# A Neural Network for Electricity Demand Modeling: El Espino Case

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## 1 Introduction

The design and optimization of microgrids for remote areas face significant challenges due to limited electricity demand data availability and quality.

This study presents a neural network model that addresses these limitations by using external variables (e.g., time, day type, humidity and temperature) to estimate electricity demand.

This model provides a valuable tool to estimate electricity demand, supporting the design and the optimization of microgrids.

## 2 Method

The method involved:

- Data collection, preparation, and analysis
- Definition and implementation of the neural network architecture
- Performance comparison of four optimizers

This study utilized real data from El Espino, Bolivia (*Figure 1*), gathered over 578 days of electricity demand records, sampled at 5-minute intervals.

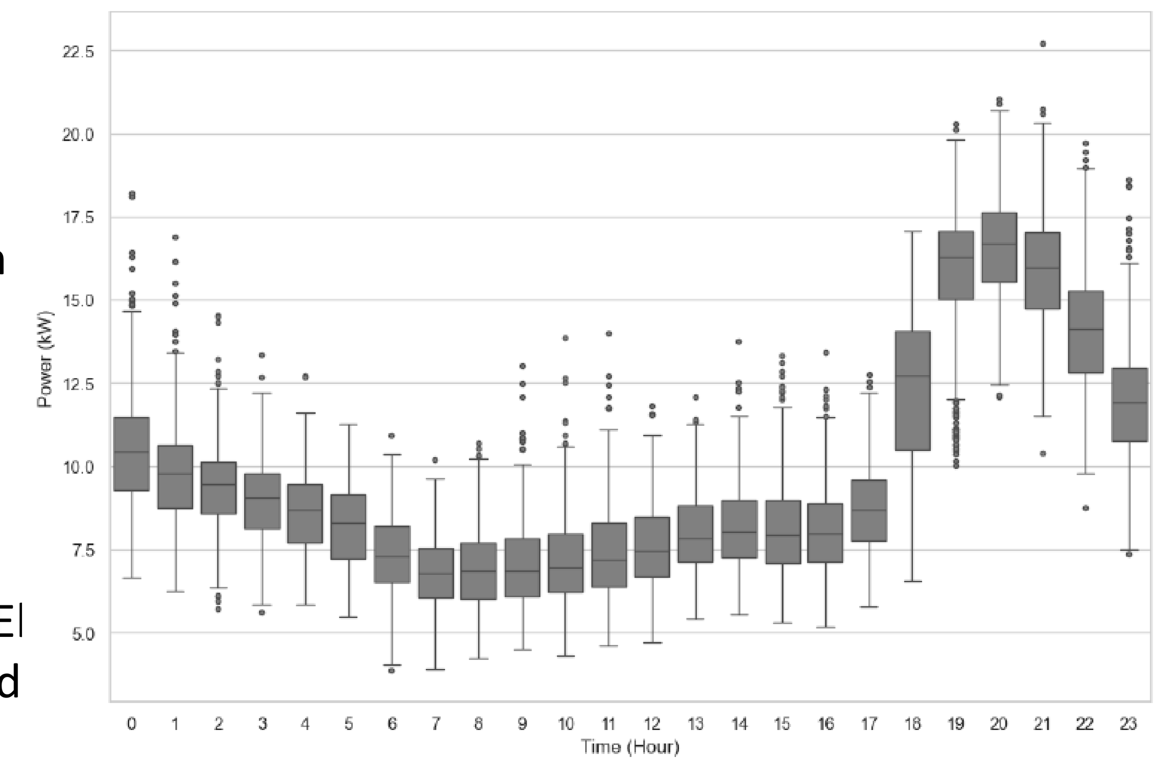


*Figure 1: Distribution of energy consumption per hour of the day*

## 3 Results

The neural network architecture comprised seven layers with Rectified Linear Unit (ReLU) activations and a batch normalization layer for stable scaling. Key input variables included time (Month and Hour), day type (working day vs weekend) humidity and temperature (*Figure 2*).

The study compared the performance of Adam, Adagrad, Adadelta, and Stochastic Gradient Descent (SGD) on key error metrics, including Mean Absolute Error (MAE) and Mean Squared Error (MSE), as shown in *Table 1*.

| | MAE | MSE |
|---|---|---|
| ADAM | 10,24% | 9,26% |
| ADAGRAD | 10,49% | 10,75% |
| ADADELTA | 13,94% | 14,13% |
| SGD | 12,69% | 13,59% |

*Table 1: Comparative Analysis of MAE and MSE Losses among Optimizers*

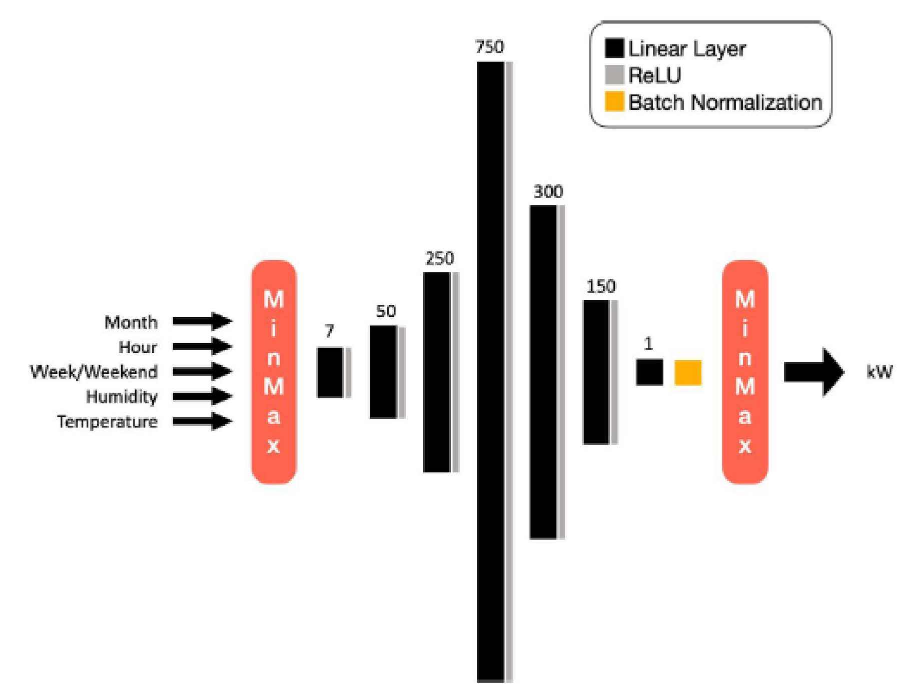


*Figure 2: Neural Network's Architecture*

Model training was conducted with 13,872 hours of data, divided into training, validation, and testing sets.

The Adam optimizer consistently achieved the lowest errors, with a MAE of 10.2% and MSE of 9.3%, indicating a high level of accuracy and stability. Its superior performance suggests that Adam is especially suitable for handling the non-linear and variable electricity demand data characteristic of El Espino.

## 4 Discussion

The neural network model, by moving beyond traditional demand modeling that relies on complete datasets, demonstrates robust performance in estimating electricity demand for remote areas, addressing the typical data constraints.

The inclusion of metadata, such as temperature and humidity, enables the model to provide reliable predictions despite data scarcity and variability.

However, certain limitations exist, such as a risk of overfitting due to limited datasets and the reliance on metadata accuracy.

## 5 Conclusion

This neural network model provides a reliable and innovative method for estimating electricity demand in remote areas, achieving an accuracy rate close to 90%.

Future work could incorporate additional factors, such as solar radiation, and the same method could be extended to other regions with electricity demand data available. Notably, the model can be applied to locations with similar characteristics even where continuous data is sparse, making it a flexible model for demand estimation.

This work has important implications for microgrid design and optimization, offering practical solutions for demand estimation in remote areas.

## References

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