

Climate Change: Assessment of the Vulnerability of Nuclear Power Plants and Cost of Adaptation

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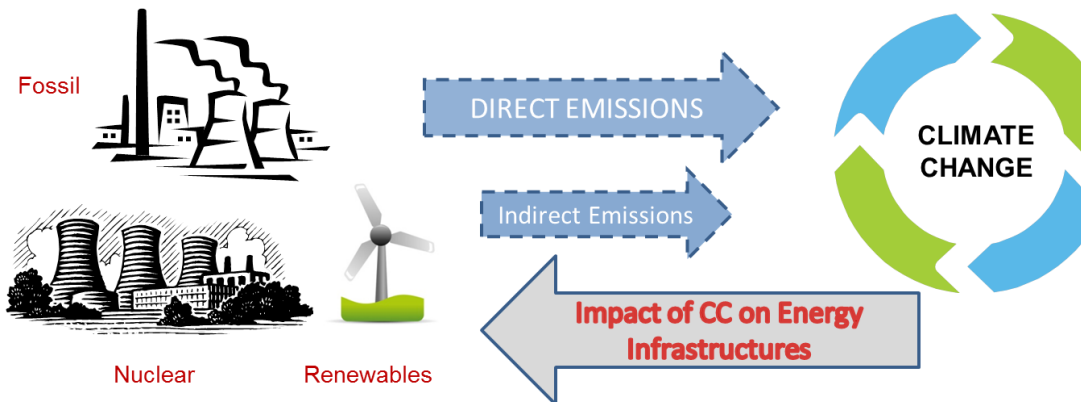
**3rd Forum on the Climate – Energy Security Nexus:
Electricity Sector Resilience**

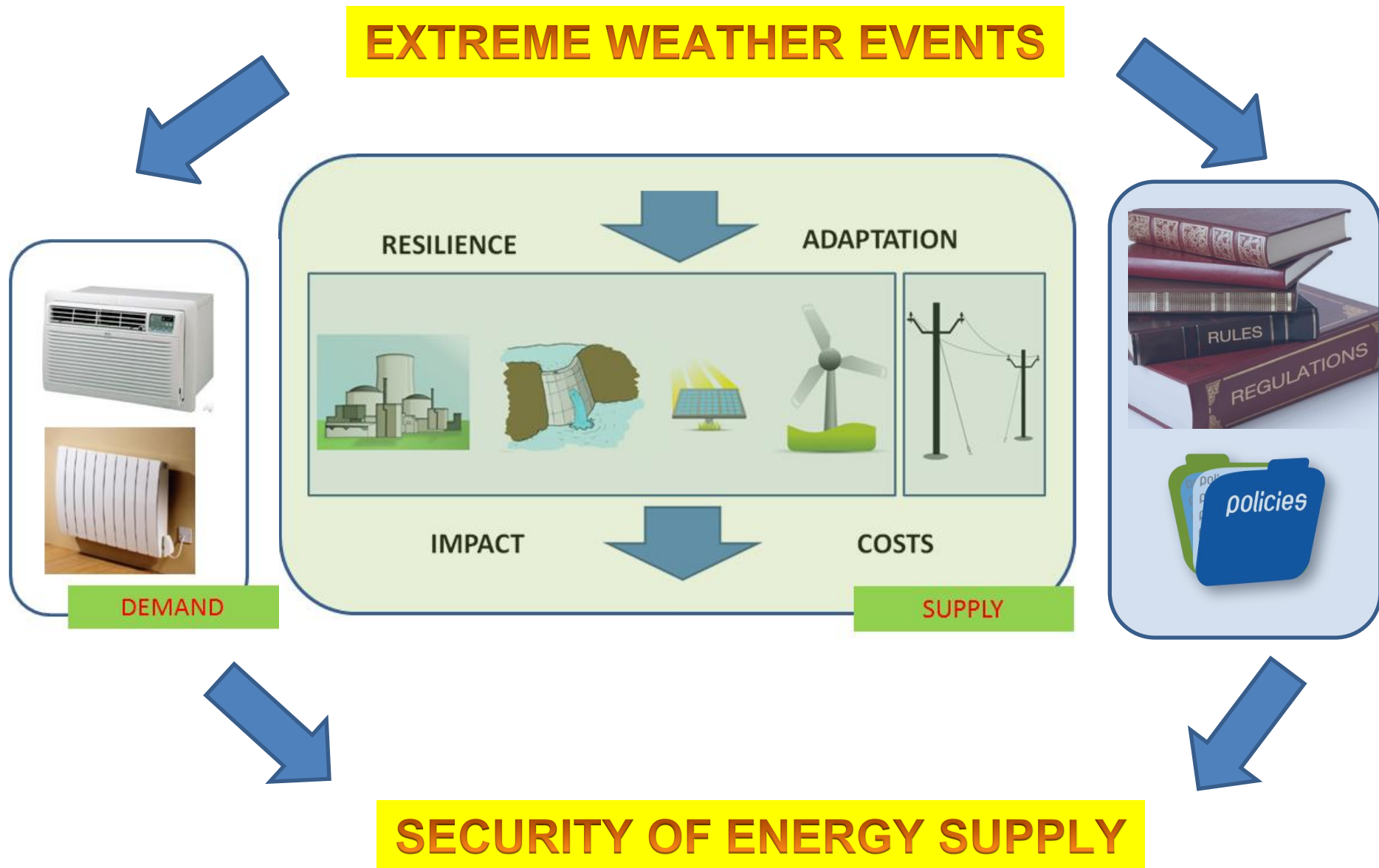
Friday, 25 October 2013, International Energy Agency, Paris



Ad hoc Expert Group on CC: Assessment of the Vulnerability of NPPs and Cost of Adaptation

- 9 NEA countries: Austria, Canada, Czech Republic, Finland, France, Germany, Korea, Spain, US + IAEA, EC, IEA, OECD/ENV + consultation with industry
- Cost impact of CC on operation of NPPs and cost of adaptation measures
- Impact of extreme weather events on NPP operation & safety (case studies): Heat waves, droughts, floods, storms, ice storms, frazil...
- Energy-Water nexus: cooling
- Regulations & policies (environment and safety)
- Security of energy supply aspects







December 1999: Major storm, combined with high tides, led to partial flooding of the Le Blayais NPP (France)

Measures requested by the Safety Authority following this event:

- ✓ Increase height of flood barriers (dykes)
- ✓ Ensure water-tightness of NPP basement
- ✓ Improve weather alert system

June 2011: severe flooding from the Missouri river.

- ✓ Robust flood barriers requested by the Regulator.





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AJOUTER UN COMMENTAIRE

Centrale de Golfech : la température de Garonne sous surveillance



Depuis la canicule de 2003, qui avait conduit la centrale nucléaire de Golfech à arrêter temporairement l'une de ses deux tranches pour éviter d'accroître le réchauffement de l'eau de Garonne, la température du fleuve est surveillée scrupuleusement.

à la centrale nucléaire de Golfech, la canicule de 2003 est encore dans les têtes, qui avait vu une des deux tranches du site golfechois être stoppée temporairement et avait engagé les autorités à donner une dérogation à EDF pour ses autorisations de prélèvements et de rejets d'eau (1). Le

pompage en Garonne est, en effet, essentiel au fonctionnement de la centrale puisqu'il sert à compenser l'évaporation des aéroréfrigérants et à refroidir des circuits auxiliaires de sûreté ou de support à la production. Il y a 9 ans la situation était ubuesque puisque certaines nuits la température de l'eau rejetée dans Garonne par la centrale était inférieure à la température en aval !

theguardian

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Environment > Drought

Persistent drought in Romania threatens Danube's power

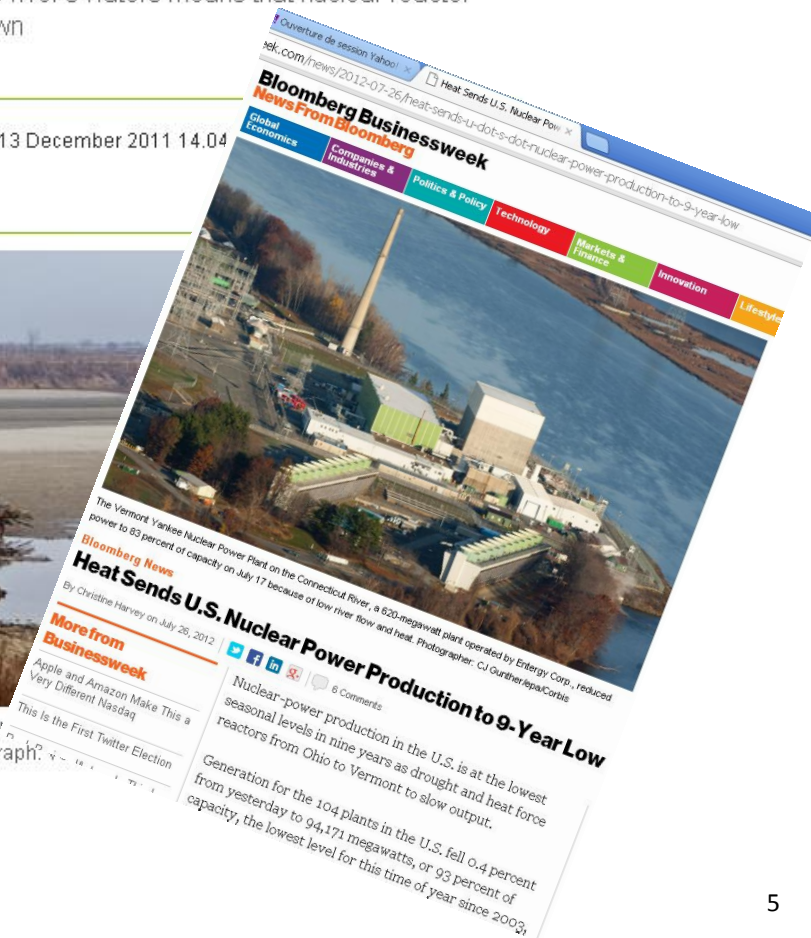
Drop in the level of the river's waters means that nuclear reactor may have to close down

Mirel Bran

Guardian Weekly, Tuesday 13 December 2011 14.04



Season of drought ... Romania's Danube's river bed. Photograph:



Energy Infrastructure Outages		
Infrastructure	Total	Worst Day Outages
Refineries*		
Number	6	2
Capacity (thousand barrels per day)	1,170	308 (26% of Capacity in Path of Sandy)
Pipelines		
Products		Buckeye, Colonial, Plant
Crude		None
Natural Gas		New Jersey Natural Gas
Ports		
		Hampton Roads, Baltimore, York, Long Island, South Boston
Petroleum Terminals		
		57
Nuclear Power Reactors		
	30**	3 shut down, 2 reduced

*Includes only refineries in the path of Hurricane Sandy
 **There are 26 nuclear power reactors at 17 different sites in NRC Region (Northeast) and 4 reactors at 2 different sites in Virginia.
 Source: OE/ISER Situation Reports, NRC

Storms



Source: NOAA



Frazil

Forest fires



Experience in fighting wild fires in the Russian Federation in 2010

State Secret EM

Protection of communities



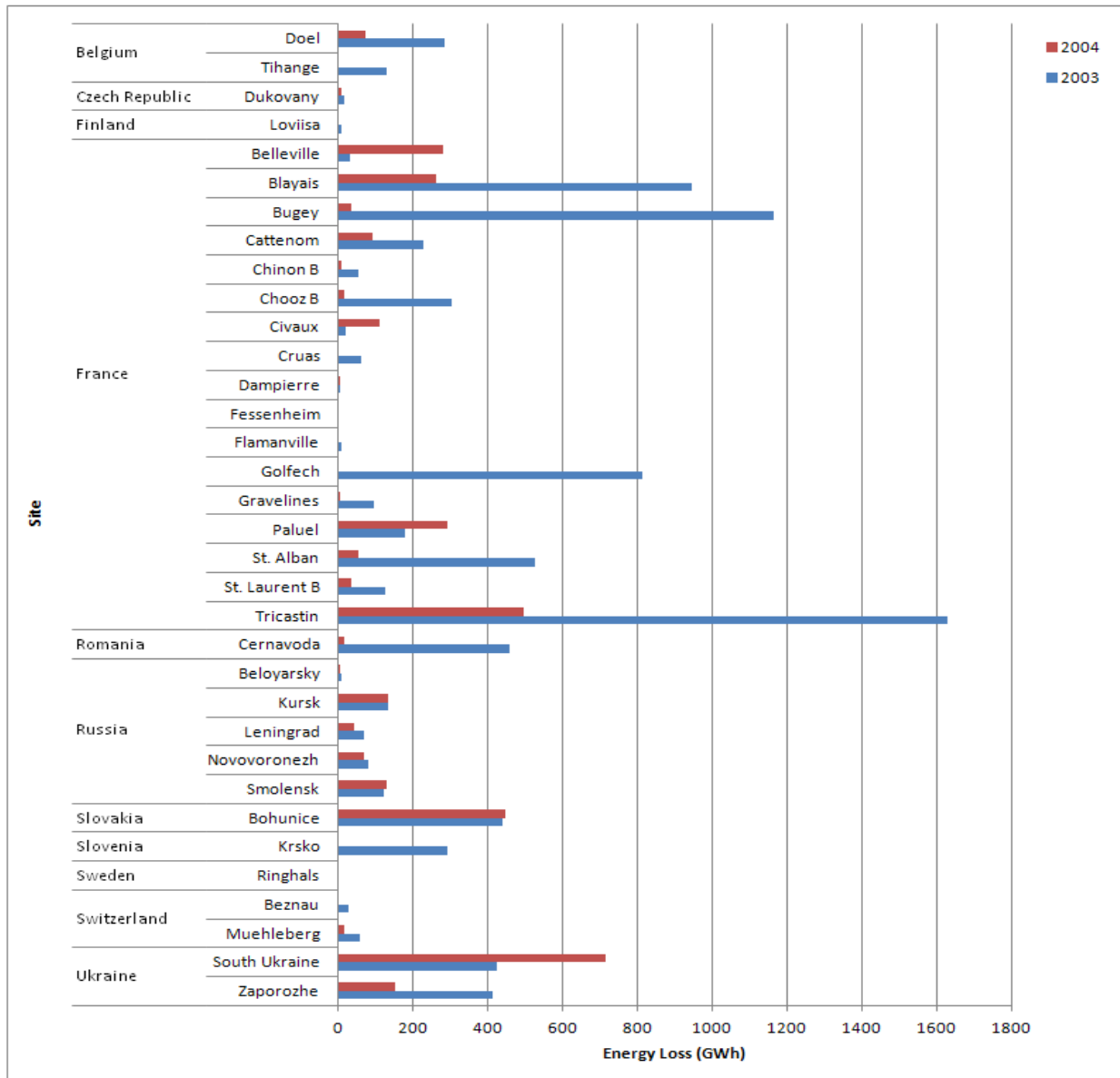
As a result, we managed to defend more than 4,600 settlements with a population of over 500,000 people, to protect facilities, critically important for the national security, federal nuclear centers in Sarov, Snezhinsk, and Novovoronezh nuclear power plant as well as power generation and transportation facilities, and social service agencies.



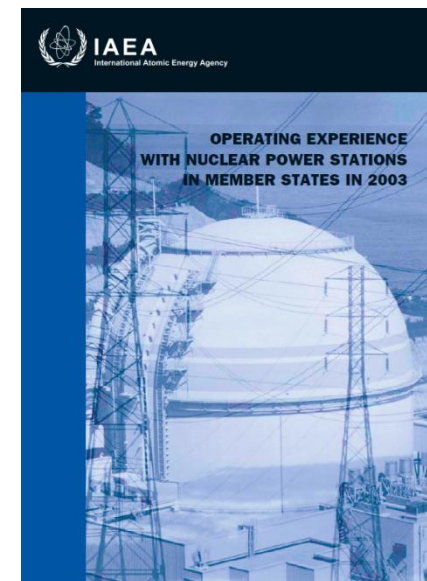
Ice storms



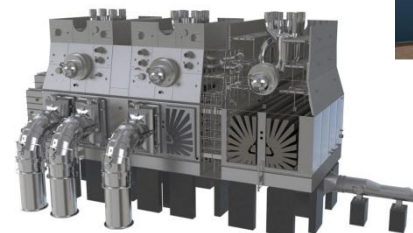
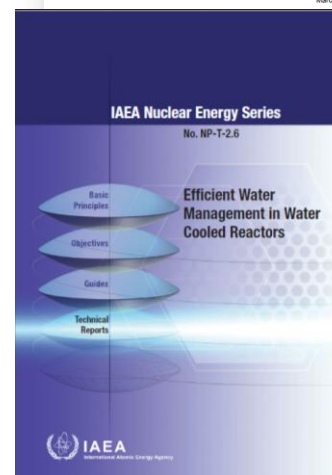
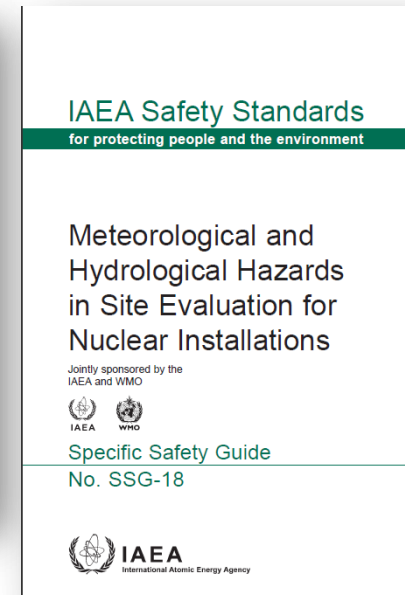
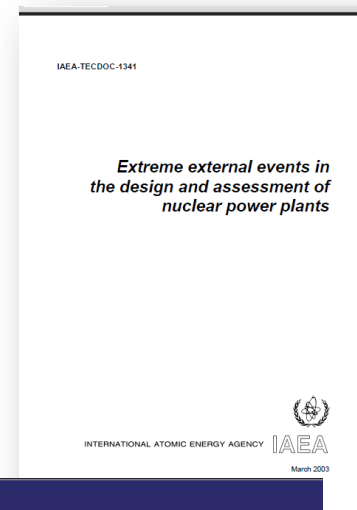
How to evaluate the cost?



- **Loss of output (GWh)** due to cooling water constraints
- Data available from IAEA annual reports.
- Figure on the left for European reactors, comparison between 2003 (heat wave) and 2004.



- Guidelines (e.g. siting), safety standards, regulations
- Design (e.g. taking into account CC risks)
- Technology (e.g. cooling technologies)
- Planning and plant management (e.g. based on demand forecast, outage planning)



Palo Verde NPP, largest NPP in the United States, uses treated waste water from city of Phoenix and other municipalities.

Adaptation Measures in Finnish NPPs

(TVO/Pekka Viitanen, Fortum/Reko Rantamäki, FMI/ Pekka Alenius, Hilppa Gregow, Milla Johansson, Pauli Jokinen, Kirsti Jylhä, Hanna Mäkelä, Seppo Saku, Aalto U./S. Syri)

■ Olkiluoto NPP:

- Measures to prevent blockage (by snow) of air intakes of heating, ventilation and emergency diesel generators
- OL3: heating of air intakes
- Pumping “warm water” upstream of cooling water intake to prevent frazil ice formation



■ Loviisa NPP:

- Construction of air cooling system (tower) to supplement sea cooling in case of frazil ice or other pbs with sea water
- Heating water intake grids to prevent frazil or pumping warm water upstream
- Study on building deep water intake in case of high sea temperatures (possibly economical in the future)

