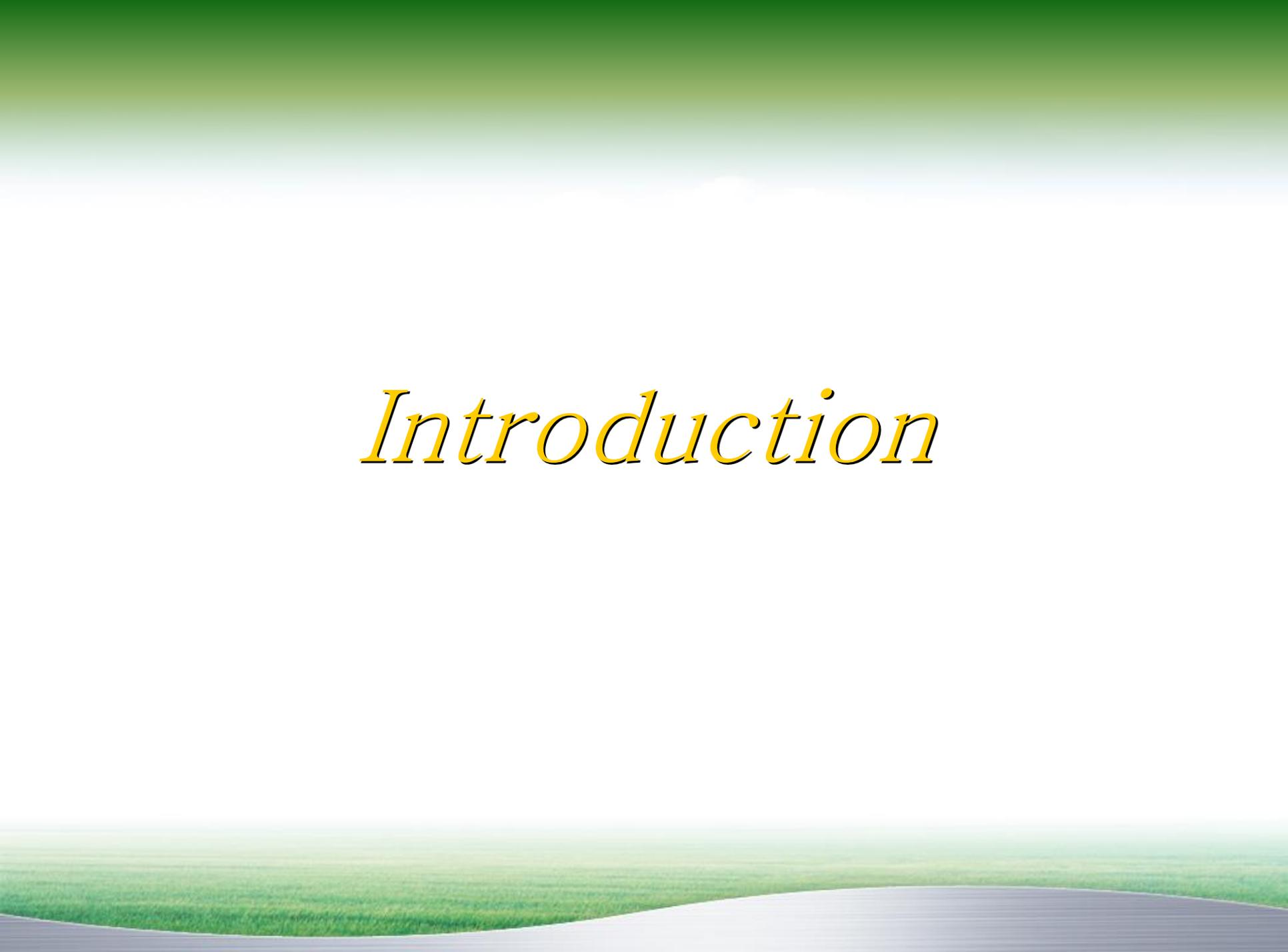


A hand holding a green globe against a bright blue sky with a sunburst and a green field.

A Study on the Improvement for Heat Supply
Forecast using the Analysis of Heat Demand
Characteristics

2015. 2

KOREA DISTRICT HEATING CORP.

The background of the slide features a soft-focus landscape. At the bottom, a grey asphalt road curves from the left towards the right. Above the road is a vast, green field that stretches to a hazy horizon. The sky is bright and white, with a prominent sunburst or lens flare effect centered in the upper half of the image. The overall color palette is dominated by greens, greys, and bright whites.

Introduction

Introduction

Research background

- ❑ There was a huge blackout and a national loss, because of a **mistake for electricity demand forecast**. This increased the interest in overall demand forecast. KDHC is also carrying out the heat demand forecast but **needs an accurate forecast** of the heat demand **by improvement**.
- ❑ To improve the accuracy of the heat demand forecast, it is **important to draw additional main factors** by statistical technique and this research intends to **develop new statistical technique** using additional main factors.

Introduction

Research Objective

- ❑ Improvement of heat supply load forecasting method by statistical technique development and system construction
 - Improvement of forecasting method using time series and regression analysis

Research Contents

- ❑ Study of the analysis of heat demand characteristics and the deduction of key factor
 - Analysis of current heat supply load forecasting method
 - Analysis of each branch heat load characteristics
 - Deduction of key factor

Contents

1

Forecasting engine(KDHC)

2

Exploratory analysis

3

Improvement direction

Forecasting method

❖. Forecasting method

Forecasting

- ❑ **Dynamic decision** relating to corporate activities will **start in the forecast activities**
- ❑ Company produces products to sell on the market. Company collects and analyzes data related to the market to predict future demand. Therefore, **forecasting is one of essential business activities.**
- ❑ **Forecasting reduces the uncertainty and the risk** for product planning, facilities planning, workforce planning, production planning, financial planning, etc. Therefore, forecasting gets management effectiveness.
- ❑ **Accurate forecasting needs diagnosis and prediction** for economic environment, social environment, cultural environment, political environment, technical environment, government policy, etc.



Forecasting engine
(KDHC)

I . Forecasting engine

Simplification of algorithm

INPUT (ambient temperature, past heat demand amount)

Forecasting(day) by regression equation

Heat demand forecasting(day) correction

OUTPUT (Heat demand forecasting(hour))

Removal of outlier

Seasonal characteristic weighting, Holiday pattern of each branch

Seasonal hourly pattern of each branch

I . Forecasting engine

Characteristics of regression model

- ❑ Regression model : The focus is on the relationship between a dependent variable(Y) and an independent variable(X). This model can get Y according to forecasting value X.

Ex) $Y=aX+ b$

- ❑ When forecasting value X is inaccurate, forecasting value Y is also inaccurate.

Ex) When ambient temperature forecasting in the national weather service is wrong, the error of heat demand forecasting increases.

Exploratory analysis

II. Exploratory analysis

Analysis process

S1 Pre-investigation

- Studies of past research
- Studies of factors & model used existing forecasting
- Definition of potential additional factors

S2 Data preparation

- Definition of extract data(definition of factors' pool)
- Data extraction(manual/auto, internal/external)
- Data verification
- Improvement of data quality & extraction of additional data
- Variable conversion(creation of derived variable)
- Exploratory analysis

Heat demand forecasting

S3 Model implementation

- Migration of existing model
- Building of new model pool
- Model evaluation & selection

S5 Model improvement

- Application & performance evaluation of additional factor model
- Improvement plan of model & forecasting process

S4 Additional factor selection

- Model performance evaluation of potential additional factors
- Selection of final additional factors

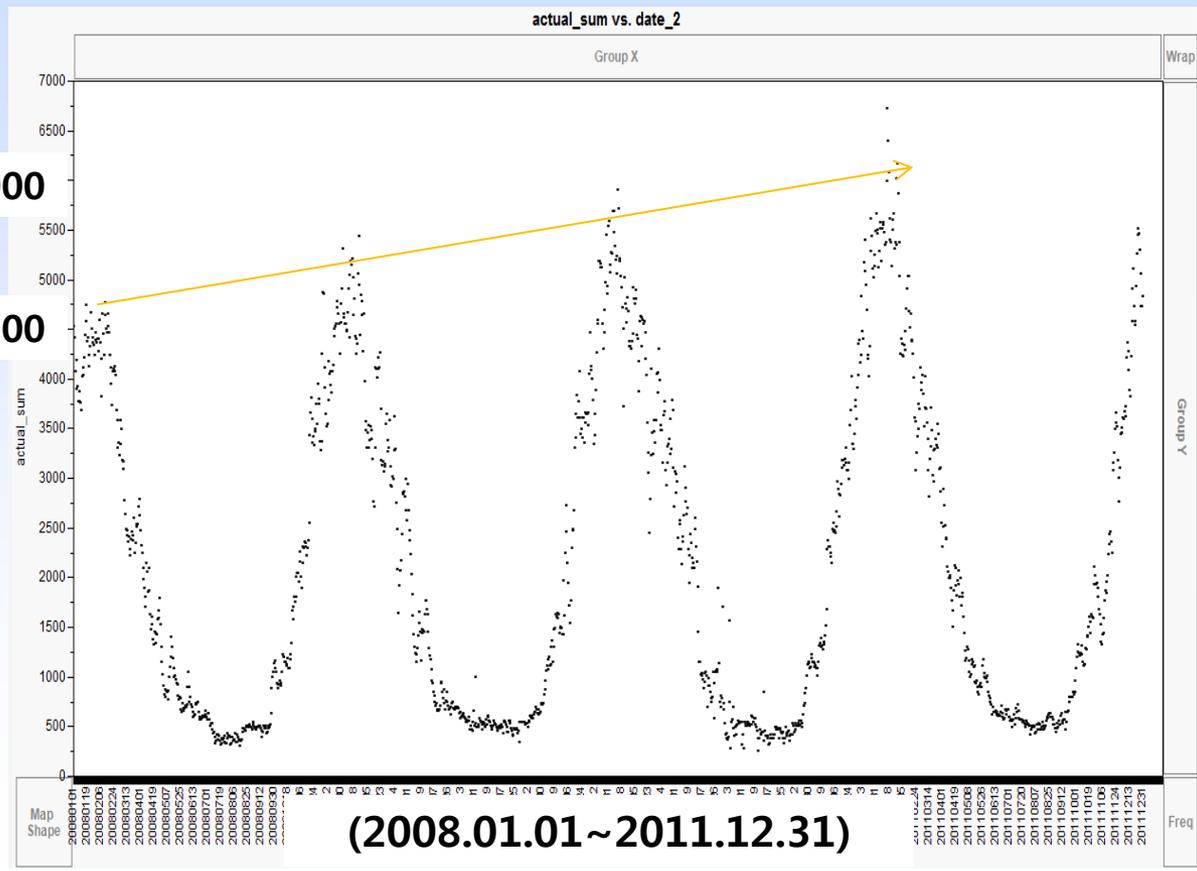
II. Exploratory analysis

Exploratory analysis result (1)

Heat demand result analysis (1)

Maximum heat demand amount increases by year : about 30~40Gcal/h increases every year

Heat demand result (Gcal/h)



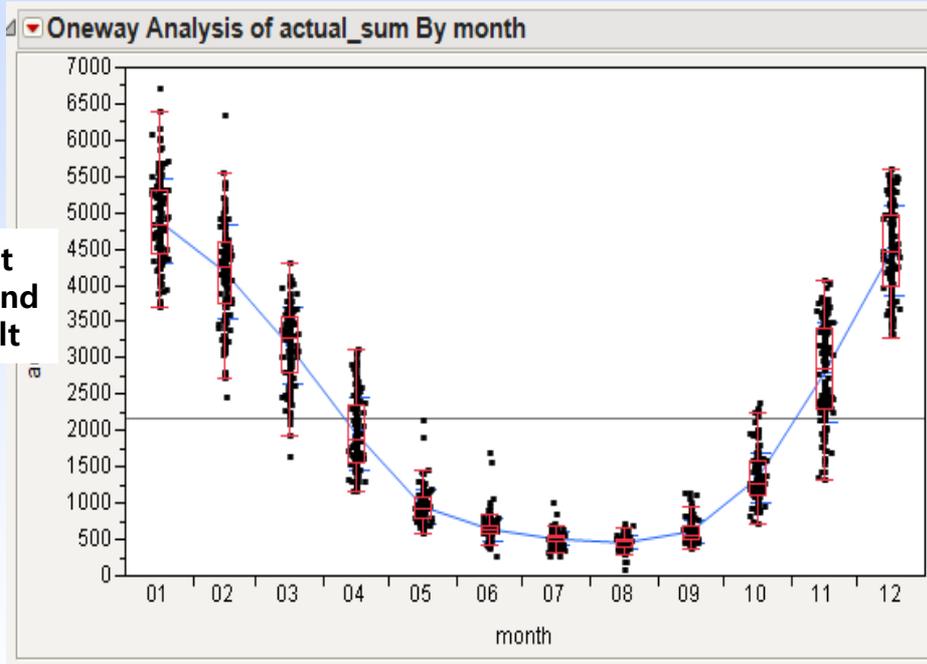
II. Exploratory analysis

Exploratory analysis result (2)

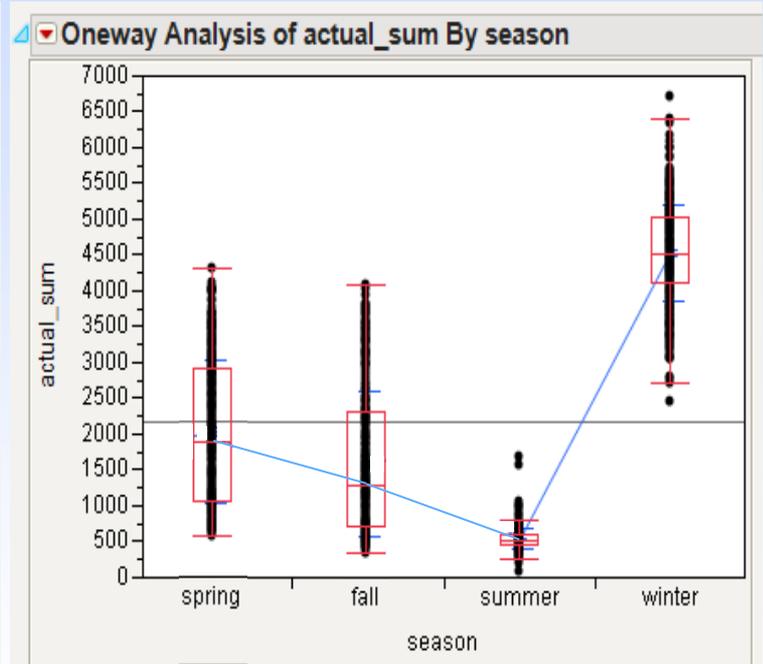
Heat demand result analysis (2)

- Wide heat demand variations by each month & season

Heat demand result



(2008.01.01~2011.12.31)



(2008.01.01~2011.12.31)

II. Exploratory analysis

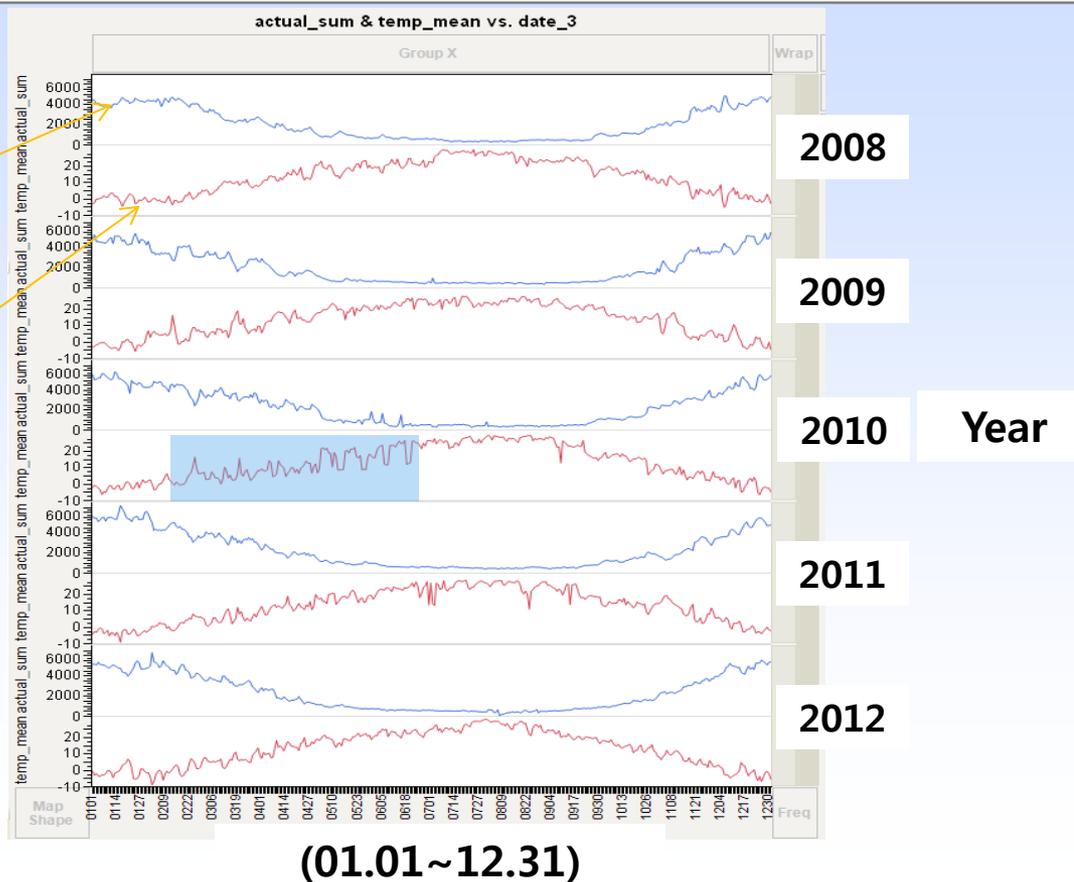
Exploratory analysis result(3)

Temperature result analysis (1)

- Wide temperature variations by each day : 2010. 2~2010. 6

Heat demand result

Ambient temperature result



II. Exploratory analysis

Exploratory analysis result (4)

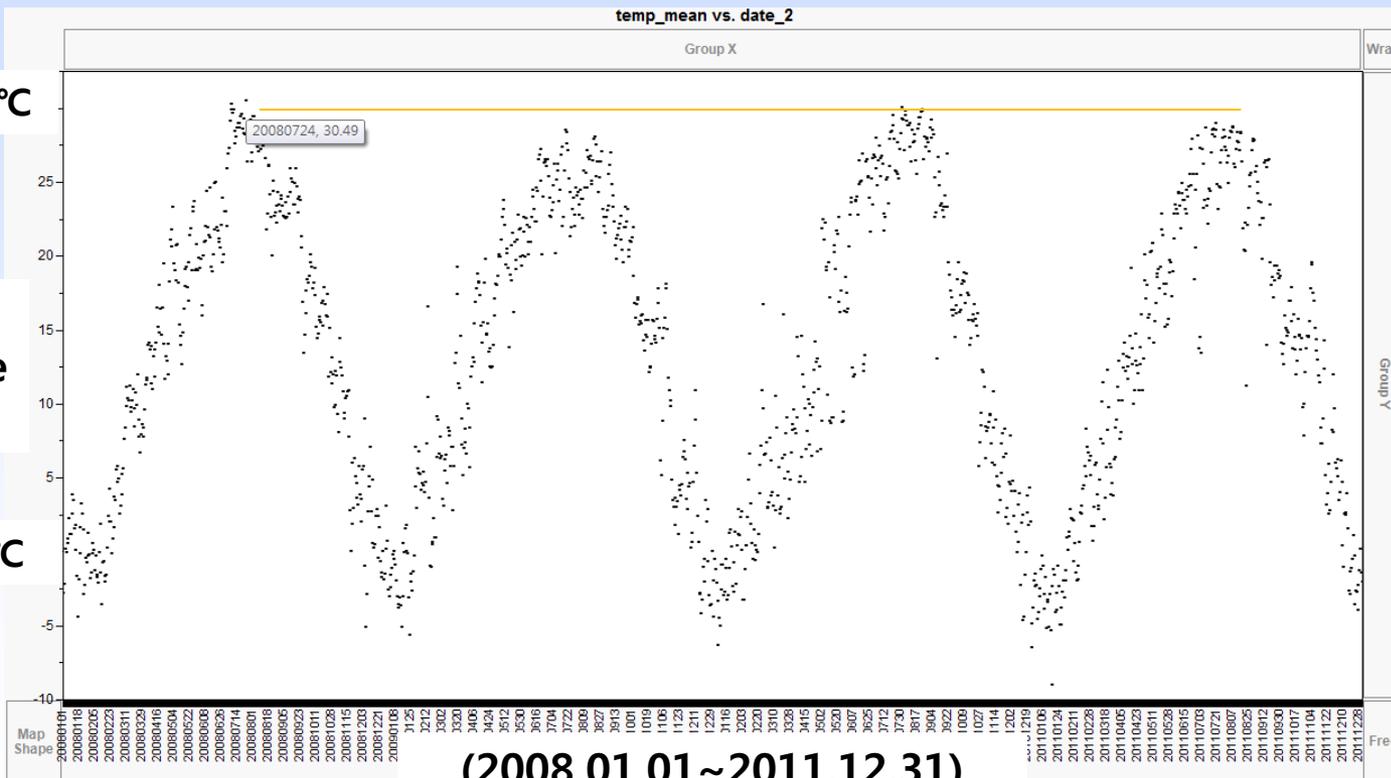
Temperature result analysis (2)

▪ Temperatures show similar pattern by year → different from increase of maximum heat demand

Ambient temperature result

30°C

0°C



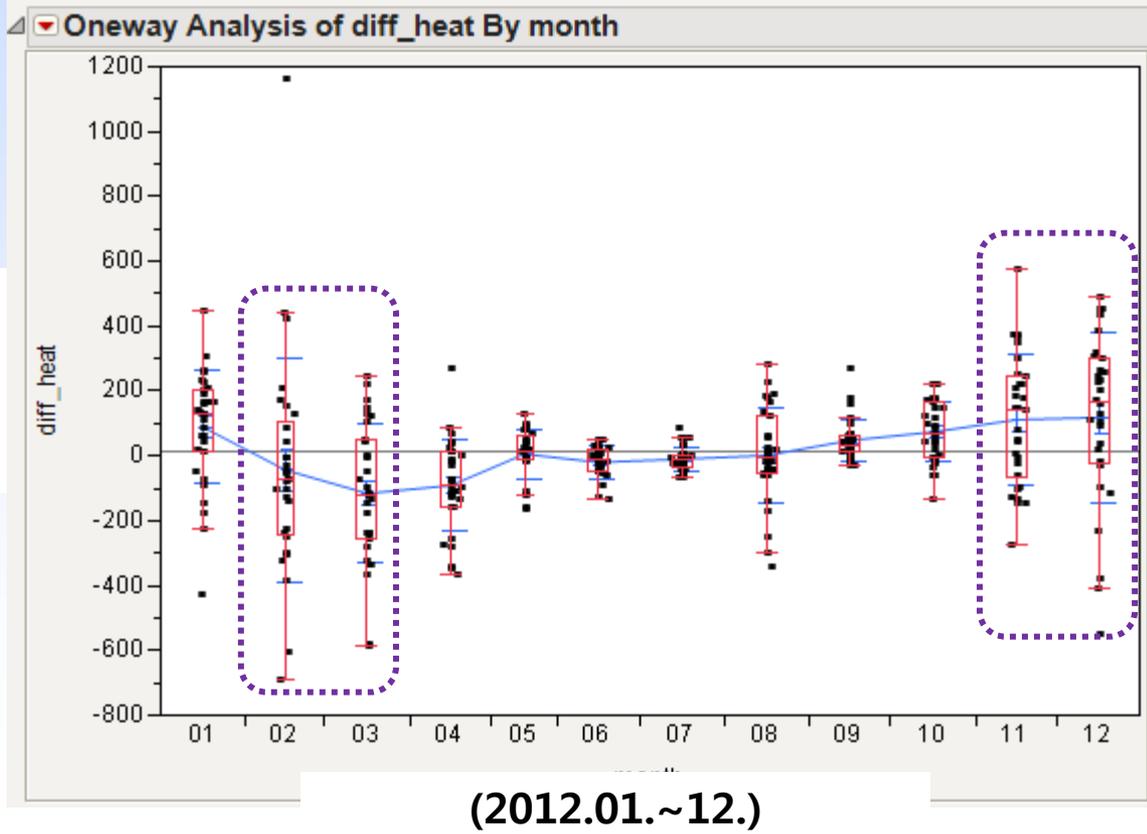
II. Exploratory analysis

Exploratory analysis result (5)

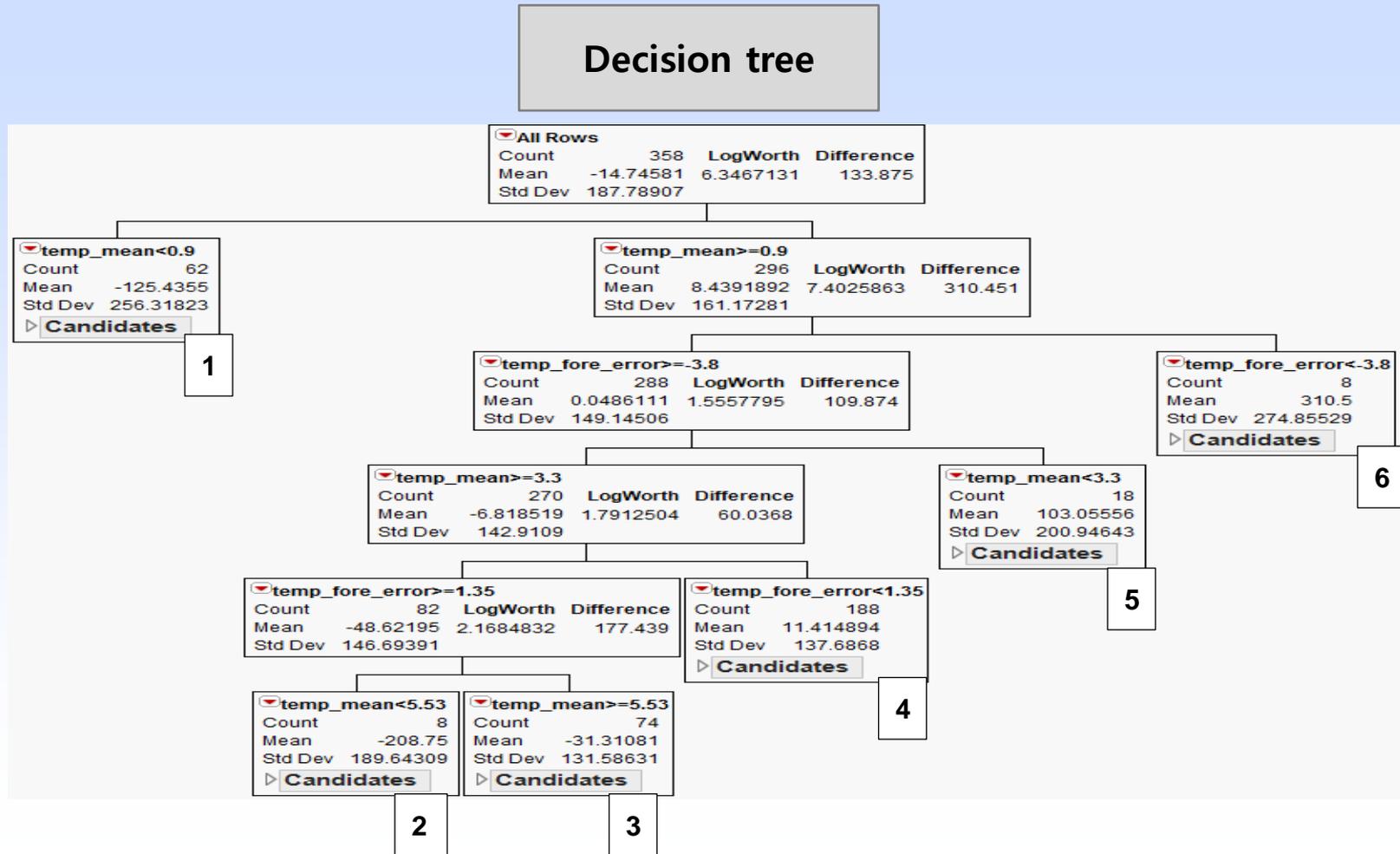
Heat demand forecasting error analysis (1)

- Heat demand forecasting error is large in Feb. ~ Mar. and Nov. ~ Dec.

Heat demand forecasting error



II. Exploratory analysis



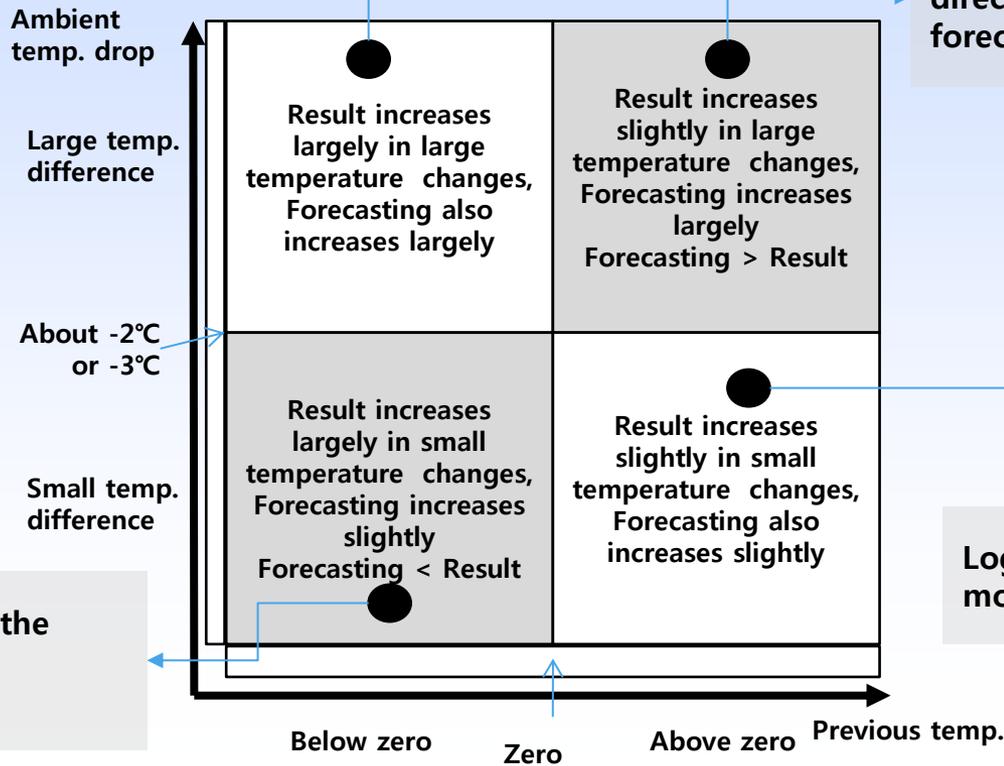
II. Exploratory analysis

Additional key factor

- Existing model is needed to complement through previous temp. and temp. difference

Logic continuance of existing model

Correction is needed in the direction of decreasing forecasting



Correction is needed in the direction of increasing forecasting

Logic continuance of existing model

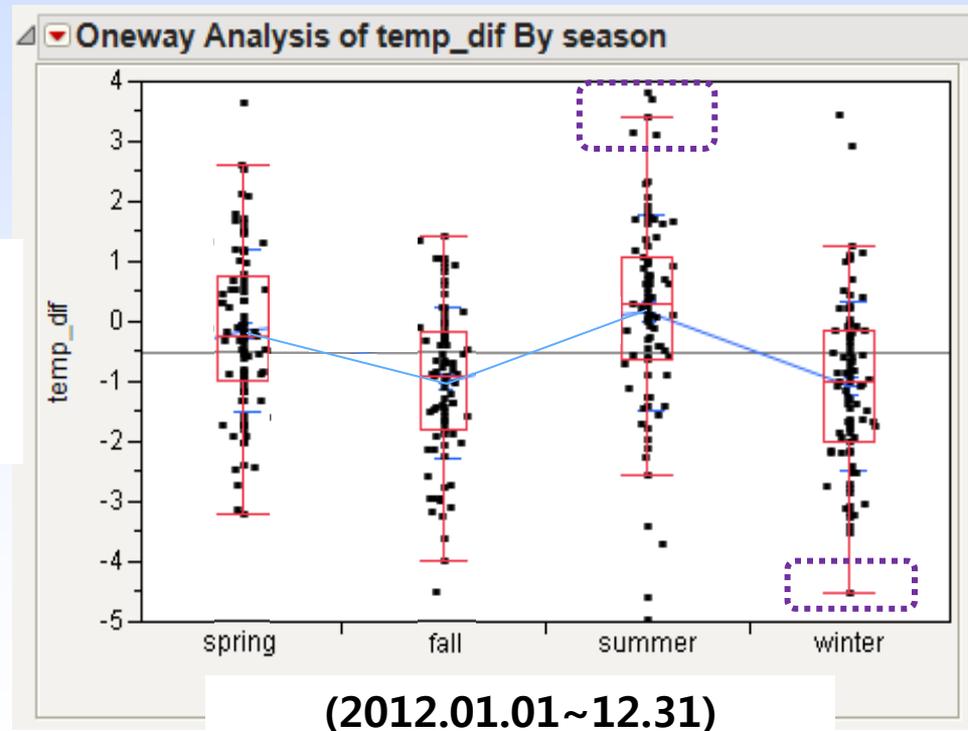
II. Exploratory analysis

Exploratory analysis result (7)

Ambient temperature forecasting error analysis (1)

- Error in summer & winter is large : error of 4°C above exists

Ambient temperature forecasting error

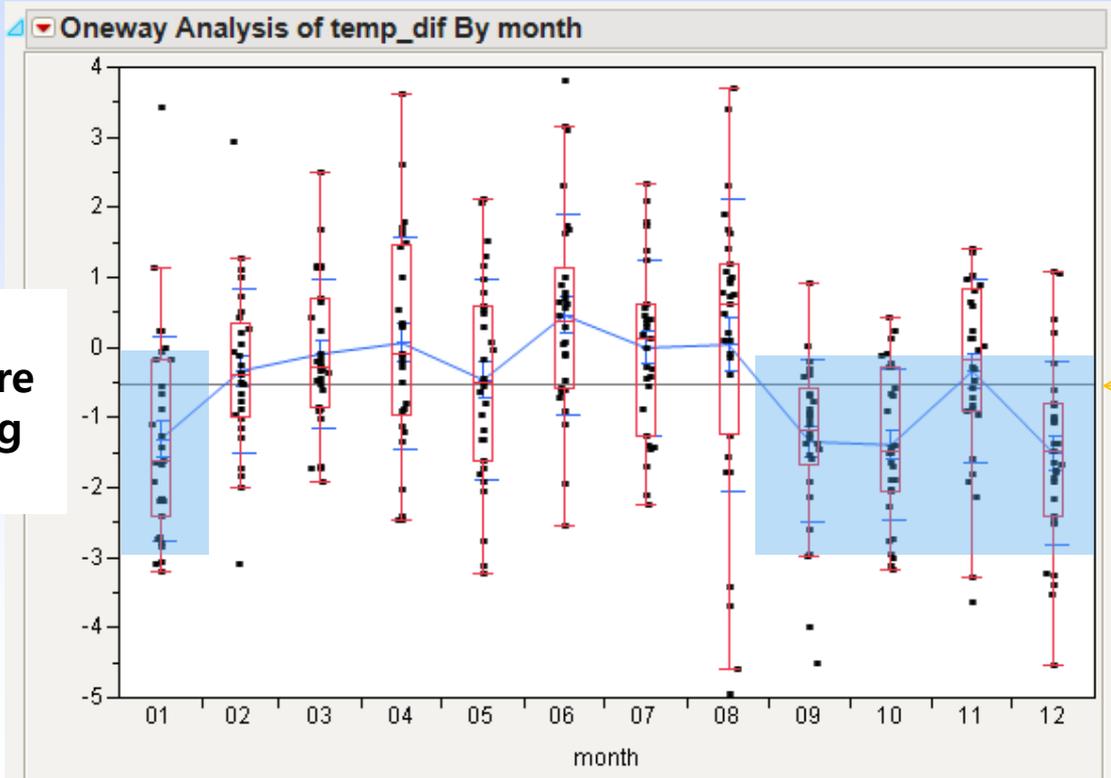


II. Exploratory analysis

Exploratory analysis result (8)

Ambient temperature forecasting error analysis (2)

- Forecast 1~2°C less than real temperature(result) during Sep. ~ Dec. & Jan.



Ambient temperature forecasting error

Mean error

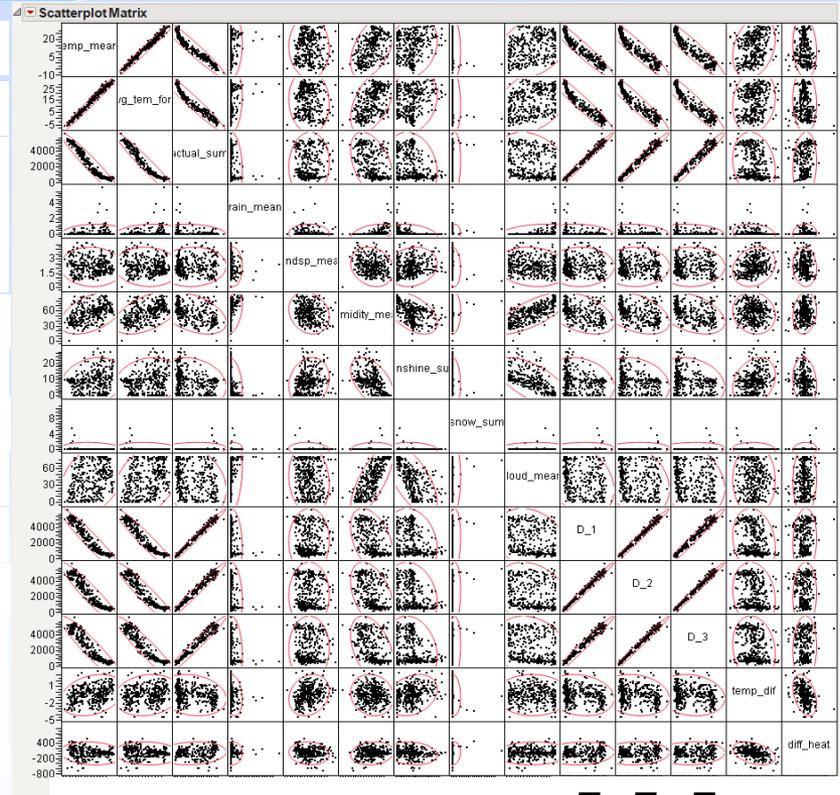
(2012.01.~12.)

II. Exploratory analysis

Exploratory analysis result (9)

Relational analysis between factors (1)

Temp.(result)
Temp.(forecasting)
Heat demand(result)
Rainfall
Wind speed
Humidity
Sunshine
Snowfall
Clouds
Heat demand(result)(D-1)
Heat demand(result)(D-2)
Heat demand(result)(D-3)
Temperature difference
Heat demand difference



Heat demand difference
 Temperature difference
 Heat demand(result)(D-3)
 Heat demand(result)(D-2)
 Heat demand(result)(D-1)
 Clouds
 Snowfall
 Sunshine
 Humidity
 Wind speed
 Rainfall
 Heat demand(result)
 Temp.(forecasting)
 Temp.(result)

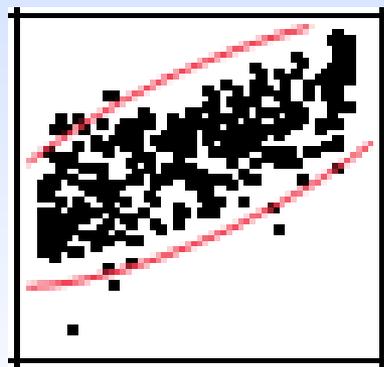
II. Exploratory analysis

Exploratory analysis result (10)

Relational analysis
between factors (2)

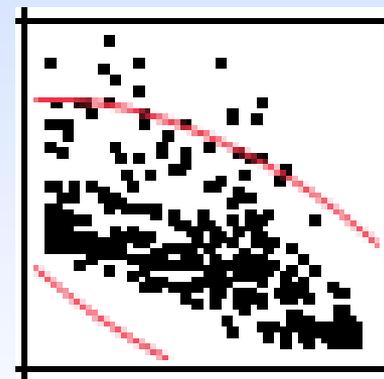
- Correlation number between humidity and clouds is 0.748
- Correlation number between sunshine and clouds is -0.643

Humidity



Clouds

Sunshine



Clouds

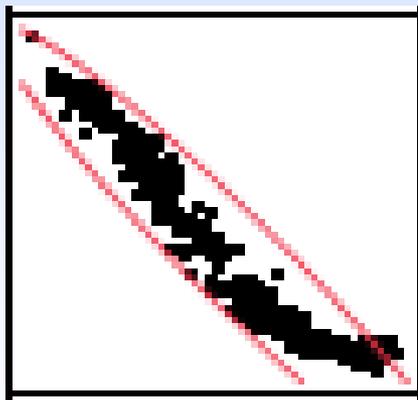
II. Exploratory analysis

Exploratory analysis result (11)

Relational analysis between temperature & heat demand

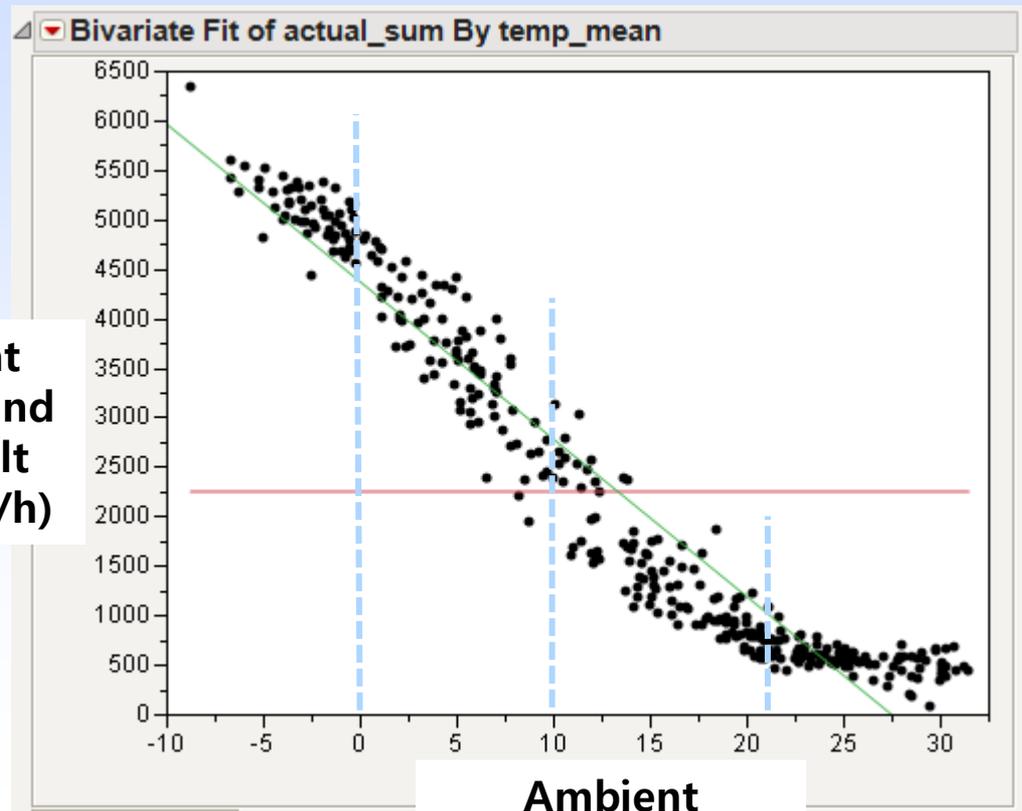
- Correlation is negative (correlation number -0.965)
- Inclination decreases below 0°C, increases between 0~10°C, and becomes zero more than 21°C.

Heat demand result



Ambient temperature

Heat demand result (Gcal/h)



Ambient temperature (°C)

A landscape with a road curving through a green field under a bright sky. The road is a light grey color and curves from the bottom left towards the right. The field is a vibrant green, and the sky is a bright, hazy white with a green gradient at the top.

Improvement direction

III. Improvement direction

Improvement direction

1

Using additional factors

- Using temp. difference as an additional factor in existing model
- Continuous exploration of key factors in each branch
 - Addition of factors that reflects consumer characteristics

2

Utilizing a combination of time series & regression model

- Using time series model as baseline forecasting (considering stability) and correcting it through regression method (ARIMAX)

3

Utilizing forecasting model considered variation of ambient temp.

- Model development in each area considered previous temp. & temp. difference

4

Correction considered the pattern of ambient temp. forecasting error

- Correction of ambient temp. forecasting considered the pattern of temp. forecasting error in each branch, month, and season

Thank you !



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