Reactor options for the Czech Republic

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Criteria

- Vendor credibility
- Price
- Availability of finance
- Construction experience
- Operating experience
- Ability to satisfy European safety requirements
- Size, must be a PWR
Reactor options for Czech Rep

• Rosatom AES-2006

• Areva EPR

• Areva/Mitsubishi Heavy Industries Atmea One

• Westinghouse AP1000

• China General Nuclear Hualong One

• Korean Electric Power APR1400
AP1000

• Westinghouse was given Chapter 11 bankruptcy protection in March 2017. Its parent, Toshiba, is on the verge of bankruptcy & trying to sell Westinghouse but no likely buyer

• 8 AP1000s under construction, 4 China, 4 USA, none in operation. All at least 4 years late & far over budget. If no buyer for Westinghouse, 4 US units may be abandoned

• Recent costs estimates prior to construction ca $6,000-7,000/kW. Latest cost estimate for Vogtle project (US) ca $11,000/kW

• South Carolina (Summer): ‘Our experience with Westinghouse [is] a trend of continuous deceit & non-transparency’, and [we are] a victim of financial malfeasance’.

• Little prospect of government loan guarantees

EPR

• Areva NP collapsed March 2015. Support by French government & plan for EDF to take majority stake but conditions cannot be fulfilled till end 2018

• 4 EPRs under construction, 2 China, 1 Finland, 1 France, none in operation. All at least 4 years late & far over budget

• Reactor vessels for China & France sub-standard. Lids may have to be replaced in 2024. Resulting investigation revealed QC falsification by Areva NP going back up to 50 years

• Recent costs estimates (Hinkley) prior to construction ca $7,000/kW. Latest cost estimate for Flamanville (France) ca $7,000/kW

• Little prospect of French government loan guarantees

• Design approved by UK (2012), under review by France & Finland. 1600MW so too big?
Atmea One

- 50/50 joint venture with Areva & MHI. Will Areva survive?

- No orders. Possible orders for Jordan, Turkey, Argentina now seem unlikely

- No credible cost estimates

- Little prospect of French loan guarantees, possible Japanese loan guarantees

- Detailed design review not carried out. 1100 MW so OK
AES-2006

• Rosatom strongly backed by Russian government

• 1 AES-2006 in operation since Feb 2017. Initial operation unreliable. 5 under construction, 3 Russia, 2 Belarus. Russian plants 4 years or more late, unquantified delays in Belarus

• Accidents during construction at Leningrad & Belarus, allegations of corruption & poor quality materials, concern about shortage of skills & inadequate supply chain

• Cost estimates for Finland, Hungary, Egypt etc about $6000/kW

• Russia offers loans but does it have the capability to meet the 35 export orders it already has requiring loans?

• Design under review in Finland. About 1150MW so OK
APR1400

- KEPCO state controlled. 1 APR1400 in operation in Korea since Dec 2016. 3 under construction in Korea & 4 in UAE

- 2 APR1400s delayed by 3-4 years because QC documentation falsified & equipment had to be replaced. A number of operating plants closed for 2 years to replace equipment

- KEPCO admits version built in Korea & UAE would not meet European standards (no core catcher or aircraft protection)

- UAE prices very low ($3600/kW) but suspicions order was under-priced. How much would additional safety add?

- All 5 candidates (May 2017) for Korean President promised to phase out nuclear in Korea so government support for loan guarantees unlikely

- Updated version under review in USA but little progress yet. 1450MW so maybe too big
Hualong One

• CGN state-owned and backed by Chinese government in export markets

• 2 versions of Hualong One, CNNC & CGN. 2 of each version under construction in China, CGN version for less than 2 years. No useful information on progress

• Concerns within China & from French safety regulator about quality & safety culture in China

• No information on prices offered. China said it will offer loans but not tested yet

• UK review of CGN Hualong One started in Jan 2017 so little progress & no information yet
## Strengths and weaknesses of candidate designs

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<tr>
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<th>EPR</th>
<th>AP1000</th>
<th>Atmea One</th>
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<tbody>
<tr>
<td><strong>Vendor credibility</strong></td>
<td>QC falsification up to 50 years. Areva bust</td>
<td>Westinghouse bankrupt</td>
<td>MHI no experience in exports</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>High (~$7000/kW)</td>
<td>High (~$7000/kW)</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Availability of finance</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Construction experience</strong></td>
<td>Very poor (4 reactors)</td>
<td>Very poor (8 reactors)</td>
<td>None</td>
</tr>
<tr>
<td><strong>Operating experience</strong></td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Satisfy European regulator?</strong></td>
<td>Yes</td>
<td>Probably</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>1650MW – too big?</td>
<td>1200MW - OK</td>
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# Strengths and weaknesses of candidate designs

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<th>Hualong One</th>
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<tr>
<td>Vendor credibility</td>
<td>Lack of experience in open markets</td>
<td>No experience in open markets</td>
<td>Only export to UAE</td>
</tr>
<tr>
<td>Price</td>
<td>High ($6000/kW)</td>
<td>Unknown</td>
<td>Old design low</td>
</tr>
<tr>
<td>Availability of finance</td>
<td>Offered, but lack of capability?</td>
<td>Probably offered</td>
<td>Unknown</td>
</tr>
<tr>
<td>Construction experience</td>
<td>Poor (6 reactors)</td>
<td>Little experience (4 reactors)</td>
<td>Some delays due to QC issues (6 reactors)</td>
</tr>
<tr>
<td>Operating experience</td>
<td>Minimal &amp; poor so far</td>
<td>None</td>
<td>Minimal</td>
</tr>
<tr>
<td>Satisfy European regulator?</td>
<td>Being tested in Finland</td>
<td>Review just started in UK</td>
<td>Major upgrades needed</td>
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<td>Size</td>
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UK Experience: Hinkley Point C

• Hinkley, 2 EPRs (3.2GW), first of 5 projects to add 16GW of nuclear in UK by 2030

• Uses EPR technology, unproven in operation & suffering appalling problems of cost & time overruns in the 3 projects using it. Supplied by Areva NP, in financial collapse & might not be saveable & has been falsifying quality control records for safety critical items of equipment for up to 50 years.

• In 2008, construction start 2012, expected completion 2017 at cost of €4bn (€4.4bn), latest estimate construction start 2019-21, completion 2025-27, cost £19.6-20.3bn plus finance costs (+30%)

• Power bought on 35-year take-or-pay inflation-indexed contract for >£100/MWh. Off-shore wind £57.50/MWh

• Likely to require UK taxpayer guarantees worth about £14bn. If Flamanville not in service by end 2020, offer of guarantees expires

• Uncertainties: Can Areva NP be rescued? Can EDF raise the cash? Will the appeal against the Commission state-aid approval be successful?

• Other 4 projects equally problematic
Is there an alternative to nuclear?

• Wrong question. Is nuclear an option? Experience from USA, UK, Russia, France, China suggests nuclear will at best be a very expensive option providing much less than forecast and at worst will fail completely

• Over its 60 year history, nuclear has consistently failed to meet expectations, renewables have consistently exceeded expectations

• Czech plans risk locking Czech Rep into a very risky policy for the next 20 years at the expense of proven, cheaper, more flexible options

• Czech Rep can profit on the vast experience with low-carbon technologies generated in countries such as Germany, China, Denmark