Smart City Implementation with *"Internet by Design"*
- Strategic use of Cloud and Data Center-

Hiroshi Esaki, Ph.D.,
Professor, The University of Tokyo
Director, WIDE Project
Director, Green University of Tokyo Project

"Internet by Design"

1. **Evidence & Experience Based Research**
   Reject: kings, presidents and voting.
   Believe in: rough consensus and running code.
2. Provide **"alternatives"**, intentionally
   - ✓ **New component with the same interface**
   - ✓ Open interface for **legacy system**
3. **Best-Effort** (e.g., stupid) Network and Intelligent End-Node

   Does not have any responsibility for end-to-end service
4. **Autonomous, distributed, cooperation**
5. **Transparent**
   - ✓ Anyone can do anything, with Opt-Out
   - ✓ One asset, for multiple purposes


Energy Saving
Shared Multi-Purpose Eco System for Sustainable Growth
New Services

Contents

1. Strategic use of Cloud & DC
   a. Facility on the net
   b. Computers into the net
2. Yet another strategic use of DC
   a. HVDC
   b. DC for power generating sites

“Strategic use of Cloud & DC”

1. Facility on the Net(Cloud)
2. Computers into the Net (Cloud/DC)

東京大学
THE UNIVERSITY OF TOKYO

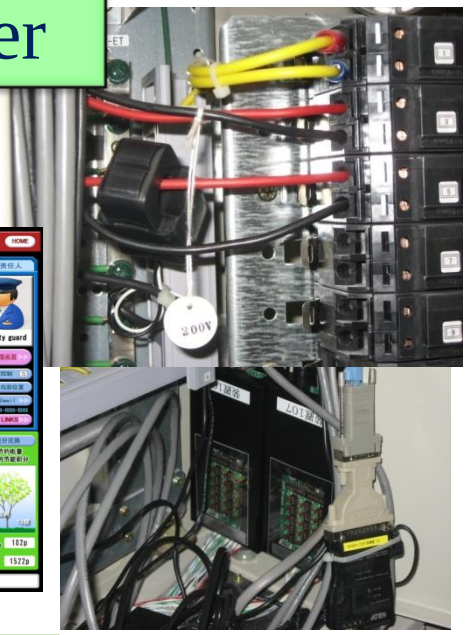
Energy Saving
at The University of Tokyo in Summer of 2011

	Peak (2010)	**Peak (2011)**	**Total (2011)**	**RoI**
Major 5 campus	66 MW ($60M/yr)	69% (△31%)	75%-78% (22%-25%)	less than 1 month
Eng. No2 Bldg.	1 MW ($1M/yr)	56% (△44%)	69% (△31%)	2 yrs


12 Fl. EECS & Machinery Dept.

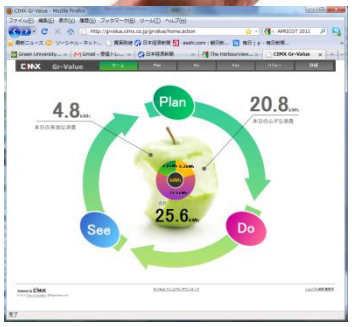
【Contributions】
1. Multi-Vender for sustainability
2. Global Standards for procurement

Smart Meter

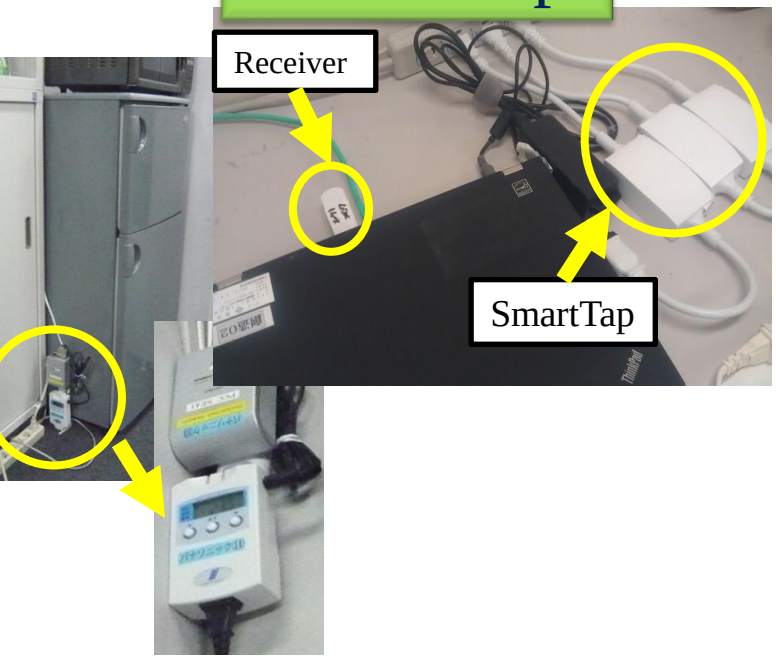


With Smart Phone

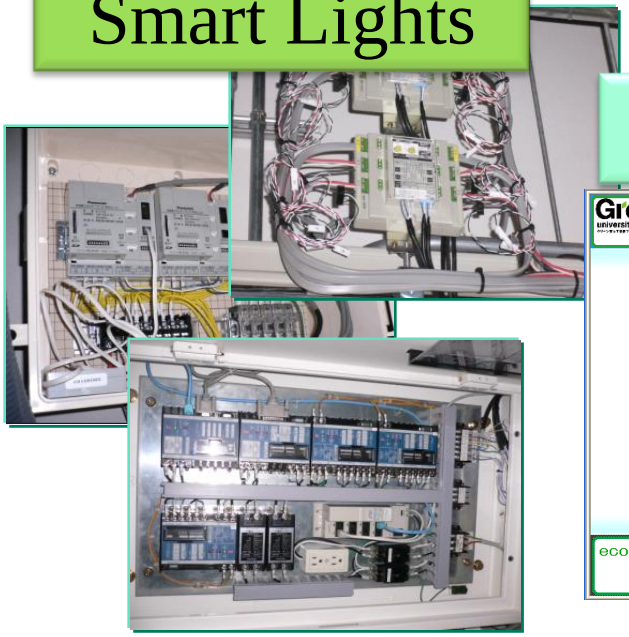
Smart Kiosk



Smart Tap



Smart Lights



Smart HVAC

Live E!

in 2005

ipv6 Promotion Council

Building Automation WG
in 2003 at

ipv6 Promotion Council

Collaboration
with Tokyo Gov.
since 2004

Established FNIC in2006
(Facility Network Interop)

Since 2005
(7th at Kyoto)

APAN Asia-Pacific Networking Group

NiCT

DUMBO2006
with AIT

มหาวิทยาลัยเกษตรศาสตร์
Kasetsart University

KU+KUS with MIC+JGN2

JGN2 plus

Indian Institute of Technology Hyderabad

IIT Hyderabad
With IMD

Green university of Tokyo Project グリーン東大工学部プロジェクト

In 2008

Beijing Olympic
In 2008

清華大學 Tsinghua University

China-Japan Green IT
Project funded by MIC
in 2009

FIAP in 2009
(Live E! architecture)

ISO IEC

JTC1 SC6 WP7

IEEE

IEEE 1888 in Feb.

NIST

SGIP

BACnet

with NIST@USA
B2G in SGIP (Smart Grid
Interoperability Panel)
toward CoS

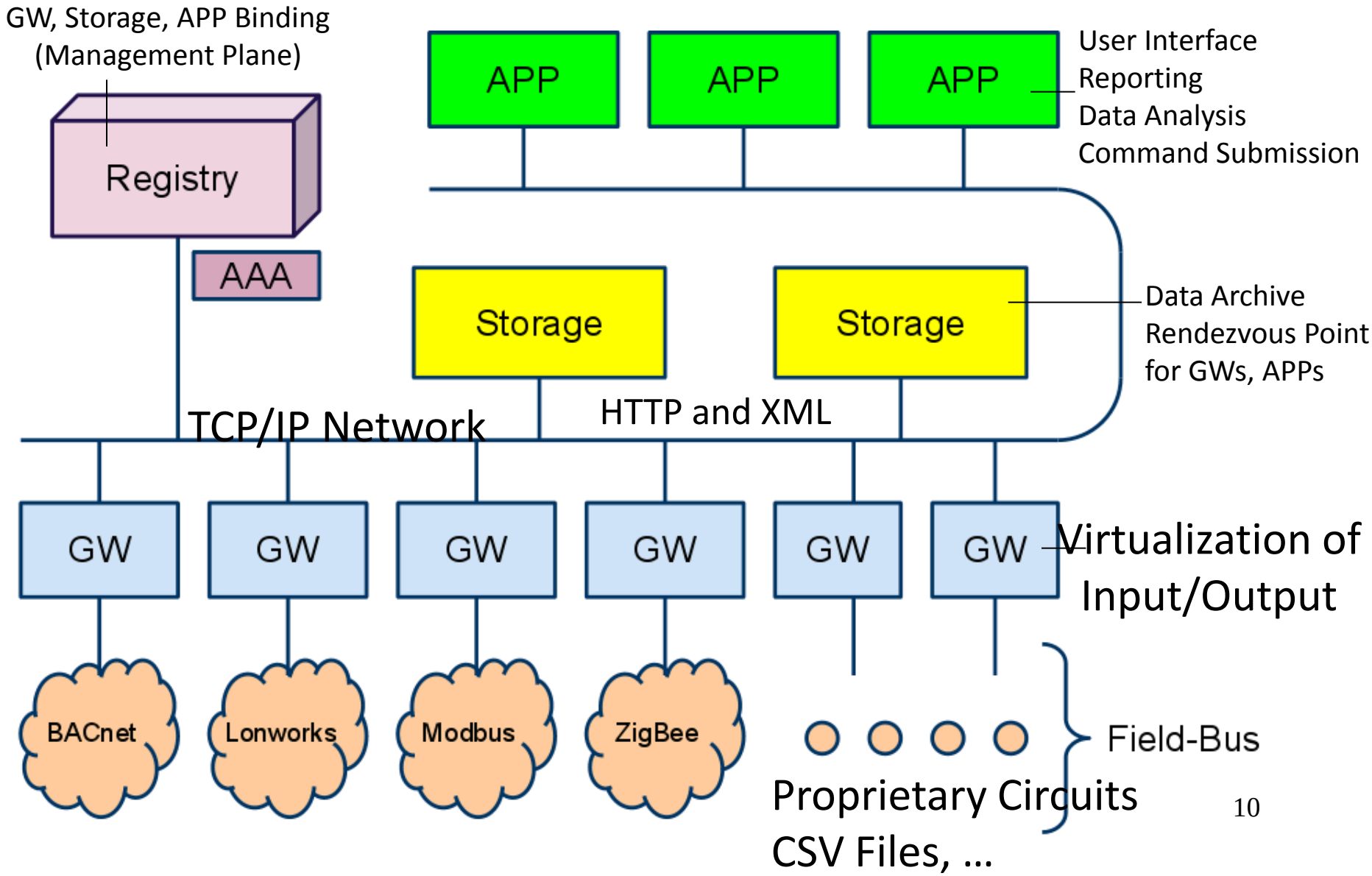
Goal of IEEE1888

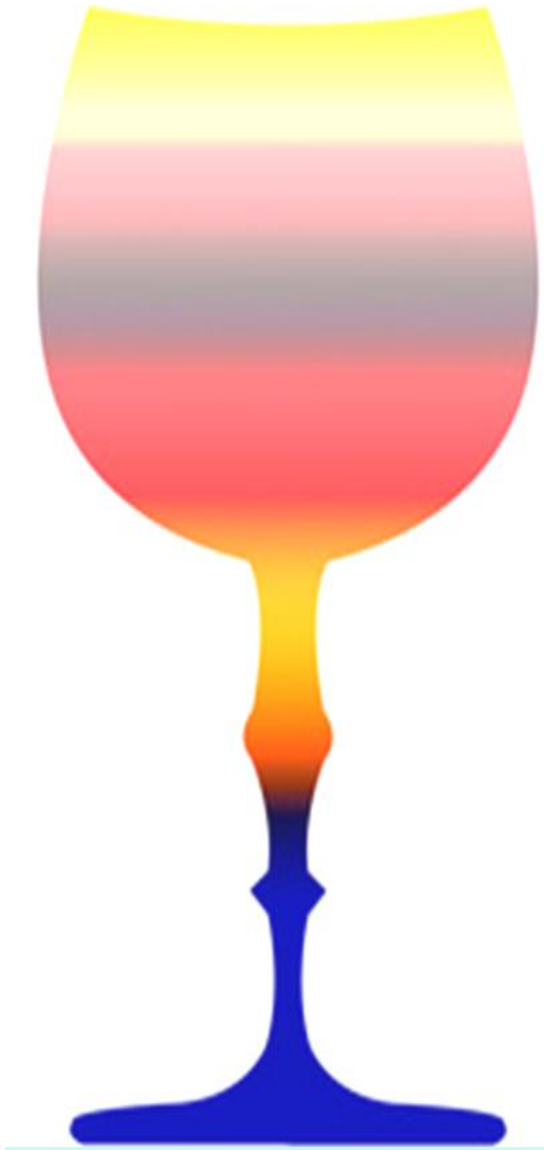
1. Smooth migration to open and multi-vendor system
   - **Accommodation of legacy and unique systems via GW**
2. Changing the business structure of building industry.
   - From “vendor” oriented to “user “oriented

   ➔ **User can define the technical specification of smart building,** same as happening SDN and cloud in DC
3. New applications/services using common and transparent platform
   - BigData {and OpenData} operation
   - One assets, for multiple use,

     i.e., not only for energy saving but also **(1) energy security (i.e., BCP), (2) improvement of productivity (i.e., efficiency) and (3) new functions**.

IEEE1888 System Architecture





Yet, another
Wine-Glass Model

88 Syste

APP

face

Data Analysis
Command Submission

Storage

ork

HTTP and

Modbus

Independency
from HW,
i.e., SDN

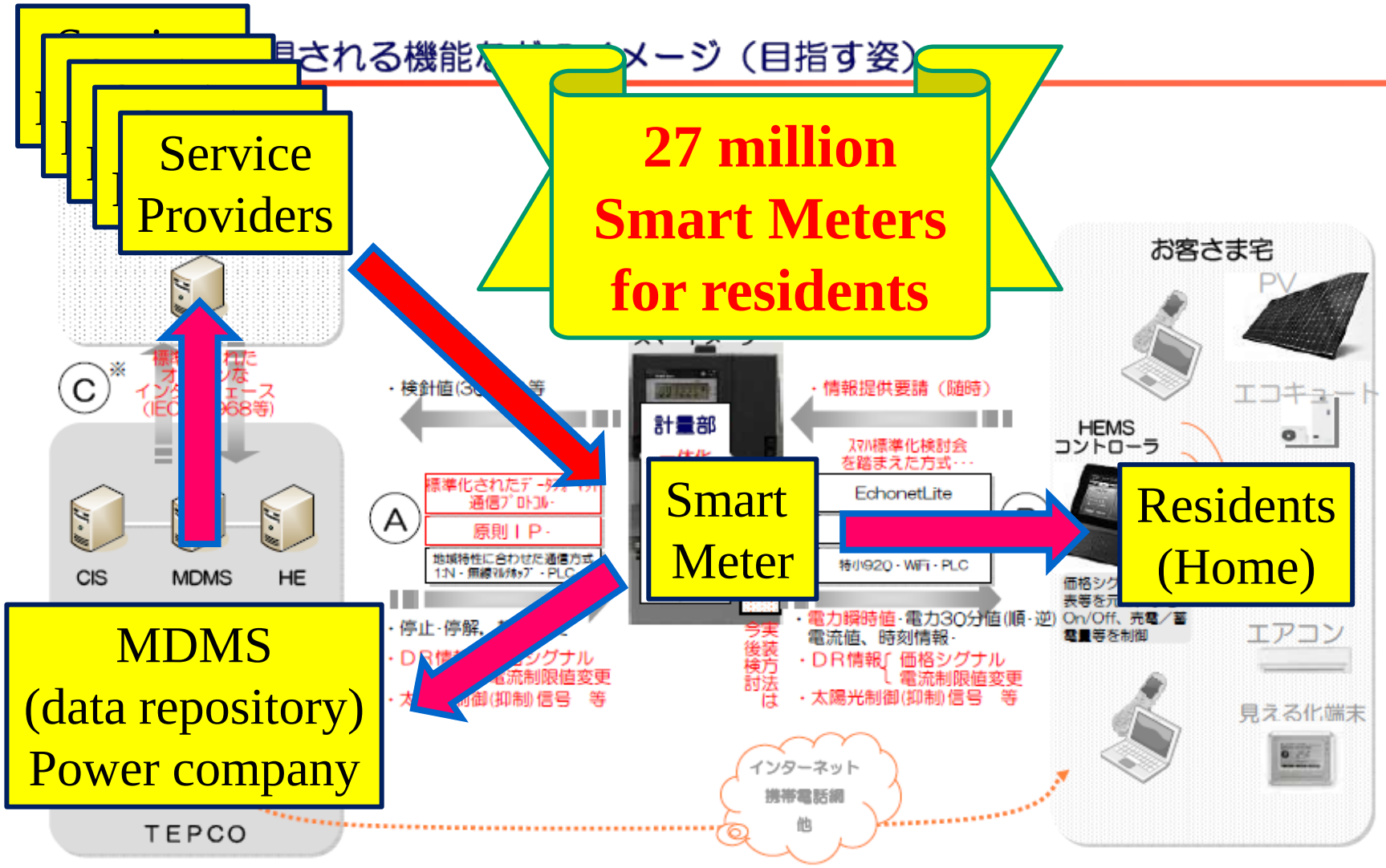
Data Centric for
Transparency

Integration and
Interoperability
via GW for legacy and
{new} unique systems

What GUTP provides

1. Technical specification via IEEE-SA and other standardization institutes, e.g., ISO/IEC
2. SDK
   a. Referenced implementation, with Linux VM
   b. OpenADR over IEEE1888
   c. Gateway function, e.g., BACnet, Lonworks, Modbus
3. Testing Environment
   a. Specification and software
   b. Certification / logo

東京電力(株) 2012年7月12日 公開資料
「RFCを踏まえたスマートメータ仕様に関する基本的な考え方」



※Cルートについてはスマートメーター制度検討会で検討されたようにスマートメーターの情報を直接サービス事業者が収集するケースも考えられる。

http://www.tepco.co.jp/corporateinfo/procure/rfc/repl/t_pdf/2_concept-j.pdf

東京電力(株) 2012年7月12日 公開

TEPCO's Smart Meter System

1. 27 million meters will be connected via IPv6 (e.g., 6LowPAN)
2. Three layer structure,
   i. FAN (Field Area Networks)
   ii. MDMS
      (*) Equal access of data for the third parties (applications), i.e., neutrality of data
   iii. Applications
3. Security against malicious accesses

http://www.tepco.co.jp/corporateinfo/procure/rfc/repl/t_pdf/2_concept-j.pdf

Tokyo Institute of Technology
Green Hills,No.1 Bldg

Microsoft Japan
HQ in Tokyo

Otsuka Corp. HQ

Shinryo Reinetsu
HQ and other buildings

Hitachi Info& Tele Eng Ltd.
Nakai Development Center

CANON S Tower
(Canon MJ HQ)

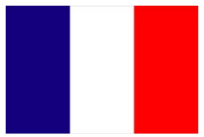
Global Collaboration

Global/International collaboration

1. ISEP/DESSC with UN foundation
2. Beijing team(e.g., Tsinghua Univ., China Telecom)
   uding Standardization)
3. C
   - EE
4. NTU
5. Vi
   –
6. i
7. DoT(
   Hyde
8. UCB with Intel, LoCaL project, in **USA**
9. SGIP of NIST in **USA**
10. UMPS/LIP6/CNRS in Paris, **France**

nation

wan



May want to have shared data-set for Big Data analysis

“Strategic use of Cloud & DC”

1. Facility on the Net(Cloud)
2. Computers into the Net (Cloud/DC)

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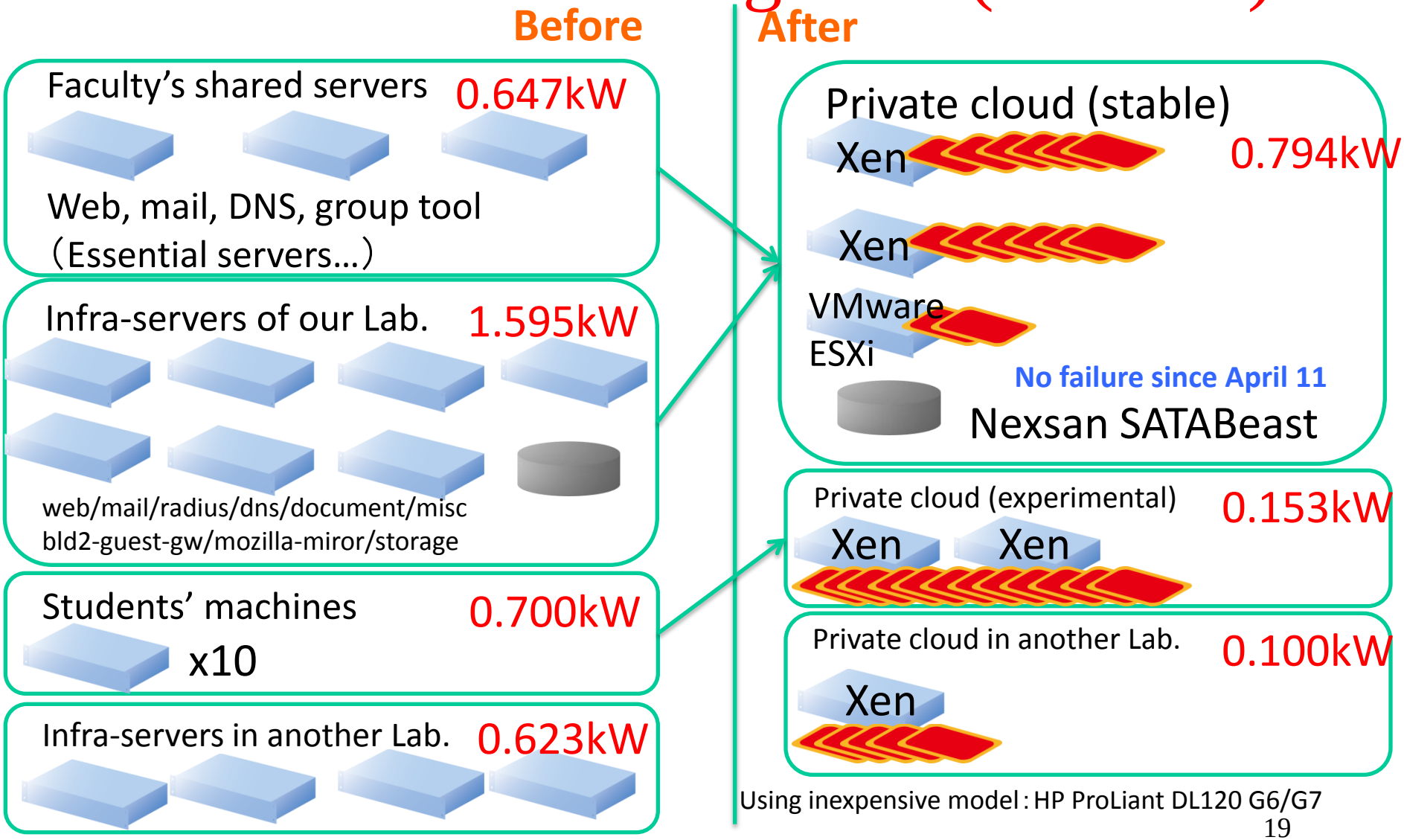
Private Cloud in our Lab.

Achievement: Saving 71% (2.52kW)!



Using inexpensive model : HP ProLiant DL120 G6/G7

Private Cloud in our Lab

RoI of investment

➔ 6 months (w/ PUE=2.0)

"True" benefits for us;

1. Manageability of system
2. BCP for power incidents
3. Comfortable environment

Tokyo Institute of Technology
Green Hills,No.1 Bldg

Best Current Practice for Commercial Building

1. Facility management control by IEEE1888
2. Servers go to Data Center = No server room in the bldg

Microsoft Japan HQ in Tokyo

CANON S Tower
(Canon MJ HQ)

What happened on Tokyo Local Government officer ?

1. Initial (Spring 2008)
   - **i.** **“Hate”** Data Center, because of huge power consumption and continuous increase.
2. Beginning 2010
   - i. Data Center is **”good”** for reduce the power consumption
3. Now
   - i. Include the **”exception”** for iDC into the **“regulation”** on the CO_2 carbon footprint reduction
   - ii. **”Promoting”** to use iDC and cloud platform

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2. **Yet another strategic use of DC**
   a. **HVDC**
   b. **DC for power generating sites**

Yet another,
Strategic use of “DC”

1. {High Voltage} DC
2. DC for Power Generating Sites

(*) Container Co-Generator and DC for mobility and easier installation

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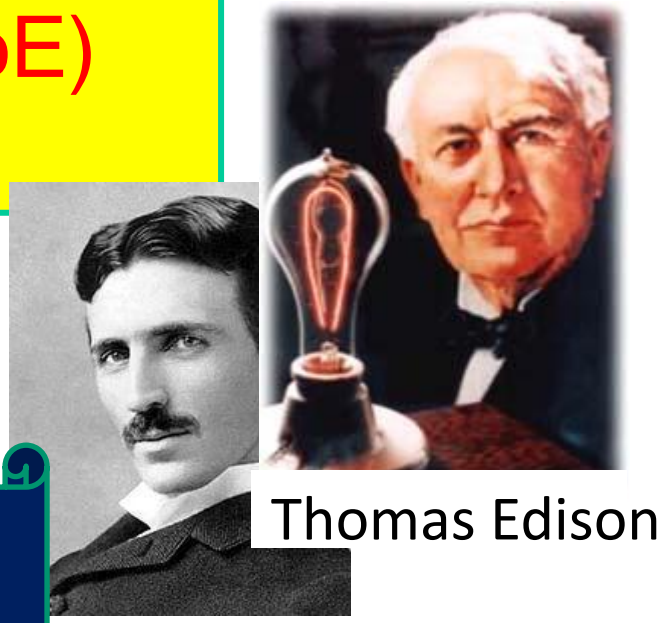
Thomas Edison, i.e., DC, Strikes Back

1. Integration of Communication line and Power line (e.g., PoE)
2. Battery operation

Innovation toward "real" infrastructure



Thomas Edison

Nikola Tesla

1. Reduction of AC-DC transformation, for improvement of efficiency
2. **Independent and Autonomous Computer System**
3. **Applying to Audio Visual system , as well**

DC power supply and solar power with container data center by Sakura Internet

VS

V

1.5

[Contribution of “Container”]

1. **Mobility** of infrastructure
2. **“Skelton and in-fill”** for bldg.
3. **Distributed/autonomous** power generation

{New} Implication of Data Center ?

1. Could be carrier neutral
2. Could change from consumer to supplier
3. 72 hour operation, after electric black-out
4. Source of heat, as well
5. Mobility and survivability of computing and power-generator function.

1. Critical Infrastructure for IT/ICT
2. Infrastructure for de-centralized energy source
3. Infrastructure for {short-term}energy security

【Business Scenario】

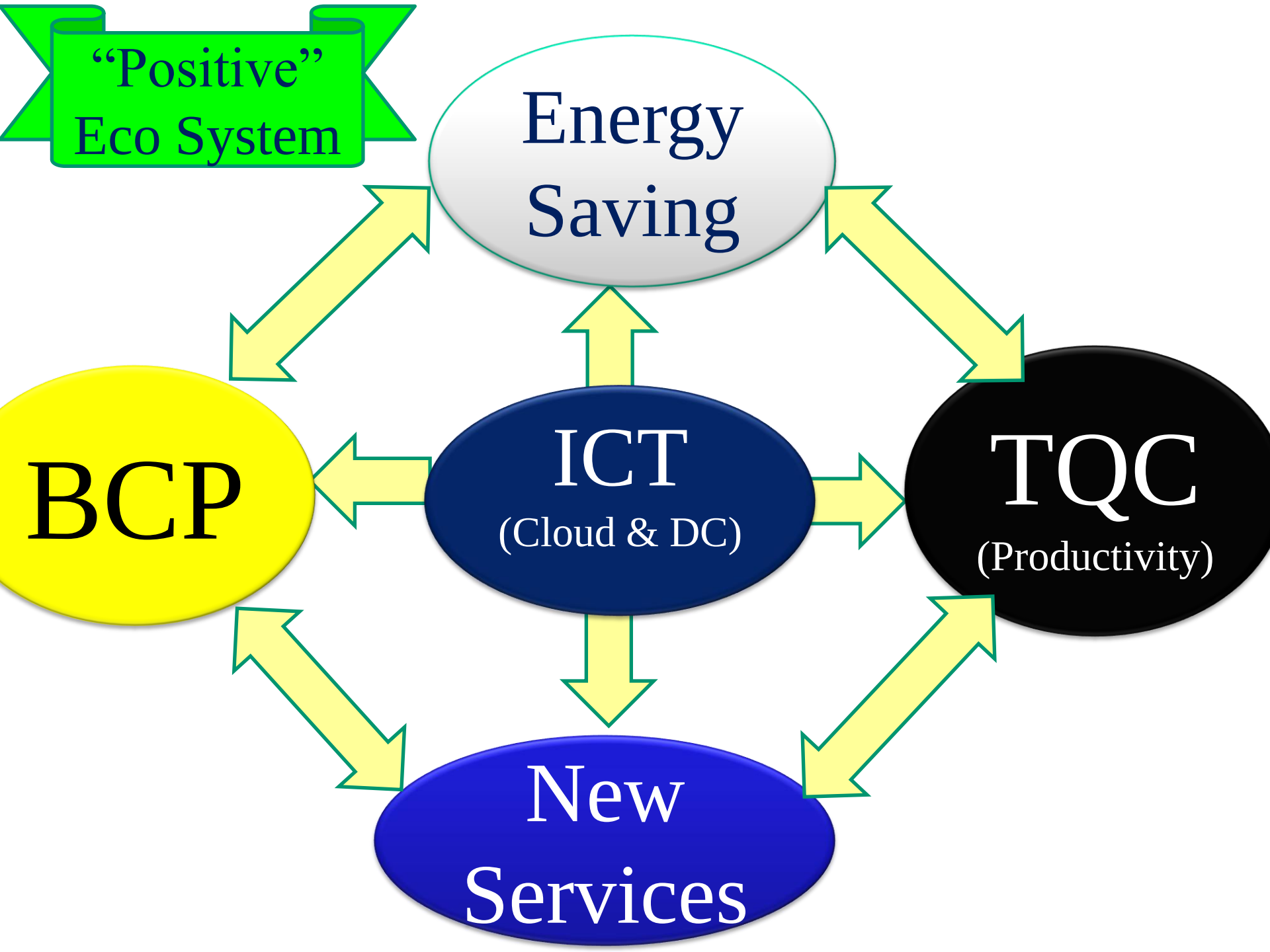
Energy Saving

- ➔ Efficiency(=Productivity)
- ➔ Security(= BCP)
- ➔ Innovation(= New Services)

RoI by Energy Saving

↓

Energy Saving Platform Delivers BigData for New Functions


"Positive"
Eco System
Energy
Saving
BCP
ICT
(Cloud & DC)
TQC
(Productivity)
New
Services

Green Univ. of Tokyo Project

- GUTP, established in **June 2008**.
  - 46 private companies and 20 NPOs (as of January 2012)
- **Eng.Building No.2**, in Hongo Campus
  - Targeted reduction; **15% in 2012, 50% in 2030**
  - 12 floor high, R&D and R&E activities
  - Established October 2005
- **5 major campus and new I-REF building**
- More than saving energy
  - Sustainability
  - New functions and business
- Global Standard
  - **IEEE1888**
  - **NIST SGIP CoS**

東京大学
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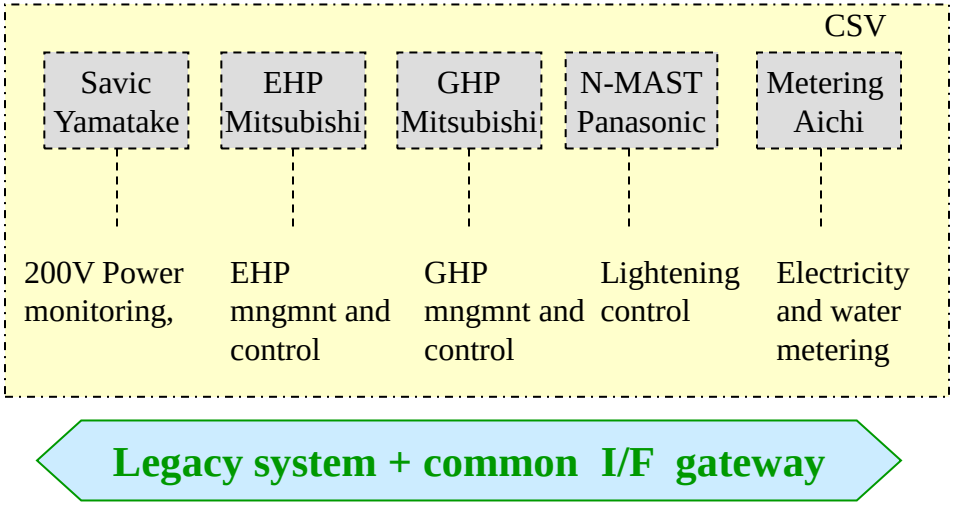
【Companies】

- **Azbil Corporation**
- **CiMX Corporation.**
- **Cisco Systems, Inc.**
- **Citrix Systems Japan K.K.**
- **ComZeit Inc.,**
- **Daikin Industries, Ltd.**
- **DSI, Inc.**
- **EMC Corporation**
- **Fujitsu Limited**
- **Hitachi Co.Ltd.**
- **INTEC Inc.,**
- **Intercom Inc.,**
- **Internet Initiative Japan Inc.,**
- **KAJIMA Corporation**
- **Kantokowa Co., Ltd.**
- **KDDI Corporation**
- **KDDI R&D Laboratories**
- **Kyosera Maruzen Systems Integration Co.Ltd.**
- **Mitsubishi Heavy Industries Ltd.**
- **Mitsubishi Research Institute Inc.**
- **Mitsui Fudosan Co.,Ltd**
- **Murata Manufacturing Co.Ltd.,**
- **NEC Corporation**
- **Nippon Steel & Sumikin Engineering Co.Ltd.**
- **NTT Comware Corp.**
- **NTT Corporation**
- **NTT Data Corporation**
- **NTT Data Customer Service Corporation**
- **NTT Data Intellink Coroporation**
- **NTT Facilities Inc.**
- **OSIsoft Japan K.K.**
- **OTSUKA Corporation**
- **Panasonic Corporation**
- **RICHO Co., Ltd.**
- **Sakura Internet Inc.,**
- **Sanki Engineering Co., Ltd.**
- **Schneider Electric Japan Group**
- **SEIKO PRECISION Inc.,**
- **SHINRYO Corporation**
- **Takaoka Electric Mfg. Co.Ltd.,**
- **Takenaka Corporation**
- **Toshiba Corporation**
- **Toyo Denki Seizo K.K.**
- **Toyo Standard Corporation**
- **Ubiteq Inc.**
- **Ubiquitous Corporation**

【Organizations/Universities】

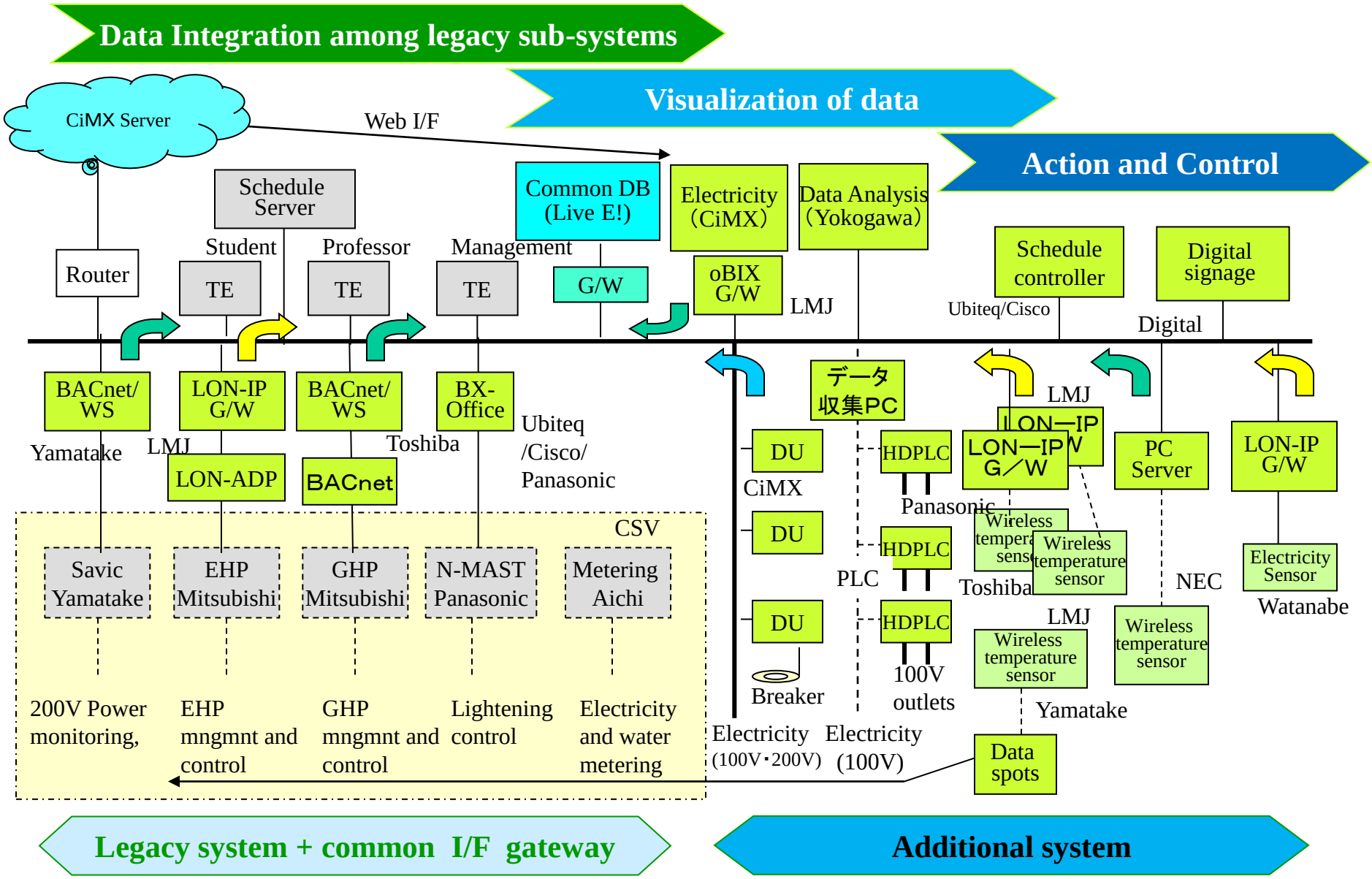
- **Green IT Promotion Council.**
- **IPv6 Promotion Council.**
- **The Institute of Electrical Engineers of Japan**
- **The Institute of Electrical Installation Engineers of Japan**
- **LONMARK JAPAN**
- **OKAYAMA IPv6 CONSORTIUM.**
- **Yamaguchi Prefectural Industrial Technology Institute**
- **WIDE Project.**
- **Tokyo Metropolitan Research Institute for Environmental Protection**
- **Chularonkorn University (Thailland)**
- **SRM University (India)**
- **Kanazawa University**
- **Gufu University**
- **Keio University.**
- **Kyushu Institute of Technology**
- **NAIST (Nara Institute of Science and Technology)**
- **National Taiwan University (Taiwan)**
- **Niigata University**
- **Nagoya University**
- **Shizuoka University**
- **Tokyo Metropolitan University**
- **Yamaguchi University**
- **Yamagata University**
- **Yamagata Research Institute of Technology**
- **The University of Tokyo**

System overview Eng.No.2 Building in Hongo Campus, Tokyo, Japan

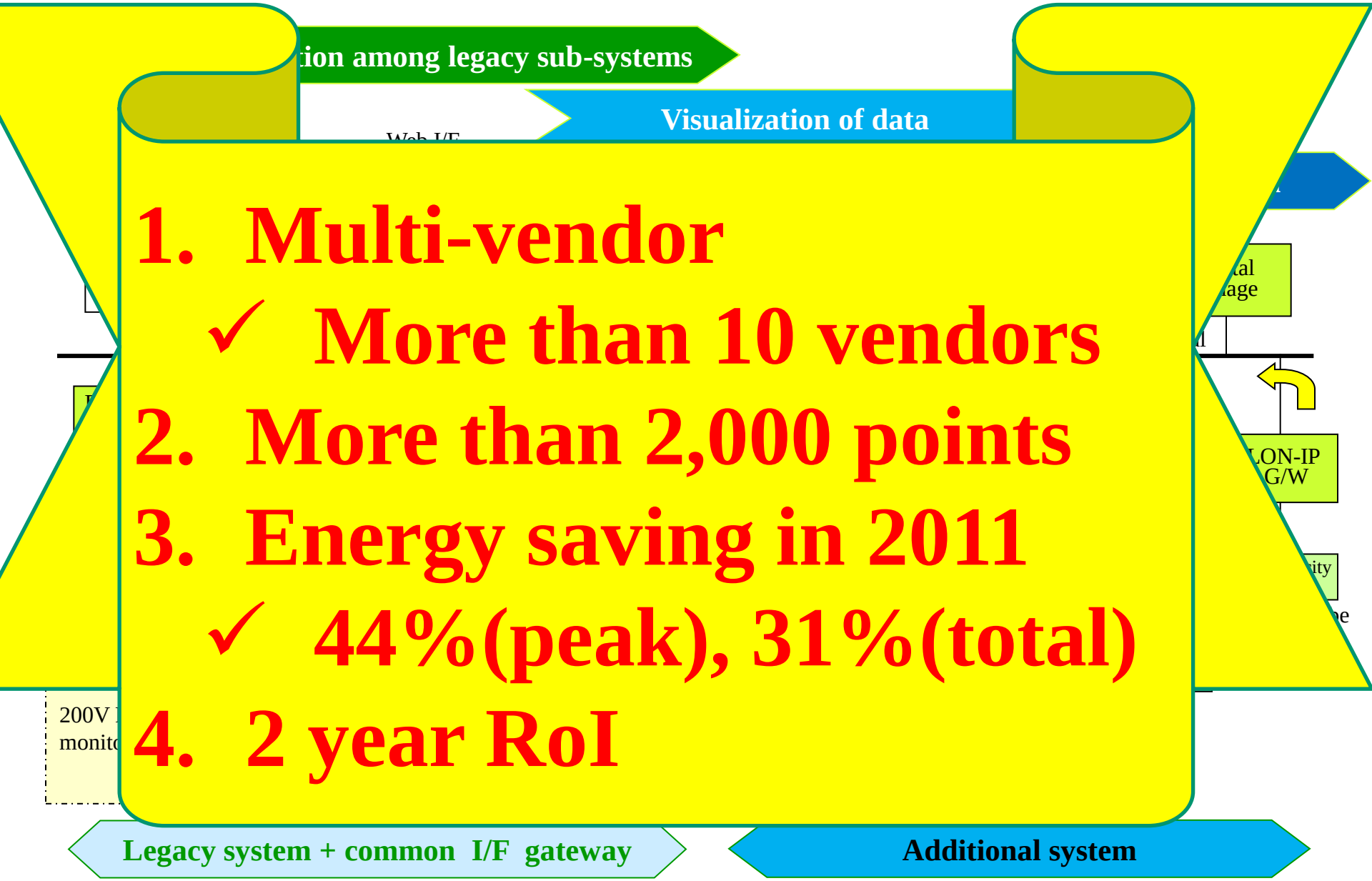


Legacy system + common I/F gateway

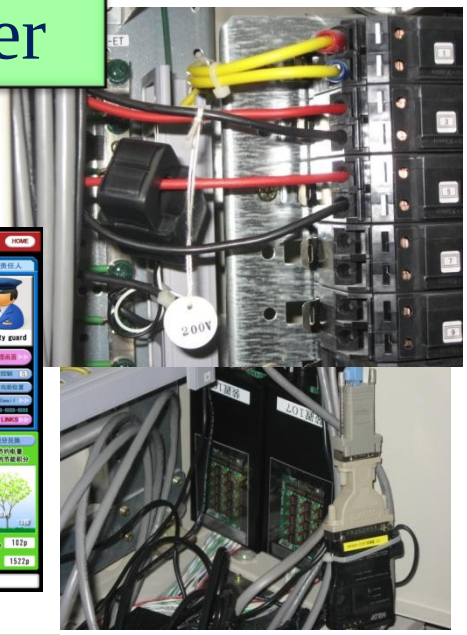
System overview Eng.No.2 Building in Hongo Campus, Tokyo, Japan



System overview Eng.No.2 Building in Hongo Campus, Tokyo, Japan

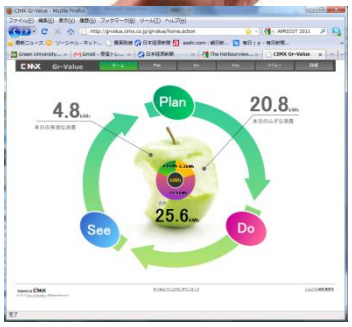


Smart Meter

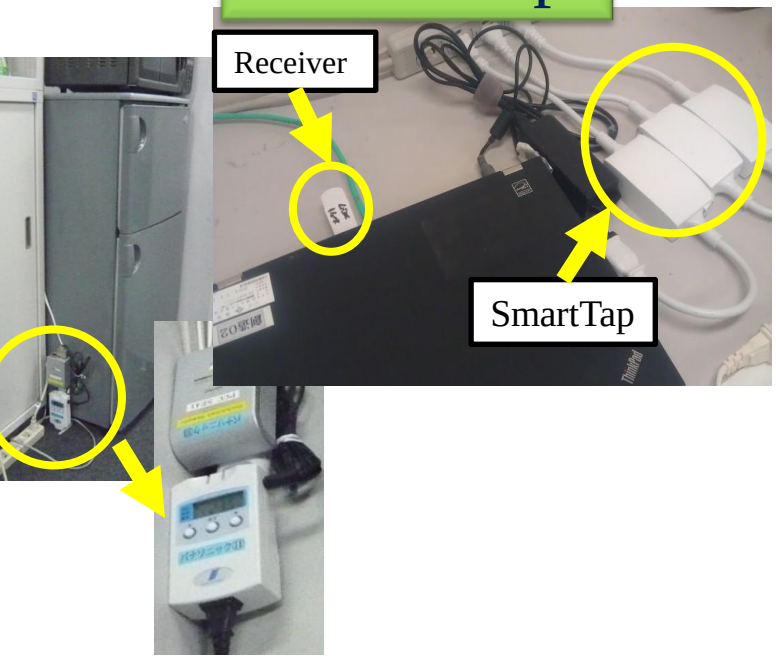


With Smart Phone

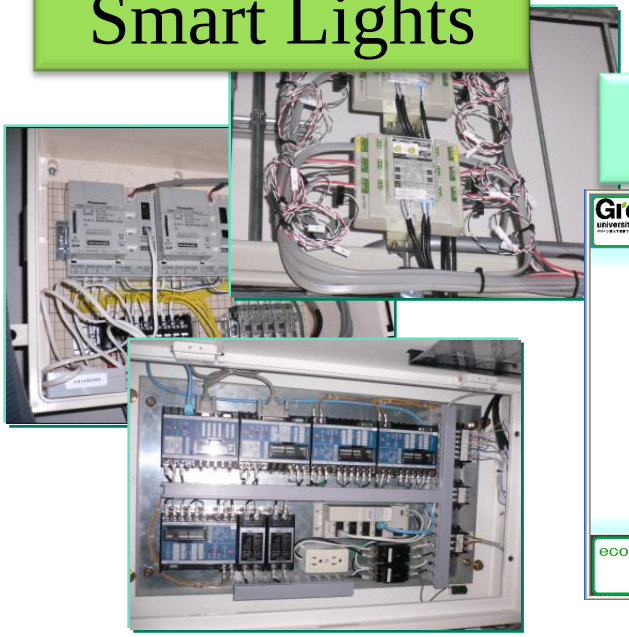
Smart Kiosk



Smart Tap



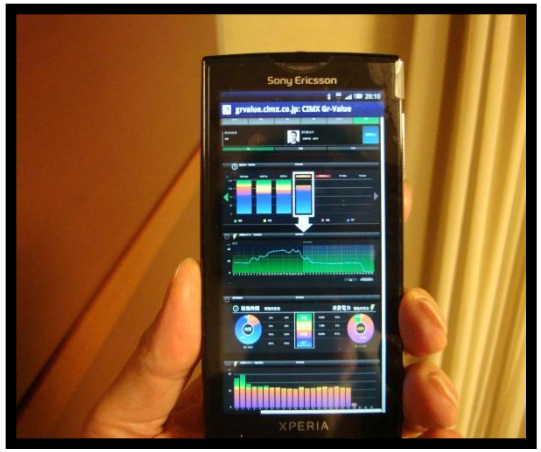
Smart Lights



Smart HVAC

Migrating; from “single screen” to “multiple screens” from “Pull” to “Push”

Green university of Tokyo Project



Android

iPhone

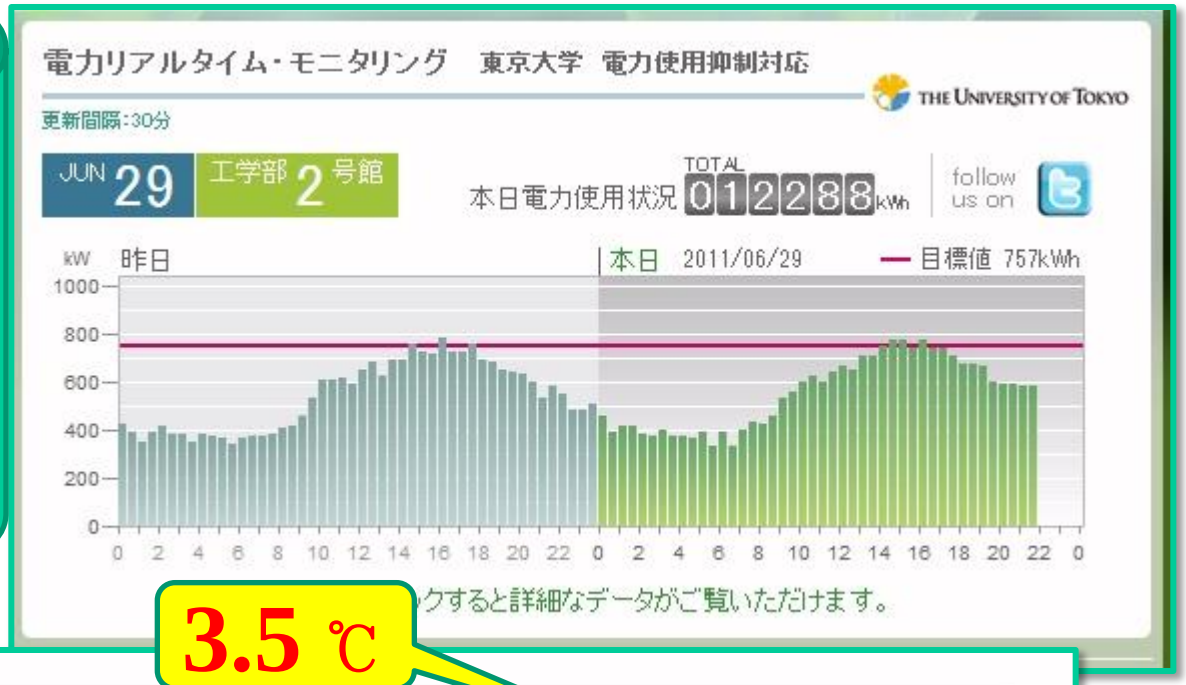
iPad

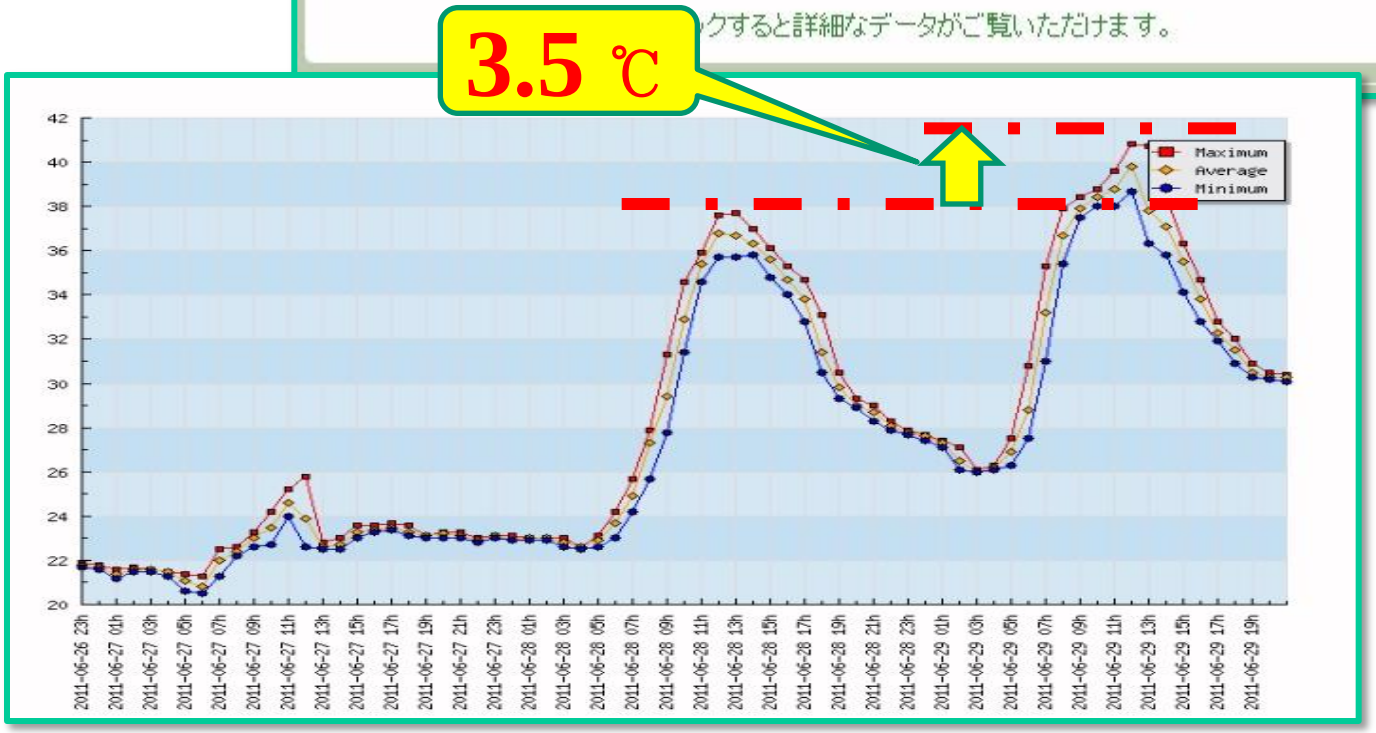
見える化・見せる化の効果?

↓

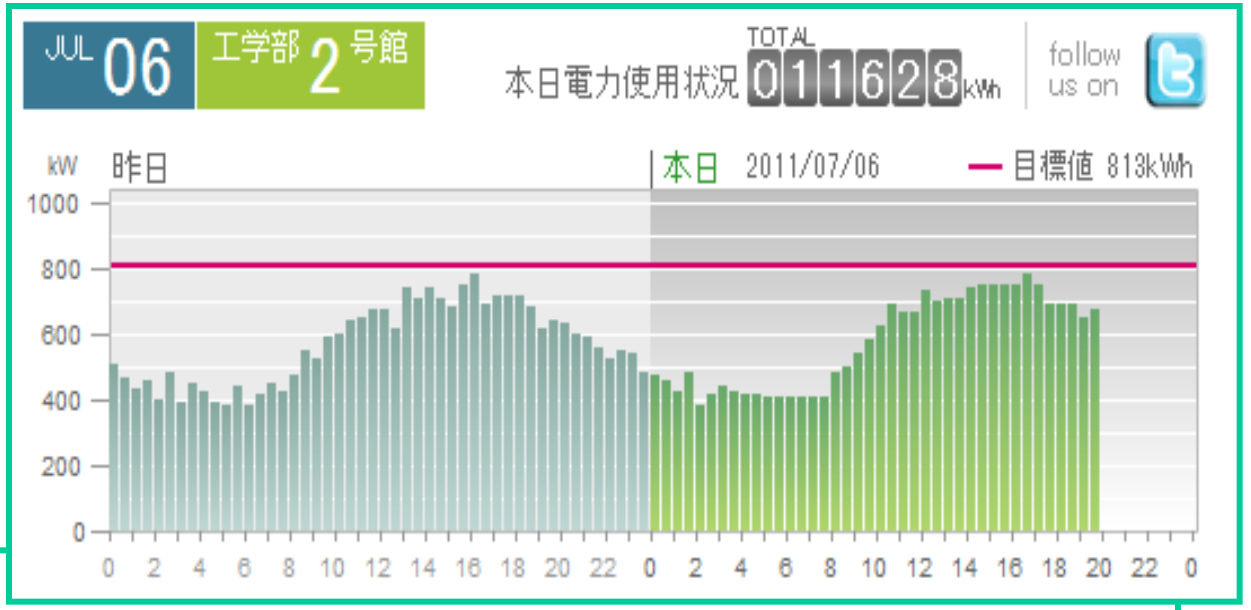
気温は違えども、ピーク値は維持。

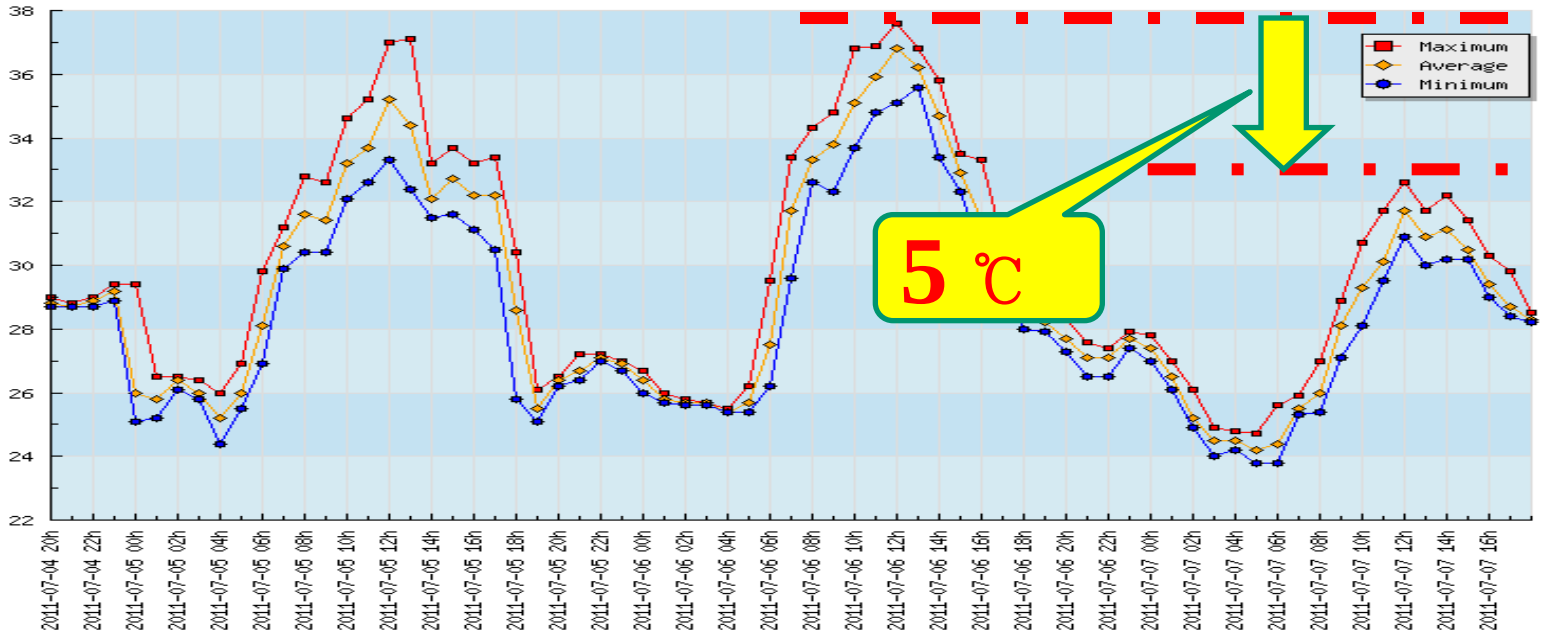
2011年6月28日&29日

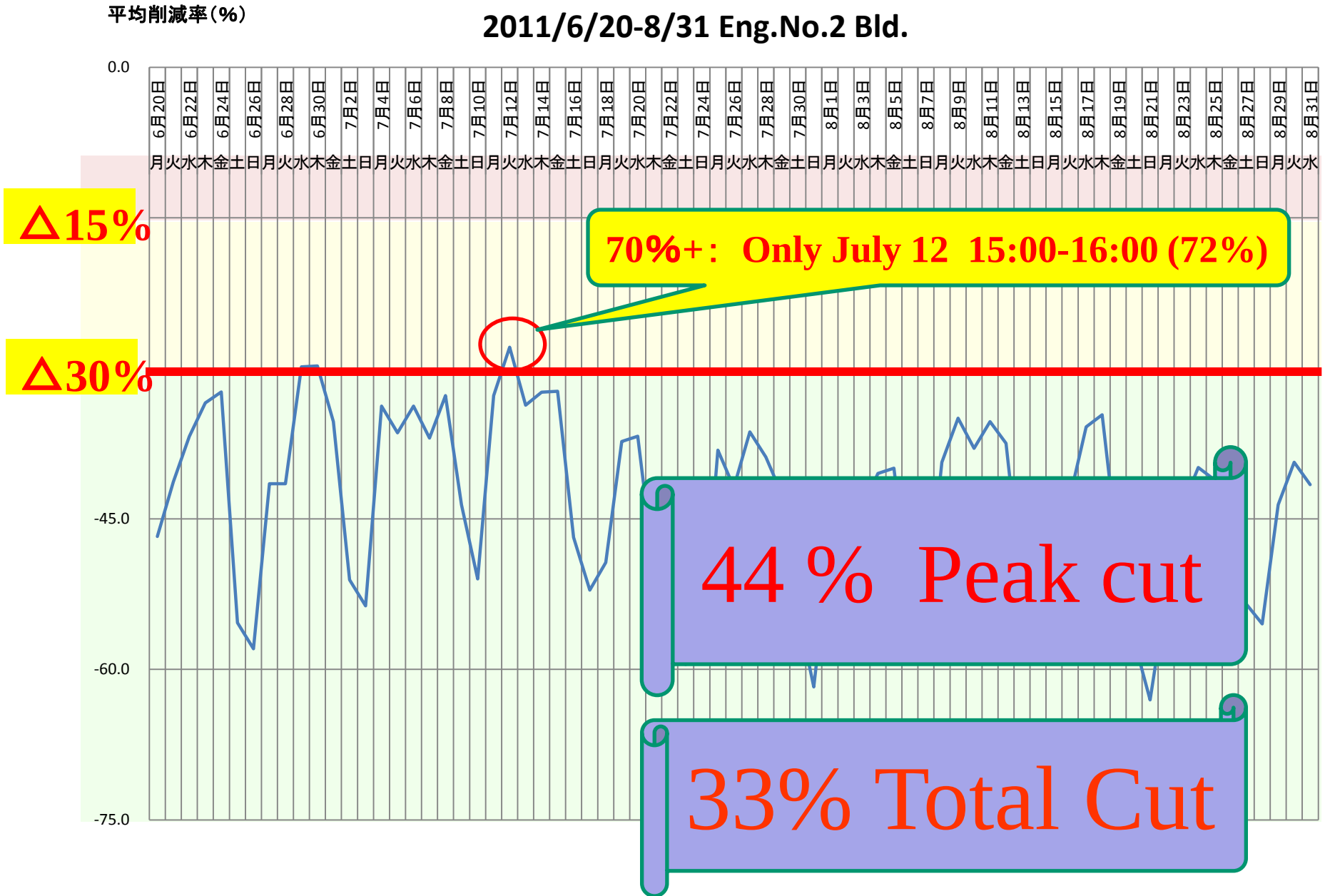




気温は違えども、
ピーク値は維持。
2011年7月5日&6日






平均削減率（%）
2011/6/20-8/31 Eng.No.2 Bld.
0.0
-45.0
-60.0
-75.0
6月20日 月
6月22日 水
6月24日 金
6月26日 日
6月28日 火
6月30日 木
7月2日 土
7月4日 月
7月6日 水
7月8日 金
7月10日 日
7月12日 火
7月14日 木
7月16日 土
7月18日 月
7月20日 水
7月22日 金
7月24日 日
7月26日 火
7月28日 木
7月30日 土
8月1日 月
8月3日 水
8月5日 金
8月7日 日
8月9日 火
8月11日 木
8月13日 土
8月15日 月
8月17日 水
8月19日 金
8月21日 日
8月23日 火
8月25日 木
8月27日 土
8月29日 月
8月31日 水
△15%
△30%
70%+： Only July 12 15:00-16:00 (72%)
44 % Peak cut
33% Total Cut

<< IEEE1888 Application Example >>

Handling the Current and Historical Data of Building Facilities

10F EHP HVAC Statuses

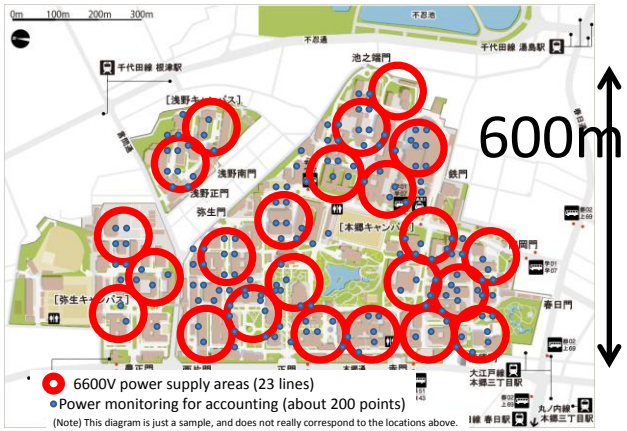
Not only energy information !!

Tim 2011-09-08 09:02:06

e: 部屋名	運転	モード設定	温度設定	温度計測
101B	OFF	冷房	26	28.9
102B1	ON	冷房	25	25.6
102B2	OFF	冷房	22	29.3
101C1	ON	冷房	28	27.6
101C2	OFF	冷房	27	27.2
102C1	OFF	冷房	28	29.3
102C2	ON	冷房	26	25.6
103C1	OFF	冷房	27	30.1
103C2	ON	冷房	27	27.2
10SV	ON	冷房	23	23.2

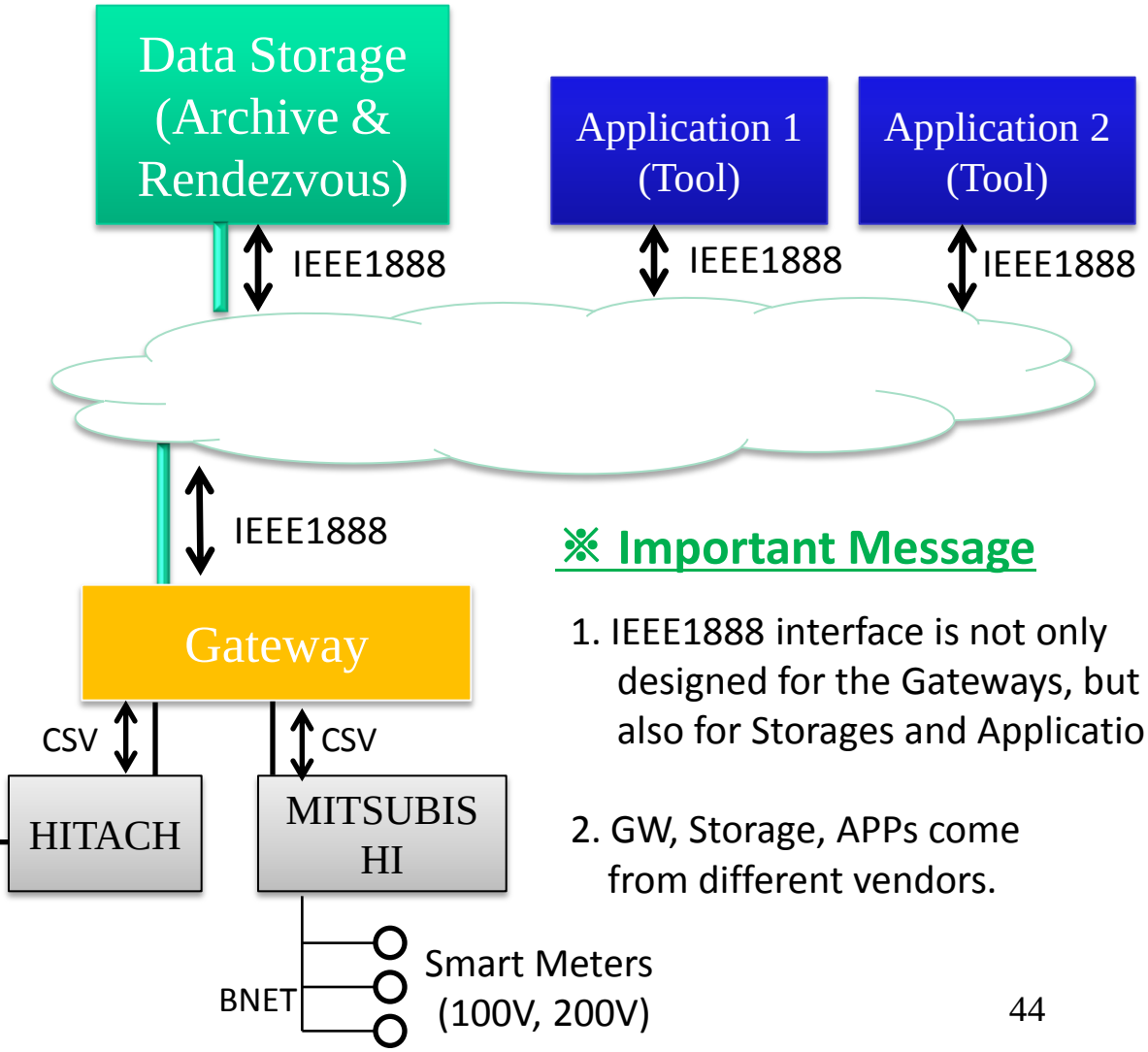
(*) 過去180秒以内に更新されていない項目は　で表示されます。

A System for Metering Electricity



Supply power to the Campus

30,000 kW Substation
(66kV → 6600V)

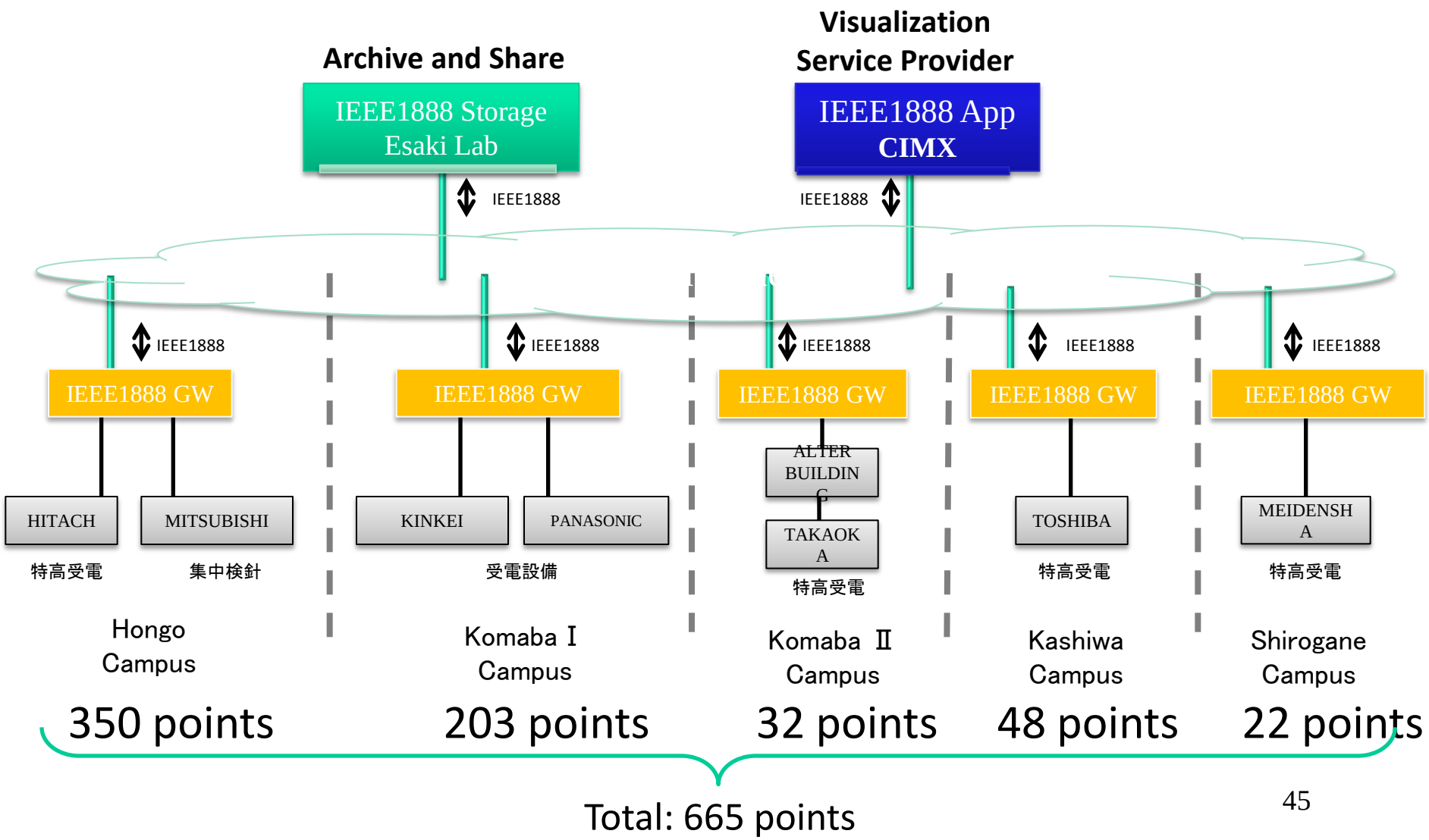


※ Important Message

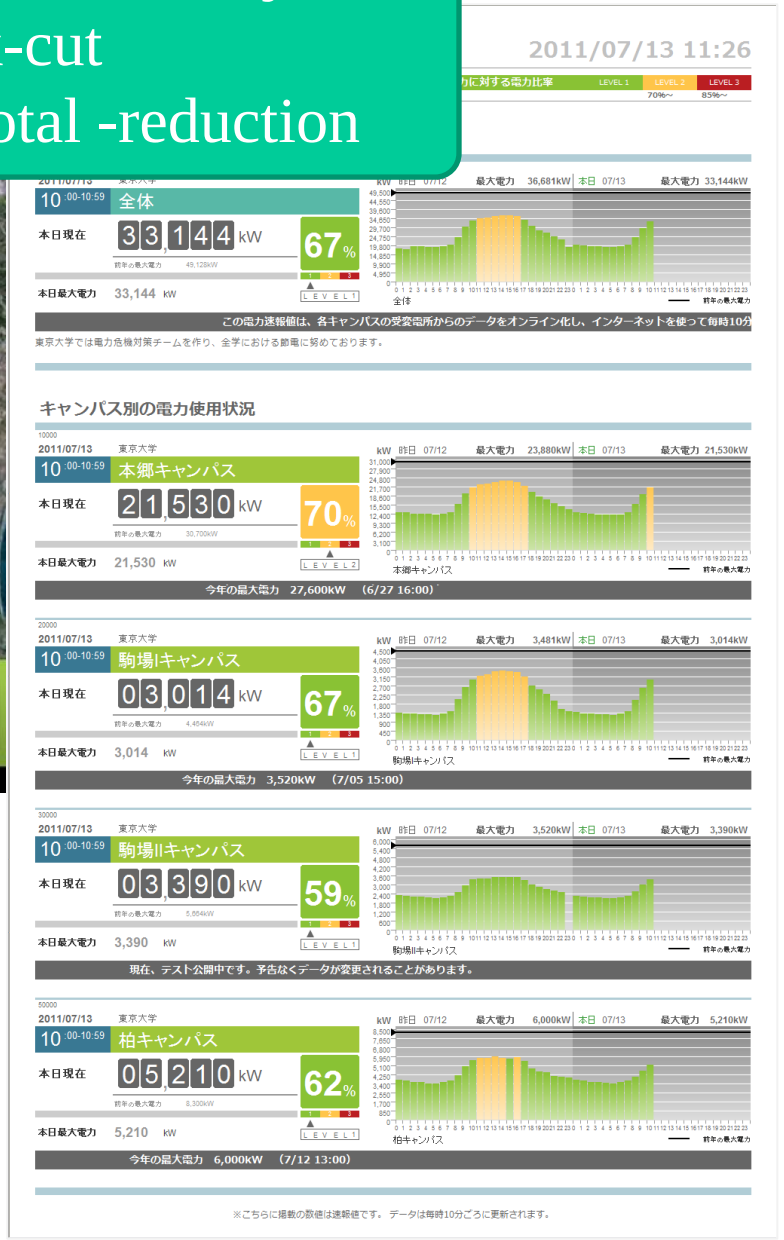
1. IEEE1888 interface is not only designed for the Gateways, but also for Storages and Applications.

2. GW, Storage, APPs come from different vendors.

Connecting 5 Campuses on the Same Platform

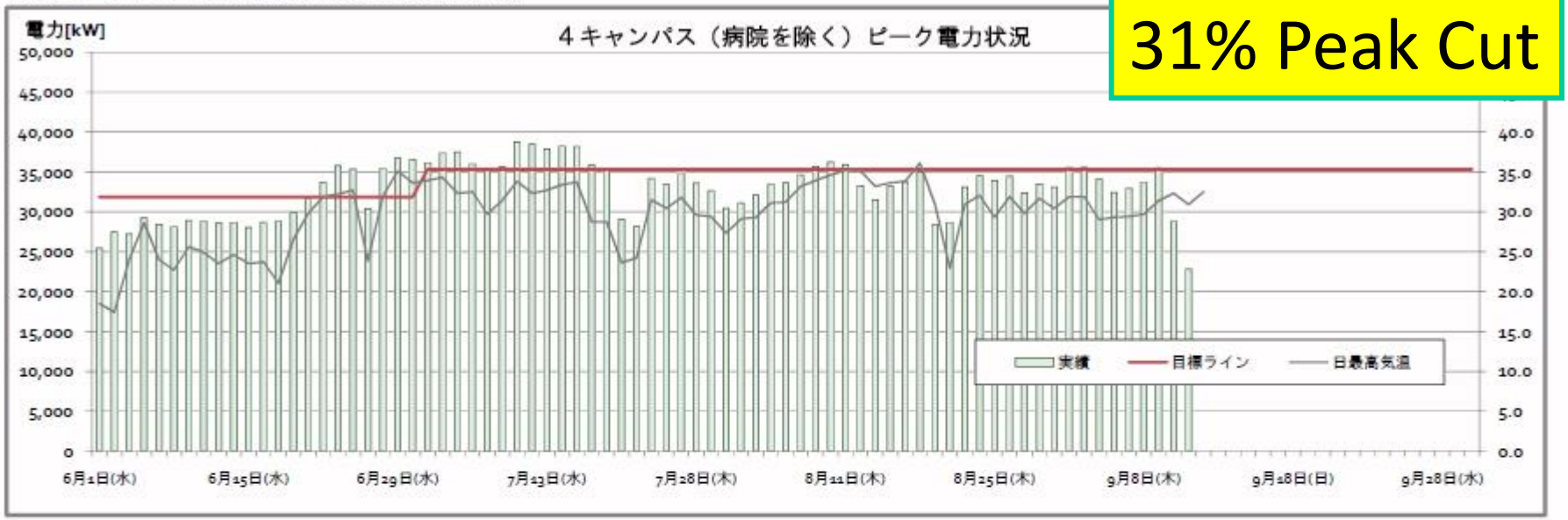


66MW, 60 MUSD/year
- 31% peak-cut
- 20-25% total -reduction

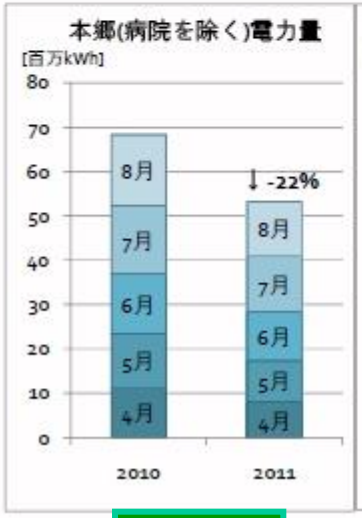


電力ピークカット目標達成状況及び電力量実績

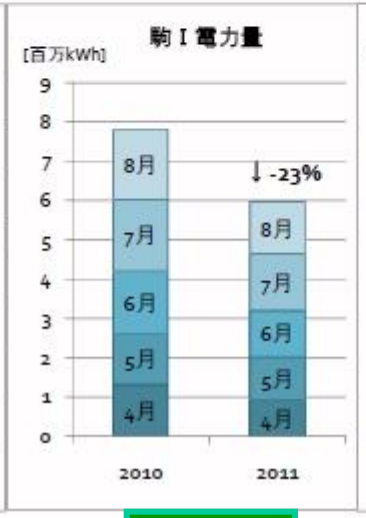
2011. 9. 13　環境課



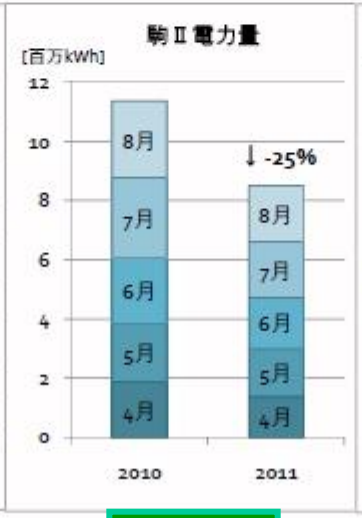
31% Peak Cut



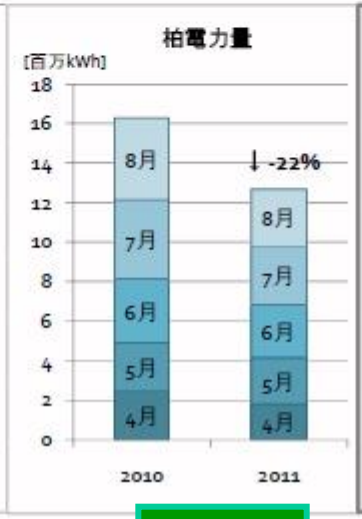
22%



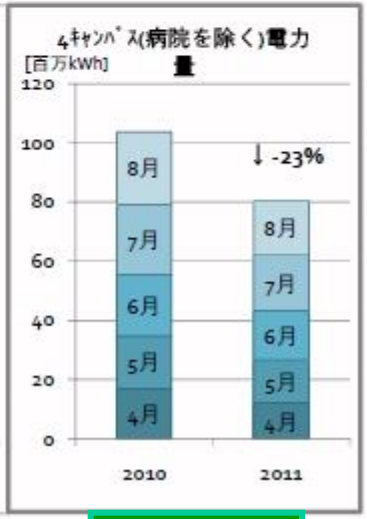
23%



25%



22%



23%

Smart Tap Integration with IEEE1888

- Esaki-Lab at The Univ.of Tokyo

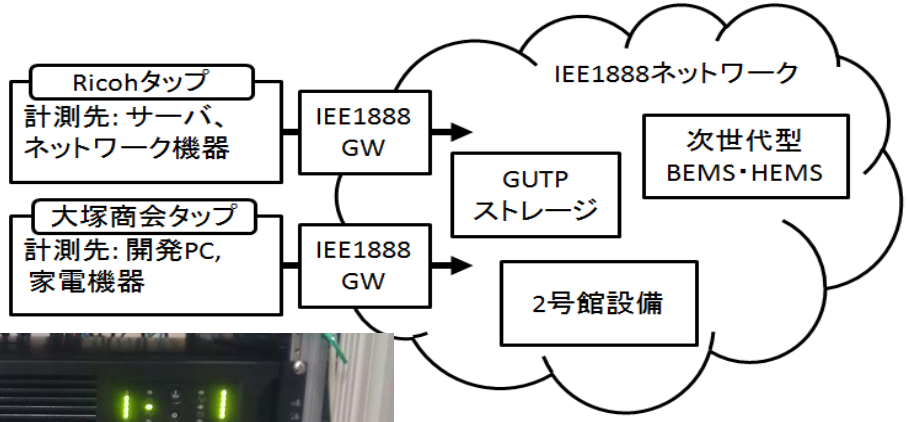
東京大学 THE UNIVERSITY OF TOKYO

1. Ordinary Smat-Tap By Plugwise Inc.,

Plugwise

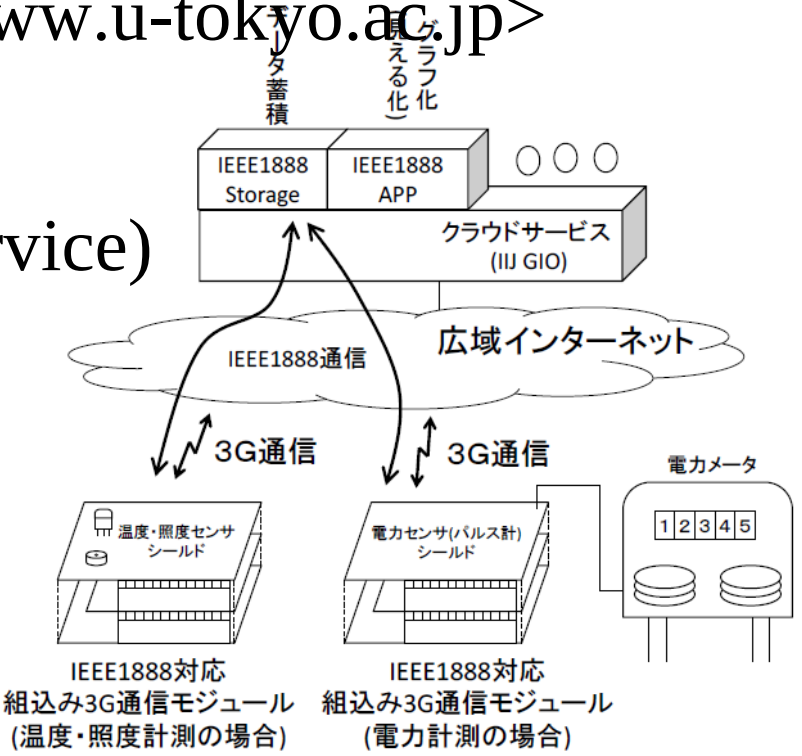
2. Smart-Tap for Rack in computer room
   by RICHO Company Ltd.

RICOH



IEEE1888 over 3G

- Partners
  - Internet Initiative Japan (IIJ) Inc., <www.iij.ad.jp>
  - 3G Shield Alliance <www.tabrain.jp/newfolder1/a3gsa.html>
  - The University of Tokyo www.u-tokyo.ac.jp>
- Feature of the System
  - IIJ GIO Service (Cloud Service)
  - IEEE1888 sensor module with 3G link



IEEE1888 Development Kits by FUTABA Kikaku

Tokyo Institute of Technology
Green Hills,No.1 Bldg

Microsoft Japan
HQ in Tokyo

Otsuka Corp. HQ

Shinryo Reinetsu
HQ and other buildings

Hitachi Info& Tele Eng Ltd.
Nakai Development Center

CANON S Tower
(Canon MJ HQ)

Thang Long Industrial Park
（Vietnam）

浜松市
（政令指定都市）

Global/International collaboration

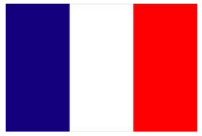
1. ISEP/DESSC with UN foundation
2. Beijing team(e.g., Tsinghua Univ., China Telecom), **China** (Including Standardization)
3. Chularonkorn University, **Thailand**
   - EE Building BEMS, SEIKO Factory Automation
4. NTU(National Taiwan University), Taipei, **Taiwan**
   – MoU with College of EECS
5. MIC/NISCI/HTU/VDC with Japanses MIC, **Vietnam**
   – Smart Industrial Park, Data Center, Buildings
6. iDA and NTU in **Singapore**
7. Universiti Teknologi Petronas, **Malaysia**
8. DoT(Department of Telecomm.), IIT-H and SRM, **India**
9. UCB with Intel, LoCaL project, in **USA**
10. SGIP of NIST in **USA**
11. UMPS/LIP6/CNRS in Paris, **France**
12. ISO/IEC JTC1 SC6 WP7












International Collaboration