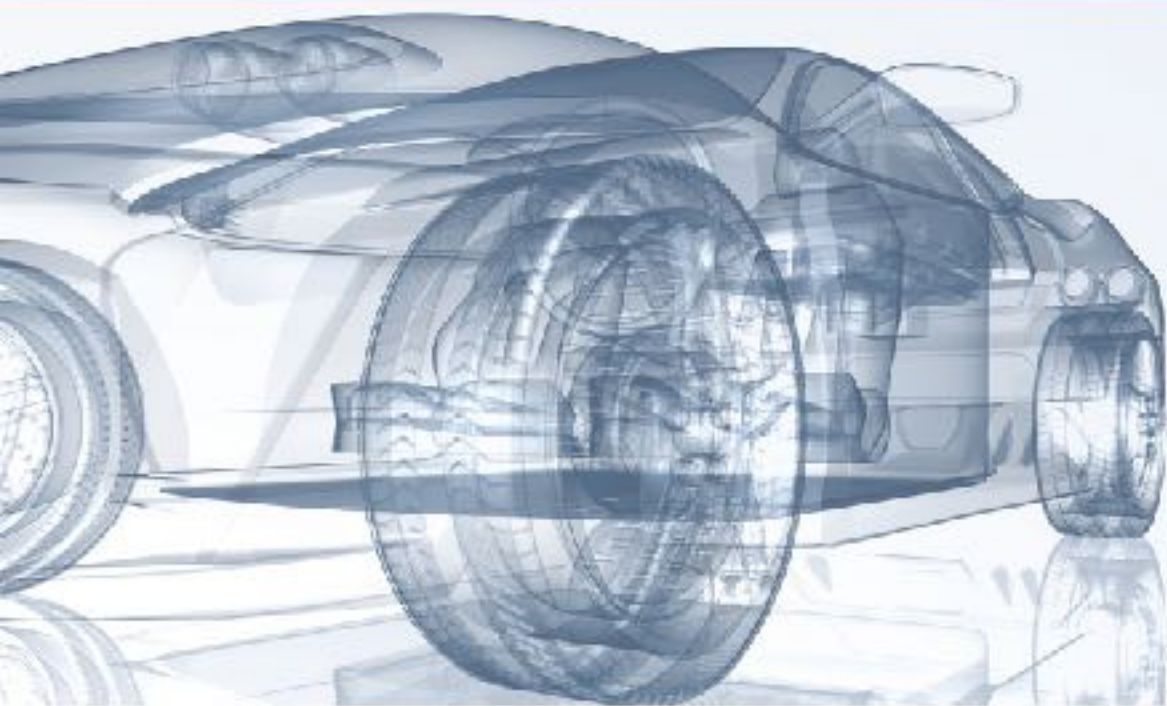


# evs 30



The 30th International  
Electric Vehicle  
Symposium & Exhibition

**October 9–11, 2017**  
Messe Stuttgart, Germany

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## ***A New Predictive Electric Bus Model Using Big Data For Estimating Battery Pack Capacity***

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***Mehmet Uğraş CUMA-Assist. Prof. Dr. in EEE from Çukurova University***

## ***Agenda***

- ***A Short Presentation About TEMSA***
- ***Paper Presentation***
  - \*Introduction***
  - \*Data Collection Process***
  - \*Data Sets***
  - \*Neural Network model and Simulation***
  - \*Results***
  - \*Conclusion***

# TEMSA Adana Plant










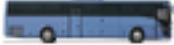





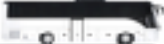










**Total Area:** 550k m<sup>2</sup>  
**Covered Area:** 115k m<sup>2</sup>

**Annual production capacity of**

- 2,500 Motor Coach,
- 2,000 Midibus
- 7,600 Light Trucks

# TEMSA Product Line-Up

COACH		INTERCITY	CITY	
 MARATON/ MARATONVIP	 TS45	 LD S3	 AVENUE PLUS / LF 18	
 SAFIR PLUS VIP / SAFIR PLUS / HD	 TS35E	 MD9 IC	 AVENUE PLUS / LF 12	 AVENUE IBUS / LF 12 IBUS
 LD	 TS30	 MD9 LE	 AVENUE PLUS / LF 12 CNG	 AVENUE EV / LF EV
 MD9	 HD RHD		 MD9 LE	 MD9 electric CITY
 CPALIN / MD /	 MD9 RHD		 OPALIN CITY/ MD7 CITY	 TOURMALIN
 PRESTIJ SX			 PRESTIJ SX CITY	

## **TEMSA Electric Vehicles**

### **MD9 electriCITY**

**Battery Capacity: 240kWh**

**Battery Type: NMC**

**Motor Power: 100kW**

**Range: 300km**



## **TEMSA Electric Vehicles**

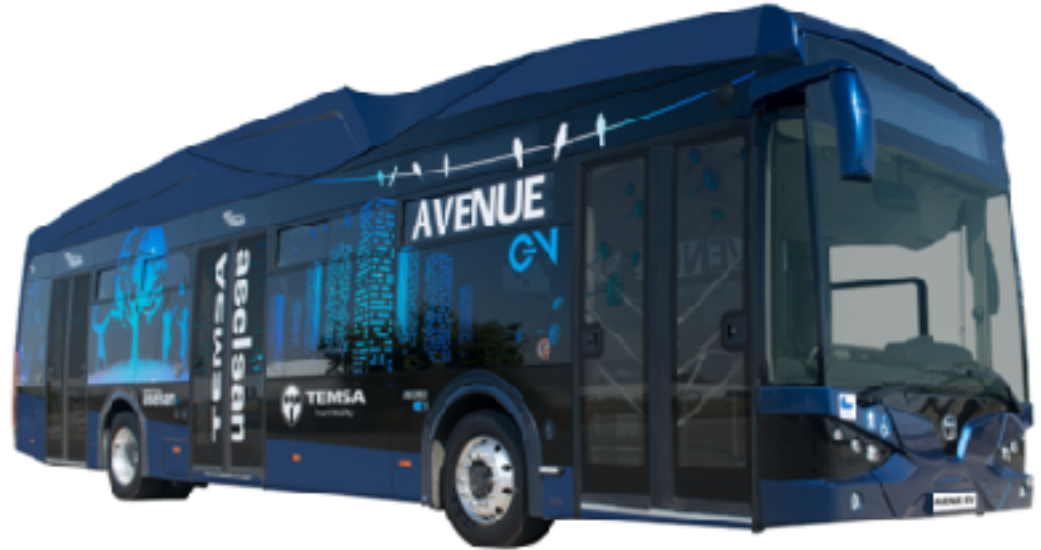
### **Avenue EV Flash Charge**

**Battery Capacity: 120kWh**

**Battery Type: LTO**

**Motor Power: 200kW**

**Range: 140km**



## ***Introduction***

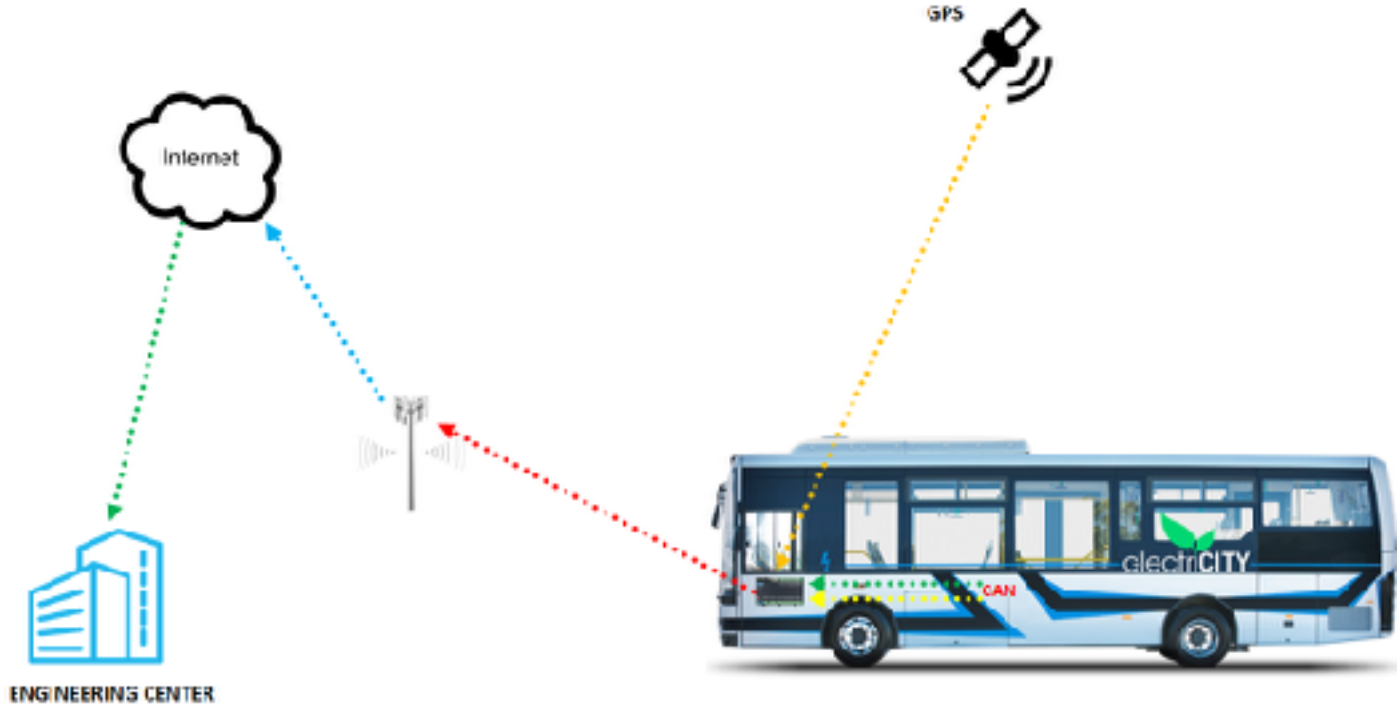
- ***One of the biggest critical issue for electric vehicles is range anxiety.***

### ***Keywords:***

- ***Battery Capacity Estimation***
- ***Big Data***
- ***Neural Network***



## Data Collection Process



## Data Collection Process

▪ **Fleetics is a big data tool which is developed by TEMSA and STM companies for collecting, monitoring and analyzing the vehicle generated data.**



**Web App.**

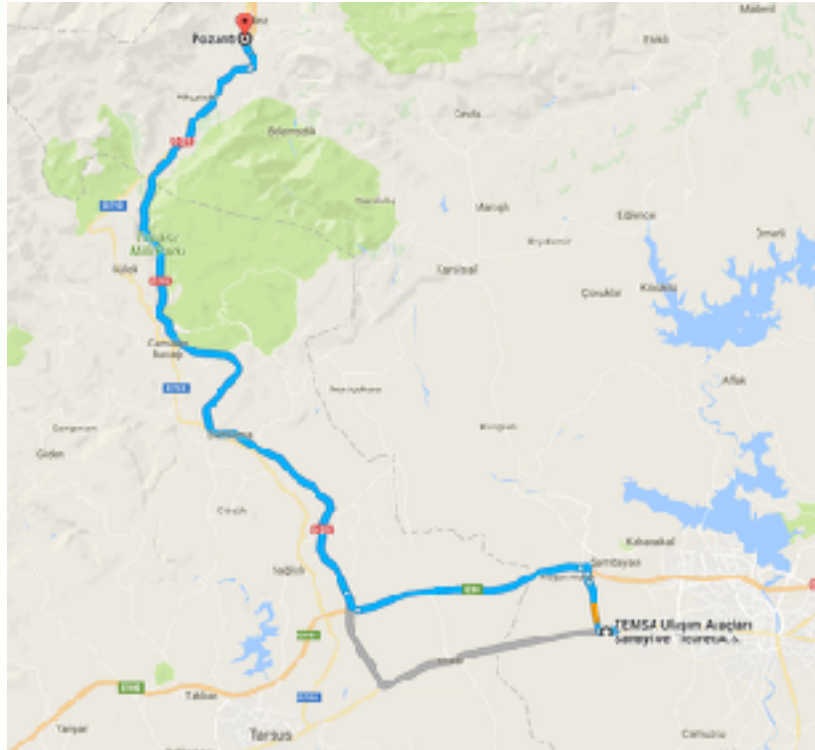


**Touch Screen APP.**



**Mobile App.**

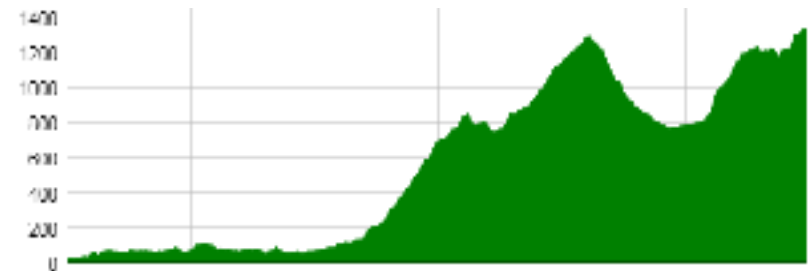
# Training Data Set



## Route Information

- **Distance: 179 km**
- **Average Speed: 60km/h**
- **Travel time: 2,97h**

## ▪ Elevation Profile(m)



# Training Data Set

**Acceleration(m/s<sup>2</sup>)**



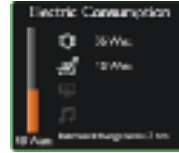
**Data Range**  
[-1.46;1.11]

**Gradient**



**Data Range**  
[-0.72;0.76]

**Aux\_HV\_Unit\_Usage(%)**



**Data Range**  
[75;100]

**Vehicle Weight(kg)**



**Data Range**  
[10200;11800]

**Traffic Density(Vpkm)**



**Data Range**  
[2;15]

**Drag Force(N)**



**Data Range**  
[0;2422]

**Ambient Temp(C°)**



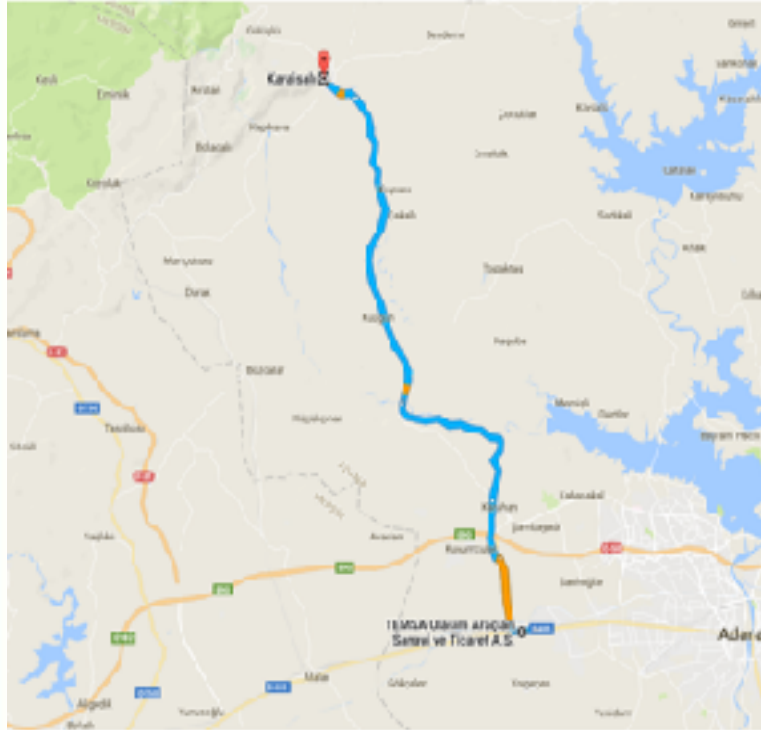
**Data Range**  
[30;34]

**Energy Consumption Per Sample(Kwh)**



**Data Range**  
[-0.113;0.101]

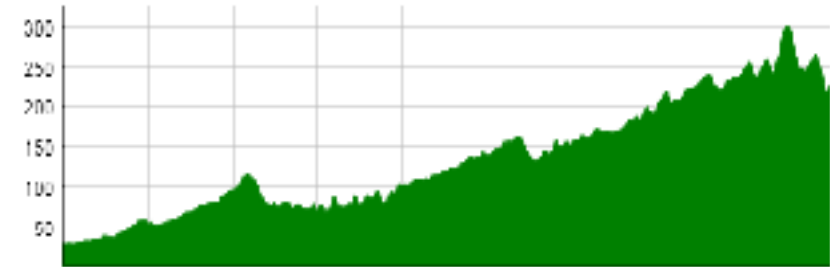
# Test Data Set



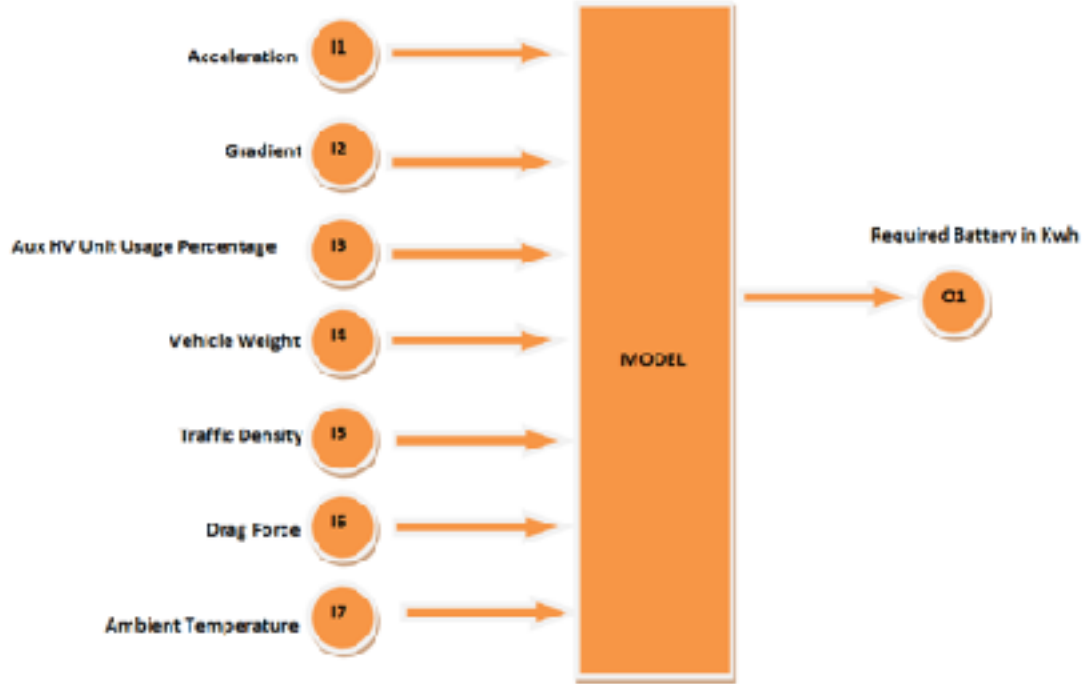
## Route Information

- Distance:79,2 km
- Average Speed:52km/h
- Travel time:1,58h

## ▪Elevation Profile(m)

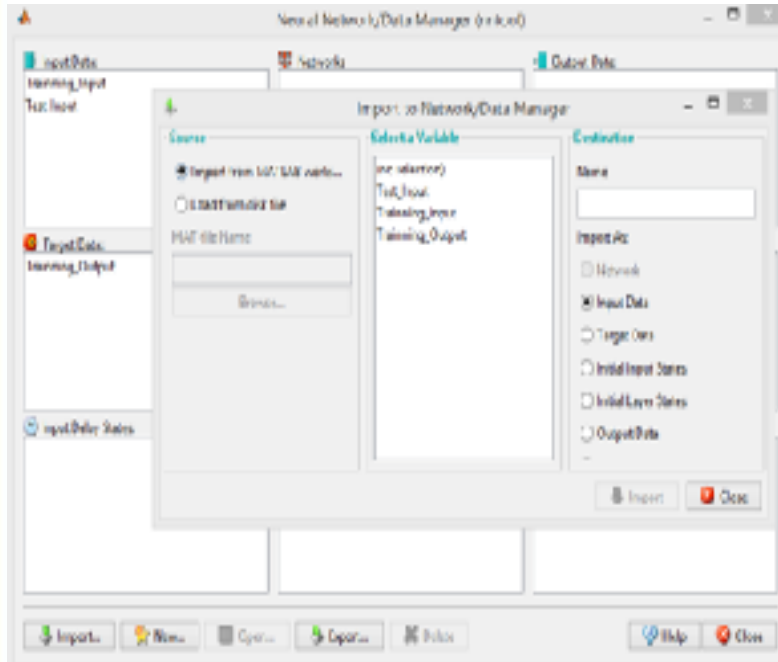


## Neural Network Model

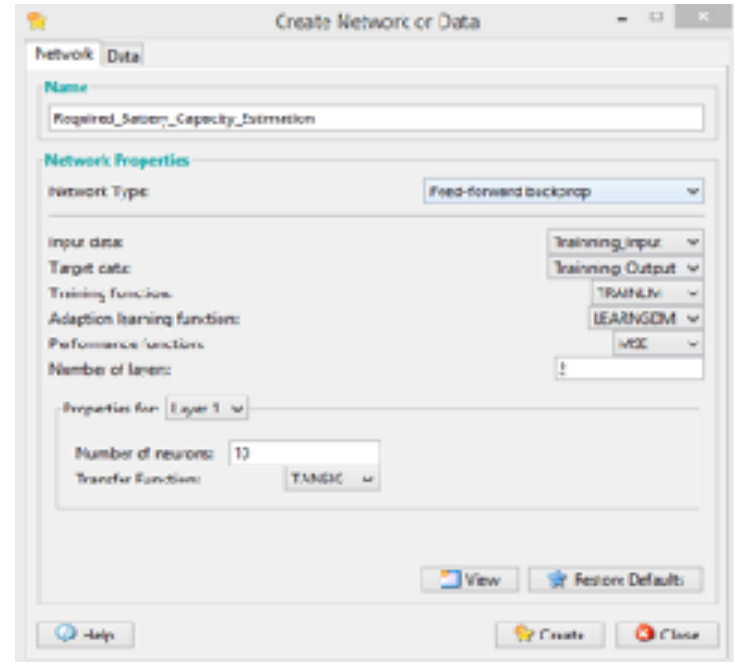


# Neural Network Simulation

## Data Importing



## Setting Neural Network



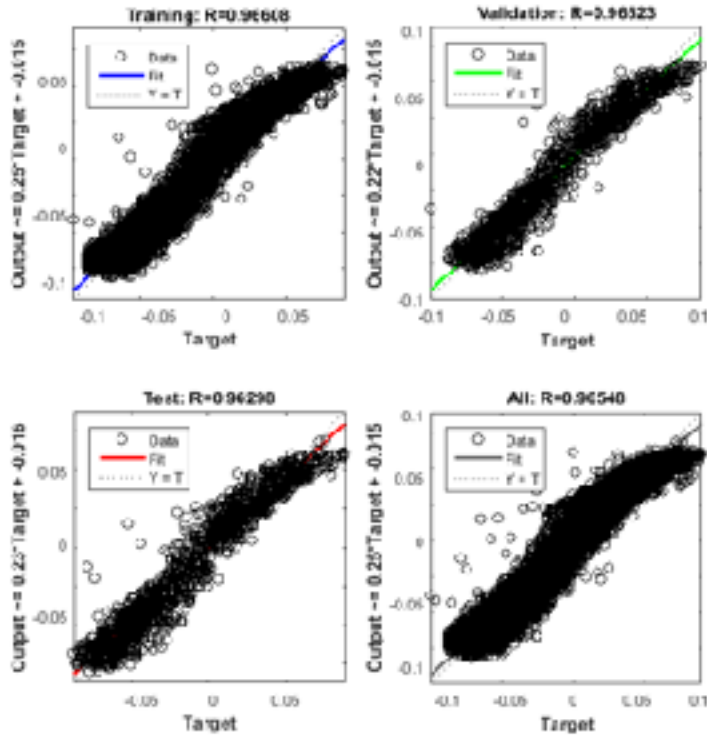
# Neural Network Simulation

## Training process

## Prediction Process



## Simulation Results



Predicted Required Energy(Kwh)	Measured Required Energy(Kwh)	Accuracy %
48,6	52,4	~93

## Conclusion

- ***Data collection from an electric bus has been achieved.***
- ***A predictive model has been developed to design a battery model according to the different usage scenarios and different routes.***
- ***This study can save from more battery price, more battery weight by helping designer to decide optimal battery capacity.***
- ***Accuracy of predicted kwh is acceptable level according to measured values. The accuracy can be increased by collection more data in different routes, usage scenarios and environment conditions.***

***Thank you for your attention!***

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