The impact of different financing structures on investor risk

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General background

**Objectives**

- More realistic model of the choices of a private investor, taking into account the effect of taxes and the capital structure of the project
- Representing the main sources of risk associated with a NPP project
- Effect of the financial leverage on the NPV and on the risk for equity and bond-holders
- Comparison of technologies with different capital/operating costs

**Financial model**

- Detailed cash-flow model which takes into account
  - Taxes (35%)
  - Depreciation (MACRS) and tax shield on debt
  - Models explicitly the net cash flow to the firm and to equity-holders
- Static Discounted Cash Flow Model (*Adjusted Present Value*)
  - Cost of capital (5% → 15% in nominal term)
  - Debt ratio (30% → 70%)
  - Cost of debt (5% → 7%)
Sources of Risks in a NPP project

- **Construction risk**
  - ✔️ Uncertainty regarding overnight costs
  - ✗ Uncertainty on length on construction period (IDC)

- **Operational risk**
  - ✔️ Load factor: triangular distribution between 75% and 95%

- **Electricity market risk**
  - ✔️ Short-term variability of prices
    - First-order auto regressive model: $P_{t+1} = P_t + \alpha(\mu - P_t) + \epsilon_t$ (random component)
    - Possibility to suspend production when electricity prices are below variable costs
  - ✔️ Long-term changes in the price trajectory
    - Parametric study (-30% → +30%, i.e. ±16 €/MWh)
    - Creation of 4 scenarios of possible electricity price variations (low to high price risk)
  - ✗ No correlation with fuel prices
    - Results are not representative for gas/coal PP
- With current wholesale electricity prices (and prevailing construction costs) it is unlikely that a new NPP could be financed without governmental support.
Financing NPP in continental Europe
Sensitivity to electricity price

Net Present Value of a NPP investment – sensitivity to electricity price

[Graph showing the net present value of a NPP investment for different electricity price increases and opportunity costs of capital]
- A combination of increase in electricity prices and reduction of construction costs is needed to make a NPP project viable in continental Europe.
NPV distribution of cash flows after commissioning (I)

<table>
<thead>
<tr>
<th>Change in electricity price</th>
<th>-30%</th>
<th>-20%</th>
<th>-10%</th>
<th>Zero</th>
<th>+10%</th>
<th>+20%</th>
<th>+30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Electricity Price Risk</td>
<td>0%</td>
<td>1%</td>
<td>25%</td>
<td>48%</td>
<td>25%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Moderate Electricity Price Risk</td>
<td>1%</td>
<td>5%</td>
<td>20%</td>
<td>48%</td>
<td>20%</td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>Medium Electricity Price Risk</td>
<td>5%</td>
<td>10%</td>
<td>15%</td>
<td>40%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>High Electricity Price Risk</td>
<td>8%</td>
<td>12%</td>
<td>15%</td>
<td>30%</td>
<td>15%</td>
<td>12%</td>
<td>8%</td>
</tr>
</tbody>
</table>
- Risk as uncertainty of future cash flows (once the plant has been build)
- PPA (or long term contract) reduce significantly the variability of future cash flows
- Investors could be interested in this cash flow profile? At which discount rate?
- What could be the premium that they are willing to give-up for it?
StDev of construction costs is of a similar magnitude of electricity market risk (Medium and High scenarios)
Risk can be defined as the probability that the NPV of the project is negative (shortfall risk) – risk that the revenues are insufficient to cover the costs.
The model allows us to estimate the shortfall risk for a nuclear new build

- PPA reduce the shortfall risk

- Still to determine what is the value of this risk reduction for an investor (cost of capital and/or NPV)
**Impact of financial leverage (I)**

- APV = Value if all equity financed + PV of Tax shield on debt.
- Leverage increases the NPV of a project
- Leverage increases risk for both bond- and equity-holders
Impact of financial leverage (II)

Risk for a bond-holder

No changes in construction costs, no construction delays; electricity market risk—base case)

- Metric for risk: the net cash flow to the firm is insufficient to meet debt obligations at least once in the project lifetime.
**Risk for a bond-holder**

- At low debt ratios risk for bond-holders is rather limited, even for unexpected electricity price falls.
- At 70% DR and above, electricity market risk for bondholders starts to be significant.
- Take into account the risk of cost overruns and construction delays (to be done).
- Are other metrics for risk more appropriate?
- Still to determine the respective risk for an equity holder.
Conclusion

- With current electricity market prices (and overnight costs) no new nuclear build could be envisaged in continental Europe without strong governmental support.

- PPA (CfD) reduce the risk for investors (both equity and bond-holders), and thus the opportunity cost of capital.

- Risk for bondholders is very limited at low debt ratios (30-50%) even under adverse electricity market conditions.
  At higher leverage, bondholders assume a part of project risk.

- Stochastic models give a good representation of investor’s risks in a NPP project (but as in all models results are as good as the assumptions taken).
Thank you for your attention
### Technical assumptions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant size [MWe]</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Construction Time [years]</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Plant operation life [years]</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Load Factor [%]</td>
<td>85%</td>
<td>Stochastic</td>
</tr>
</tbody>
</table>

### Economic assumptions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overnight Cost (Real) [€/kWe]</td>
<td>4186</td>
<td>Stochastic</td>
</tr>
<tr>
<td>Decommissioning cost - fraction of overnight</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Total O&amp;M Cost [€/kWh]</td>
<td>10.57</td>
<td></td>
</tr>
<tr>
<td>Fraction of fixed O&amp;M Costs</td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>Fuel Cost [€/kWh]</td>
<td>4.72</td>
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<tr>
<td>Back-end Costs [€/kWh]</td>
<td>1.58</td>
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</tr>
<tr>
<td>Average electricity prices [€/MWh]</td>
<td>54.78</td>
<td>Stochastic</td>
</tr>
</tbody>
</table>

### Financial assumptions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate</td>
<td>2%</td>
<td>Parameter</td>
</tr>
<tr>
<td>Increase in electricity prices</td>
<td>2%</td>
<td>Parameter</td>
</tr>
<tr>
<td>Opportunity cost of capital</td>
<td>5% to 15%</td>
<td>Parameter</td>
</tr>
<tr>
<td>Cost of debt</td>
<td>5% to 7%</td>
<td>Parameter</td>
</tr>
<tr>
<td>Debt ratio</td>
<td>30% to 70%</td>
<td>Parameter</td>
</tr>
<tr>
<td>Tax rate</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>Debt repayment (years)</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Depreciation length (years)</td>
<td>15 (MACRS)</td>
<td></td>
</tr>
</tbody>
</table>
Rates of return

* Source: Brealey and Myers, “Principles of corporate finance” 7th ed.
OECD/NEA Workshop on “Electricity price and Nuclear New Build”, Paris, 19 September 2013