



energy  
visions

2050

## Future energy conversion technologies

Satu Helynen, VTT

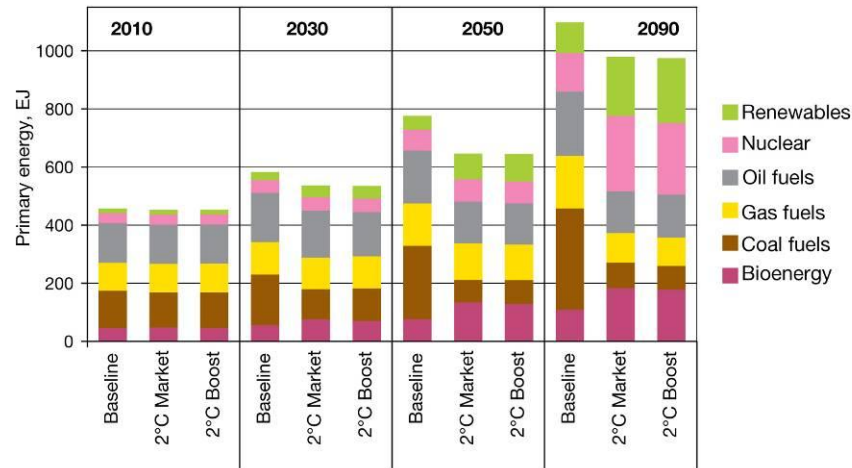


Business from technology

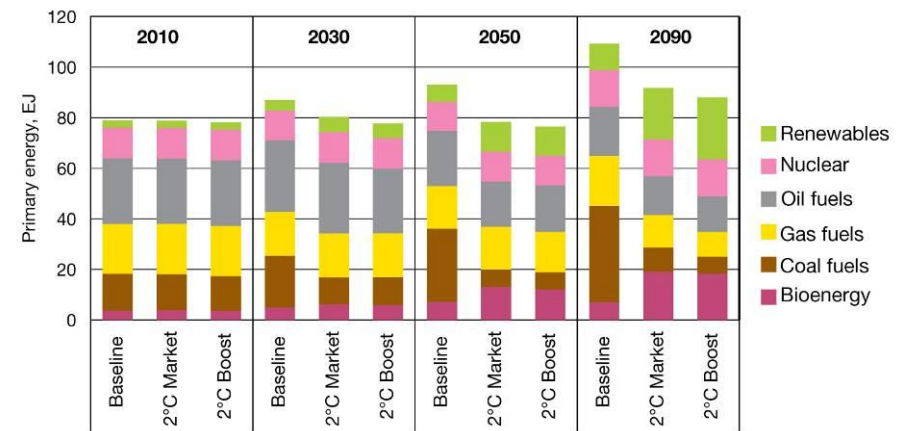
# ENERGY CONVERSION – STILL BASED MAINLY ON FOSSIL FUELS BUT SLOWLY CHANGING

Global and European primary energy consumption

Global primary energy supply by energy source, Baseline and 2°C mitigation scenarios

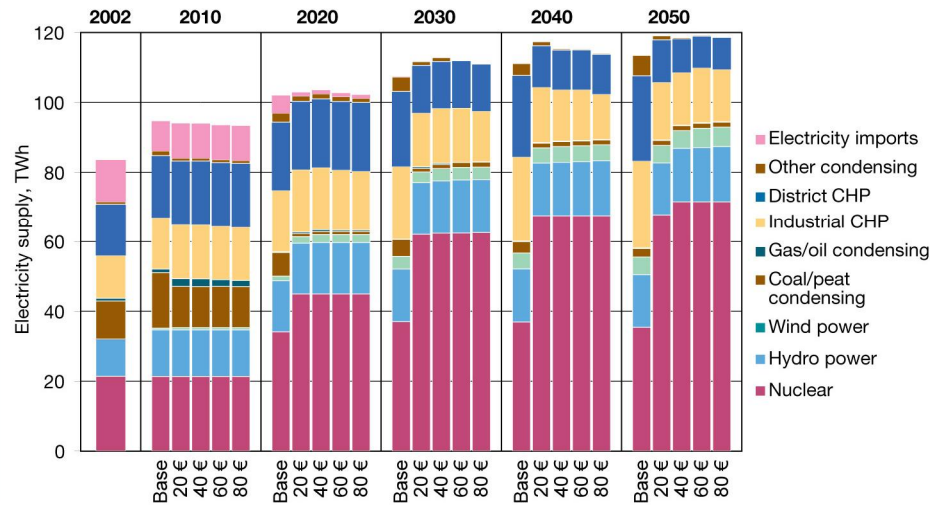


European primary energy supply by energy source, Baseline and 2°C mitigation scenarios

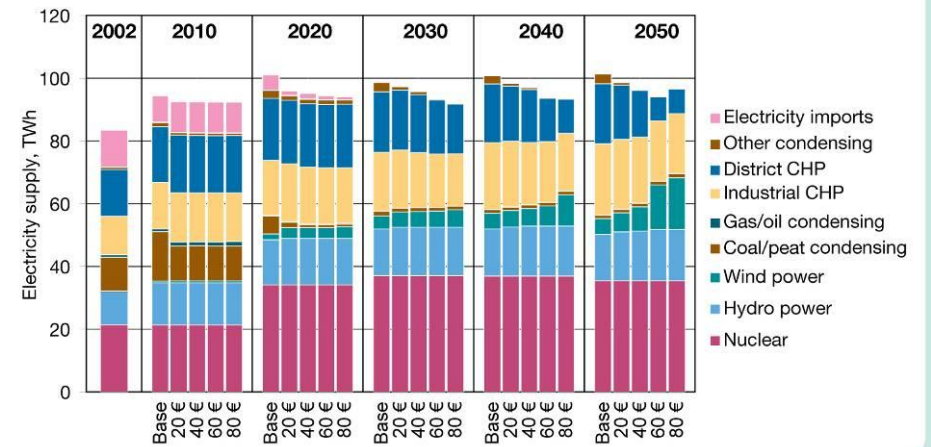


# SCENARIOS FOR FINLAND 2050 PRIMARY ENERGY CONSUMPTION - ELECTRICITY PRODUCTION

**Total electricity supply by main category in the Base Case B scenarios for Finland** (high potential for new nuclear power)

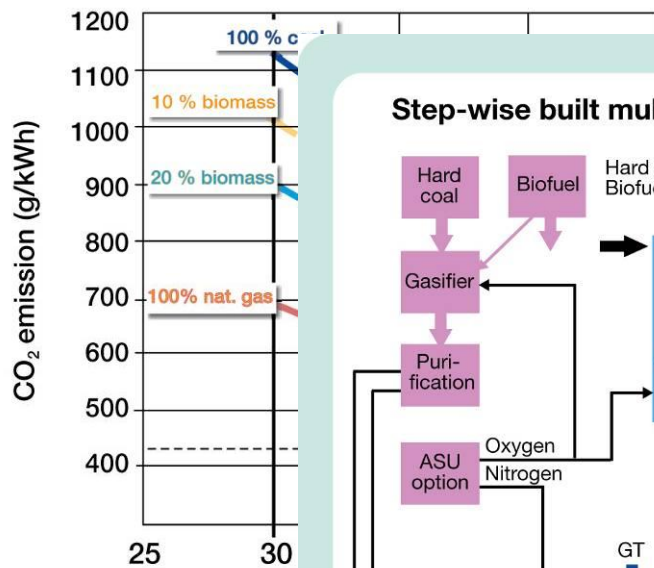


**Total electricity supply by main category in the Boosted scenarios for Finland** (conservative potential for new nuclear power)



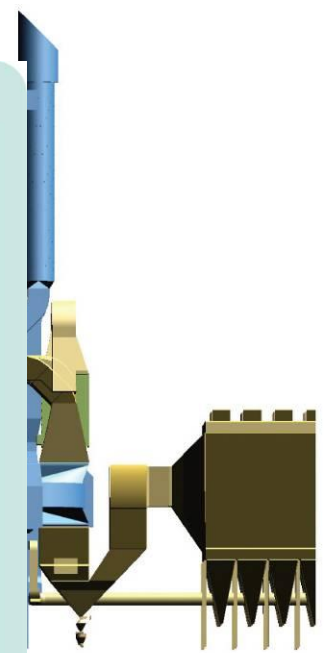
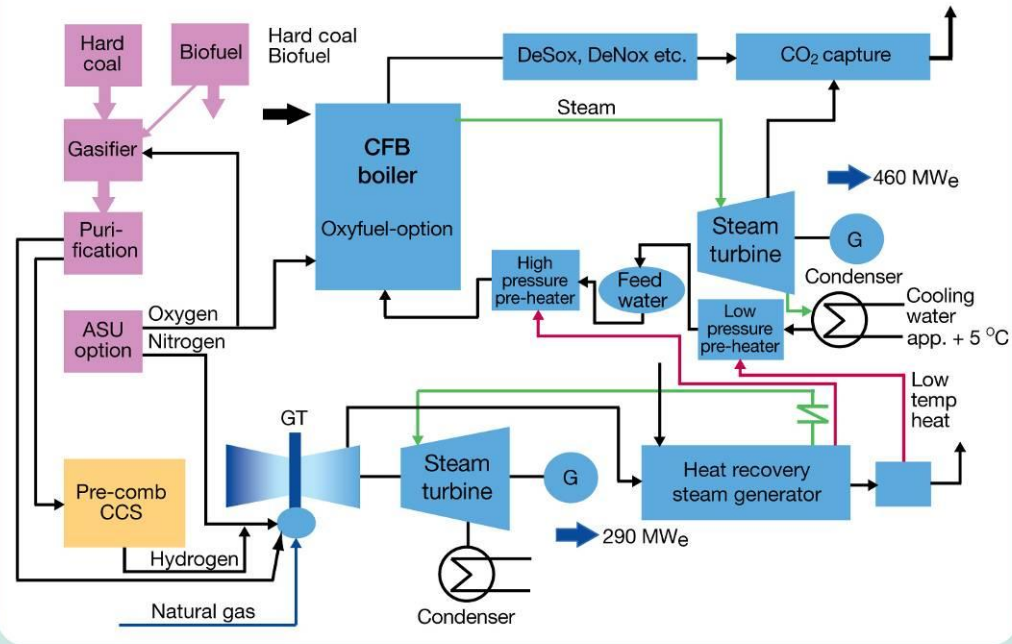
# FOSSIL FUELS PLANTS - SIGNIFICANT REDUCTION BY CCS

CO<sub>2</sub> emission reduction possibilities w



Supercritical circulating fluidised bed boiler

Step-wise built multifuel high-efficiency CHP with carbon capture

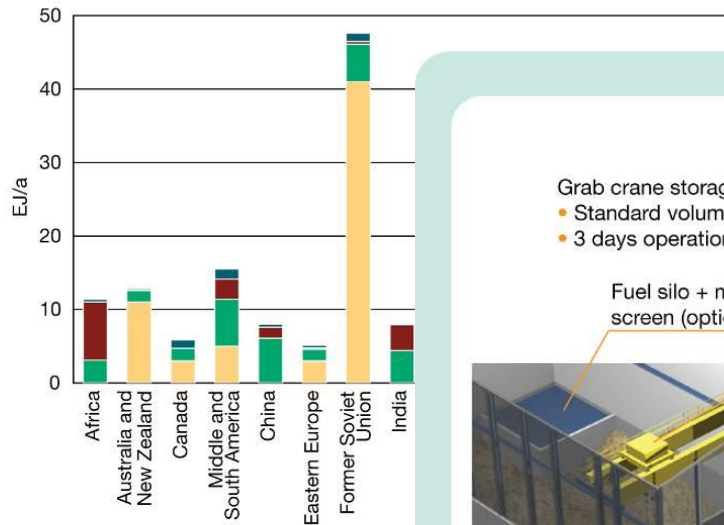


Foster Wheeler

Pohjolan Voima

# BIOENERGY CHAINS IMPORTANT FOR A RELIABLE FUEL SUPPLY

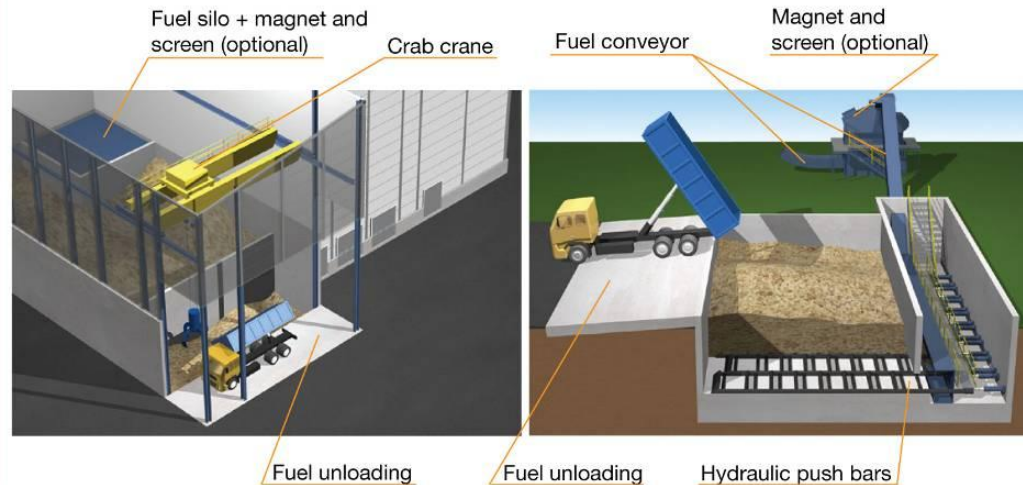
Global biomass-based energy potential by region in 2050



## Fuels storage alternatives

- Grab crane storage
  - Standard volume 2500 m<sup>3</sup>
  - 3 days operation

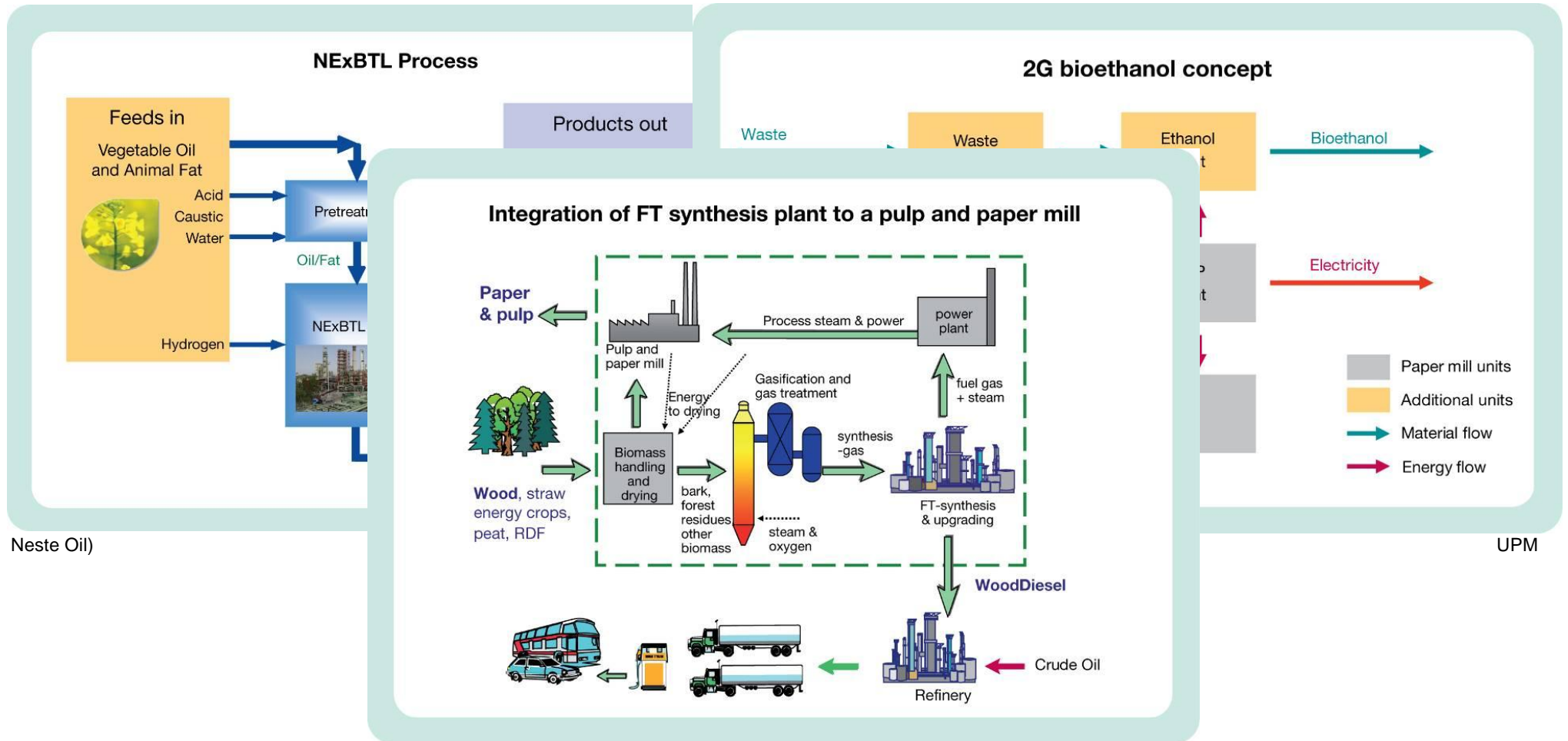
- Push bar storage
  - Standard volume 500 m<sup>3</sup>
  - 16 hours operation



Raumarster

Wärtsilä Biopower BP5)

# BIOFUELS - R&D ON ADVANCED TECHNOLOGIES

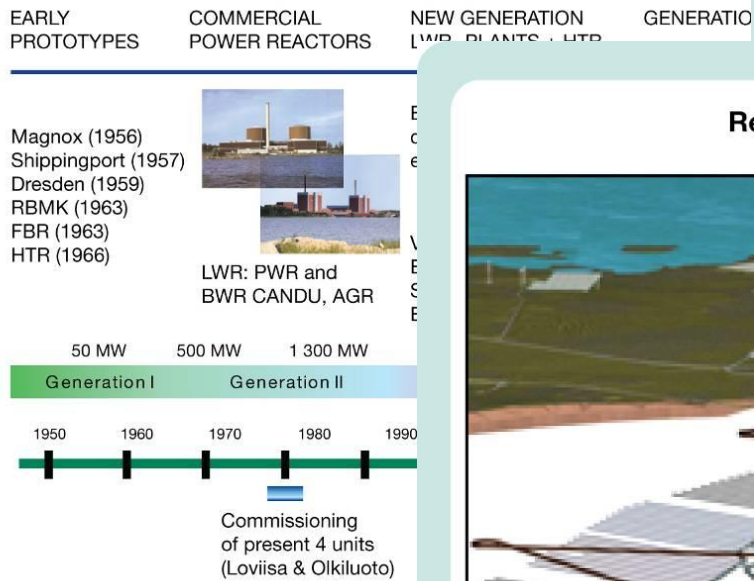


Neste Oil)

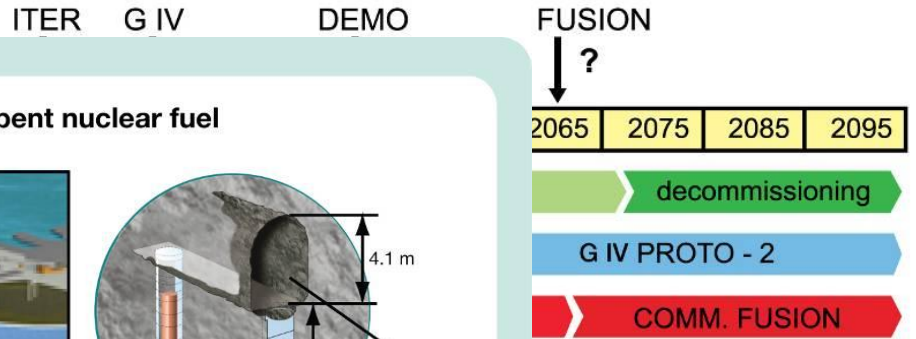
UPM

# NUCLEAR ENERGY – A COMPETITIVE, YET CONTROVERSIAL OPTION FOR THE FUTURE

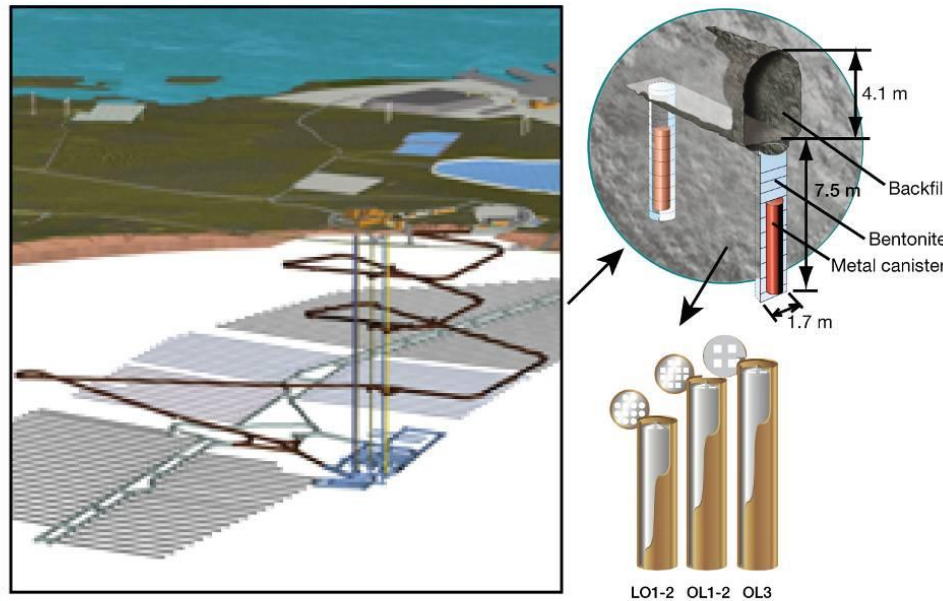
## Evolution of nuclear power



## An indicative timeline for the emergence of new types of nuclear reactors



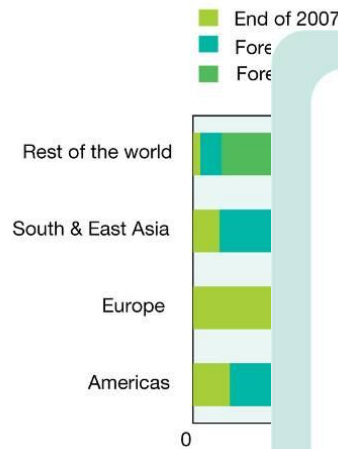
## Repository for spent nuclear fuel



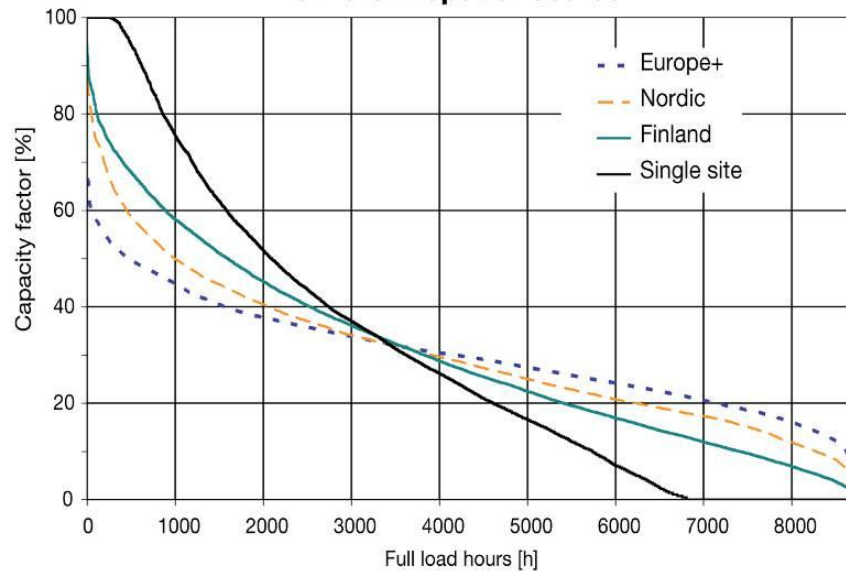
Olkiluoto, Finland

# WIND POWER– NEW ELEMENT FOR POWER SYSTEMS

Global wind energy market by region



Approximate duration curves for wind power at different spatial scales



WinWind

## CONCLUSIONS

- Several technologies and energy sources are needed: breakthrough of one single concept of the sustainable energy production is not foreseen
- Especially important for Finland
  - Competitive nuclear power for base load electricity for energy-intensive industry utilising the local raw materials such as wood and minerals
  - Utilising of smaller heat loads and improving power-to-heat ratio in CHP plants, because the heat demand is declining
  - Development of bioenergy technologies
  - Special requirements for wind energy: arctic conditions for off-shore, limited amount of condensing power and hydropower available compared to other countries
  - Several options on renewable fuels for transportation sector are available