# EGNRET 49th Meeting

# Deployment of Energy Storage for the Expanding Renewable Energy Supply
## - Chinese Taipei's Approach -

**Bureau of Energy**
**Ministry of Economic Affairs**

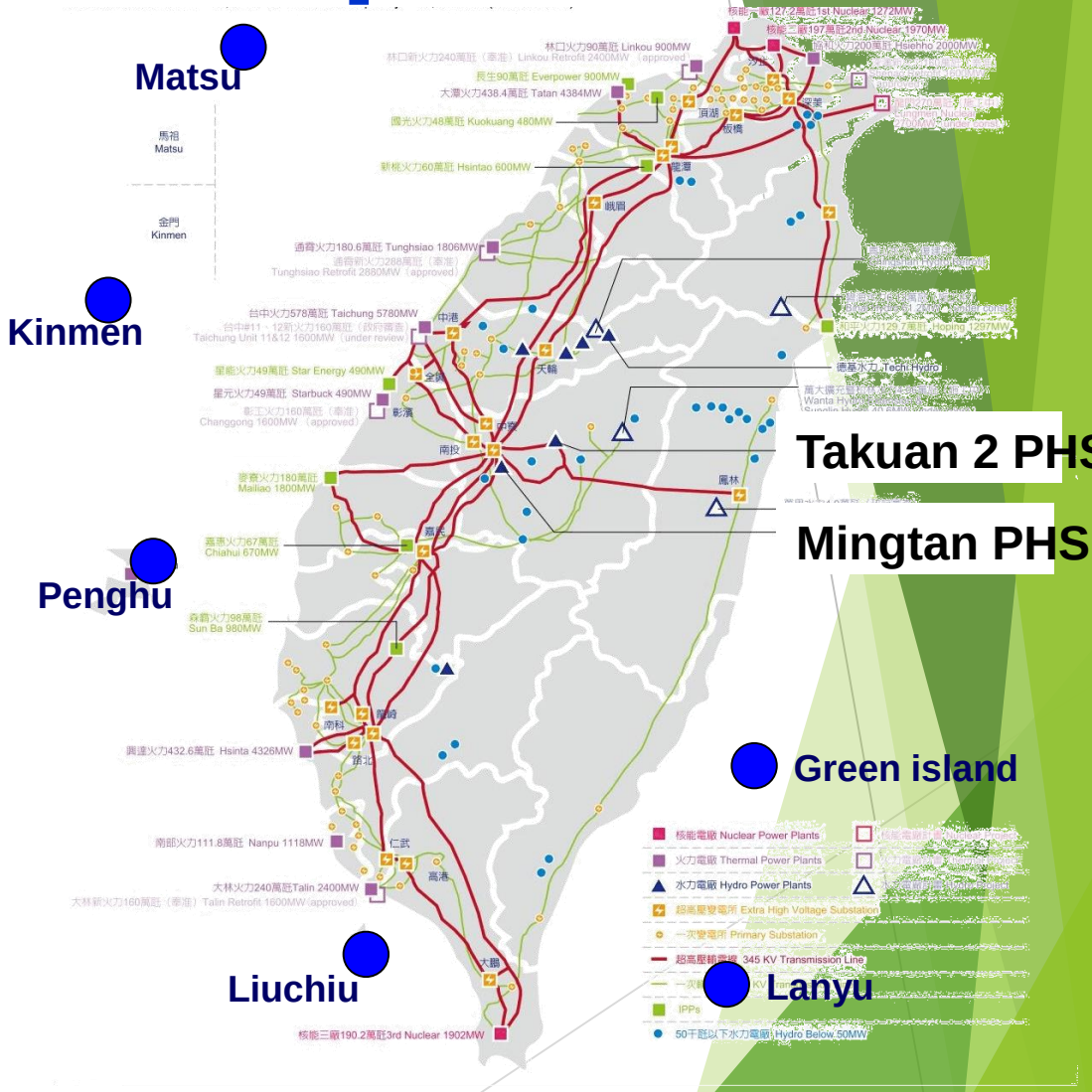
**Oct. 25, 2017**
**Chinese Taipei**

# Energy Storage Background

- Energy storage is one of the four strategies of Chinese Taipei government green energy policy. It is also one of the solutions for renewable energy expansion.
- To achieve 20% renewable energy by 2025, energy storage may enhance the installation capacity of renewable energy.
- Energy storage technology demonstration will build next generation renewable energy power grid. Renewable energies can be fully utilized with a stable and safe power grid.
- Search for the strategy that balancing Chinese Taipei energy storage technology development and expansion of renewable energies.

# Power Grid and Energy Storage in Chinese Taipei

- **Installation Capacity: 48,703 MW**
  - Peak load 36,594 MW (Aug. 15, 2017)
  - Total Generation in 2016 264,114 GWh
- **Storage Capacity: 2,602 MW**
  - Takuan 2 PHS 1,000 MW
  - Mingtan PHS 1,602 MW
  - Constant speed generator
- **Intermittent Renewable Energy by 2025: 24.2 GW**
  - Wind power 4.2 GW
  - Solar power 20 GW




Source: Energy Statistical Handbook, BOE, 2016-2017; Tai-power, 2017

# Microgrid Energy Storage Demonstrations

**NCSIST ( Tungkeng, Kinmen )**

**ESS Spec.:**

- China Electric-50kW/150kWh (Recycled-LIP LIB)

**Testing Features:**

- Community central ES
- Energy management & control of power flow

**INER ( Longtan, Taoyuan )**

**ESS Spec.:**

- ABB-100kW/60kWh (LIP LIB)
- Prudent Energy - 5kW/10kWh (VRB)

**Testing Features:**

- Continue isolated island operation
- Smooth switching between grid connected and island operation
- Adjustment and control of remote demand-side response

**Taipei City (Xinglong public housing )**

**ESS Spec.:**

- Leader Info-20kW LIB

**Testing Features:**

- Regulation and backup of grid connected PV

**NPUST Smart Grid Demonstration**

**ESS Spec.:**

- Energy-100kW/40kWh (LIB)
- ITRI-100kW convertor

**Testing Features:**

- Smooth PV output


**TRI (Shulin )**

ESS Spec.:

- 30kW/63.3kWh (LIP LIB)
- SEI 125kW/750kWh(VRB)
- ITRI 7kW/35kWh (VRB)

Testing Features:

- Voltage drop compensation
- Demand-side response regulation & control
- Micro-grid

**TaTung (Linbian Micro-grid in Pingtung)**

**ESS Spec.:**

- Solartech-60kW/60kWh
- ITRI-100kW PCS

**Testing Features:**

- Independent operation

**NCSIST(Rebuilt zone of Morakot disaster area, Xiaolin II village, Kaohsiung)**

**Feature**: high renewable/backup power ratio

**Pratas islands, Taiping island, Spratly islands**

**Feature:**

high renewable energy ratio

Taiping island 612kWh lead acid battery

**Micro-grid at Cimei, Wangan, and Wulai (TPC)**

**Testing Features:**

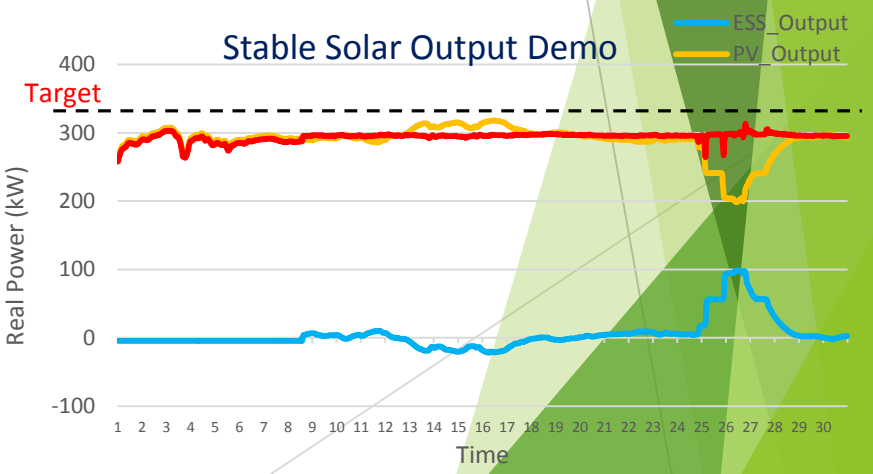
Micro-grid with high renewable energy

# Tainan: 1MWh ESS Demonstration platform

- Renewable system integration: PV, ESS, power dispatching test
- PV system:410 kWp; LiB ESS:700 kW/1000 kWh; Load:650 kWp


**Renewable Energy Integrated Energy Storage System Verification:**

- ✓ Short term regional power balance
- ✓ Stable renewable energy output
- ✓ Scheduled control
- ✓ Power quality / operational verification




Renewable output stability verification

# ESS Demonstration Planning in Power Transmission and Distribution System

- **ESS Demonstration in Power Transmission and Distribution System to Increase the installed PV and wind capacity and to help achieve renewable energy generation target to 20% by 2025.**

**Central government**

中華民國經濟部
Ministry of Economic Affairs, R.O.C.

ESS policy promotion and standard setting

**Taipower company**

Demo site providing
Development of the standard of grid-connected ESS

**Universities and institutes.**

Installation and demonstration
Safety validation and standard
Energy storage policy development
Energy storage status survey

**Local government**

Demo site assessment and communication with the public

Transmission System Level

**Bulk energy storage system**

Distribution System Level

**Distributed energy storage system**

**Chinese Taipei local compan**

Combined with battery system and energy storage system manufacturers to verify technology

# The Energy Storage Industry in Chinese Taipei

# Status of Chinese Taipei Energy Storage Development

1. Chinese Taipei's investment in energy storage technology:
   a. Industries focus on lead-acid batteries and lithium-ion batteries,
   b. Research institutes (ITRI, INER and NCSIST) are mainly developing of advanced batteries (AIB, VRB, FC, LTO).
2. Chinese Taipei has a lot of battery pack (including electrodes, modules) and power converter manufacturers. Some of them is capable of manufacturing components.
3. Few system integration vendors are in Chinese Taipei. They are new developer and are less competitiveness.

| Advanced batteries development | Pack (Cell、Module、BMS) | PCS | System Integration |
|---|---|---|---|
| • **ITRI :** AIB, VRB, FC, LTO<br>• **INER**: VRB<br>• **NCSIST:** Refurbish, reuse, and recycling of lithium ion battery | • DELTA electronics<br>• Phoenix Silicon International corporation(PSI)<br>• E-One Moli Energy<br>• Amita Tech.<br>• LYNO-POWER<br>• C-Life<br>• Kung Long, CSB, Yuasa, GS<br>• Battery Module/BMS：SIMPLO, DynaPack, Celxpert, STL TECH, Emerald Battery, DELTA electronics, Darfon, Quan Yang | • DELTA electronics<br>• MEAN WELL<br>• Rich Electric<br>• Allis Electric<br>• Fortune Electric<br>• Lite-On<br>• AcBel<br>• TECO<br>• Stark Technology, Inc. (STI)<br>• Chroma | • DELTA electronics<br>• Tatung<br>• Chung-Hsin Electric and Machinery Manufacturing Corp. |


**AIB:** Aluminum Ion Battery
**VRB:** Vanadium Redox Flow Battery
**FC:** Fuel Cells including DMFC, PEMFC, SOFC
**LTO:** Lithium Titanate Battery

# Chinese Taipei Company ESS Strength

1. Delta Electronics
   - US California Fremont (commissioned by 2015.10 )
     - 250kW/106kWh LiB ESS System
   - JP Ako City (commissioned by 2016.7)
     - 500kW/362kWh LiB ESS System
   - TW Longtan (commissioned by 2014.12)
     - 120kW/60kWh LiB ESS System

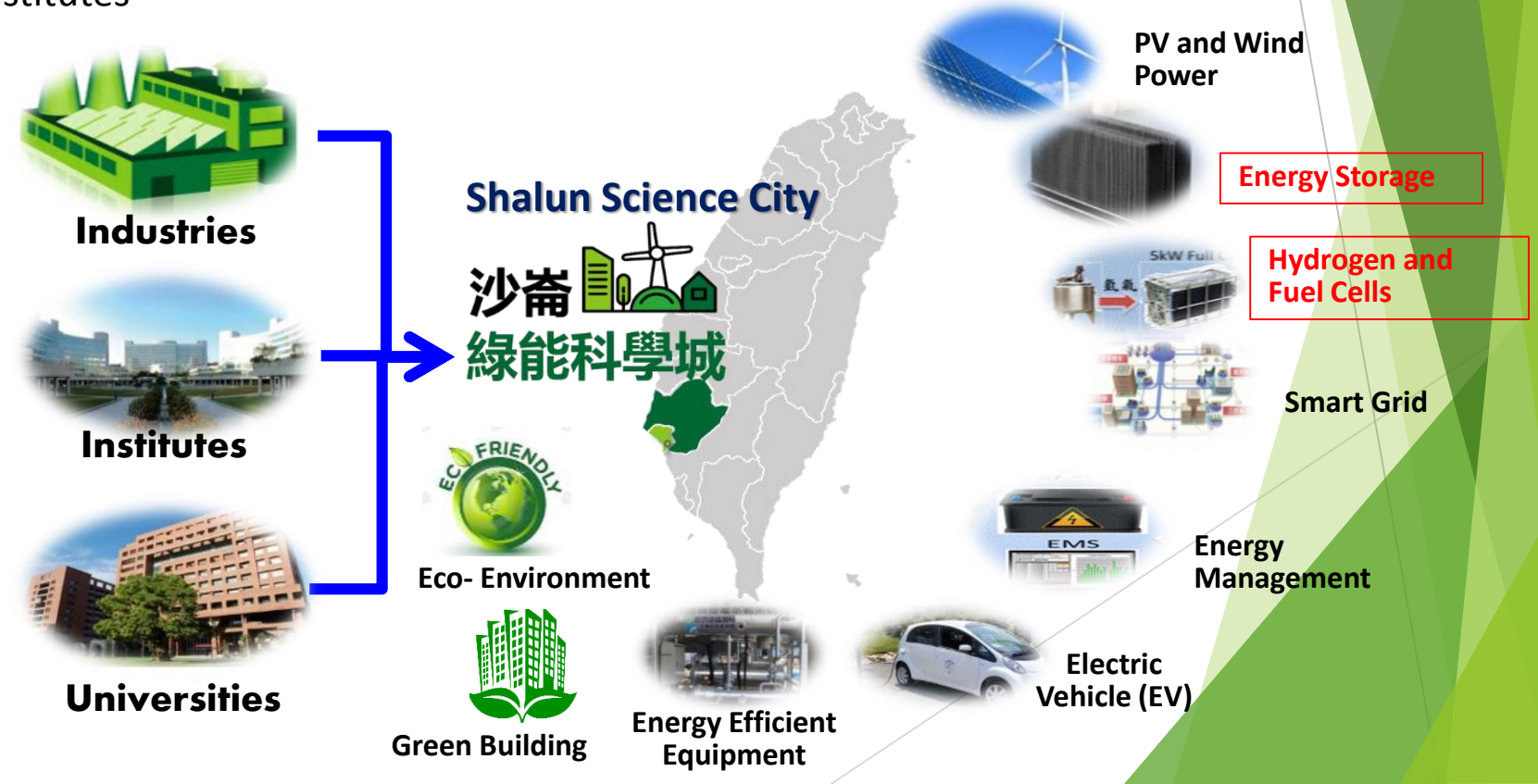

台達首座自營太陽能電廠於日本兵庫縣赤穗市完工揭幕
4MW PV-8 areas only one with ESS, will add in the future

2. Phoenix Silicon International corporation
   - Major Business Area：Japan、Chinese Taipei
   - Household energy storage cabinet in JP.
   - Uninterruptible power system in Chinese Taipei (AUO, UMC)

UPS system and energy storage cabinet from PSI.

# Renewable and Energy Storage Synergy in Shalun Green Energy Science City

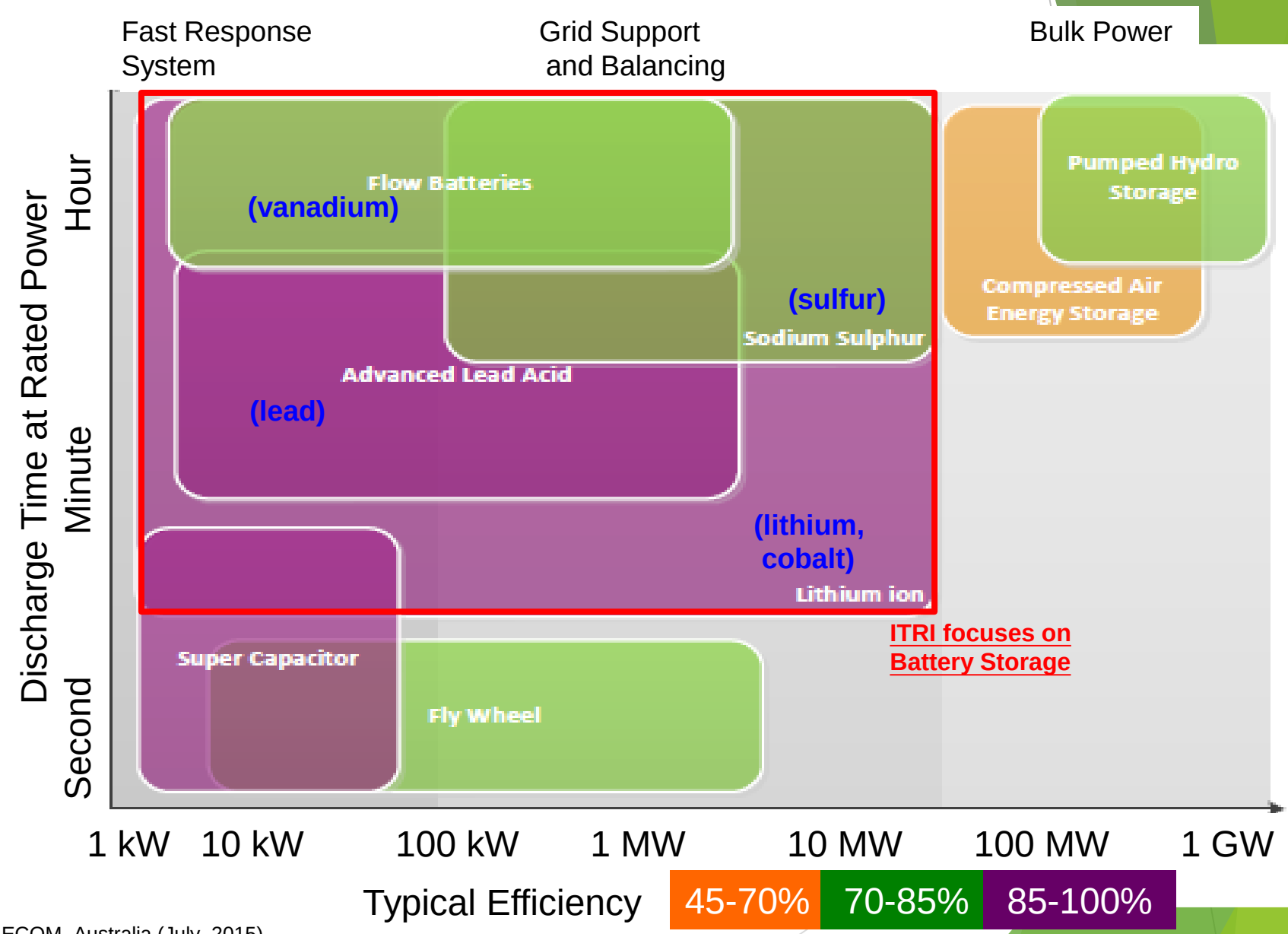
- **Four developing topics :** energy creation, energy storage, energy efficiency and conservation, energy system integration
- **From ESS technology to application**：establish a R&D development-demonstration site
- **From ESS research to commercialization**：Integrate with industries, universities and institutes



# The Development of Energy Storage Technology :

# Aluminum Battery

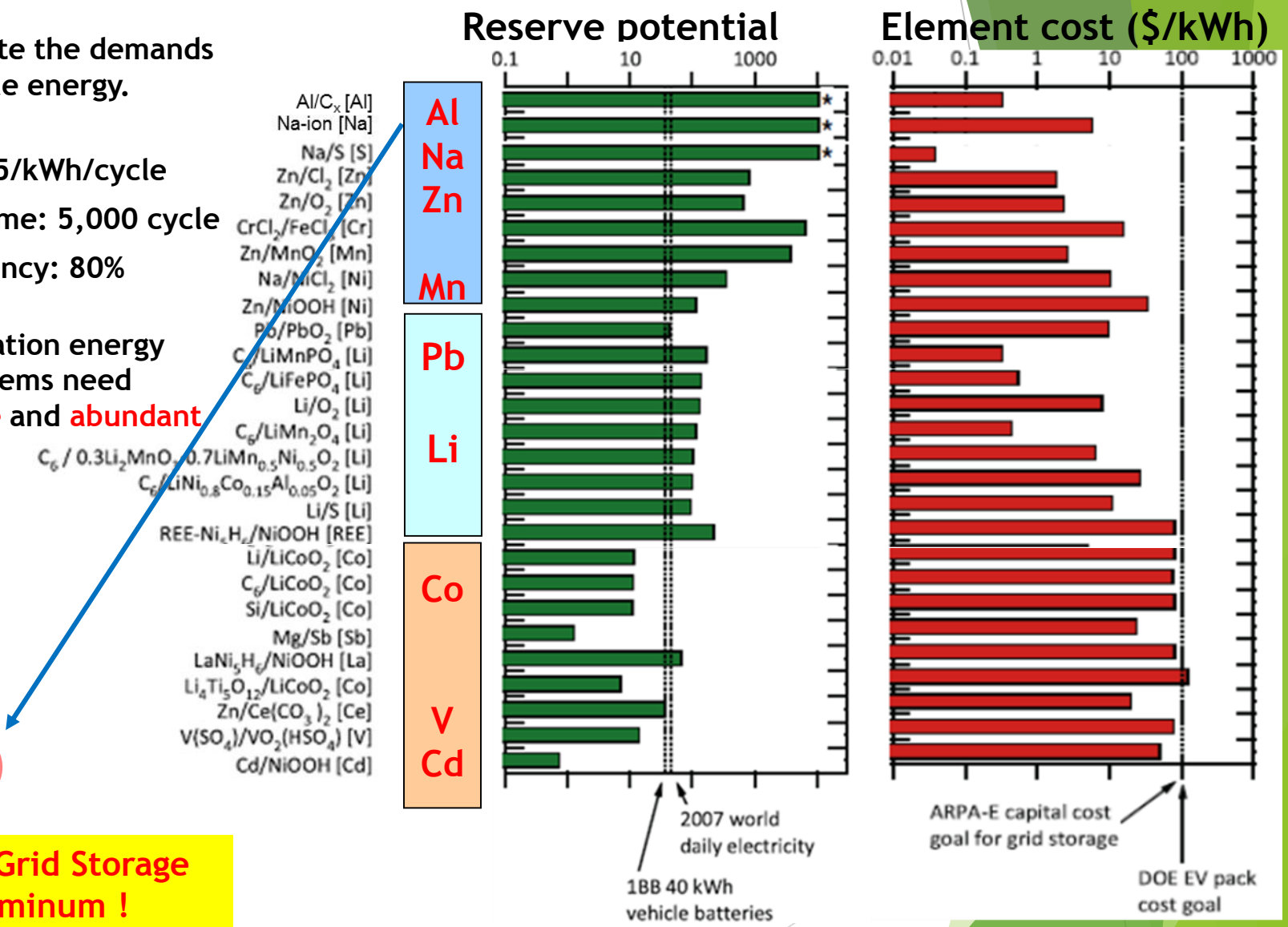
# Conventional Energy Storage




Ref.: AECOM, Australia (July, 2015).

# Electrode Metals for Batteries

- To coordinate the demands of renewable energy.
  - Cost: $0.025/kWh/cycle
  - Life time: 5,000 cycle
  - Efficiency: 80%
- Next-generation energy storage systems need inexpensive and abundant elements.

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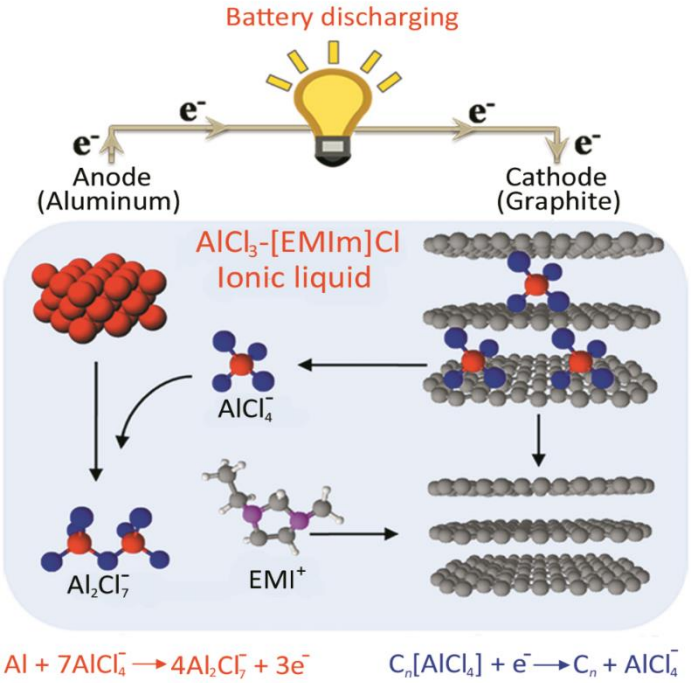
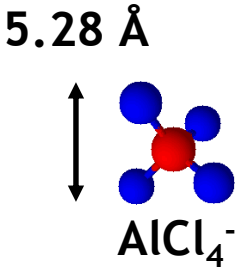
**Potential Grid Storage by Aluminum !**

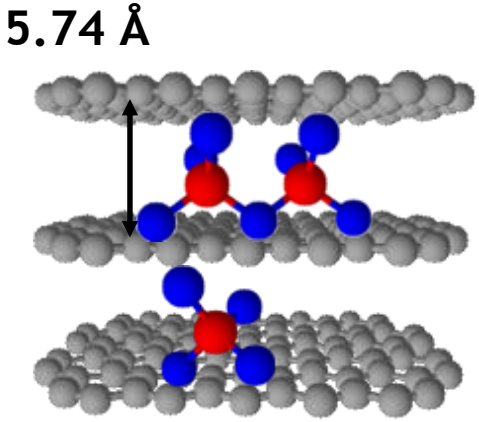
Ref.: ITRI, 2016; Journal of Power Sources 196 (2011) 1593.

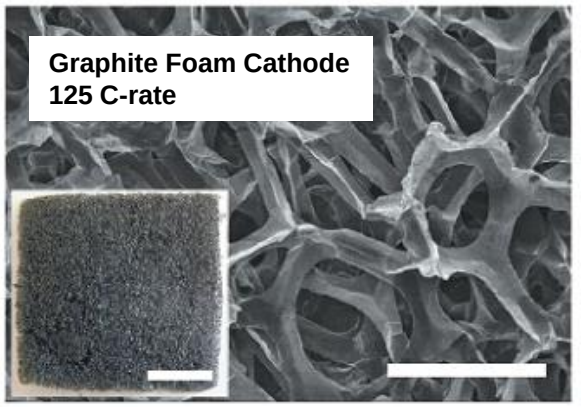
# Aluminum Battery: A breakthrough!

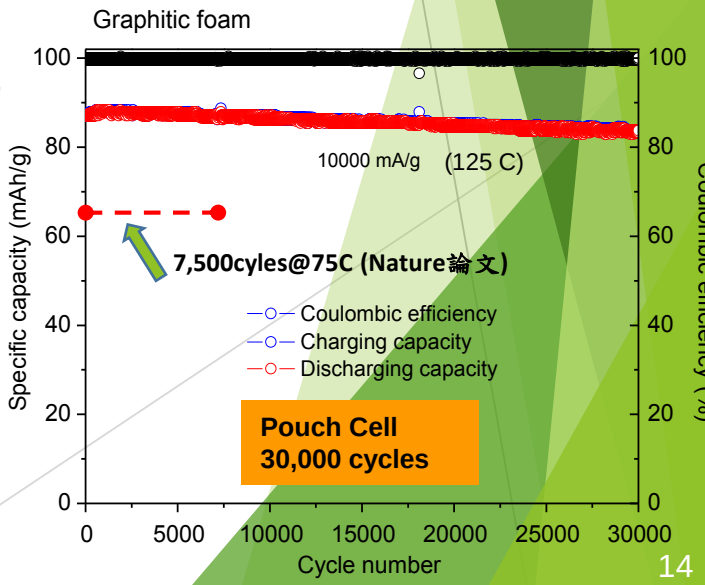
- Anode material：Aluminum
- Cathode material ：Graphite
- Electrolyte：EMIC-$AlCl_3$ Ionic liquid
- Energy density 40-80 Wh/kg; Power density 3,000 W/kg; more than 10,000 cycles.




Ref: Nature 520 (2015) 325.

# Aluminum battery: Prototyping


NATURE | LETTER

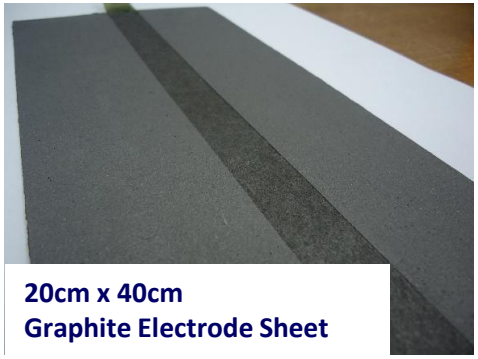
Ref: Nature 520 (2015) 325.

## An ultrafast rechargeable aluminium-ion battery

1. Department of Chemistry, Stanford University
2. Green Energy and Environment Research Laboratories, ITRI

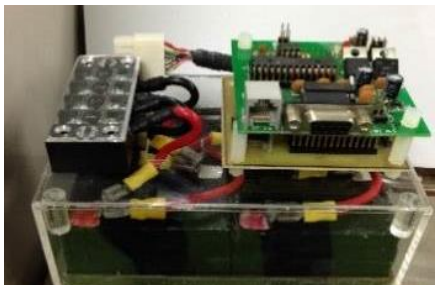
Meng-Chang Lin, Ming Gong, Bingan Lu, Yingpeng Wu, Di-Yan Wang, Mingyun Guan, Michael Angell, Changxin Chen, Jiang Yang, Bing-Joe Hwang & Hongjie Dai





20cm x 40cm
Graphite Electrode Sheet

2V / 1Ah Battery Cells
(homemade)



Battery with BMS
(Battery Management System)

# Thank you



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