KU LEUVEN

Facilitating variable generation of renewables by conventional power plant cycling

Costs and benefits

Kenneth Van den Bergh and Erik Delarue
University of Leuven (KU Leuven)

ENERDAY, Dresden

Introduction

The framework

Intermittent renewables

- ✓ Partly unpredictable
- ✓ Variable in time

Need for flexibility

- ✓ Power plant cycling
- ✓ Renewables curtailment
- ✓ Storage
- ✓ Transmission
- ✓ Demand response

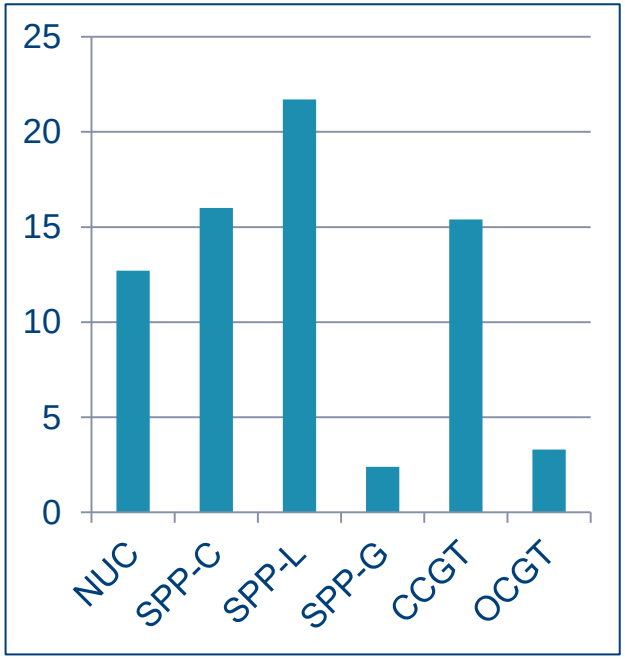
What is the operational cost in a power system with variable renewables?

KU LEUVEN

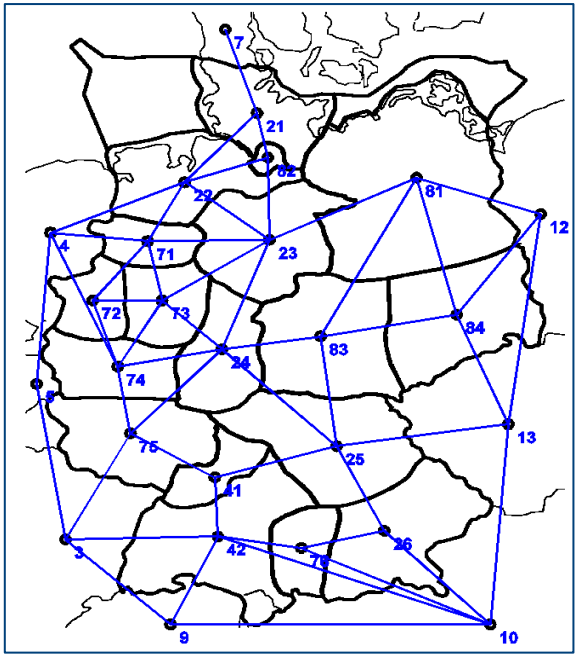
Methodology

System description - Germany 2013

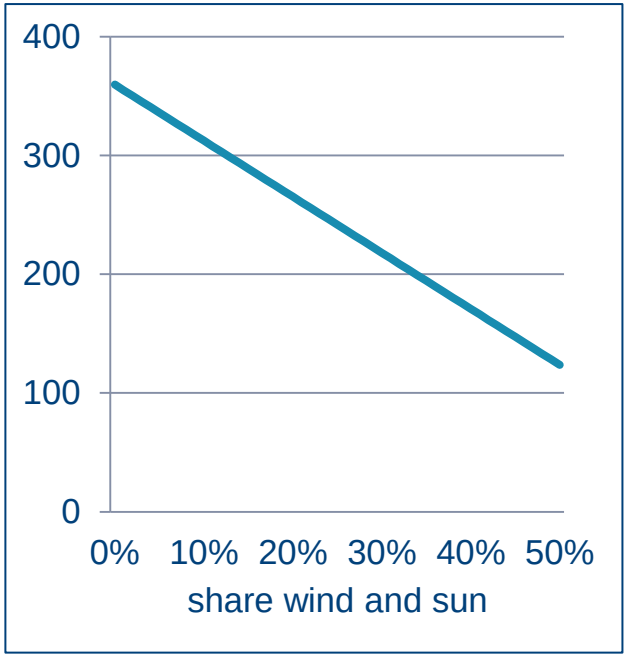
Installed conventional capacity [GW]



Electricity grid



Residual load [TWh/y]



Methodology

Model description - unit commitment model

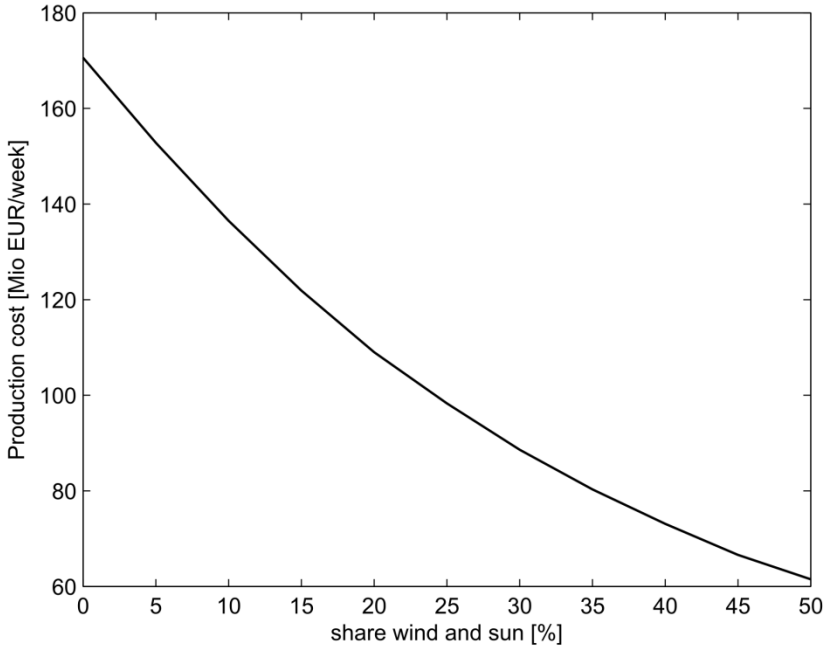
- Pure operational (quarter-hourly time step)
- Deterministic approach
- Minimization of operational system cost
  - s.t market clearing
  - s.t. technical constraints (power plants, electricity grid)
- Formulated as mixed-integer linear program

KU LEUVEN

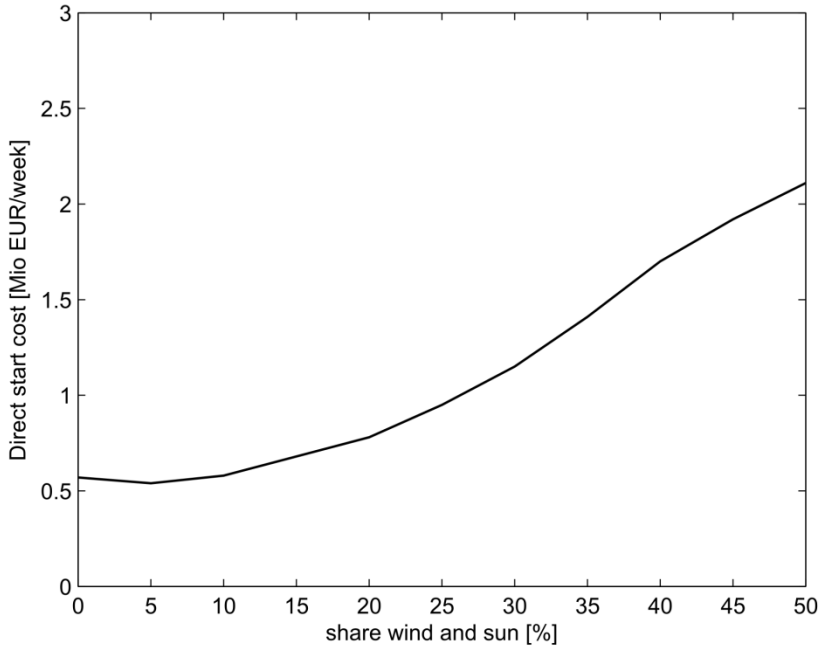
Results

The operational system cost

Production costs



Cycling costs (only direct start cost)

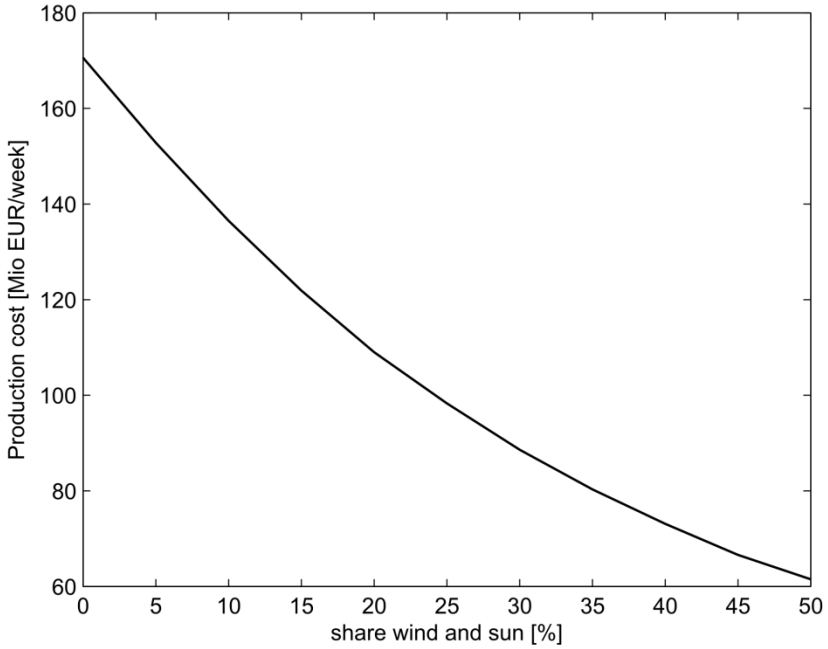


KU LEUVEN

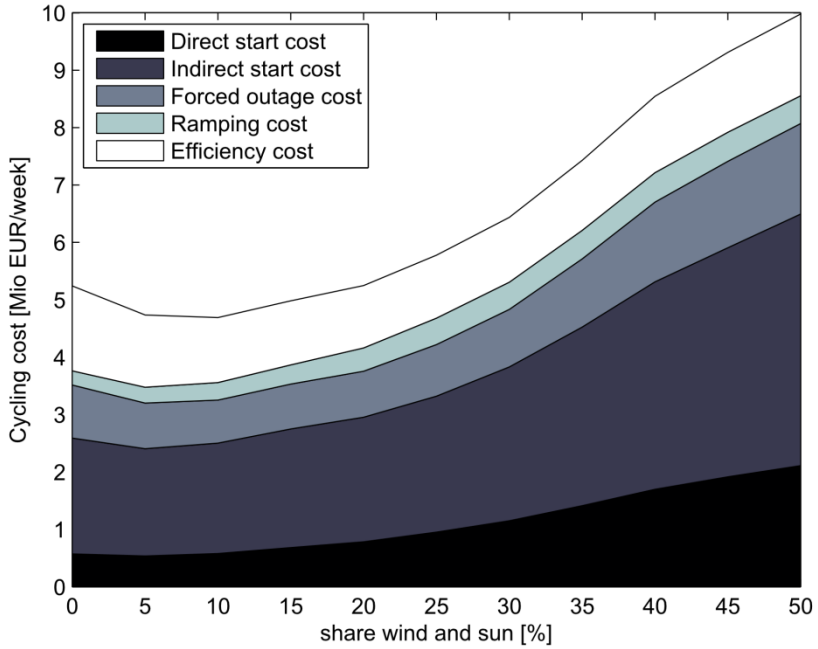
Results

The operational system cost

Production costs



Cycling costs (all costs ex-post)

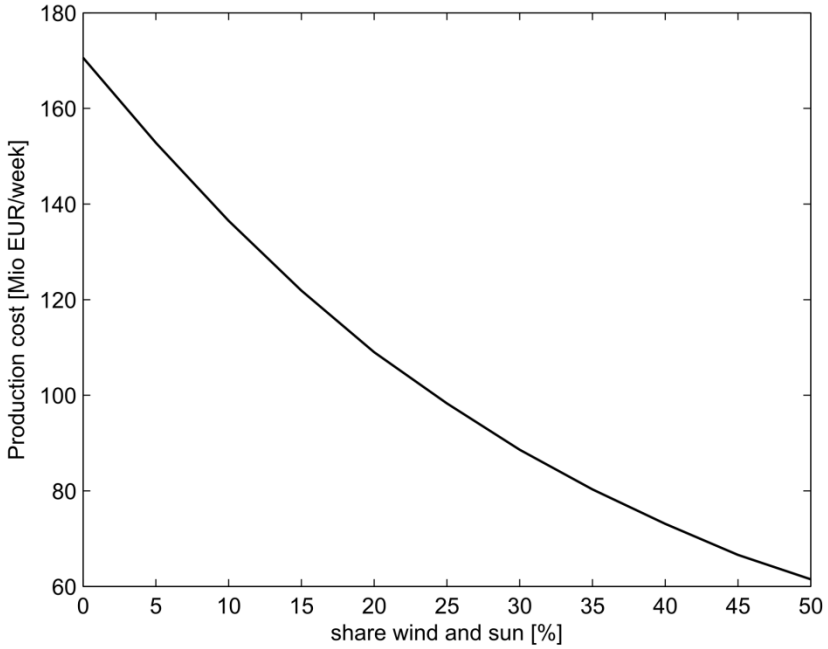


High dynamic portfolio

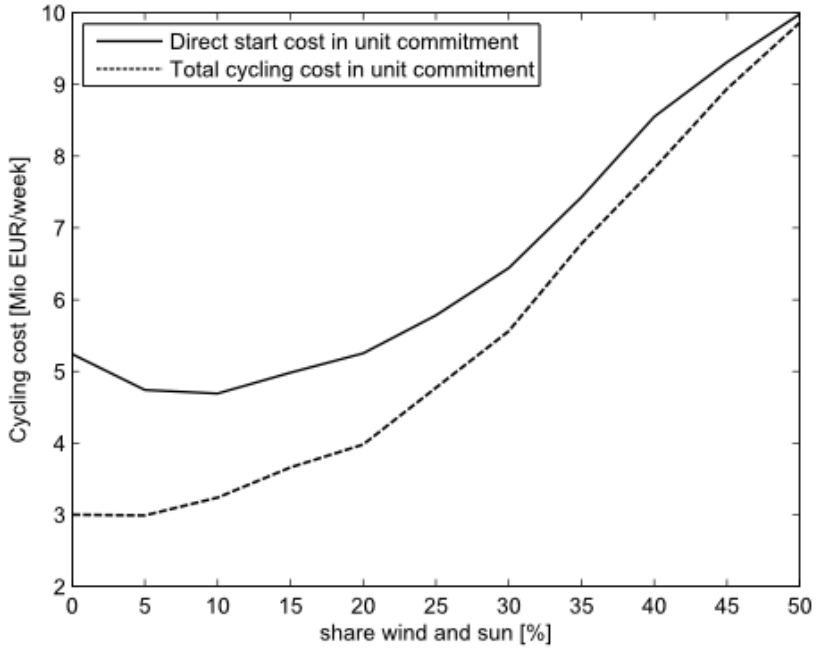
Results

The operational system cost

Production costs



Cycling costs (all costs in optimization)



Conclusions

From a system perspective, renewables decrease operational generation costs.

Analyzing the costs and benefits of renewables, it is important to be clear on

- system perspective versus utility perspective;
- operational perspective versus investments perspective.

Appendix

Introduction

Variability of intermittent renewables

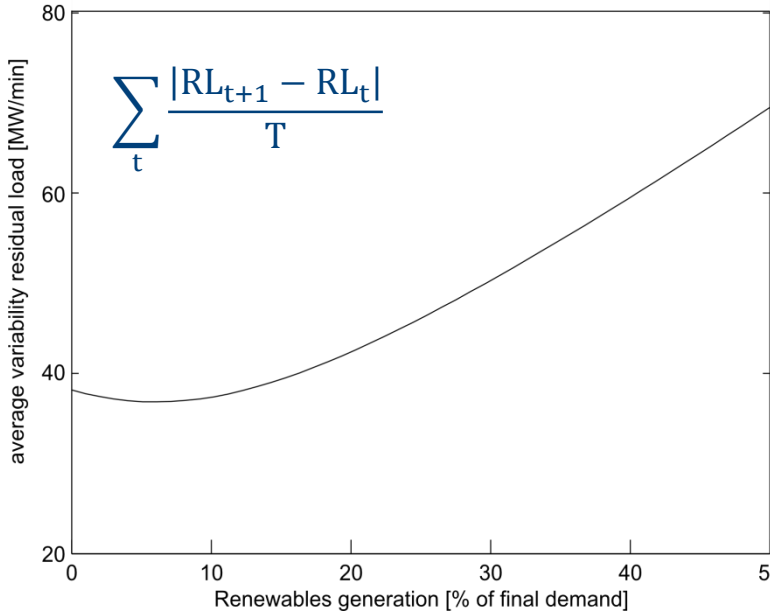
Intermittent renewables

- ✓ Partly unpredictable
- ✓ Variable in time

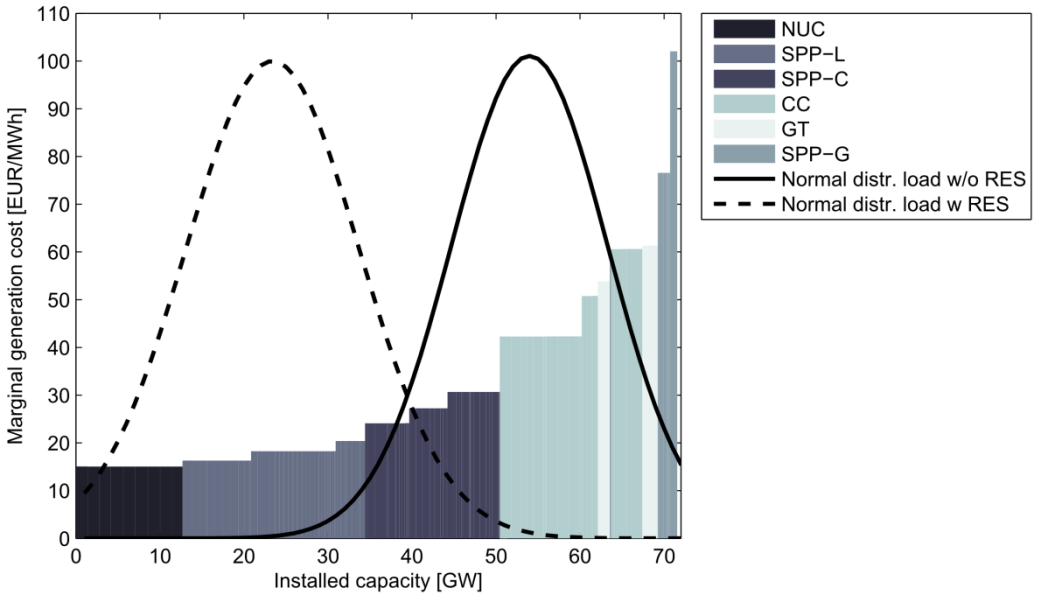
Need for flexibility

- ✓ Power plant cycling
- ✓ Renewables curtailment
- ✓ Storage
- ✓ Transmission
- ✓ Demand response

Increased variability in residual load



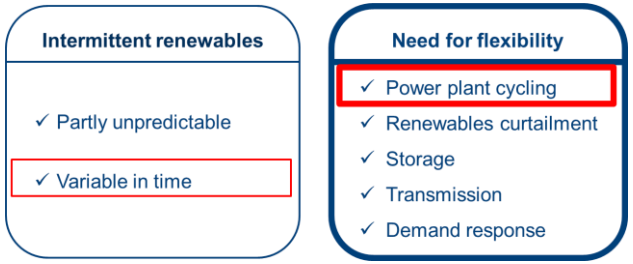
Decreased magnitude of residual load



Based on data for Germany 2013

Introduction

Cycling of conventional units



Cycling costs

1) Direct start costs
2) Indirect start costs
3) Forced outage cost
4) Ramping cost
5) Efficiency cost

↓

average values used

Technical parameters

1) Minimum power output
2) Ramping constraint
3) Minimum up and down times

↓

low and high dynamic portfolio

Source: Kumar et al.; NREL (2012)

Source: DIW Berlin (2013)

KU LEUVEN