

České vysoké učení  
technické v Praze

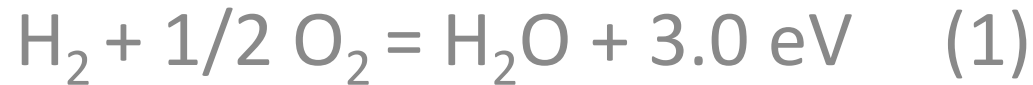
Fakulta strojní

# Nuclear fuel challenges

Dr. Radek Škoda  
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# Energy basics = Physics 101



EXERCISE:

$$(3)/(1) \approx ?$$

$$(3)/(2) \approx ?$$

Per nukleon

# How much fuel?

Mass-wise:

≈ 10 t/year for VVER 440

≈ 20 t/year for VVER 1000

Cost-wise:

≈ half billion CZK/year for VVER 440

≈ billion CZK/year for VVER 1000

Czechs spend ≈ 4 billion CZK annually....

Price increase from 2010 to 2015: 2400 \$/kg -> 2700 \$/kg

## Cost of 1 kg of enriched uranium

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Uranium	9 kg U308	\$50 per lb	990
Conversion	7.6 kg U	\$13 per kg	99
Enrichment	7 SWU	\$150 per SWU	1050
Fabrication	1 kg	\$300 per kg	300
Total			\$2439

Need about 20 tonnes of enriched uranium for an average large reactor refuel, so cost will be about \$50 million

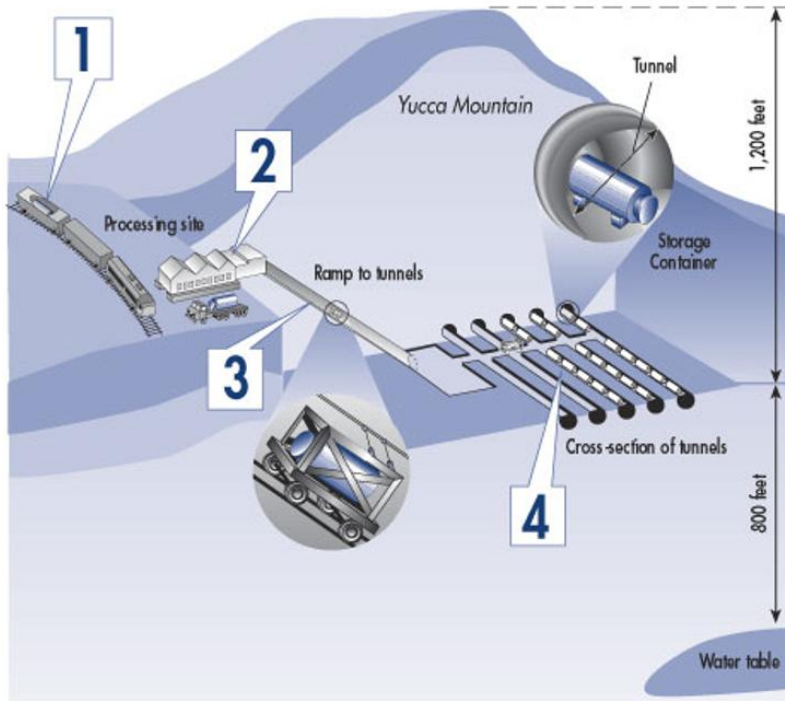
Total front end world market is now worth about \$25 billion annually



# Dry storage, VVER solutions:



# Dry storage, U.S. PWR/BWR



1. Canisters of waste, sealed in special casks, are shipped to the site by truck or train.
2. Shipping casks are removed, and the inner tube with the waste is placed in a steel, multilayered storage container.
3. An automated system sends storage containers underground to the tunnels.
4. Containers are stored along the tunnels, on their side.



# Repositories around

Country	Location	Formation	Depth	Estimated time
Finland	ONKALO	Granite	400m	2020
Sweden	FORSMARK	Granite	450m	2025
USA	YUCCAN MOUNTAIN, NV	Ignimbrit	300m	Cancelled in 2010
Germany	GORLEBEN	Salt mine	800m	Cancelled
Czech Republic	????	????	????	2065

**NONE WORKING**