



# Accumulation of nuclides like $^{137}\text{Cs}$ from fallout

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# The issue of Cs-137 in firewood and biomass combustion: a review

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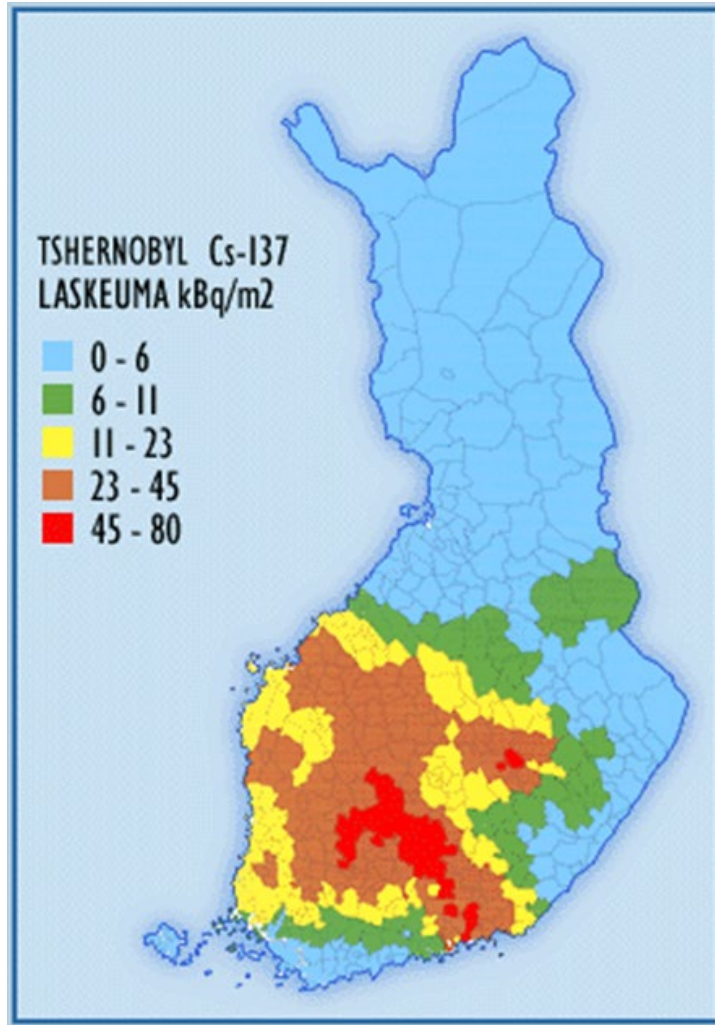
# The issue in a nutshell

- Fallout Cs-137 is a part of the environment for many decades still
- Cs-137 gets strongly concentrated into the ash in biomass combustion
- EU-BSSD leaves room for interpretation on how to regulate Cs-137 in biomass ash, has resulted in national variability in Europe
- Biomass as an energy source is increasing in EU, resulting also in increasing imports
- Biomass ash can be a valuable resource and should not be wasted due to Cs-137
- Sometimes e.g. heavy metals prevent the use of ash but depending on waste classifications, landfills might not accept Cs-137 contaminated ash
- Climate-driven need to increase alternative energy sources, the advancement of circular economy and associated international trade calls for harmonization of regulations

# Cs-137 fallout in Finland (as an example)

1986

Zones  
I – V



2019 calculated

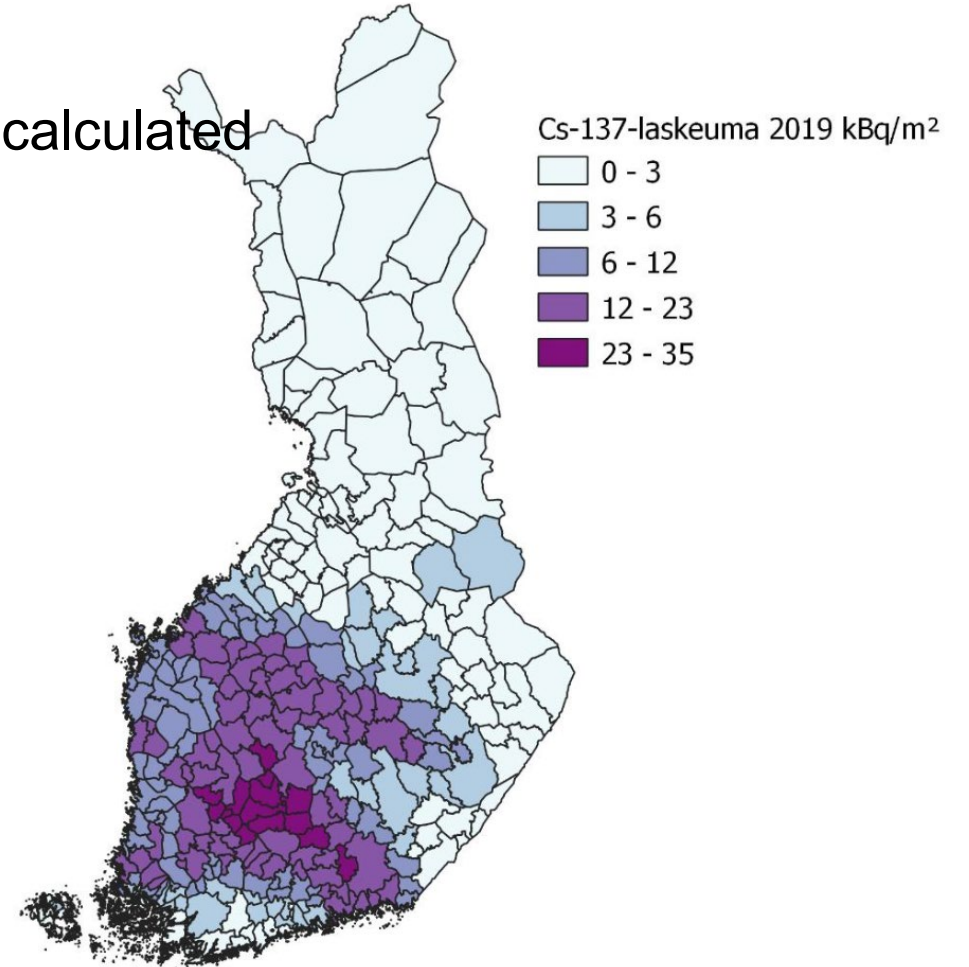


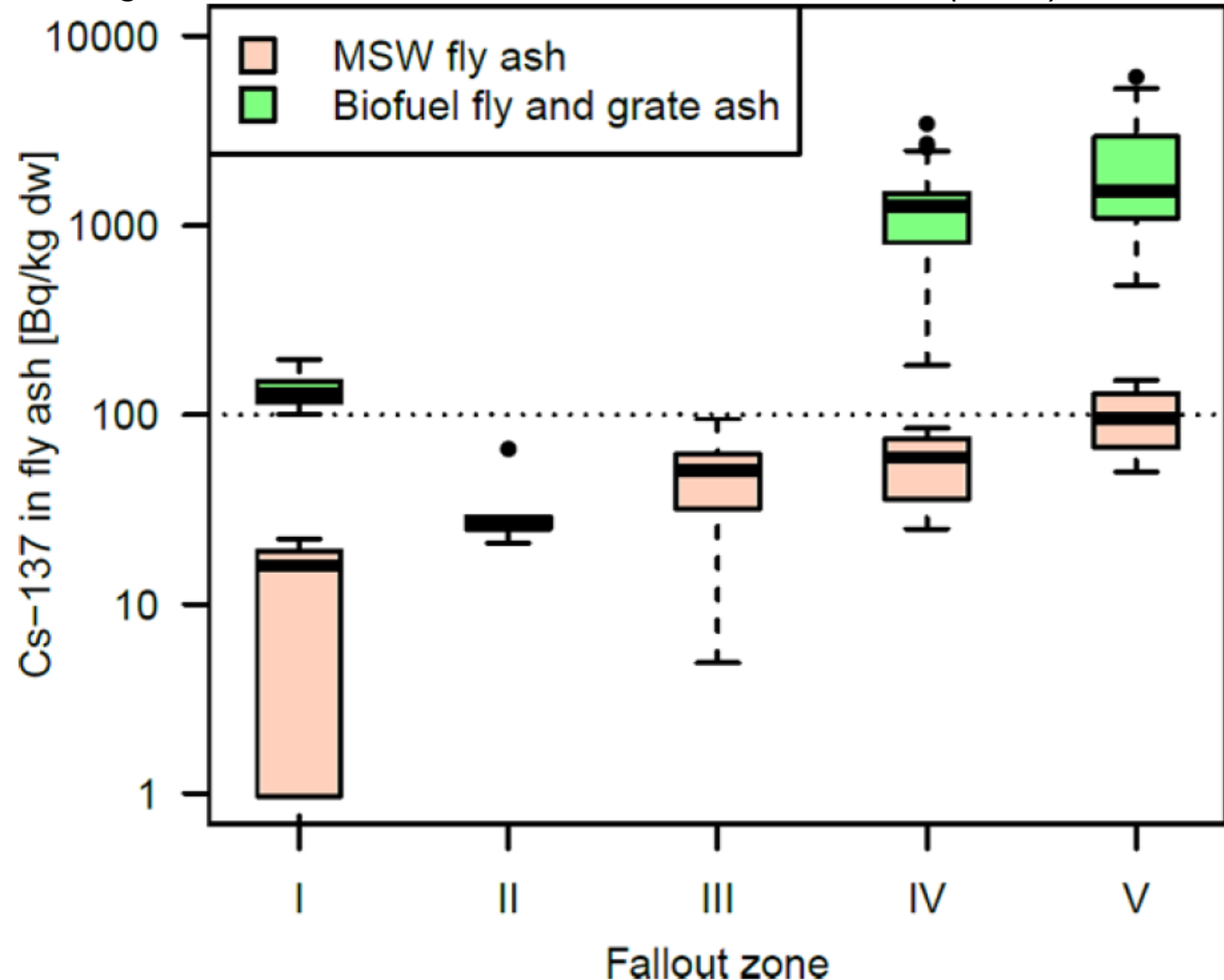
Image: Kämäräinen et al 2018, Bioenergian tuotannossa syntyvän tuhkan radioaktiivisuus, Ympäristösäteilyn valvonnan toimintaohjelma, STUK

Image: STUK (<https://stuk.fi/tsernobylin-onnettomuuden-vaikutukset-suomessa>)

# Cs-137 concentrates into the ash in biomass combustion

- In Finland:
  - wood has on average 13 Bq/kg of Cs-137, but bark has 3 – 15 times more depending on species of tree
  - Woodchips, pellets and firewood used as biofuel contain also bark
- Forest biomass ash in Finland contains  $> 100$  Bq/kg Cs-137, even in areas of least fallout
- Average biomass fly ash had 1300 Bq/kg (2016 level)
- Biomass fly ash contains ca. 1 order of magnitude more Cs-137 than Municipal solid waste (MSW) fly ash from the same fallout zone

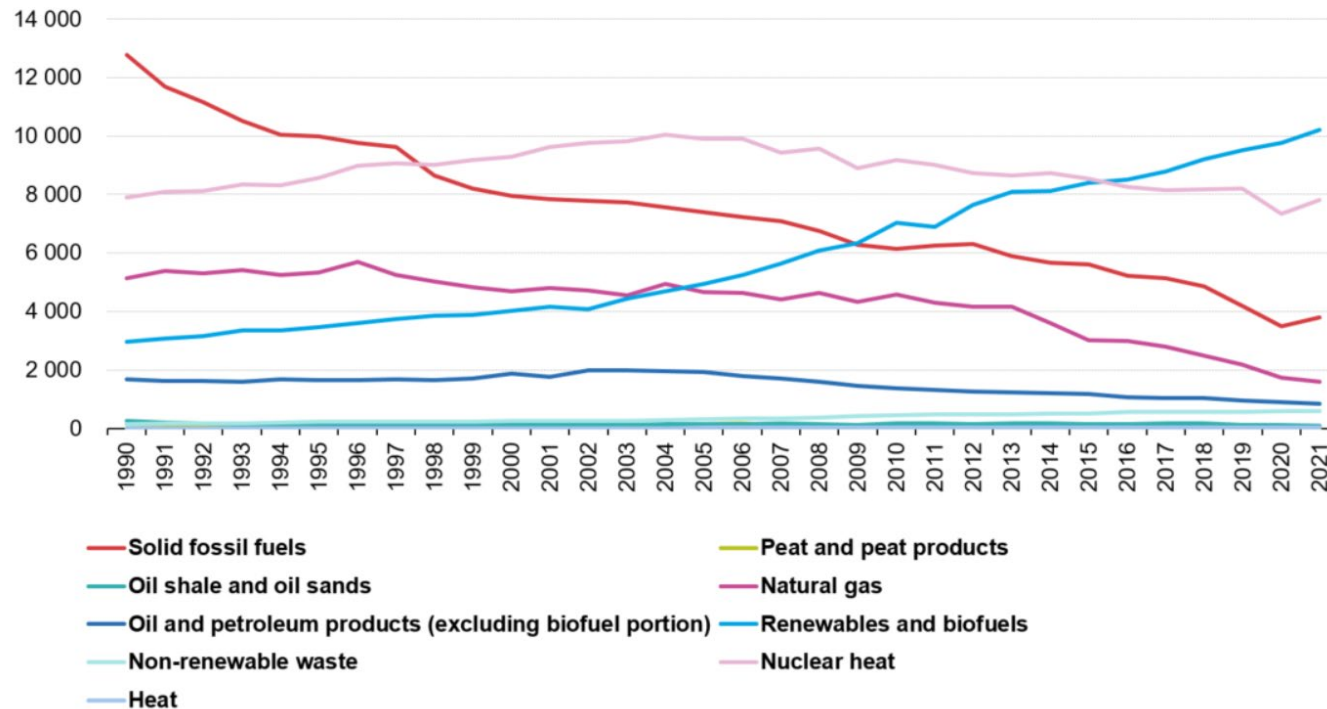
Figure from Kallio et al 2023 J. Radiol. Prot. 43 (2023) 021502



# Solid Biofuels and biomass combustion are increasing

- From bioenergy in Europe, primary solid biofuels represent the largest share at 70 %
- From solid biofuels, forest biomass ('woody biomass') represents nearly 70%
- European Commission: *'Increasing wood use is also seen as part of the EU's efforts towards the de-carbonisation of the economy. This may require greater mobilization of wood and possibly increasing wood imports'*
- Even countries that received little fallout in 1986 cannot avoid the issue of Cs-137 as biomass can be imported from fallout affected areas

Primary energy production by fuel, EU, in selected years, 1990-2021  
Petajoule (PJ)



Source: Eurostat (online data code: nrg\_bal\_c)

eurostat



# How to regulate artificial nuclides according to the EU-BSSD when they are present in the environment?

- EU-BSSD leaves room for interpretation with regard to Cs-137 in biomass and ash:
  - **Planned or existing exposure?**
  - **Radioactive waste or not?**
- i) If existing exposure, reference levels can be applied
  - compare to building materials and commodities
- ii) If planned exposure, exemption and clearance are applied
  - Annex VII of the EU-BSSD: For the purpose of exemption or clearance the effective dose to the public:
    - **for artificial radionuclides is of the order of 10  $\mu$ Sv or less in a year**
    - for naturally-occurring radionuclides is of the order of 1 mSv or less in a year
  - Radioactive waste?

# Variability in the interpretation of EU-BSSD

- For example the Netherlands, Spain and Denmark have implemented the exemption and clearance level of 100 Bq/kg for Cs-137 for unlimited quantities
- Belgium: Import and use of Cs-137 contaminated firewood is an existing exposure situation and a reference level of 0.1 mSv/a is applied for the public, corresponding to 1000 Bq/kg of Cs-137
- Finland: Fallout Cs-137 is an existing exposure situation comparable to natural radiation, reference level is 0.1 mSv/a for the public:
  - Ash with <1000 Bq/kg of Cs-137 can be used without assessment
  - higher concentrations can be used with a case specific assessment (if no screening formula)
  - screening formulae applied for road construction, earthworks and use as forest fertilizer
- Sweden: ash with >1000 Bq/kg of Cs-137 is considered contaminated
  - ash with 1000 – 10000 Bq/kg Cs-137 can be reused, > 10 000 Bq/kg must go to landfill



# Conclusions

- Cs-137 is concentrated into ash even if low in the biomass
- Definitions of planned and existing exposure situations in the EU-BSSD lead to different national interpretations when applied to Cs-137 in ash
- Conservative dose assessments may indicate doses higher than 10  $\mu\text{Sv/a}$  for the use of Cs-137 contaminated ash, but for the most common uses of ash the reference level of 0.1 mSv/a would rarely be exceeded
- The increase of energy production from biomass and associated international trade calls for harmonization of regulations, to facilitate ash use and disposal
- Harmonized regulations would be needed to make it simpler for industries (including landfills) and end-users to demonstrate compliance, including situations when the biomass is imported

## Discussion

- Should Cs-137 in biomass combustion ash be regulated as a planned or existing exposure situation?
- Is an exemption criteria of 10  $\mu\text{Sv/a}$  practical for an artificial nuclide which is present in the environment for 100+ years? Should reference levels be used?
- What can be done at the European level to make sure that near-trivial doses are not preventing the increase of bioenergy use, the beneficial use of biomass ash when possible, and disposal when necessary?

