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TEMELINomics



TEMELINOMICS

Why CEZ cannot afford to build Temelin 3&4

By Ivan Kotev

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SUMMARY

The following study examines CEZ's plans to enlarge its existing nuclear power plant Temelin with the addition of two reactors. The report is arranged in three parts.

In the first part, we re-examine the stated costs of the project and consider what costs might have been overlooked. We use the concept of Levelised Cost of Electricity (LCOE) to analyse the capital and operating cost incurred over the life of the plant, and we conclude that a number of significant costs have either been excluded or passed on to consumers.

In the second part, we review CEZ's financial statements and identify reasons why the company cannot afford to build Temelin 3&4. These include the fact that projected cash outflows coincide with other investments worth more than the project itself; the fact that CEZ does not have enough money on its books; and the fact that the company's performance is deteriorating.

In the third part of the study, we do a simple valuation of the project, eliminating many of the downside risks, and concluding that even under these conservative assumptions, the project will fail to break even.

INTRODUCTION

CEZ's CFO Martin Novak told the Czech press in July 2011 that by the time construction is underway, CEZ will be making so much money that it will not need a loan for Temelin 3&4. He added that he "must smile at the suggestion that CEZ would not have the money" and stated that "whatever the estimates of the cost, CEZ will be generating so much cash between the start of construction in 2015/2016 and its completion in 2020 that it will be enough."

In the pages that follow, we explain how the economics of Temelin 3&4 are flawed. We demonstrate that CEZ is financially unprepared to build two new reactors. And we conclude that the project will most likely lose money.

RE-EXAMINING THE COSTS

Plans for Temelin 3&4

In January 2008, CEZ announced plans to add two new reactors to its existing nuclear plant at Temelin in the Czech Republic. Since then, CEZ's financial position has deteriorated. But the firm's management continues to pursue its plans, and even intends to expand the existing NPP Dukovany. The construction of Temelin 3&4 is scheduled to start in 2016 and to go online in 2025.

CEZ is now holding a tender for EPC contractors. There are three bidders: Westinghouse, Areva and a consortium of Rosatom and Skoda JS. The technological specifications of each are detailed below.

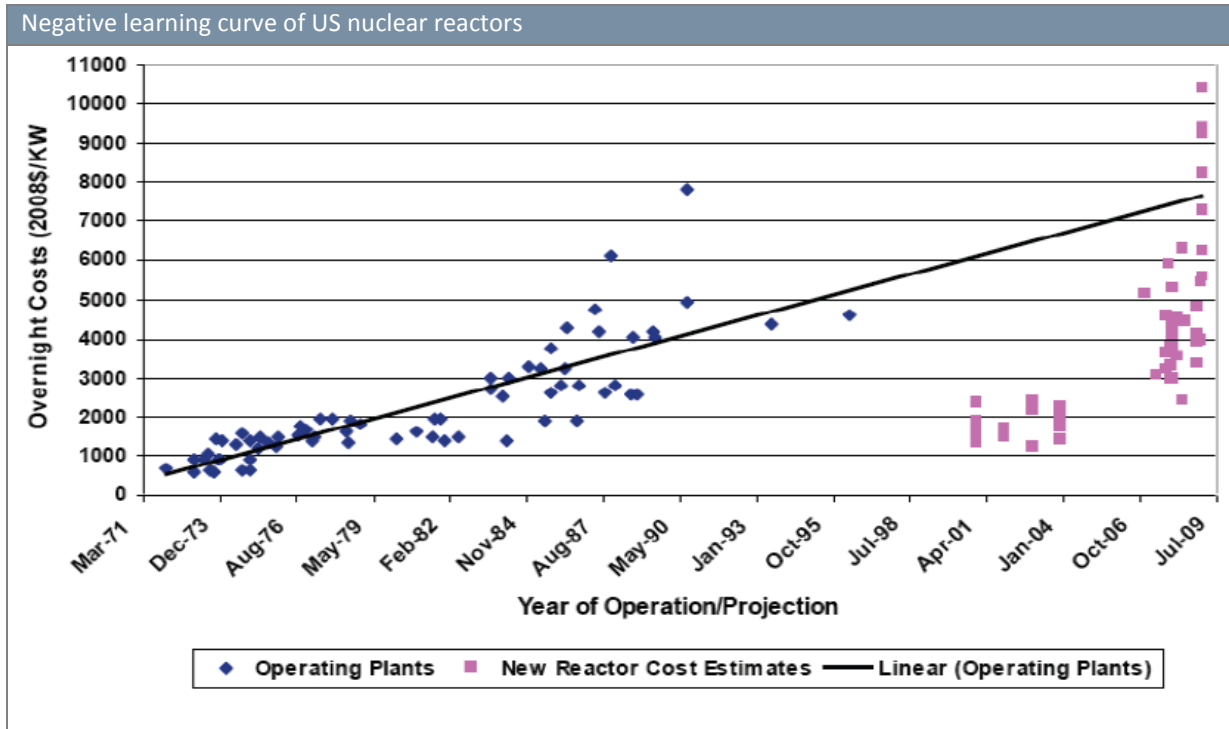
Overview of basic technological requirements and technology of the three bidders				
Bidder	CEZ's basic specifications	AREVA	Rosatom – Skoda JS	Westinghouse
Reactor type	Pressurised water reactor (PWR) Generation 3+	EPR – European Pressurised Reactor Generation 3+ PWR	MIR 1200 – Modernised International Reactor (Generation 3+ PWR)	Advanced Passive 1000 - AP1000
Capacity per reactor	More than 1,000MW	1,600MW	1,158MW	1,200MW
Availability target	90% or more	>92%	>90%	>93%
Net efficiency	Up to 37%	36-37%	36.20%	33%
Operational lifetime	60 years	60 years	60 years	60 years

Negative learning curve

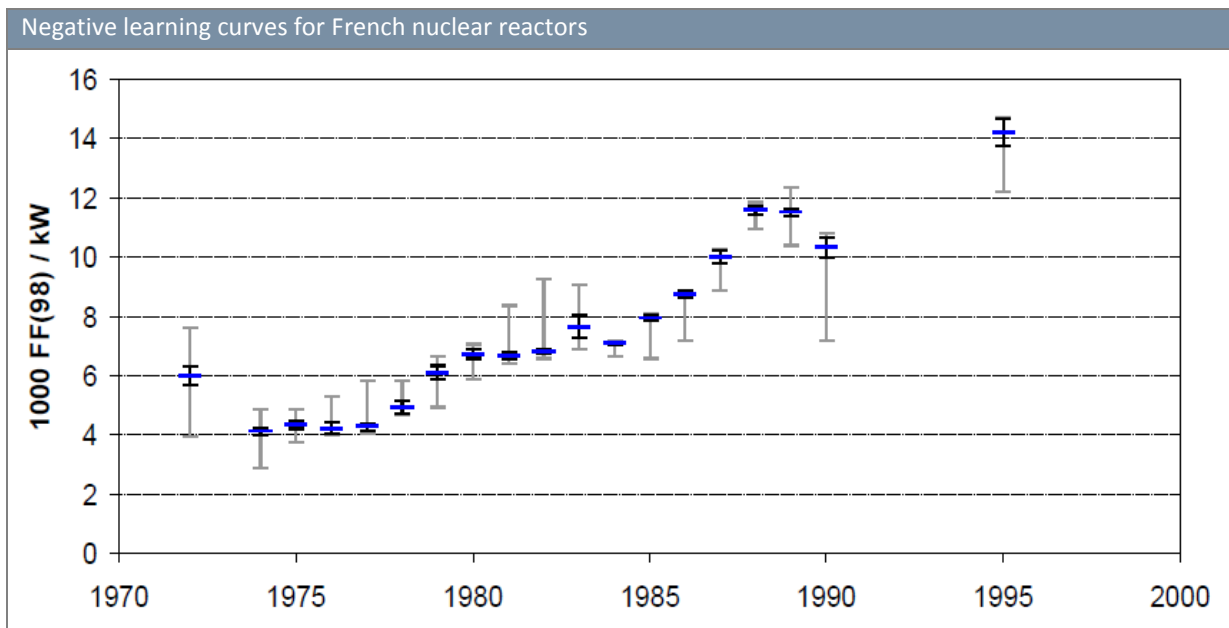
A common problem of nuclear projects is that they fall behind schedule and go over budget.

Delays are frequent. As of 1 April 2011, there were 64 reactors under construction in 14 countries, with most in Russia, China, South Korea and India. Of the 64 reactors, 27 have been delayed, of which 12 have been delayed for over 20 years. Another 23 reactors do not have an official start date. (Mykle Schneider Consulting, 2011)

Cost overruns occur often. Unlike many technologies that face a U-shaped learning curve, the cost of nuclear projects increases with time. One reason for the increased costs is that safety is constantly being improved. Upgrading and changes in technical design impose additional costs. And certainly, every year of delay is a fixed cost that leads to budget overruns.



Source: (Schneider, June 2011) (Cooper, September 2010)



Source (Schneider, June 2011), (Grubler, October 2009)

Cost of Temelin 3&4

The media commonly cite the cost of the Temelin to be some €8 billion (CZK 200bn) (Czech Position, 2011). According to the EIA, this estimate includes only overnight construction costs and implied interest during construction. Overnight construction costs include owners cost, engineering, procurement, construction and contingency. We will now consider what other costs could reasonably be added.

Nuclear economics

Compared to other sources, nuclear energy has high initial costs and low variable costs of production. An adequate way to analyse the economics of a nuclear plant is through the concept of Levelised Cost of Electricity. This theoretical method is criticized for disregarding the type of electricity sold (baseload, peakload), for being too sensitive to discount rate, and for revealing economics only at a certain point in time. However, the method is widely accepted because it illustrates the entire cost of generating electricity from nuclear energy. This price is shown by discounting all capital and operating costs associated with the project to present value and spreading them over the electricity generated over the entire life of the plant.

Levelised cost of electricity (LCOE)

$$\text{Levelized cost of electricity generation (€/MWh)} = \frac{NPV_{\text{Total capital and operating costs}}}{NPV_{\text{Net electricity generation}}}$$

$$NPV_{\text{Total capital and operating costs}} = \sum^n \frac{\text{Total costs (CAPEX + OPEX) for power in year } n}{(1+r)^n}$$

$$NPV_{\text{Net electricity generation}} = \sum^n \frac{\text{Net generation in operating year } n}{(1+r)^n}$$

r = annual discount rate. The model is most sensitive to the discount rate. Usually it's 5-10%

Net generation = gross generation minus auxiliary use

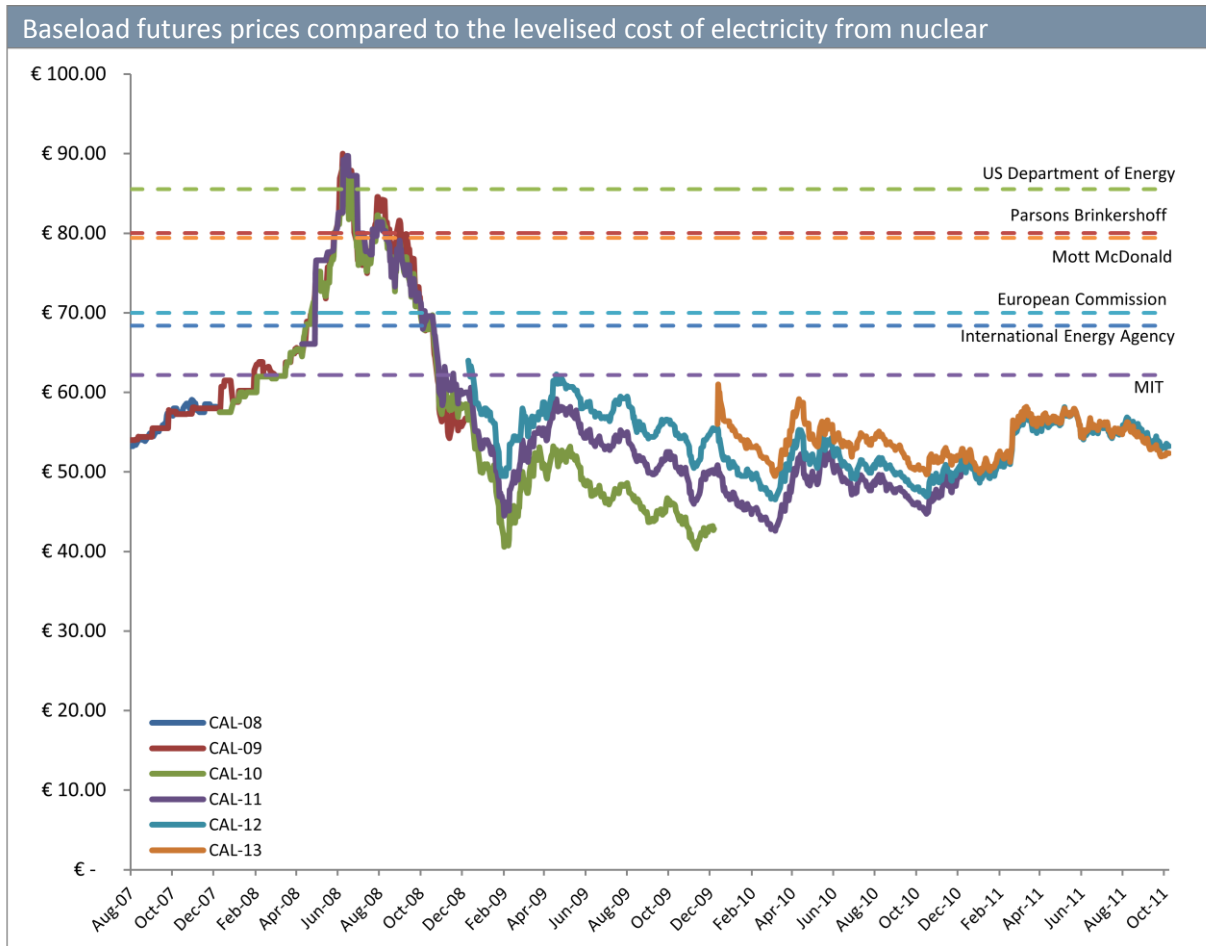
n = operating year

Source: Candole Research, (Mott McDonald, June 2010)

LCOE is usually interpreted as the breakeven tariff below which selling electricity occurs below the total cost of producing it. We have gathered some LCOE estimates over the last 3 years from various sources in order to compare them with current market prices. Please note that the tariff is often presented as a range due to changes in scenarios and discount rates:

- International Energy Agency, LCOE for Czech Republic: €51.62/MWh (at 5% discount rate) to €85.17/MWh (at 10% discount rate) (International Energy Agency, 2010)
- Parsons Brinkershoff: €66.58/MWh to €93.45/MWh (Parsons Brinckerhoff, 2010)
- US Department of Energy: €81.20/MWh to €89.86/MWh (US Department of Energy, December 2010)
- MIT: €62.18/MWh (Deutsch, Forsberg, Kadak, Kazimi, Moniz, & Parsons, 2009)
- European Commission: €50/MWh (bottom of range at moderate fuel price scenario) to €90/MWh (top of range at high fuel price scenario) (European Commission, 2008)
- Mott McDonald: €79.43/MWh (Mott McDonald, June 2010)

In recent years, the prices of electricity on the Prague Energy Exchange (PXE) have been below the break-even cost of electricity (LCOE) from nuclear power. We compared the market for electricity futures, with the break-even estimates by the various sources. The chart compares electricity futures prices (CAL) over the last four years with the LCOE estimates.

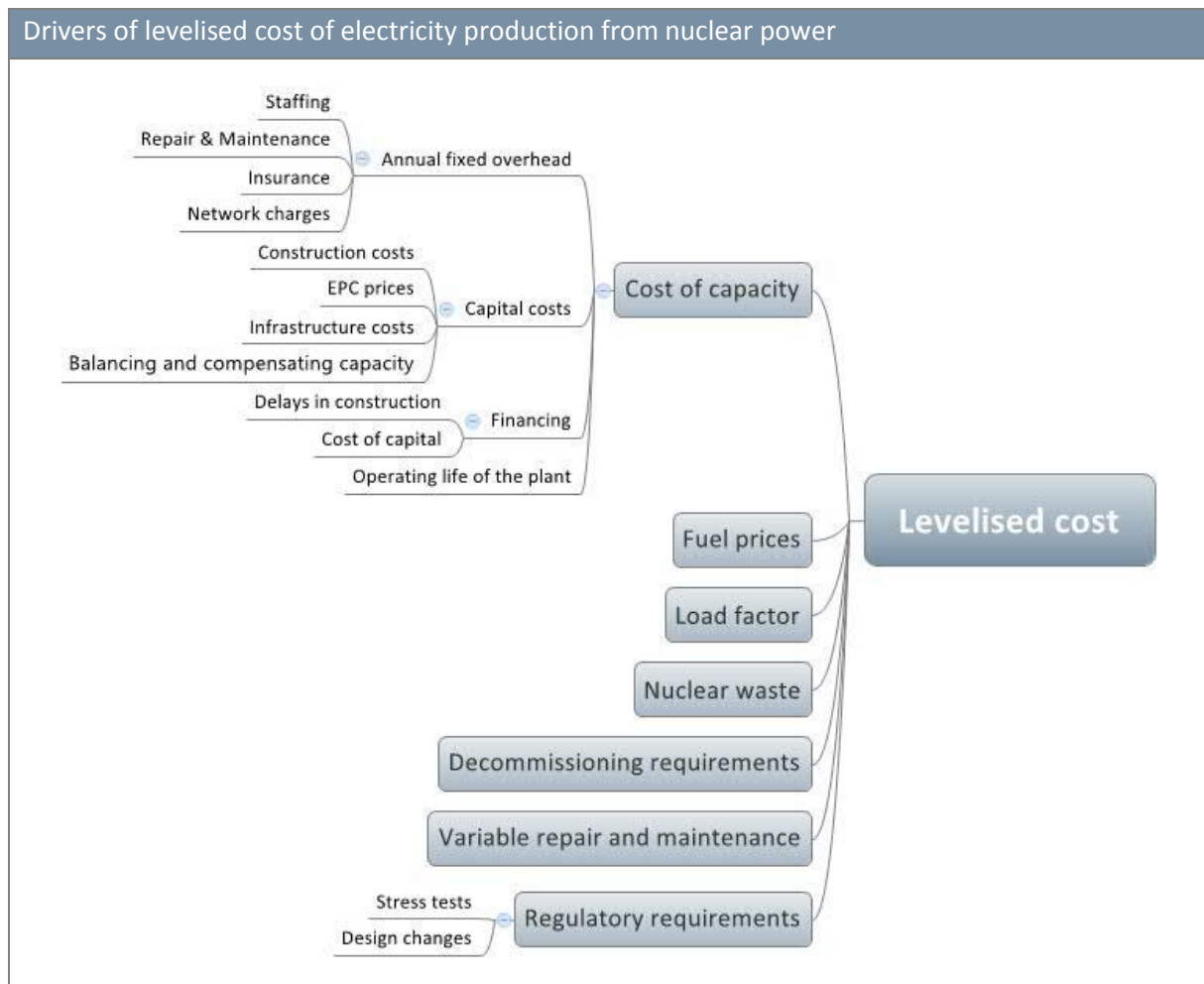


Source: (International Energy Agency, 2010), (Parsons Brinckerhoff, 2010), (US Department of Energy, December 2010), (Deutsch, Forsberg, Kadak, Kazimi, Moniz, & Parsons, 2009), (European Commission, 2008), (Mott McDonald, June 2010). Estimates are converted using exchange rates as of 17 November 2011. Lines indicate the middle of the ranges.

The comparison of the current market prices against the levelised cost of producing electricity from nuclear has two implications. The first is that, if Temelin 3&4 were to go online now, in 2012-2013, CEZ would be selling electricity below the total cost of generating it. The second is that the price difference may weaken CEZ's access to financing. When banks assess the risk of providing a credit to CEZ, the economic feasibility of the plant will be harder to justify if market prices are lower than LCOE. This implies that banks would require a higher risk premium and therefore higher interest rate.

Drivers of levelised cost of electricity

The chart below presents the main cost drivers associated with producing electricity from nuclear fission.



Source: Candole Research, (Mott McDonald, June 2010)

Financing

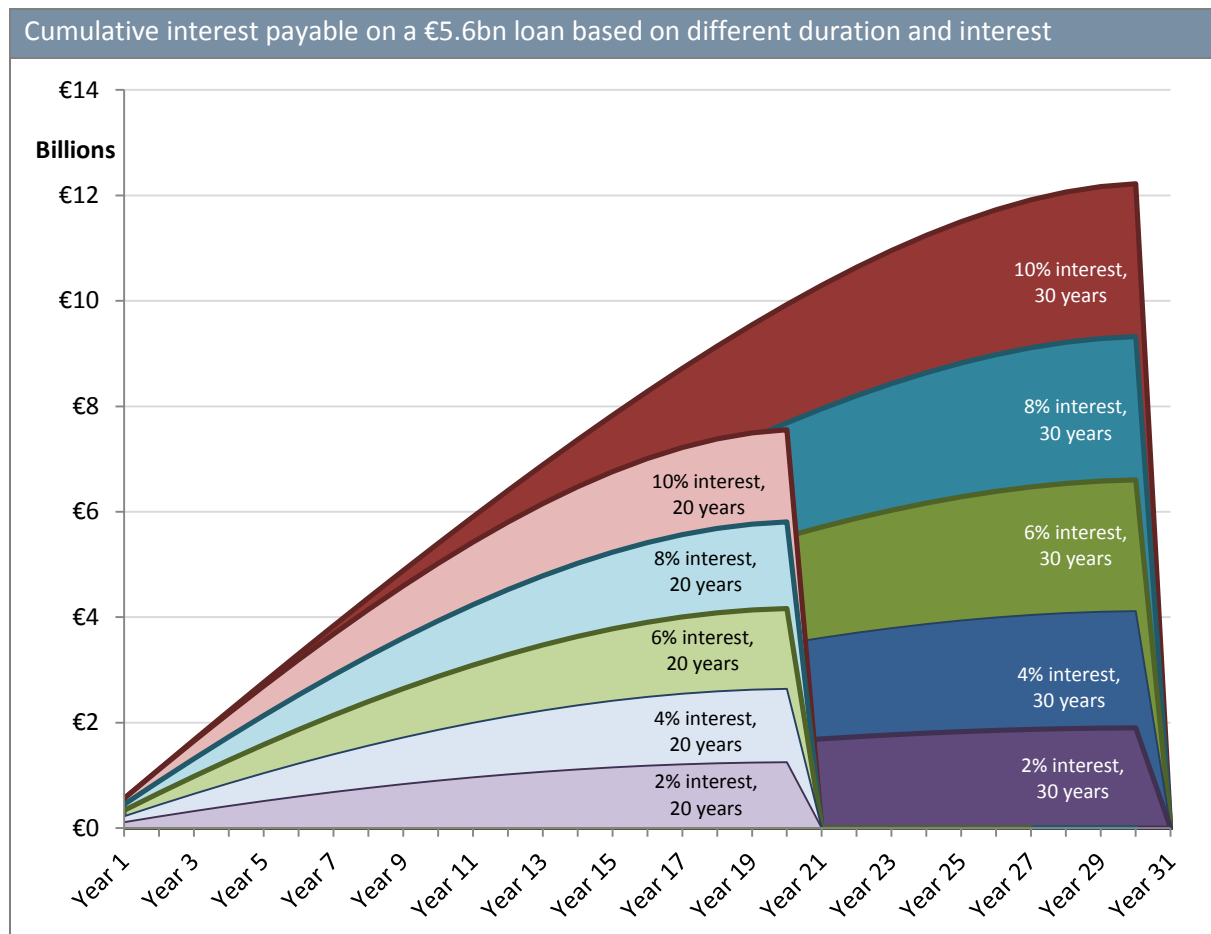
The €8bn estimate is an overnight cost, which is a hypothetical scenario in which the equipment is delivered today and launched tomorrow and ignores the 5-7 years that it typically takes to construct a nuclear reactor.

CEZ does not have €8bn readily available to pay for two new reactors, which means that the company has to issue equity, issue bonds or take a loan. Such large loans are usually expensive to arrange and service. The cost of debt may depend on many factors, among which are:

- **Capital structure:** It is unlikely that CEZ would be able to borrow up to 100% of €8bn since this would mean nearly doubling the long-term liabilities of the company. For example, if bonds are issued, the annual coupon payable (assuming 4%) would be 320mn alone, which is about as much as the CEZ Group made as net income in Q2-Q3/2011 combined. For simplicity, we will assume that it will borrow 70%.
- **Interest rate:** We will assume 2-10% interest on the loan.

- **Duration:** We assume 20 or 30 years for repayment.

The different scenarios show that the cumulative interest payable can vary widely. Results also need to be added to the “cost” of the project, because they are the cost of the external financing.



Infrastructure

In early December 2011, CEZ agreed to pay €64mn to the South Bohemian Region for the reconstruction of roads around Temelin (Vácha, 2011). These roads will enable the transport of large components during construction and so should be added to the valuation.

Insurance

Insuring nuclear plants falls under the complicated category of “Damocles risks”, or a low-probability high-magnitude event (Aven & Renn, 2010).

An important reason for the lower operational cost of producing electricity from nuclear compared to fossil fuels is that the insurance premium paid by nuclear operators is artificially low due to caps on liability for nuclear accident. Many studies have shown that, if full insurance premium was accounted for, then the production price of electricity would increase substantially. A report for the European Commission by ExternE found that externalities of nuclear energy cost €0.2/kWh in Germany, mostly due to the insurance premium. (ExternE, 2005). A more recent study by Versicherungsforen Leipzig, a spin-off of the University of Leipzig, shows that the cost of insuring a

nuclear reactor from accident at market prices would cost anywhere between €0.14/kWh and €2.36/kWh. (Günther, Karau, Kastner, & Warmuth, April 2011).

The difficulty in establishing the cost of damage in a nuclear disaster and the high cost of insurance explain why governments intentionally undervalue the risks and exempt the nuclear sector from costs other businesses would normally pay. Currently, the nuclear insurance premium in Germany costs approximately €0.08/MWh (Baetz, 2011), capping the whole insurance pool in the country at €2.74 billion. However, a study made in the 1990s shows that the worst case scenario disaster would cost Germany more than double this amount, or €7.6 trillion - hence the implicit subsidy of the governments to the nuclear sector. As Klaus Toepfer, head of the United Nations Environment Programme, put it: "Capping the insurance was a clear decision to provide a non-negligible subsidy to the technology" (Baetz, 2011).

The Czech Republic is one of the countries that subsidise its nuclear sector and its energy champion. In 2009, the country increased the mandatory minimum insurance cover required for each reactor to CZK 8 billion (€296 million) (World Nuclear Association, 2011). This amount is still negligible in the case of a disaster - for comparison, the cost the Fukushima clean-up is estimated at ¥25 trillion (€240,000 million) (Japan Center for Economic Research, 2011).

We expect the insurance coverage and premiums to grow, initiated externally by the European Union. Even before the Fukushima Dai-Ichi disaster, convergence of nuclear liability schemes was considered:

"A harmonised liability scheme, including a mechanism to ensure the availability of funds in the event of damage caused by a nuclear accident without calling on public funds, is in the view of the EESC also essential for greater acceptability of nuclear power. The current system (...) is inadequate for this purpose. The insurance problem of an extremely low probability of an accident combined with potentially very serious and costly damages needs to be addressed in an open, constructive and practical way. One possibility could be an insurance pool scheme."

(Economic and Social Committee, Section for Transport, Energy, Infrastructure and the Information Society, 2007)

Nuclear waste repository

Nuclear waste disposal is a major operating expense – it can be up to 5% of the cost of generating electricity (World Nuclear Association, 2011). Radioactive waste is generally classified into three categories depending on radiation intensity and the length of time radiation is emitted:

- Low-level waste (LLW), the bulk of the radioactive output, generally has just 1% radioactivity. It consists of residues from radioactive plants: contaminated grit, tool, protective clothing, metal, paper and plastic wrapping. They are disposed of in surface repositories and have a half-life of 30 years. (Centre for Experimental Geotechnics, CTU in Prague)
- Medium-level waste (MLW) contains higher amounts of radioactivity and sometimes requires shielding. It contains contaminated materials from reactor decommissioning and service materials such as fuel jackets, structural materials of fuel units. (Centre for Experimental Geotechnics, CTU in Prague)
- High-level waste (HLW) releases large quantities of heat, requires cooling and screening and accounts for 95 % of the total radioactivity generated in the production of electricity. Only a

handful of countries reprocess high-level waste during a process called vitrification, and the Czech Republic is not one of them. (Centre for Experimental Geotechnics, CTU in Prague)

In the Czech Republic there are 6 reactors in operation, 4 at Dukovany and 2 at Temelin. The country does not have a state policy on reprocessing and the decision is left to CEZ, which is fully responsible for the storage and management of its used fuel until it is handed over to the state organization Radioactive Waste Repository Authority (World Nuclear Association, 2011).

The Czech Republic has only one repository that deals with radioactive waste from energy – Dukovany. Dukovany is the largest of the three and was intentionally built for the disposal of low and intermediate-level waste generated at the two nuclear power plants; it has a capacity of 55,000 m³. This is sufficient to hold waste from both plants even if their life is extended by 10 years.

However, the country does not have a final repository. In July 2011, the EU adopted a directive for the disposal of used nuclear fuel and radioactive waste. Member countries must present waste management plans for the EC to review by 2015. Member states have two years to bring their legislation in line with this directive.

The description of the nuclear repositories in the Czech Republic is the following:

- **Interim Spent Fuel Storage Facility Dukovany.** Fuel spent in NPP Dukovany is stored long term in this facility, until a permanent deep geological repository is built. As its capacity was insufficient, a second new storage facility was built to accommodate the remaining fuel spent in NPP Dukovany. (State Office for Nuclear Safety)
- **Spent Fuel Storage Facility Dukovany.** This is the second fuel storage facility built for Dukovany. It is believed that the combined capacity of these two storage facilities is sufficient to accommodate all fuel spent in all four reactors of NPP Dukovany during its operational lifetime. (State Office for Nuclear Safety)
- **Spent Fuel Storage Facility Temelin.** Construction of the facility started in 2009 and finished in 2010. The final cost of the facility came to CZK 1.5bn, compared to the initial estimates of CZK 490mn. For comparison, the second facility at Dukovany, which was built by CEZ, cost CZK 400mn.
- **Deep Geological Repository.** There is a plan to build a deep repository. It should be at least 500m underground and should cover an area of several square kilometres. The first estimates from 1999 were put at CZK 47bn. A special account was created by the Ministry of Finance, in which CEZ contributes, but by 2009 this account had accumulated just CZK 13bn. The search is under way for a suitable location for the site. Originally six locations were chosen, but due to protests the locations were dropped at the end of 2009 by government decision. In an attempt to restore the search, a law passed at the end of 2011 would grant the affected municipalities an annual compensation of up to CZK 4mn (€160,000) from the “nuclear account” set up to accumulate funds for the decommissioning of the NPPs. Construction of the new deep geological repository should start in 2050 and launch in 2065. (Radioactive Waste Repository Authority)

Grid development

The grid needs to be reinforced if it is to handle the increased supply of electricity from two new Temelin reactors.

There is a plan for a 120km 400kV transmission line between Kocin and Mirovka, which is supposed to bear most of the volume, and its construction is scheduled for 2016-2020. This investment will be the largest in the TSO's (CEPS) 20 year investment plan - over €480mn (CZK12bn), out of a €880mn (CZK22bn) total investment plan for 2010-2030. The project is into its second year of planning, and already has EIA approval. CEPS counts on the project construction lasting up to 10.5 years, meaning that the transmission line could be ready by 2020; however, appropriation of land under the power lines might be delayed and go over budget.

Since this reinforcement of this grid section is necessary only because of the additional reactors connected to the grid, the €480mn cost must be considered as a part of the investment project. For CEZ, this cost is an externality, because it is borne by a different legal entity. However, for the state, the main shareholder in CEZ, this is irrelevant. From the perspective of the state, the cost must be included in the overall calculation.

A recent proposal by the regulator would also introduce an "investment factor" into the formula in order to help the TSO recover the additional investment expenses on Temelin connections. This would pass on the cost of grid reinforcement to consumers. The arrangement is designed to smooth the increase in the transmission network charges for consumers.

Decommissioning

Estimates of decommissioning costs range from \$500 million per reactor (Song, 2011), or 15% of the investment cost (International Energy Agency, 2010).

In order to save for decommissioning, energy companies usually either prepay the expense, setting aside the money even before the plant starts operating. Or an external sinking fund, or an external levy, which is built up over the years from a percentage of the electricity rates charged to consumers, is created (World Nuclear Association, 2011).

Regulatory requirements

Regulation of nuclear plants is likely to become stricter. It can be expected that stress tests would be performed more often (about €5.5mn each (Katanska, 2011)). More importantly, changing regulations may impose one-off design changes in the future plant, which would mean additional capital investments.

Build times

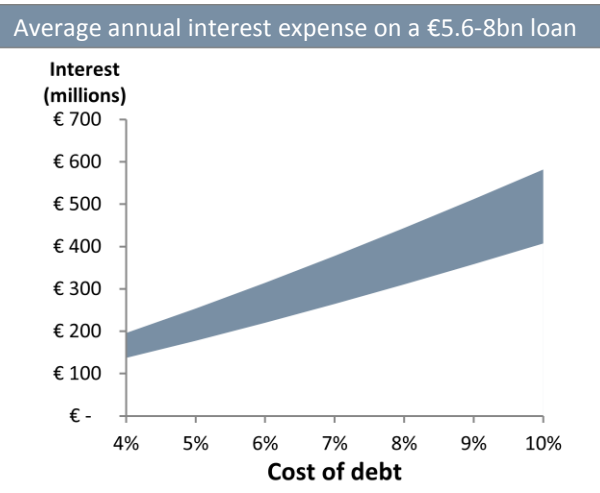
There are 432 operating nuclear reactors in the world today, and for those under construction build times have usually been wrong (see the *Negative learning curve* section).

The world's average construction time since 1993 is 5.3 years. In France, research by Mott McDonald shows that the average build time is 6.7 years. Westinghouse claims build times of less than 4 years and Areva of less than 4.5 years. (Mott McDonald, June 2010).

It is unclear whether these build times are realistic. One of the reasons is lead time of components – for example, as Mott McDonald suggests, a reactor nozzle ring order placed today has a lead time of 5 years. It is unclear to what extent the three bidders for Temelin have already booked their orders. Another important detail is that the quoted construction times are usually preceded by preparation works. For example, UK's NPP Hinkley Point C has estimated site preparation works of 30-36 months (Mott McDonald, June 2010).

There are various reasons why build times are longer than planned. First, there could be social problems, such as those in Tamil Nadu in India. The launching of NPP Kudankulam built by Atomstroyexport has been delayed because of protests following the Fukushima accident (Yurman, 2011). In Taiwan, the Lungmen Nuclear Power Plant has been repeatedly delayed due to political controversy. Second, there is a growing uncertainty regarding safety checks (Pfeifer, 2011) which would most likely make it more difficult for projects to receive approval by nuclear regulators, causing further delays in construction times. Third, there could be issues with raising financing.

Every year of delay makes the project more expensive. There are fixed costs such as employing personnel, paying interest on loans and insurance premiums during construction, among others, which have to be paid regardless of the launch date. The chart on the right shows a range of annual interest expense (70-100% debt on €8bn cost), given 4-10% interest rate. Even though the payment schemes are much more complicated, this simplified version illustrates the magnitude of the losses CEZ can incur if there is even a 1 year delay in construction.



Currency risk

Currency risk is important both to the selling price of electricity and to the investment and operating costs. Changes in exchange rates may influence the cost of construction, the cost of fuel and the selling price of electricity, among other costs.

Conclusion

Building two more reactors at Temelin would require more than the suggested €8bn. The cost of financing would increase the overall cost by €1-7bn (at 70% debt with 2-10% interest for 20y), which can be exacerbated by even a 1-year delay (additional €112mn-€560mn). Additionally, there are external costs, such as grid reinforcement, which are already being passed onto CEPS and then to consumers. There are other risks as well, such as the introduction of a higher insurance premium against a disaster, and currency risk. If the plant were to launch in 2012-2013, it would be selling electricity at about a third below its break-even price.

WHY CEZ CANNOT AFFORD TEMELIN 3&4

Reason 1: Conflicts with other investments

Announced projects

CEZ has announced other large capital investments where cash outflows coincide with the planned expansion of NPP Temelin. Here are some of the larger announced investments in power plants:

- **Wind parks** (3000MW) in Germany, Poland, and Romania. CEZ hopes to build two parks by 2016, when the Temelin expansion is scheduled to start, with the profits from the renewable projects used to finance the nuclear plant project (Johnstone, 2011).

We consider this explanation misleading because such a project would conflict with, and not precede the Temelin project. The reason is that CEZ has to find money to pay for the parks, wait for the parks to pay back, and only then invest the remaining extra returns into Temelin. The cost of 1MW wind is between €1-1.3mn, which means €3.45bn for the total 3000MW. An average wind park in Germany has about 8.2 years payback period (using a sample valuation for a 2.7MW wind park in Aachen with a Vestas turbine, at €1.15mn/MW), and construction time of about 2 years (or 4 in the case of the 600MW Romanian wind park). If CEZ starts with the projects in 2013, waits an average of 2 years to launch, and another 8.2 years to pay back the initial investment, it will already be 2023. The free cash flow from the wind parks from just 1.8 years of operation (from the time the parks have paid back until 2025 when Temelin is supposed to launch) would be contributing just €615mn to the nuclear plant.

- **TPP Ledvice** (660MW) - a new plant in Czech Republic - with expected service life of 40 years, scheduled to launch in December 2014 (CEZ, 2011). Our estimated cost is €800,000/MW, or €528mn. If we assume it is 70% completed and paid, then €158.4mn remains.
- **CCGT Počerady** (841MW) – The construction of the new Czech plant is scheduled for 2011-2013 (CEZ, 2011). Our estimated cost is €800,000/MW, or €672mn. Assuming 50% have been paid, then €336mn remains.
- **CCGT Melnik** (800MW) – a new plant to be built between 2012 and 2015 in the Czech Republic (CEZ, 2011). Our estimated cost is €800,000/MW, or €640mn.
- **CHP Prunerov** (750MW) – the refurbishment of the Czech plant is scheduled for 2012-2014 and is expected to cost €1bn (Lidové noviny, 2011). If 30% advance has been paid, then €700mn remains.
- **CHP Elektrownia Skawina** (430MW) – the new CHP in Poland is scheduled for 2012-2014 (Platts, 2010). Our estimated cost is €800,000/MW, or €344mn
- **CHP in Silesia** (800MW) – again in Poland, scheduled for 2013-2015. Our estimated cost is €800,000/MW, or €640mn MW (Platts, 2010).

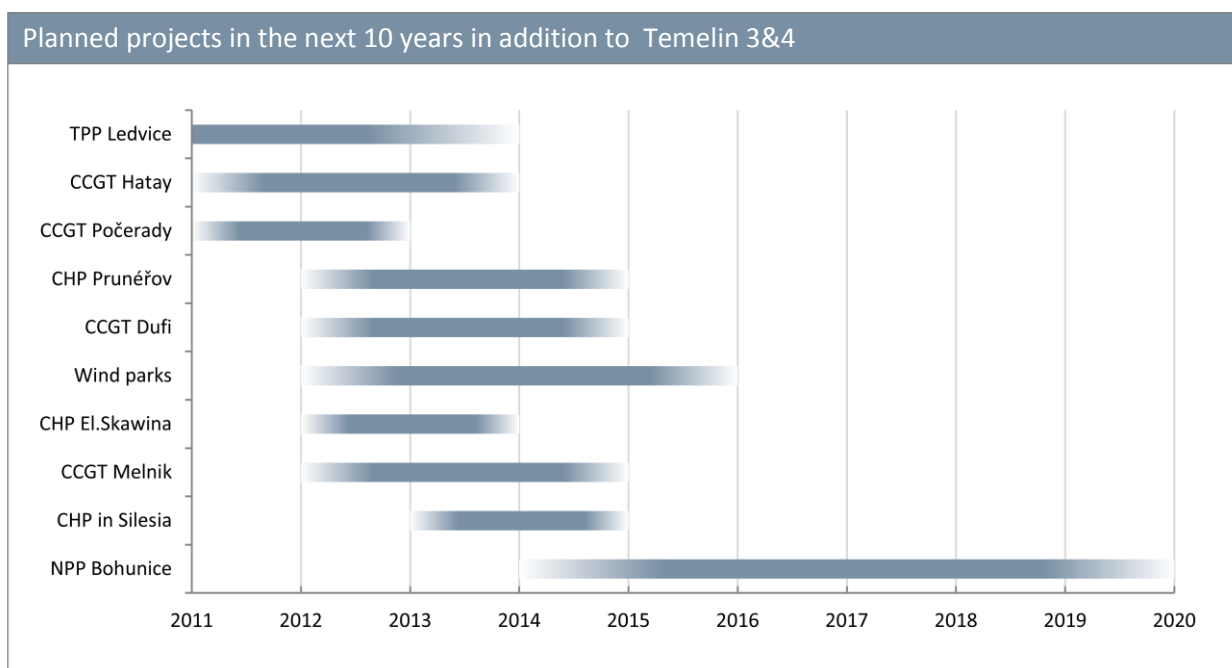
- **CCGT Dufi** (830MW) in Hungary, in a 50% joint venture with MOL, scheduled for 2012-2015 (CEZ, 2011). Our estimated cost is €800,000/MW, or €322mn for CEZ only (50% of total). If 30% have been paid, then €232.4mn remains.
- **CCGT Hatay** (800 - 900MW) in Turkey, in cooperation with Ak Enerji, scheduled for 2011-2014 (CEZ, 2011). Our estimated cost is €800,000/MW, or €270mn for CEZ only (37.5% of total). If 30% have been paid, then €189mn remains.
- **NPP Jaslovske Bohunice** (1000-1600MW) in Slovakia, where CEZ has a 49% stake in a joint venture with the state company Javys and is expected to cost up to €2.9bn for CEZ only (49% of total) (Economist Intelligence Unit, 2010)
- **TOTAL: €10.81bn, of which remaining €9.63bn to pay**

We have excluded some projects that are near completion or on hold:

- TPP Tusimice in Czech Republic, renewal in 2007 -2012
- CCGT Slovnaft (800 - 900MW) in Slovakia, currently on hold
- Wind parks Fantanele & Cogelac in Romania, for €1.1bn EUR
- Small cogeneration projects with the Czech boiler producer TEDOM, most recently 50 MW in small cogeneration plants.

Coinciding projects

We believe CEZ is engaged in more projects than it can afford. The following chart illustrates what CEZ is planning, excluding Temelin 3&4:



CEZ has over ten ongoing constructions of power plants between 2012 and 2015. Although not all project costs have been disclosed, if we assume a cost of €800,000/MW for CCGT and CHP projects,

by 2020 CEZ will have completed projects worth €10.81bn. This is close to the accounting value of CEZ's net plants in service as of Q3/2011 (€11.48bn at 25kc/eur).

Obviously, CEZ is planning to replace its plants in service over the next 10 years (as some will go offline) before Temelin 3&4. This has to be accomplished through a combination of debt and equity. However, CEZ will have to contribute equity beyond its means - CEZ currently has €971mn cash and €1.7bn receivables.

Raising 70% of the remaining €9.63bn cost of all these projects through debt implies that the company's debt to equity ratio will increase from the current 159% to 235%, which in a period of declining profitability, looks unlikely.

Reason 2: Not enough money on the books

Let us assume that Temelin 3&4 is on schedule and that the cost estimate of €8bn is correct. Here is CEZ's balance sheet at the end of September 2011:

CEZ's balance sheet as of Q3/2011, in millions of euros (converted at 25kc per €1)

ASSETS		Q3/2011	EQUITY		Q3/2011
Fixed assets:			Stated capital		€ 2,152
Property, Plant and equipment			Treasury shares		-€ 175
Plant in service		€ 23,470	Retained earnings and other reserves		€ 6,643
Less accumulated provision for depreciation		€ 11,987	Total equity attr. to equity holder of parent		€ 8,620
Net plant in service		€ 11,483	Minority interests		€ 230
Nuclear fuel, at amortized cost		€ 341	Total equity		€ 8,850
Construction work in progress		€ 3,054			
Total PPE		€ 14,878			
Other, non-current assets:			LIABILITIES		Q3/2011
Investment in associates and joint-ventures		€ 430	Long-term liabilities		
Investments and other financial assets, net		€ 2,130	LT debt, net of current portion		€ 6,975
Intangible assets, net		€ 615	Accumulated provision for nuclear decommissioning and fuel storage		€ 1,485
Deferred tax assets		€ 22	Other LT liabilities		€ 939
Total other non-current assets		€ 3,197	Total LT liabilities		€ 9,400
Total fixed assets		€ 18,064	Deferred tax liability		€ 989
Current assets			Current liabilities		
Cash and cash equivalents		€ 971	ST loans		€ 295
Receivables, net		€ 1,717	Current portion of LT debt		€ 131
Income tax receivable		€ 295	Trade and other payables		€ 2,557
Materials and supplies, net		€ 249	Income tax payable		€ 9
Fossil fuel stocks		€ 109	Accrued liabilities		€ 724
Emission rights		€ 194	Total current liabilities		€ 3,716
Other financial assets, net		€ 988	Total liabilities		€ 14,094
Other current assets		€ 211			
Assets classified as held for sale		€ 146			
Total current assets		€ 4,880			
Total Assets		€ 22,954	Total liabilities and stockholders' equity		€ 22,954

Source: Company filings

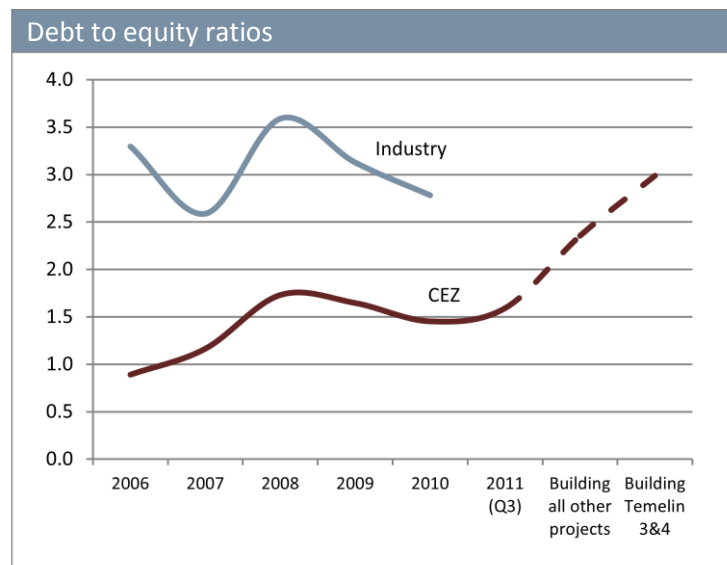
The table allows us to infer that, even if CEZ decides to use all its cash in hand, it would be still be short of more than €7bn. Using all its cash in hand would threaten the normal course of operations

(as the working capital would be used for a capital investment). And so external financing must be used.

Raising debt

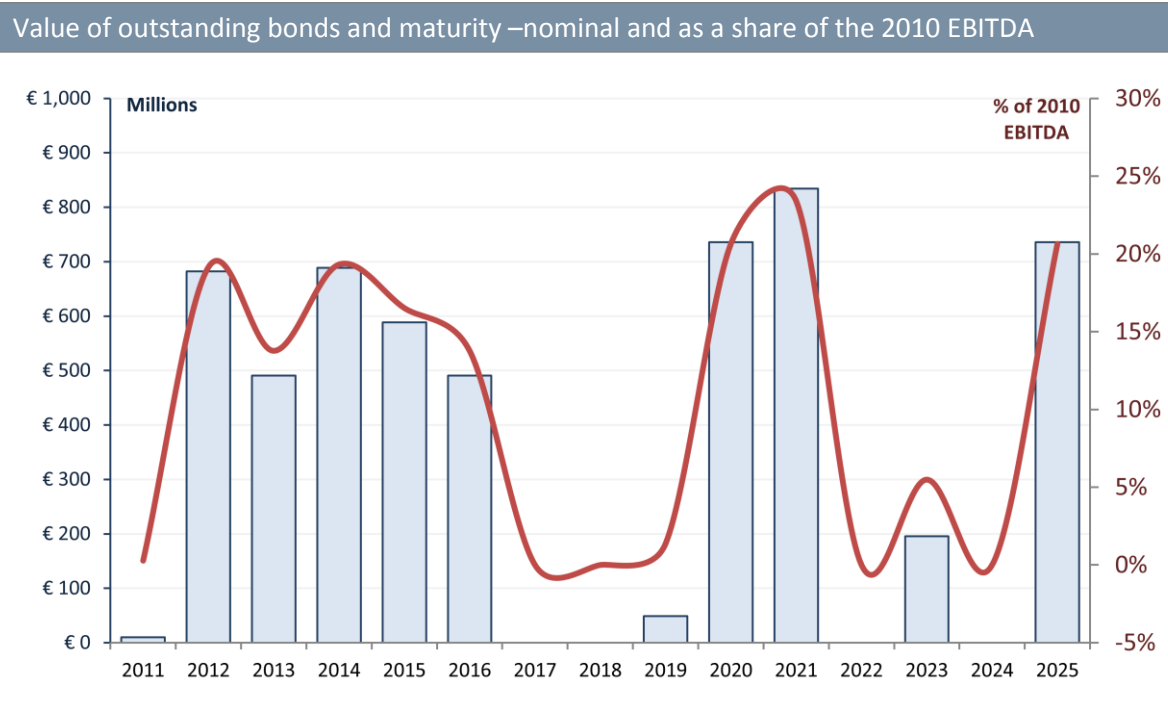
The management of CEZ correctly argues that it has lower leverage compared to its peers. We compiled an industry average (based on results of PGE, Tauron, EnBW, Fortum, EON, RWE, EDF, Alpiq and Endesa), which shows that over the last four years CEZ had below-average debt to equity ratio. However, if CEZ decides to proceed with all its planned projects, as explained in the previous section, and with expanding Temelin (using 70:30 D/E), then the company would move to above average debt to equity.

A general characteristic of leverage is that it magnifies performance. In the case of CEZ, loading so much additional debt would greatly increase interest payments, which means fixed costs increase (business risk), along with the exposure to electricity price fluctuations (price risk). As the capital structure becomes more levered, the cost of financial distress increases and savings from tax shields are offset by excess interest payments. If the capital structure is changed beyond its optimal point, the value of the firm



(and share price) starts decreasing. Other effects include lowered credit rating, increased cost of debt and increased cost of equity; this will lead to an increasing WACC, which may alter the profitability of the projects invested in, rendering them unattractive.

There are two areas for concern. First the growing leverage would come at an escalating cost, which would limit CEZ's flexibility during economic cycle downturns. Second, CEZ has to repay large amounts of long-term bonds maturing in the near future. By 2025, the year when Temelin 3&4 is supposed to launch, CEZ has to repay €5.59bn, of which €2.99bn are due in the next five years, by 2016. This would limit the group's ability to use future net income to finance Temelin 3&4.



Note: Some bonds were issues in CZK, EUR, USD, or JPY, which we converted into EUR for simplicity. Source company filings

Sale of unprofitable assets

It is possible that CEZ may sell some of its unprofitable assets to raise money. How much money can the company raise if it decides – and succeeds – in selling its non-profitable foreign assets?

- **CEZ Bulgaria** – selling the local distribution company would be understandable, given its weak performance and the difficult regulatory environment:

CEZ in Bulgaria, 2010 annual results							
Division	Revenues (mn)	Y/Y Δ	Net profit (mn)	Y/Y Δ	Net profit	ROA	ROE
CEZ Bulgaria EAD	€ 53.52	-24%	€ 0.12	8%	0.22%	0.43%	21.43%
CEZ Electro Bulgaria AD	€ 602.48	-3%	€ 1.56	-47%	0.26%	1.65%	4.44%
CEZ Elektroprodukcija Bulgaria AD	-		- € 0.80	-52%	0.00%	-35.09%	-40.00%
CEZ Laboratories Bulgaria EOOD	€ 0.56	-14%	€ 0.04	0%	-7.14%	-33.33%	-50.00%
CEZ Razpredelenie Bulgaria AD	€186.16	-12%	€ 8.80	-54%	4.73%	2.52%	3.19%
CEZ Trade Bulgaria EAD	€ 28.96	-27%	€ 0.28	-48%	0.97%	9.59%	22.58%
TPP Varna	€ 29.96	10%	€ 1.28	-97%	0.11%	0.09%	0.11%

Note: all nominal values in CZK were converted in EUR at 25kc per €1 exchange rate.

Source: CEZ Group 2010 annual report.

A comparable recent transaction was the sale of E.ON Bulgaria to Energo-Pro for €133mn in December 2011.

- **TPP Varna** – the sale of the Bulgarian 1,260MW TPP has long been rumoured. A comparable transaction would be Contour Global's acquisition of the 908MW TPP Maritza East 3 from Enel in March 2011. If the sales price of €0.59mn/MW is similar for the 1260MW TPP Varna, then the transaction could be worth up to €743.4mn
- **Ak Enerji** - CEZ is selling its 37.5% stake at the Turkish joint venture. Estimates show that CEZ already has 20 bidders and can expect to sell its stake for about €252mn (KBC Securities, 2011).

- **CEZ Shpërndarje** – CEZ privatized 76% of the Albanian distribution company in 2009 for €102mn. If CEZ decides to sell, it might receive anywhere between the purchase price and the comparable transaction in Bulgaria (or an average of €117.5mn)

Even if CEZ succeeds in selling the above four units, the company would unlikely receive more than €1.245bn (before transaction costs and taxes), or about 15% of the quoted €8bn cost of Temelin 3&4.

Reason 3: Deteriorating group performance

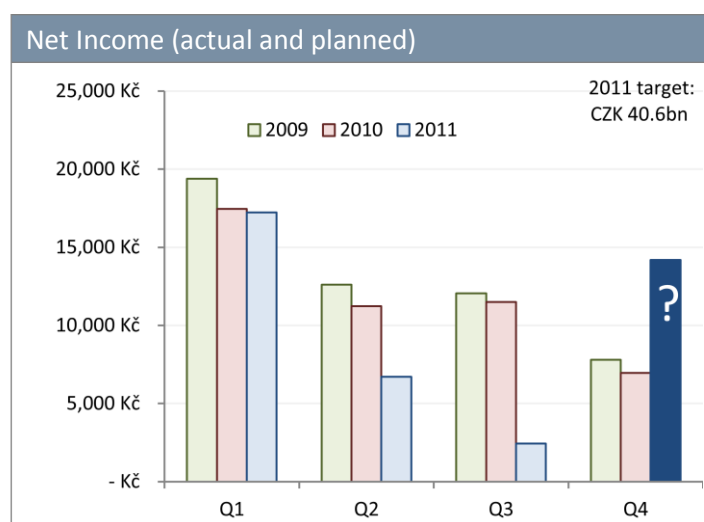
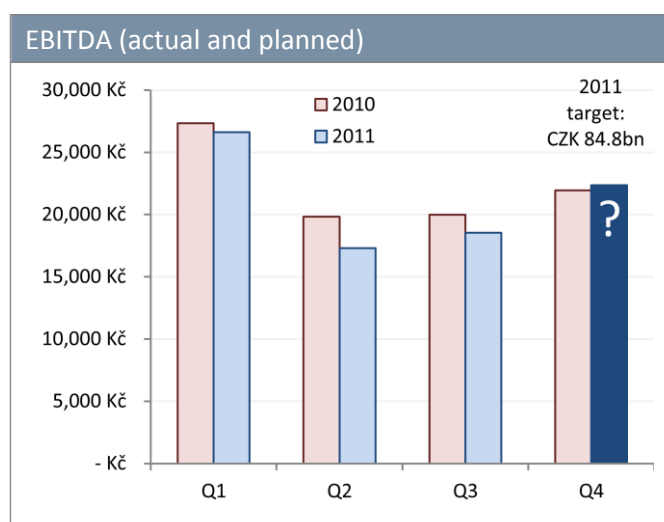
CEZ continues to maintain higher profitability compared to its competitors. In our reports “[Power Abuse](#)” and “[Power 2 Abuse](#)”, we argue that CEZ's dominant position allows it to abuse its market power and so make above average profits. However, there are several indicators that the group's performance is deteriorating. We believe these problems would impede CEZ's ability to borrow at attractive rates to finance Temelin 3&4.

Profitability

We expect CEZ to miss its annual target for 2011. The company is being overly optimistic in its forecasts – the Q3/2011 report confirms the annual targets for EBITDA of CZK 84.8bn and net income at CZK 40.6bn. However, during the first three quarters of the year the group has an EBITDA of CZK 62.44bn and net income of CZK 26.4bn.

In order for the company to meet its targets, EBITDA in Q4/2011 has to be higher than Q4/2010, even though during all previous quarters this year it was lower. If CEZ is to meet its 2011 target, net income for Q4/2011 has nearly double that of previous years.

The problem with profitability is that if CEZ plans a certain level of net income every year before Temelin 3&4 is built, then every time the net income falls short of expectations, it has to be compensated in the next year.



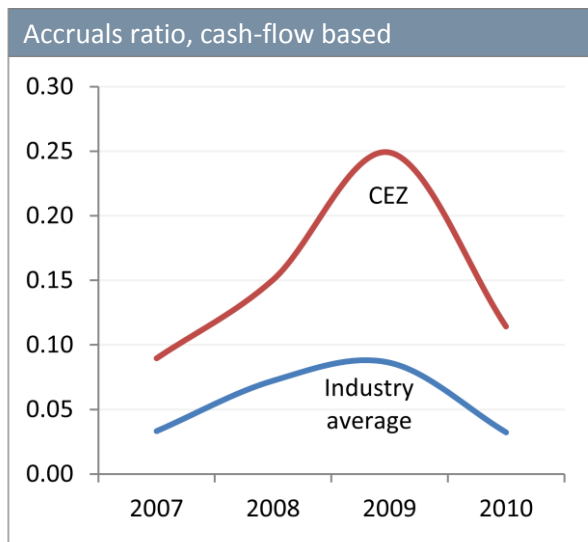
Overall, we expect CEZ to miss its target by approximately 18%, resulting in earnings per share of 62.08kč instead of the planned 75.47kč.

Deteriorating earnings quality

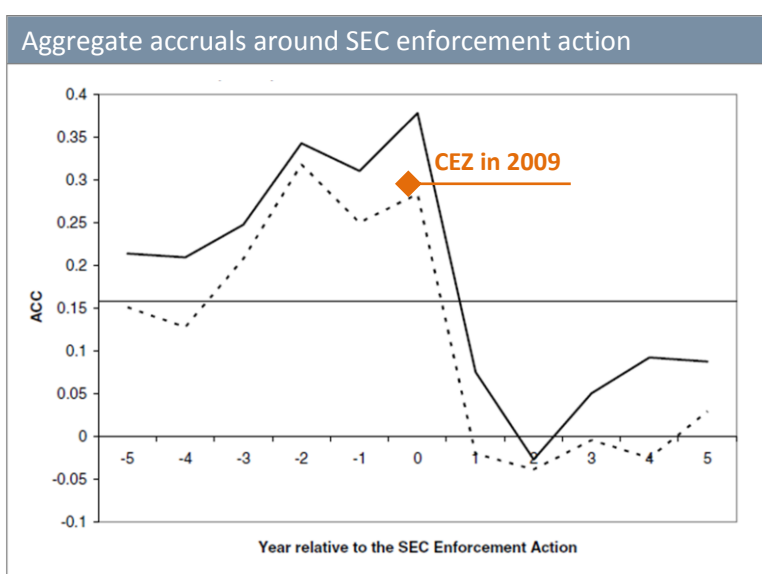
CEZ’s earnings quality has several red flags. Earnings quality can be interpreted as persistence and sustainability. Generally, financial reporting quality “relates to the accuracy with which a company’s reported financials reflect its operating performance and to their usefulness for forecasting cash flows” (Richardson & Tuna, 2011). One of the ways to measure it is by using the accruals ratio, a size-neutral indicator that measures how a financial statement prepared on a cash-basis compares with the same statement prepared under accrual-basis; in other words, how cash streams compare to stated earnings. A low accruals ratio indicates good earnings quality.

We compared CEZ’s earnings quality with that of its key competitors (PGE, Tauron, EnBW, Fortum, EON, RWE, EDF, Alpiq and Endesa). As the graph indicates, since 2007, CEZ has shown a consistently worse earnings quality than the industry average. The earnings quality was worst in 2009, which implies that during that year it displayed the most serious misalignment between cash streams and stated earnings.

In the United States, high accruals ratio has been shown to be a leading indicator for enforcement actions by the US financial regulator, the



Securities and Exchange Commission (SEC). Alleged earnings manipulation is typically a reason for concern among shareholders. Richardson, Sloan, Soliman, and Tuna (2006) tracked a sample of 76,165 firms, subject to SEC regulations, between 1979 and 2001. Accruals have been calculated for each company five years prior to and after an investigation by SEC. One of the authors’ conclusions is that “extreme accruals are systematically associated with



Source: (Richardson, Tuna, Sloan, & Soliman, 2006), CFA Institute

alleged cases of earnings manipulation”. The bold (dotted) line represents the mean (median) accruals ratio of the sampled companies. The straight horizontal line represents the aggregate accruals for the average listed company.

From an investor’s standpoint, these accrual ratios are a reason for concern that financial statements, although not necessarily manipulated, consistently differ from the economic reality facing CEZ.

Creditworthiness

There are several ways to measure creditworthiness of a company. The various methods show mixed results for CEZ.

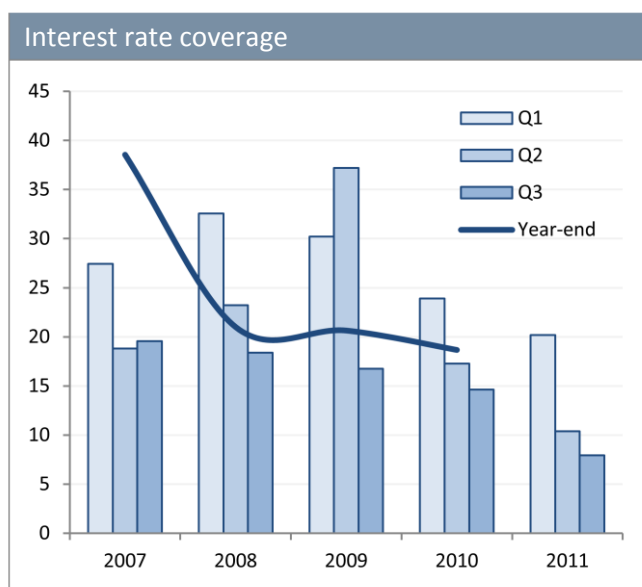
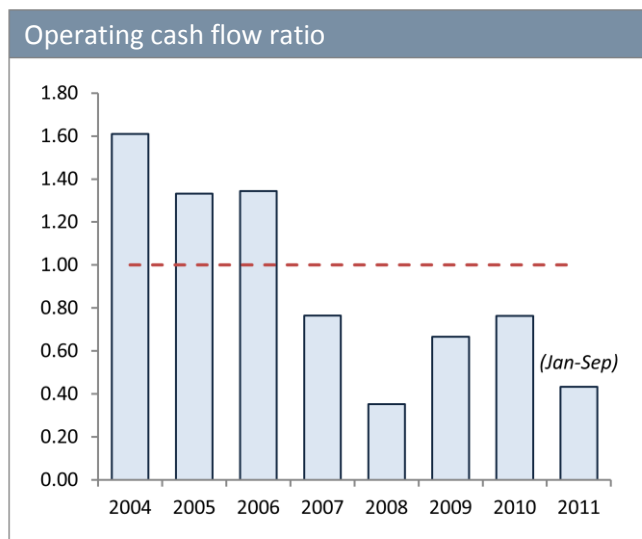
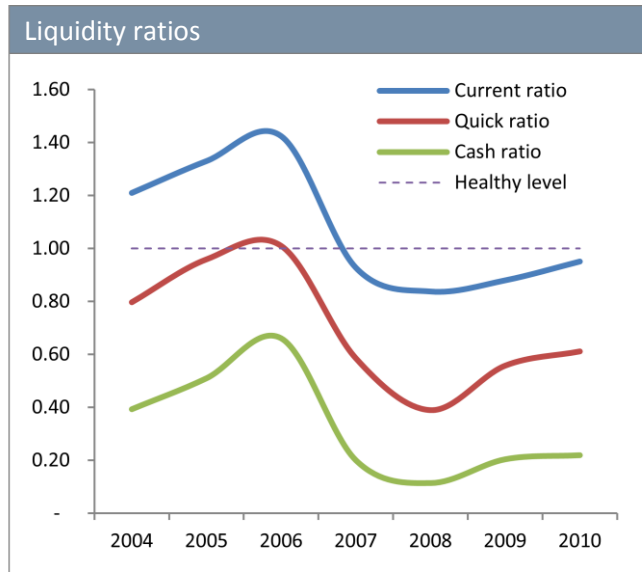
The current ratio, which measures a company’s ability to pay short-term obligations, has fallen below the healthy level of 1 since 2007 and has remained there ever since. Results for the first nine months of 2011 show improvement, although the entire annual performance is still not announced.

Another way to measure short-term liquidity is the operating cash flow ratio. If the operating cash flow ratio is less than 1, it generally means the company has generated less cash over the year than it needs to pay off short term liabilities. It may signal a need to raise money to meet liabilities.

CEZ’s interest coverage ratio is declining as well. This ratio is used to show how comfortably a company can pay interest on outstanding debt. Although the interest coverage ratio is still above healthy levels in CEZ’s case, it is declining fast and is unlikely to show improvement given the growing debt levels of the group (debt was 68% of equity in in 2004, and 159% in Q3/2011).

Effectiveness

CEZ’s use of its assets has deteriorated. The group was better at making money from every koruna of assets in the past. In 2010 the asset turnover, or the money generated



from every asset, approached 2004 values. The asset base of the company has grown faster than the sales those assets generate.

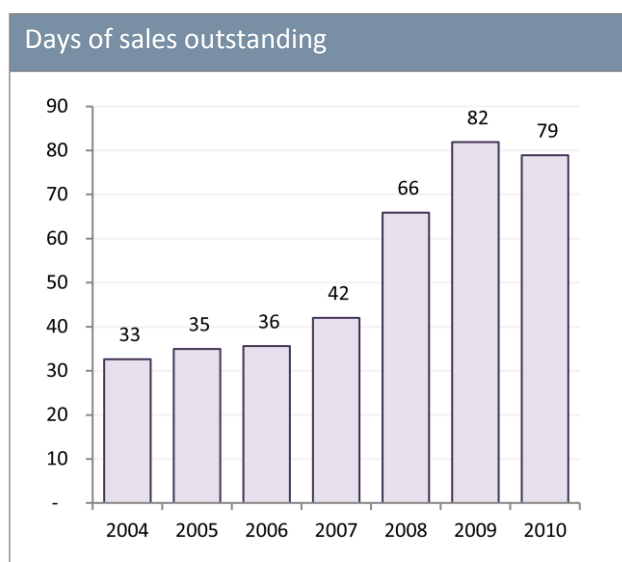
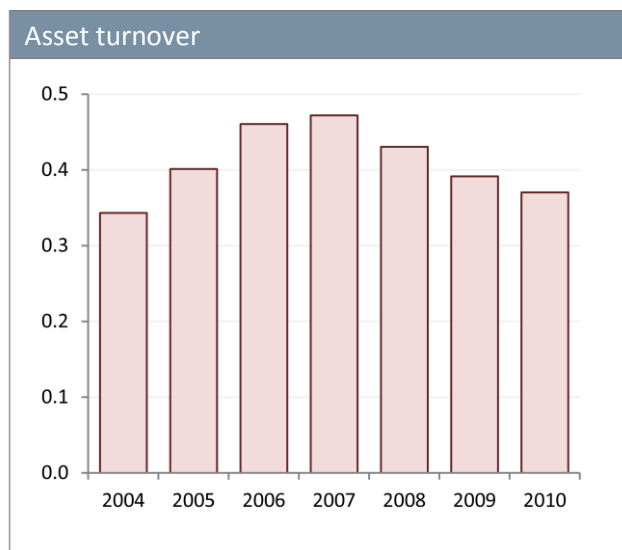
Another red flag is its deteriorating effectiveness. The group has become less good at collecting payments – in 2004 it took the group 33 days to collect a payment, while in 2010 it took an average of 79 days. This puts further downward pressure on operating cash flows and the ability to finance the project with future proceeds.

Potential legal liability

Legal proceedings against CEZ may result in substantial claims against the company. The European Commission will likely conclude its antitrust investigation of the company shortly. CEZ is being investigated for coal and electricity market manipulation, hindering access to market and cartel agreement. A potential fine is capped at 10% of worldwide turnover, or approximately €795mn, assuming 10% of the 2010 revenue in the case of CEZ.

Conclusion

We believe that CEZ lacks the funds to build Temelin 3&4. Plans to build projects worth at least €17bn, all by 2025, would seem to us to be incompatible with CEZ's performance in recent years. Deteriorating net income and management of receivables suppress operating cash flows, which will make it more difficult for CEZ to finance the projects with future net income.



VALUATION OF TEMELIN 3&4

Using a simplified valuation, we shall now demonstrate why an investment into two new reactors at the plant will be disappointing from a financial point of view. We accept fully that any financial valuation that attempts to predict prices and events nearly a century ahead is a purely theoretical exercise and subject to large errors. For the want of a better financial tool, we have used the industry-standard DCF model with as few factors as possible. We performed 5,000 iterations in a Monte Carlo simulation, a computerized mathematical technique that randomises values given volatility in explanatory variables. Finally, we adhered to the planned timeline, with construction starting in 2016 and finishing in 2025, and a 60-year operating life.

Our assumptions

Valuation assumptions			
Factor	μ	σ	Comment
WACC	7.5%	0.75%	It is unclear what CEZ's internal company WACC could be for such a project. However, we believe that our Monte Carlo simulation accounts for any potential differences in estimates. We take the average of 5% and 10%, the most often used discount rates in the LCOE valuations
Inflation	2.50%	0.25%	We assume that electricity prices grow at 2.5% per year (please note that the compound annual growth rate of the electricity price since Aug 2007 has been lower than 2.5%). Every annual observation of the electricity price also deviates from the trend line.
Payroll expenses	18%	1.8%	As a share of total revenue (common size). Mean result taken from the Bulgarian NPP Kozloduy over the last 4 years (~20%). We decreased the mean result, because expanding an existing power plant would require lower headcount than for a new one.
Fuel expenses	€14/MWh	10%	Fuel costs combined (front and back end, in Germany) (World Nuclear Association). We also assume that fuel expenditures (uranium, enrichment, and then disposal) will grow with the speed of inflation.
Debt %	70%	7%	Capital structure of the project
Cost of debt	7%	0.70%	Interest rate on loan
Loan duration	30	Fixed	30-year loan
Tax rate	19%	Fixed	Corporate tax rate
CZK:EUR exchange rate	25kc	Fixed	Fixed
Annual electricity production	15,242,400	1%	2,000MW at 88% availability. We assume all production is sold.
Depreciation	-	-	Linear over 30 years
Capital investments	Estimate today	Timeframe	Comment
Road infrastructure	€ 64,000,000	2012-2013	In early December 2011, CEZ agreed to pay €64mn to the South Bohemian Region for the reconstruction of roads around Temelin (<i>Vácha, 2011</i>).
EPC cost	€8,000,000,000	2016-2025	As quoted by CEZ. 10% payable upfront (2016), 40% midway (in 2021), 50% upon completion (2025)
Decommissioning	€1,200,000,000	2085-2095	15% of initial investment (World Nuclear Association, 2011)
Electricity	Mean μ price	σ	Comment
Price in 2013 (baseload CAL13)	€ 54.03	0	Average daily closing prices of futures on PXE (Jan2010-Oct11) <i>Source: PXE</i>
Price in 2014	€ 55.65	0	The mean electricity sales price grows linearly at the rate of inflation (2.5%, see second row above). The electricity will also deviate from this mean at $\sigma=10\%$ of the price
Price in 2026 (First year of operation)	€ 74.84	€ 7.48	The mean price continues to grow at the rate of inflation
Price in 2085 (Last year of operations)	€ 321.00	€ 32.10	The mean price continues to grow at the rate of inflation

Each one of the following assumptions has a mean value and a standard deviation in order to account for possible changes in the factors. We then conduct a Monte Carlo simulation, which analyses 5,000 different combinations of the factors and their deviations.

Factors we disregard

We believe there are more downward risks than upward potential in this plant expansion. Even so, we will disregard many of the factors influencing the project profitability. A far from comprehensive list of the factors we disregard includes:

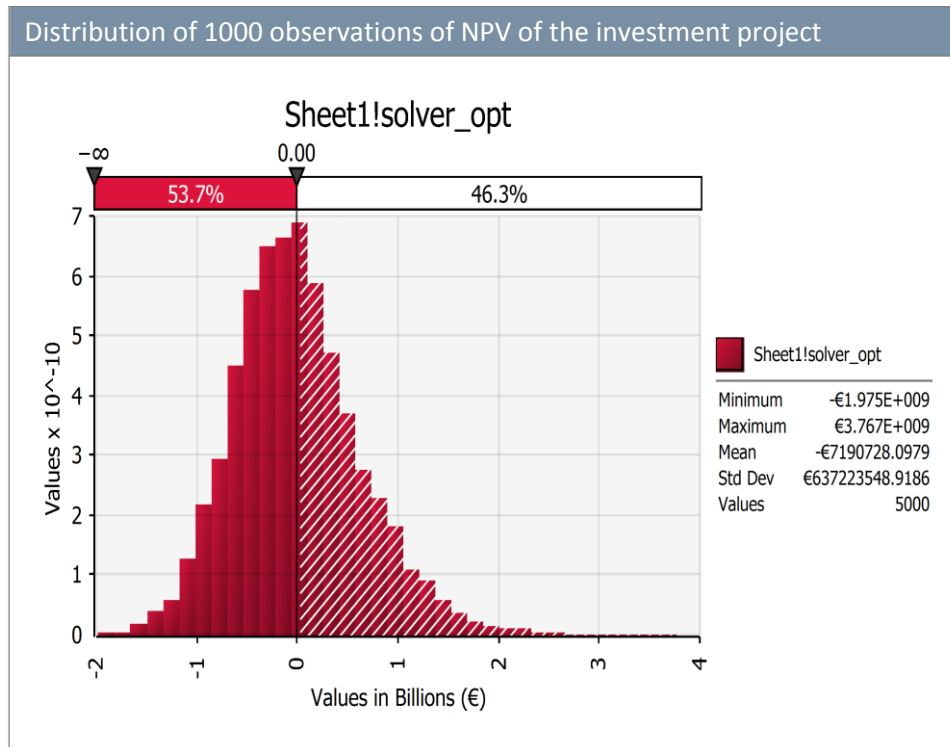
- **Delay in build times**, which would cause large interest payments and fixed overhead, but no revenue.
- **Insurance premium** payable on electricity production, which we expect to grow due to EU-wide efforts to increase the cap on nuclear liability;
- **Balancing capacity** – we will assume that existing capacity of the plant will be sufficient to balance the two additional reactors connected to the grid;
- **Difficulties in raising financing** – we assume CEZ will be able to find 70% debt for its project at attractive rates;
- **New regulatory requirements**, such as stress-tests, design changes, and others;
- **Extra costs** - we disregard any chances of unexpected expenses of any sort;
- **Transmission fees** and transaction costs are disregarded;
- **Grid development** cost (€480mn) will be paid for in its entirety by the TSO and then passed on to consumers;
- **Nuclear repository** will not be built;
- **Currency risk** does not exist, or is entirely hedged;

Certainly, there are thousands of other uncalculated risks during the life of the plant. However, we will simplify the valuations as much as possible.

Results

Profitability

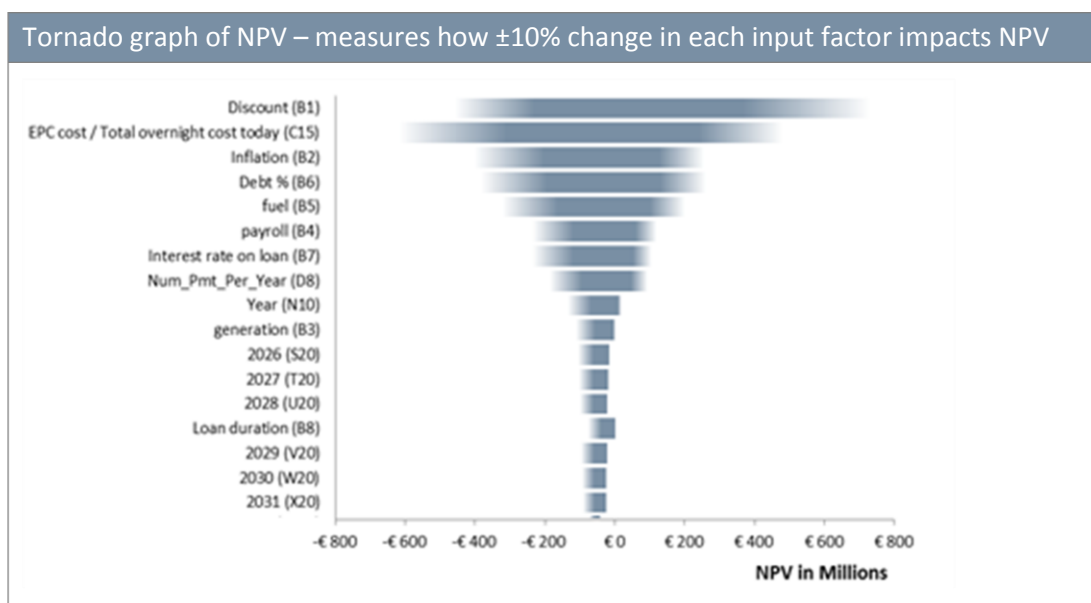
We use Net Present Value (NPV) of Free Cash Flows to Equity (FCFE) to analyse project profitability. Our simple valuation shows that Temelin 3&4 is an investment with negative net present value (NPV). Results show that in 53% of the cases, the net present value of the project is negative (meaning that a rational investor would not touch it). The average NPV is -€ 56,490,965.



We assume that there would be no delays in construction, no budget overruns and no other initial expenses apart from the €8bn contract price and the €64mn for roads. With these considerations in mind, the average sales price at which the expansion project breaks even is €163.99/MWh.

Sensitivity to the most important factors

The project’s sensitivity to changes in input factors is graphically represented in the chart below. The tornado graph measures how a ±10% change in each of the inputs influences project profitability, holding all other inputs constant.



- 1) The most important factor is the discount rate (cost of capital) used. We assume 7.5%, but increasing the leverage to the levels that CEZ desires would possibly make WACC higher. A WACC of 8.7% decreases NPV by nearly €400mn.
- 2) The cost of constructing the plant is the second most important factor. Assuming there are no external costs besides the €8bn, a 10% overrun in budget in the EPC decreases NPV by €600mn
- 3) The growth of the price of electricity and total fuel costs.
- 4) Debt levels are another fundamental factor, where the higher the equity investment, the higher will be the profitability. If CEZ uses 58% debt, the NPV is +€261mn, holding all other variables constant.
- 5) Fuel prices. One of the benefits of uranium is that its prices are not very volatile.
- 6) Payroll expenses. Adding two more reactors to an existing plant would require smaller workforce than if the plant was built from scratch.
- 7) Interest rate on loan – will depend on the financing scheme
- 8) Number of payments per year. More frequent payments (e.g. twice a year) make the effective interest rate higher.
- 9) Price of electricity. Due to the specifics of discounting, it is more important for the electricity prices to be high in the early years of operation than in the later years.
- 10) Availability of the plant. It has to be higher than 89% (above Temelin 1&2) for the investment to be profitable, holding all other parameters constant.

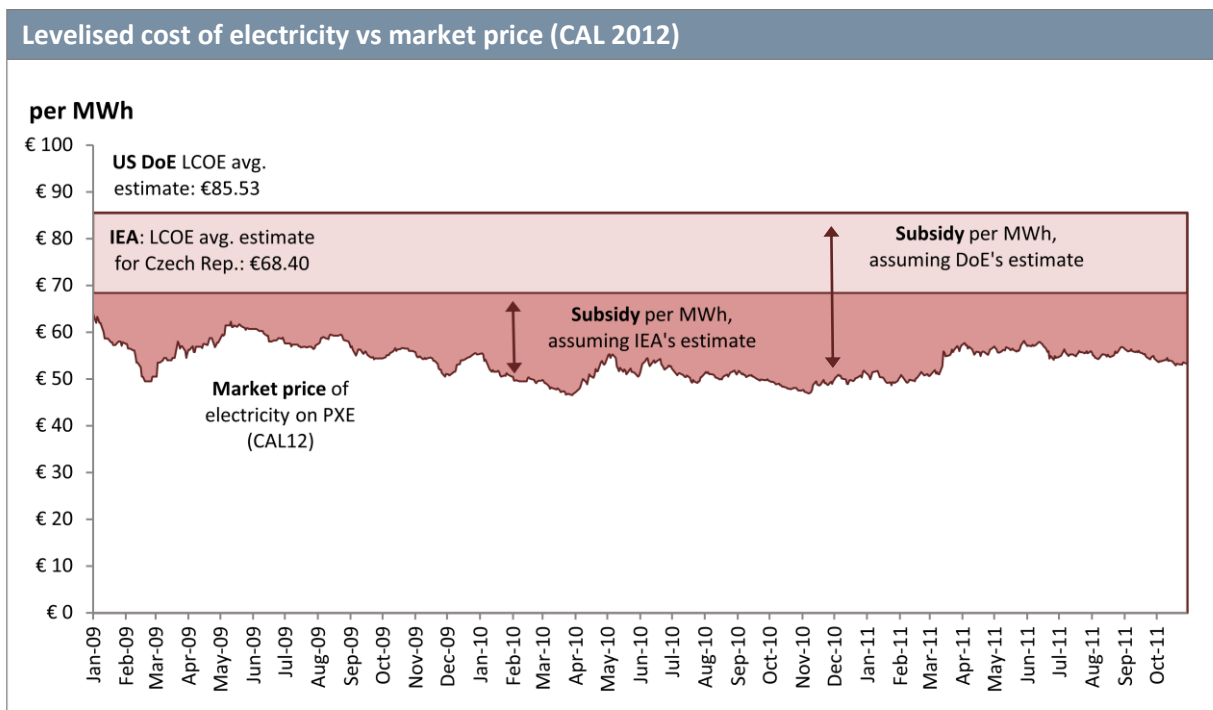
Subsidies

Given these results, we understand why CEZ is seeking some form of government support to mitigate some of the risks (Fojtik, 2011). According to CEZ itself, state support could come in one of the following variants: (1) obligatory purchase of all Temelin production, (2) a consumer contribution that would cover the investment costs (the contribution would be incorporated into the final electricity price), and (3) a fixed feed-in tariff for nuclear production (Fojtik, 2011). There could also be loan guarantees. The exact method of state support has not been clarified.

- **Subsidy 1:** Loan guarantees would be beneficial for the project. The problem with a state backed loan is that it would be interpreted as the Czech state borrowing the guaranteed amount.
- **Subsidy 2:** Guaranteed purchase. Our financial model assumes that all electricity that CEZ generates will be sold.
- **Subsidy 3:** Sponsoring the initial investment. The third subsidy is in the form of paying for the initial investment of the plant. This is already happening, with the cost of grid development being passed onto consumers. We might expect that the state would struggle to justify additional sponsorship involving tax payers' money given that 30% of CEZ is privately owned. And yet local peculiarities, such as inadequate scrutiny by regulators and the weakness of

other market participants, suggest that any opposition to special treatment for CEZ is likely to be ineffective.

- **Subsidy 4:** Fixed feed-in tariff for nuclear production. If the government decides that it should subsidise CEZ by offering a subsidy for electricity from nuclear plants, then the cost of the subsidy would be shifted onto the consumer. If CEZ was to break even on the project, the feed-in tariff has to be set at the levelised cost of electricity (which changes through time). If we assume that Temelin 3&4 launches in 2012, then the subsidy would be the difference between the market price and the LCOE – or up to 60% of the market price.



Recent studies show that the subsidies often exceed the value of the energy produced (Union of concerned scientists, 2011). In Japan, when accounting for state subsidies, the cost of 1kWh of electrical power between fiscal 1970 and fiscal 2007 was ¥10.68 for nuclear, ¥3.98 for hydroelectric, and ¥9.9 yen for thermal generation (The Mainichi Daily News, 2011).

CONCLUSION

We consider the economics of Temelin 3&4, or the *Temelinomics* if you like, to be quite unconvincing. We regard as overblown the statements of CEZ's CFO Martin Novak that "whatever the cost estimates, CEZ will be generating so much cash between the start of construction in 2015/2016 and its completion in 2020 that it will be enough." On the contrary, we suspect that CEZ lacks the money to undertake the planned €8bn investment. We note that the company's performance is deteriorating, as is its creditworthiness. Bonds need to be refinanced and coincidental projects worth more than €10bn must be completed. To accomplish all this will involve committing to loans that would lever the company above the industry average and make it less able to respond to future business risks –and for that matter, to legal risks such as conviction for alleged abuse of dominant market power and unreported related party transactions of the company's management. And we stress that from a strictly financial perspective, even if the project goes according to schedule and is on budget, it is likely to generate negative NPV.

We note that CEZ is being subsidised in the construction of Temelin 3&4. The state has capped the nuclear insurance liability, which substantially decreases the insurance premiums payable. And CEZ transfers the cost of expanding the grid, which would otherwise not be necessary, to consumers. We expect that further subsidy will be required.

For all these reasons, we are unable to find a compelling economic justification for the project. We acknowledge that there might be other motives to embark upon the construction, such as energy security –or even rent seeking. As we observed in "[CEZ Unplugged](#)", our study published two years ago, "the risk to investors that CEZ's management may be tempted to seek rents while executing the investment plan remains high given the government's cavalier approach to scrutiny of the management it appoints." Past procurement decisions, such as the choice of contractor (whose ownership remains unclear to this day) to lead the construction of a temporary nuclear storage facility at Temelin, as well as mounting suspicion of unreported related party transactions by CEZ's management, strengthen doubts about management commitment to maximising shareholder value. We do not consider the recent replacement of Martin Roman by Daniel Benes as CEZ's CEO to be significant, not least because Roman remains the chairman of CEZ's supervisory board.

We see no good reason to believe that the burden on CEZ's free cash flow caused by wasteful procurement practices and investment will be removed simply because the politicians who are the majority shareholder say so. Nor are we hopeful that minority shareholders will oppose a value destructive investment of the kind Temelin 3&4 in our view represents. The reasons for our pessimism were explained in the conclusion to "[CEZ Unplugged](#)":

"If CEZ was truly a private company, public authorities would quickly learn to treat CEZ as any other dominant private company. They should be less motivated to protect CEZ, and more willing to demand and to publish information, for instance on whether CEZ abuses its dominant position. The public authorities would become the independent arbiters they cannot be today as they struggle to regulate and to hold accountable a company in which their superiors are shareholders. And shareholders would be motivated to hold the management

accountable for value-diluting decisions through the supervisory board. The management could then focus on maximising shareholder value and resist pressure to support possibly competing objectives of the state as dominant shareholder, such as the pursuit of national security or social policy. Rent-seeking behaviour and wasteful spending would become the shareholders' problem, not that of Czech taxpayers, who today implicitly underwrite CEZ through the state's shareholding." (Ondrich, 2010)

Our conclusions at that time hold true today. It is Czech taxpayers who will pay for Temelin 3&4. We hope that this study is a useful contribution to the debate about whether they should be willing to do so.

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