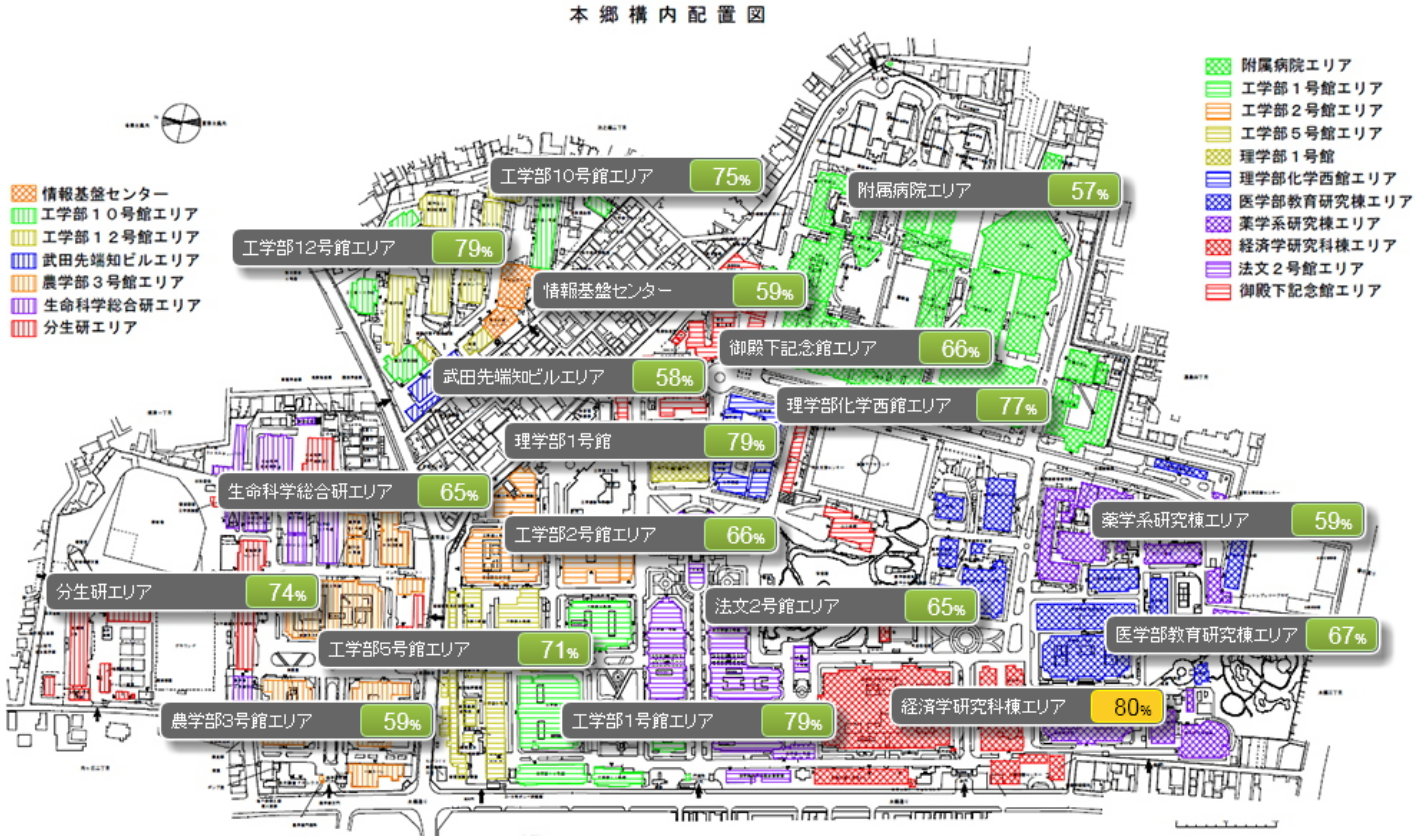
Power Data Management on the Internet Space: Case Study in the University of Tokyo

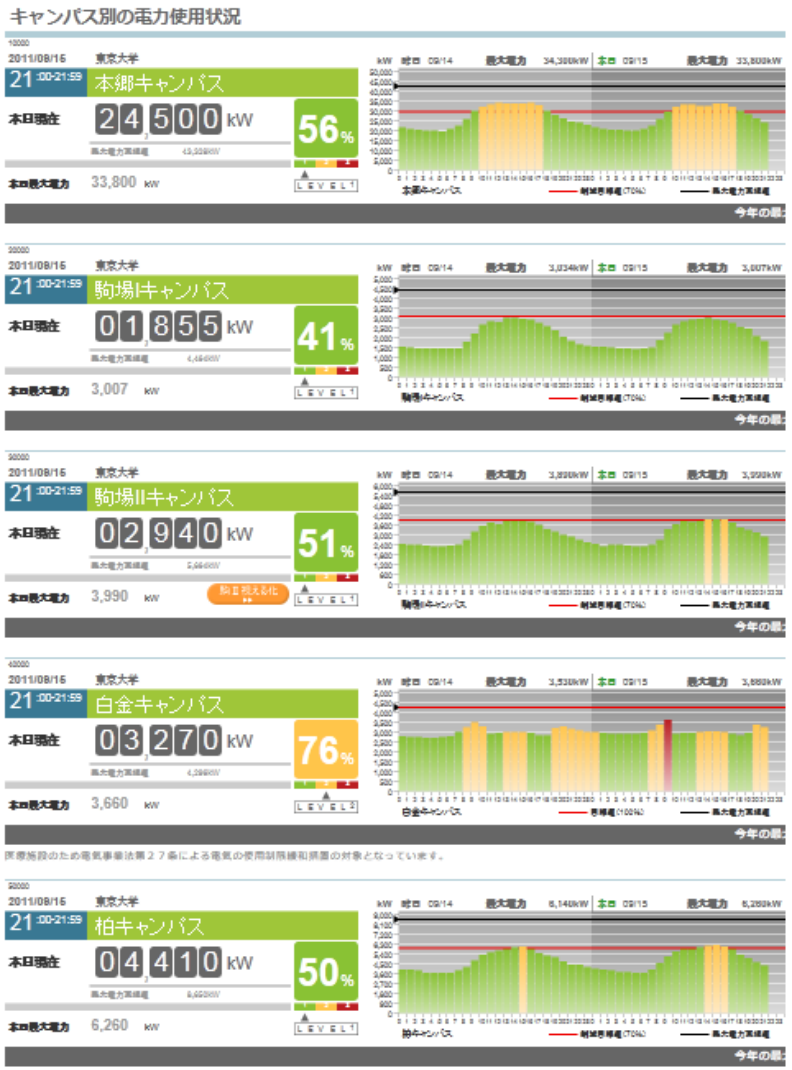


Hideya Ochiai, Ph.D.,
The University of Tokyo

In July, 2011
Visualization of Electric Power began in UoT

- Features
  - Integration of 5 Campuses
  - Aggregated power exceeds 50MW

- Background
  - M9.0 Earthquake
  - Power Plants Damaged
  - Power Shortage in Summer
  - Peak Shifting
  - Work in Holiday
  - …



Campus-Level Electric Power Visualization of the University of Tokyo

UoT is 50 MW electric power consumer

- UoT consumes the 1/1000 power of Tokyo Electric Power Company
- Hongo campus is known as the worst CO2 emission organization in Tokyo (at least in the past).
- 50 MW corresponds to the consumption of the houses of Bunkyo-ward of Tokyo.

- How big is 50 MW ?
  - 50 MW can boil 100ℓ water in 1 second.
  - 50 MW can make 250 ton's train to 100km/h in 2 seconds.
  - 50 MW x 1 hour costs 10,000 USD (if 1kWh is 24JPY).

M9.0 Earthquake in Japan

- 2011-03-11 14:46, M9.0 earthquake attacked the east side of Japan.
- Tsunami hit the coast line around 16:00, and destroyed many cities, villages, power plants … .

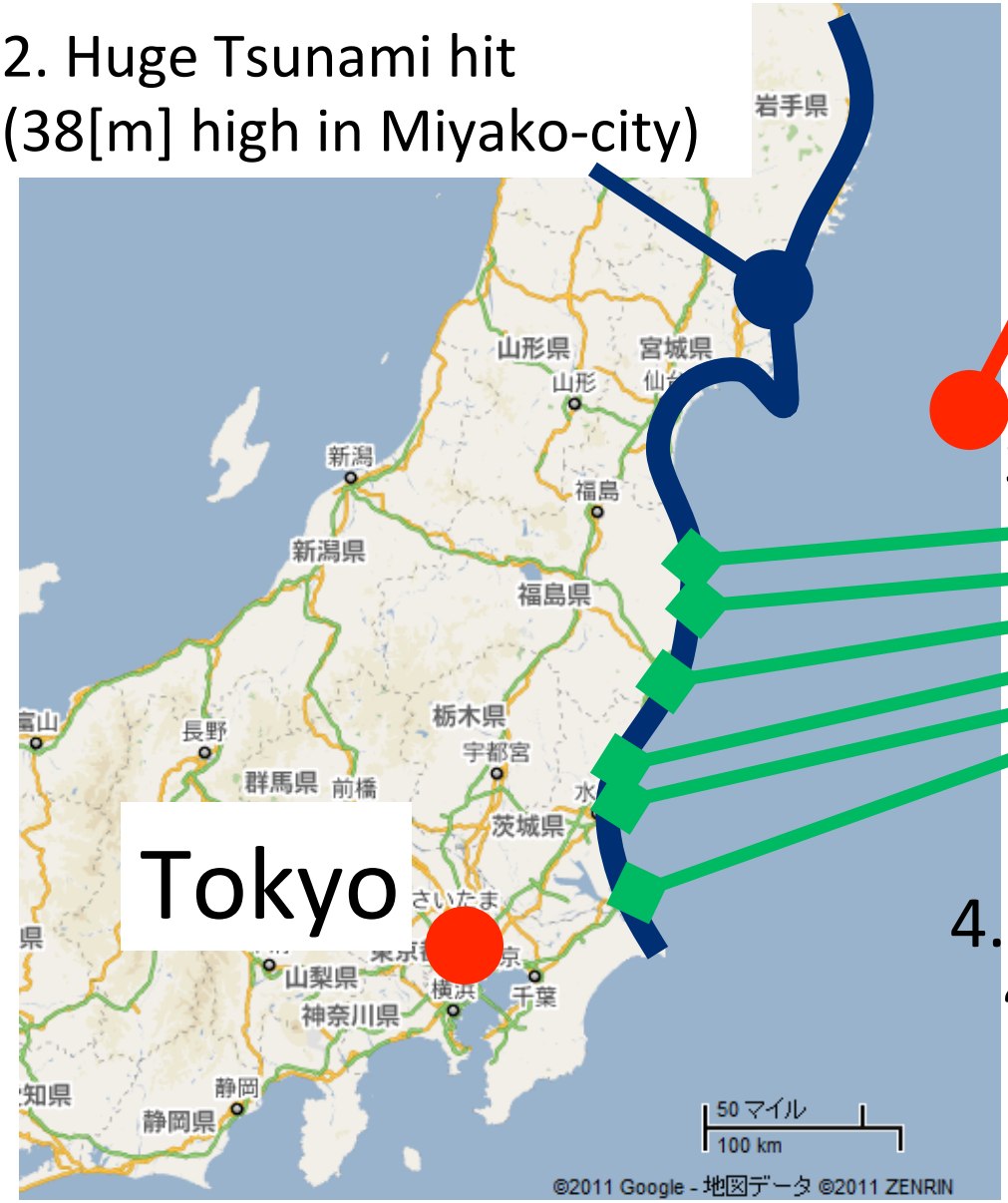
Cite: http://f.hatena.ne.jp/yonta24/20110312145623

Cite: http://www.防災グッズ通販.biz/tsunami.html

http://www.youtube.com/watch?v=v6C09V0PcFI
http://www.youtube.com/watch?v=NW7vENdDu1o

Severe Electric Power Situation cased by Tsunami disaster

2. Huge Tsunami hit
(38[m] high in Miyako-city)



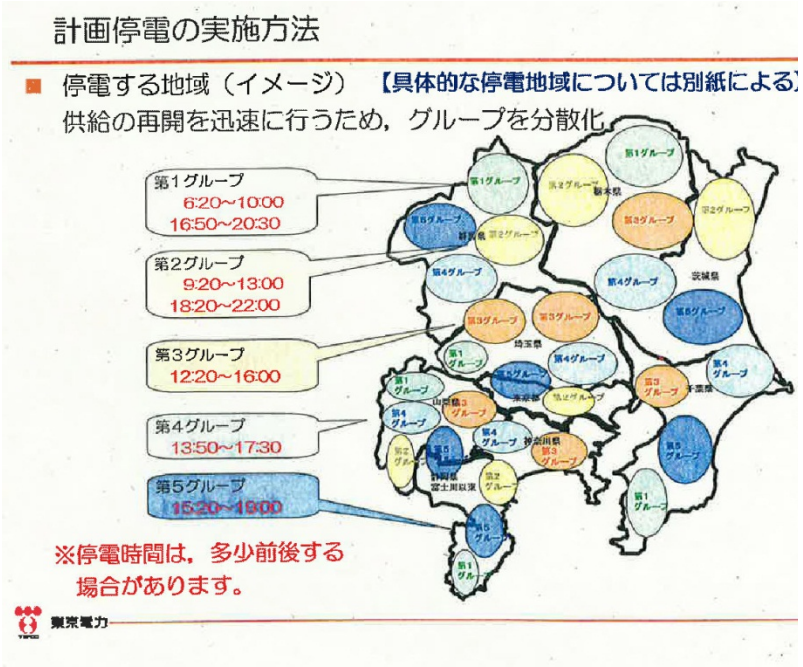
1. Earthquake (M9.0)
11th Mar. 2011

3. Damaged Power Plants (for Tokyo
- Fukushima Daiichi Power Plant (nuclear)
- Fukushima Daiini Power Plant (nuclear)
- Hirono Power Plant (thermal)
- Tokai Daini Power Plant (nuclear)
- Hitachinaka Power Plant (thermal)
- Kashima Power Plant (thermal)

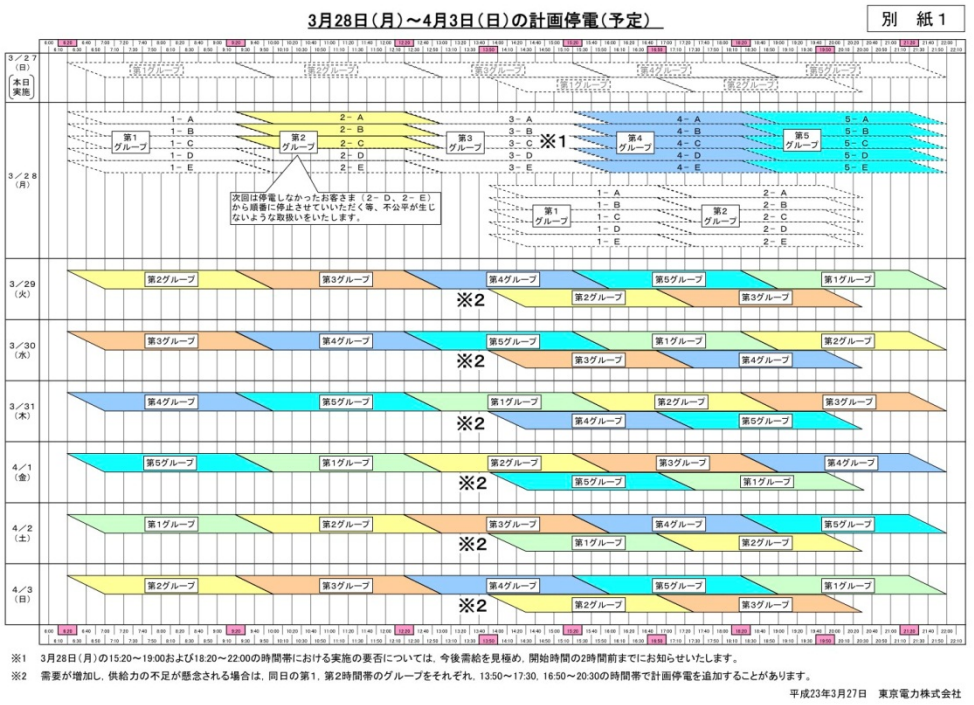
4. We have faced
“shortage of electric power”.

Load Shedding (Rolling Blackout)

Blackout Area Groups

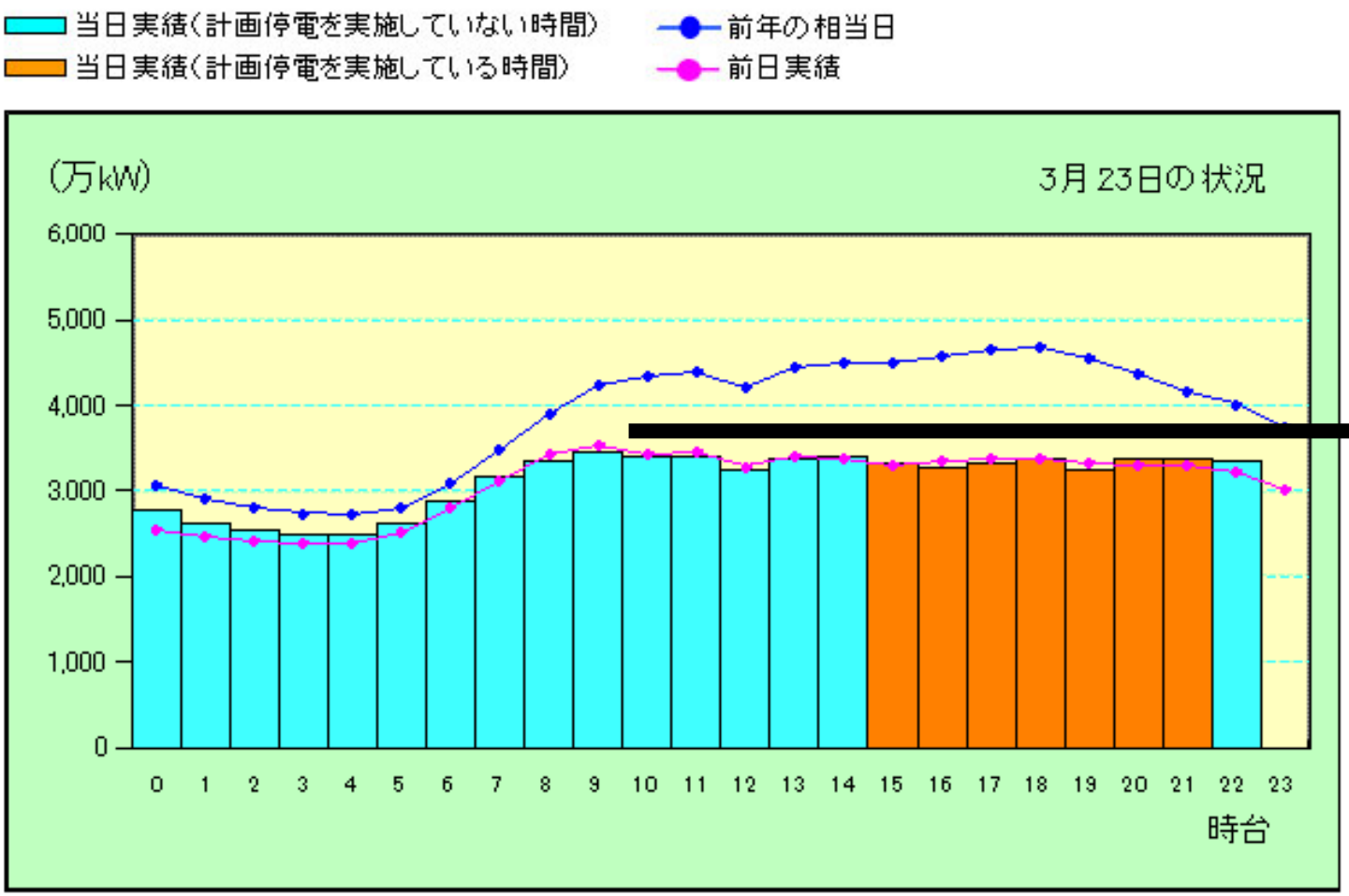


Blackout Schedule



Load Shedding on 23rd March (12days after the earthquake)

本日は、15:20～22:00 に計画停電を予定しています。

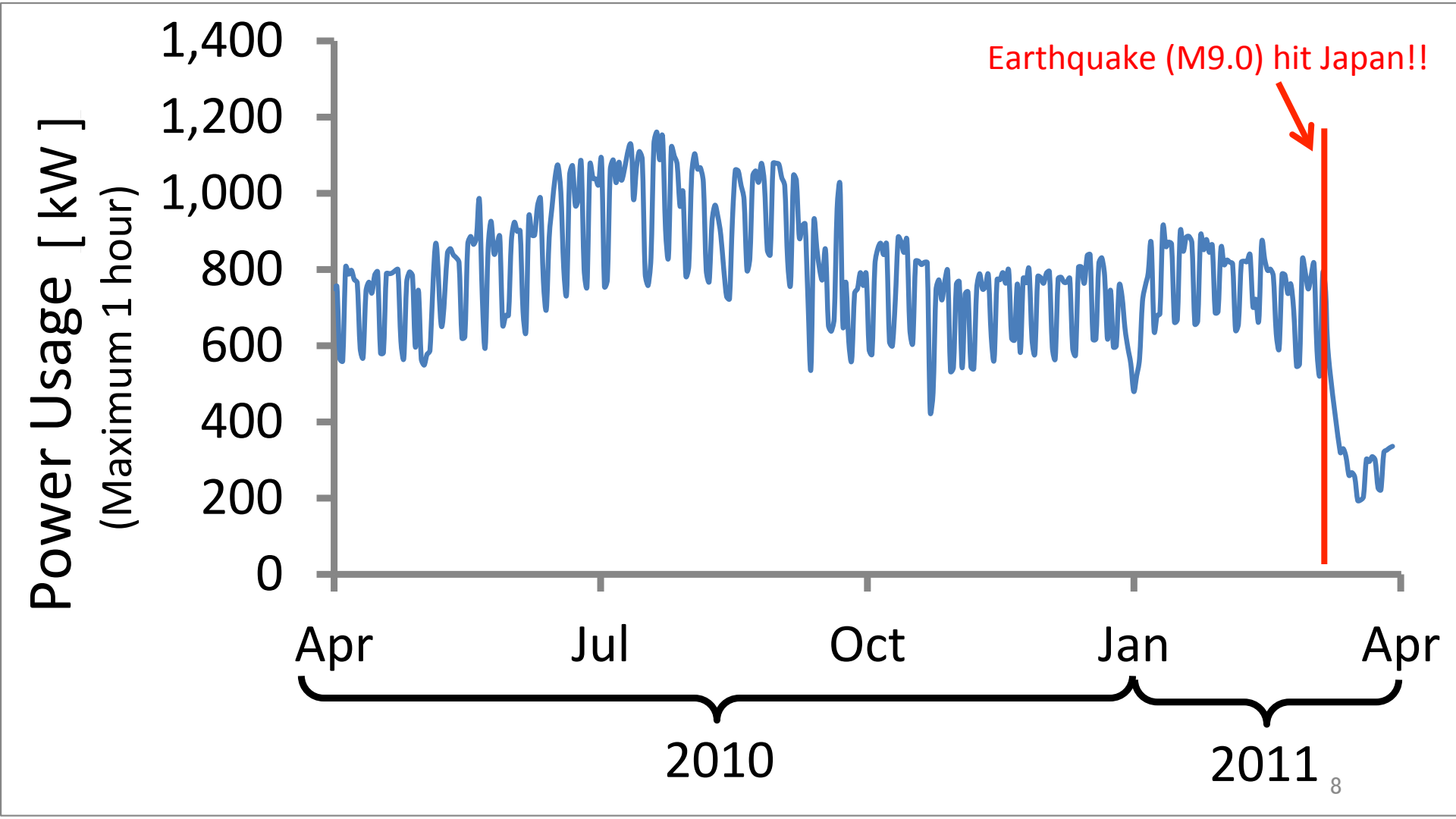


Power Supply Capacity

本日のピーク時供給力：3,750 万kW (3月23日 1時5分更新)

Great Impact to the Electric Power Usage

Eng. Bldg. 2
University of Tokyo



Severe Power Situation Continued …

- Load Shedding finished after 28th March.
  - Continued 17days after the earthquake.
- Spring season (April, May, June) was OK.
  - People don't use electricity.
- Another crisis was coming in the summer season (July, August, September).
  - Recovery of power plants needs a lot of time.

- Japanese government forced us "15% power saving".
- The University of Tokyo declared "30% power saving".

30 % power saving … How ?

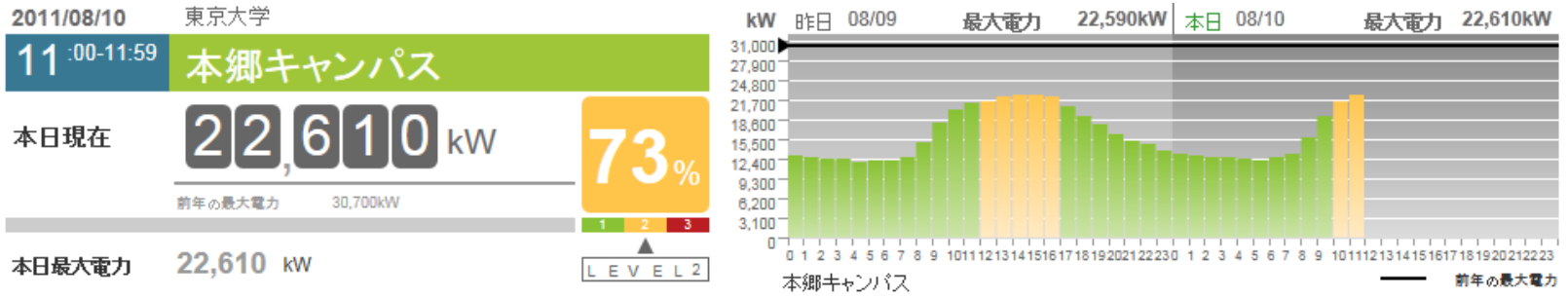
- Turn off lights
- Set air conditioner to 28 ℃ (in summer)
- Migration of servers to virtual machines …
- Shutdown unnecessary computers …
- Shutdown vending machines …
- Shutdown elevators …
- Shutdown TV monitors …
- Shutdown …
- Stop working …

Too Much ?
Enough ?
Need More ?

- People (in the University) realized the importance of
  - Realtime Power Management
  - Realtime Annoucement to People
  - Not only summarized information, but **in detail**

Requirements to the System
(The University of Tokyo's Case)

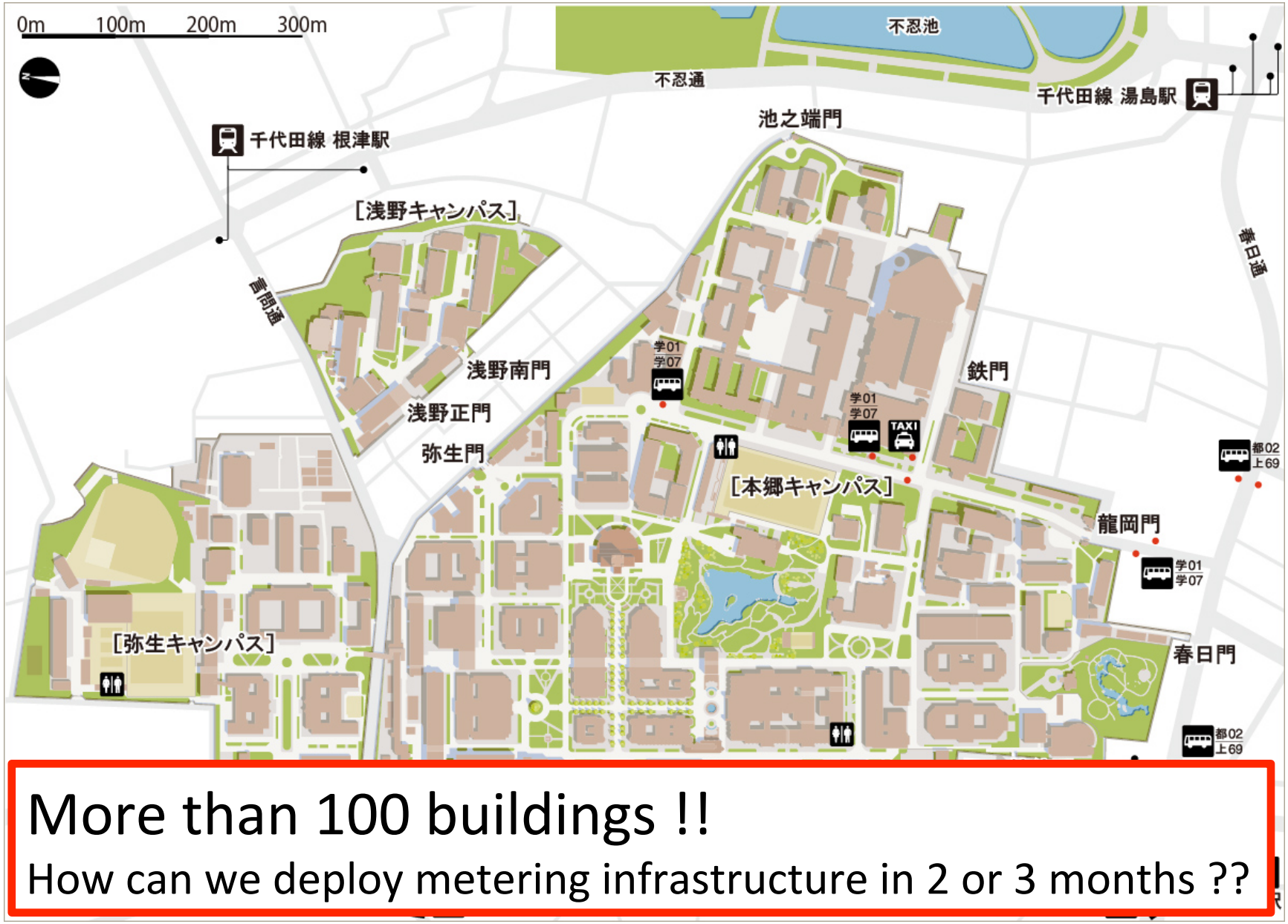
- Visualize the electricity usage of 5 Campuses on the Web



See: http://ep-monitor.adm.u-tokyo.ac.jp/campus/denryoku

- Realtime (update every hour)
- As many buildings as possible
- The service should start at the beginning of July (only 2 months left at that moment).

Monitoring targets (Hongo campus case)



More than 100 buildings !!

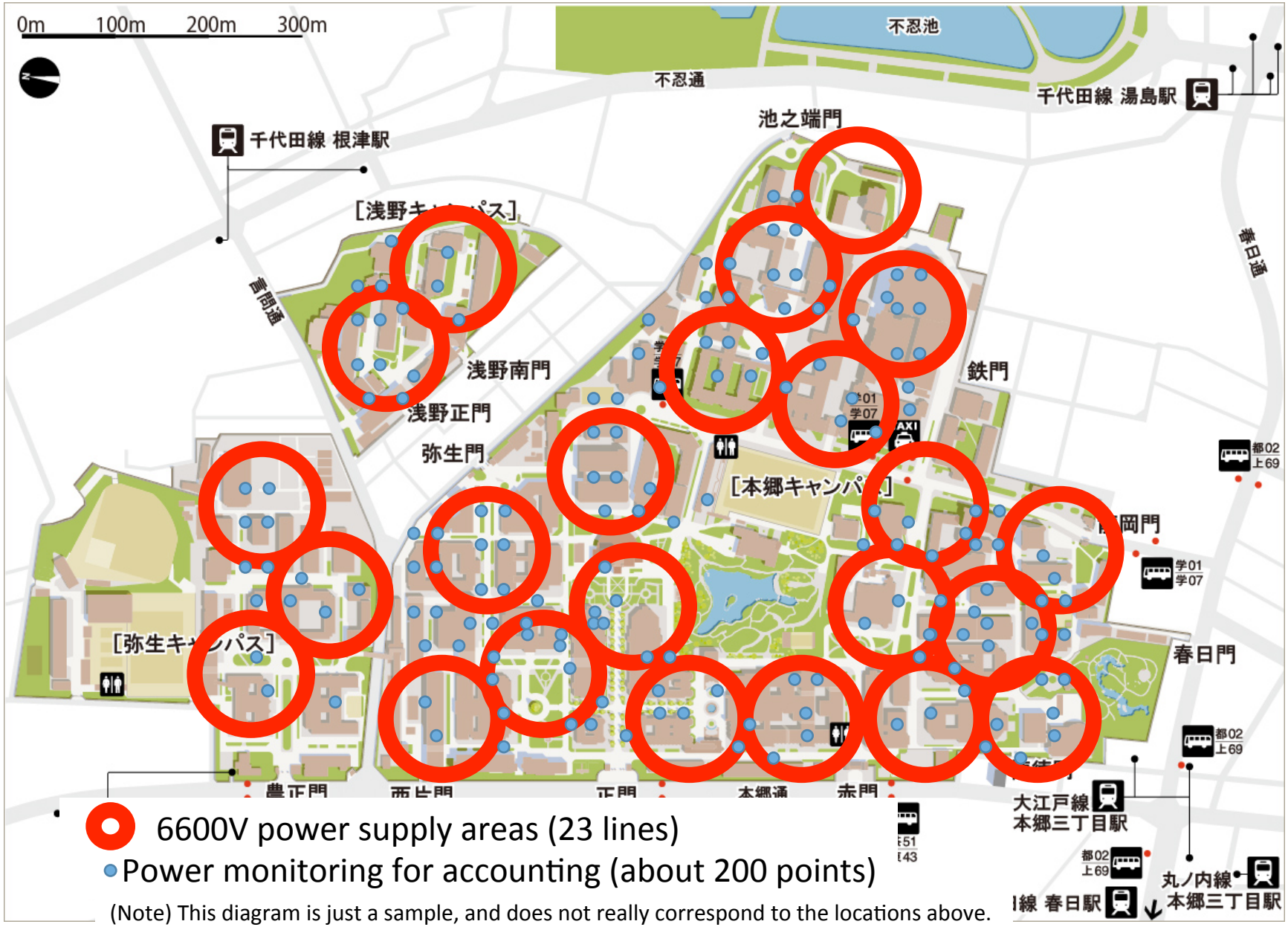
How can we deploy metering infrastructure in 2 or 3 months ??

Key Success Factor 1:
Getting power data from electrical substation

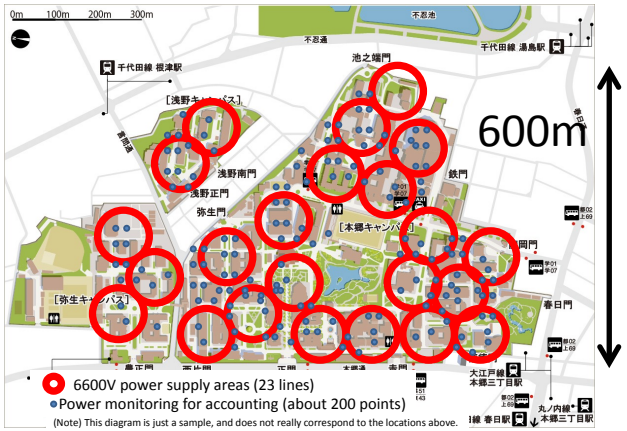
cite: http://upload.wikimedia.org/wikipedia/commons/2/2a/Inokashira_line_kugayama_electrical_substation.JPG

There is a big transformer
in this building (Hongo campus).

Power data available at the substation

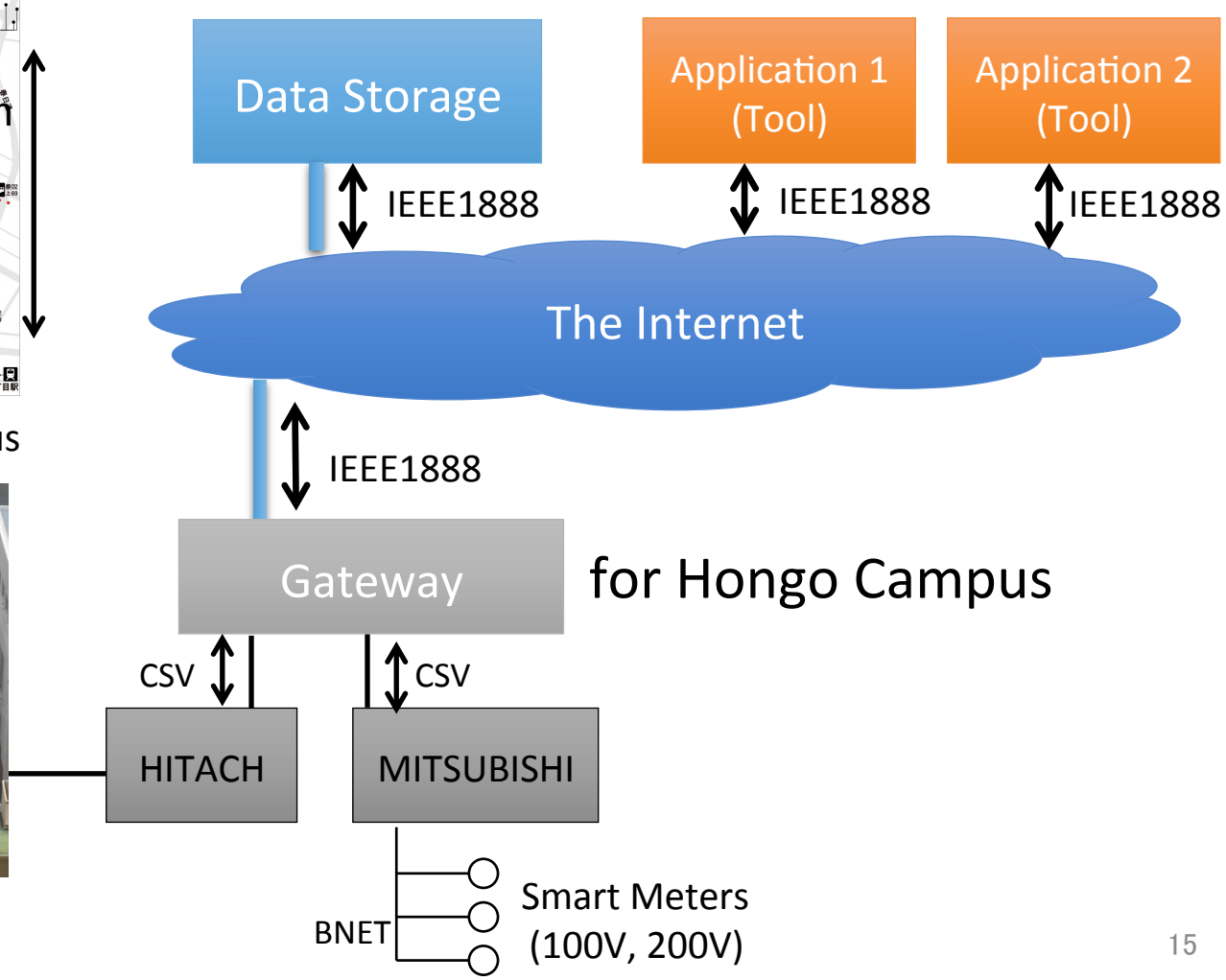


Key Success Factor 2:
Putting the power data on the Internet with IEEE 1888 protocol

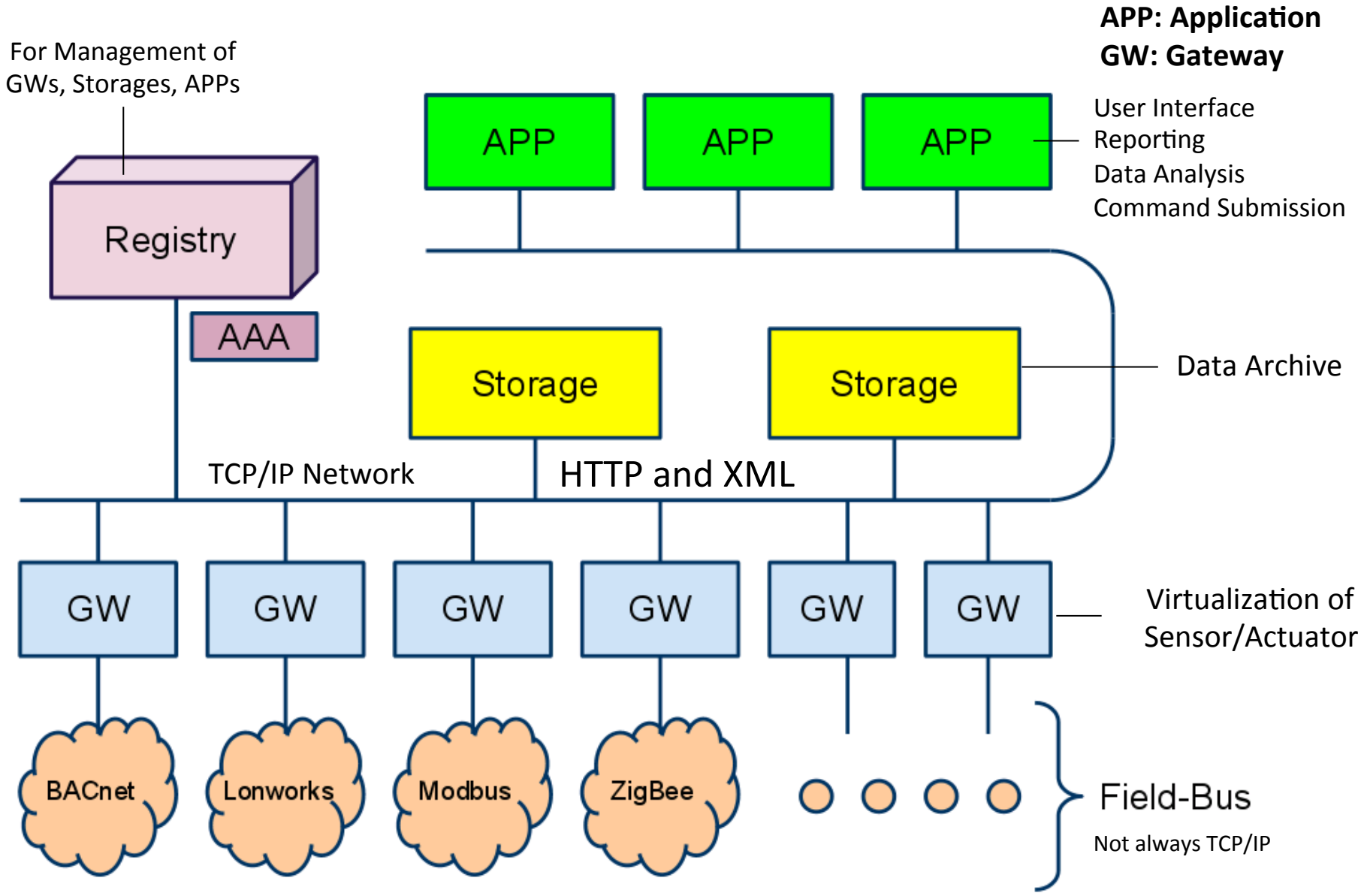


Supply power to the Campus

30,000 kW Substation
(66kV → 6600V)



IEEE1888 System Architecture



IEEE1888 Message Example (conceptual)

```
<transport>
 <body>
  <point id="http://gw.espdragon.jp/u-tokyo/hongo/hismac/019/1h">
   <value time="2015-02-21T08:00:00+09:00">17900</value>
  </point>
  <point id="http://gw.espdragon.jp/u-tokyo/hongo/hismac/110/1h">
   <value time="2015-02-21T08:00:00+09:00">430</value>
  </point>
  <point id="http://gw.espdragon.jp/u-tokyo/hongo/hismac/118/1h">
   <value time="2015-02-21T08:00:00+09:00">730</value>
  </point>
  <point id="http://gw.espdragon.jp/u-tokyo/hongo/hismac/122/1h">
   <value time="2015-02-21T08:00:00+09:00">370</value>
  </point>
 </body>
</transport>
```

Total Power

Feeder A (Area A)

Feeder B (Area B)

Feeder C (Area C)

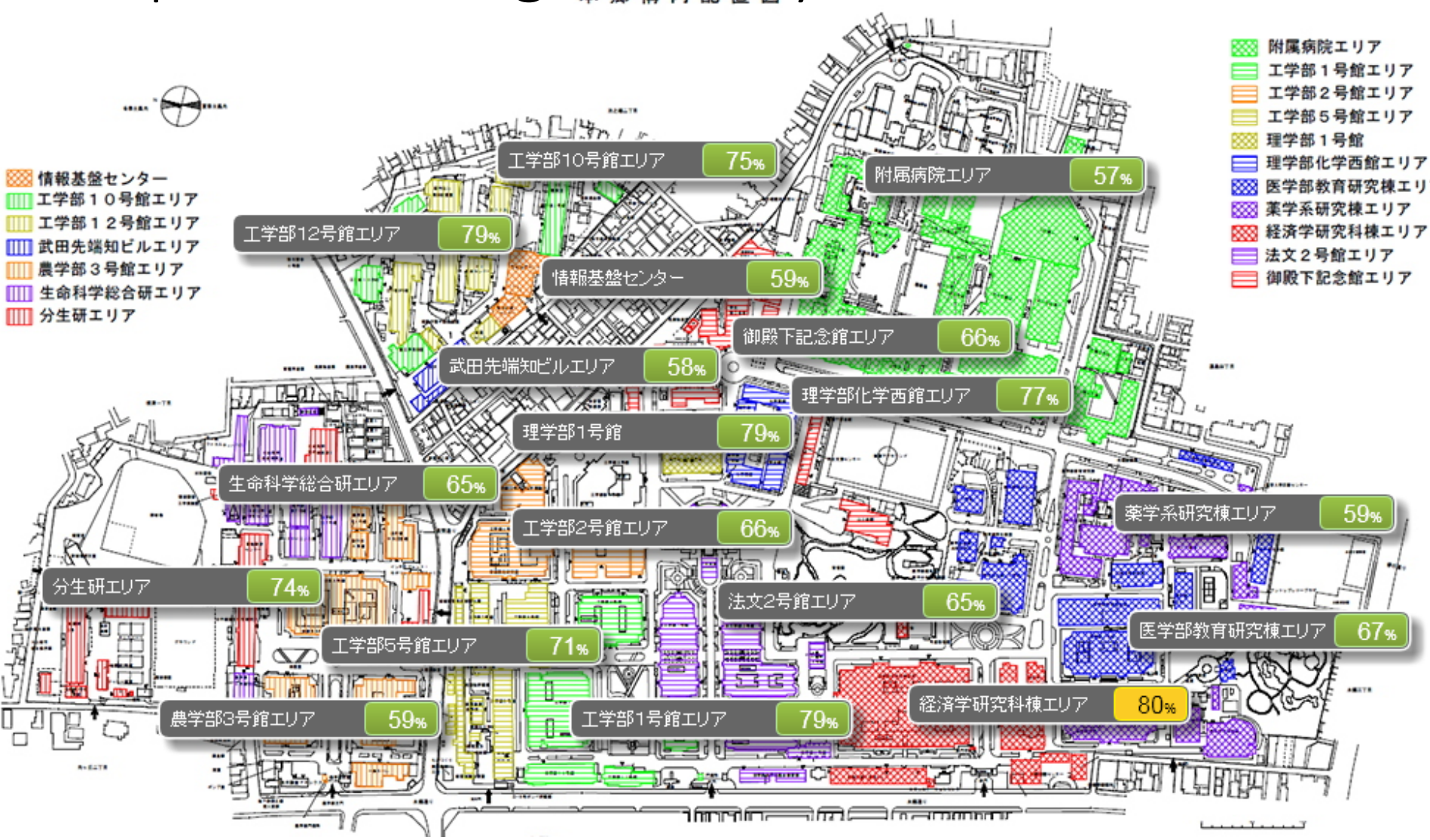
IEEE1888 Gateway

for translating proprietary protocol into IEEE1888

Vender Specific Protocol and Data Formats → IEEE1888 Protocol

IEEE1888 Storage
for archiving collected data on the Internet

IEEE1888 Application
for power management by area

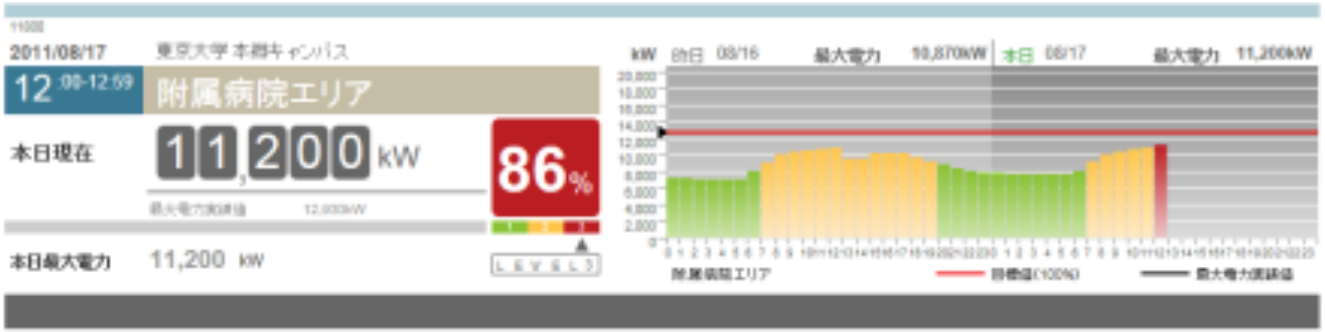


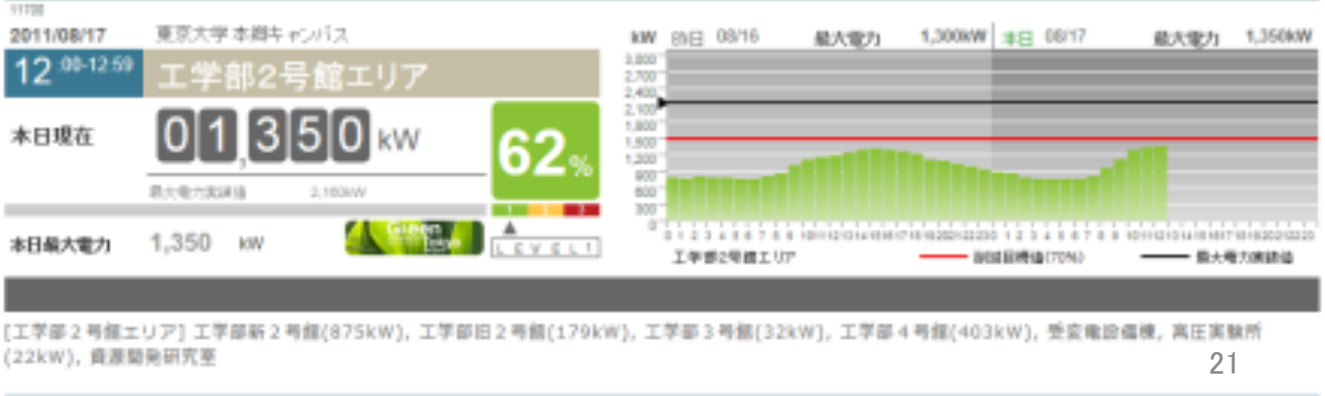
http://ep-monitor.adm.u-tokyo.ac.jp/areamap/

IEEE1888 Application
For power management by time

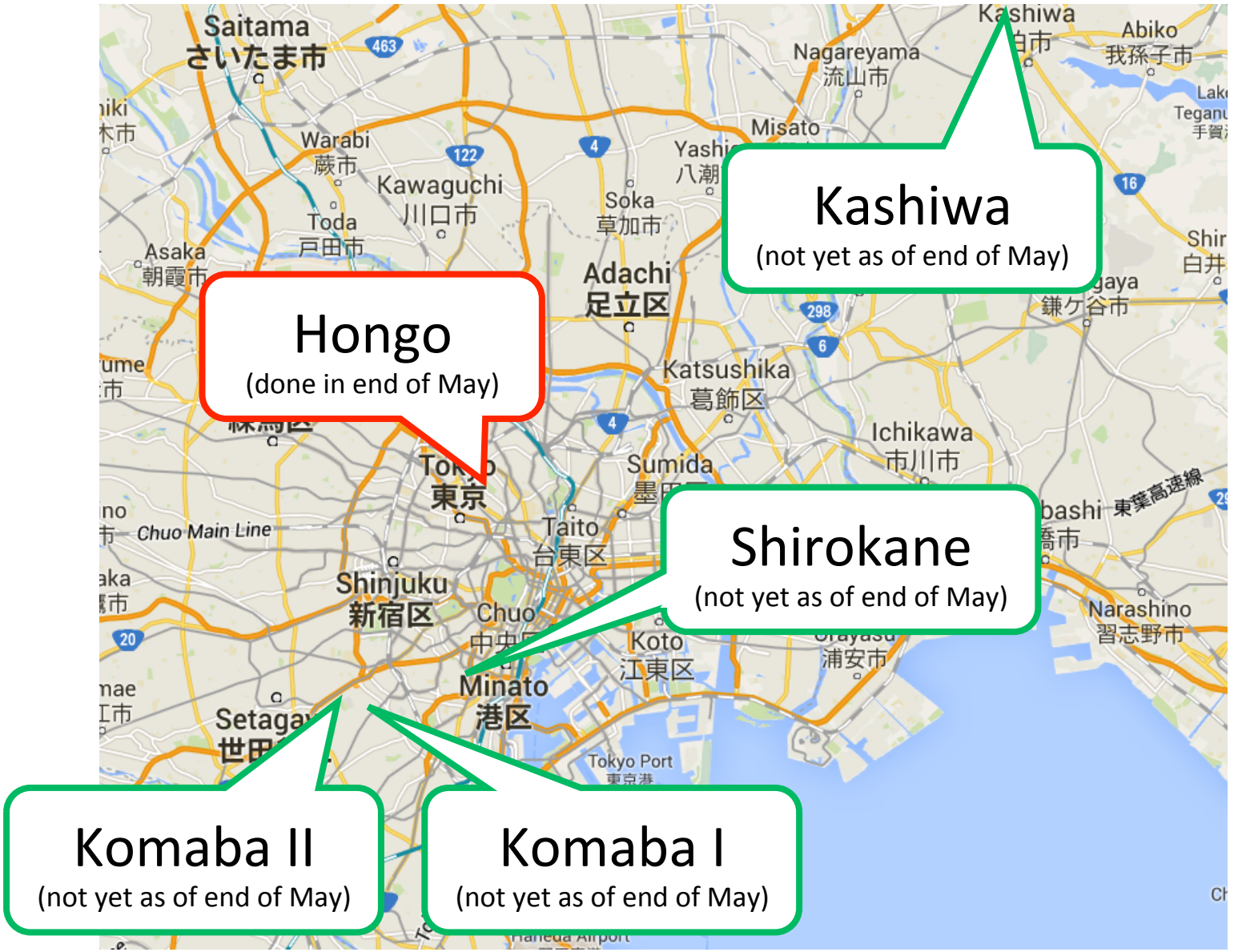
Visualization Page

Zoom





Integration of Five Campuses (1/2)



We have to integrate before July !! Only one month left !!

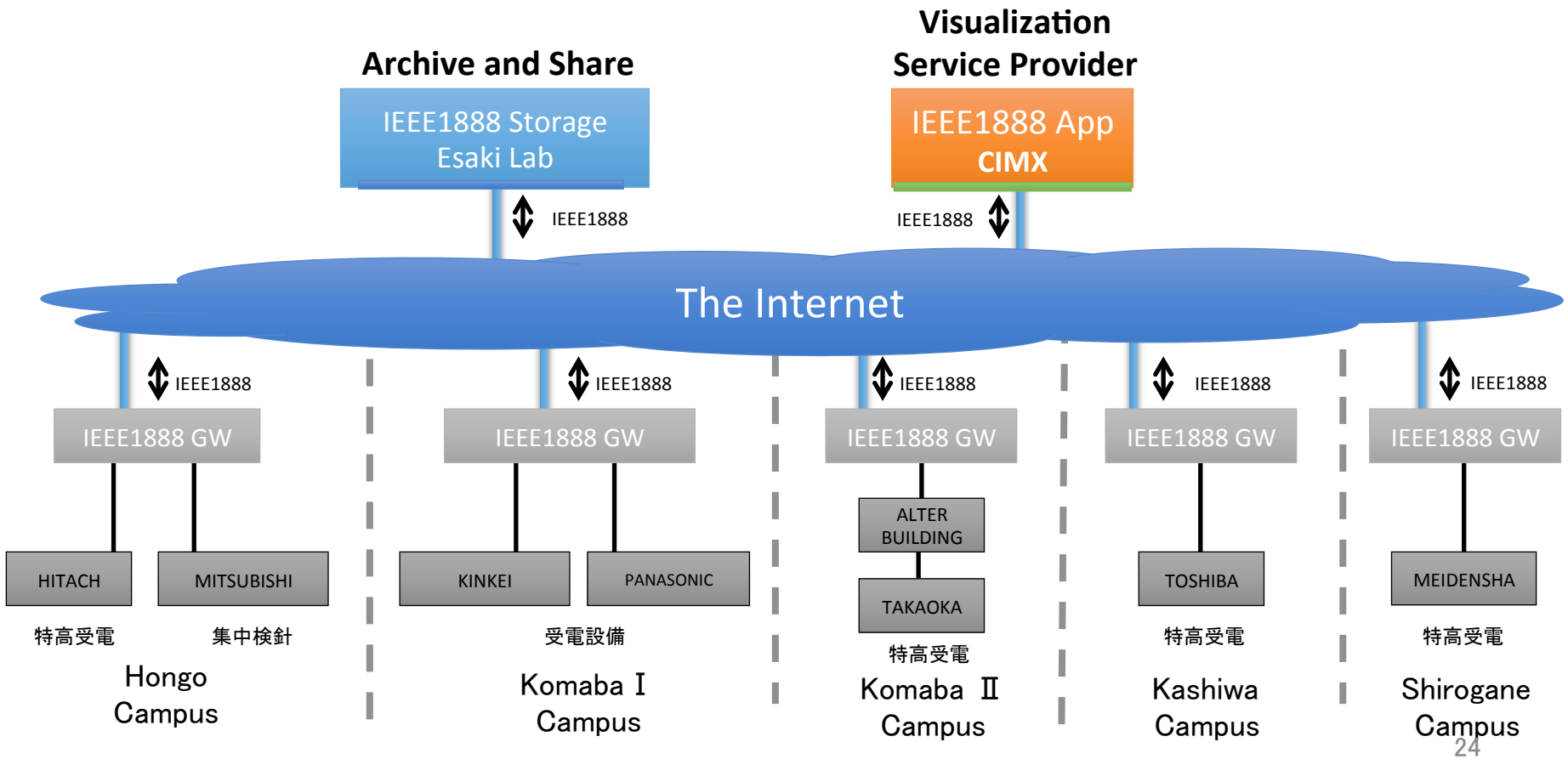
Integration of Five Campuses (2/2)

- Different campuses have different vendors' meters
  - HITACHI, MITSUBISHI, TOSHIBA, KINKEI, Panasonic, Takaoka, A-building, Meidensha…

- Different types of data and interface
  - CSV + SMB protocol
  - CSV + FTP protocol
  - UDP
  - SQL access

Key Success Factor 3:
Translation into the standard (= IEEE1888)

- Generalization into IEEE1888 (with Gateways)
- Data management and visualization on the general framework
- Enabled short-term deployment (only 1 month: June)



Power Usage Visualization (show by campus)

http://ep-monitor.adm.u-tokyo.ac.jp/campus/denryoku

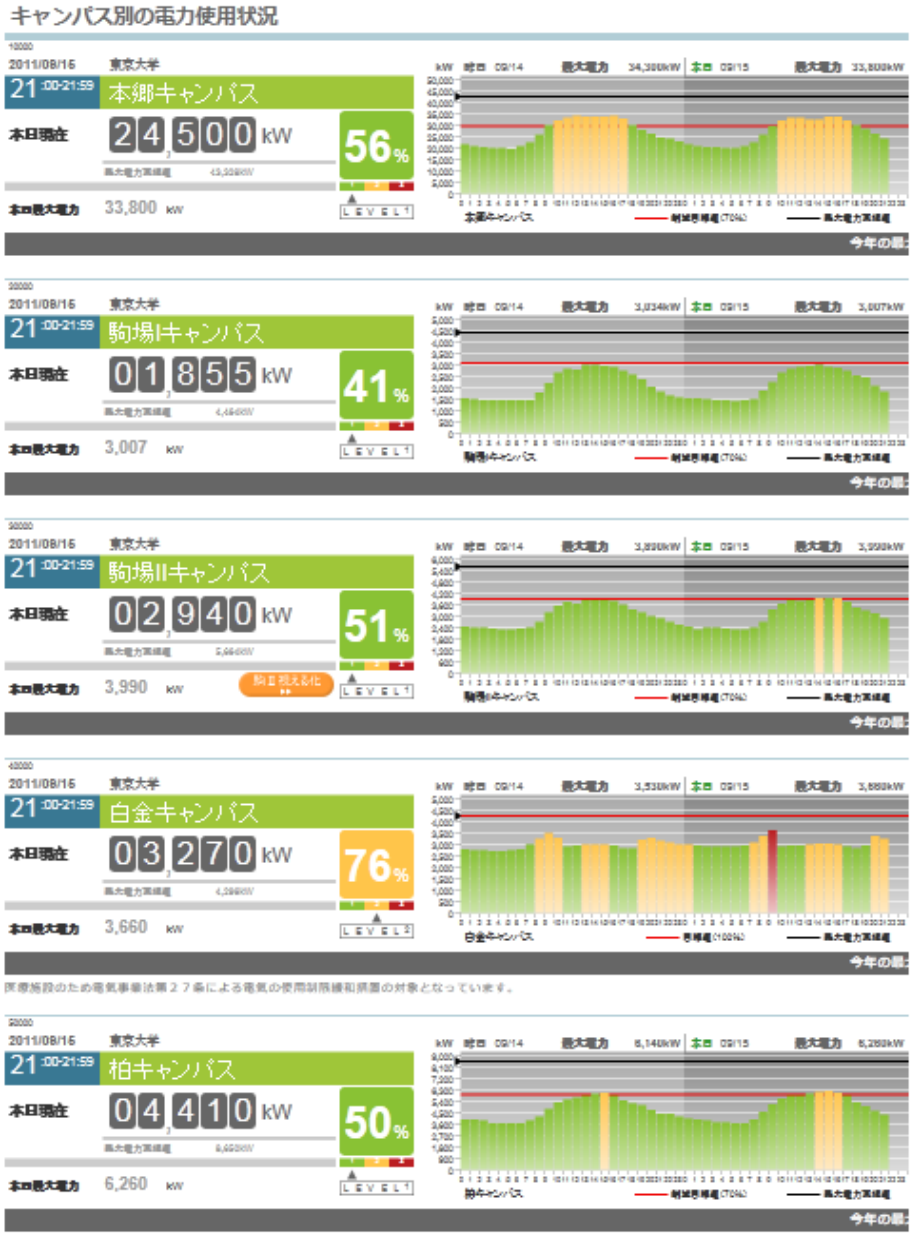
Hongo Campus →

Komaba I Campus →

Komaba II Campus →

Shirokane Campus →

Kashiwa Campus →



Three-Layer Visualization

Portal Site

entry

Top Layer (show by Campus)

全体のページ

第1階層

全体

キャンパスA　キャンパスB　キャンパスC

※

キャンパスのページ

第2階層

Middle Layer (show by Area)

Internal

エリアのページ

第3階層

Bottom Layer (show by building)

棟

エリア

キャンパス

全体（5キャンパス合計）

※キャンパスの下にエリア区分が存在しないキャンパスもあります。

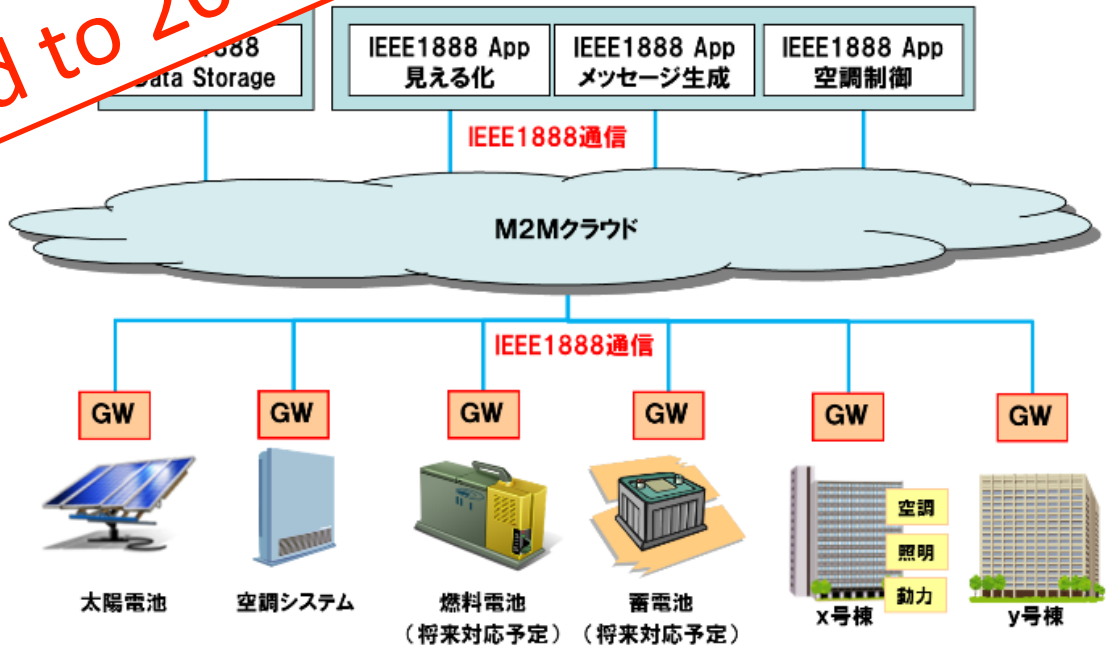
Result and Conclusion

- There were no rolling blackout in the summer.
- Actions were made based on the realtime data.
  - We could point out the hotspot
  - Appropriate energy savings (not too much) were made.
- Power Management Infrastructure of the University of Tokyo
  - Data collection from July 2011 is continued.
  - Demand response activities (based on alarm and broadcasting) are made in summer.

Installation in Tokyo Institute of Technology

Tokyo Institute of Technology
EEI Building
4570 Solar Pa W

They extended to 20 buildings in 2014 !!

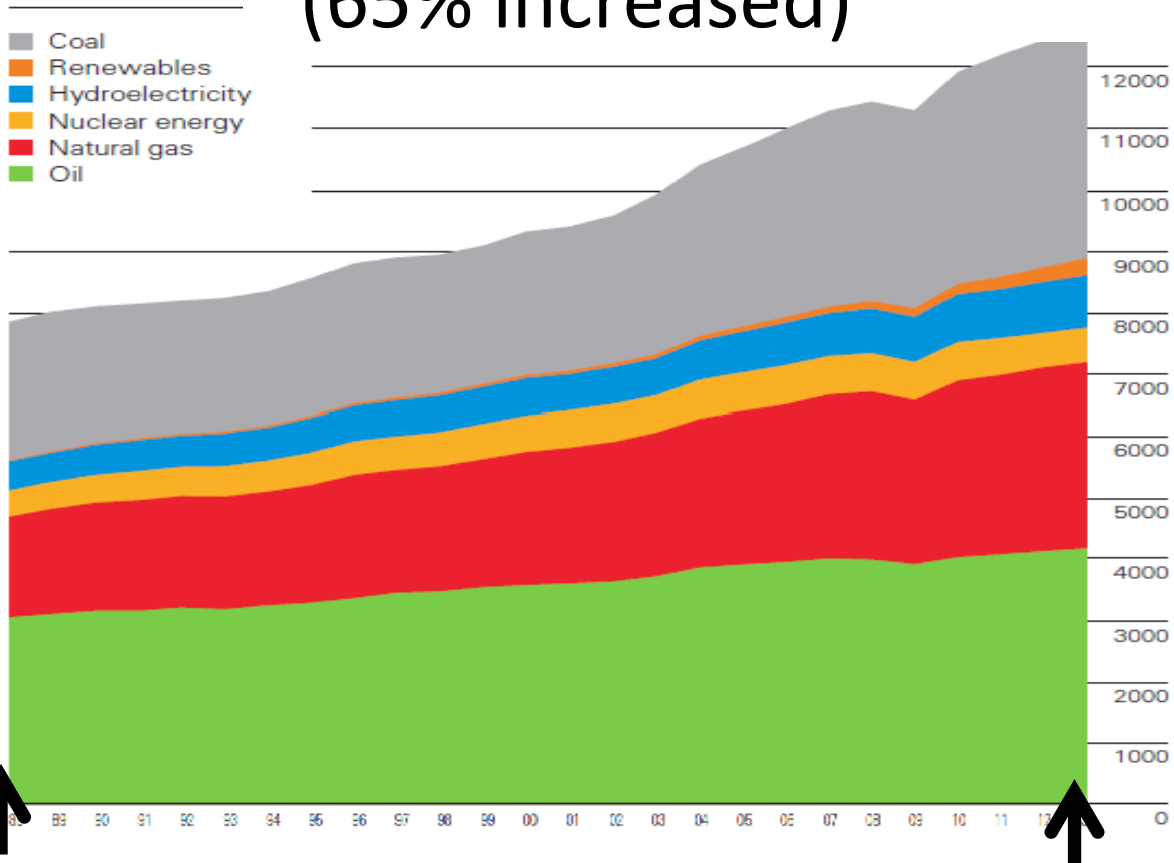


F ity Management
with IEEE1888 protocol

Cite: http://www.nttdatacs.co.jp/news/20121204.html

Why Green ICT ?

World energy usage in 25 years
(65% increased)



1988 Cite: BP Statistical Review of World Energy 2014 2013

*** Concern**

- Natural Resources
- Global Warming

*** Important Goals**

- Management of Energy Usage
  (e.g., Electric Power)
- Use of Renewable Energy
  (e.g., Wind, Solar Power)

*** Technology**

ICT Infrastructure
(intelligent control)

Deployment in 2 months