# Revision of Calorific Value and Carbon Emission Factor for Japanese Inventory - 2014

Dec. 13, 2017

**Kazunari Kainou**

Fellow, RIETI / IAI, Gov. of Japan
Lecturer, GrasPP / University of Tokyo
Member, UNFCCC CDM Executive Board

# Revision of Calorific Value and Carbon Emission Factor for Japanese Inventory 2014

## - Contents -

1- Backgrounds and Motivations
2- Methods for Data gathering, Quantification
3- Major Results
4- Lessons Learned

**The analysis and views addressed in this document are The author's own one, DOES NOT represents any organi--zation's views nor opinions that the author belongs now.**

# 1. Backgrounds and Motivations

## 1.1 Outdated and Inconsistent CEF

**- GCV**

・ Revised by METI, with 5 years interval.

**- CEF**

・ MOE responsible, but most of them are measured in 1992, >20 years ago.

・ Though cross checked in 2006 with IPCC 2006 G/L, mostly outdated.

← **Japanese GCV and CEF was NOT consistently quantified.**

# 1. Backgrounds and Motivations

## 1.2 Issues for the GCV/CEF revision (1)

### - Need for revision

- **Accuracy** of General Energy Statistics gradually degraded by possible bias

### - Obstacles for revision

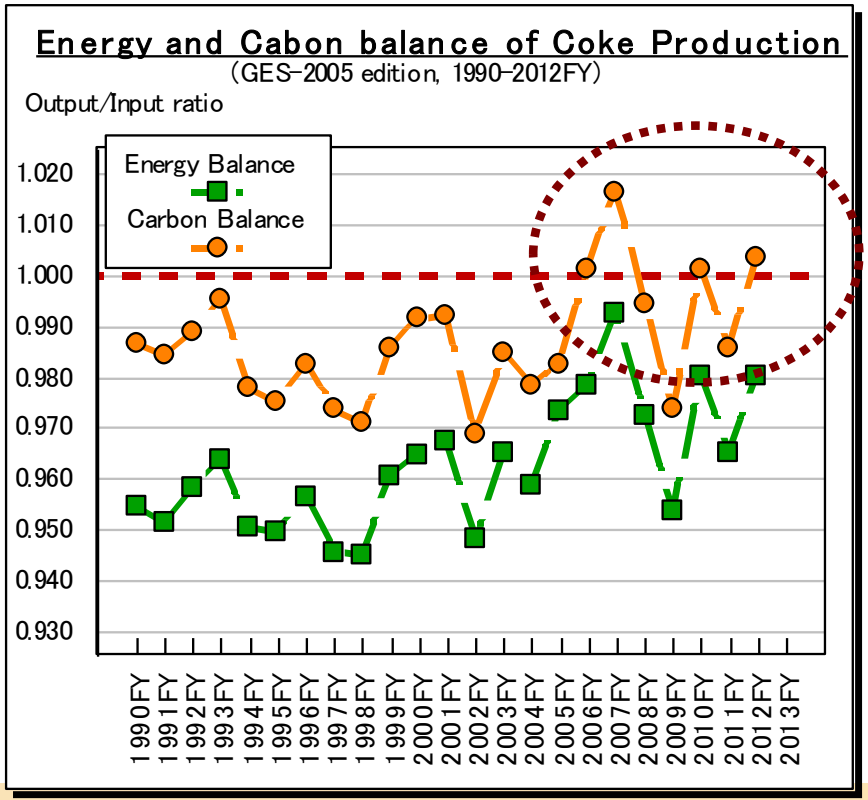
- Frequent revision shall cause **confusion** for the users, need 5 to 10 yr interval
- Sample measurement are fairly **costly** (>$500/sample !) and need great efforts for quantification

# 1. Backgrounds and Motivations

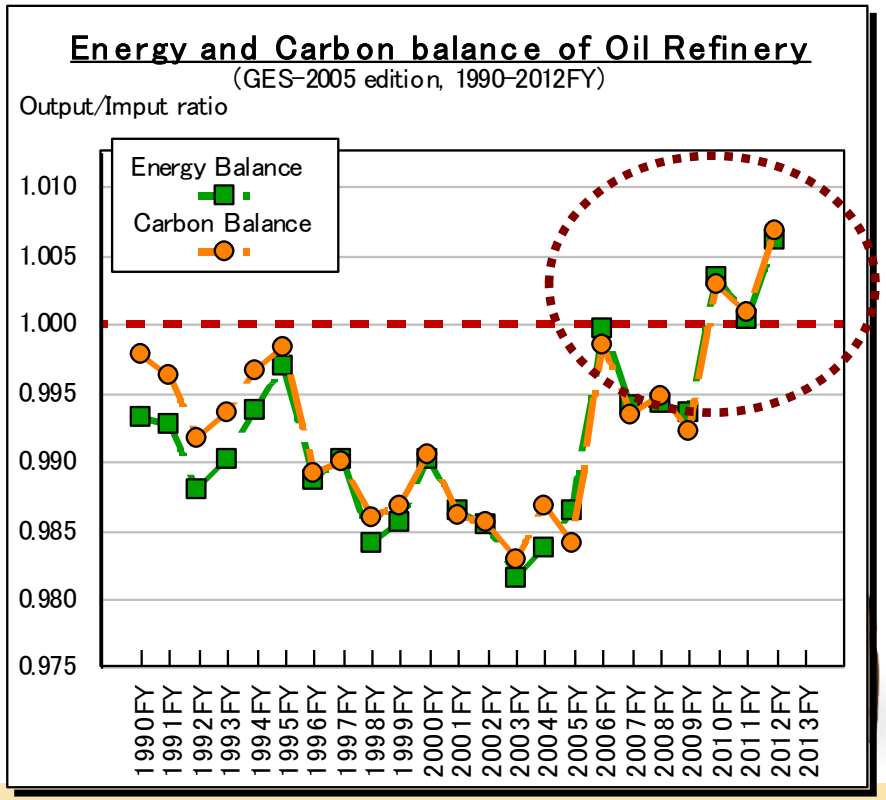
## 1.3 Issues for the GCV/CEF revision (2)

- **Energy & Carbon I/O** in GES Japan

[Coke Production]




[Oil Refinery]



# 1. Backgrounds and Motivations

## 1.4 Agreement of GoJ (2011)

**- Ministerial Cooperation**

・ MOE & METI agreed **joint revision** of GCV and CEF consistently and agreed resource allocation for measurement

**- Official request to Japanese Industry sector for data cooperation**

・ To minimize the budget expend-iture, MOE & METI requested data submission for industry sector

# 2. Methods for Data gather, Quantification

## 2.1 Measures for Valid Data gathering

**- Consistent measurement**

・Quantified chemical composition, GCV, NCV and CEF from **same sample set**

**- Clear condition specification**

・At the startup stage, we clearly specified **measurement condition** of the revision

・"SATP" Standard Ambient Temp.& Pres., 298.15K(25℃), $10^5$Pa

・"ar" As Received for solid fuels

# 2. Methods for Data gather, Quantification

## 2.2 Quantification approaches (1)

**- Gaseous fuels**

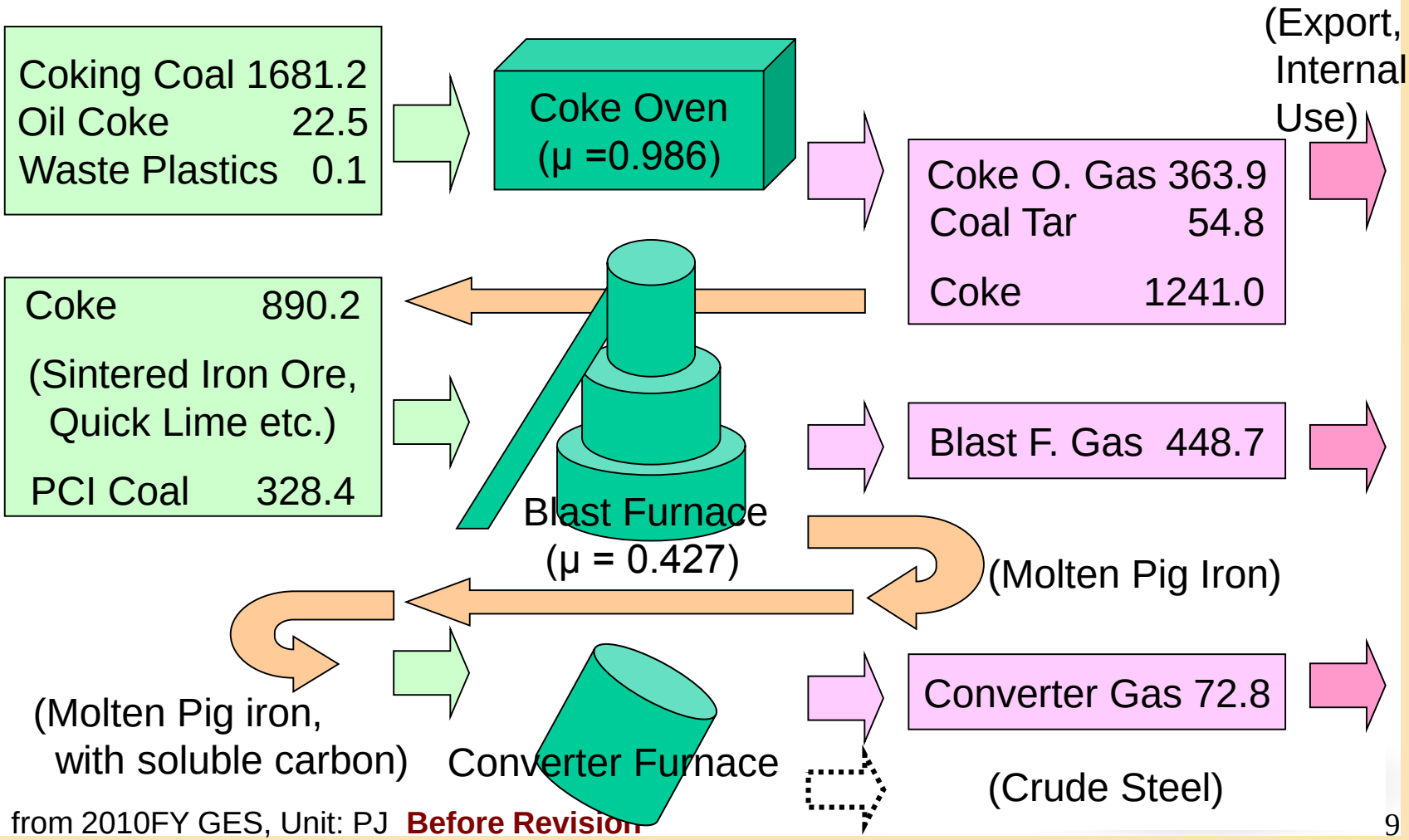
- Gathered **Gas-Chromatograph** data
- Took weighted average of pure gas GCV & CEF etc. using chemical composition

**- Solid/Liquid fuels**

- Gathered **directly measured** GCV&CEF data or asked measurement with fee
- Excluded “measurement condition unknown data” from provided data

# 2. Methods for Data gather, Quantification

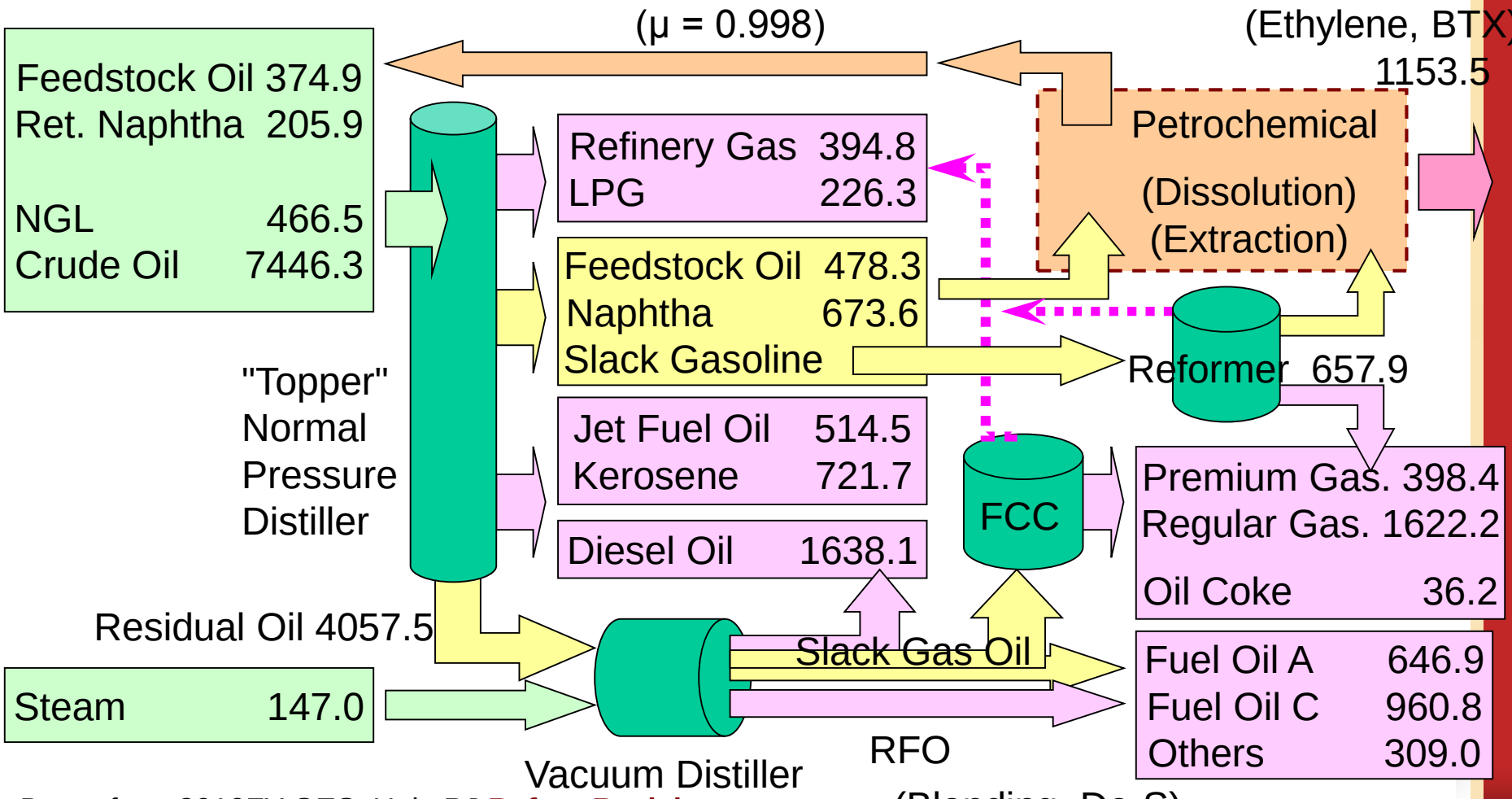
## 2.3 Accuracy check by Iron/Steel model




Data: from 2010FY GES, Unit: PJ **Before Revision**

# 2. Methods for Data gather, Quantification

## 2.4 Accuracy check by Oil Refinery model




Data: from 2010FY GES, Unit: PJ **Before Revision**

# 2. Methods for Data gather, Quantification

## 2.5 Interpolation and QA/QC

**- Interpolation & approximation formula**

・For Coal, Crude Oil and Oil Products, **interpolation & approximation formula** are estimated by regression analysis for possible “calibration” & “adjustment”

**- QA/QC**

・Dare to quantified NCV&(NCV-)CEF to compare **IPCC 2006 G/L data**

・Compared data for verification

# 3. Major Results

## 3.1 Quantification of GCV/CEF

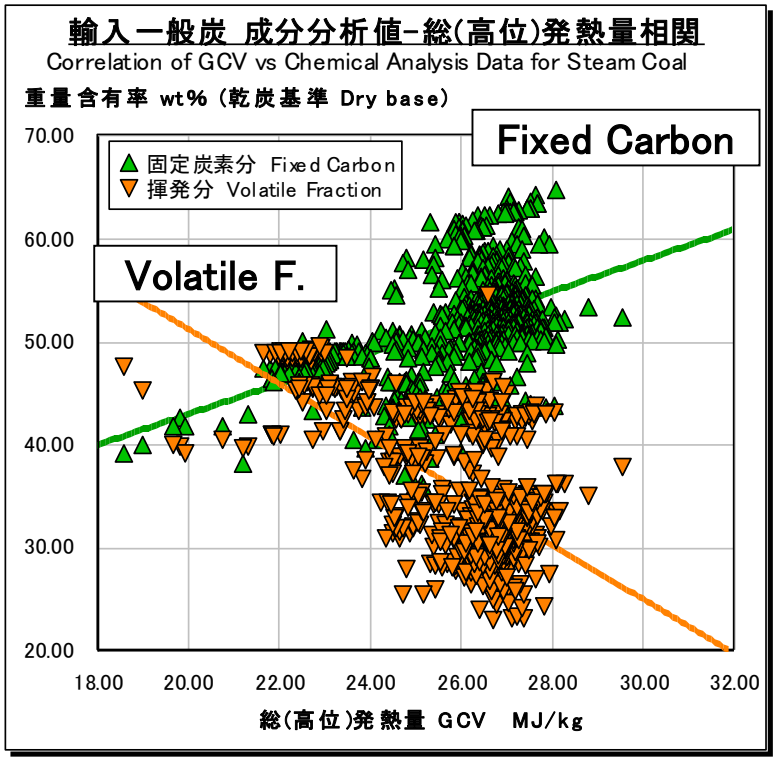
- Quantified GCV, NCV and CEF for various fuels for Japanese standard and GHGs inventory for UNFCCC in 2014
- Approved by Gov. of Japan in 2015
- Detailed values are available here;

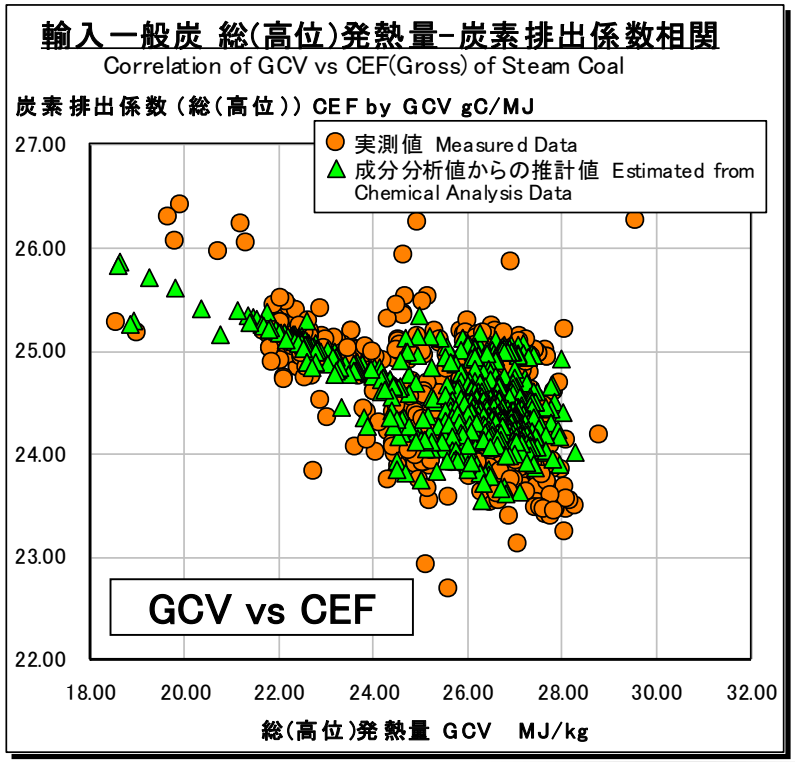
  http://www.rieti.go.jp/users/kainou-kazunari/14j047_e.pdf
- Most of the value proved to be similar with IPCC 2006 G/L default

# 3. Major Results

## 3.2 Quantification of interpolation and approximation formula (1) Coal

GCV= 0.05FC-0.03VF-0.03W-0.21A+0.83S+30.7 $R^2$=0.904

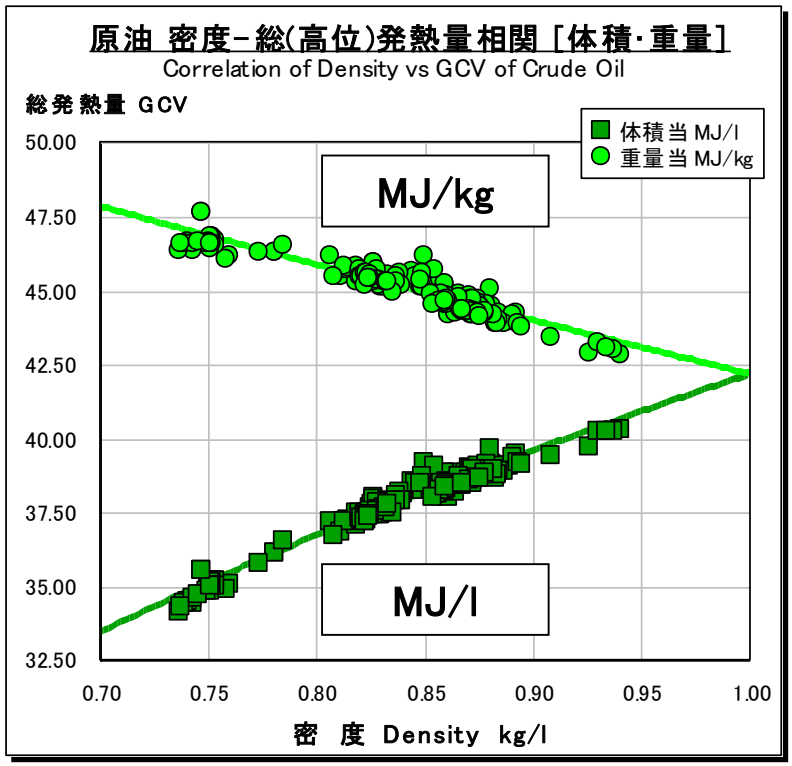


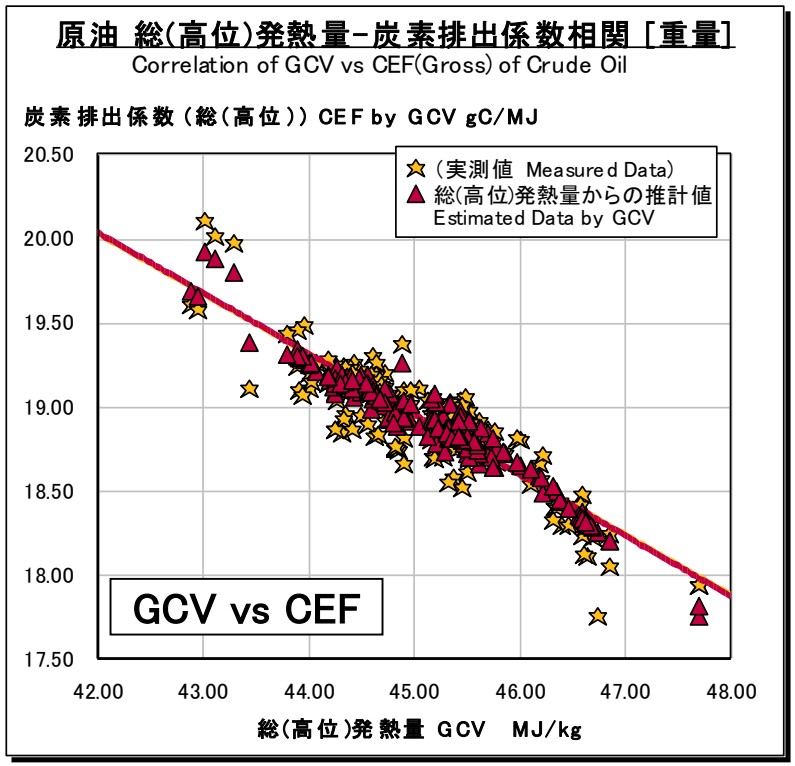



# 3. Major Results

## 3.3 Quantification of interpolation and approximation formula (2) Crude Oil

$GCV = -23.0D^2+73.7D-0.27S-7.47A-0.24W-7.33 \quad R^2=0.982$

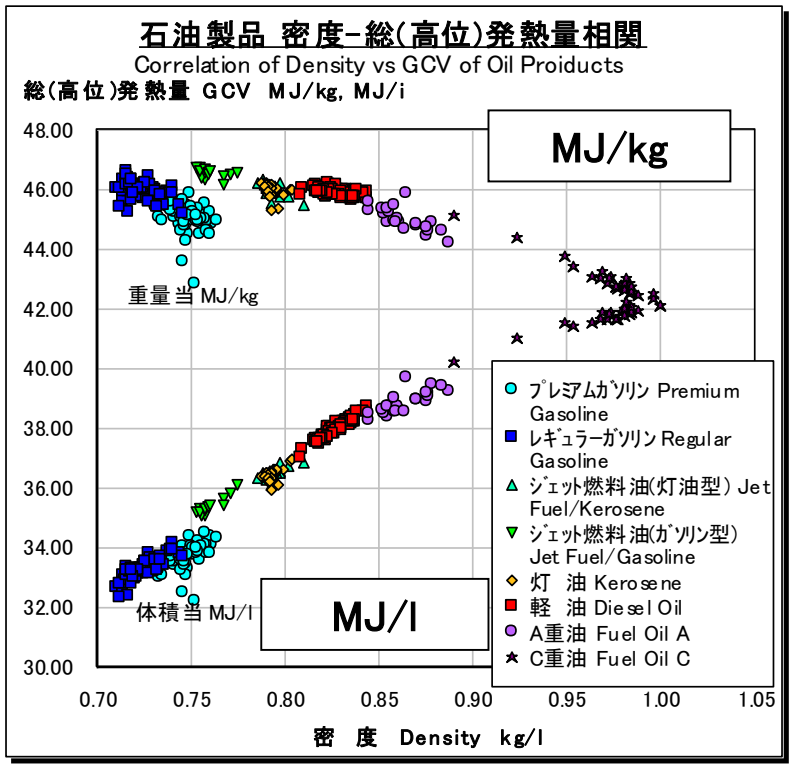


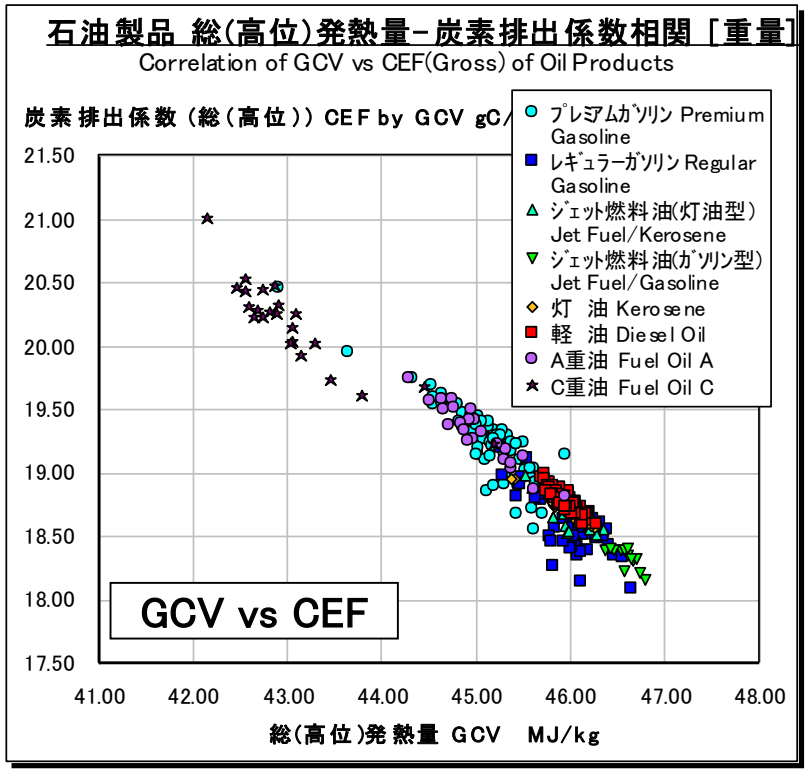



# 3. Major Results

## 3.4 Quantification of interpolation and approximation formula (3) Oil Prod.

$GCV = -26.8D^2+85.7D-0.74S+34.4A-22.8W-14.8 \quad R^2=0.982$

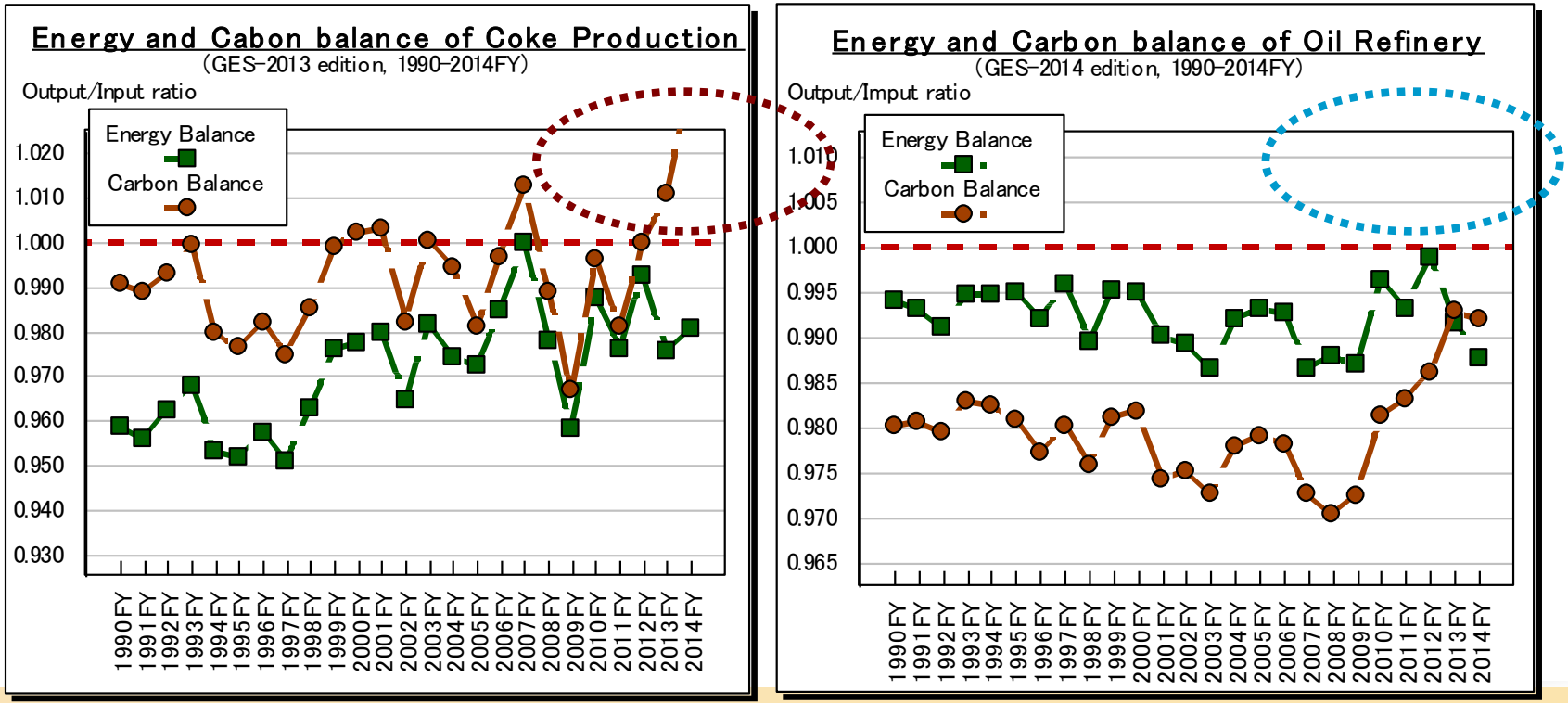


# 3. Major Results

## 3.5 Accuracy improvement by revision

- Oil Refinery I/O seems to have been improved, but needs further efforts



# 4. Lessons Learned

## 4.1 Clear authority commitment needed

- GCV&CEF are used for “de-jure” and “de-facto” mandatory standard in Japan
- In this case, **MOE and METI clearly committed** to the revision and requested cooperation for Japanese industry sector with “**one voice**”
- This kind of comprehensive survey for GCV&CEF revision are far beyond the academia’s efforts reach

# 4. Lessons Learned

## 4.2 Clear prior specification of conditions for measurement were successful

- In this case, due to the delay of MOE & METI budget arrangement, we had **enough preparation time** to design how to quantify efficiently and accurately
- Among all, **clear prior specification and announcement** of measurement conditions (“SATP” & “ar”) played crucial role for valid data gathering

# 4. Lessons Learned

## 4.3 Interpolation & approximation formula of GCV&CEF work well

- For minor fuels and/or marginal change of fuel characteristics are proved to be able to calibrated or adjusted by **inter-polation & approximation formula** with certain accuracy
- This approach shall improve data availability through enabling the use of regular industrial analysis data

# 4. Lessons Learned

## 4.4 Numerical modeling of industrial process in energy statistics helpful

- In this case, Japanese GES have already introduced **numerical modeling** approach for major energy transformation process such as Oil Refinery in 2005
- That approach enabled both **easy identification** of accuracy problems and **clear expression** of the outcome of the improvement