# Rethinking Renewable Energy Auctions: Revenue Stabilisation

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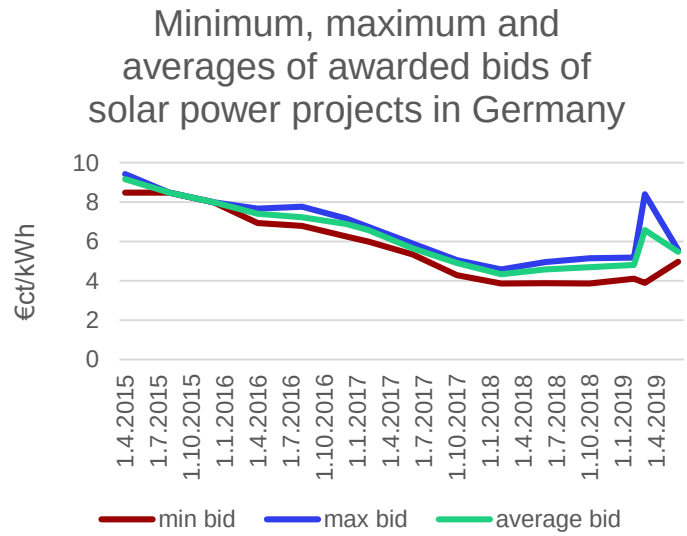
16th IAEE European Conference, Ljubljana, 25. - 28. August 2019
Energy Challenges for the Next Decade

# Background & Research motivation

- RES support:
  - administratively set feed-in tariffs/premiums are phasing out
  - auctions become dominant policy instruments for setting support levels for renewable energy projects
  - bid prices are significantly below former feed-in tariffs/premiums
  - examples of zero-subsidy bids for sliding premiums in German and Dutch wind offshore projects

- Question: Without required support  payments – will auctions become obsolete?




Source: Bundesnetzagentur 2019

# Research idea: Potential future policy reorientation

- Mechanisms to ‘stabilise’ revenues rather than ‘provide’ revenues
- Although level of support payments becomes less important due to falling costs, exposure to uncertainty remains / increases
- Volatility of revenues has impacts on liquidity and thus on:
  - Risk profile of investment
  - Loan conditions, incl. debt capacity
  - Investment decision

- PPAs and hedging are not always an option

→ additional measures are necessary to assure debt service → liquidity management

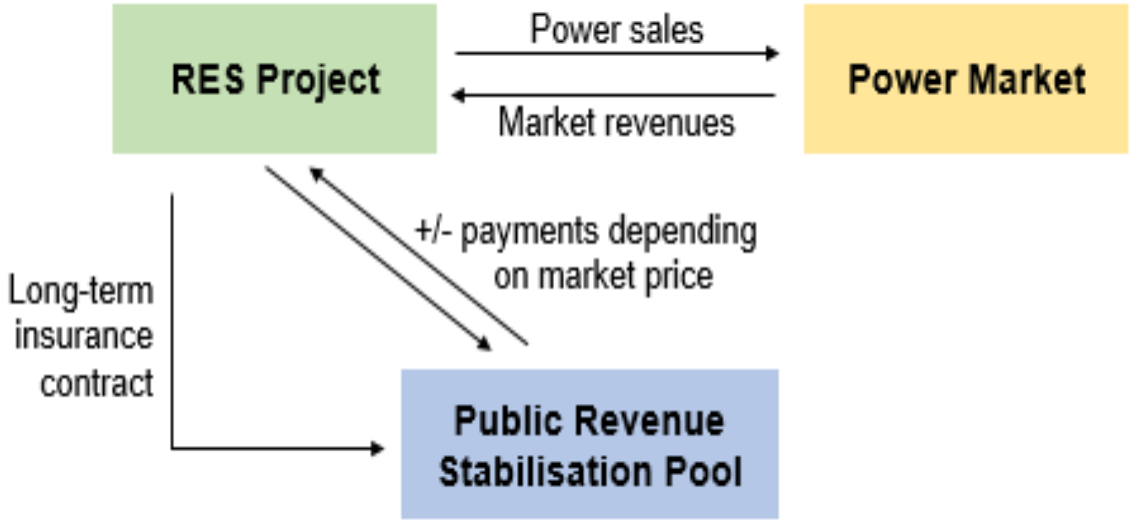
- Auctions may be used to granting access to this „liquidity“, i.e. insurance-type reserve pool

# Research Topic: Revenue stabilisation

- Different liquidity management options:
  1) project internal cash flows
  2) public reserve pool
  3) commercial reserve pool, e.g. by bank

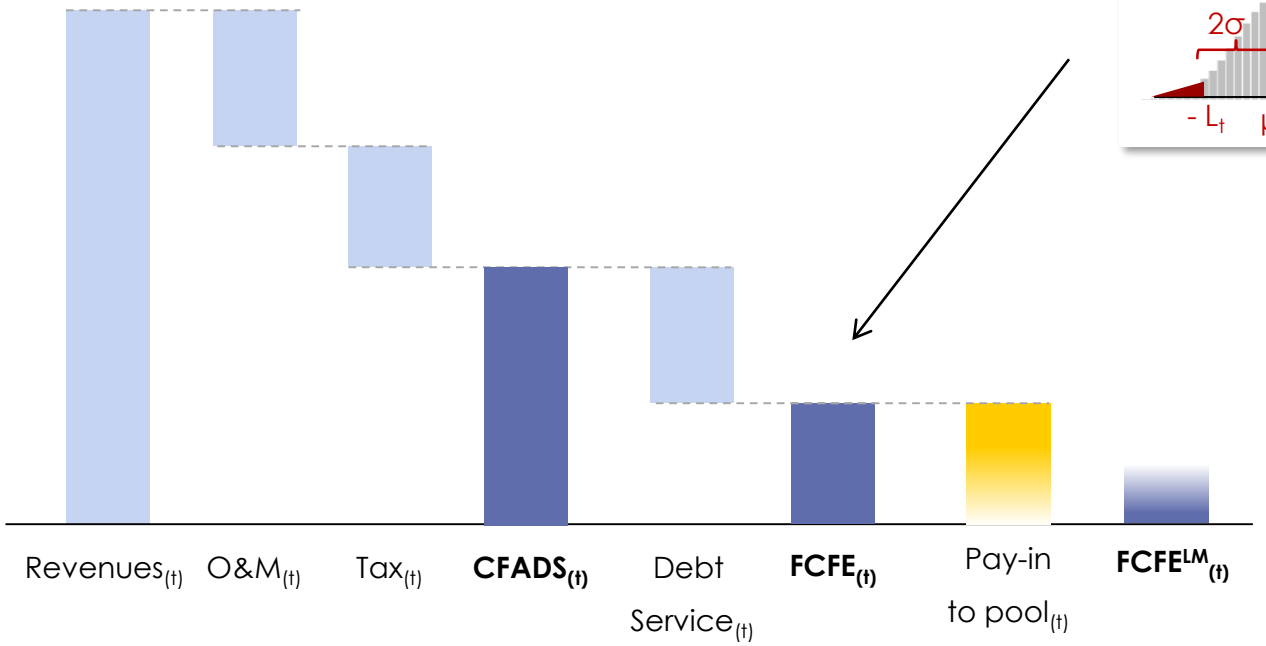
- Indicator: debt capacity, i.e. maximum feasible debt share

- **Research question: Can a public revenue stabilisation pool enable higher debt capacity and reduce default risk?**



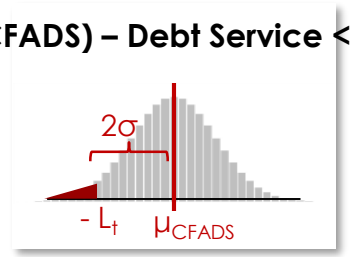
# Research approach: Liquidity Management

**Cash waterfall – operating phase**




**Probabilistic forecast of next years' cash flows**

**E(CFADS) – Debt Service < 0?**




Amount of pay-in to pool depends on the expected liquidity requirements at 2σ-confidence level

# Research approach: Liquidity Management

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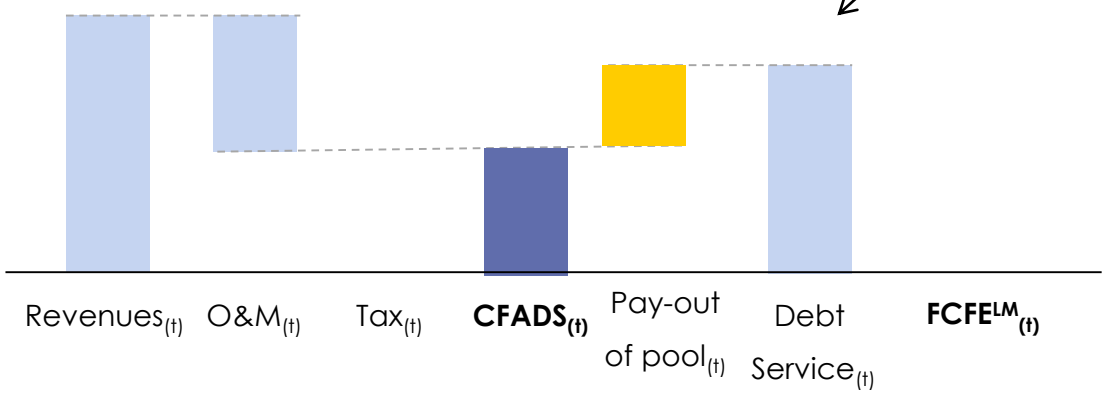


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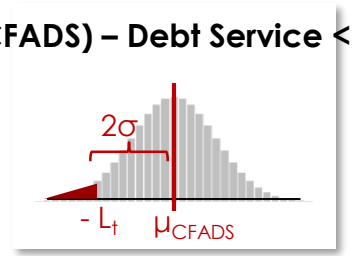
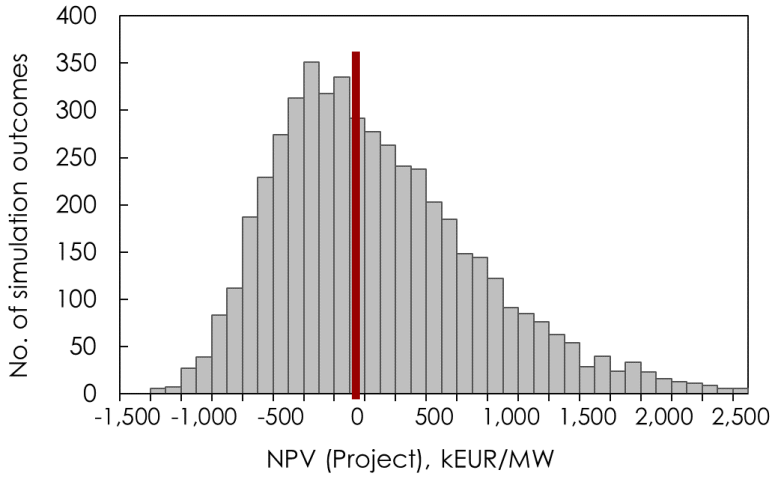


# Method: Approach

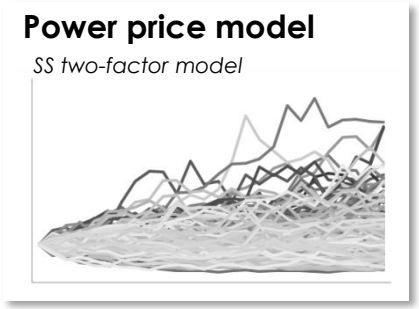
- Liquidity management approach and restrictions:
  – reserves to cover 95% confidence interval of financial distress ($E(CFADS)_t$ – $Debt\ Service_t < 0$ )
  1) Full market exposure: no liquidity management (reference)
  2) Liquidity management at project level: reserves only from earlier project cash flows
  3) Public liquidity reserve pool: net zero payments ($\sum_{t=1}^{T} L_t^{IN} = \sum_{t=1}^{T} L_t^{OUT}$)
  4) Private liquidity reserve pool: as 3), plus interest payments for short term 'loan' from pool

- Application case:
  - Future offshore wind park in Germany
  - Modelled on cost & price assumptions for a park commissioned in 2025
  - Expectedly at the threshold to be profitable without net support payments ($NPV_{(project)} \approx 0$)
  - Annual price and production variations



# Method: Stochastic model

- Stochastic cash-flow model, multi-year, Monte-Carlo simulation
  - Two-factor power price model (Schwartz-Smith)

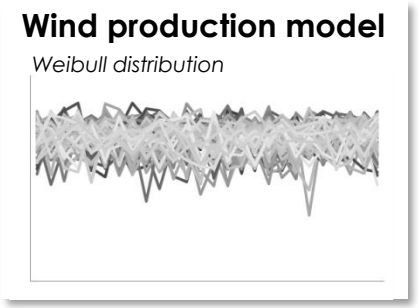



$$\ln(S_{t+\Delta t}) = \xi_{t+\Delta t} + \chi_{t+\Delta t}.$$

Implementation after Davis (2012)

$$S_{t+\Delta t} = \exp\left(\xi_t + \mu_\xi \Delta t + e^{-\kappa \Delta t}\chi_t\right) \exp\left(\sigma_\xi \sqrt{\Delta t}\varepsilon_t + \sigma_\chi \sqrt{\frac{1-\exp(-2\kappa\,\Delta t)}{2\kappa}}\varpi_t\right)$$

  - Stochastic wind power generation using Weibull distribution

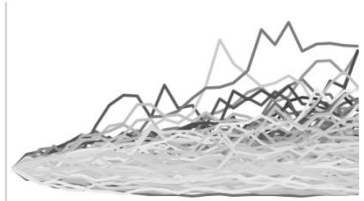



$$q_t = P\lambda(-\ln(1-\varepsilon_t))^{\frac{1}{k}}$$

# Method: Stochastic cash flow simulations

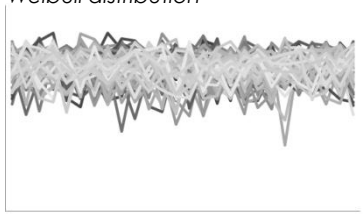
**Power price model**

*SS two-factor model*



**Wind production model**

*Weibull distribution*



**Cash flow model**

**Operating cash flow**
- Revenues $R_t$ (… for all years $t=0$ …$T$)
- Operational cost $C_t$
- Interests $\Theta_t$
- Payable Tax $T_t$

**Cash flow from investment activity**
- Capital expenditures $I_t$

**Cash flow available for debt service *CFADS*$_t$**
- Withdrawals from reserve fund $L^{IN}{}_t$
- Debt Service $DS_t$

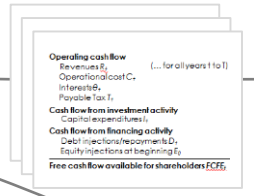
**Free cash flow available for shareholders *FCFE*$_t$**
- Injections into reserve fund $L^{OUT}{}_t$

**Free cash flow after liquidity management *FCFE*$_t^{LM}$**
- Cost of equity

**Sum of discounted *FCFE*$_t^{LM}$**

**= 'Value to Shareholders' *SHV***

**Monte Carlo Simulation**



**Quantile analysis**

***Maximum debt share***

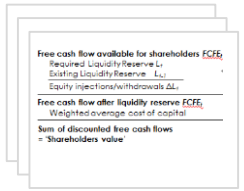
**E(DSCR;P75) > 1**

***Reserve requirements and potentials***

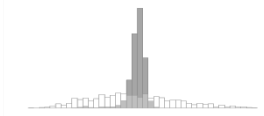
**E(DSCR; 2σ) > 1**

$\sum_{t=1}^{T} L_t^{IN} = \sum_{t=1}^{T} L_t^{OUT}$

**Monte Carlo Simulation**

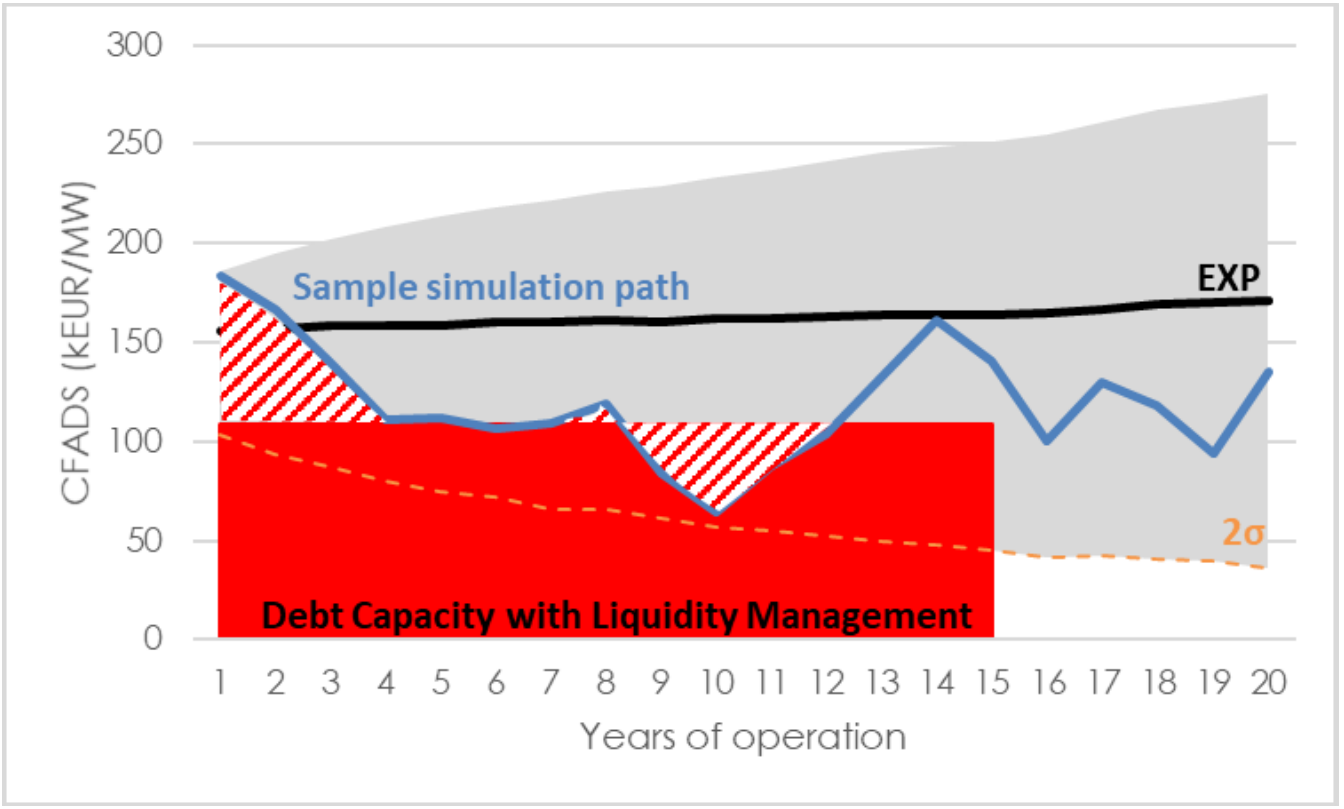


**Default probabilities and shareholder values**



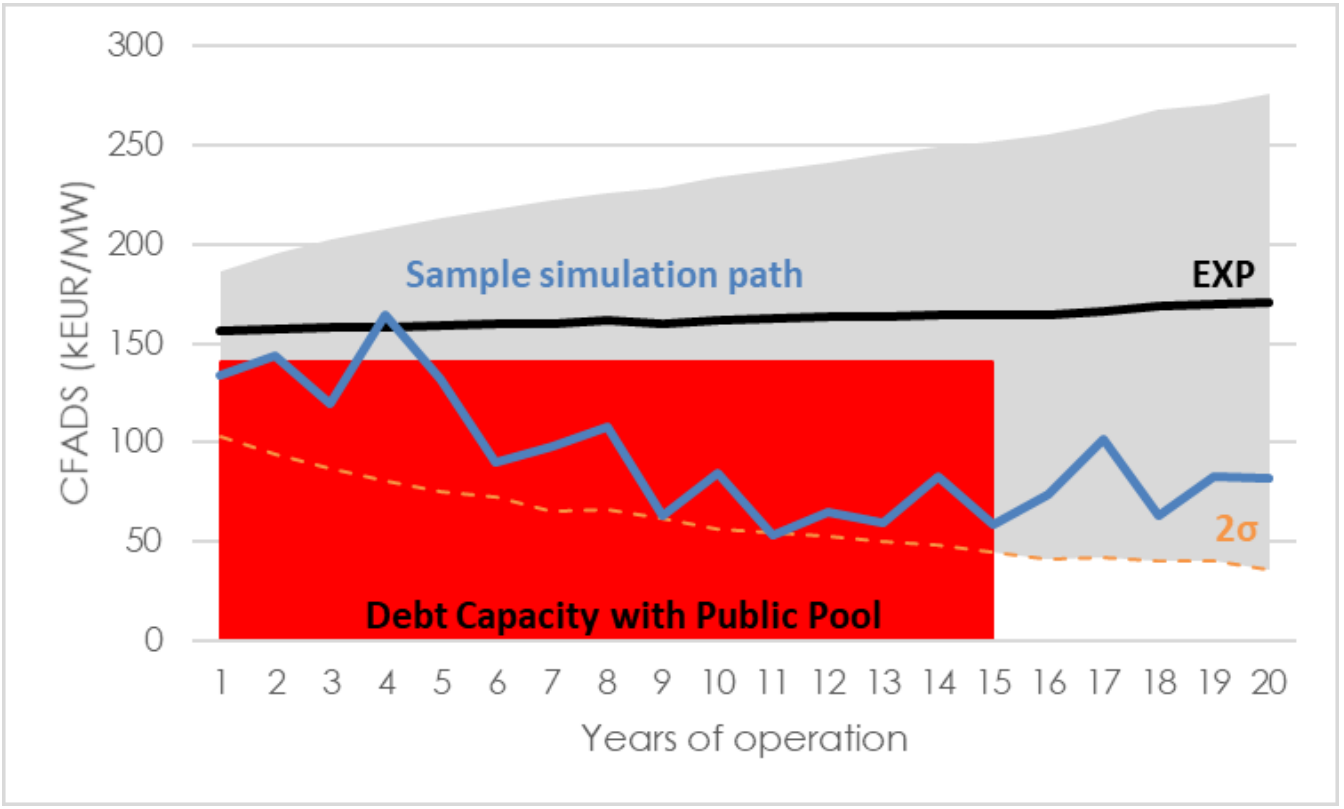
# Results: Debt capacities

| Scenario | Max. debt capacity |
|---|---|
| Full market variability (as reference) | 54.0% |
| | |
| | |
| | |



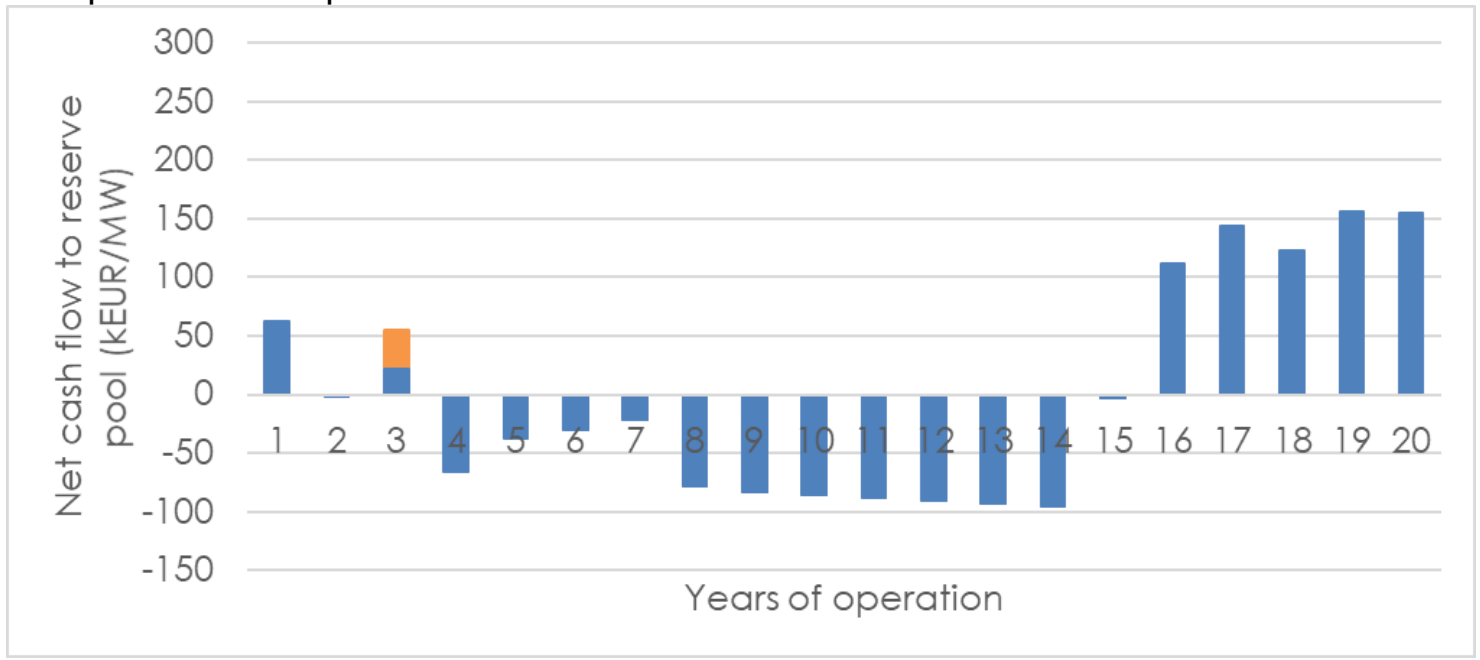
# Results: Debt capacities

| Scenario | Max. debt capacity |
|---|---|
| Full market variability (as reference) | 54.0% |
| Liquidity management at project level | 61.4% |
| | |
| | |



# Results: Public vs. private reserve pool

Sample simulation path



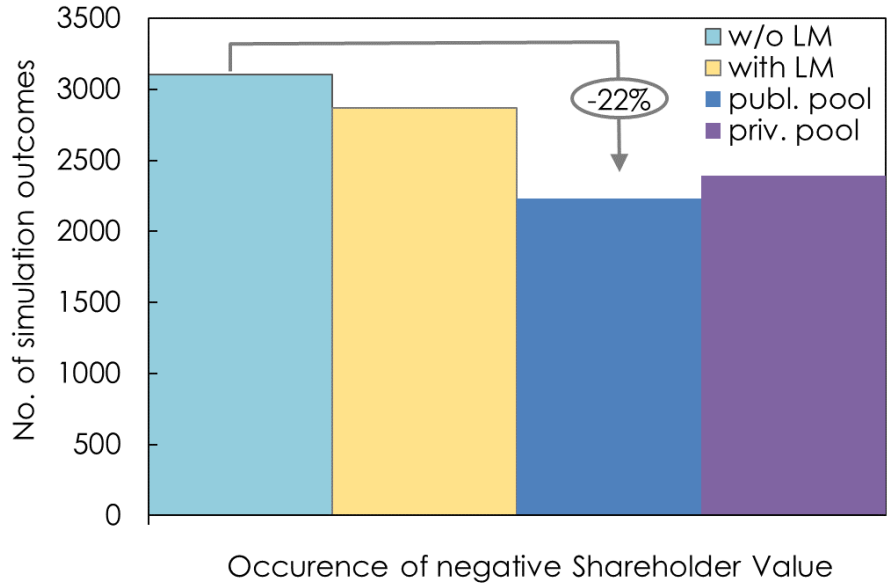

→ Sum of all nominal payments is zero

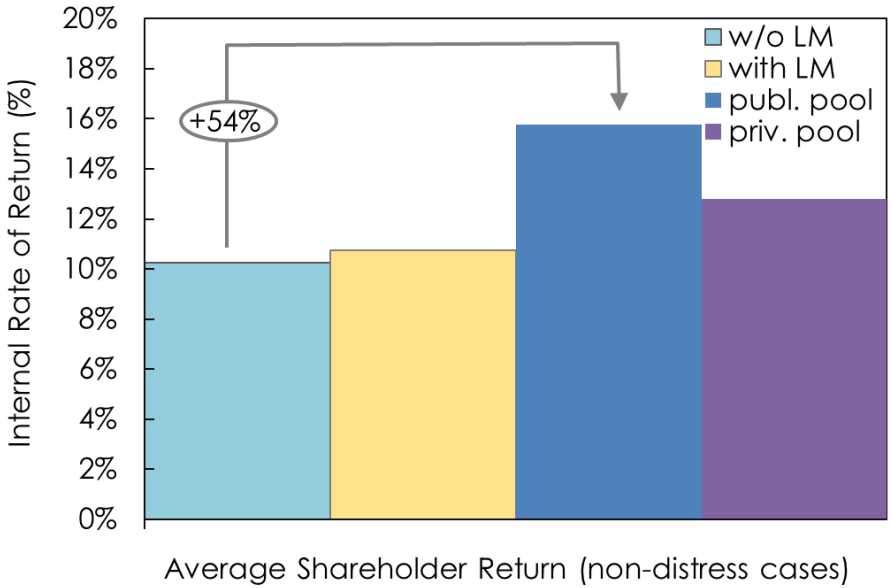
→ Short term interest payments increase reserve requirements and shift them in time

Open issues to be investigated:

- Injection requirements and timing
- Financing of public pool (sufficient portfolio effect?)

# Results: Shareholder value



# Conclusions

- Our conclusion
  - Liquidity reserve pools enable higher debt shares & more attractive investments
  - Public reserve pools seem an appropriate vehicle to provide liquidity (to be investigated further)
  - This will ensure future RES deployment at low LCOE & net zero support

- Next steps in the research
  - Shorter time horizon for liquidity management (monthly?)
  - Implement a mixture of strategies (internal liquidity management plus pool)
  - Overall financing of the public pool (modelling of all injections and withdrawals)

- Policy implications
  - In the past, revenue stabilisation was a ‘side effect’ of support schemes (e.g. FIT)
  - Currently, we are in a transition phase using auctions for the allocation of support, with ever lower shares of ‘secured’ revenue -> *financing becomes an issue*
  - There is a case for establishing public liquidity reserve pools (insurance-type scheme) - Auctions could be a vehicle to provide access

# Time for Questions & Comments