

## 1 Background

**Social Background** : Energy demand for air conditioners is projected to more than triple by 2050, when around two-thirds of the world's households will use them.

**Research Background** : Conventional standard values do not reflect regional differences, and the results of the calculation of the use phase vary greatly depending on the scenario assumptions.

## 2 Objective

1. Calculation of **energy consumption and greenhouse gas (GHG) emissions reflecting the actual usage by region**, considering regional characteristics and housing attributes.
2. Artificial intelligence and HEMS data are used to **create a model that forecasts electricity consumption** based on regional and residential attributes.

## 3 Method

### 【Life Cycle Assessment (LCA)】

Target	Home Air Conditioner(AC)
Functional unit	Life cycle(LC) of a single AC, from manufacture to disposal
Use data	<ul style="list-style-type: none"> <li>• Industry data: Primary data (raw material procurement, manufacturing, use, distribution, and disposal stages.)</li> <li>• Measured data: 3 years of HEMS data (usage stage) for 583 households in Japan. (Only all-electric homes)</li> </ul>
Method	Amount of activity x GHG emission factor
Impact	Global warming
System boundary	

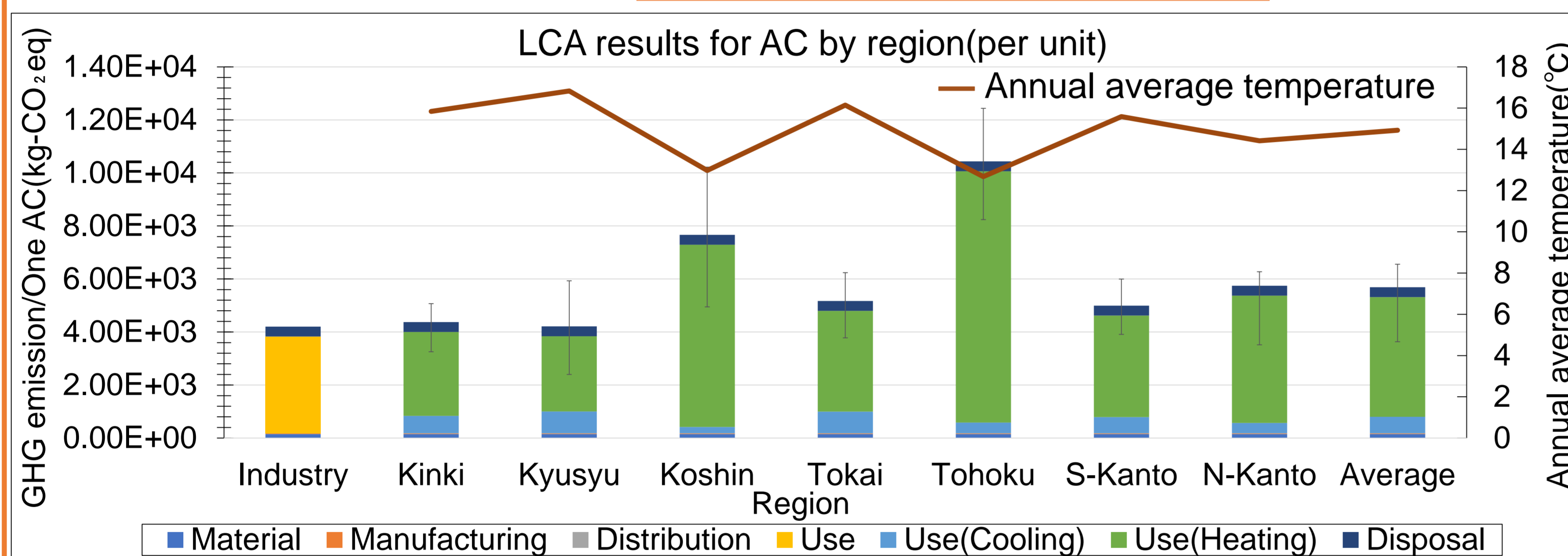
### 【 Comparison of accuracy of electricity consumption forecasting models 】

Objective variable : Energy consumption / Use application : IBM SPSS Modeler 18.2.2

Method of model	Scenario	Using variable
Generalized Linear	Only temperature	Outside temperature
Generalized Linear	Extracted variables	Region, Temperature, How to use AC, Number of household AC, Insulation specification
Generalized Linear	All variable	Region, Temperature, Humidity, How to use AC, Number of household AC, Insulation specifications, Number of floors, Total floor area whole-house air-conditioning
Neural Network	All variable	Same as above

## 4 Result

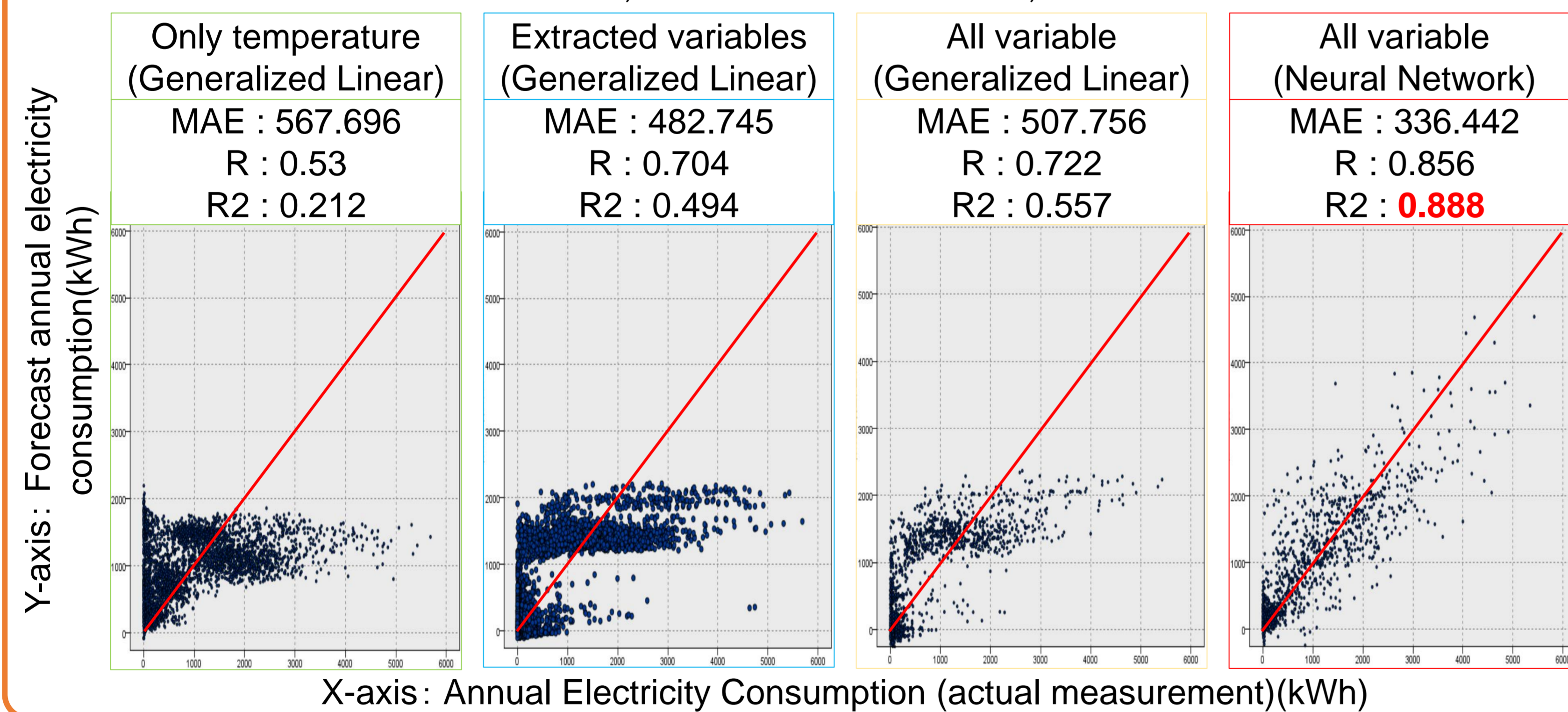
### LCA of ACs based on measured data



- ✓ The LCA results for each region show **a large effect of heating use**, which is more pronounced in regions with lower average temperatures.
- In some cases, such as in the Kinki and Kyushu regions, it is smaller depending on the value of the emission factor used.
- It is important to consider the region in terms of temperature and electricity company as well as lifestyle considerations.

### Comparing the accuracy of energy consumption prediction models(annual)

MAE = Mean Absolute Error, R = correlation coefficient, R2 = coefficient of determination



- ✓ It is thought that the variation is greater due to individual differences in lifestyle and temperature experience.
- ✓ Using AI, it is possible to predict energy consumption more accurately than with generalized linear model.
- In the future, it will be possible to deal with differences due to individual differences by considering the operating conditions.
- **By using the prediction model, it is possible to conduct LCA and future estimations that reflect the actual situation of each attribute.**

## 5 Conclusions & future plans

### Results and discussion

- ✓ LCA based on actual data range depending on the average temperature and emission factors of each region.
- **By using HEMS data, I was able to calculate result of LCA that reflected actual usage conditions.**
- ✓ Energy consumption prediction using neural networks by AI is much more accurate than ordinary regression analysis.

### Future plan

- ✓ To improve the accuracy of the AI-based electricity consumption forecasting model to forecast and optimize the future electricity consumption and GHG emissions of each region due to global warming and heat islands.
- ✓ To create a model that can suggest lifestyle improvements by considering the operating conditions of ACs in the analysis.

## 6 Challenges and limitations

- ✓ The number of data is limited, and the number of data varies from region to region.
- ✓ Changes in energy consumption due to ageing, maintenance etc. are not reflected.
- ✓ The data does not reflect regional differences other than the stage of use.
- ✓ Model and size could not be determined from the data, and therefore could not be reflected.