Energy Storage Solutions Panorama for Telecom Stand-By applications

ETSI – 2015 Energy Workshop

By Claude Campion
3C Projects

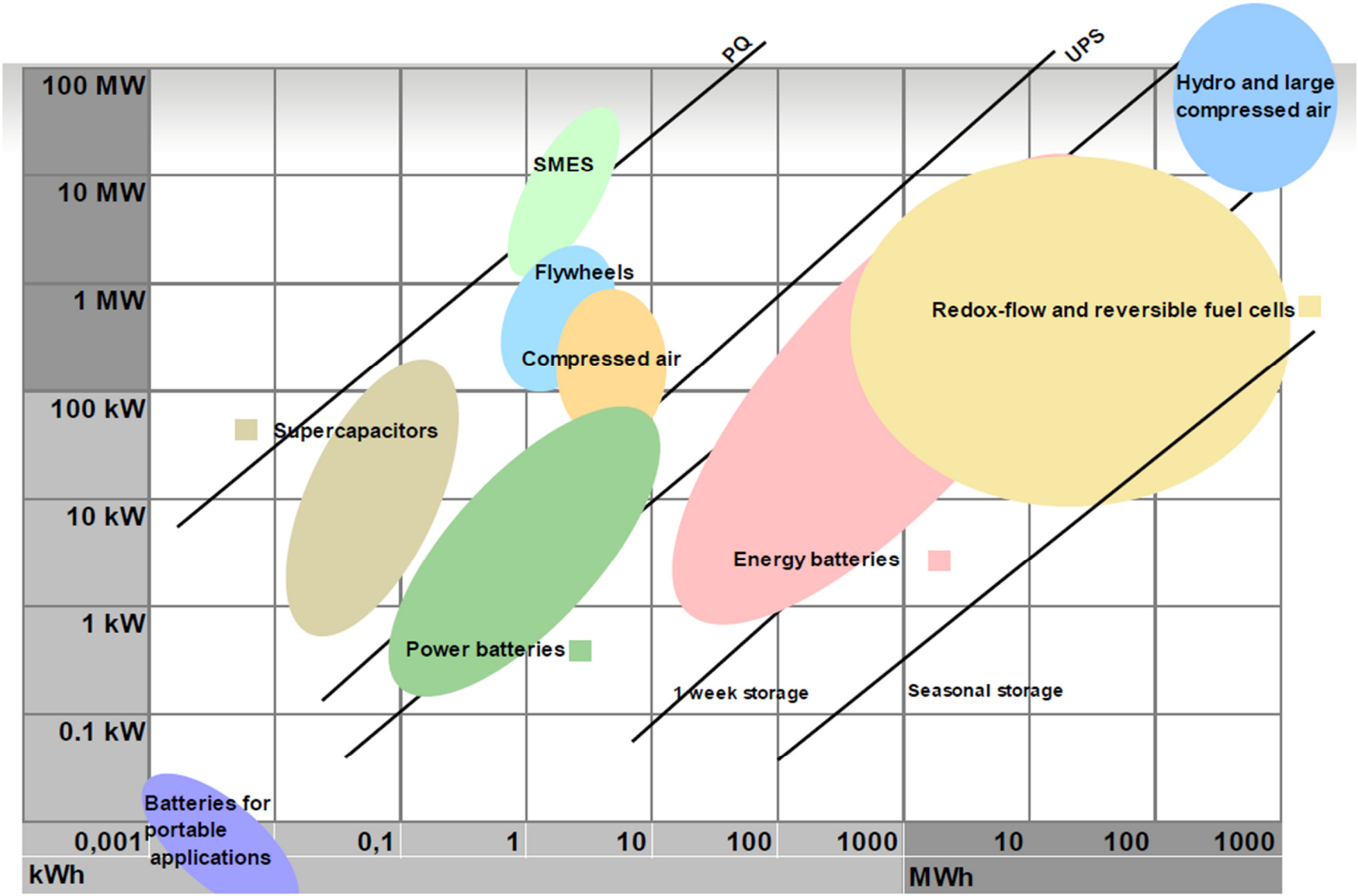
Energy Storage Solutions Panorama for Telecom Stand-By applications

3C Projects

- 3C Projects founded in 2011 by Claude Campion coming from large battery industry, is a unipersonal independent company located in Clichy nearby Paris
- Main Activities are :
  - Technical support : Test lab or field investigation, storage energy solutions selection analysis, training course, test or maintenance procedure update, battery monitoring specifications
  - Marketing support : Promotion of R&D license for use in industry, Specific Technology and Market development surveys
- Main References are :
  - Orange; EDF (French Utility) ; SNCF (French Railways) ; Electrabel (Belgium); BAE (Germany); ForseePower (France); Albioma (France)…
- More information at **www.3cprojects.eu**

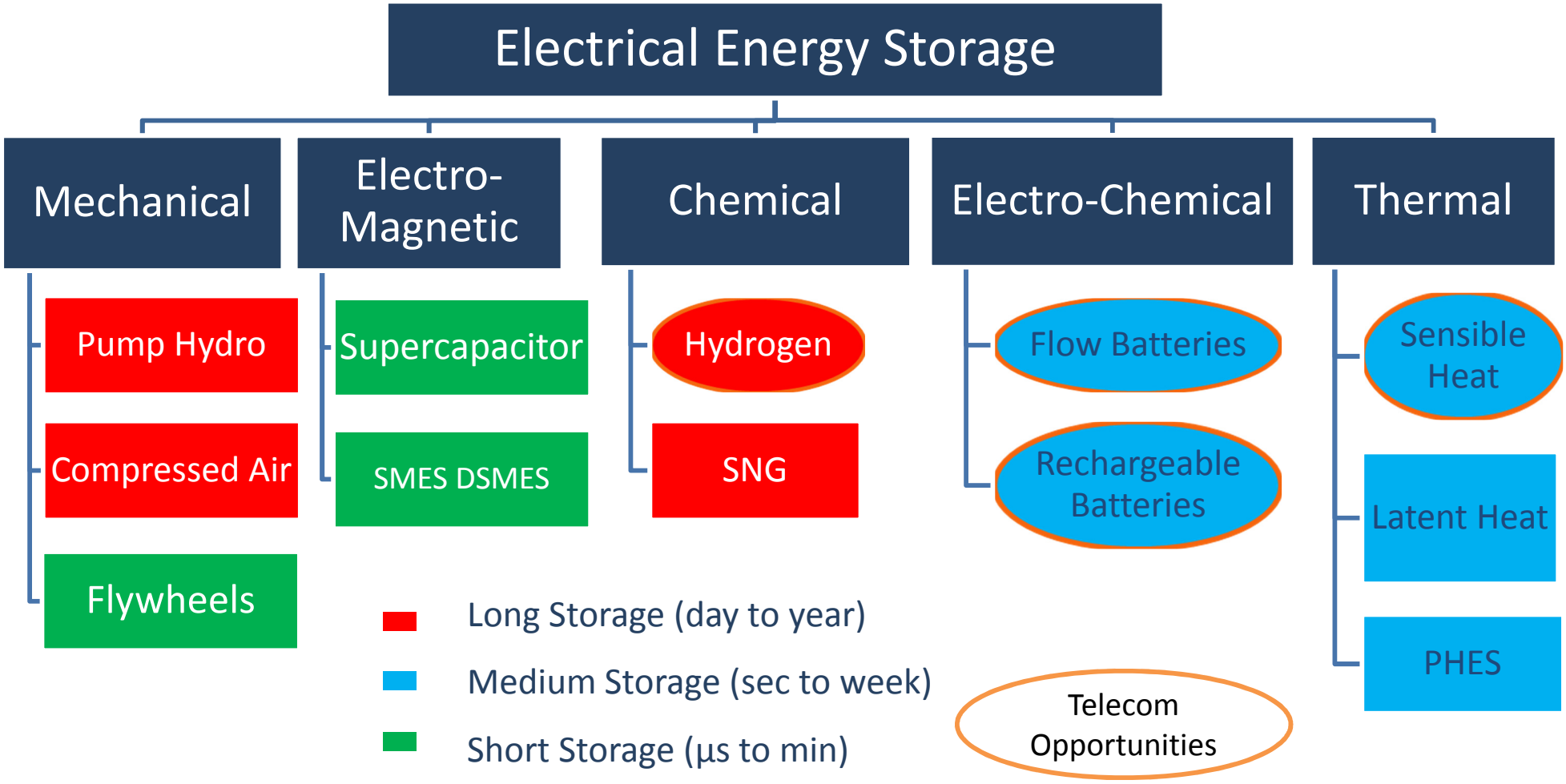
Batteries & Energy Storage Solutions

3C Projects



EC Document "Energy Storage : A key technology for decentralized power, power quality and clean transport" - 2001

Batteries & Energy Storage Solutions



Classification according IEC ESS WP 12/2011

Lead Acid Batteries Flooded

3C Projects

Strengths	Mature Technology - Cell Cost of 80 € - 150 €/kWh Good extreme temperature acceptance - Convenient cycling performance for tubular variant
Weaknesses	Limited cycle life for flat plate variant - Water topping up Efficiency of 80-85%
Opportunities	Large global production capacities Large capacities range from 10Ah to 4000 Ah
Threats	Competition with Li-Ion

Main Technologies

PbSb (flat or tubular) ; PbCa (Flat) ; Plante ; PbC

Telecom Opportunities

- Large central office back-up
- Wireless outdoor and Off-Grid BTS (PbSb Tubular)
- Starting Engine (PbSb or PbCa flat)
- Microwave Antenna

Lead Acid Batteries AGM

Strengths	Mature Technology - Cell Cost of 100 - 130 €/kWh Good Power Performances - Balancing and Maintenance free
Weaknesses	Limited cycle life Reduced life operation at high temperature
Opportunities	Large global production capacities Standard format
Threats	Competition with Li-Ion

Main Technologies

PbCa (flat thin / thick) ; Pure Lead

Telecom Opportunities

- UPS – Data Center
- Large or district office back-up
- Wireless outdoor or indoor BTS
- Starting Engine
- Microwave Antenna – PABX - DSL

Lead Acid Batteries Gel

3C Projects

Strengths	Mature Technology - Cell Cost of 120 - 180 €/kWh - Good cycling ability Balancing and Maintenance free
Weaknesses	Poor Power Performance Life time affected at high temperature operation
Opportunities	Large global production capacities High reliability and safety reputation
Threats	Competition with Li-Ion

Main Technologies

PbCa (flat or tubular)

Telecom Opportunities

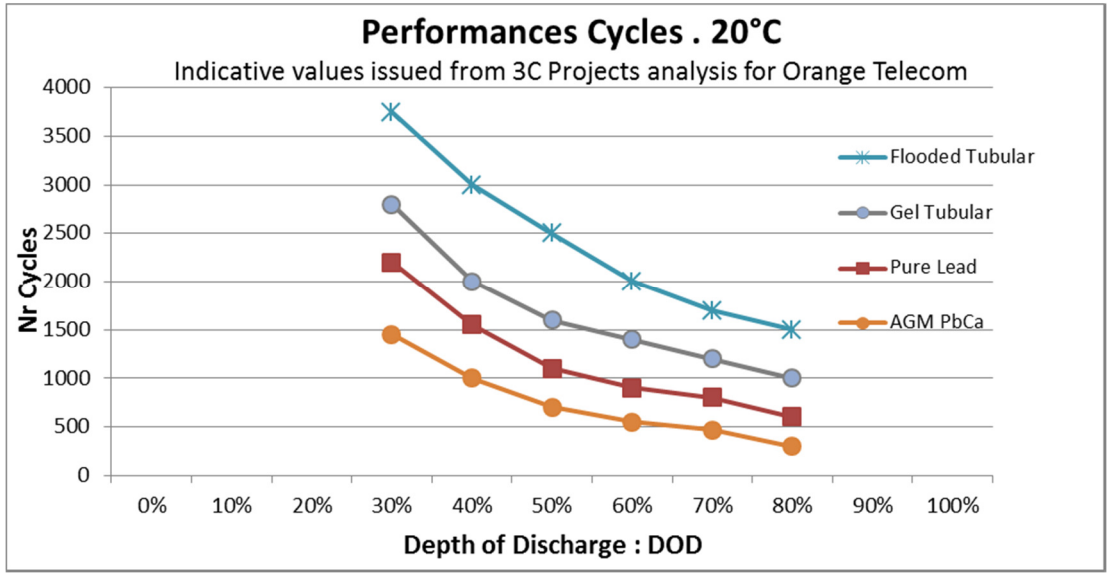
- Large or district central office back-up
- Wireless outdoor, indoor and off-grid BTS
- Microwave Antenna – PABX - DSL

Lead Acid Batteries Summary

3C Projects

Large Differences in Term of Battery Choice

- kWh Cost varies from 1 to 3 according types
- Life operation can be from 3 years to 25 years according type and temperature operation
- Cycling performances are quite different from type to type



- Today Lead Acid battery is the largest player for stand-by applications
- IEC/EN 60896-1 & 2 ruled the type test performances (float & cycling)
- IEC/EN 61427 provides recommendations for PV applications

NiCd Batteries

3C Projects

Strengths	Mature Technology - Extreme low temperature performances Robust reliability - Good energy density
Weaknesses	Cost around 400 €/kWh Recycling process of Cadmium
Opportunities	Engine starting at low temperature On board rail application & extreme temperature PV applications
Threats	Competition with Li-Ion - Cadmium ban

Main Technologies

Pocket plates (flooded or sealed) & Sintered plates

Telecom Opportunities

- Wireless outdoor and off-grid BTS
- Microwave Antenna
- Engine starting

NiMH Batteries

Strengths	Mature Technology - Extreme low temperature performances Robust reliability - Good energy density -
Weaknesses	Cost around 450 €/kWh
Opportunities	Hybrid Vehicle (Toyota Prius) Portable applications
Threats	Competition with Li-Ion

Main Technologies

Flat or Cylindrical

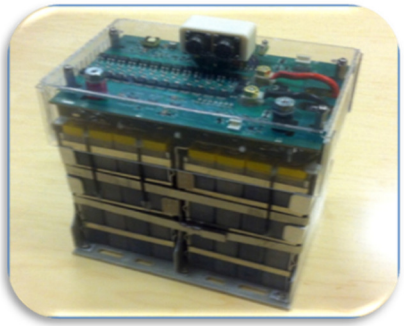
Telecom Opportunities

- Handy terminal
- PABX

NiZn Batteries

3C Projects

Strengths	Cycling performance - Wide temperature range operation - No electronic balancing - Recyclability - Energy density
Weaknesses	No long field experience feed back
Opportunities	Abondance of material New jocker for extreme temperature cycling operation
Threats	Competition with Li-Ion & Lead Acid



Main Technologies

SCPS License or Powergenix License

Telecom Opportunities

- Wireless outdoor and off-grid BTS
- Microwave antenna
- Engine starting

NiFe Batteries

3C Projects

Strengths	Mature technology - Very long life operation up to 25 years No electronic balancing - Recyclability
Weaknesses	High maintenance cost due to high rate of water consumption
Opportunities	Abondance of material
Threats	Competition with Li-Ion & Lead Acid

Main Technologies

Edison type

Telecom Opportunities

- Wireless outdoor and off-grid BTS
- Microwave Antenna

Nickel based Batteries Summary

3C Projects

Niche Applications and New Players

- Nickel Cadmium keeps strong positions on railways and cold starting engine due to safety maturity
- NiMH keeps market shares in HEV and portable tools due to its safety operation, maturity, as well as good energy density
- NiZn is a new player and can afford right opportunities for cycling operations at extreme temperature operations with expected reasonable cost
- NiFe is coming back and field experiences are looking with great attention
- Competition with lithium based batteries is tough (Battle is lost for portable except for power-tool)
- IEC/EN 61434, 60623, 62259, 60622, 61951 provides major information for type test performances
- IEC/EN 61427 is the reference for PV applications

Lithium LiFePo4 Batteries

3C Projects

Strengths	High Cycling Performances - Partial State of Charge Capability Good safety operation
Weaknesses	Cell cost about 320 €/kWh & Pack cost around 450 €/kWh Need electronic pack balancing - Low & High temp. operation
Opportunities	Renewable energy storage applications Bus & Commercial EV
Threats	Competition with Li-Ion Titanate anode batteries & Flow batteries

Main Technologies

Cylindrical, Pouch (Polymer), Large prismatic

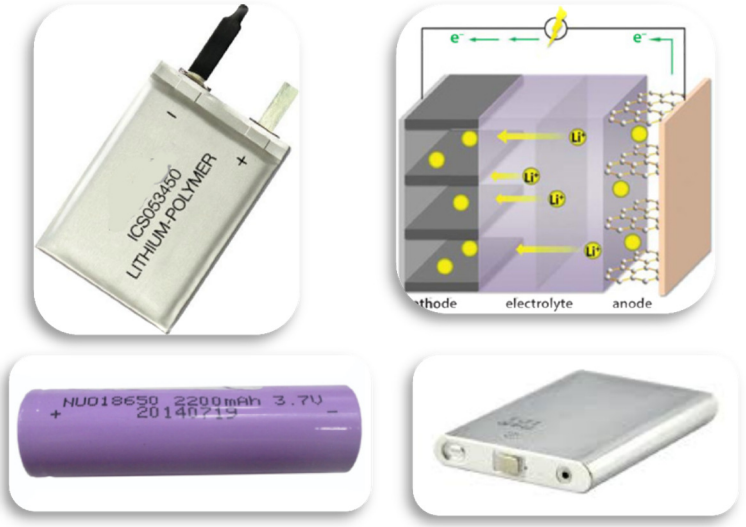
Telecom Opportunities

- Wireless outdoor and off-grid BTS
- Microwave antenna

Lithium Ion Batteries (LCO, LMO, NCA, NMC)

3C Projects

Strengths	High Cycling Performance - Partial State of Charge Capability High Energy & Power Density
Weaknesses	Cell cost from 250 €/kWh to 600 €/kWh Need electronic pack balancing - Limited low & high temp. operation
Opportunities	Portable equipment - EV Batteries Grid support
Threats	Limited supply in Lithium



Main Technologies

Cylindrical – Prismatic
Pouch (Polymer)

Telecom Opportunities

- Terminal (Phone, Tablets, Laptop...)
- NCA, NMC, LMO can play for off-grid applications, Antenna and BTS equipment

Lithium Ion Batteries (LTO anode)

3C Projects

Strengths	Very High Cycling operation > 10 000 Cycles Good safety operation and good charging suitability at low temp.
Weaknesses	Cell cost over 450 €/kWh - Lower energy density Need electronic balancing - Limited high temp. operation
Opportunities	Renewable energy storage Grid support - UPS short backup
Threats	Limited supply in Lithium Few suppliers

Main Technologies

Prismatic & Pouch

Telecom Opportunities

- Wireless outdoor and off-grid BTS
- UPS Short Backup

Lithium Metal Polymer Batteries (LMP)

3C Projects

Strengths	Very High Cycling Performance > 5 000 Cycles Can work at extreme temperature
Weaknesses	Pack cost over 700 €/kWh - lower effeciency Need electronic cell balancing and thermal management
Opportunities	Renewable energy storage EV batteries
Threats	Limited supply in Lithium Limited supplier

Main Technologies

Prismatic Pack

Telecom Opportunities

- Wireless outdoor and off-grid Antenna or BTS

Lithium based Batteries Summary

3C Projects

Large difference in term of battery choice

- Cycling performances vary from 1 to 30 according, shape, size, cathode and anode material as well as supplier manufacturing process.

Example of announced performances : (Here below extract from Lishen datasheets)

P/N	Cathode	Capacity (mAh)	Life Cycles	Shape
LR1865BI	NMC	1500	300/75%	Cyl.
LR1865LA	NMC	2000	300/75%	Cyl.
LR1865SK	LCO/NCM	2600	300/80%	Cyl.
LR1865SA	LCO	2800	300/80%	Cyl.
LR1865SC	LCO	3000	300/80%	Cyl.
LR1015AB	LCO	60	500/80%	Cyl.
LR1865SD	LCO/NCM	2200	1000/80%	Cyl.
LR1865EC	LFP	1350	1000/80%	Cyl.
LP2714897	LFP	20000	2000/80%	Prism.

- Up to now very few long period field experiences, project sizing and economics are mainly based on data-sheet
- Standards for safety are fixed, concerning stand-by type test the standard processes are on going.

Sodium Batteries (NaNiCl - NaS)

3C Projects

Strengths	Very High Cycling Performances 5 000 - 10 000 Cycles Can work at extreme temperature
Weaknesses	Pack cost over 700 €/kWh Need thermal management - Thermal losses - Low efficiency
Opportunities	Renewable energy storage Grid support
Threats	Lack of safety confidence - Competition with lithium

<u>Main Technologies</u>

Fiamm, GE for NaNiCl & NGK for NaS

<u>Telecom Opportunities</u>

Wireless outdoor and off-grid BTS at extreme temperature with NaNiCl

<u>Standards</u>

No specific type test standard up to now

Redox-Flow Batteries

Strengths	Energy and Power are Independenly scalable Cyclic lifetime > 10 000 Cycles
Weaknesses	Low efficiency of 60 - 74 % Lack of long field experience. Cost still at about 500 € / kWh at scale
Opportunities	Expiration of patent protection Cheap raw materials are available
Threats	Only few manufacturers Wrong field experiments results

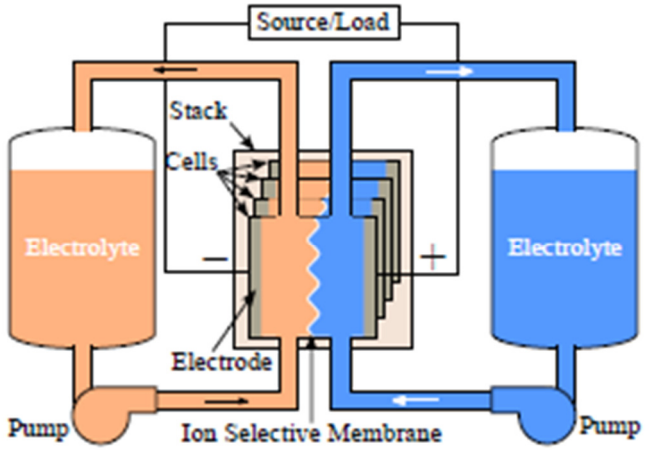


Figure 2.2: Design of a generic flow battery system

Main Technologies

VFRB (Vanadium) – ZnBr – FeCr – H_2Br

Telecom Opportunities

Large central office connected to Renewable Energy supply source and operating at extreme temperature

TES – Thermal Energy Storage (Hot or Cold)

3C Projects

Strengths	Scalable Size. Mature Cyclic lifetime > 10 000 Cycles
Weaknesses	Low efficiency of 60 - 70 % Not adapted for electricity recovery
Opportunities	Extreme temperature operation micro-grid systems
Threats	Not considered as inovative

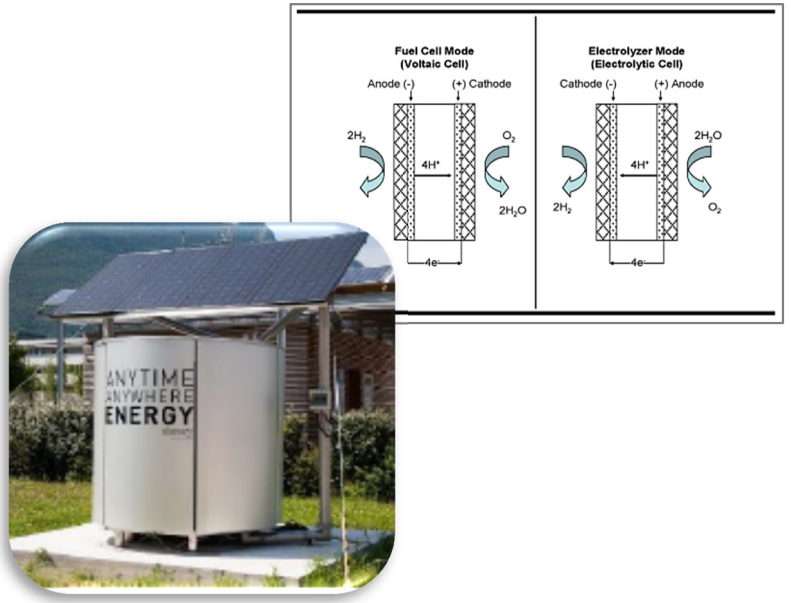
<u>Telecom Opportunities</u>

As an improvement of renewable energy integration Cold TES can be part of energy efficiency approach for systems and Hot TES with associated applications can be explore.

Hydrogen and Regenerative Fuel Cell (RFC)

3C Projects

Strengths	Autonomous concept Excellent cycling performance Scalable
Weaknesses	Low efficiency arround 50 % total Lack of long field experience. CAPEX Cost 600 € - 1000 €/kWh
Opportunities	Seasonal storage for Renewable Energy Combination with EV propulsion
Threats	Safety regulation Electrolyser and fuel cell membrane reliability



Technologies

Electrolyser PEM + Fuel Cell + Solid, Liquid or Compressed Hydrogen Storage

Telecom Opportunities

Seasonal storage for antenna or off-grid BTS

Conclusions

- Energy storage solutions are multiple
- Operation conditions have to be well set to ensure the right choice
- LCOE (Life Cost of Energy) linked to CAPEX, OPEX and service life is a good approach to set the cost effective choice
- Dual or Hybrid solutions are more and more considered :
  - Power + Energy or Cycling + Floating
    - Lithium + Lead
    - Lithium NMC + Lithium LTO
    - Supercapacitor + lead
    - Supercapacitor + lithium
    - Electrochemical + Thermal
    - Electrochemical + Chemical
- New developments are on the way :
  - LiS : Lithium Sulfur
  - Metal Air : Zn-Air, Li-Air,

Conclusion

3C Projects

No one energy storage solution is predominant

each one has its adapted fitment

Thank You