
- aims to combat various species of disease-transmitting mosquitoes, including carriers of the Zika virus and malaria

SIT is an environmentally-friendly insect pest control method involving the mass-rearing and sterilization, using radiation, of a target pest, followed by the systematic area-wide release of the sterile males by air over defined areas, where they mate with wild females resulting in no offspring and a declining pest population.
Clean Water and Sanitation

Isotope hydrology

- makes use of different isotope contents in surface and groundwater to determine
- origin and evolution of groundwater
- sources and history of water
- past and present rainfall conditions
- recharge of aquifers
- mixing and interactions of water bodies
- evaporation processes
- geothermal resources and
- pollution processes and sources
- water quality and the risk of contamination
Key enabler for the implementation of all other SDGs. Nuclear power offers:
- quasi zero GHG emission electricity generation
- avoids local air pollution detrimental to human health and the environment
- potential lynch pin for energy systems transformation
- predictable long-term generating costs
- reliable base load supplies
- small fuel and waste volumes
- quasi unconstrained long-term resource availability
- nuclear wastes are managed
- jobs in a highly skilled workforce
- most externalities internalized

No smooth sailing:
- Climate benefits not rewarded
- high upfront capital cost difficult to finance
- electricity increasingly seen as a commodity
  - Short-run prices matter
  - 24/7 reliability often ignored
  - political and public tolerance
Radiation and radioisotopes in industries

- non-destructive testing
- quality control & inspection of finished goods
- highly sensitive gauges to measure the thickness and density of materials (sheet metal, textiles, paper napkins, newspaper, plastics, photographic film and other products)
- sterilization
- radioisotopes as tracers to
  - track leakage from piping systems
  - measure velocity of flows,
  - gauge the efficiency of filtration systems
  - monitor the rate of engine wear and corrosion of processing equipment
- Radioactive materials to
  - locate and quantify oil, natural gas and mineral deposits
  - inspect metal parts and welds for defects
  - calibrate instruments
  - manufacture ceramics and glassware
  - generate heat or power for remote weather stations, space satellites and other special applications
Take urgent action to combat climate change and its impacts

- **Nuclear power - A truly low carbon energy source**
  - quasi zero GHG emission on a life cycle basis
  - avoids local air pollution detrimental to human health and the environment
  - small fuel and waste volumes
  - readily available
  - already avoids substantial GHG emissions

- **Nuclear S&T**
  - Electron beam flue gas desulphurization

Source: McKinsey
Radiotracers are unique nuclear tools that can be used:

- to study pollution, its transport and dispersion in coasts and oceans
- to examine the growth rates in calcifiers, such as corals, mussels, limpets and other molluscs, whose skeletons are composed of calcium.
- to determine how ocean acidification is affecting the eggs and juveniles of vertebrate fish species, and cephalopods, such as finfish, octopus and cuttlefish.
- Carbon-14 or phosphorus-32 allow the study of nutrient dynamics and lead to a better understanding of the foundations of an ecosystem.
- Using short-lived isotopes, radioecologists examine contaminant accumulation in marine organisms and biomagnification.
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

- Nuclear S&T contributes to peace
  - Nuclear security – preventing non-state actors and terrorists from getting hold of radioactive materials
  - Safeguards and verification: preventing the spread of nuclear weapons - a vital contribution to international peace and security
Other SDGs

- Not explicitly mentioned today but indirectly covered by those addressed
- Any particular nuclear S&T method benefits several SDGs
Concluding remarks

- Nuclear Science and Technology can make significant contributions to the achievement of the 2030 Agenda for Sustainable Development, especially when
  - a S&T application has no or only inferior alternatives
  - S&T application enhances/supplements non-nuclear methods/techniques
  - partnerships help expand access to science and technology toward achieving the SDGs

- And what about nuclear power?
Nuclear power - One size does not fit all

Countries differ with respect to
- energy demand growth
- alternatives
- financing options
- weighing risks and preferences
  - accident risks (nuclear, mining, oil spills, LNG...), cheap electricity, air pollution, jobs, import dependence, climate change

There is no technology without risks ("no-silver bullet")

Benefits > risks or risks > benefits (perceived or real)

If the international community is serious about combating climate change – nuclear power can be an integral part of the solution.
A long and bumpy road ahead .....