

# Nuclear Technology in the Water-Energy-Food Nexus

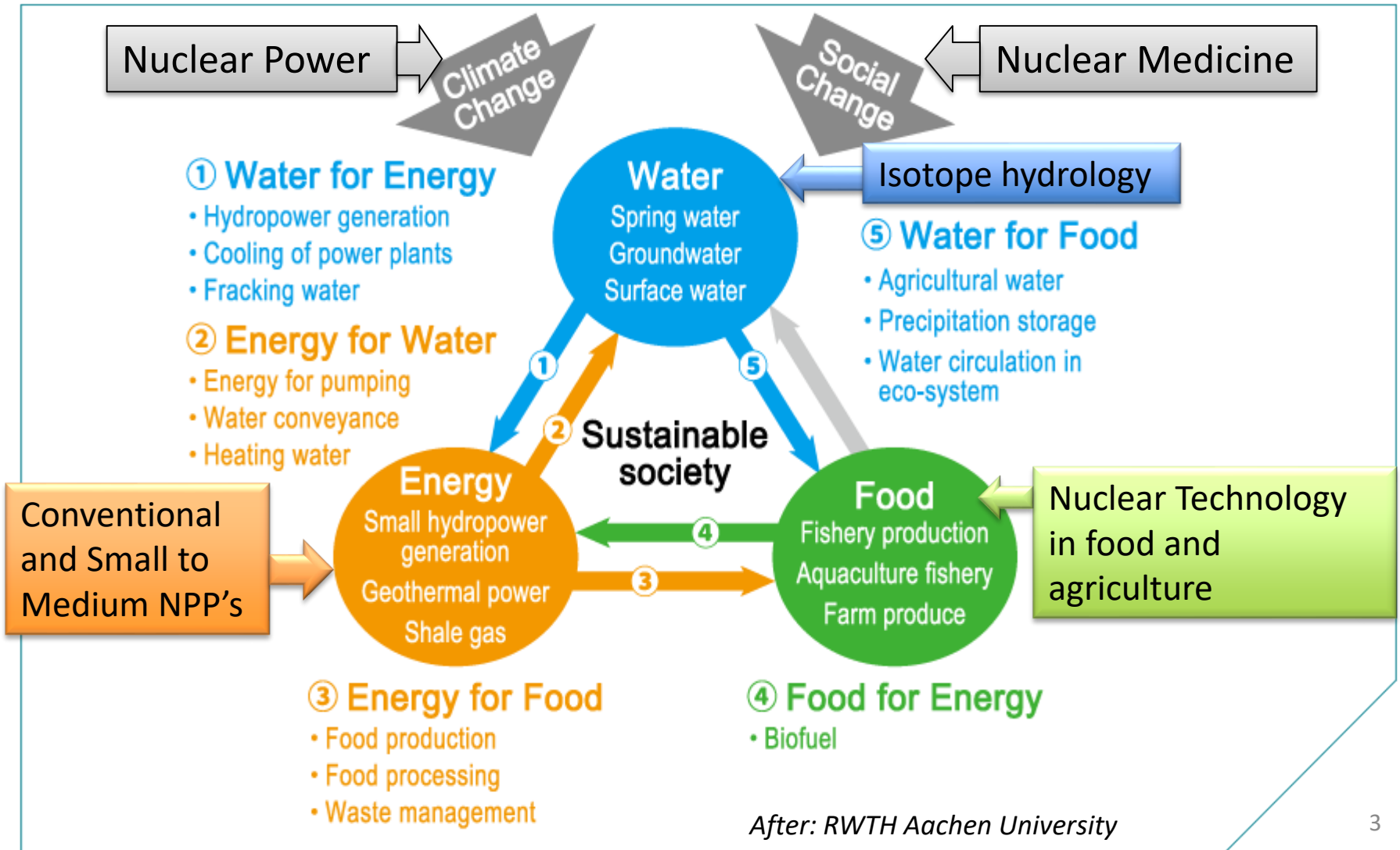
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# Water-Energy-Food Nexus



## Conventional and Small-to-Medium Nuclear Power Reactors

### Water consumption (Conventional NPP's)

Consumption = Withdrawn + Evaporation - Return

Once through = no consumption + possible temperature impact on aquatic life

Cooling tower = increased consumption less impact

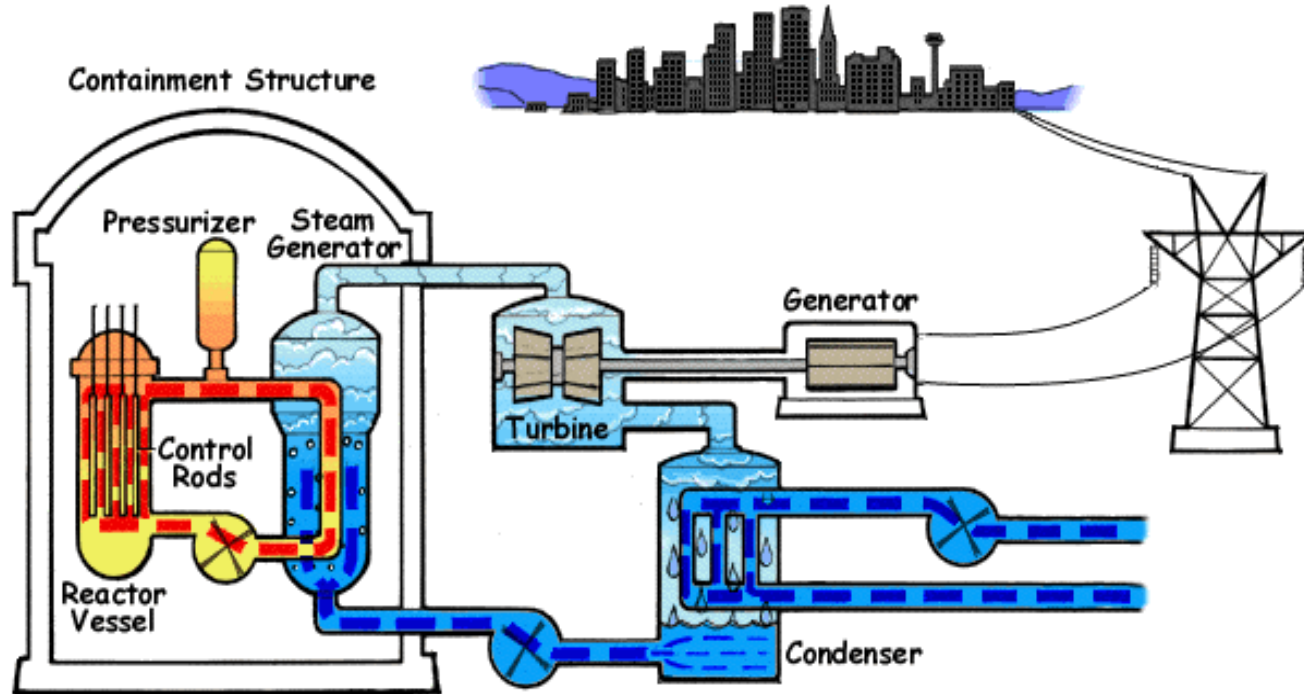
1514 litres water consumption per MWh (once-through)

2725 litres water consumption per MWh (Cooling Tower)



Nuclear is comparable to coal, but is situated on coastal sites using sea water!

# Water consumption by PWR's in perspective



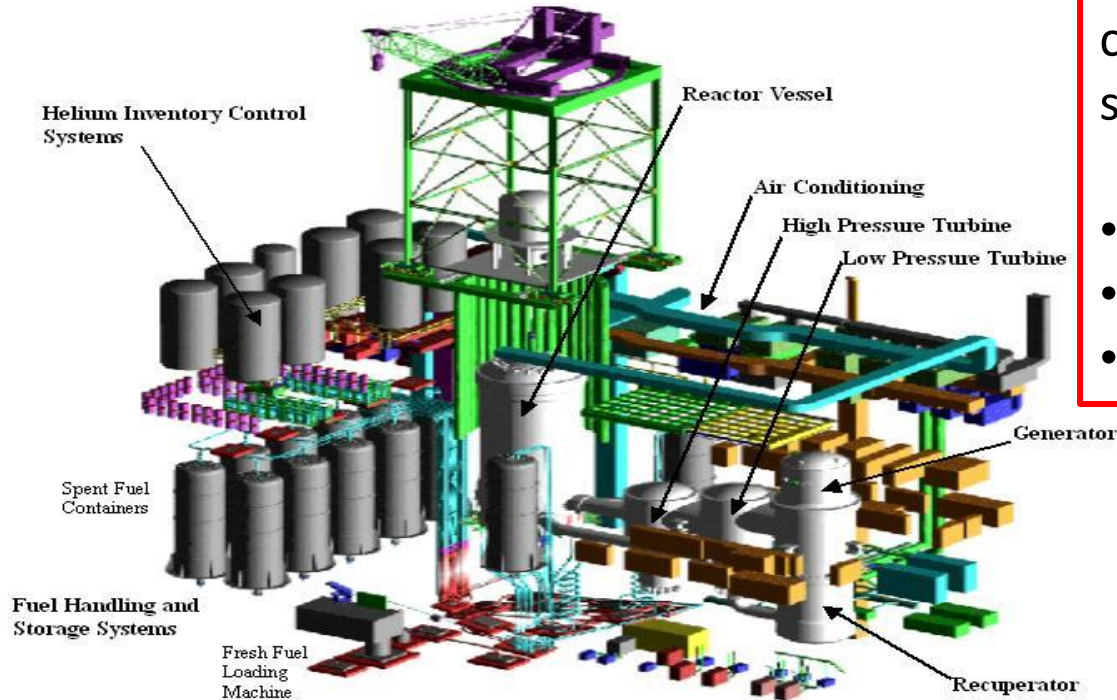
PWRs – Situated at coastal sites

For coastal sites, the consumption of water is rarely if ever a problem



# Small to medium gas cooled reactors

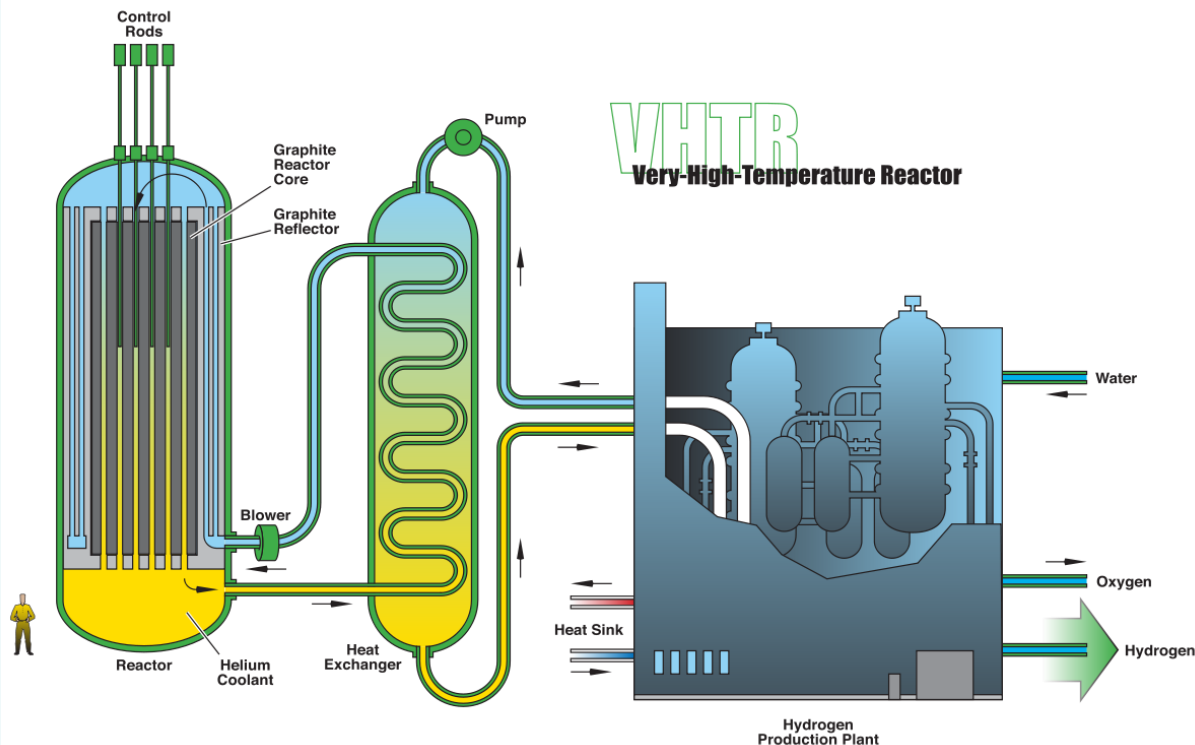
The no water consumption energy solution



Future trend - no water consumption for cooling of small nuclear reactors:

- Electricity
- Desalination
- Ground water pumping

## ■ Environmental care through development of a hydrogen economy



Very High Temperature Nuclear Reactors (gas cooled) provide process heat for hydrogen production without water consumption

## *Typical applications:*

- Detecting harmful algal blooms (red tide)
- Sources of nitrate pollution
- Optimisation of irrigation and use of fertiliser
- Groundwater management
- Aquifer mapping, dating and recharge studies
- Desalination



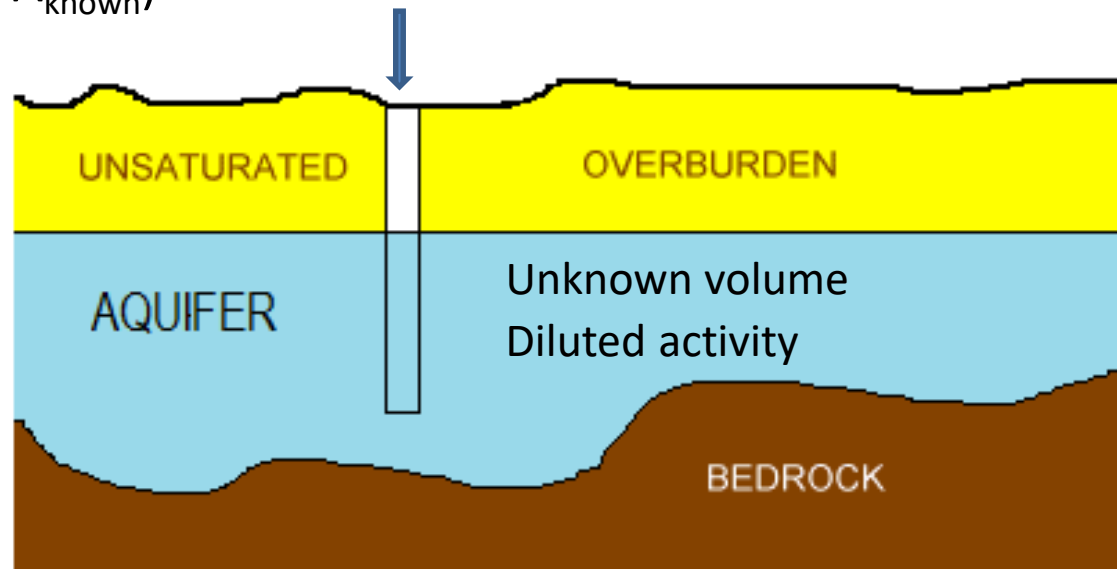
## Isotope hydrology principle

Introduce known volume of an isotope with known activity into the aquifer

Extract a sample after dilution in aquifer and measure the activity

$$V_{\text{unknown}} = V_{\text{known}} (A_{\text{diluted}} / A_{\text{known}})$$

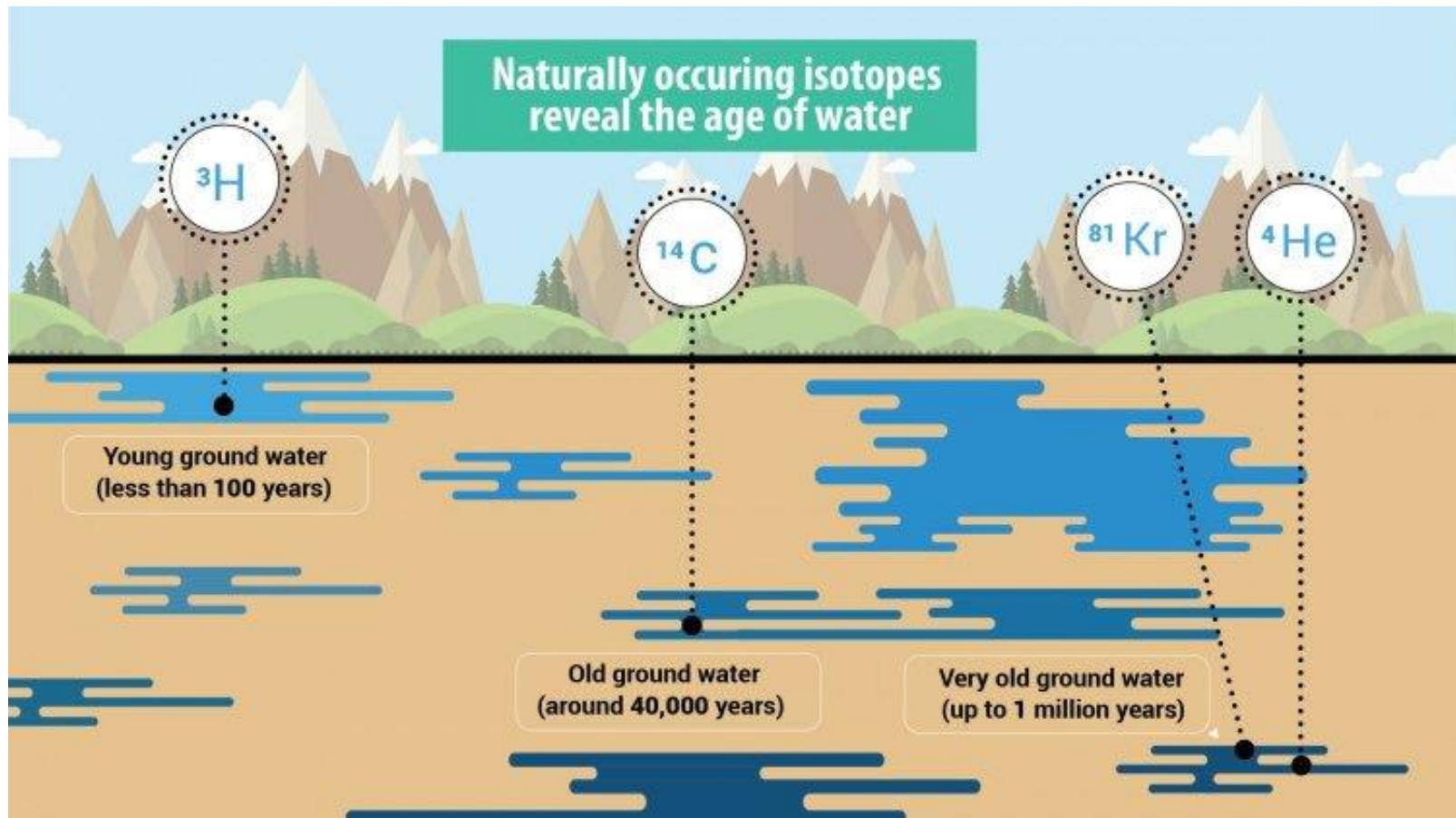
- Volumes
- Flow rates
- Mixing rates
- Age of the water



Important tool for quantitative resource management

# Isotope hydrology continued

Important to understand the impact of withdrawal versus replenishment



- Feasibility of integrated nuclear desalination plants proven with >150 reactor-years of experience, mainly in Kazakhstan, India and Japan.
- BN-350 fast reactor at Aktau, Kazakhstan, supplied up to 135 MWe of electric power while producing 80,000 m<sup>3</sup>/day of potable water over 27 years, with 60% of its power used for heat and desalination.
- In Japan ten desalination facilities linked to PWRs operating for electricity production supply 14,000 m<sup>3</sup>/day of potable water.
- SMRs for desalination: SMART (South Korea), CAREM (Argentina)



## FAO/IAEA “Atoms for Food” partnership

### *Crop Production:*

- Isotope techniques optimize the uptake of nutrients by plants.
- Plant breeding methods using irradiation produce varieties of crops that supply higher yields or thrive in harsh climates.

### *Agricultural Pest Control:*

- Application of the sterile insect technique (SIT) suppresses or eradicates major insect pests threatening crops and livestock.

### *Environmental Protection:*

- Isotope techniques assist in reducing soil erosion, land degradation and water pollution.

# Some achievements

100 countries use radiation-based plant breeding techniques to improve food and industrial crops.

30 countries use nuclear methods to contribute to improved irrigation and crop production.

Gamma irradiation of more than 60 kinds of food is approved in over 40 countries.

30 countries use the sterile insect technique against key insect pest species and are embarking on area-wide pest management. More than 3.5 billion Mediterranean fruit flies are produced every week.

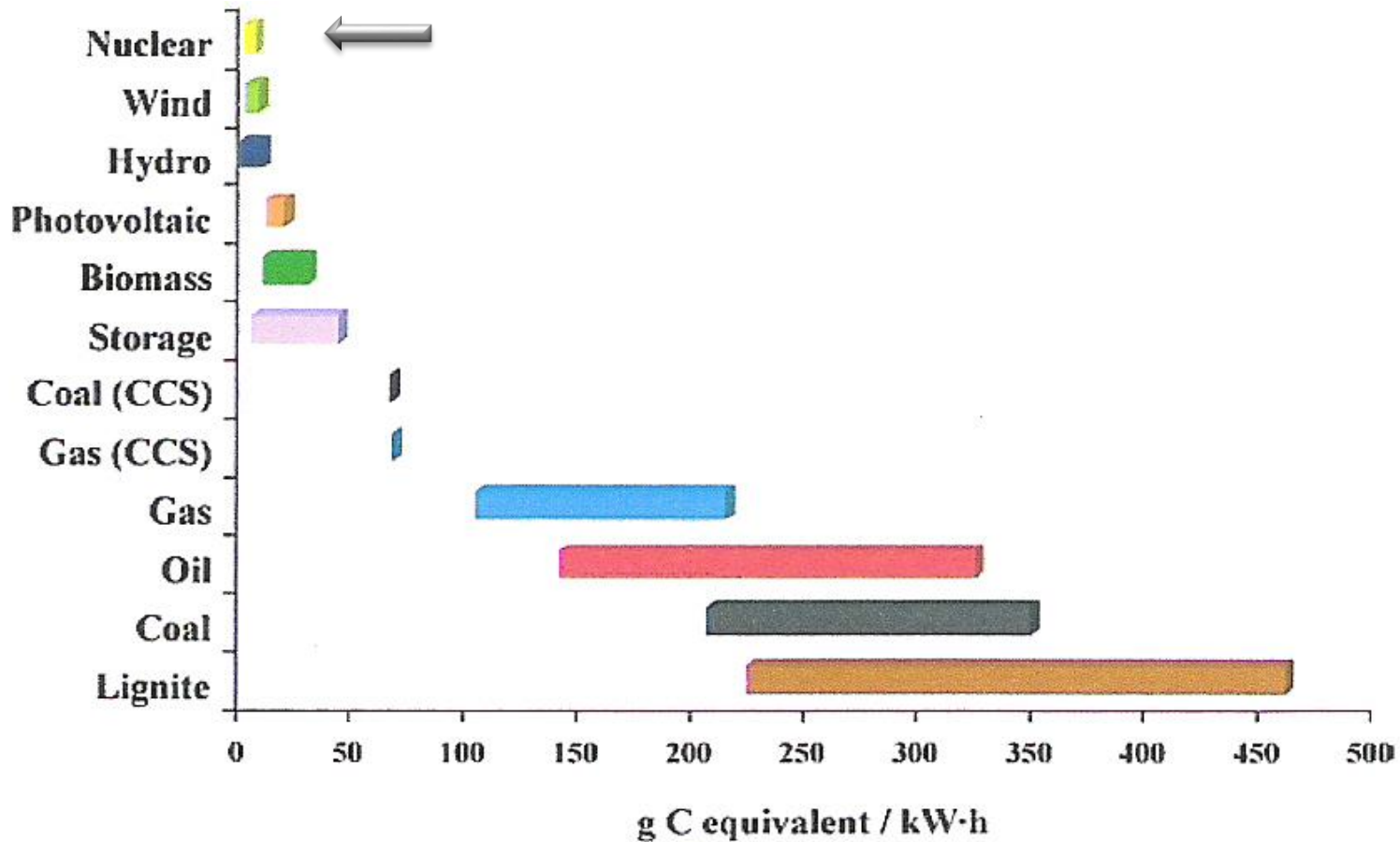
95 countries use isotopic and nuclear techniques to identify land and water management practices to improve nutrient and water use efficiency for crop productivity and environmental sustainability.



- Mediterranean fruit fly eradicated in Mexico (1981) and in certain areas in Argentina and Chile (1995).
- Screwworm eradicated in Southern USA, Central America and Libya.
- Zanzibar tsetse-free by 1997.
- Tsetse SIT underway in Southern Ethiopia.
- **Various SIT programs in South Africa.**

# Nuclear technology against climate change

## CO<sub>2</sub> Emissions from electricity generation



Some scenarios with assumption of unconstrained global emissions:

- Run-off increases on average by ~5% (as high as 48% in places)
- Increased drying highly probable in the Western Cape
- By 2050 median demand for irrigation water will increase by 6.4%
- Higher temperatures will lead to dryer conditions on average



# Conclusions

- Nuclear technology (NT) is a key factor in effective W-E-F management
- Nuclear energy mitigates against anthropogenic climate and small high temperature gas cooled reactors in particular have very attractive W-E-F friendly features, such as desalination
- Water monitoring and management through NT is a proven value adding activity world-wide
- NT has wide, proven and impactful applications in food and agriculture



**Nuke is Neat!**

**Thank You**

**Questions?**

