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Development of a System Dynamics Model for a Utility Revenue Evaluation under Distributed Energy Resources

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PRESENTATION OUTLINE

- Introduction
- Problem statement
- Aim of the study
- Literature review
- Research method
- Case study, results & discussion
- Concluding remarks

INTRODUCTION

- The fourth industrial has change how business is done across the world.
- It has also improve renewable energy technology deployment.
- There has been a stead reduce in the cost of renewable energy systems, especially solar systems.
- We now have more households that own their electricity generating systems.

Problem Statement

- Cut-down on non-renewable energy resource for power generation.
- Increased availability of distributed energy resources.
- Increased in energy theft.
- Increased in energy poverty.
- Increased household disconnecting from national grid.

Aim of the Study

- To study the impact of distributed energy resources on utility firms' revenue.

Literature Review

S/n	Authors	Contributions
1	(Turan et al., 2001)	Developed an SD model that evaluate electricity gap in Turkey.
2	(Hasani & Hosseini, 2011)	Used a SD model to determine the profitability of a utility firm based on expected cost of energy.
3	(Ahmad & bin Mat Tahar, 2014)	Analyzed the contributions of renewable energy policy on energy generation at national level.
4	(Feofilovs et al., 2018)	Developed a SD model for energy storage problem in oil and gas industry.

Research Method

- This study uses system dynamics (SD) modelling approach to achieve its aim.

- SD uses the interrelationship among system parameters to simulate a system’s performance.

- Here, the relationship between actual and perceived system’s parameters are considered.

System’s Parameters

- Quantity of energy produced and demanded
- Surplus electricity
- Energy revenue

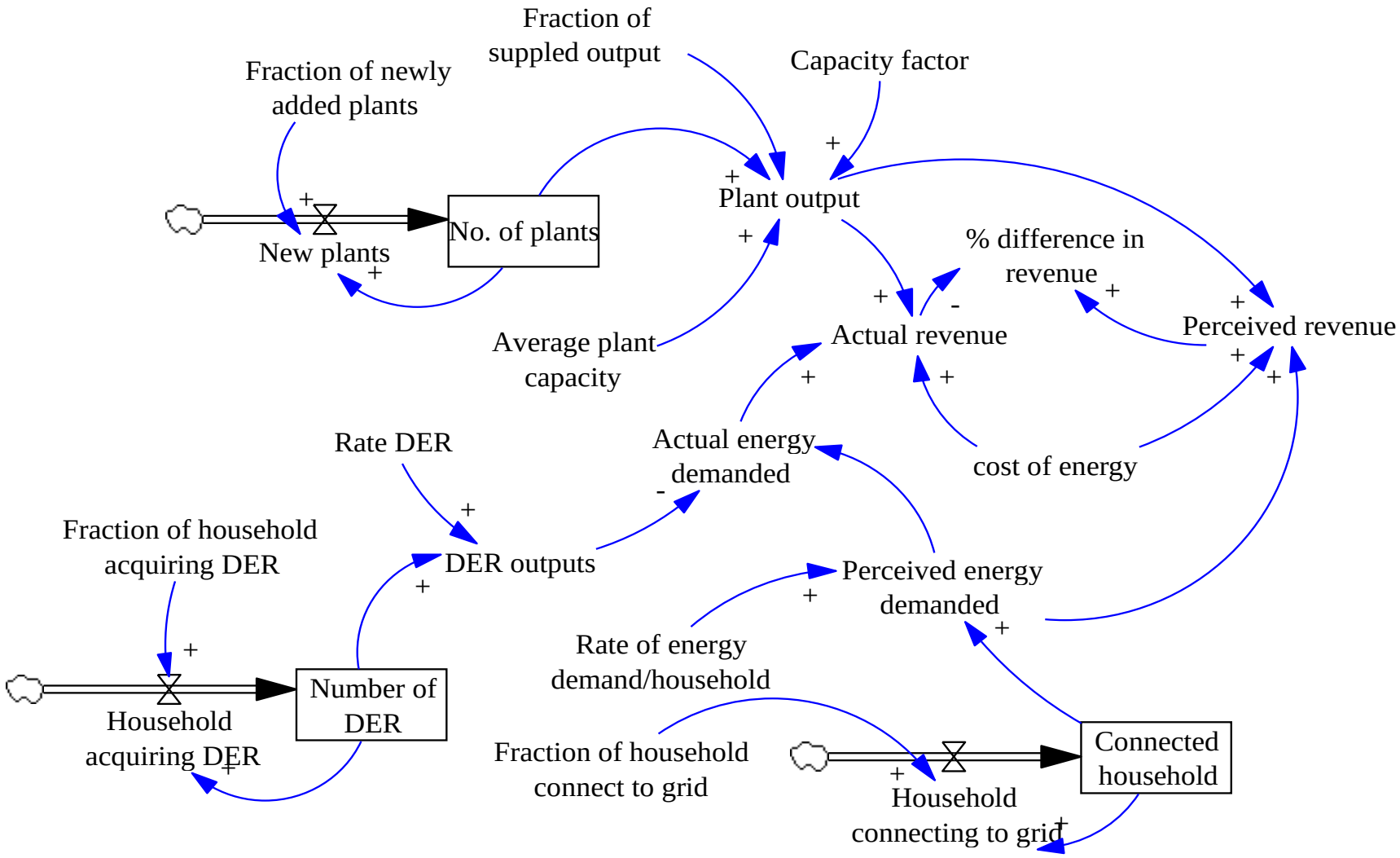

Figure 1: Proposed SD model

Case Study

- The proposed SD model performance is evaluated based on data sets in South Africa.
- The electricity price is taken as 1kWh @ 89c.
- Estimated rate of electricity demand per month for a household of four people is 1233kW.
- To simulate a utility firm revenue, it was assumed that the firm uses five gas turbines of 350MW, with a 90% capacity factor.
- 5000 households.

Results

- The firm's average electricity supply is 1,123,496kW / yr.
- The actual average electricity demand is 1,133,985kW/yr.
- The perceived average electricity demand is be 1,137,548kW/yr.

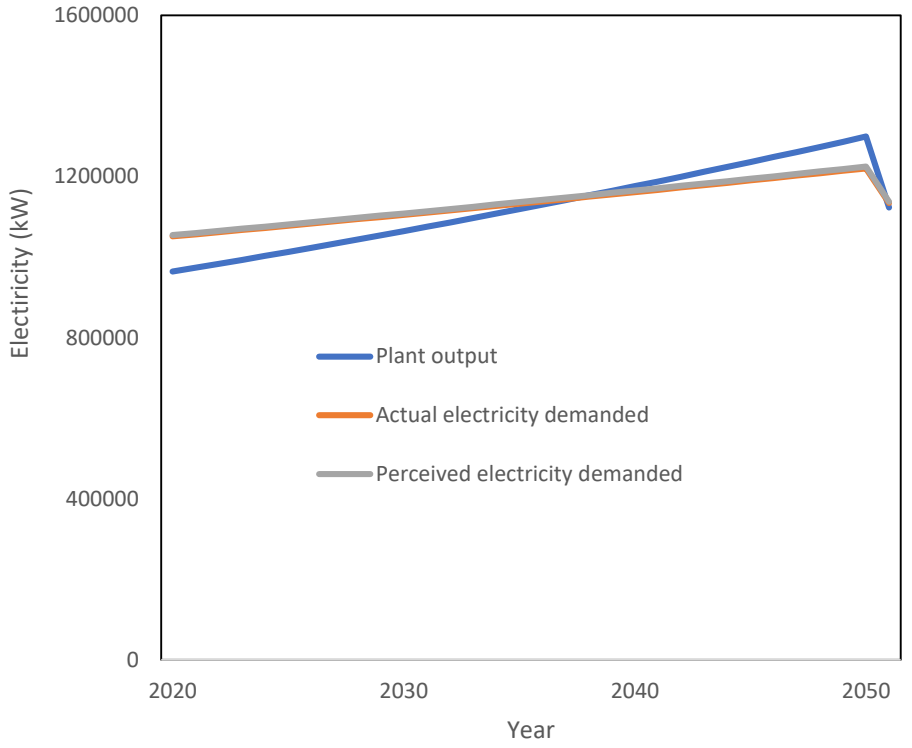

Figure 2: Quantity of electricity produced and demanded (kW)

Results

- The actual average electricity shortage is 46,875.56kW.
- The actual average electricity surplus is 39,891.54kW.
- The perceived average electricity shortage is 47,554.74kW.
- The perceived average electricity surplus is 38,992.50kW.

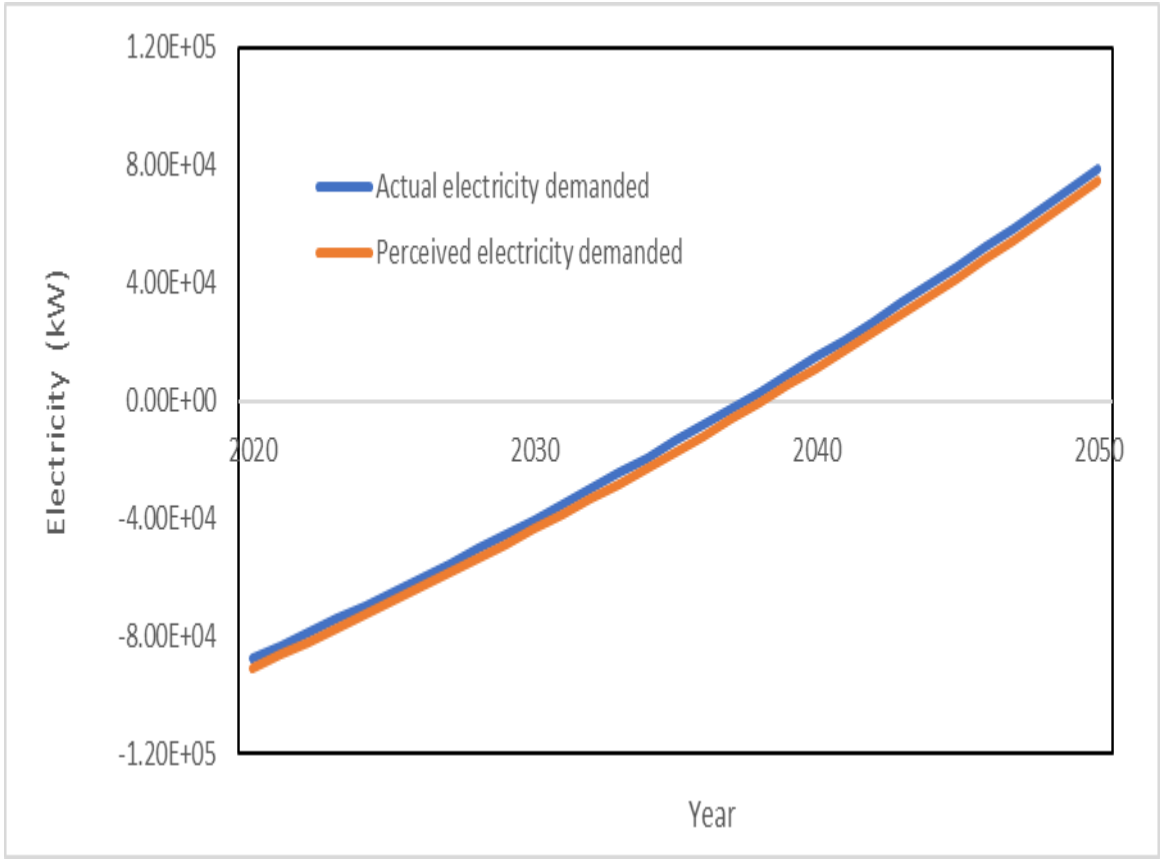

Figure 3: Average energy shortage and surplus (kW)

Results

- The firm's actual revenues is R30, 536,000.00.
- The firm's perceived revenues is R31,814,000.00.
- The firm's actual average revenue is R985, 032.26.
- The firm's perceived average revenue is R1, 026,258.06.

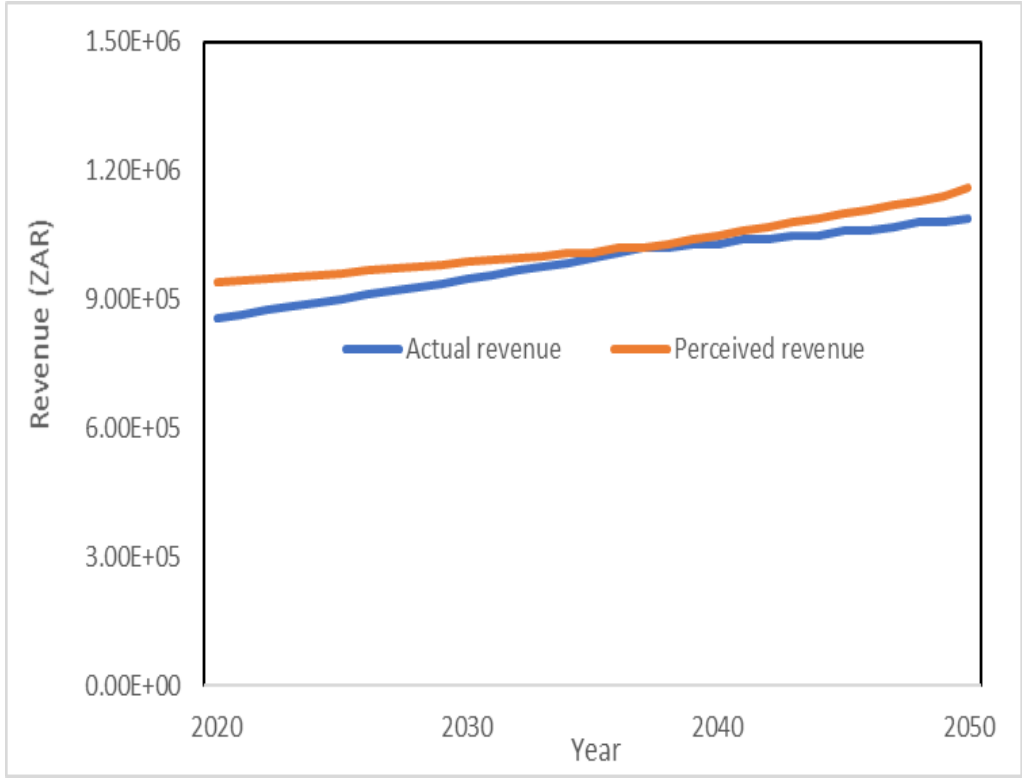

Figure 4: Electricity revenue (ZAR)

Results

- The first 38 years, there will be a decrease in the % difference between the actual and the perceived revenue.

- After 2038, the firm will experience a increase in the % difference between the actual and the perceived revenue.

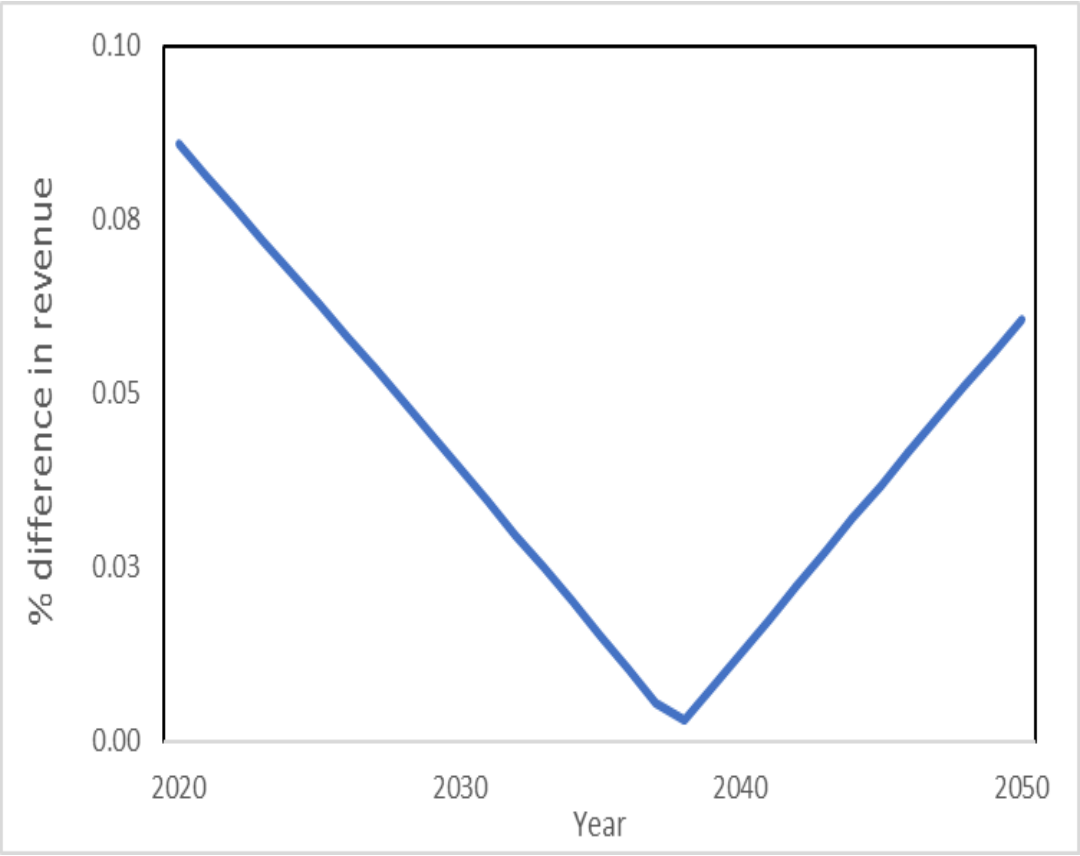

Figure 5: % difference between actual and perceived revenue

Concluding Remarks

- This study used system dynamics approach to study the impact of distributed energy resources on utility firms' revenue.

- Techno-economic and social parameters that affect utility revenue were considered.

- The model was able to determine the point at which a utility firm should reevaluate the amount of energy that is supplied to households.
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- The model showed that the impact of DER on utility revenue will decrease for specific periods, and then follows a steady increasing trend.

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