



Cost estimation for spent fuel management in Slovakia

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Nuclear power in details



Slovak Republic

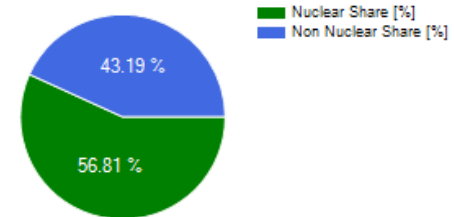
Source: IAEA PRIS

SUMMARY

Nuclear Power Reactors

Under Construction	Operational	Long-Term Shutdown	Permanent Shutdown
2	4	0	3

Electricity Production Share in 2014



Annual Electrical Power Production

Total Electricity Production (including Nuclear)
25382.00 GW.h
 (Net, 2014)

Nuclear Electricity Production
14420.33 GW.h
 (Net, 2014)

REACTORS

Name	Type	Status	Location	Reference Unit Power [MW]	Gross Electrical Capacity [MW]	First Grid Connection
BOHUNICE A1	HWGCR	Permanent Shutdown	Jaslovské Bohunice	93	143	1972-12-25
BOHUNICE-1	PWR	Permanent Shutdown	Jaslovske Bohunice	408	440	1978-12-17
BOHUNICE-2	PWR	Permanent Shutdown	Jaslovske Bohunice	408	440	1980-03-26
BOHUNICE-3	PWR	Operational	Jaslovske Bohunice	471	505	1984-08-20
BOHUNICE-4	PWR	Operational	Jaslovske Bohunice	471	505	1985-08-09
MOCHOVCE-1	PWR	Operational	LEVICE	436	470	1998-07-04
MOCHOVCE-2	PWR	Operational	LEVICE	436	470	1999-12-20
MOCHOVCE-3	PWR	Under Construction	LEVICE	440	471	
MOCHOVCE-4	PWR	Under Construction	LEVICE	440	471	



Slovak nuclear history

(Knowledge is based on experiences)

1957 – start of the built of NPP A1

1972 – operation of NPP A1, start of built of NPP V1

1976, 1977 – 2 accidents at NPP A1,

1979 - decision about A1 decommissioning

1979, 1980 – operation of NPP V1, 1984, 1985 – operation of NPP V2

1995 – creation of National Nuclear Fund of SR for decommissioning

1998, 1999 – operation of NPP EMO1,2

2000 – Bohunice rad/waste treatment and conditioning centre

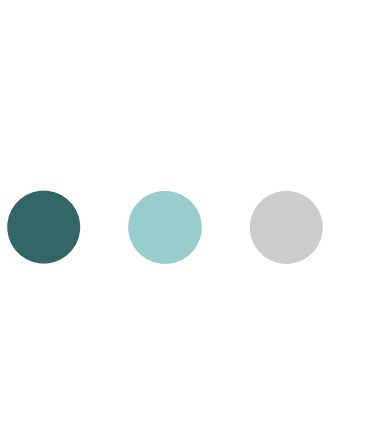
2001 – National radioactive waste repository

2006, 2008 – shut down of NPP V1, since 2011 in decommissioning

2008, 2014 – Strategy of SR for decommissioning and SF treatment

**2015 – Slovak national policy and program for decommissioning,
RAW and SF treatment**

National Nuclear Fund of SR (NNF)

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- Created by Law no. 238/2006 Z. z. from 16.03.2006, valid since 01.07.2006,
 - Before – since 1994 State fund for decommissioning of nuclear facilities and radioactive waste and spent fuel management.

Now:

- **National nuclear fund for nuclear facility decommissioning and for spent nuclear fuel and radioactive waste management.**
- *NNF is external segregated fund (all money are located in state account)*



National nuclear fund NNF

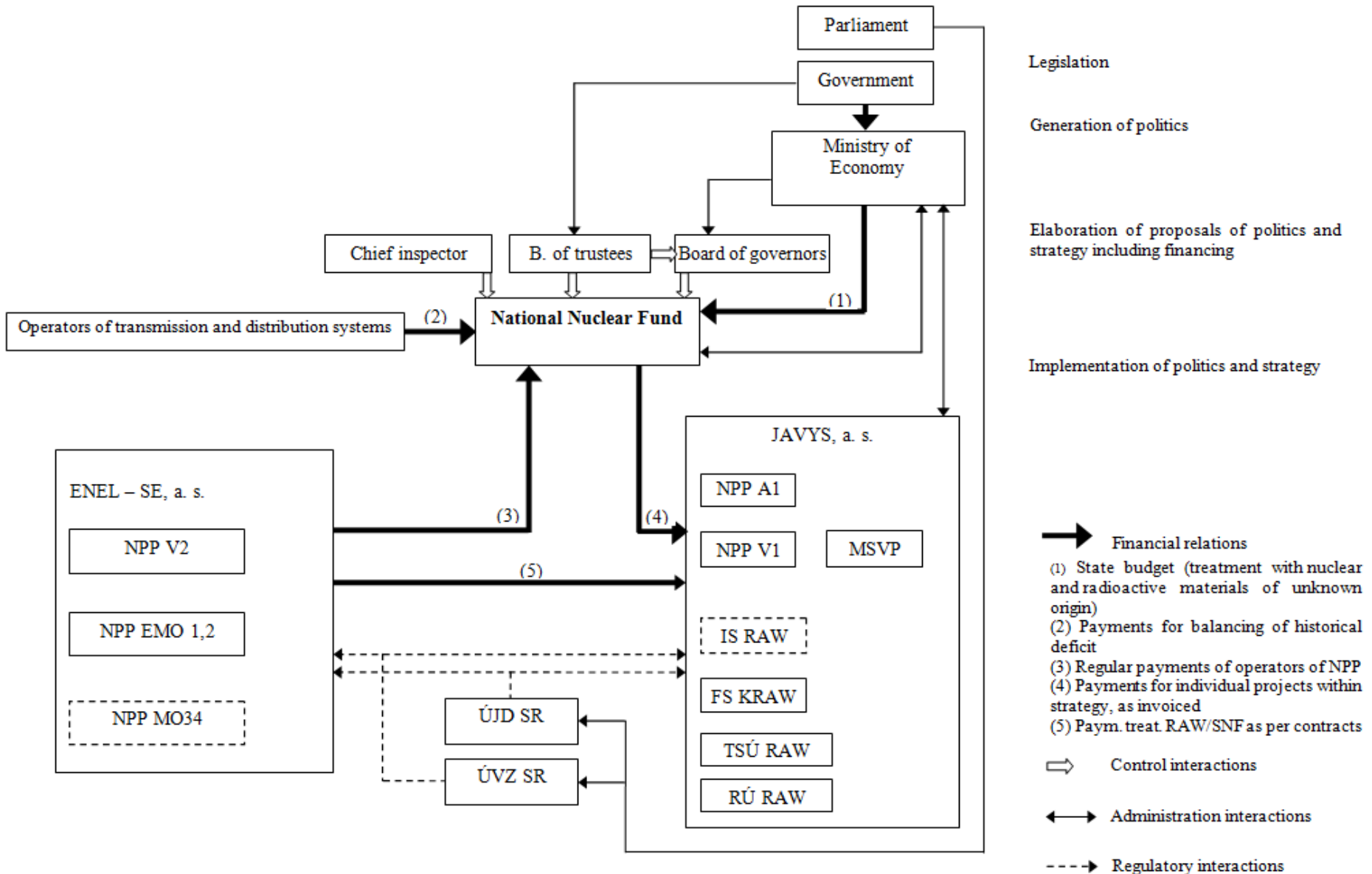
○ Purpose of the organization:

- to concentrate and manage financial means intended for the decommissioning of NI and treatment of SF and RAW
- to provide these financial means in non-discriminatory and transparent way

◎ Responsibilities of the Board of governors:

- To discuss and submit a budget proposal for respective year with projected budget for next 5 years to the MoE SR
- To elaborate and evaluate national policy and program for decommissioning, RAW and SF treatment
- To update the policy and program in 6 year intervals
- Based on approved program to elaborate medium and long term proposals for financial plan of NNF
-

Institutional structure





National policy and National programme for nuclear spent fuel and waste management

Main formal motivation:

- Requirement of the **EC Directive 2011/70/Euratom**

Actual situation:

- National policy and National programme were elaborated and approved by Government of Slovak Republic in 08-2015



Principles of the National Policy

- (a) the generation of radioactive waste shall be kept to the minimum which is reasonably practicable, both in terms of activity and volume, by means of appropriate design measures and of operating and decommissioning practices, including the recycling and reuse of materials;
- (b) the interdependencies between all steps in spent fuel and radioactive waste generation and management shall be taken into account;
- (c) spent fuel and radioactive waste shall be safely managed, including in the long term with passive safety features;
- (d) implementation of measures shall follow a graded approach;
- (e) the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials;
- (f) an evidence-based and documented decision-making process shall be applied with regard to all stages of the management of spent fuel and radioactive waste

Costs summary for the Back End

Item [mil. €]	Price in 2013	Nominal price	Discounted price
Decommissioning costs for NPP A1 (incl. disposal costs for RAW in DR)	577,240	702,742	628,823
Disposal costs of RAW from NPP A1 in Mochovce repository	160,150	214,816	182,295
Contribution of NPP A1 to costs for DR (2,70 % of total costs)	100,725	272,923	152,497
Decommissioning costs for NPP V1	344,829	388,212	363,230
Disposal costs of RAW from NPP V1	47,835	54,555	50,683
Storage costs for SNF from NPP V1	107,052	166,941	129,392
Contribution of NPP V1 to costs for DR (16,32 % of total costs)	604,421	1 649,669	921,763
Decommissioning costs for NPP V2	728,272	1 219,908	914,079
Disposal costs of RAW from NPP V2	35,156	57,003	43,500
Storage costs of SNF from NPP V2	158,256	328,582	217,191
Contribution of NPP V2 to costs for DR (29,31 % of total costs)	1 093,427	2 962,732	1 655,446
Decommissioning costs for NPP EMO12	667,890	1 495,351	953,299
Disposal costs for RAW from NPP EMO12	35,156	75,214	49,178
Storage costs of SNF from JE EMO12	43,722	130,907	70,560
Contribution of NPP EMO12 to costs for DR (25,85 % of total costs)	964,349	2 612,986	1 460,023
Decommissioning costs for NPP MO34	734,256	2 183,843	1 188,179
Disposal costs of RAW from NPP MO34	35,156	101,228	56,087
Storage costs of SNF from NPP MO34	43,722	169,342	79,074
Contribution of NPP MO34 to costs for DR (25,82 % of total costs)	963,230	2 609,954	1 997,601
Costs for IRAM	43,618	200,213	80,701
Institutional control of repositories	10,085	80,050	24,928
Management of NNF	61,788	97,206	74,903
TOTAL COSTS	7 560,335	17 774,377	11 293,432

Time schedule for the development of DGR

	Time scale
The decision on continue or stop in the double path (route)	2020 (postponed to 2030)
More detailed investigation (confirmation of the suitability) : <ul style="list-style-type: none"> • One site in crystalline hostrock • One site in claystone hostrock 	2023
R&D and engineering activities needed for sitting licence; communication with public; preliminary Safety case	2024-2030
Final and standby site selection	2030
Sitting licence	2030 - 2032
R&D and engineering activities needed for construction licence; detailed Safety case	2030-2040
Construction licence	2040
Construction of the underground laboratory – 300 m	2040-2047
DGR construction; EB development; demonstration activities; Safety case	2040-2065
Operation licence	2065
Operation phase	2115



Uncertainties, risks, challenges

The main challenges

- Estimated costs (specific differences A1/V1), optimization, improvements
- Period of collection of incomes (40 or 60 years of operation VVER 440 ?)
- Costs for deep geological repository

Role of the National programme

- Strategic document, national strategy for the back end transferred to programme and implemented in the law on National Nuclear Fund,
- Besides the Atomic Act the main document for the development in DGR

Areas for possible support

- Any feedback welcome,
- Advices/recommendations for update (2021) and for reporting on progress, key performance indicators,
- Expectations of the peer review,
- Joint projects and studies aimed at comparison of the cost assessment (reference projects),
- DGR.



Incomes under the terms of the Act 238/2006 Coll.

o Resources of Nuclear Fund :

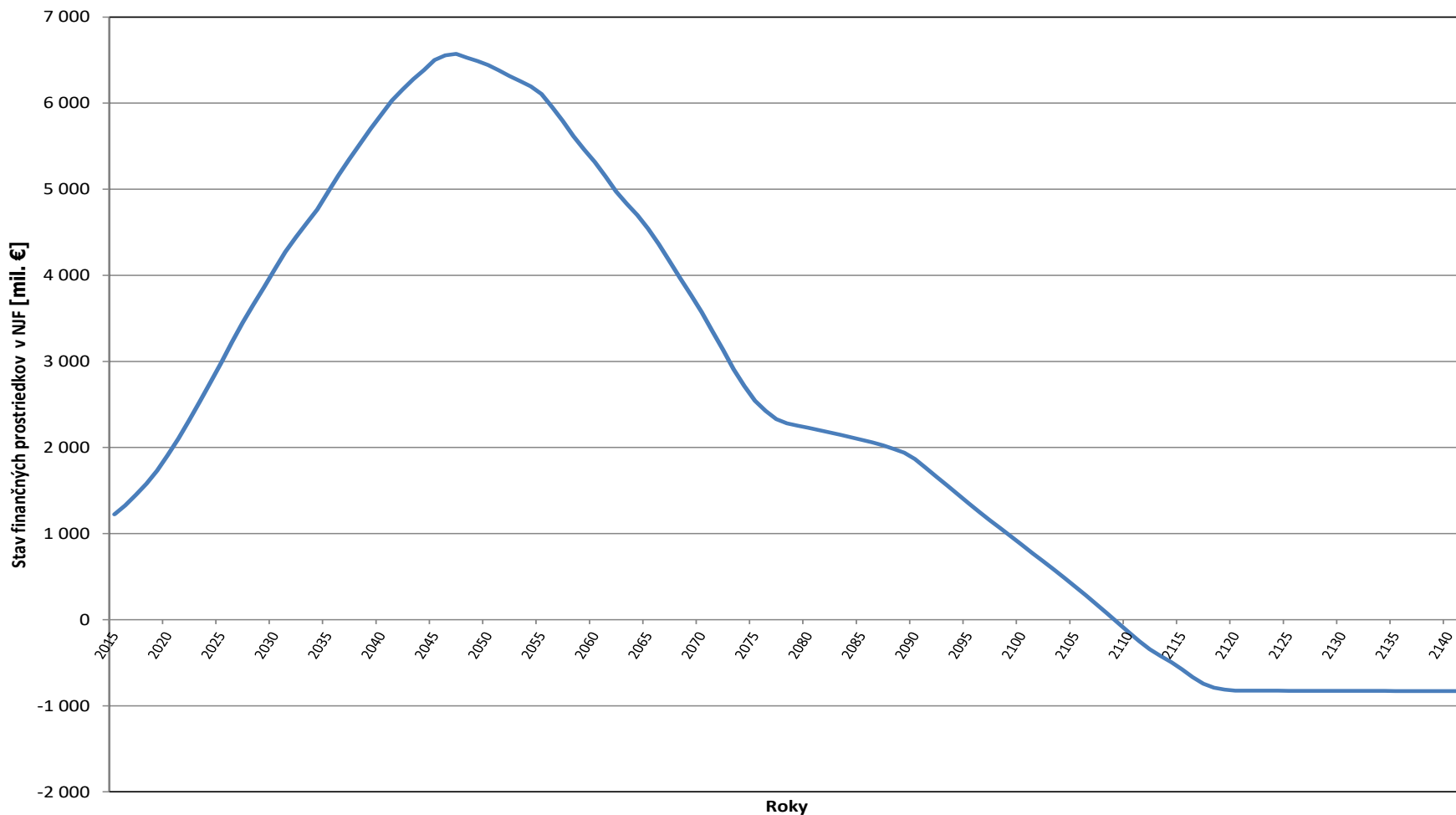
- Contributions of licensees for operation of nuclear installations producing electricity
 - Payments of 14 641,93 € for every megawatt of installed electric capacity (for year 2016)
 - Payments 5,95 % of electricity sales price produced in nuclear installations for previous year **in 2017 cca 61 MEuro**
- Payment collected from transmission and distribution system **(3,21 Euro/MWh, cca 64 MEuro/yr.)**
- Penalties imposed by Nuclear Regulatory Authority SR **(300.000 Skk in 2007, 200.000 Euro in 2018)**
- Incomes from deposits on NNF accounts **(4,05% from deposit 700 MEuro for period 2011-2020) in 2017 cca 40 MEuro**
- Subsidies from state budget **(cca 325.000 Euro/yr. for IRAM)**

- Now – new methodology coming from state decreets for each year focused on concentration of full amount to the date of NPP shut-down

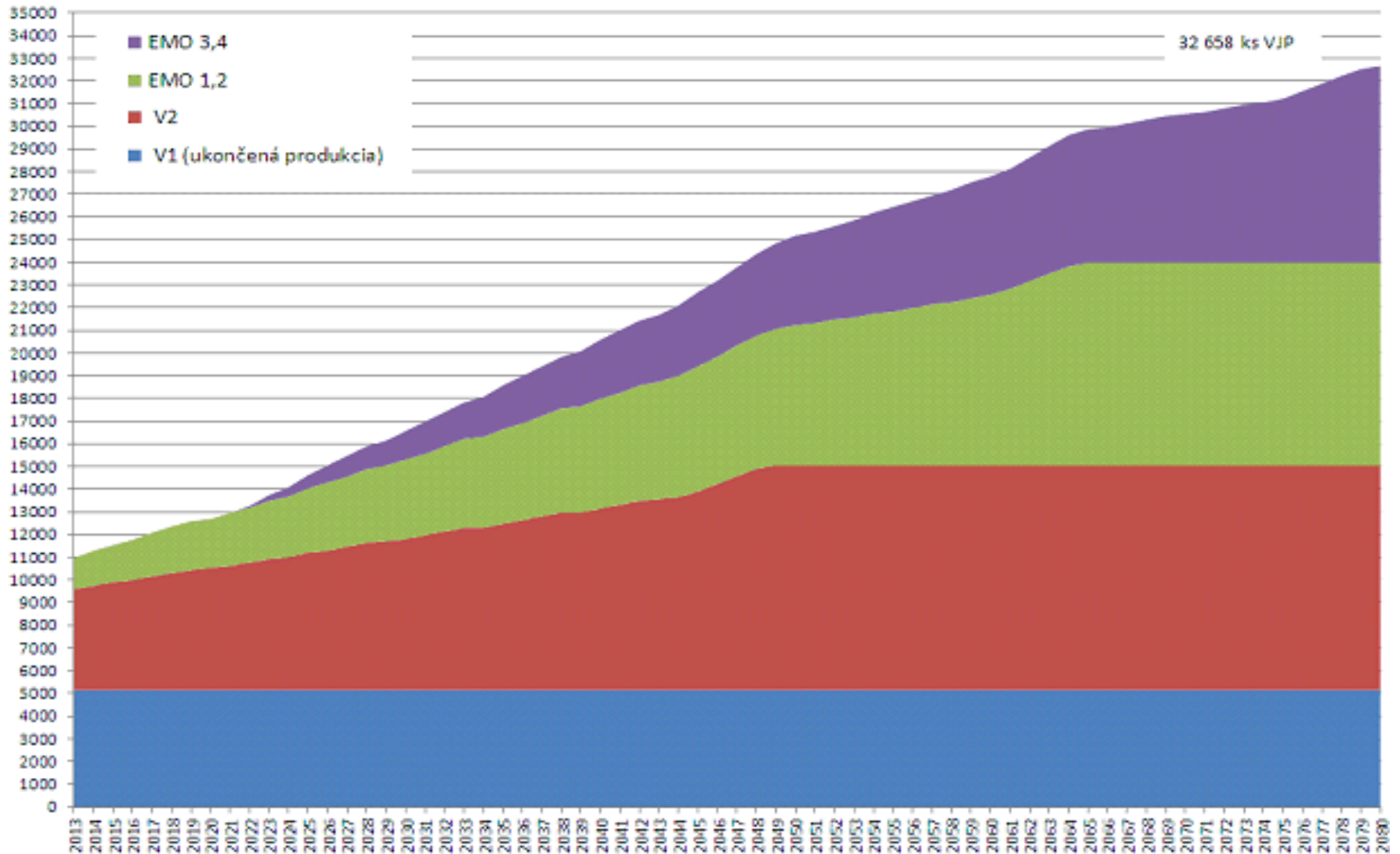
Balance of NNF financial resources until 2020

[mil. €]	2015	2016	2017	2018	2019	2020
Opening balance	1 225,129	1 322,972	1 416,114	1 510,117	1 632,133	1 775,500
Income from electricity production	62,021	61,455	63,711	95,099	108,654	112,031
Transfer from ME SR from TS payment	67,481	63,444	63,698	64,844	66,142	75,335
Subsidy from state budget (IRAM)	0,147	0,373	0,380	0,388	0,395	0,403
Treatment with IRAW	0,026	0	0	0	0	0
Interests	35,701	37,155	37,000	38,500	40,040	41,540
NNF incomes in total	1 391,233	1 486,799	1 580,903	1 708,948	1 847,364	2 004,809
Decommissioning of NPP A1	-46,17	-43,64	-36,22	-33,54	-32,57	-38,34
Decommissioning of NPP V1*	-16,07	-19,88	-25,22	-32,50	-26,71	-14,50
Treatment with IRAM (St. Budg.)	-0,15	-0,38	-0,38	-0,39	-0,40	-0,40
Depositing of RAW from Decommissioning	-1,85	-2,60	-3,60	-4,80	-5,60	-6,60
Development of deep disposal	-0,03	-0,05	-0,59	-1,53	-2,60	-3,80
Storage of SNF	-3,31	-3,38	-4,00	-3,27	-3,19	-3,14
Management of NNF	-0,70	-0,76	-0,77	-0,79	-0,80	-0,85
NNF expenditures in total	-68,28	-70,69	-70,79	-76,81	-71,86	-67,63
Closing balance	1 322,972	1 416,114	1 510,117	1 632,133	1 775,500	1 937,178
* Not costs covered by BIDSF						

Balance of financial means in NNF in years in existing legislation.

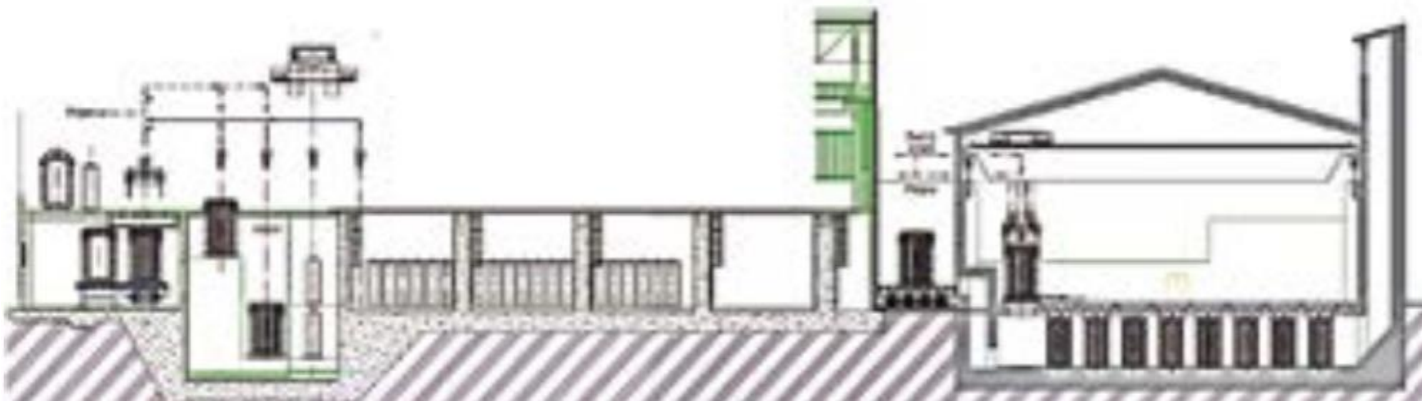


Forecast of production of SNF in SR for considered 60 years of units operation



Spent nuclear fuel management

- Total amount to end 2018 12.374 FA
 - V1 – 5.143 FA, V2 – 5.167 FA, EMO1,2 – 2.064 FA
- NNF funded 5.143 FA (V1), A1 in RF
- Total capacity of Wet Storage 14.112 FA
 - (85 % full, enough until 2022)
- New Dry Storage Facility in built (2018-2021)



Costs for storage of SNF

	2015	2016	2017	2018	2019	2020	after 2020
JE V1 – decommissioned JE							
Number of caskets of SNF	5 143	5 143	5 143	5 143	5 143	5 143	5 143
Cost for storage – prices of 2014 [ths. €]	3 525	3 189	4 143	3 937	2 732	2 732	131 477
Cost for storage – in nominal prices [ths. €]	3 595	3 318	4 397	4 262	3 016	3 076	250 666
JE V2 – 40 years of operation							
Number of caskets of SNF	4 759	4 847	5 024	5 151	5 290	5 434	7 354
Cost for storage – prices of 2014 [ths. €]	5 478	5 579	5 783	5 929	6 089	6 255	271972
Cost for storage – in nominal prices [ths. €]	5 587	5 804	6 137	6 418	6 722	7 044	551 478
EMO12 – 40 years of operation							
Number of caskets of SNF	1 632	1 776	1 920	2 064	2 160	2 304	6 600
Cost for storage prices of 2014 [ths. €]	1 878	2 044	2 210	2 376	2 486	2 652	191 037
Cost for storage – in nominal prices [ths. €]	1 916	2 127	2 345	2 572	2 745	2 986	393417
EMO34 – 40 years of operation							
Number of caskets of SNF							6 132
Cost for storage– prices of 2014 [ths. €]							180 849
Cost for storage– in nominal prices [ths. €]							474905
TOTAL prices of 2014 [ths. €]	10 881	10 812	12 136	12 242	11 307	11 638	775 335
TOTAL in nominal prices [ths. €]	11 098	11 249	12 879	13 251	12 484	13 107	1 670 466

Costs for handling of VJP and RAO originated as a result from operation of nuclear power plants are considered a part of costs of the holder of permission for operation of nuclear installation and are not a subject of reimbursement of NJF, but they are reimbursed directly by operators of nuclear installations.



Total costs for storage of SNF in Slovakia

Total costs for storage of SNF in Interim storage Jaslovské Bohunice [ths. €]

	40 years of operation	60 years of operation
JE V1	272 331	272 331
JE V2	589 196	979 647
EMO12	408 108	826 810
EMO34	474905	1 092 209
Total	1 744 540	3 170 997



New Law 308/2018 with new methodology (replace the existing Law 238/2006)

The utility has to contribute to NNF in regular yearly (not quarterly) payments without considerations to actual electricity production and actual market electricity prices.

The utility has to contribute to NNF according to 60 strategy.

According to conceptual plans of decommissioning – cost for each separate nuclear facility are calculated.

Expected actualisation of cost estimates shall take place every 6 years. The value of contribution to NNF for utility will be issued by the Governmental Resolution.



Accounting rules applied in Slovakia

Slovenské elektrárne, a.s. and JAVYS, a.s, record its long-term liabilities for nuclear facilities decommissioning, future spent fuel and RAW storage and disposal cost in accordance with the International Accounting Standards IAS 37. The reserves are recorded on the basis of expert estimates of discounted future cash flows using the current interest rate of the long term state bonds.

Annual closing accounts in these companies are generated in compliance with the current Slovak legislation (Accounting Law) and Rules for accounting for the enterprises. The rules for accounting of reserves are specifically recorded in accordance with the Rules of Ministry of Finance No. 23054/2002-92 with addendums (accounting procedure § 52a).

JAVYS,a.s. as a national decommissioning entity reports in its Balance Sheet reserves for the future decommissioning of JAVYS nuclear facilities - i.e. reserves for A1 NPP, V1 NPP decommissioning, as well as reserves for decommissioning of non-reactor nuclear facilities (RadWaste Treatment Facility (Bohunické Spracovateľské Centrum), Interim Spent Fuel Storage and Final Liquid Radwaste Treatment Facility)

**Upto 1.000.000 Euro
we could speak about money.**

Over this amount – it is policy!



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