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The Value of Gas Engine Power Plant Flexibility

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Introduction

Flexibility describes the capability of a generation unit to follow the variations in electricity demand and its ability to respond possible uncertainties. This study focuses on gas engine power plant technology and the beneficial influence its flexible operation can have on a power system. Both electricity and reserve productions are considered.

Gas Engine Power Plant

The plant has a modular structure with several prime movers and a possible steam turbine to exploit the waste heat, i.e, combined cycle gas engine (CCGE). The modular structure enables optimized part-load efficiency and low minimum generation level.

Technical parameters of a CCGE plant capable of operating in single cycle (SC) and combined cycle (CC) modes. The plant can start the engines to full output within 5 min and the steam turbine within 45 min.

Max Gen	Min Gen	Efficiency	Start time	Stop time
60-700 MW	~3 % of Max Gen	SC: 47 % CC: 50 %	SC: 5 min CC: 45 min	1 min

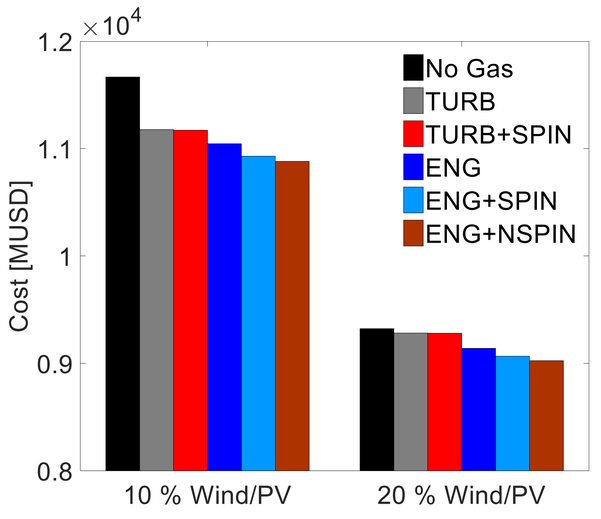
Methodology

The value of CCGE is investigated by simulating the operation of a power system in PLEXOS. The software enables a techno-economic presentation of system's generation mix and optimizes the best generation mix to supply the hourly electricity demand.

Results

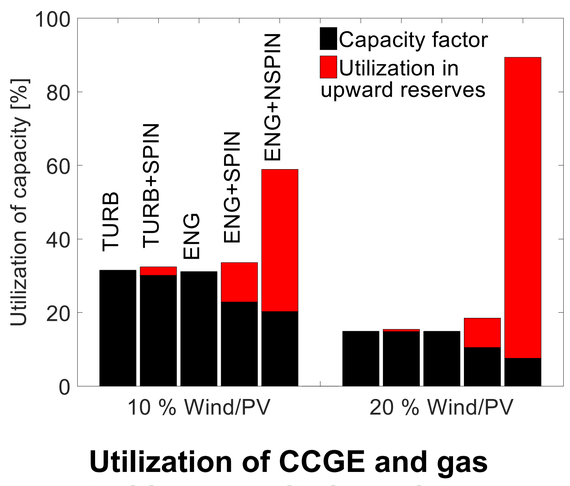
The thermal generation dominated system of South Africa (peak load 68 GW) is simulated over a year. 3 GW of either CCGEs (ENG) with 50 % efficiency or combined cycle gas turbines (TURB) with 55 % efficiency is installed to the system.

Owing to the flexibility of CCGEs, they reduce the operation cost more compared to the turbines. The rapid start-up enables CCGEs to produce a part of the reserves from non-spinning state, which further reduces the cost.

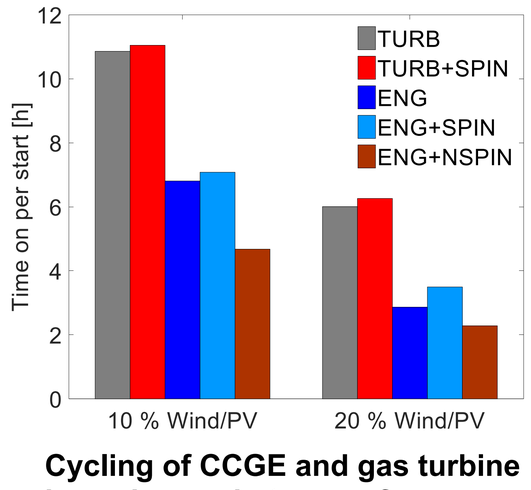


Yearly power system operation cost for two Wind/PV penetrations. SPIN and NSPIN stand for ability to produce spinning and non-spinning reserves, respectively.

CCGE capacity is effectively utilized in reserve production while it is economical to start-up for a short time period.



Utilization of CCGE and gas turbine capacity in each case.



Cycling of CCGE and gas turbine in each case in terms of average on time per start-up.

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