Review of new Czech NPP project

Economics of Dukovany

Content

- Introduction
- Review of NPP projects & review of proposed funding models
- Review of assumptions for NPP Dukovany
- Modelling results
- Conclusions

NPP Dukovany: Introduction

- The objective of this presentation is to review economics of the proposed 1.2 GW project and to assess funding schemes proposed by the Czech government.
- In particular we assess the following options:
  - ČEZ build owns the plant and arranges funding. Assumed WACC 7%-11%.
  - The Czech state owns the plant and arranges funding. Assumed WACC 3%-5%.
- The government also considers an option of third-party investors being majority owners and funders of the project. From the point of view of the plant's economics this option is equivalent to ČEZ owning and funding the plant (financial investors are unlikely to demand returns lower than ČEZ).
- The government also considers various sub-scenarios based on a type of investor (EPC-F model, financial investors). Again, those nuances can be omitted as fundamentally they do not affect economics of the plant. Any investor would require the same minimum guarantees as ČEZ.

NPP Dukovany: Review of NPP projects

- According to World Nuclear Association there are currently 55 reactors under construction. Average time during which reactors have been under construction is 8.5 years.
- The highest number of reactors under construction is in China (11) followed by Russia (7) and India (6).
- 14 reactors (25%) have been under contrition for more than 10 years.

NPP Dukovany: Review of NPP projects

The below table summarizes the most recent reactor connections. Average time of reactor being under construction is 8 years.

Name	Model	Process	Installed Capacity	Connection Date	Country	Construction Start	Years Under Construction
Tianwan 4	VVER V-428M	PWR	990	10/27/2018	China	2013	5
Haiyang 2	AP-1000	PWR	1170	10/13/2018	China	2010	8
Sanmen 2	AP-1000	PWR	1157	8/24/2018	China	2009	9
Haiyang 1	AP-1000	PWR	1170	8/17/2018	China	2009	9
Sanmen 1	AP-1000	PWR	1157	6/30/2018	China	2009	9
Taishan 1	EPR-1750	PWR	1660	6/29/2018	China	2009	9
Yangjiang 5	ACPR-1000	PWR	1000	5/23/2018	China	2013	5
Leningrad 2 1	VVER V-491	PWR	1085	3/9/2018	Russia	2008	10
Rostov 4	VVER V-320	PWR	1011	2/2/2018	Russia	2010	10
Tianwan 3	VVER V-428M	PWR	1060	12/30/2017	China	2012	5

Source: World Nuclear Association

NPP Dukovany: Review of NPP projects

- The table on the following slide summarizes economics and timing of most recent projects. This review focuses on projects in developed countries.
- Data from China and Russia are either not available or unverifiable, especially on cost of projects.
- Virgil C. Summer project was canceled in 2017 after cost and risk review upon which Santee Cooper, co-investor in the project, left the consortium and SCANA, the developer, has failed to find new investor.
- Areva/EDF have not updated Olkiluoto 3 budget since 2012.
- Project costs excludes the cost of financing.

NPP Dukovany: Review of NPP projects

- Project costs excludes the cost of financing

Project	Model	Initial planned cost	Current cost	Size (MW)	Per MW cost	Construction start	Innitial planned COD	Currently planned COD
Hinkley C	EPR 1750	$ 23.8 bn	$ 25.4 bn	3200	$ 7,937,500	2018	2025	2027
Vogtle 3&4	AP1000	$ 14.3 bn	$ 17.1 bn	2234	$ 7,654,432	2013	2016 & 2017	2021 & 2022
Olkiluoto 3	EPR 1750	EUR 3.2 bn	EUR 8.5 bn	1600	€ 5,312,500	2005	2009	2020
Paks 2	VVER1200	$ 15.0 bn	$ 15 bn	2400	$ 6,215,000	2019	2025 or 2026	2027?
Virgil C. Summer	AP1000	$ 11.4 bn	$ 16 bn	2234	$ 7,162,041	2013	2016 & 2017	Canceled, prior 2024
Flamanville	EPR 1750	EUR 3.6 bn	EUR 10.9 bn	1630	€ 6,687,117	2007	2013	2020

Source: World Nuclear Association, Reuters, Powermag, World Nuclear News

- Average cost per MW is USD 7.5mio. and does not seem to vary significantly with technology.
- Construction time of 8 years appears realistic for projects which are not first-of-a-kind.

NPP Dukovany: Review of NPP projects

All projects rely on a combination of various forms of state support:

Guaranteed power offtake tariffs. Broadly there are 2 types:

- **CfD scheme**: pre-agreed strike price. Kicks in after COD. Consumers pay the difference between the tariff and the power price. If the power price is above the strike price, the utility pays to the state budget.
  - Example: Hinkley C, UK, GBP 92.5/MWh in 2012 money increased by inflation for 35 years.
  - *Advantage:* consumers do not bear the risk of cost overruns and delays.
  - *Disadvantage:* budget overruns and delays are factored into risk premium and increase the cost of capital.

NPP Dukovany: Review of NPP projects

All projects rely on a combination of various forms of state support:

Guaranteed power offtake tariffs. Broadly there are 2 types:

- **Regulated tariff**: consumers pay for the total financial cost of the plant already from the start of the construction. Project budget is approved by the regulator and the utility must ask for budget reviews and approvals in case of cost overruns.
  - Example: Vogtle 3&4, USA, USD 3.73/month surcharge to power bill since 2011, increasing to USD 13.73/month since 2018 for modelled household with 1000kWh/month consumption. In 2019 the utility Georgia Power is allowed to recover USD 453.1mio from its customers.
  - *Advantage:* Lower cost of capital as construction is partly funded by consumers' contribution already from the start of the project.
  - *Disadvantage:* Consumers are fully exposed to the risk of budget overruns and delays.

NPP Dukovany: Review of NPP projects

All projects rely on a combination of various forms of state support:

- **State-guaranteed loan**: All projects benefit from loans guaranteed by the respective governments. For example the US Federal Government guarantees USD 8.3bn in loans for Vogtle 3&4 project. UK government guarantees all debt EDF may need to raise to fund Hinkley.

- **Tax credits**: States may offer tax credits to power producers when the plant is commissioned. Example: Georgia Power will receive USD 125mio/year per 1000MW for first 8 years of operation.

NPP Dukovany: Review of assumptions

NPP Dukovany construction assumptions		
Parameter	**Value**	**Note**
Installed capacity gross	1194 MW	Based on VVER 1200-491 model
Installed capacity net	1109 MW	Based on VVER 1200-491 model
CAPEX base case	EUR 7.7 bn	Average of recent 6 projects in developed countries
CAPEX low case	EUR 6.2 bn	IEA 2016 assessment
CAPEX high case	EUR 9.5 bn	Hinkley Point C
Cost of capital base	9%	EDF's required rate of return for Hinkley Point C
Cost of capital low	5%	Czech state funding based on average yield of 10 year maturity government bond since 2010 + 1.5% margin
Construction time	8 yrs	Average of recently completed projects according to World Nuclear Association

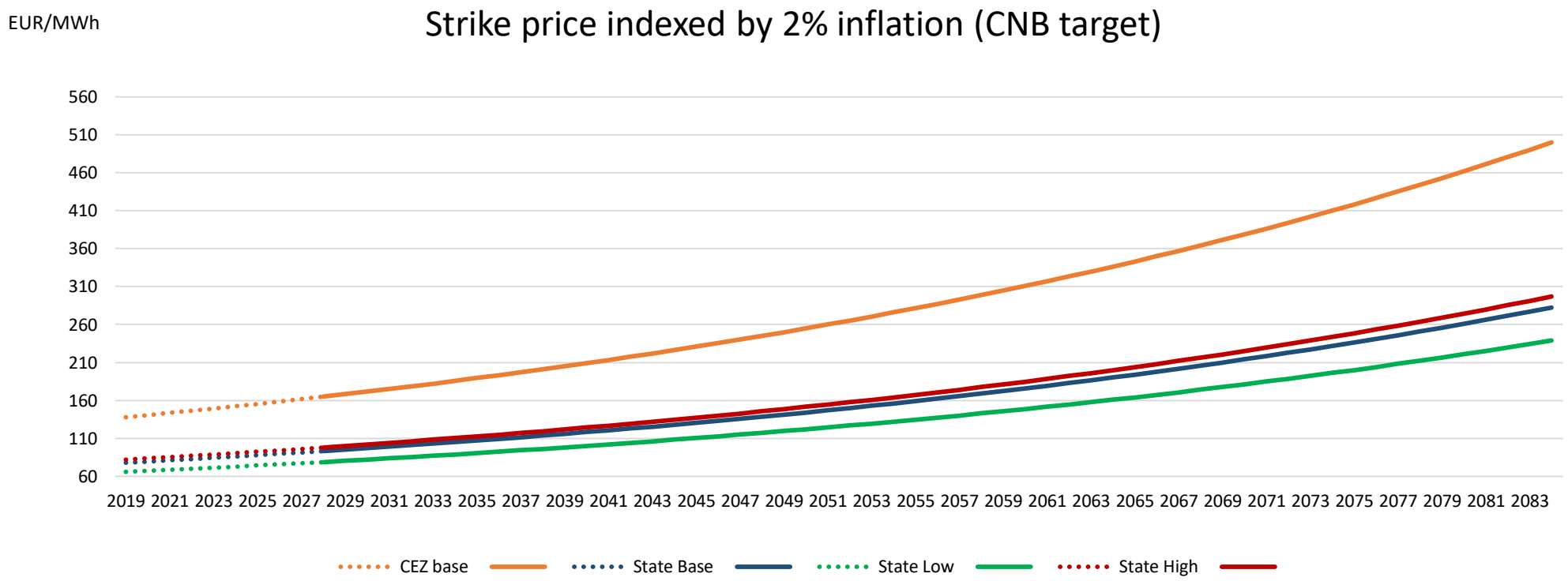
NPP Dukovany operating assumptions		
Parameter	**Value**	**Note**
Avg. load factor	92%	Temelin load factor
Fixed O&M	EUR 59 mio/year	Mott MacDonald, 2010
Variable O&M	EUR 2.22/MWh	Mott MacDonald, 2010
Fuel cost	EUR 5.55/MWh	Mott MacDonald, 2010
Decommissioning charge	EUR 2/MWh	Mott MacDonald, 2010
Lifetime	60 yrs	World Nuclear Association
Tax rate	19%	Czech corporate tax rate

NPP Dukovany: Modelling results

Scenarios					
Name	**CAPEX**	**Cost of capital**	**Description**	**Project IRR**	**Strike price**
CEZ base	EUR 7.7bn	9%	CEZ builds the plant on its balance sheet and arranges EPC-F funding with state guarantees. Model based on Hinkley C project	9%	EUR 138/MWh
State base	EUR 7.7bn	5%	Czech state issues bonds to fund the plant	5%	EUR 78/MWh
State low	EUR 6.2bn	5%	Czech state issues bonds to fund the plant	5%	EUR 66/MWh
State high	EUR 9.5bn	5%	Czech state issues bonds to fund the plant	5%	EUR 82/MWh
State base 2018	EUR 7.7bn	5%	Czech state issues bonds to fund the plant	2.1%	2018 price curve
State base 2025	EUR 7.7bn	5%	Czech state issues bonds to fund the plant	2.5%	2025 price curve

- All scenarios are based on 60 years tenor of a power-purchase agreement.
- Strike prices are expressed in real terms in 2019 money. In reality they would be adjusted by inflation.

NPP Dukovany: Modelling results



NPP Dukovany: Conclusions

- We conclude that the project is unlikely to attract any investment without significant government support. The support would have to have two components:
  - Guaranteed power offtake price (strike price)
  - State guarantee of loans

- If ČEZ would be to build the plant on its balance sheet we assess the strike price to be at EUR 138/MWh indexed by inflation over the project lifetime assuming investment cost and capital costs of recent projects.

- If the state decided to take the construction risk including the risk of budget overruns on its balance sheet the cost of capital would decrease significantly thus pushing the strike price to EUR 78/MWh indexed by inflation over the project lifetime.

NPP Dukovany: Conclusions

- Results of our model are consistent with those of the government. If we change our parameters to those used by the government (e.g. CAPEX of EUR 5352/MW, construction time of 5 years, cost of capital of 9%) we obtain similar results.

- The government appears to be underestimating investment costs and construction duration of the project in order to arrive at mode favorable strike prices (e.g. EUR 100/MWh and EUR 51/MWh respectively, both indexed by inflation.