

Based on a presentation to the IEEE PES, June 2000  
by P C Symons and A Price

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# Introduction to Flow Batteries

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IFBF



Presentation to the information session on a Cenelec  
Workshop Agreement for Flow Batteries, 6 July 2011

# Acknowledgements

- **Graphics from the IFBF**
- **Graphics from [www.innogy.com](http://www.innogy.com) accessed 2000 and used with permission**
- **Photographs from Larry Thaller, Swanbarton plc**
- **Osaka project from Sumitomo Electric Industries**
- **Market data from Escovale Consultancy Services**



**The International  
Flow Battery Forum™**

**IFBF meeting – May 2011, Edinburgh, Scotland**

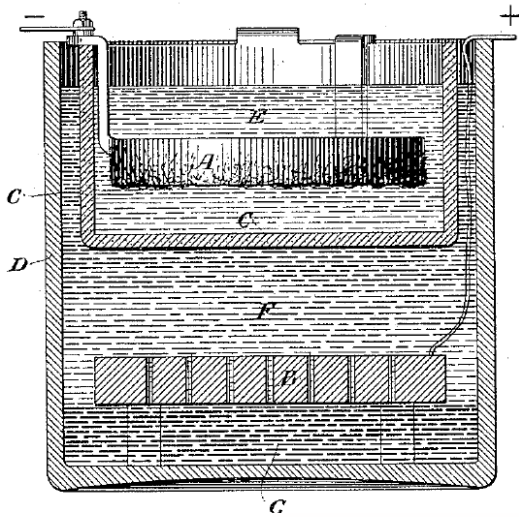
**International and intercontinental conference based on submitted papers covering:**

**commercialisation  
applications  
developments  
supply chain issues  
research**

**Delegates from most of the flow battery companies and developers, suppliers and many researchers. Followed conference in June 2010, Vienna, Austria**

# Background

*Although parts of the flow battery industry go back to the 19th century, the past twenty years have seen substantial interest and the past five years have uncovered an exponential growth in development across the flow battery sector*



C. S. BRADLEY.  
SECONDARY BATTERY.

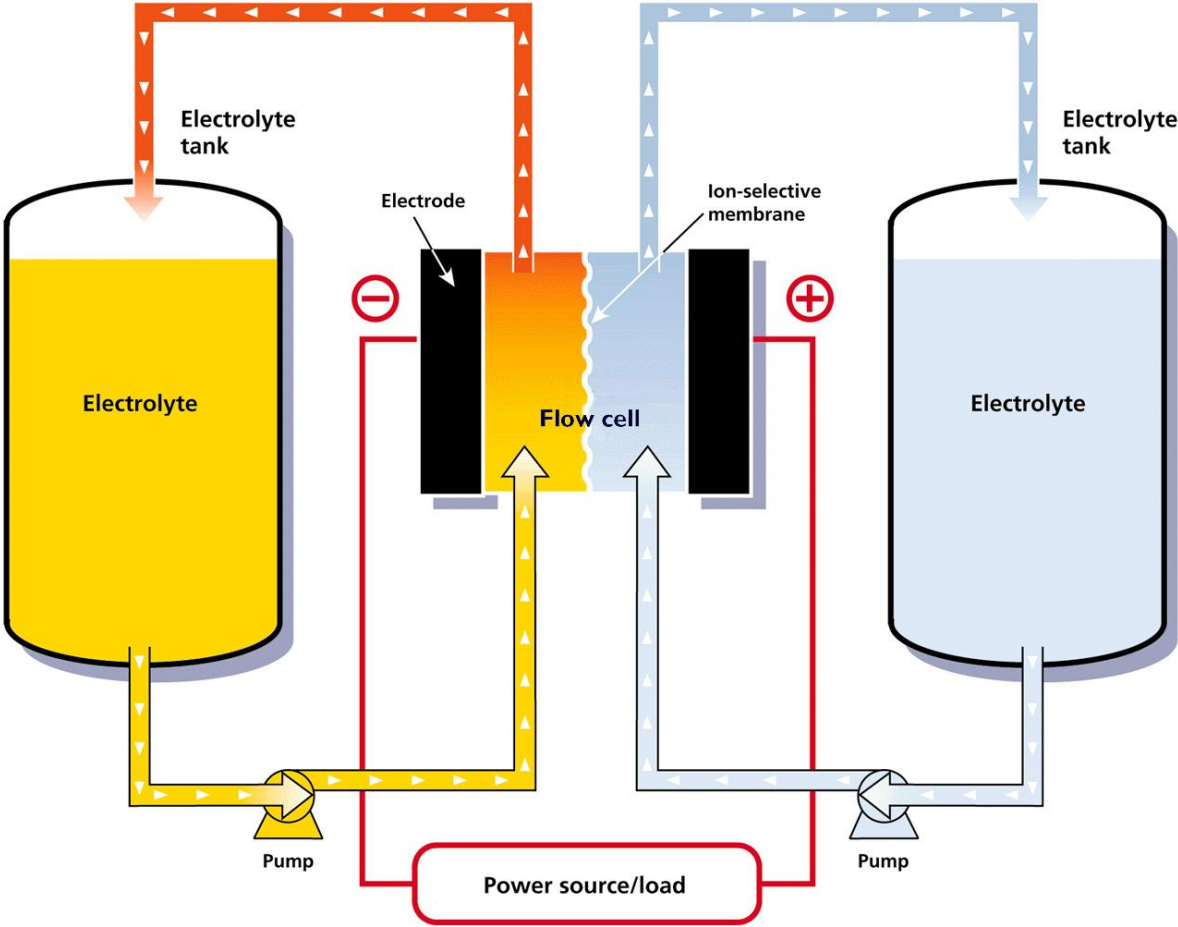
No. 312,802.

Patented Feb. 24, 1885.

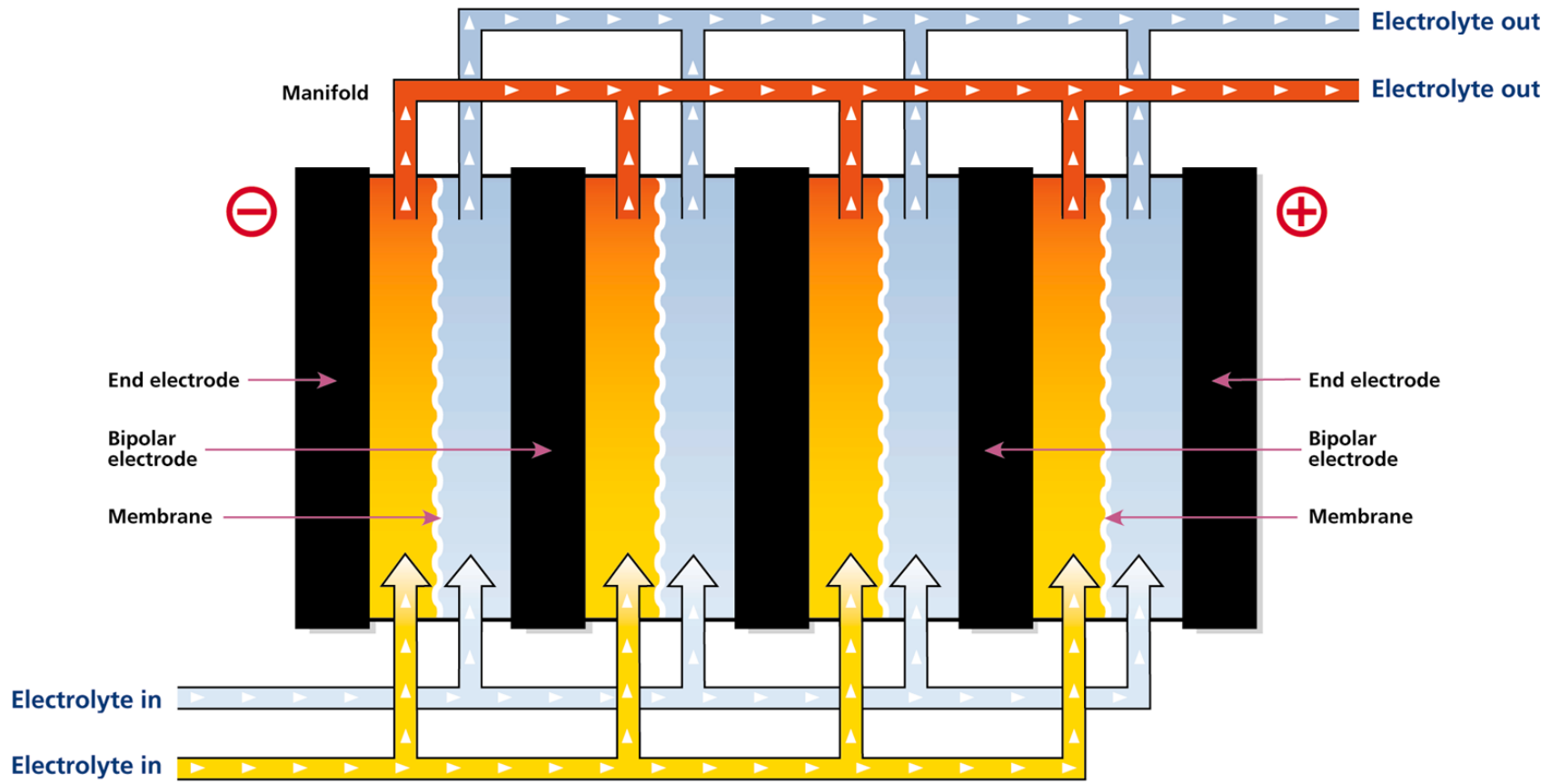
# Why consider flow batteries?

- **Opportunity for low cost manufacture for large scale production**
- **Separation of power and energy**
- **Attractive technical and operational benefits**
  - **cycling characteristics**
  - **lifetime**
  - **recyclability**
- **Available now from several manufacturers**
- **Operational experience gained**
- **Potential for further development**

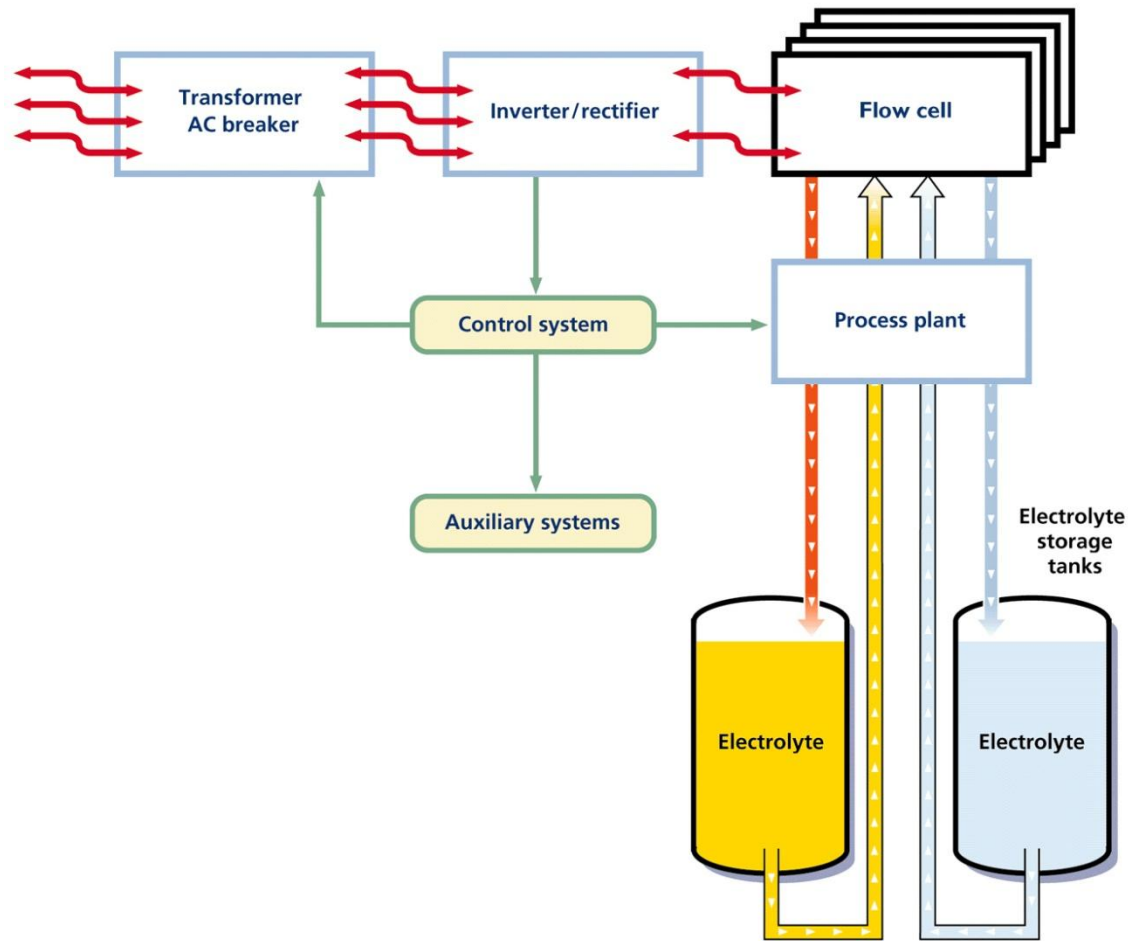
# A single flow cell



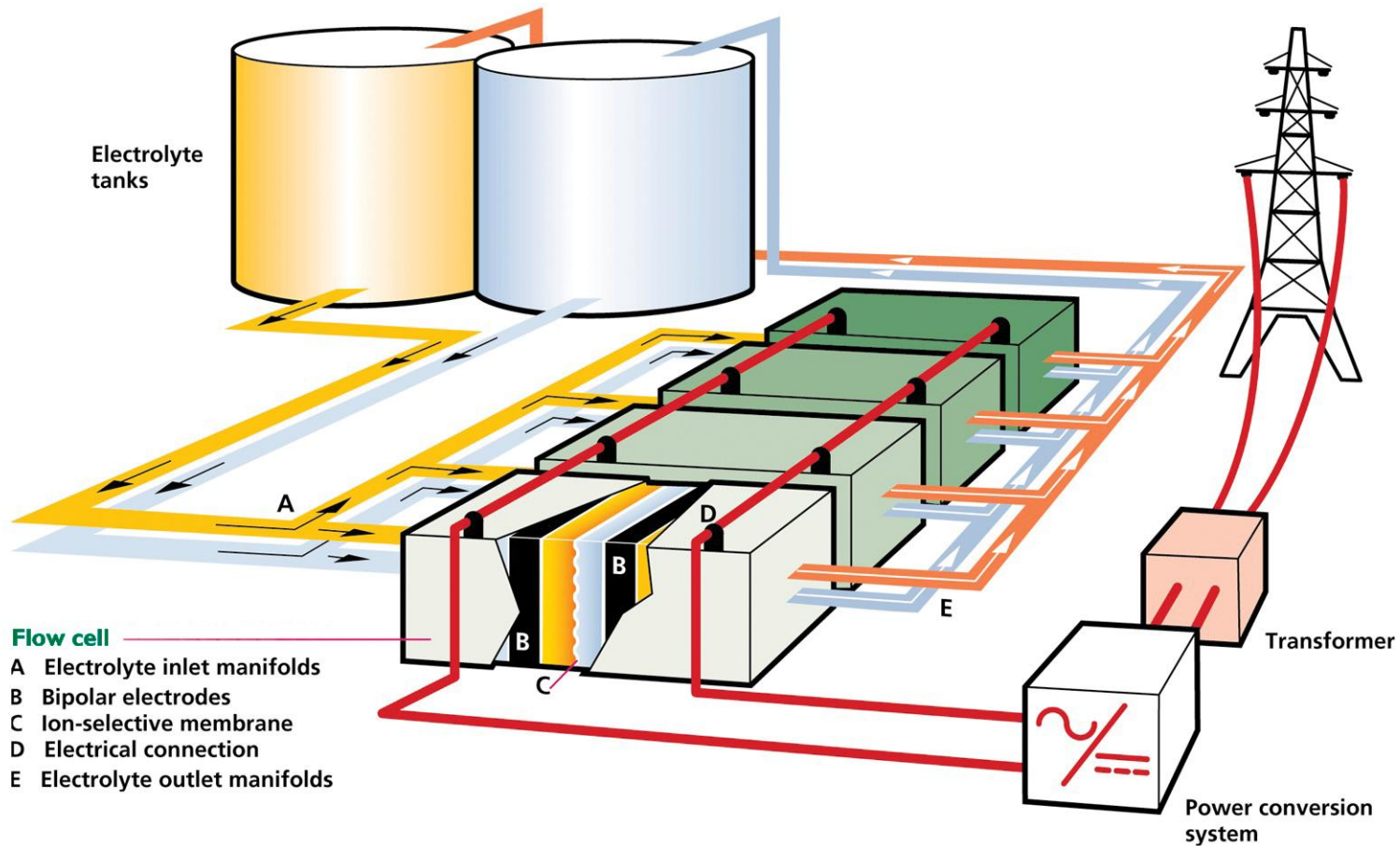
# Cross section of a bipolar module



# An energy storage plant based on flow cells

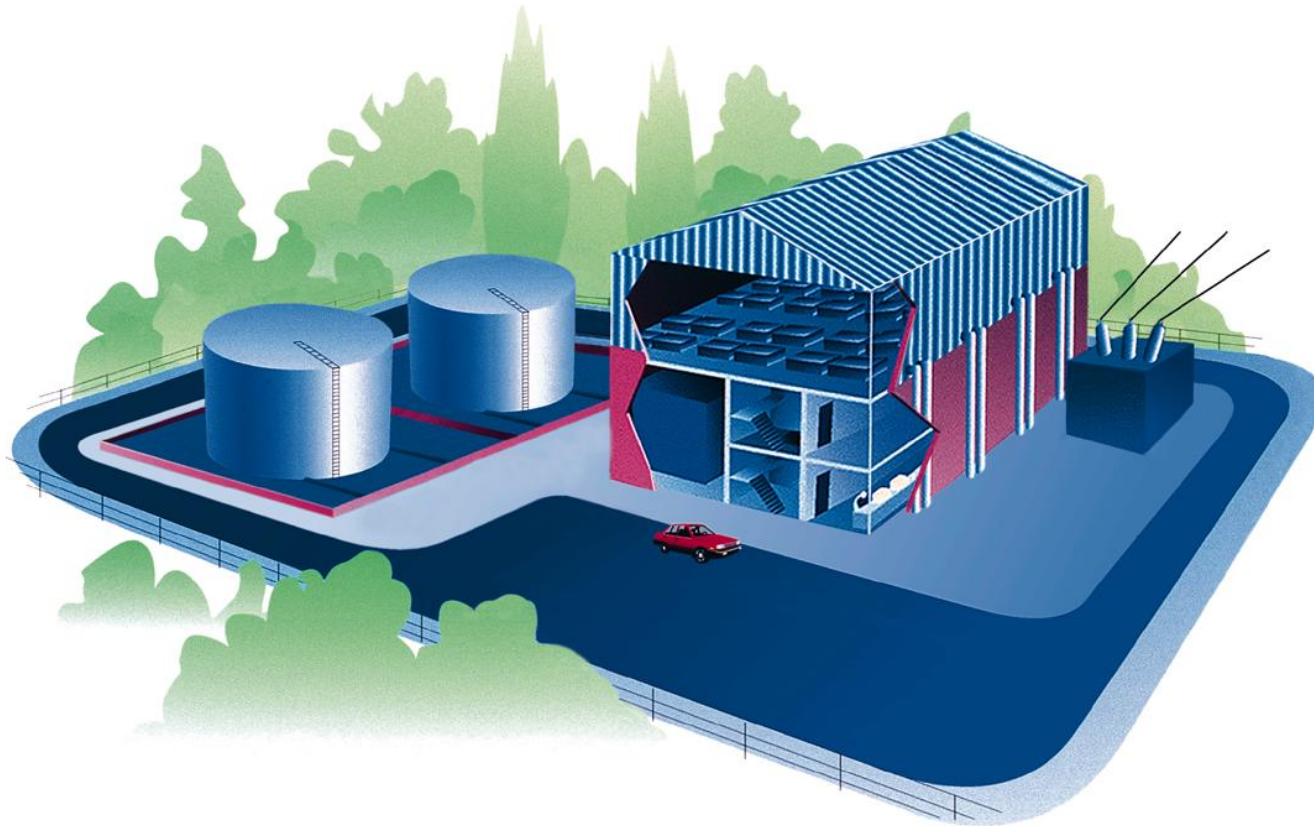


# Large plant configuration

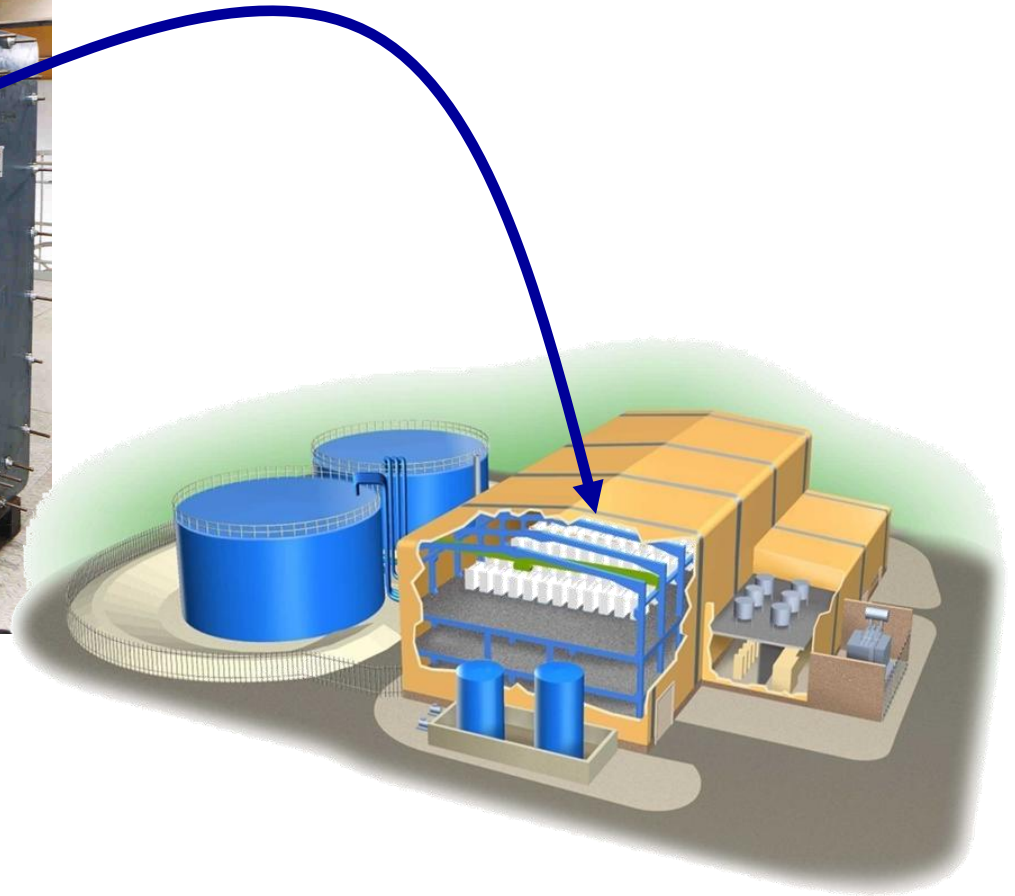


April 2000

# Multi MW options



# Proposals



# Early work

1973 - NASA

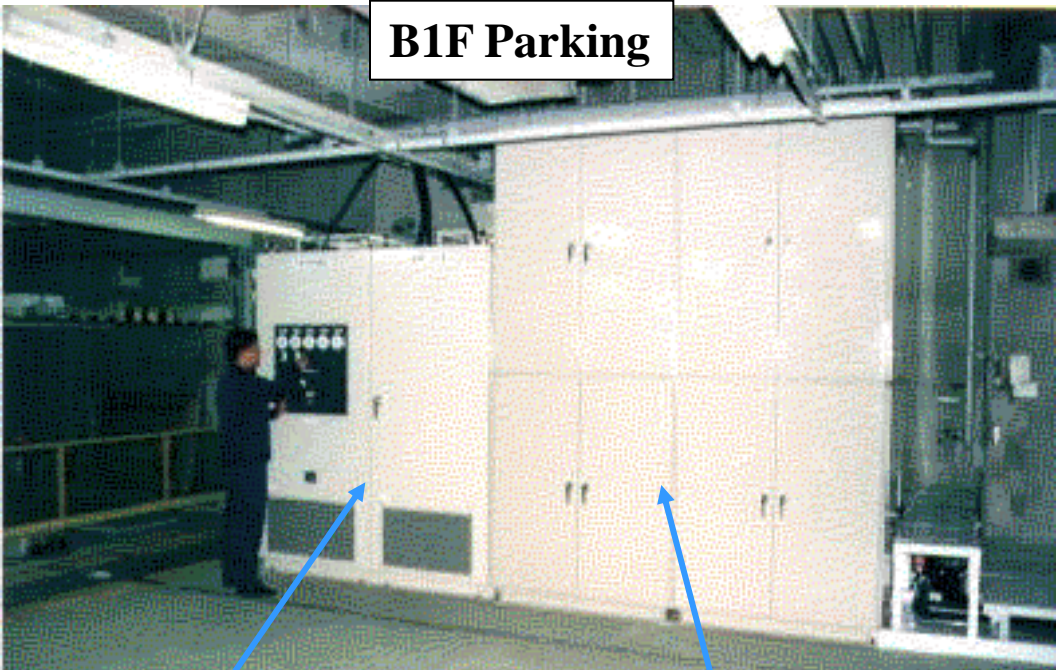


1983 - UNSW



# Application of RFB to Office Building

**B1F Parking**



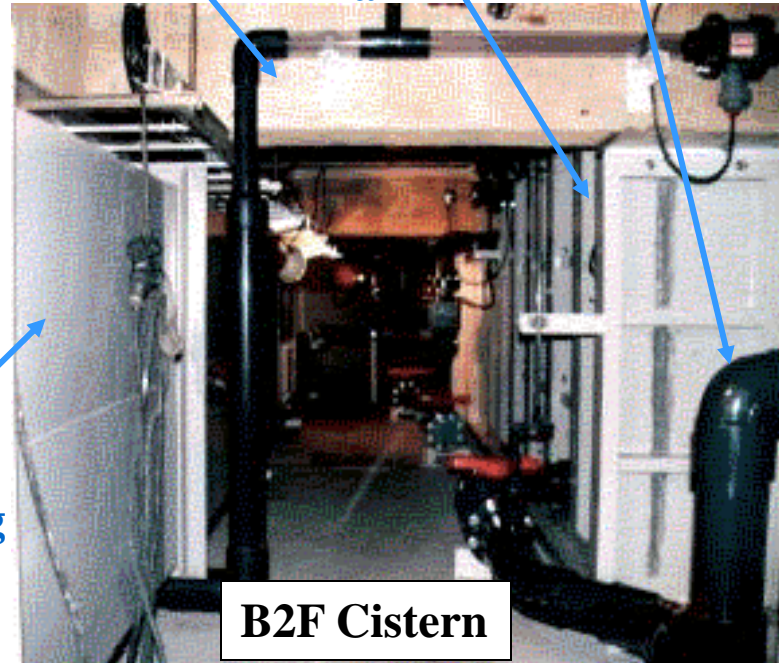
**AC/DC Converter**

**Battery Cubicle**

|                           |                      |
|---------------------------|----------------------|
| <b>Capacity</b>           | <b>100kW-8h</b>      |
| <b>Place</b>              | <b>SEM,Osaka</b>     |
| <b>Start of operation</b> | <b>February 2000</b> |



**Beam**      **Rubber Tank**      **Pipe for Electrolyte**



**Air conditioning duct**

**B2F Cistern**

# Powercell™: zinc bromine chemistry

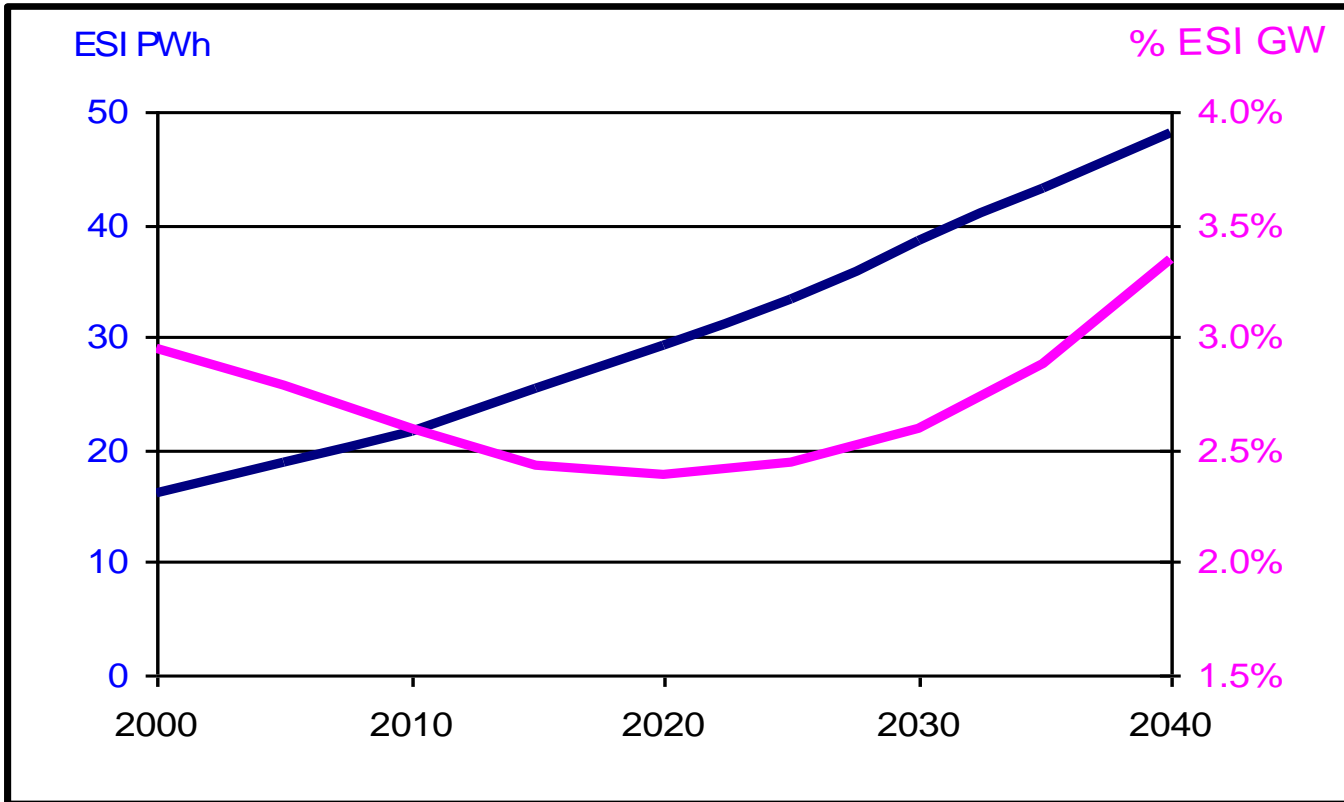


April 2000

# Current installations



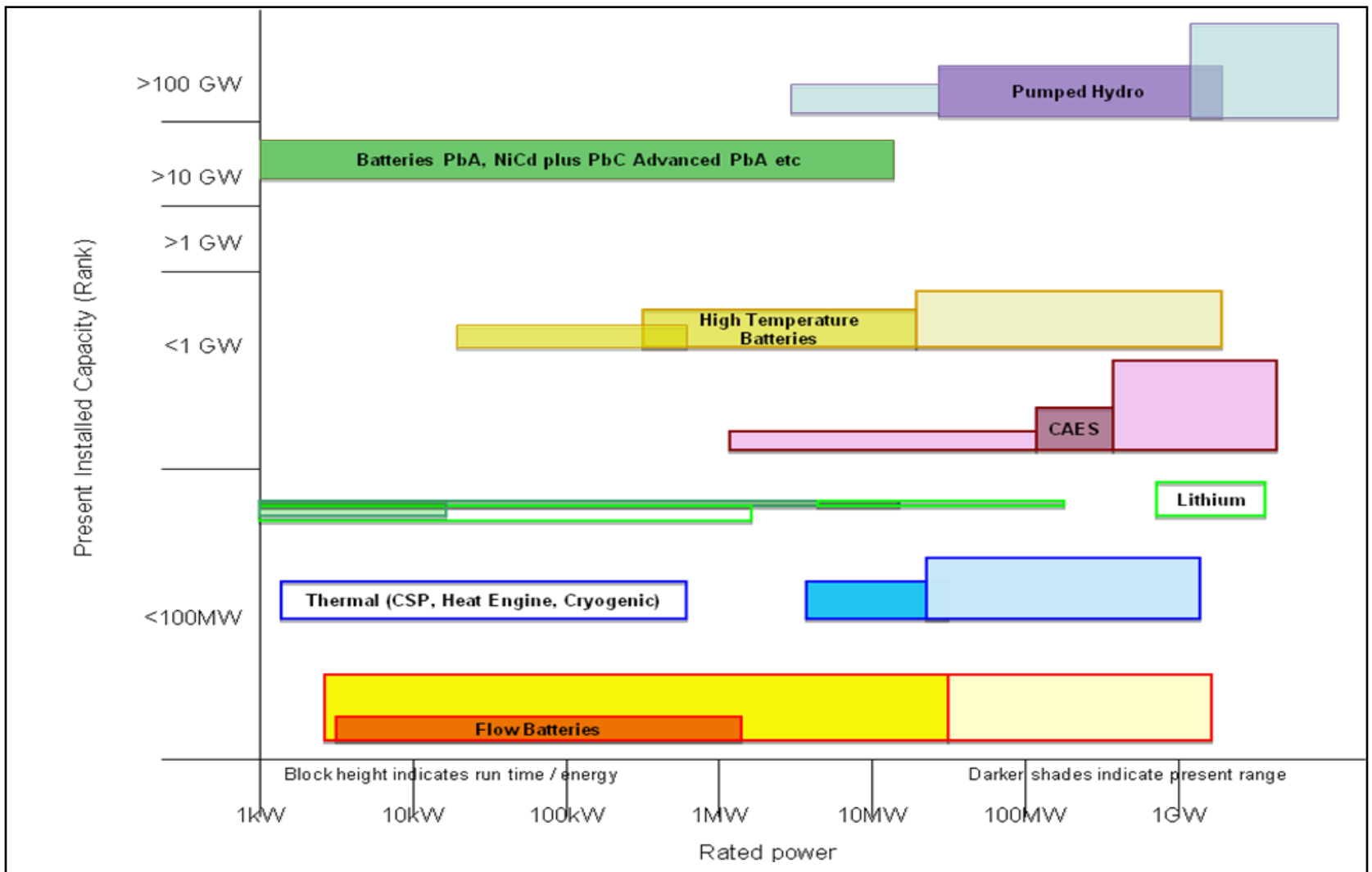
# The market opportunity for flow batteries



Source:  
Escovale,  
Sure Insight,  
Swanbarton

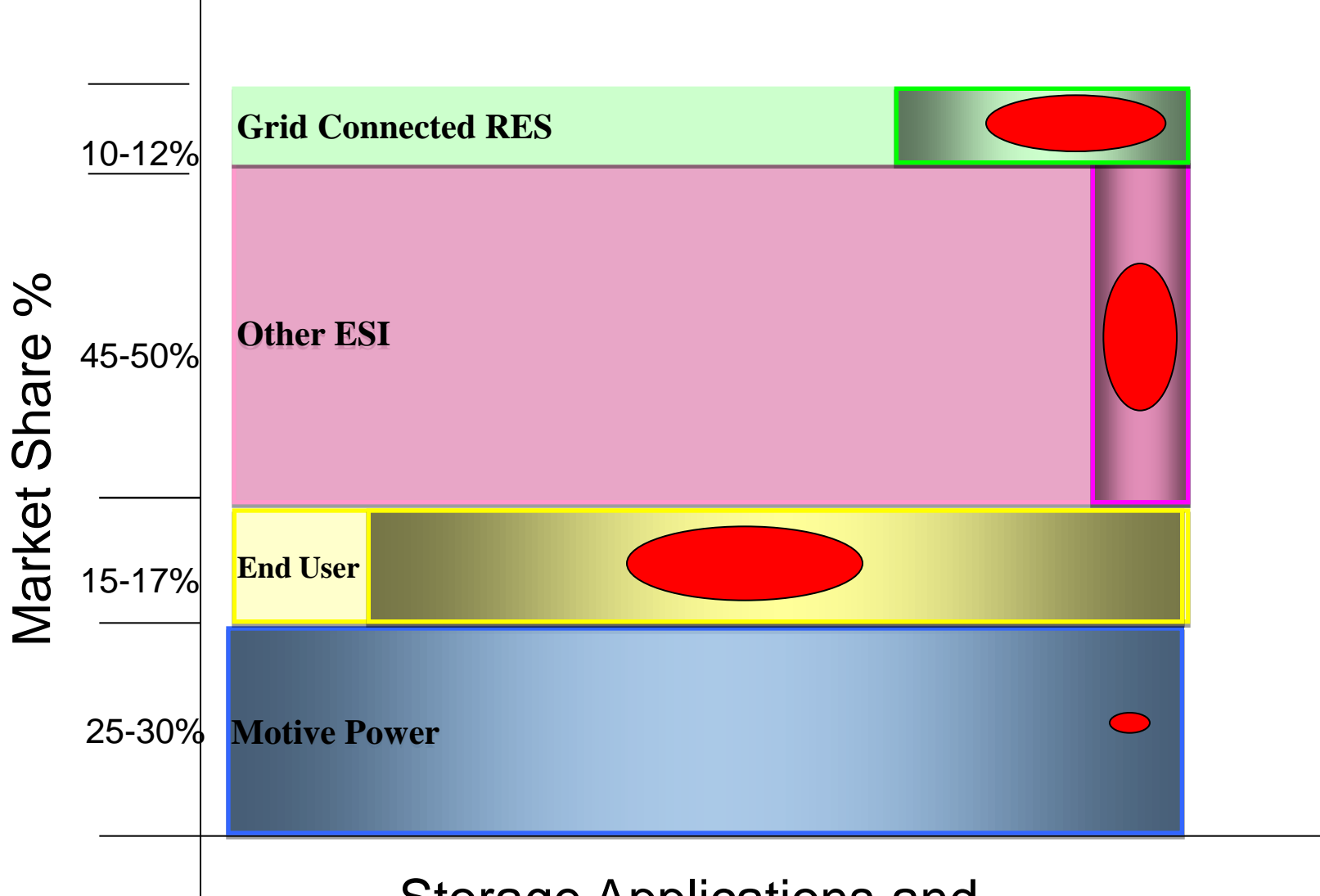
Despite strong interest, energy storage has not kept up with the growth in the global Electricity Supply Industry (ESI). In the hour plus storage category, cost effective flow battery storage can gain a substantial market





Technology contenders in the hour plus storage arena.





## Storage Applications and Technologies (2020s)

**Key**

**All Technologies**

**All batteries**

**FBs**

Sure-Insight

**ESQVATE**  
CONSULTANCY SERVICES



# Opportunities for further development

## Existing manufacturers and developers

- Consolidation of early projects and sales
- Operating experience & user familiarity
- Larger scale production and distribution – combined with cost reduction and manufacturing efficiency

## Emerging participants

- Initial research, investigation of promising ideas
- Longer term- identification of improved materials, components, performance, manufacturing
- Products to demonstration and markets

**Joint collaborative work on new standards and industry positioning.**

# Standards

## Formation of a group to develop a CEN Workshop Agreement

- Consensus based document, directly made by the stakeholders
- Often used in innovative areas, e.g. biofuels or Information Technology
- The CEN/CENELEC Workshop Agreement (CWA) represents the consensus of identified stakeholders
- Anybody interested can join (including anyone outside Europe)
- A public process
- Rules are very simple (non-bureaucratic)
- Workshops are fast (12-15 months average!)
- The CEN/CENELEC Workshop Agreement shall not conflict with European Standards, but can compete
- Preliminary meeting in Vienna, Austria on 6 July 2011

# IFBF 2012

**Summer 2012 – Germany**

**Call for papers – November 2011**

**We look forward to seeing you there!**

**[www.flowbatteryforum.com](http://www.flowbatteryforum.com)**



**The International  
Flow Battery Forum™**