The 1st International Symposium on Open Energy Systems
Okinawa Institute of Science and Technology Graduate University (OIST)

Sony CSL – OIST
DC-based Open Energy System (DCOES)

January 14, 2014

Mario Tokoro
Sony Computer Science Laboratories, Inc. (Sony CSL)

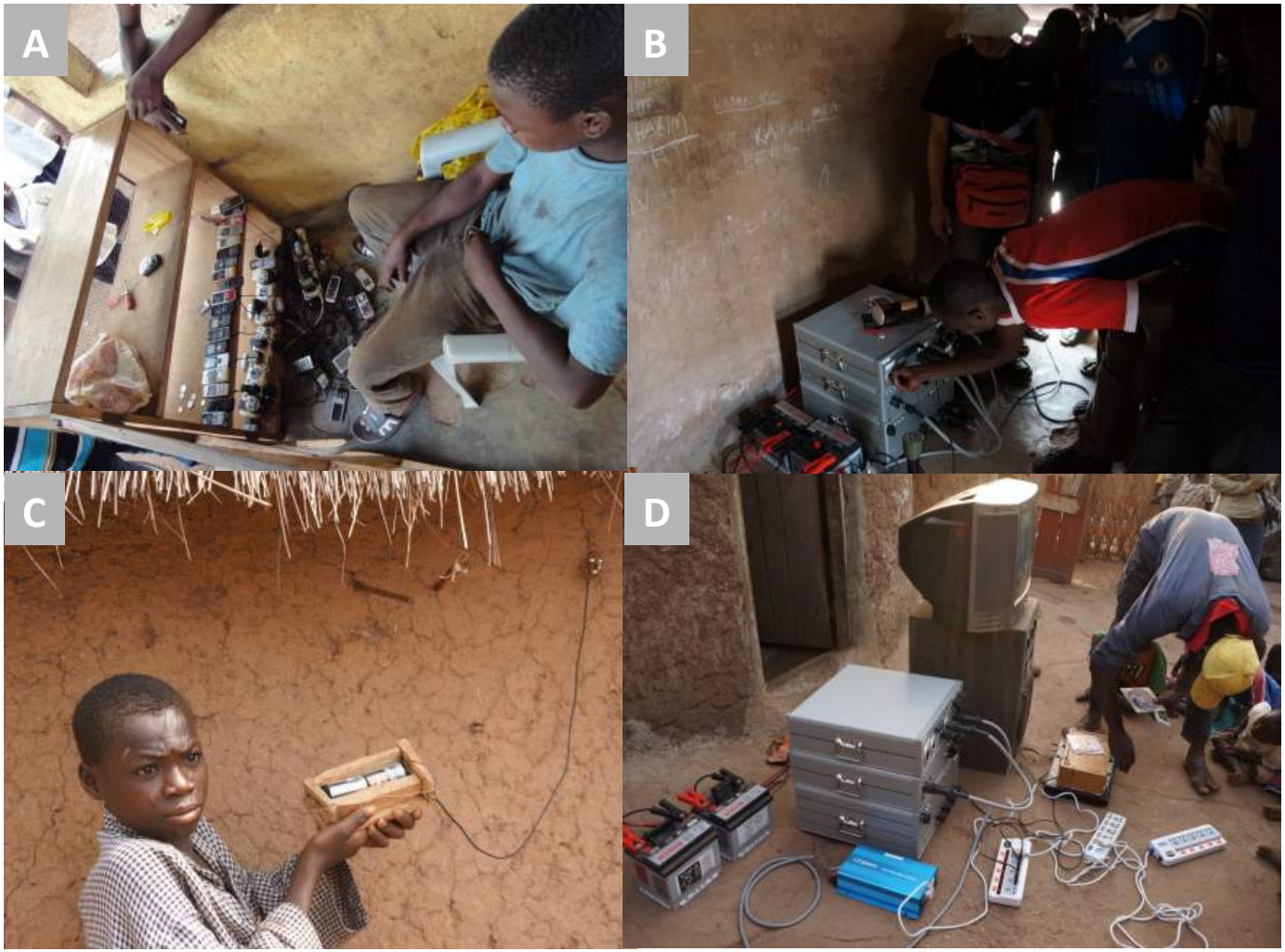
FIFA World Cup 2010 Public Viewing

- May 2010 and June-July 2010 @ Ghana
- Flexible Solar Panels and Li-Ion Batteries
- In cooperation with JICA HIV/AIDS Campaign

JICA Project

Cellular Phone Charging Business using Solar Panel and Batteries

BOP Business F/S Project (2011.4～2013.12)
Funded by JICA (Japan International Cooperation Agency)



A. Mobile phone charging service using power generator

B. Geo System trial at Kpachelo, Ghana

C. F/S in non-electrified locations

D. Geo System trial at Puriya, Ghana

Okinawa Project: Phase1(FY2011-FY2012)

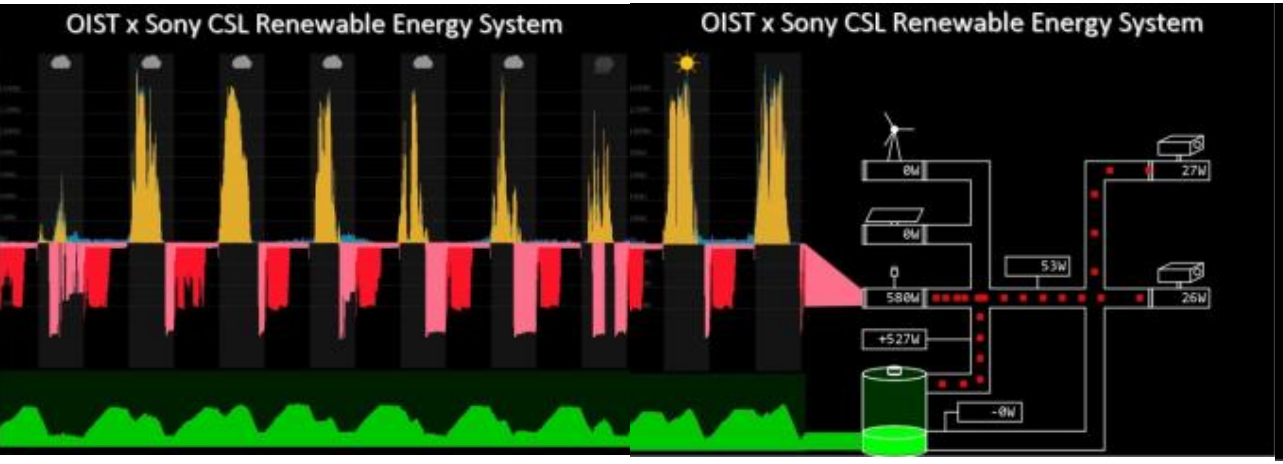
Driving 3 projectors by Renewable Energy (Solar & Wind) with Energy Servers

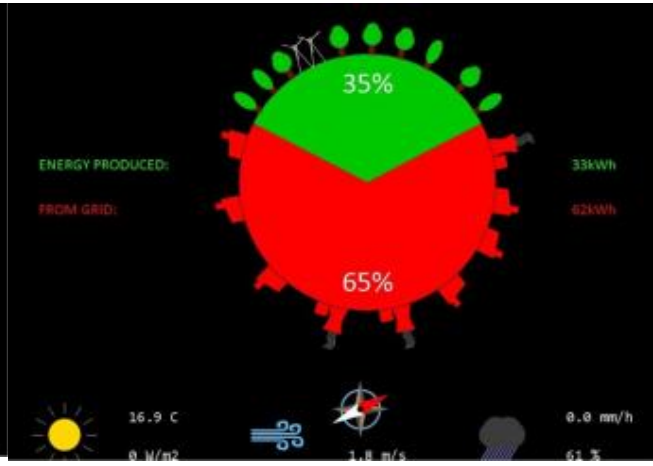
Solar Panel (10kWh)

Windmill (2.2kWh)

Energy Server

Display & remote monitoring





DCOES Project

- Oct. 2013 – Mar. 2015 at OIST, Okinawa Prefecture
- Supported by “Subtropical and Island Energy Infrastructure Technology Research Subsidy Program”, Okinawa Prefectural Government
- Solutions and new business for energy issues in Okinawa, island countries and the world

DCOES Project Organization

Sony CSL

Mario Tokoro
Yoshiichi Tokuda
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Annette Werth
Tadashi Morita

OIST

Hiroaki Kitano
John Dickison
Taichiro Sakagami

Okisokou Co. Ltd.

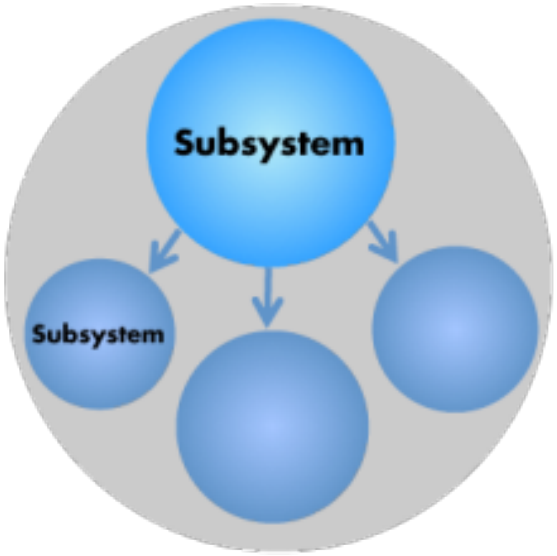
Sony Business Operations Inc.

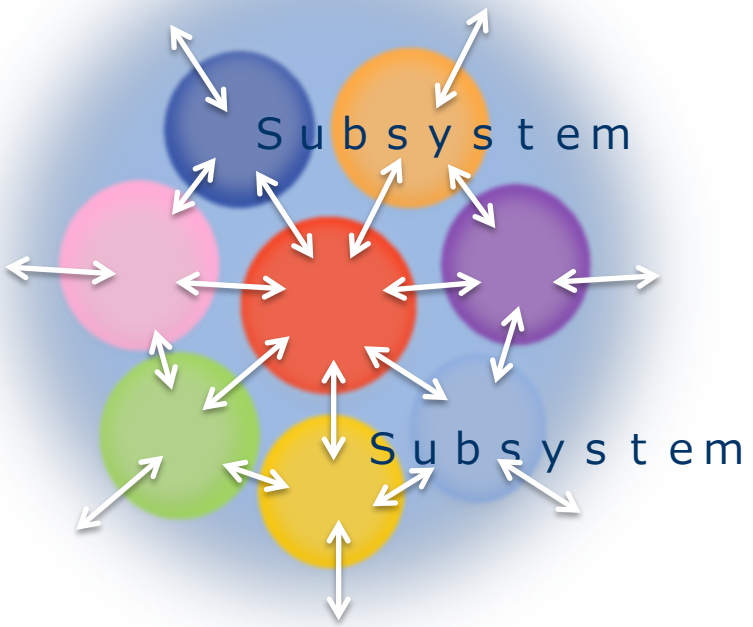
Sony Energy Devices Corporation

Sony Corporation

Open **E**nergy **S**ystems(**OES**)

<A solution for global energy and sustainability problems>





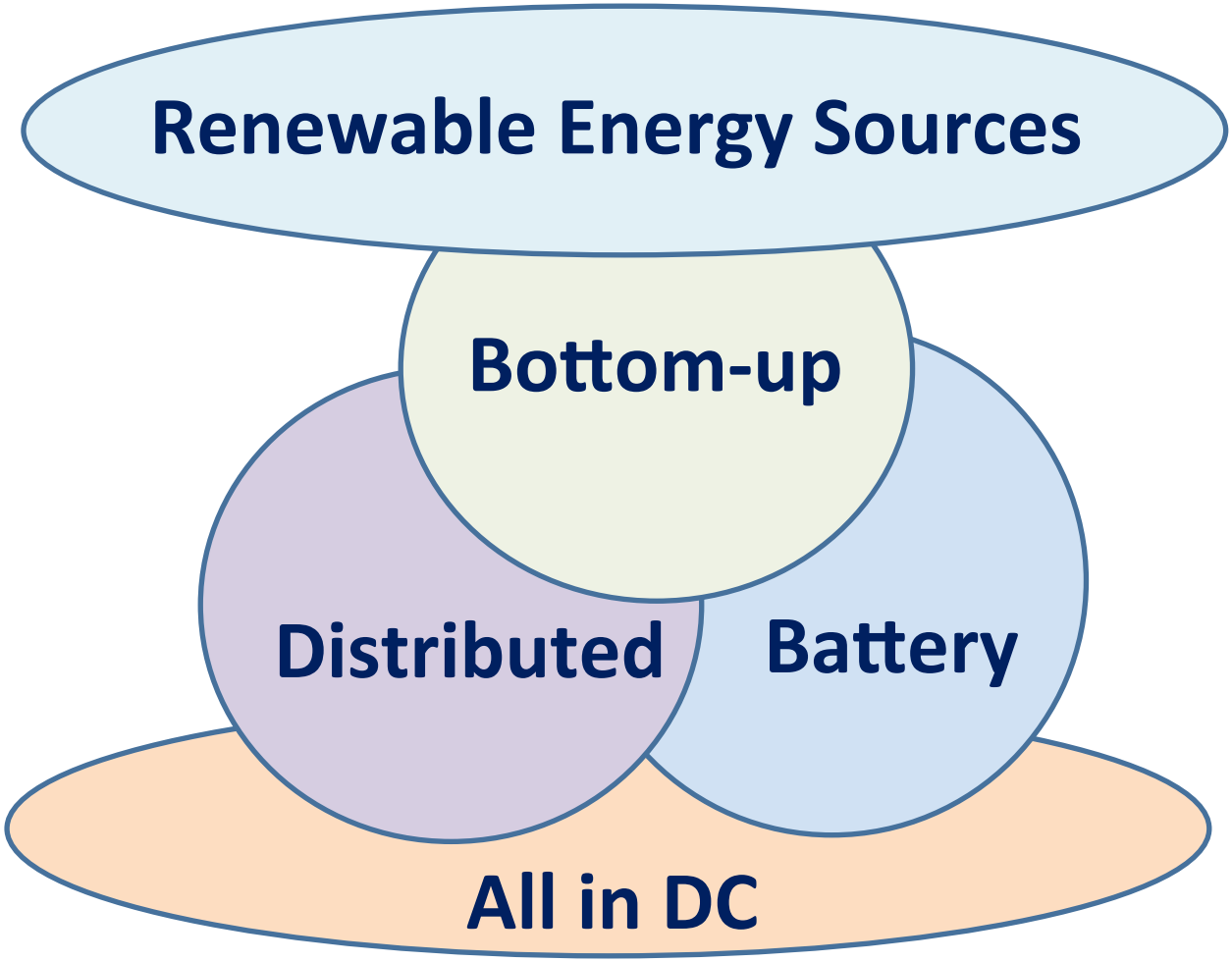
Conventional system

Top-down power transmission based on large scale power generation

OES

Bottom-up and interconnection based on unstable distributed power sources

How to realize OES: DCOES Approach

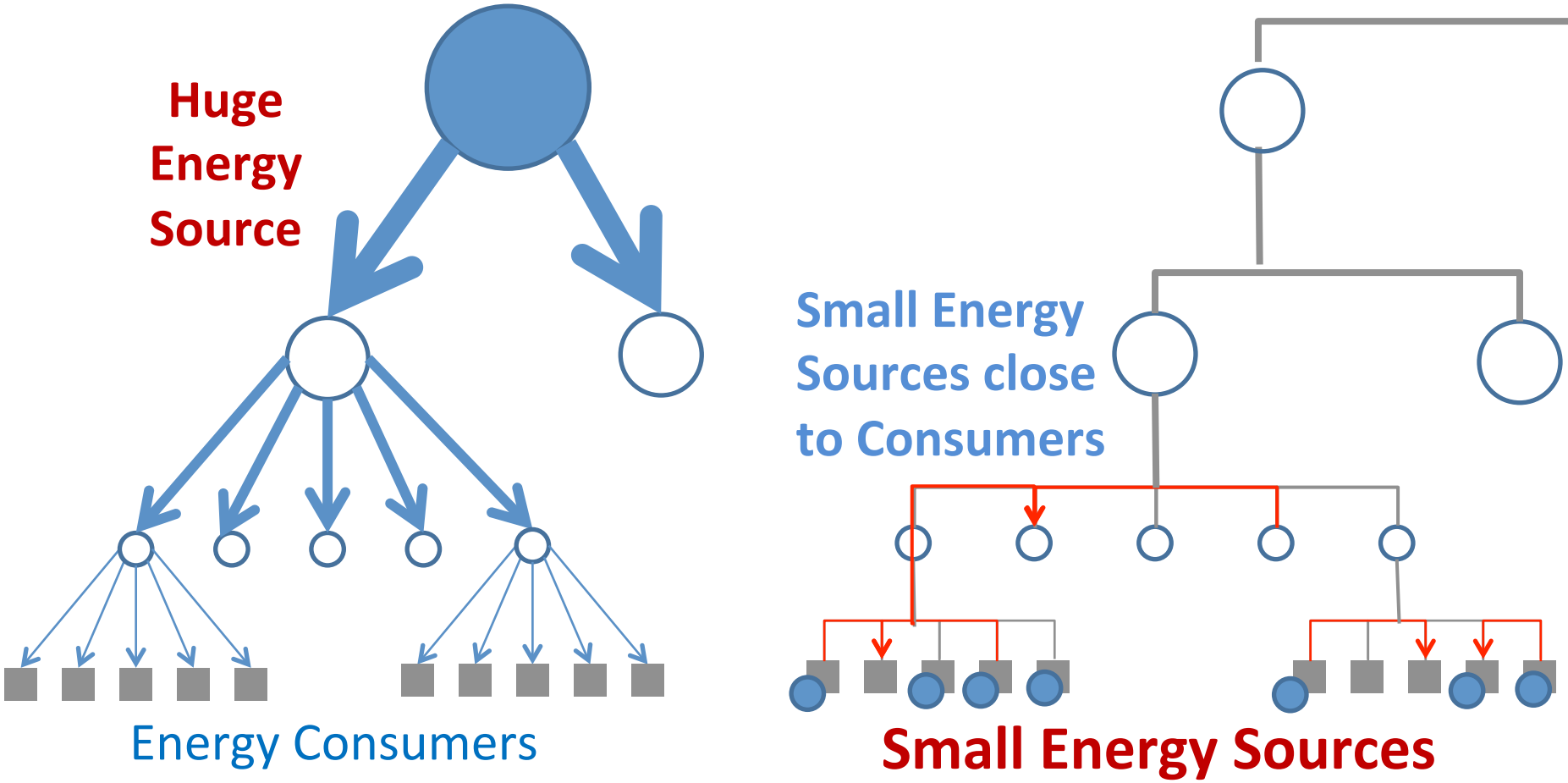


Conventional System vs DCOES (1)

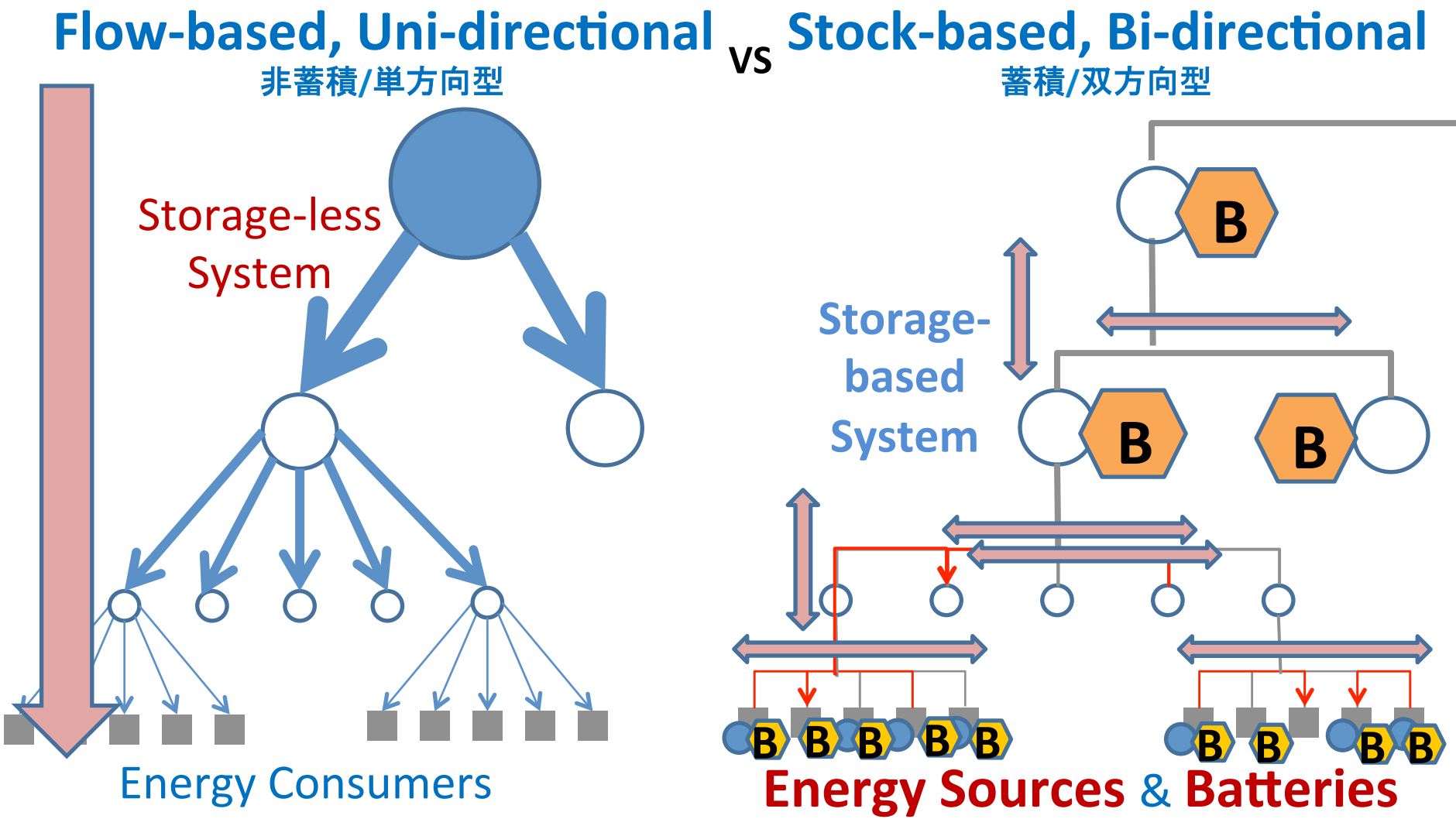
Top-down, Centralized
トップダウン/集中型

vs

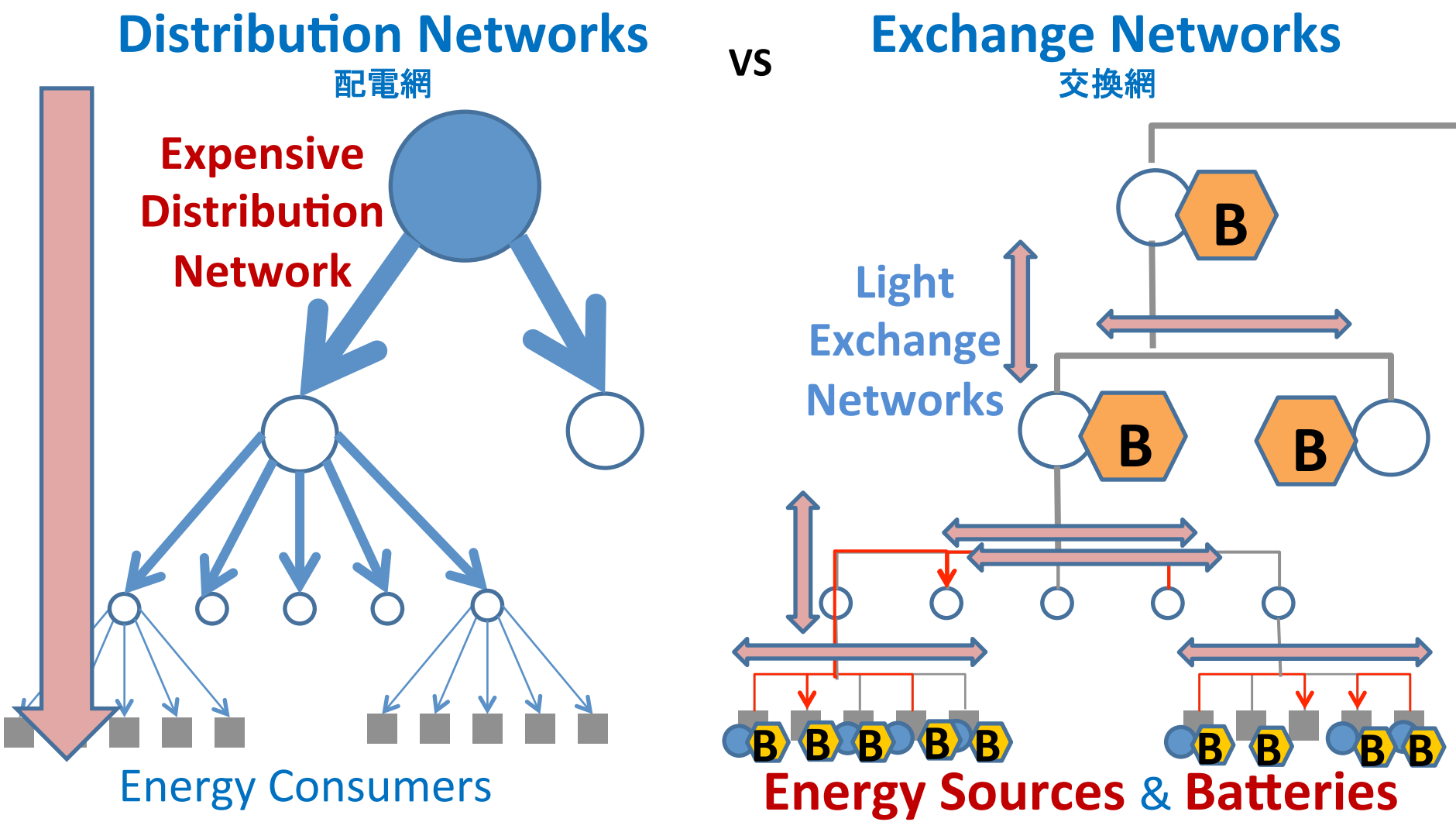
Bottom-up, Distributed
ボトムアップ・分散型



Conventional System vs DCOES (2)



Conventional System vs DCOES (3)



Conventional System vs DCOES(4)

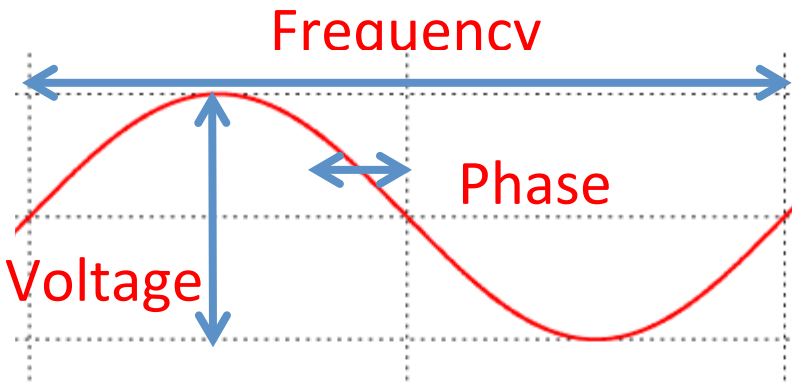
AC-based for Transformers

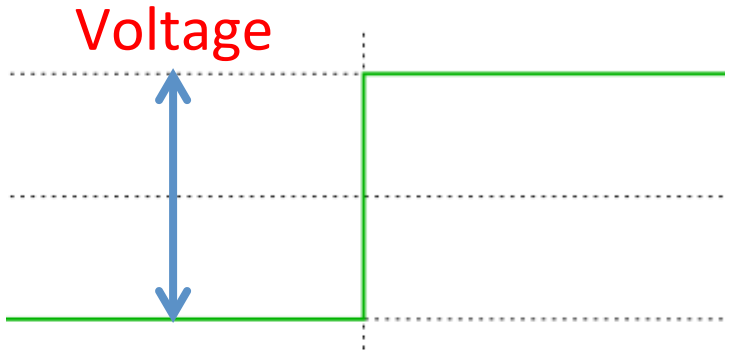
- Reactance loss of power is not negligible
- Interconnection of networks is difficult due to synch.

VS

DC-based for Batteries

- Efficient DC/DC converters are now available
- Interconnection of networks is easy (no synch. is necessary)





Conventional System vs DCOES Summary

Conventional Systems

- Top-down
- Centralized Energy Source
  - Usually at a remote place
- Flow-based
  - Storage-less system
  - Uni-directional
- Distribution Network
  - Expensive Networks
  - Long Power Mileage
- AC-based
  - Reactance Loss is not Negligible
  - Interconnection of Networks is difficult due to Synchronization

DCOES

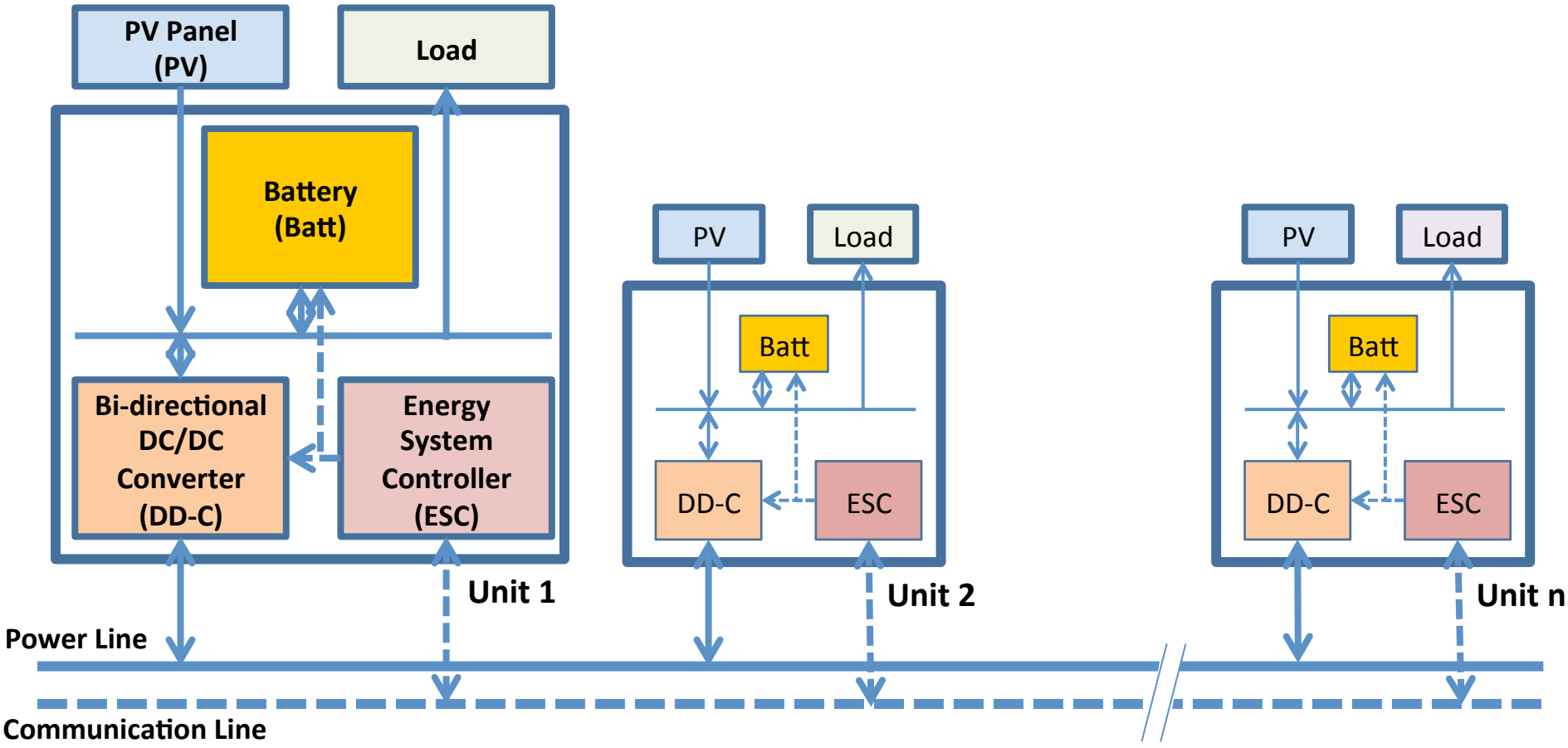
- Bottom-up
- Distributed Energy Sources
  - Close to Consumers
- Stock-based
  - Storage (Battery) -based
  - Bi-directional
- Exchange Network
  - Inexpensive Networks
  - Short Power Mileage
- DC-based
  - Efficient DC-DC Converters are now available
  - Interconnection of Networks is easy (no Synchronization)

DCOES IMPLEMENTATION

Environment for Experiments

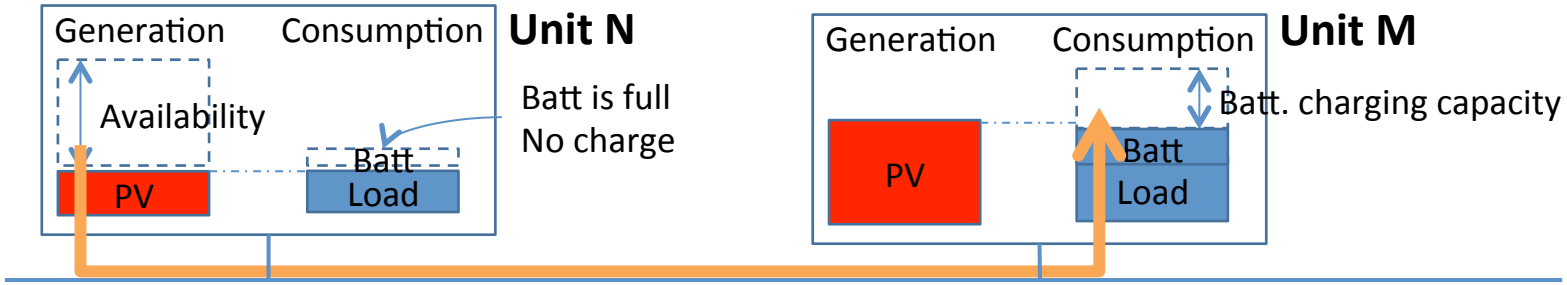
- At OIST Campus Faculty houses
  - 9 houses for FY2013
  - 20 houses for FY2014
- Size of each house
  - 2LDK: 105 m2
  - 3LDK: 148 m2
- Batteries
  - Olivine-type Lithium-ion iron phosphate batteries by Sony
  - 3.6KWH (1.2KWH × 3) for each house
- PV Panels
  - HIT233(Monocrystaline hybrid type) by Panasonic
  - 2.8kW system for 5 houses and 4.2kW system for 4 houses

Basic System Structure

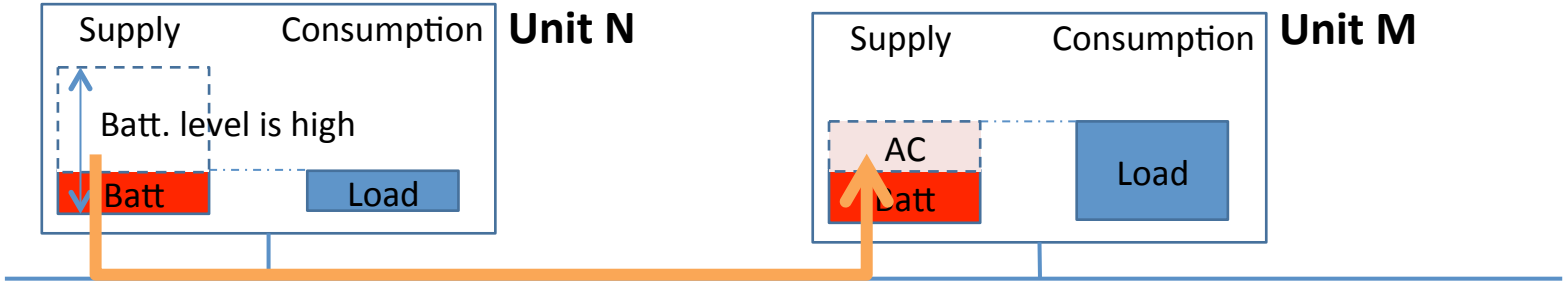


Main Scenarios

- To make use of available capacity of renewable energy generators (PV)

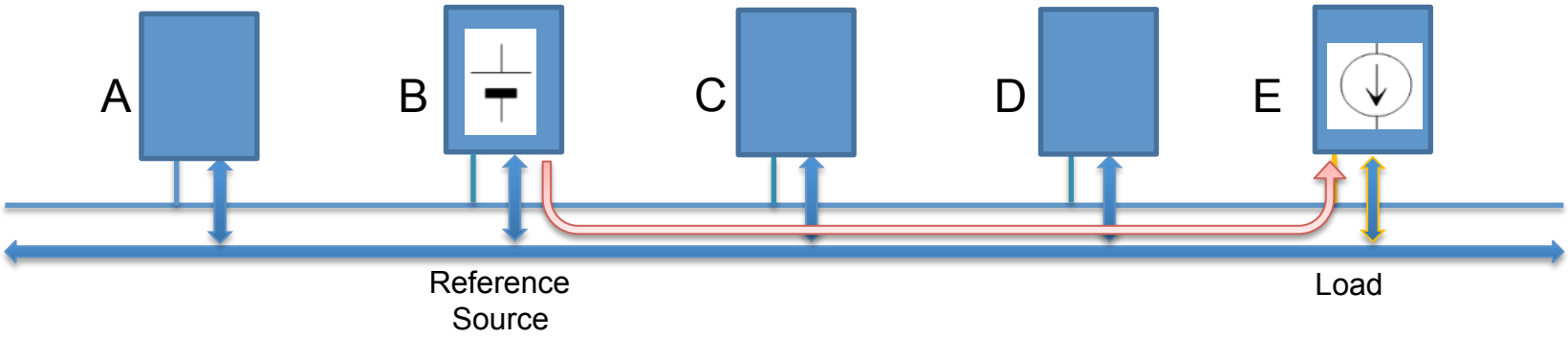


- To exchange power between batteries

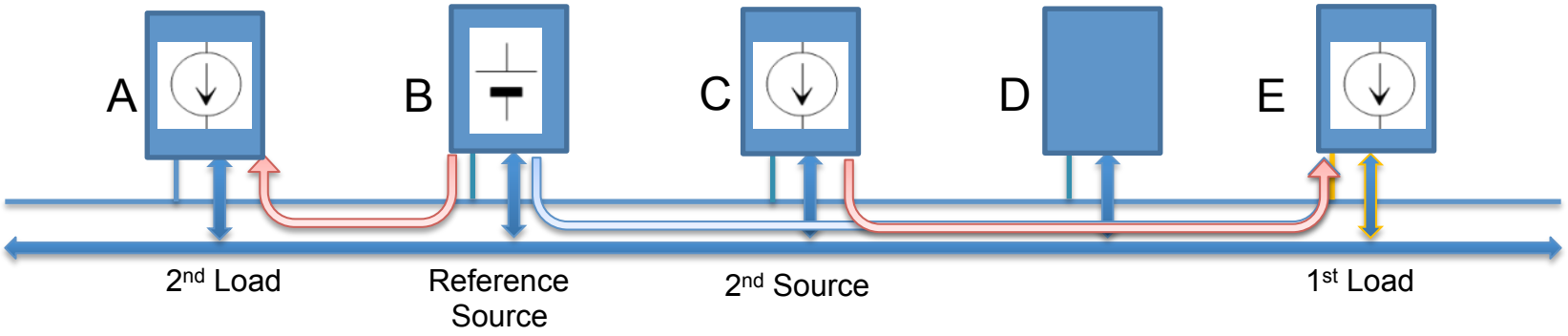


Key Technology of Energy Exchange

(1) Send power from Source (B) to load (E)

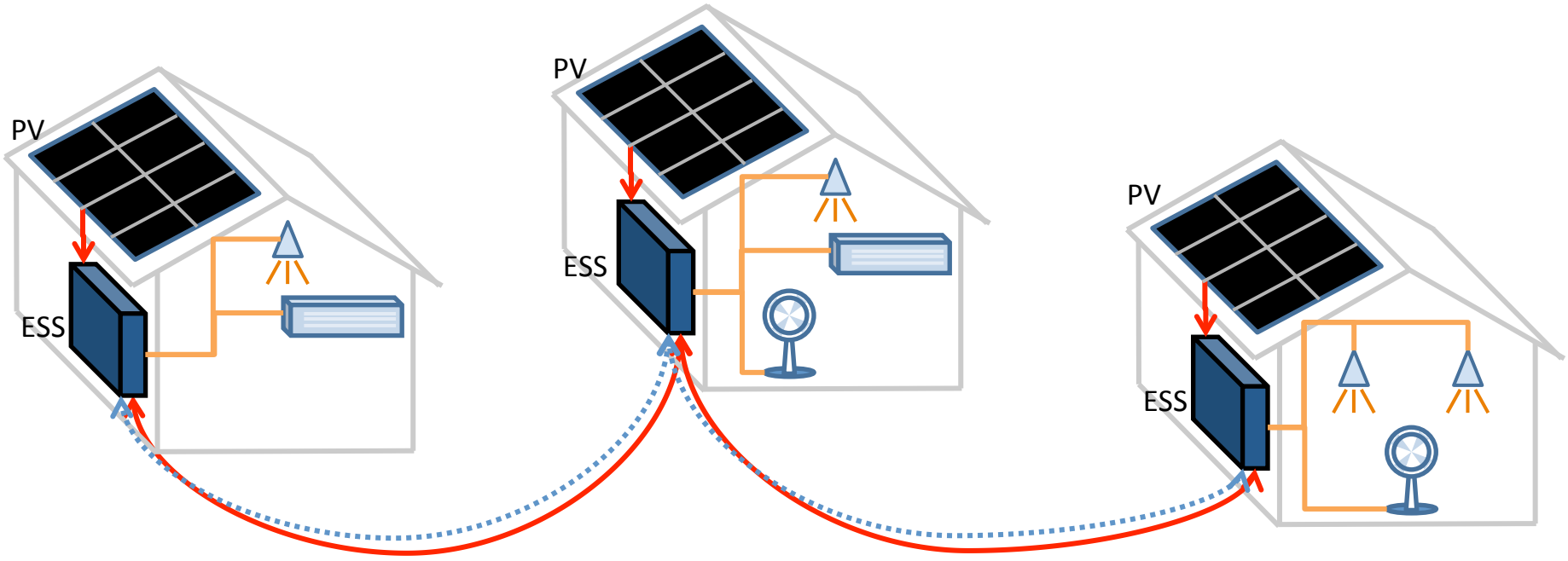


(2) Add 2nd load (A) and 2nd source (C)



Installation at OIST

On-site Feasibility Test of Energy Exchange (OIST faculty houses)



ESS: **E**nergy **S**torage **S**ystem
PV : **P**hoto **V**oltaic panel

VIDEO

OES Platform Overview

3-node Energy Exchange Experiment

PV Panel@House 204

ESS@House 204

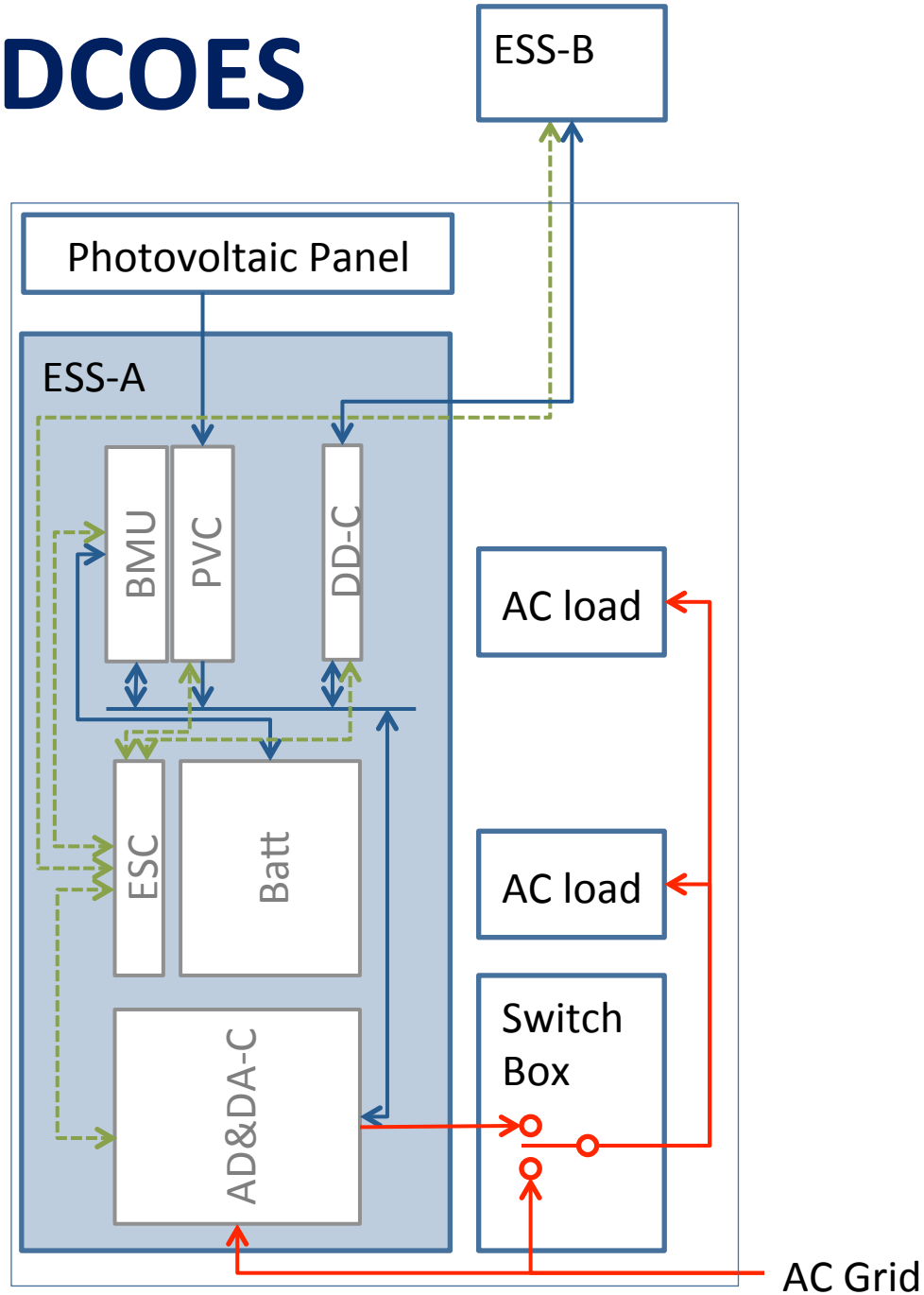
DC Power & Communication Lines

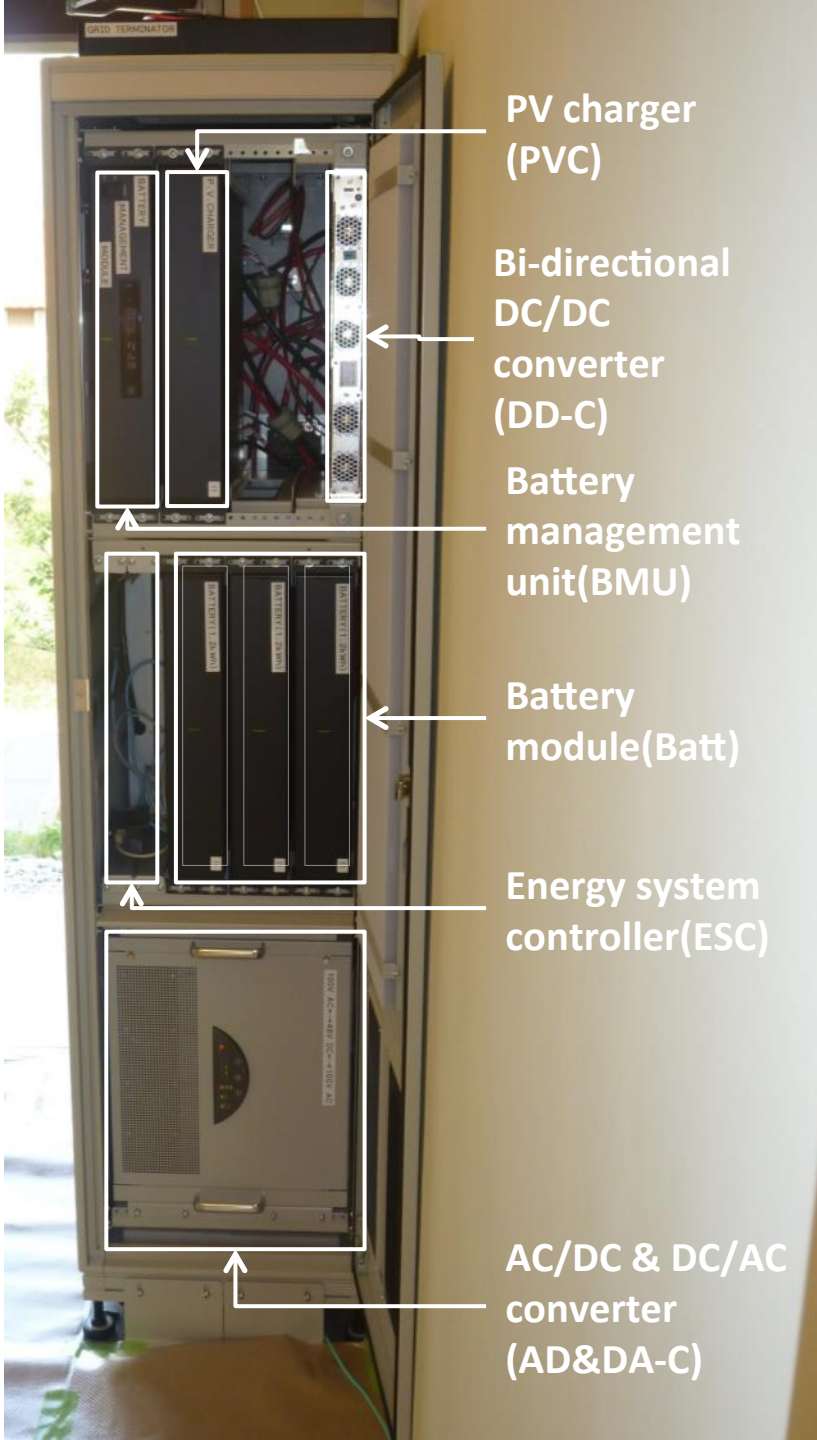
House204

House204

House203 & 202

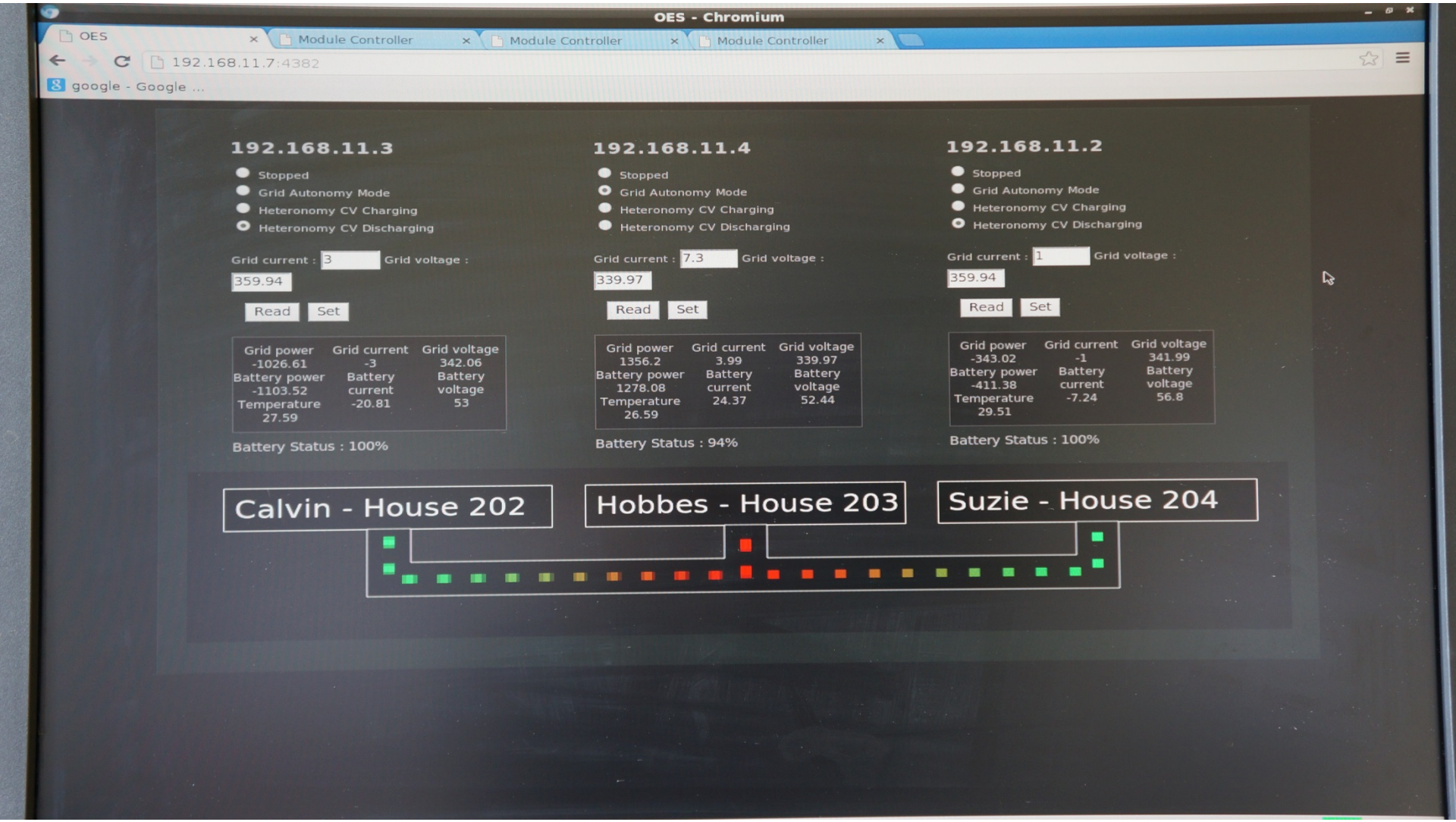
DCOES


ESS-B
Photovoltaic Panel
ESS-A
BMU
PVC
DD-C
AC load
ESC
Batt
AC load
Switch Box
AD&DA-C
AC Grid


PV charger (PVC)
Bi-directional DC/DC converter (DD-C)
Battery management unit(BMU)
Battery module(Batt)
Energy system controller(ESC)
AC/DC & DC/AC converter (AD&DA-C)

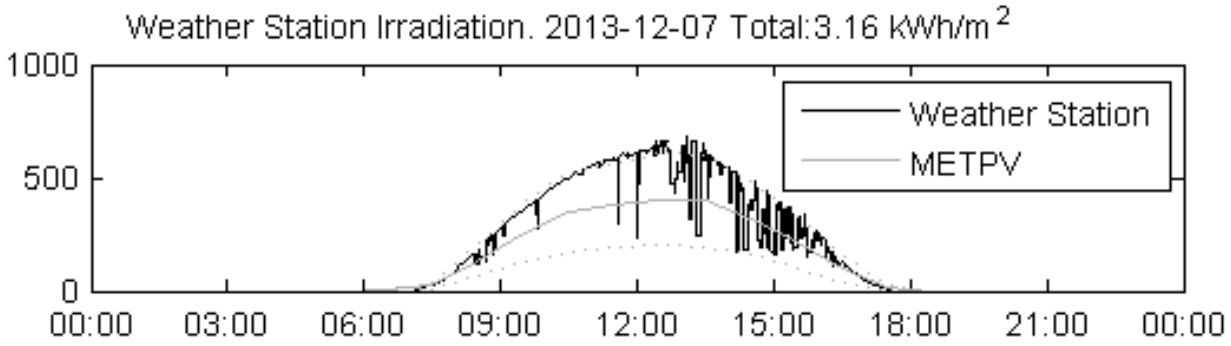
Switch Box & AC Loads

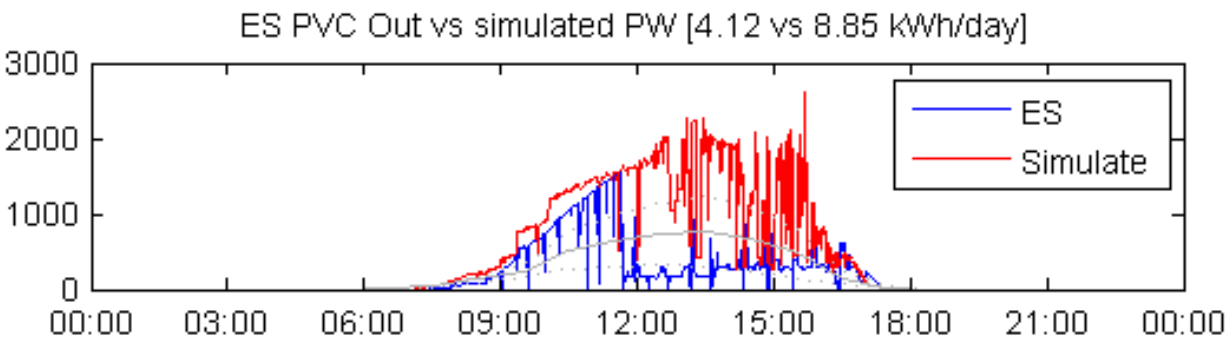
Power Exchange Experiments

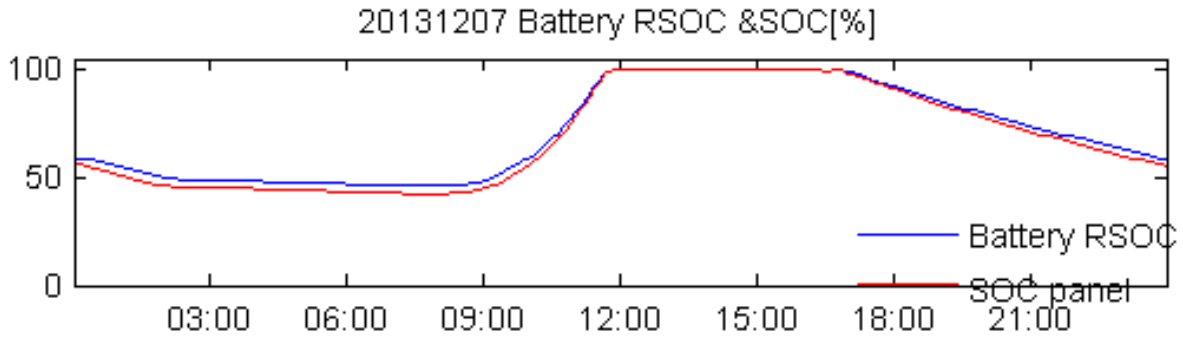


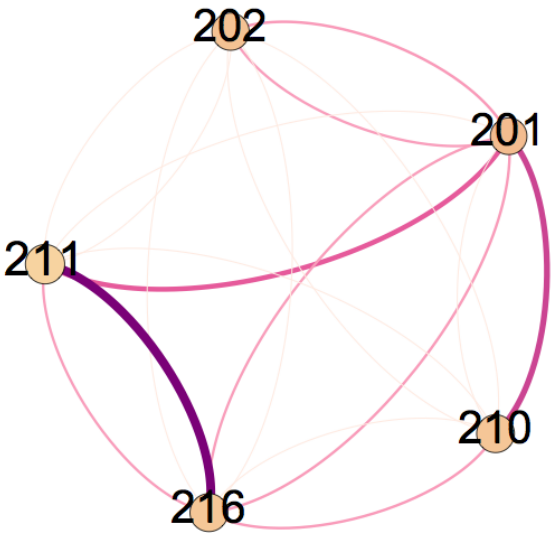
EXPECTED DCOES ADVANTAGES

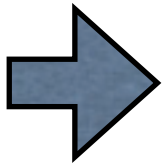
House 203 ESS Data and simulation

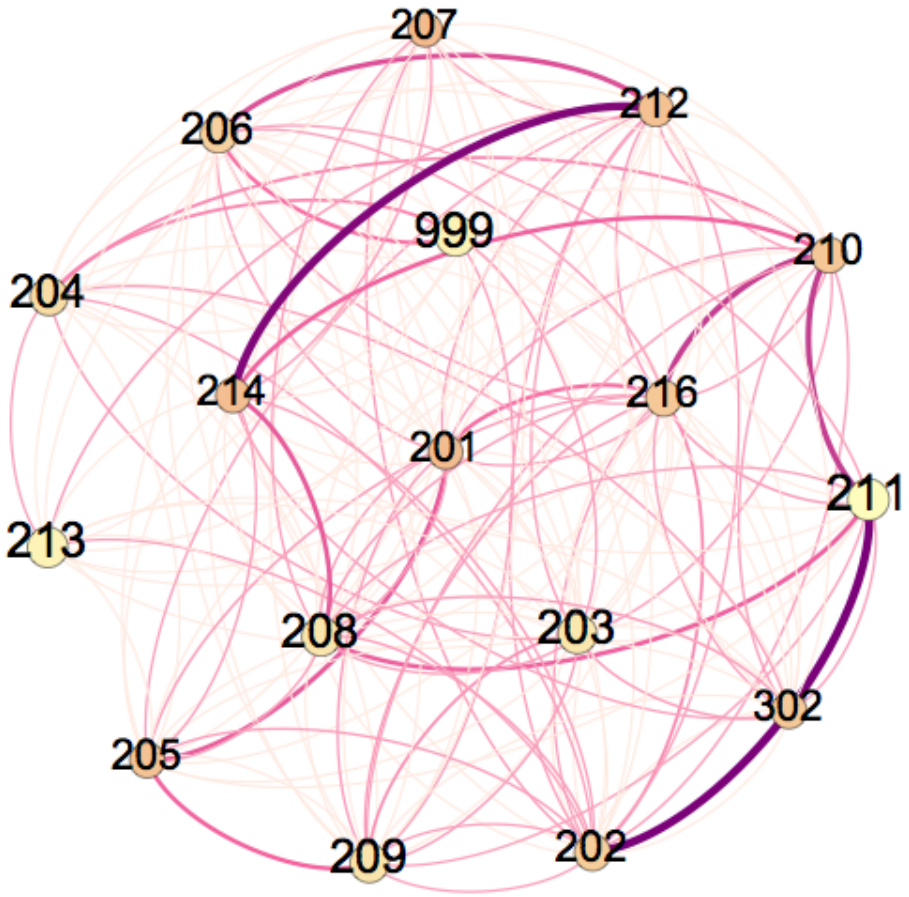






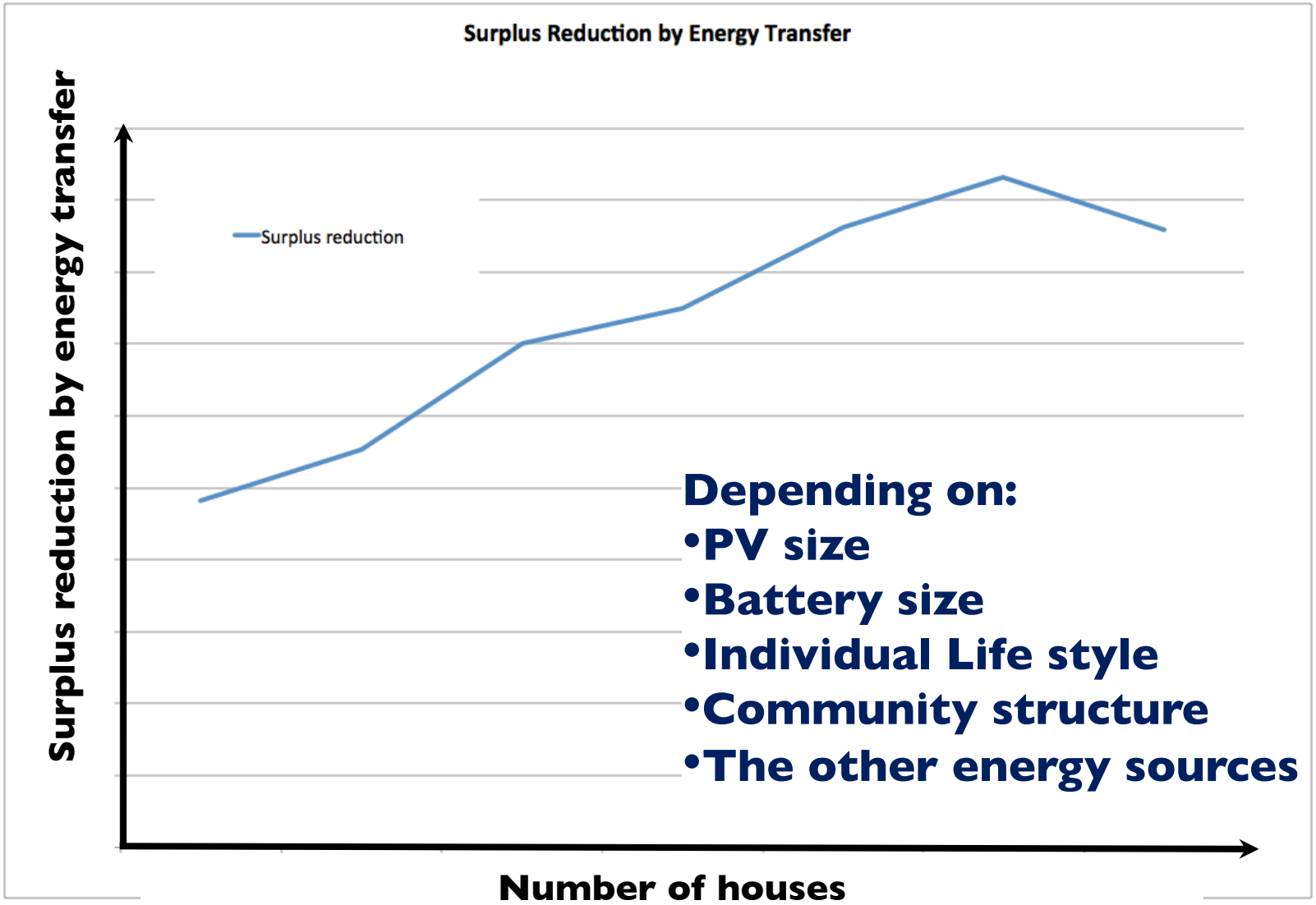




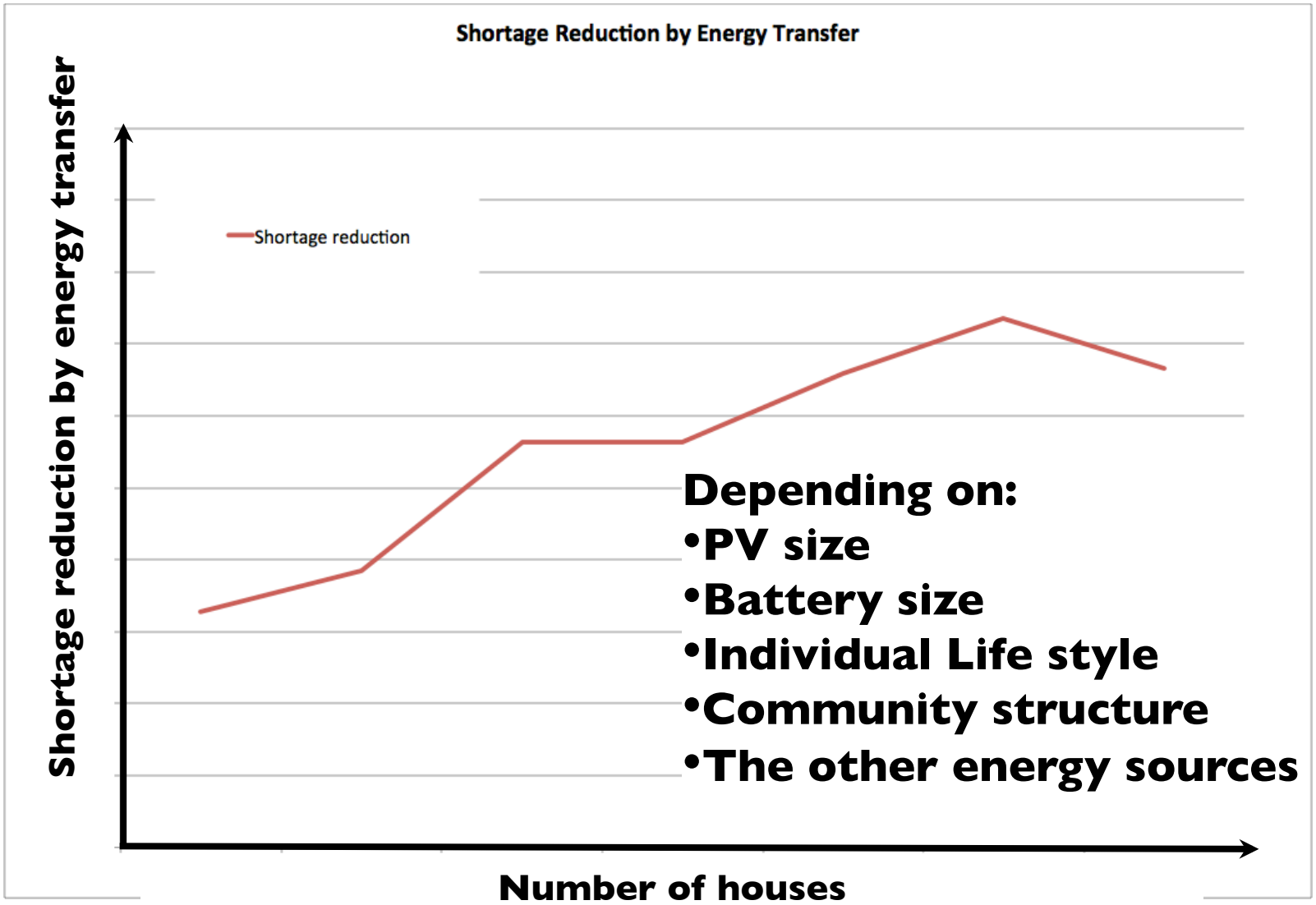


5 houses		17 houses
58 kWh	Total transfer Energy →	204 kWh
137	Total number of transfer →	512

15 days simulation
surplus reduction by energy transfer



15 days simulation
shortage reduction by energy transfer

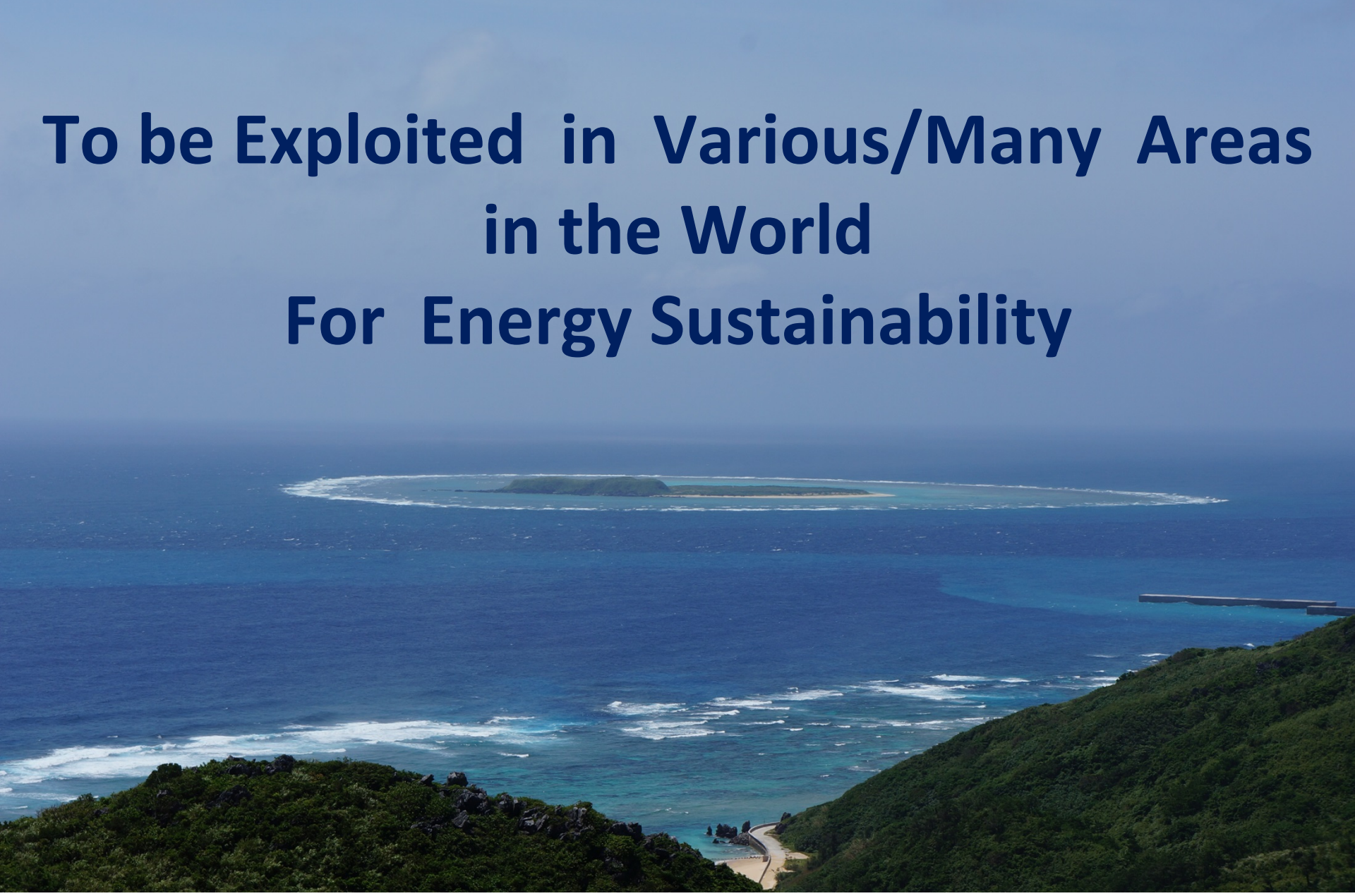


Conclusions

- **DC-based OES has advantages over conventional systems at:**
  - **Small investment for power generators and exchange networks at the cost of battery which is expected to be getting lower,**
  - **Efficient use of renewable energy, and**
  - **System's security (yet to be proven) .**
- **Key Technology for the realization of DC-based OES, which is Bi-directional DC Transmission, has been Established in a real environment.**
- **DCOES can be exploited in city areas and remote/ rural areas; developed and developing areas; and islands.**

Plan for Next Year and Then

- In FY2013
  - Connecting 9 houses
  - Collecting Various Data
- In FY2014
  - Connecting 20 houses
  - Usage (exchange) policy development with users
  - Establishing Automatic Energy Exchange Management Algorithm
- Further Wish
  - Development for full-campus DCOES including apartments, and other facilities
  - Development of DC Appliances
  - And,


To be Exploited in Various/Many Areas
in the World
For Energy Sustainability

Thank you!