An electricity consumption forecasting model for Albania based on the LSTM artificial neural network.

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"In the end we retain from our studies only that which we practically apply".

Johann Wolfgang Von Goethe

Neural Networks ?

Neural networks, inspired by the human brain, mimicking the way that biological neurons signal to one another – also known as artificial neural networks (ANNs) are a subset of machine learning and are at the heart of deep learning algorithms.

LSTM ?

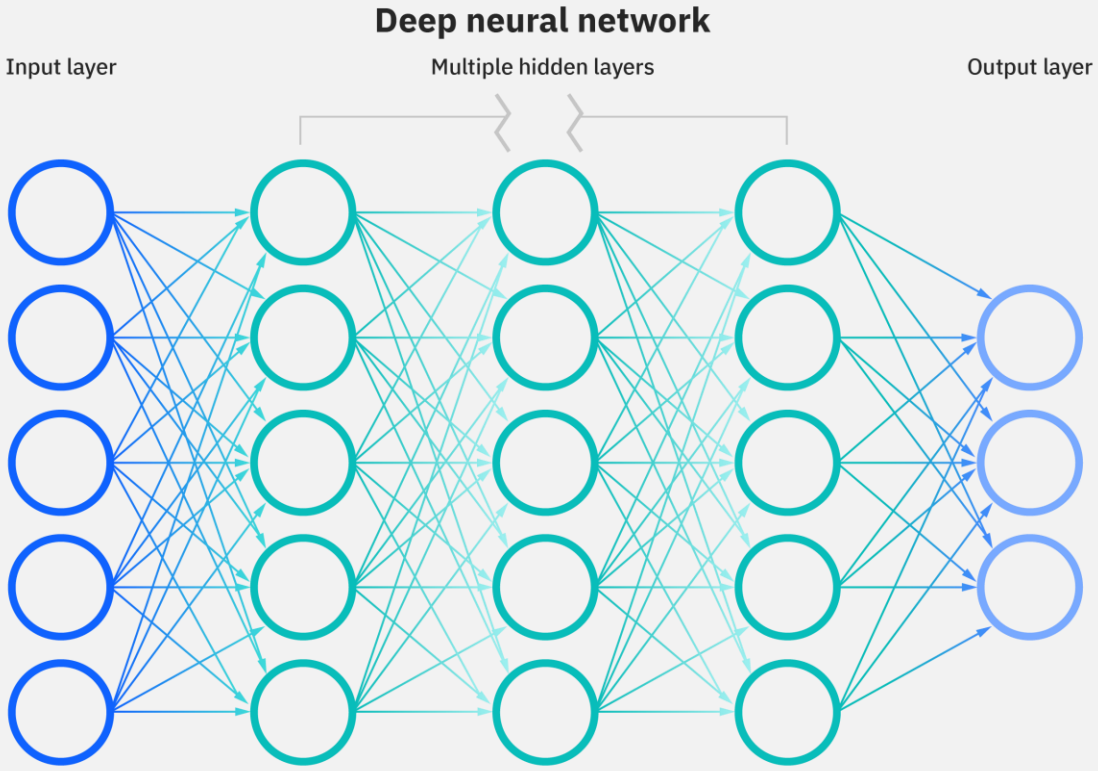
LSTM stands for **long short-term memory** networks, used in the field of Deep Learning.
It's a variety of recurrent neural networks (RNNs) that are capable of learning long-term dependencies, especially in sequence prediction problems.

ANN

Artificial neural networks (ANNs) are comprised of node layers, containing an input layer, one or more hidden layers, and an output layer.

Each node, or artificial neuron, connects to another and has an associated weight and threshold.

If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network.
Otherwise, no data is passed along to the next layer of the network.

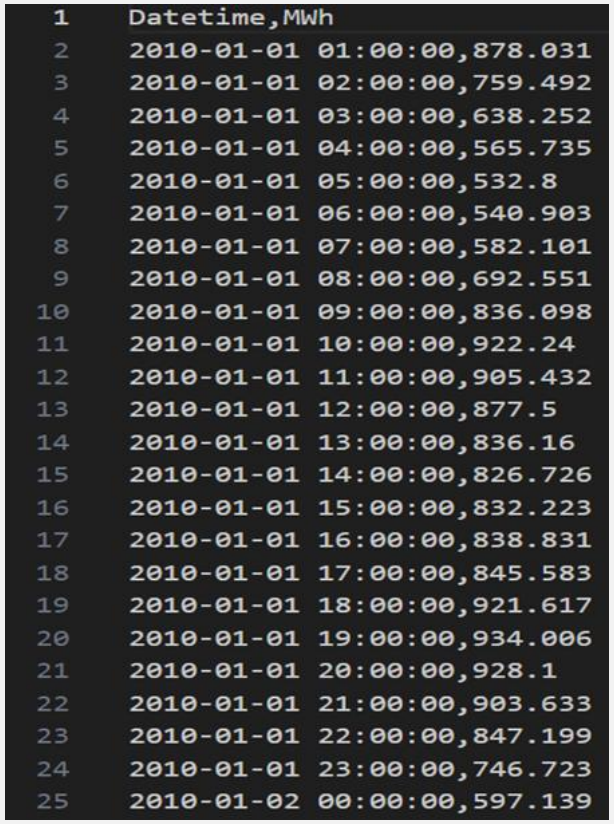


Data and Results

The proposed model in this study is based in a Python class that has an intuitive input to predict electricity consumption using deep learning, according to our available data with hourly frequency.

Hourly data (MWh) from 2010 – 2022

105193 rows

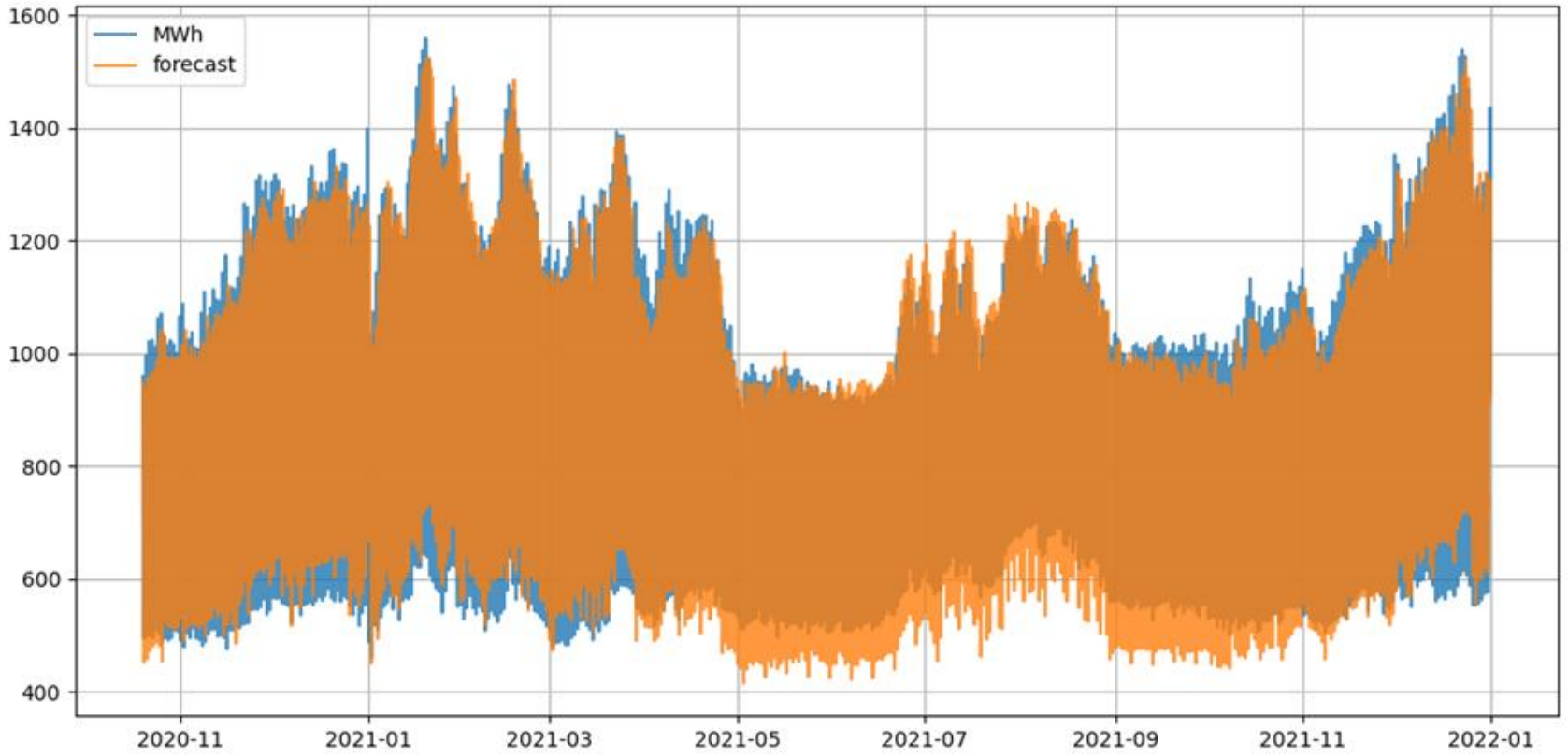


```
Datetime,MWh
2010-01-01 01:00:00,878.031
2010-01-01 02:00:00,759.492
2010-01-01 03:00:00,638.252
2010-01-01 04:00:00,565.735
2010-01-01 05:00:00,532.8
2010-01-01 06:00:00,540.903
2010-01-01 07:00:00,582.101
2010-01-01 08:00:00,692.551
2010-01-01 09:00:00,836.098
2010-01-01 10:00:00,922.24
2010-01-01 11:00:00,905.432
2010-01-01 12:00:00,877.5
2010-01-01 13:00:00,836.16
2010-01-01 14:00:00,826.726
2010-01-01 15:00:00,832.223
2010-01-01 16:00:00,838.831
2010-01-01 17:00:00,845.583
2010-01-01 18:00:00,921.617
2010-01-01 19:00:00,934.006
2010-01-01 20:00:00,928.1
2010-01-01 21:00:00,903.633
2010-01-01 22:00:00,847.199
2010-01-01 23:00:00,746.723
2010-01-02 00:00:00,597.139
```

We used a hyperparameter (aka. epoch number) to define the number of times the algorithm will run on the entire data set.

Higher epoch number (we need a supercomputer) = better accuracy

```
Epoch 1/10
370/370 [==============================] - 17s 44ms/step - loss: 261280.3594 -
Epoch 2/10
370/370 [==============================] - 14s 39ms/step - loss: 12903.4971 -
Epoch 3/10
370/370 [==============================] - 17s 45ms/step - loss: 8133.8799 - v
Epoch 4/10
370/370 [==============================] - 17s 45ms/step - loss: 23260.6934 -
Epoch 5/10
370/370 [==============================] - 18s 47ms/step - loss: 20644.8672 -
Epoch 6/10
370/370 [==============================] - 19s 51ms/step - loss: 18387.0059 -
Epoch 7/10
370/370 [==============================] - 19s 52ms/step - loss: 13937.9219 -
Epoch 8/10
370/370 [==============================] - 20s 54ms/step - loss: 13230.8057 -
Epoch 9/10
370/370 [==============================] - 20s 54ms/step - loss: 16008.0615 -
Epoch 10/10
370/370 [==============================] - 20s 55ms/step - loss: 11150.9854 -
```


MWh
forecast
1600
1400
1200
1000
800
600
400
2020-11
2021-01
2021-03
2021-05
2021-07
2021-09
2021-11
2022-01

168 hours (1 week) forecast
- epoch number 5
- epoch number 10

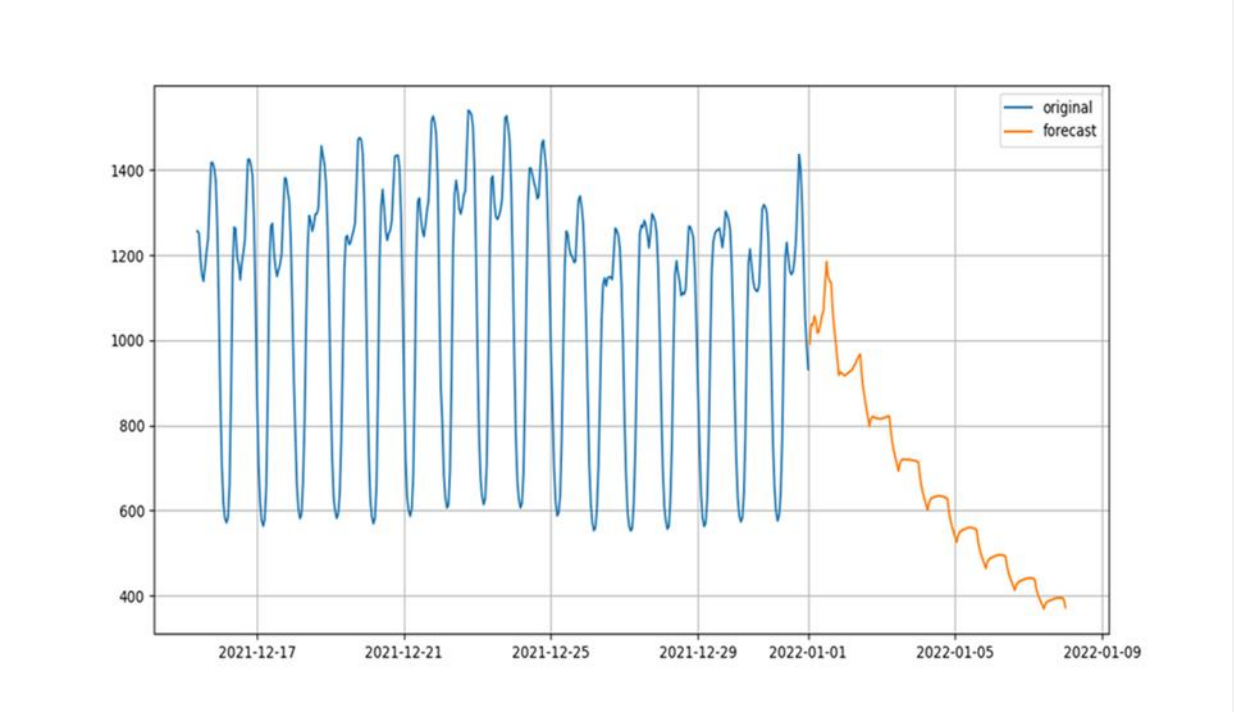
```
# Defining the model
model = Sequential()
model.add(LSTM(self.LSTM_layer_depth, activation='relu',
input_shape=(self.lag, 1)))
model.add(Dense(1))
model.compile(optimizer='adam', loss='mse’)
.
.
.

# Initiating the class
deep_learner = DeepModelTS(
data=d,
Y_var='MWh',
lag=conf.get('lag'),
LSTM_layer_depth=conf.get('LSTM_layer_depth'),
epochs=conf.get('epochs’) # the number of times the algorithm will run on
the entire data set
)


# Fitting the model
deep_learner.LSTModel()
# Forecasting n steps ahead
n_ahead = 168
yhat = deep_learner.predict_n_ahead(n_ahead)
yhat = [y[0][0] for y in yhat]
```

168 hours (1 week) forecast
5 epoch

```
Epoch 1/5
370/370 [==============================] - 10s 18ms/step - loss: 183082.3281
Epoch 2/5
370/370 [==============================] - 7s 18ms/step - loss: 6195.3916 -
Epoch 3/5
370/370 [==============================] - 6s 17ms/step - loss: 9558.4336 -
Epoch 4/5
370/370 [==============================] - 6s 17ms/step - loss: 4945.0288 -
Epoch 5/5
370/370 [==============================] - 6s 17ms/step - loss: 4345.8530 -
```



168 hours (1 week) forecast
10 epoch (better accuracy)

```
Epoch 1/10
370/370 [==============================] - 17s 44ms/step - loss: 261280.3594
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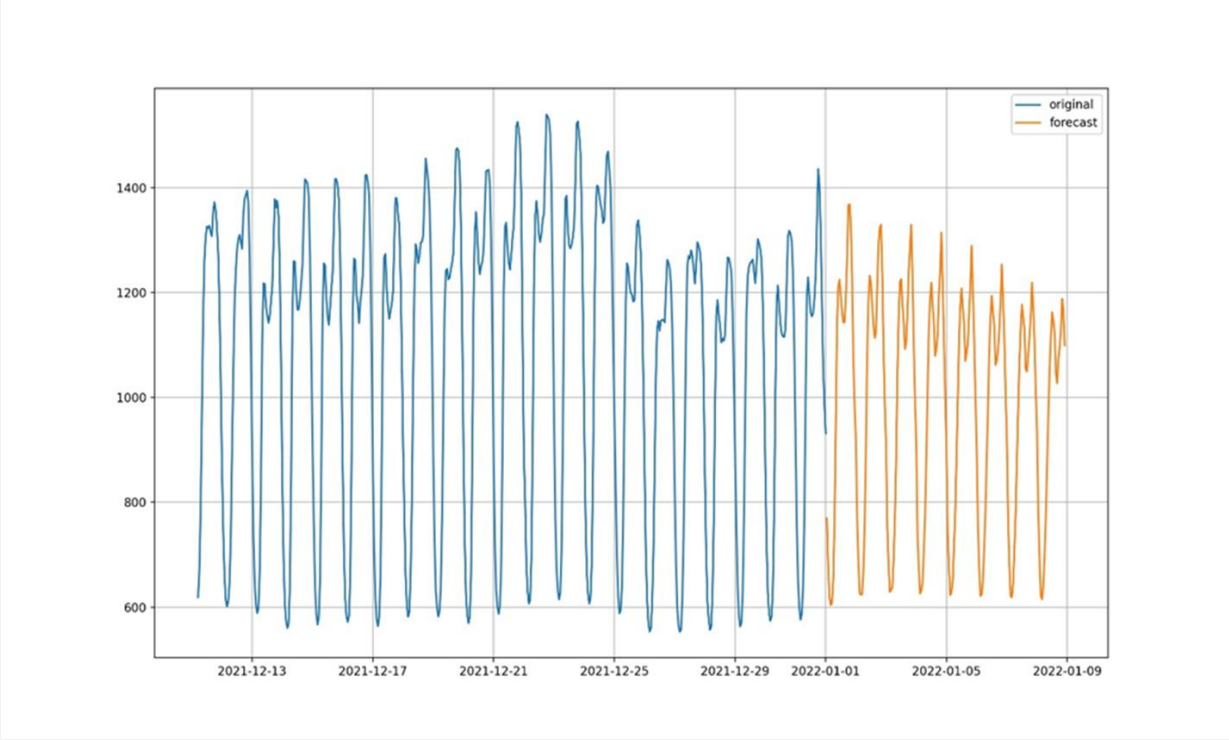

Conclusions

It is essential to prioritize energy conservation and take steps toward efficient energy management to ensure a sustainable future.

Proper management of energy consumption plays an essential role in promoting sustainability and reducing negative environmental impacts.

Forecasting electricity consumption is crucial for the Albanian government in managing cross-sectoral policies to align with European Union policies and energy production.

Conclusions

Opening the Albanian Power Exchange in 2023 requires forecasts of energy consumption.
The results of this model presented in this study will be a valuable contribution to this market.

Predicting energy consumption can be made possible through deep learning techniques.

Using these predictions can lead to significant cost savings and environmentally-friendly improvements in managing electricity.

"Saving energy reduces air and water pollution and conserves natural resources, which in turn creates a healthier living environment for people everywhere. At the same time, efficiency also saves money and creates jobs."

The American Council for an Energy-Efficient Economy (ACEEE)

Ευχαριστώ πολύ

(efharisto poli)

In the end we retain from our studies only that which we practically apply.

Johann Wolfgang Von Goethe