



# How to Promote Energy Conservation Behaviors based on Smart Meter Data Analytics

Case Studies on Energy Advice Reports for Residential and Commercial Customers

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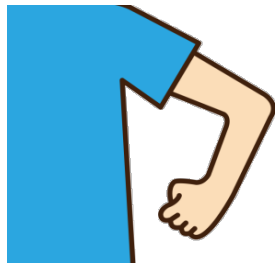
IERE-TNB @ Putrajaya, Malaysia

November 22nd, 2017

 電力中央研究所

# Today's Topics

## ◆ Information provision utilizing 'Nudging' concept



*"A nudge, as we will use the term, is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives."*

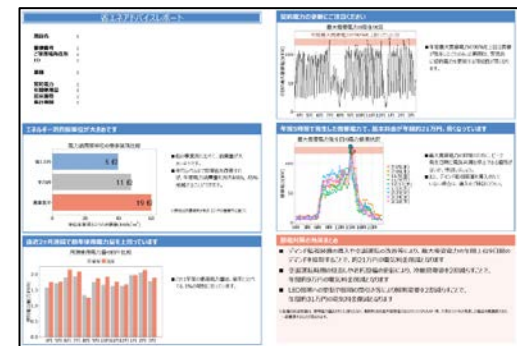
from **"Nudge: Improving Decisions about Health, Wealth, and Happiness"** p.6

## ◆ 'Nudging' consumer's energy conservation behaviors

- Information provision by automatic energy advice generating tools

## ◆ Targets of interventions

- ① Residential sector
- ② Commercial sector



# ① For residential sector

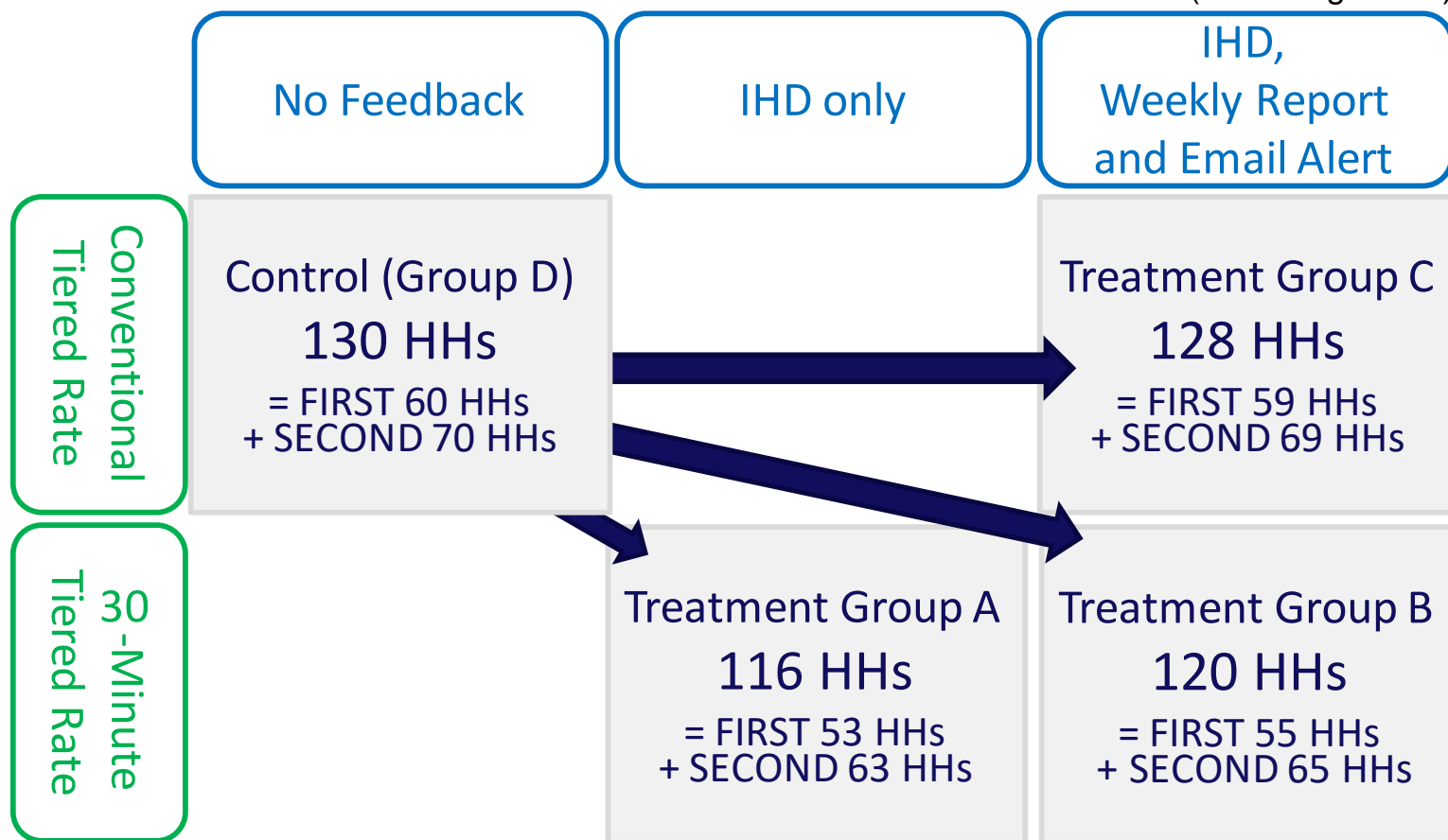
- ◆ Evaluating the peak saving impact of behavioral interventions.
- ◆ Enabled by using “smart meter” data.
  - *Information-based*: (1) IHD, (2) weekly reports, (3) email alert
  - *Price-based*: (4) 30-minute rate - uniformly designed with IHD
- ◆ RCT experiment for 16 months
  - August 2013 to November 2014
- ◆ Around 500 HHs in a condominium participated in the trial
  - From Aug 2013 ... 230 HHs  
(the 1st phase)
  - From Nov 2013 ... 230 + 270 HHs  
(the 2nd phase)



# Randomized experiment

## Information-based interventions (As of Aug. 2014)

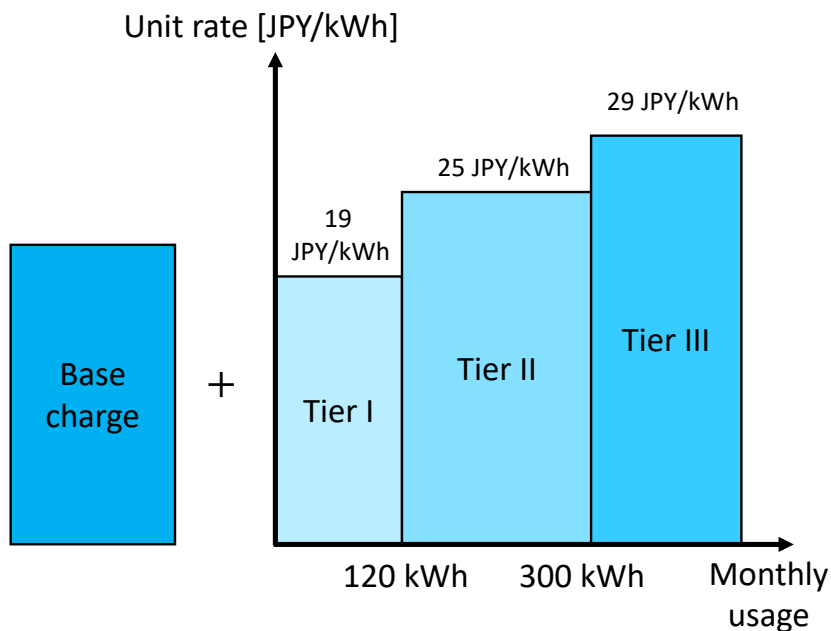
Price-based Interventions



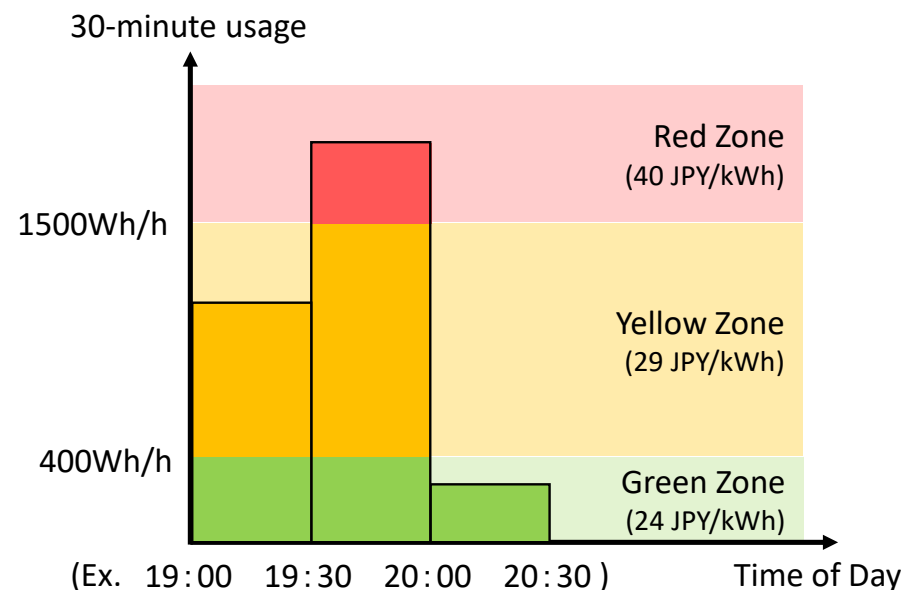
(Note: Control group (group D) is under equivalent situation to the customers of standard TEPCO services.)

# Price-based Intervention

## Conventional Tiered Rate (TEPCO's "Meter Rate Lighting B")



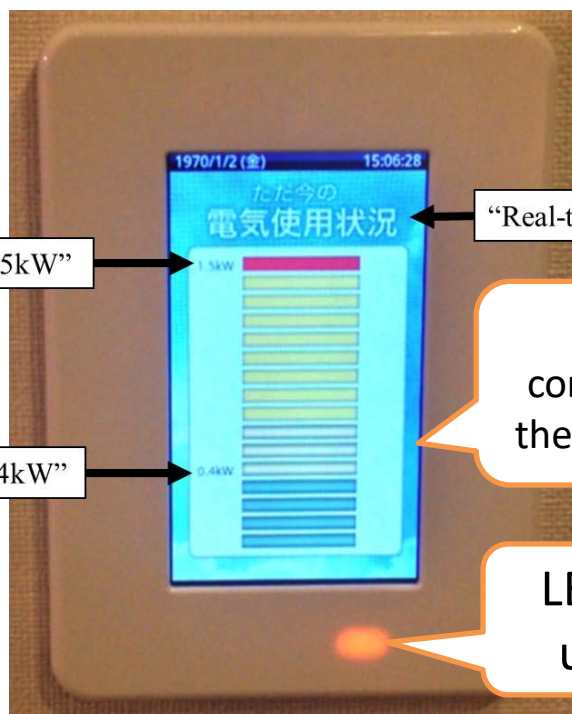
## 30-Minute Tiered Rate (Family-net Japan's "Smart Plan")



The rate increases as a function of 30-min consumption.

# Information-based interventions

## In-Home Display



“Real-time electricity usage”

“1.5kW”

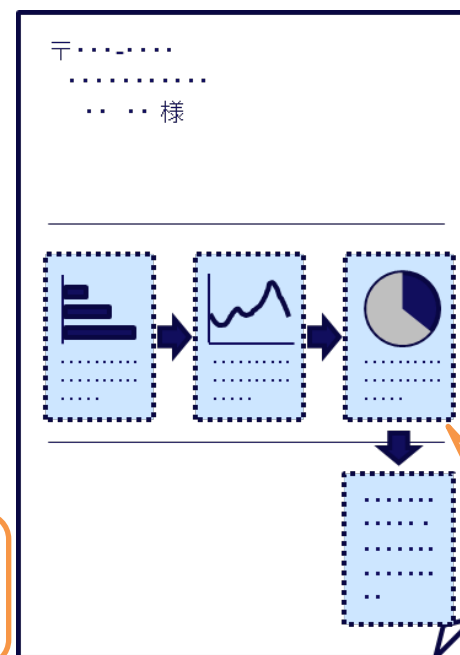
“0.4kW”

Coloring corresponding to the tariff structure

LED blinks when usage > 1.5kW

Real-time usage information  
(Assistive of the 30-min. tiered rate)

## Weekly Report

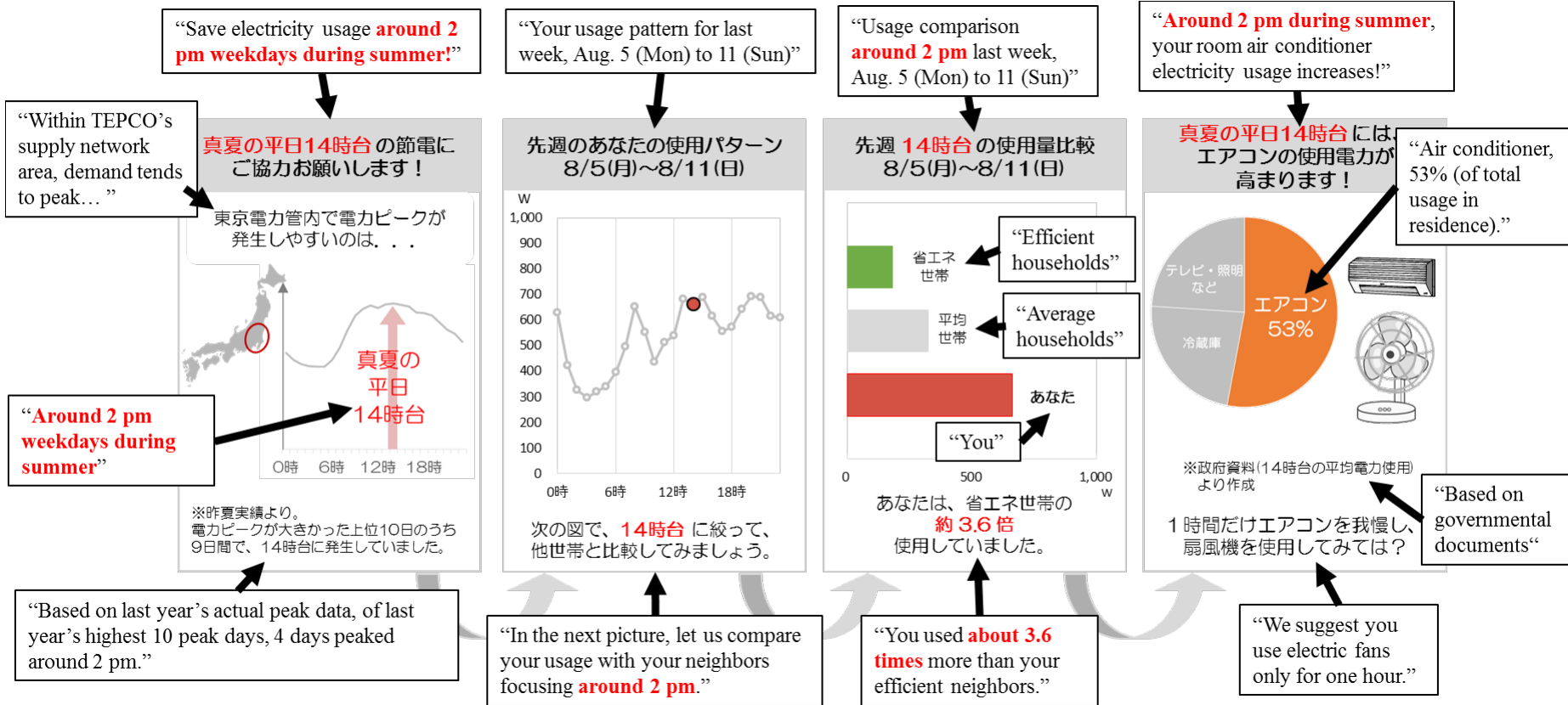


A4-size  
1 page report

Composed of  
4 modules

A variety of information including social comparison of peak time usage

# An example of 'Story'

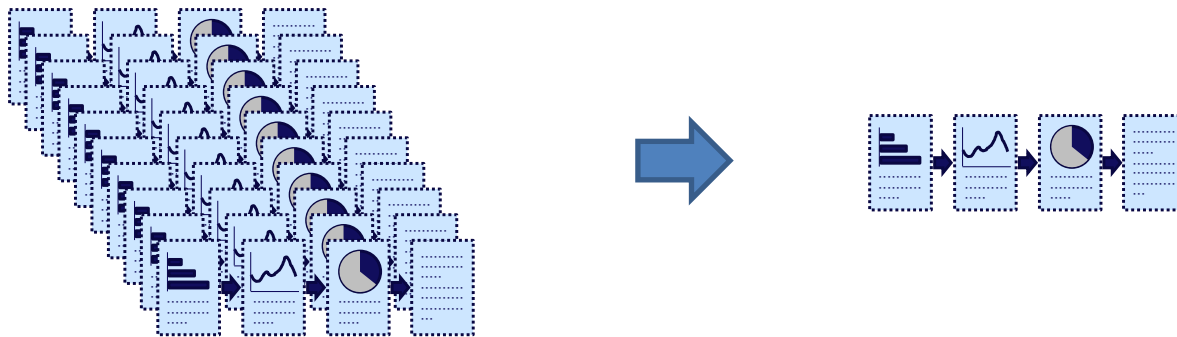


Promote energy conservation in system demand peak time by social comparison.

# Personalized story selection



A story automatically chosen by monitoring the 30-min interval data was provided to each household every week

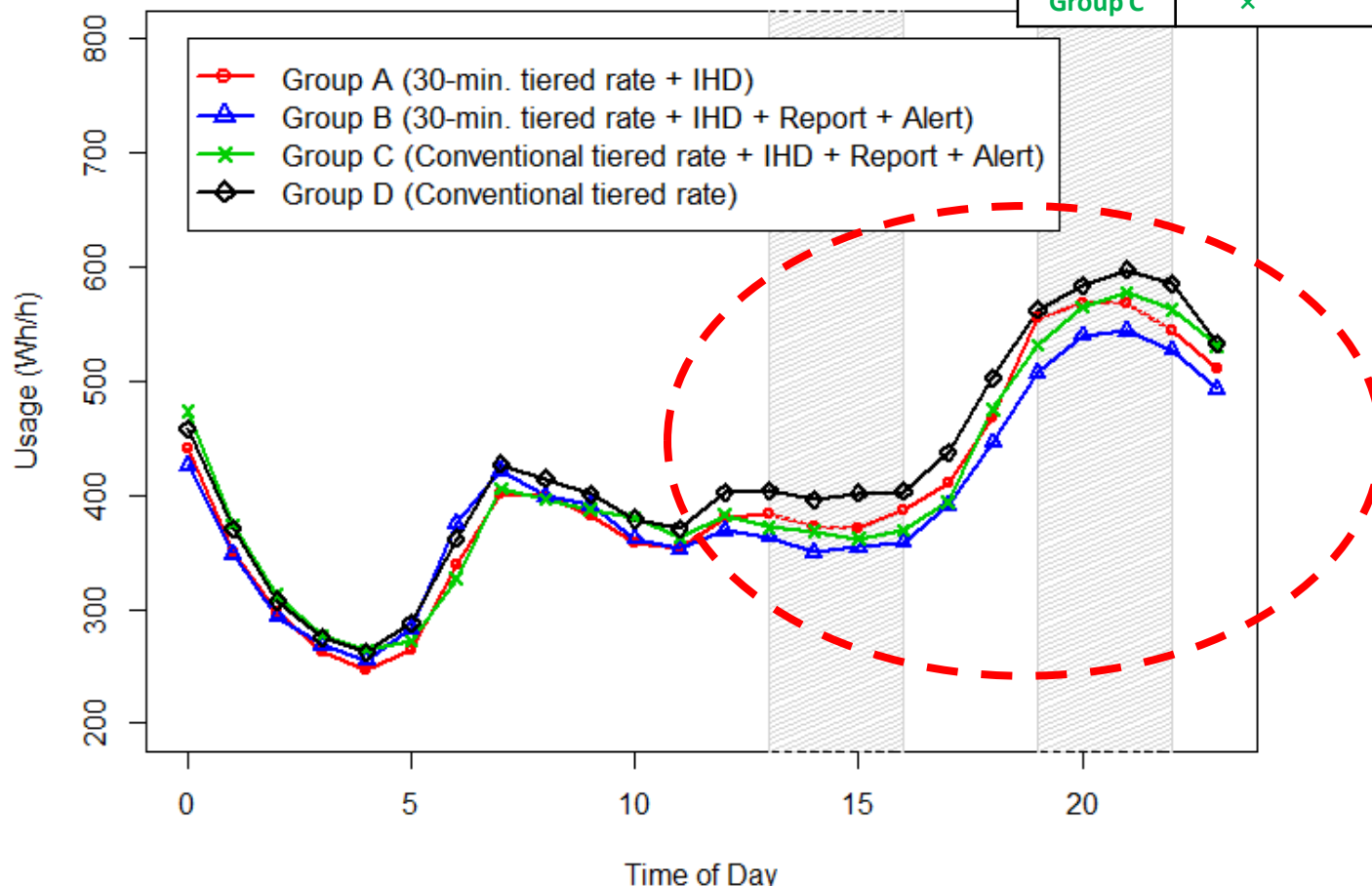


- A story estimated to be effective is chosen for each household
- Messages/advices consider the reporting season
- Stories recently provided are not chosen so as not to get customers bored



# Hourly Usage

	30-min. tiered rate	IHD	Report + Alert
Group A	●	●	×
Group B	●	●	●
Group C	×	●	●



The treatment groups showed usage reduction compared to the control group

## ② For Commercial sector

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- ◆ Adoption of smart-meters is accelerating
  - Growing amount of interval data available for energy efficiency services
- ◆ Expanding energy audits to SMEs is necessary
  - Public audit programs can reach only a fraction of SMEs
  - Traditional audits are cost- and time-intensive
- ◆ Targets
  - Utilities, Energy service providers, Multi-site companies with interval electricity meters

# Input and output of our tool

## 30-minites interval data

	ID1	ID2	ID3	ID4	...
2015/4/1 0:00	368	184	258	161	...
2015/4/1 0:30	368	161	258	138	...
2015/4/1 1:00	368	161	258	184	...
2015/4/1 1:30	368	184	129	184	...
2015/4/1 2:00	368	138	258	161	...
2015/4/1 2:30	345	161	258	161	...
2015/4/1 3:00	322	161	129	184	...
2015/4/1 3:30	345	161	258	138	...
2015/4/1 4:00	345	138	258	161	...
2015/4/1 4:30	345	161	129	161	...
2015/4/1 5:00	322	138	258	161	...
2015/4/1 5:30	322	184	129	138	...
...	...	...	...	...	...

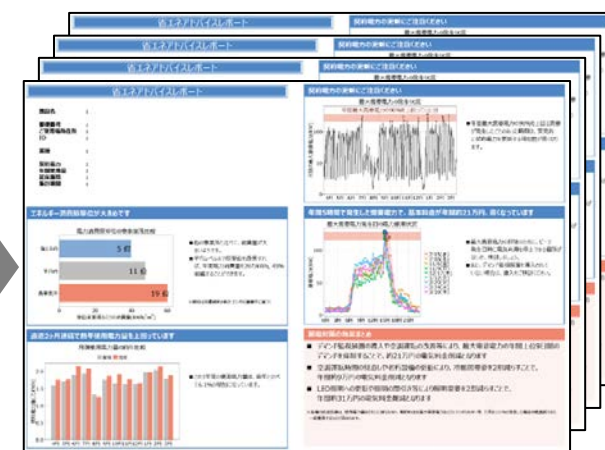
## Basic demographic data (\* optional)

	Building type	Address	...
ID1	...	...	...
ID2	...	...	...
ID3	...	...	...
ID4	...	...	...
ID5	...	...	...

Temperature  
(public data)

Our report  
generator

## Customized energy saving advice reports



# 2 pages, A4 size paper, by mail, twice a year

## Energy Saving Advice Report

Company profile

.....

.....

Building type

Data description

### Advice no.1



.....

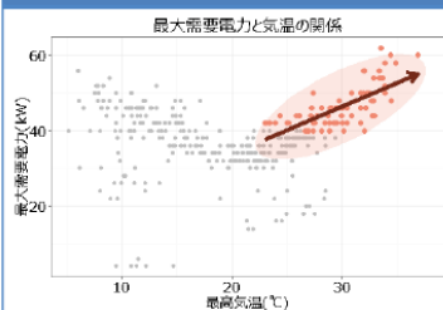
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### Advice no.2



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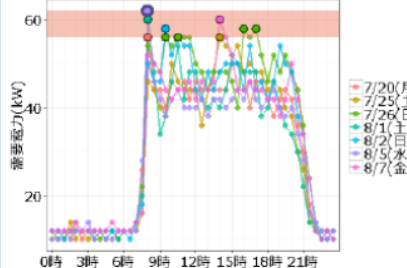
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### Advice no.3

最大需要電力発生日の電力使用状況



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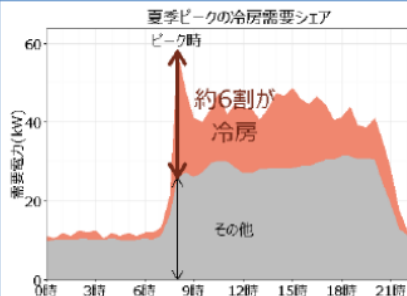
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### Advice no.4



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### Summary of recommendations

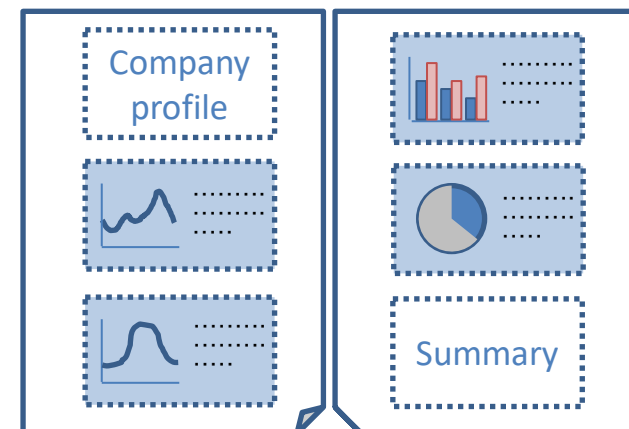
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# Design and selection of advices

Approaches for designing advices

1. Fault detection
2. Simplified disaggregation
3. Social comparison (benchmarking)
4. Selective visualization

Select the most important 4 advices for each building

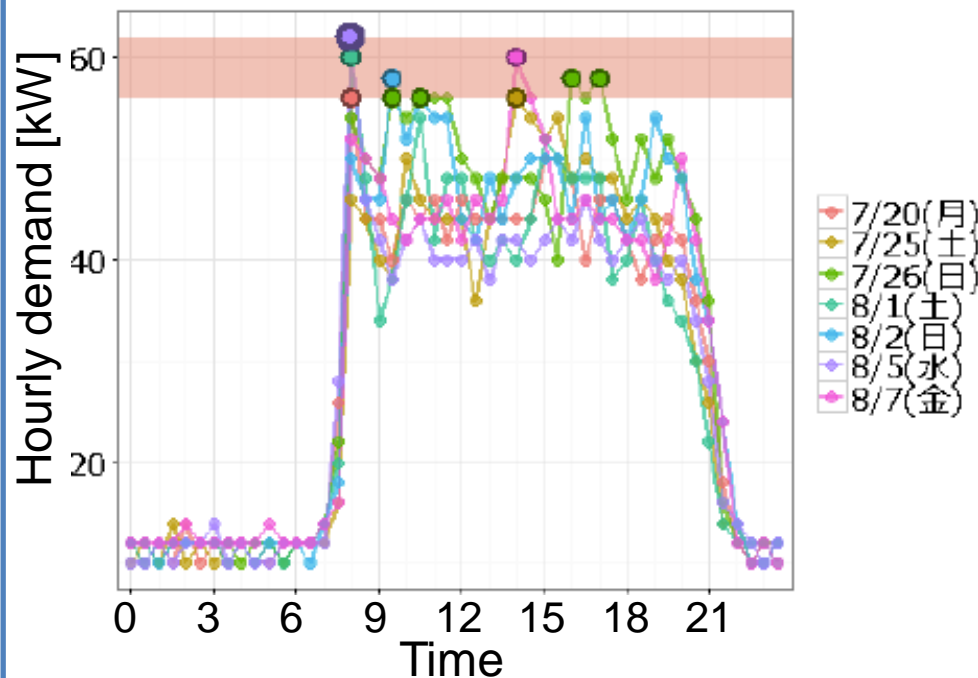


# 1. Fault detection

*Example: detecting unnecessary demand increases focusing on time of day.*

The maximum demand was increased by 6 % in the highest 5 hours.

Hourly demand in days with highest demands in a year

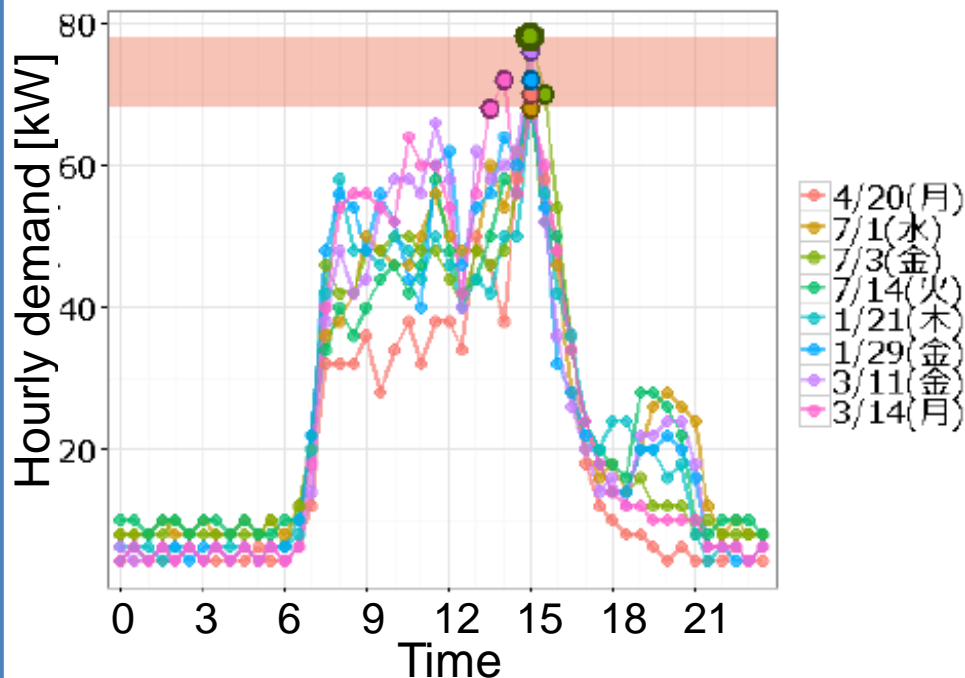


- To avoid demand peaks, be careful for operation of air-conditioning, when e.g. starting-up, or extremely hot.
- Check if any equipment can be stopped in a peak time.

# 1. Fault detection (cont.)

The maximum demand was increased by 13 % in the highest 5 hours.

Hourly demand in days with highest demands in a year

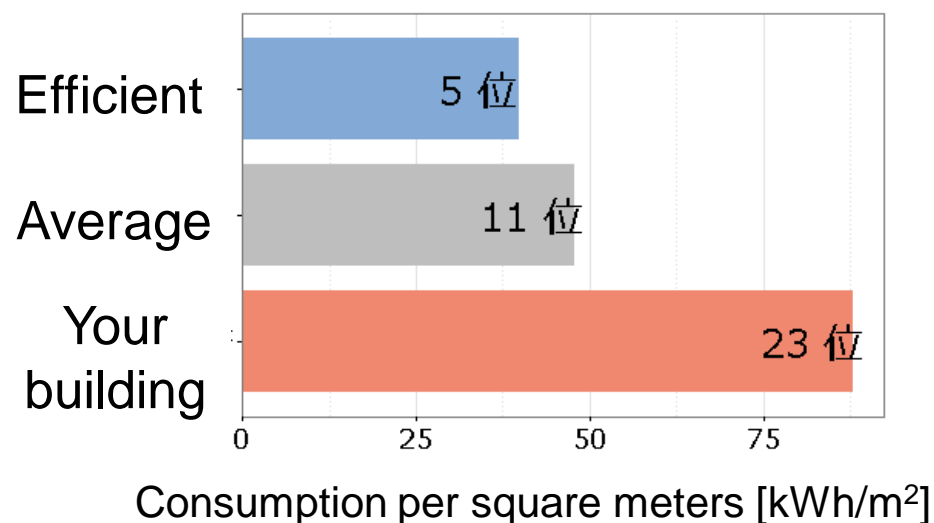


- To avoid demand peaks, be careful for operation of air-conditioning, when e.g. starting-up, or extremely hot.
- Check if any equipment can be stopped in a peak time.

## 2. Social comparison (benchmarking)

*Example: benchmarking of **yearly kWh per m<sup>2</sup>**.*

Your building consumed more than similar ones



- Your building consumed more than similar ones last year, and ranked 23rd out of 25.
- If you reduce consumption to the average level, it will save 40% of your total consumption.

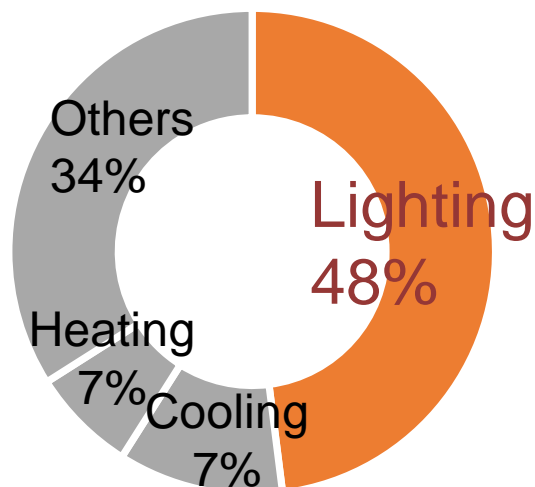


### 3. Disaggregation by end use

*Example: Disaggregation highlighting the **lighting demand**.*

Lighting accounted for 59% of total consumption last year.

Share of electricity  
consumption by end-use

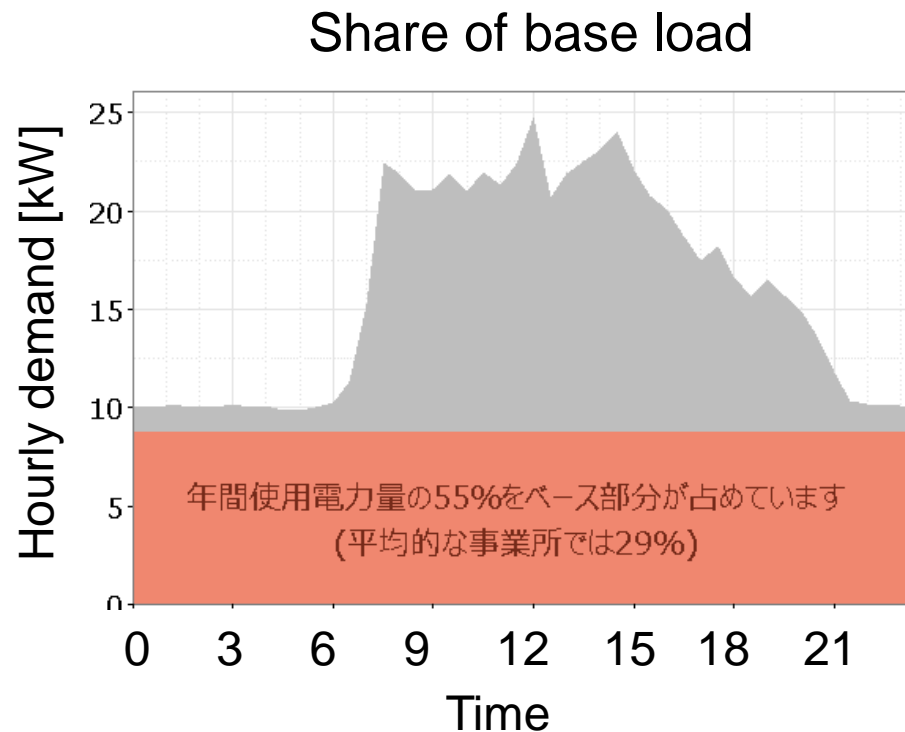


- This can be saved by reducing lamps and replacing with LED lighting.
- Measure the lighting levels and you will find areas with excessive lighting.

### 3. Disaggregation by end use

*Example: Disaggregation highlighting the **base load**.*

Saving base load by 5% reduces 60 thousand yen of electricity bill per year

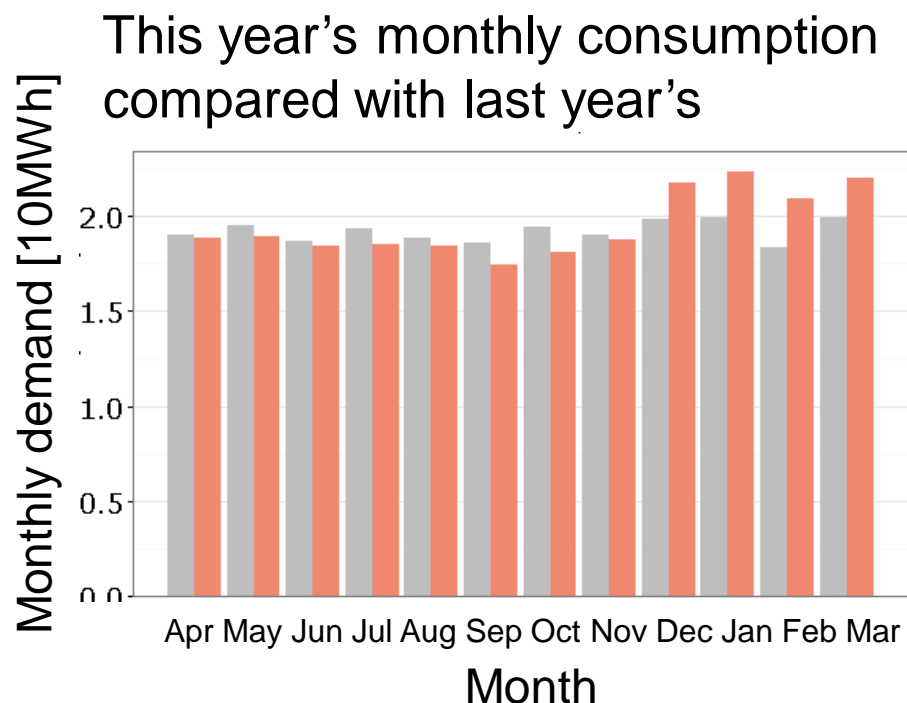


- Consumption is large not only on operating days but also at midnight or on non-operating days, and the share is high compared to other buildings.
- Saving base load by 5% reduces 60 thousand yen of electricity bill per year.
- Turn off power completely after work and check if you have equipment that can be stopped at night or on non-operating days.

## 4. Selective visualization

*Example: comparison of **monthly** consumption with last year's.*

Consumption increased in the last four months sequentially



- Consumption of this year was 5% larger than last year's.
- Identify the causes that increased the consumption.

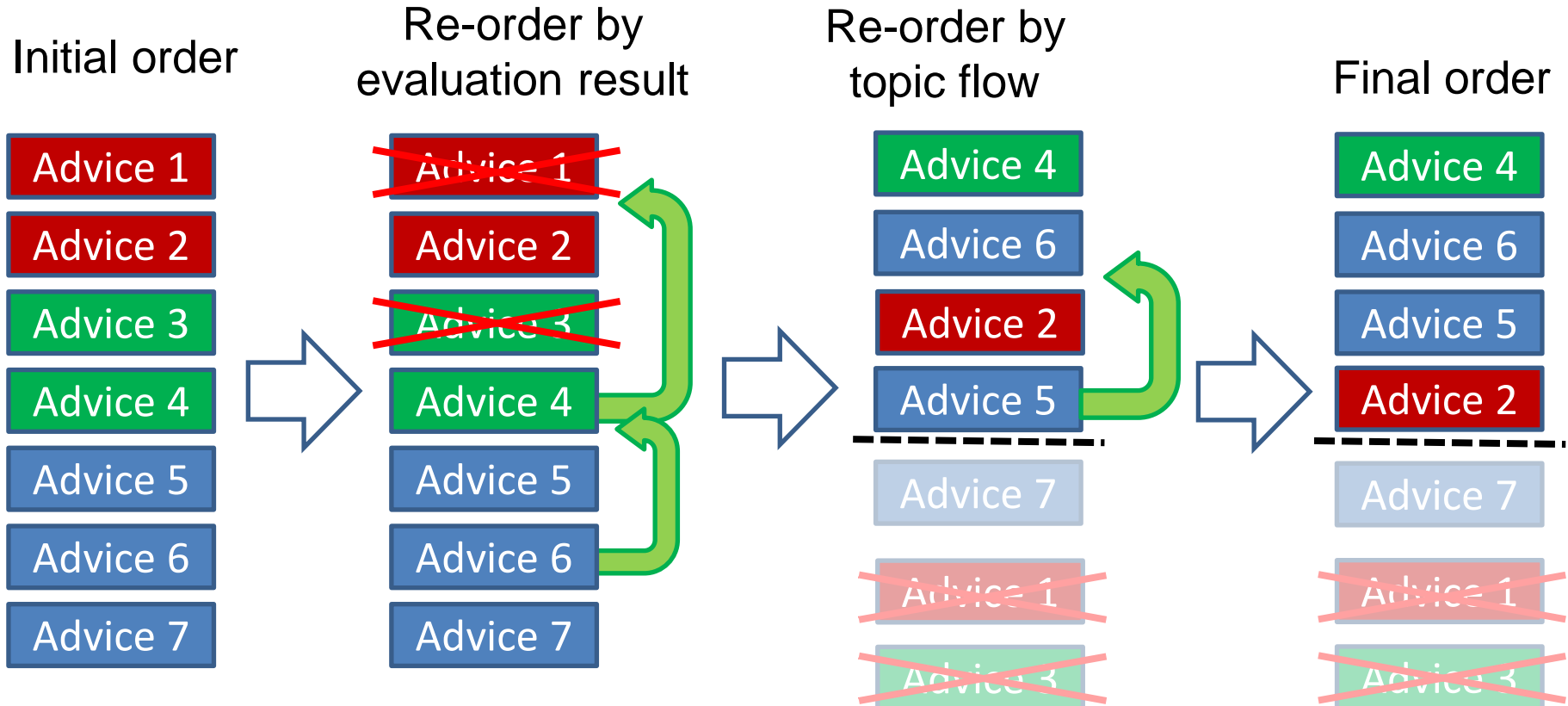
## 5. Summary

### Summary

- Introducing demand monitors or improving operation of air-conditioning to reduce the maximum demand in the 3 highest demand days could result in saving 210 thousand yen per year.
- Improving operation time of air-conditioning or updating old equipment to reduce 20% of air-conditioning demand days could result in saving 140 thousand yen per year.
- Replacing with LED or reducing lamps to reduce the lighting demand could result in saving 220thousand yen per year.

- Summary is always appeared in the end of reports
- If the savings of electricity bills are small, the terms are omitted.

# Selection of advice



# An example of output

## 省エネアドバイスレポート

施設名 : 様  
 郵便番号 :  
 ご使用場所住所 ID : CL35  
 業種 : 文化福祉  
 契約電力 : kW (2014年)  
 年間使用量 : kWh (2014年)  
 延床面積 : m<sup>2</sup>  
 集計期間 : 2015年4月~2016年3月

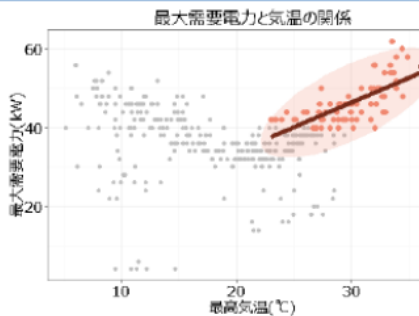
Company profile and other relevant information

### 契約電力の更新にご注意ください



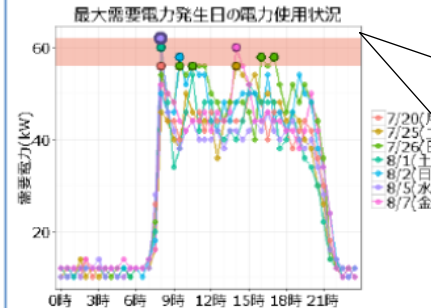
- Highlights that the peak demand tends to emerge in August.  
 - Suggests actions to prepare for the summer.

### 暑い日は契約電力の更新に要注意です



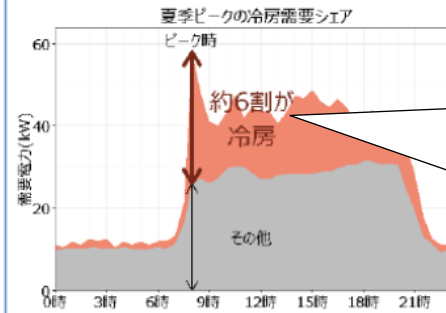
- Highlights the correlation between maximum demand and outside temperature.  
 - Emphasizes the importance of demand control when it is hot.

### 年間5時間で発生した需要電力で、基本料金が年間約10万円、高くなっています



- Shows that the highest demand is always just after opening time  
 - Recommends improving HVAC start up.

### ピーク時の需要電力の約6割が空調です



Indicates the share of HVAC to the peak time usage at 8 am.

### 節電対策の効果まとめ

デマンド監視装置の導入や空調運転の改善等により、最大需要電力の年間上位7日間のマンドを抑制することで、約10万円の電気料金削減となります  
 調運転時間の見直しや老朽設備の更新により、冷暖房需要を2割減らすことで、間約7万円の電気料金削減となります  
 ED照明への更新や照明の間引き等により照明需要を2割減らすことで、間約18万円の電気料金削減となります

Summary of applicable actions and the potential savings

## Responses from energy managers

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- ◆ “Useful to understand the patterns of electricity usage, since we do not have demand monitors.”
- ◆ “Can be utilized as important materials for planning EE measures.”
- ◆ “Too busy to take a look.”
- ◆ “We’ve already done those recommendations.”

**THANK YOU VERY MUCH  
FOR YOUR ATTENTION!**

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