

Lessons Learnt from Integrating High Penetration Renewables into a Campus Microgrid

Russell Carr

Arup

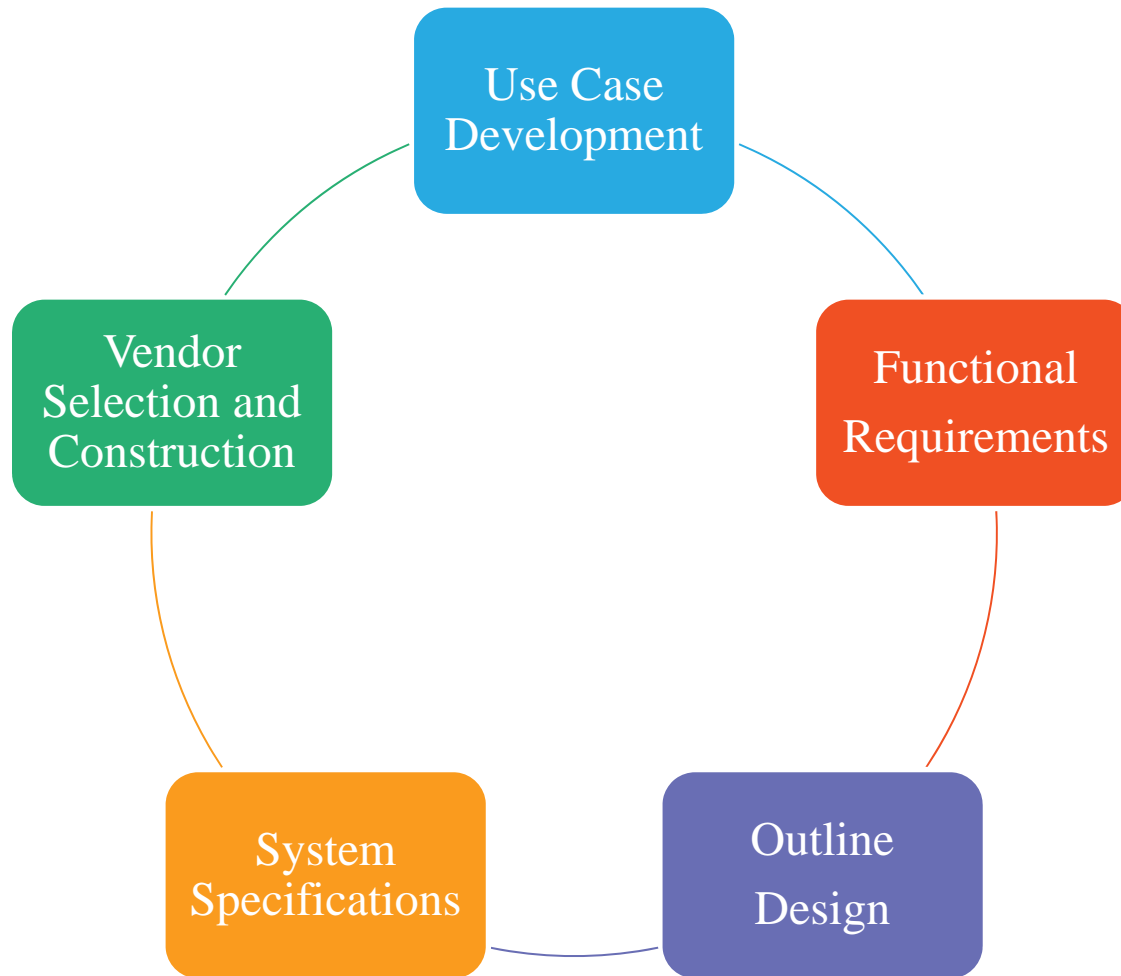
Russell.carr@arup.com

415-730-5094

Abstract

- *This confidential microgrid contains multiple MW's of PV, Fuel Cells and advanced Energy Storage. The microgrid is able to operate independently of the wider grid with the use of standby diesel generators and maintain campus operations without grid power.*
- *This presentation will focus on the process and methodology employed by Arup in the design and specification of the system and also highlight challenges and lessons learnt resulting from the detailed design of the microgrid.*

Design Process



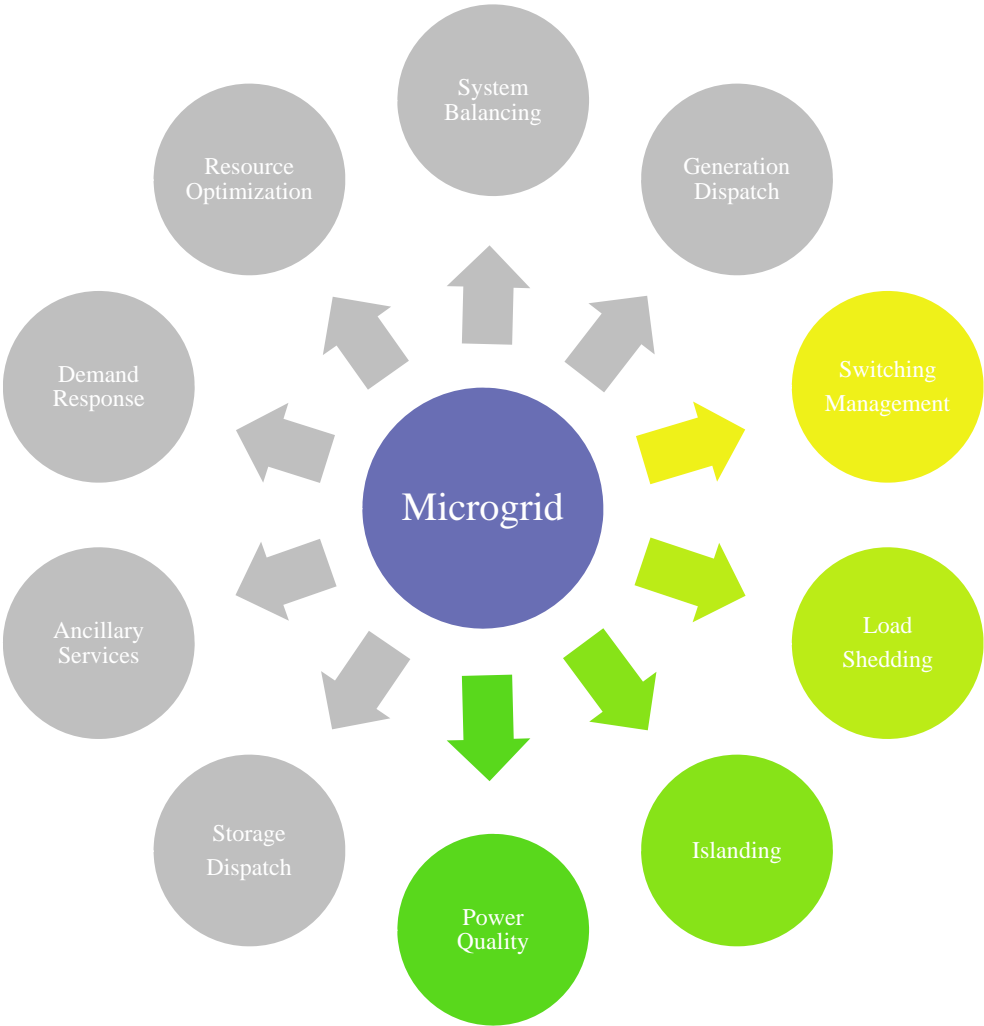
Use Case and Functional Requirements



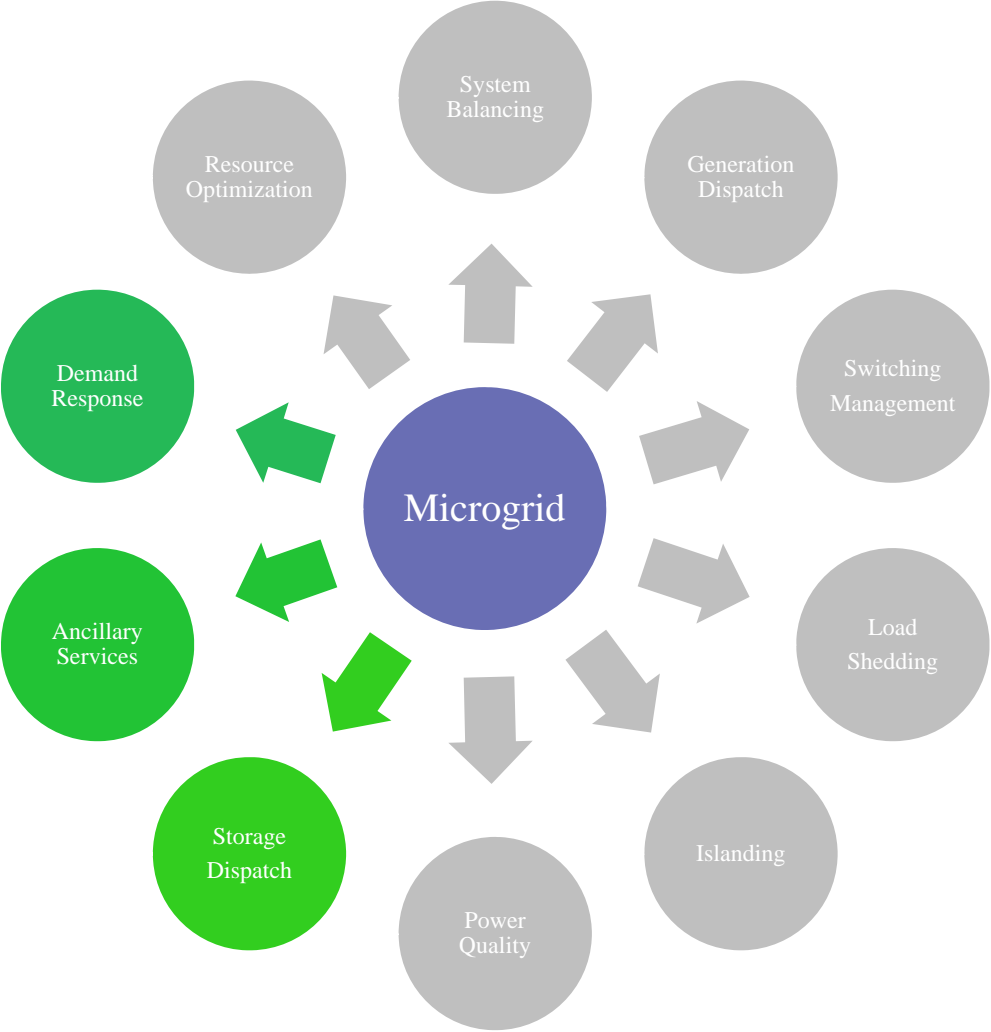
Use Case and Functional Requirements



Use Case and Functional Requirements



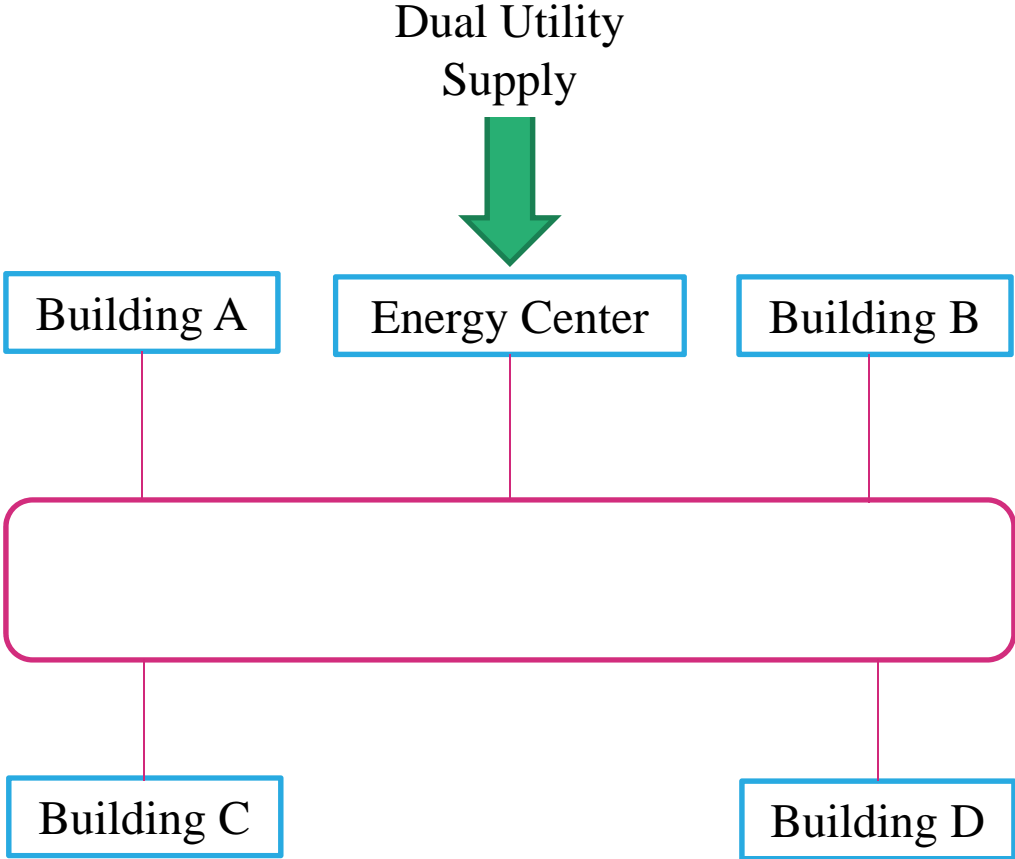
Use Case and Functional Requirements



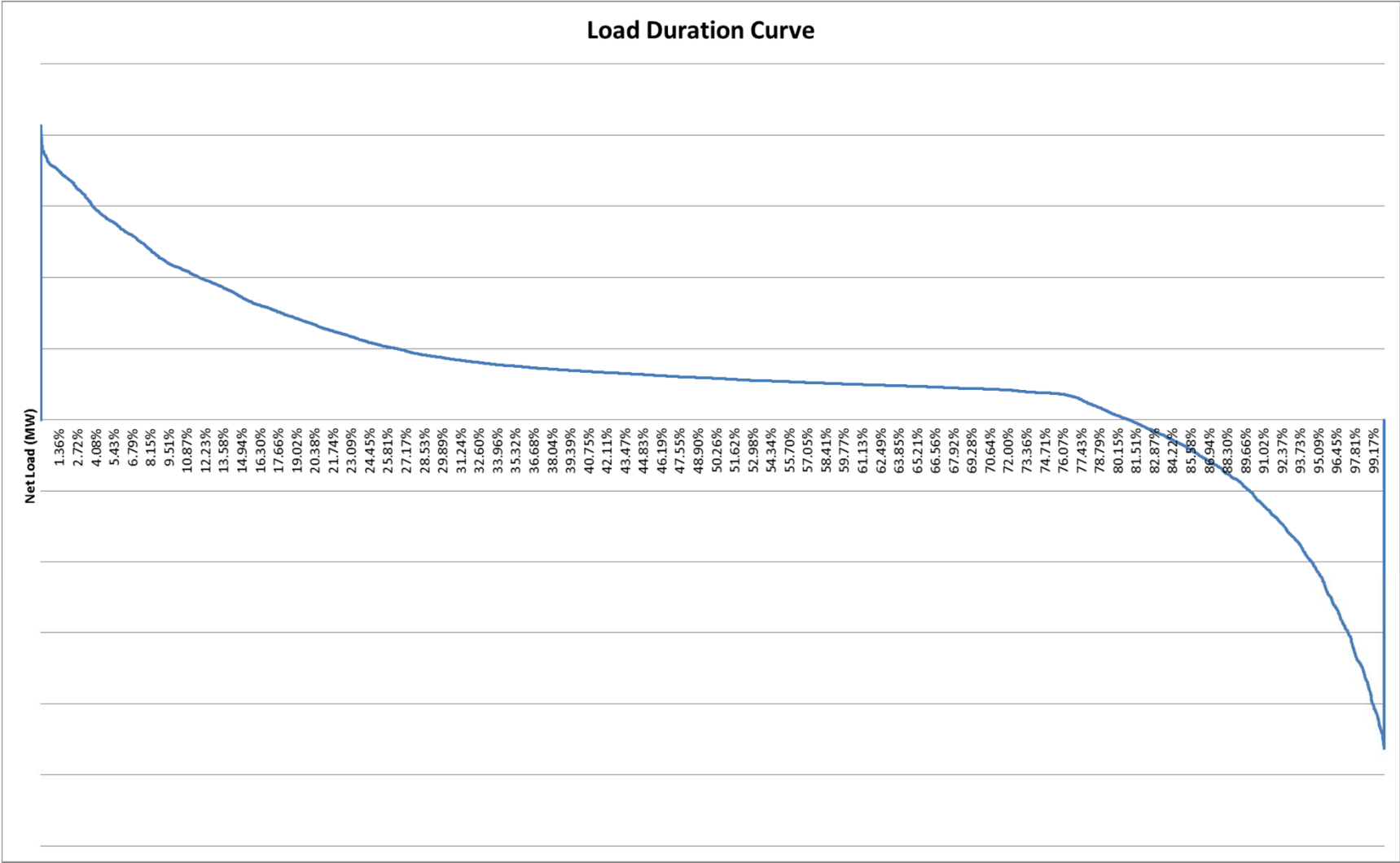
Key Use Case Outcomes

- Generate majority of electricity on site
- Participate in energy storage markets
- Maintain majority of building loads in an outage
- PV and Fuel cells to provide the majority of electricity in island mode

Outline Design



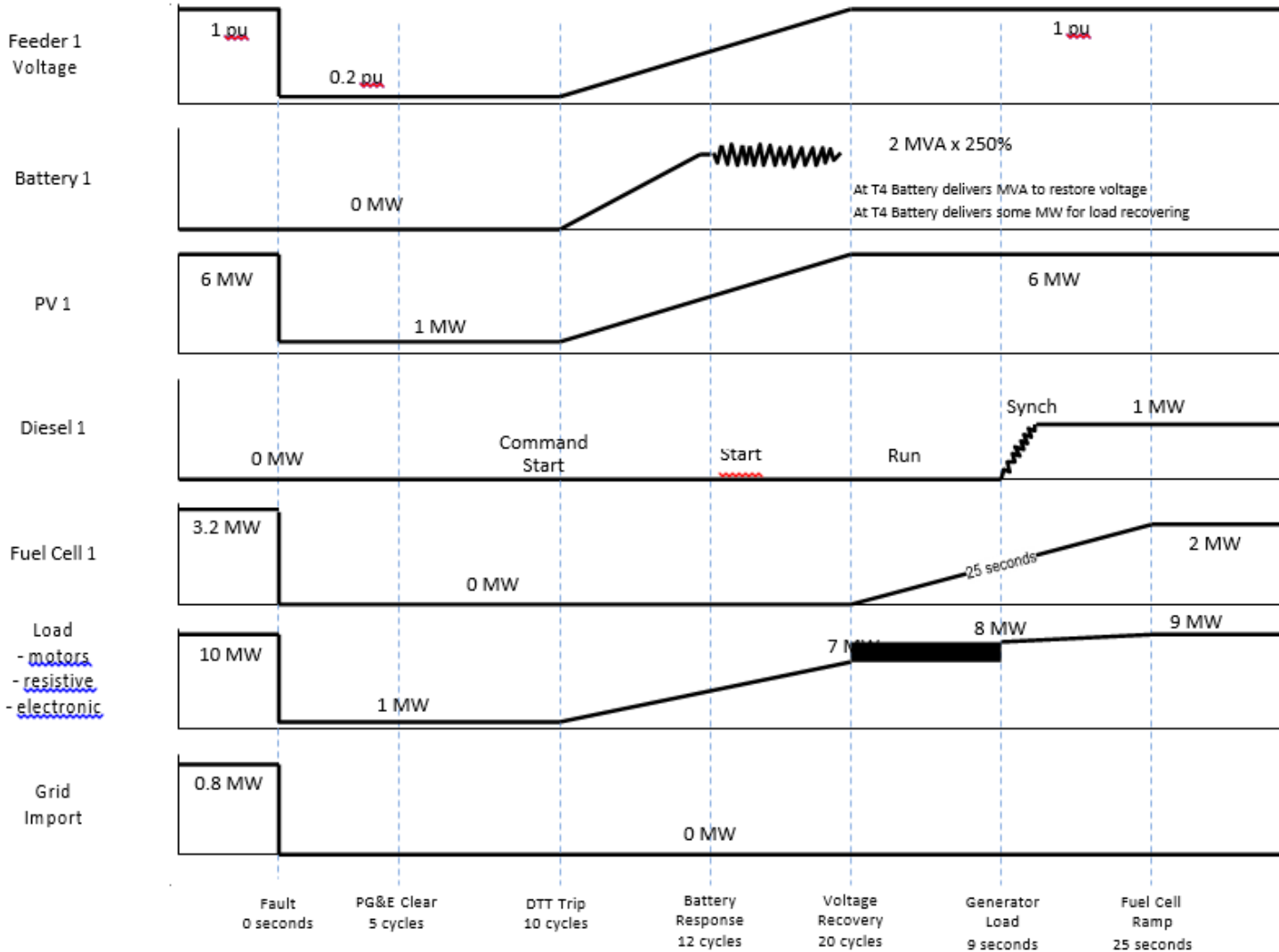
Outline Design



Outline Design

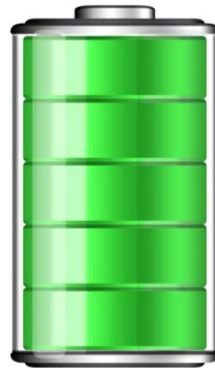
- Modes of Operation
 - Loss of a Feeder
 - Load Shed Scheme
 - Matrix of generation / load scenarios
 - Utility Momentary Loss of Power
 - Utility Brown Out
 - Natural Gas Loss (Fuel Cells)
 - Utility Under-Frequency Event
 - Resynchronize to Utility

Outline Design



Design Challenges


- Design Challenges
 - High PV penetration
 - Mixed DER assets
 - Availability of products



Solutions



Solutions



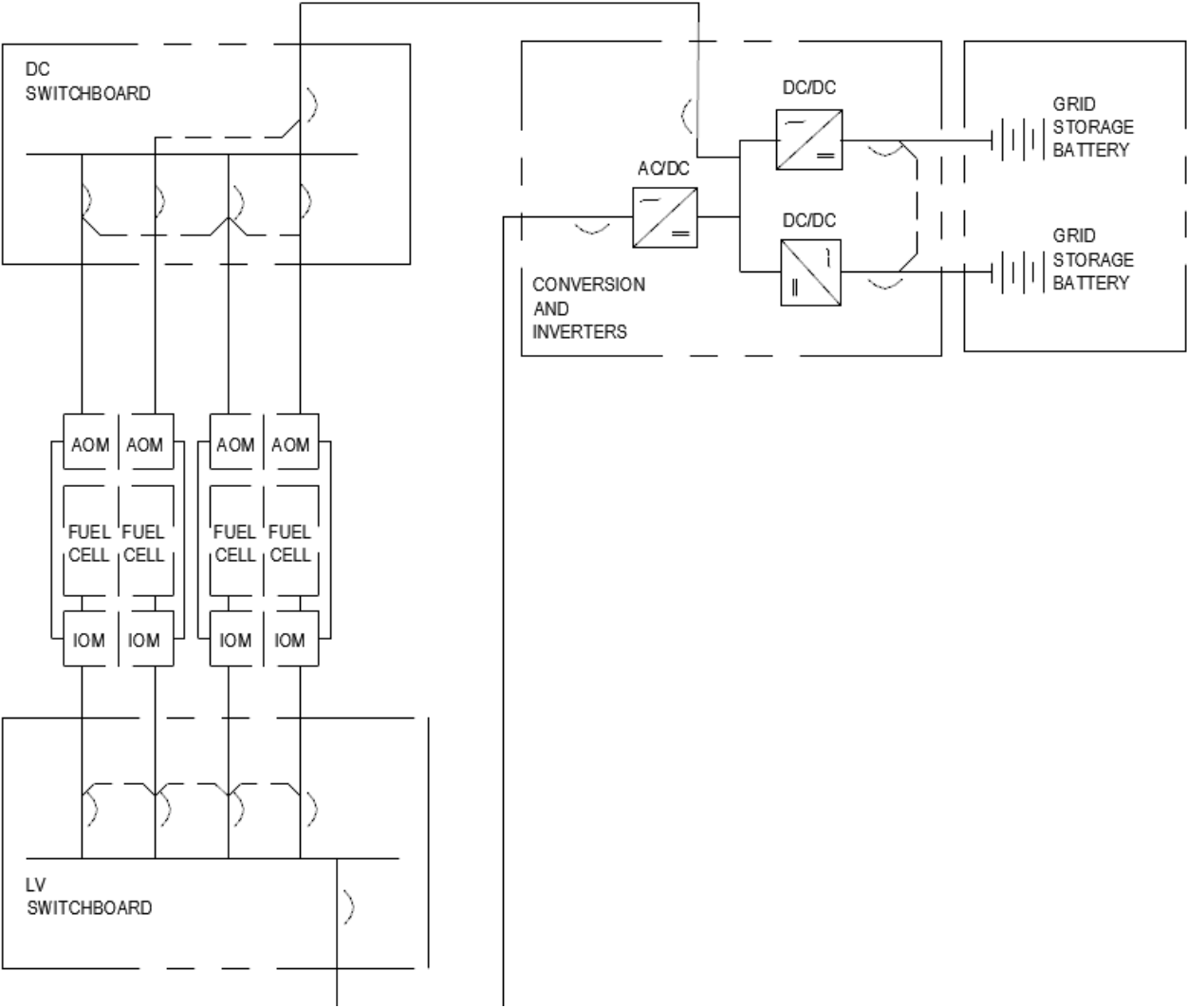
The screenshot displays the California Energy Commission website. The header includes the CA.GOV logo, the California Energy Commission logo, and navigation links for Home, About Us, Analysis & Stats, Efficiency, Funding, Power Plants, Renewables, Research, and Transportation. A search bar is located in the top right corner. The main content area features a large image of wind turbines on a hill. Below the image, the breadcrumb trail reads: Home -> electricity analysis -> rule21. The main heading is "Rule 21 Smart Inverter Working Group Technical Reference Materials". To the right of this heading is a "Related Information" box containing a link to "CPUC Rule 21". The main content area lists several categories of documents:

- » **Phase 1 Recommendations and Test Plan Documents**
 - » [Phase 1 Recommendations and Test Plan Documents](#)
- » **Phase 2 Communications Documents**
 - » [Energy Commission Phase 2 Communications Documents](#)
 - » [Recommendations for Utility Communications with Distributed Energy Resources \(DER\) Systems with Smart Inverters](#)
 - » [SIWG Phase 2 Communications Issues For the July 18 Submittal to the CPUC](#)
- » [Smart Inverter Related Presentations](#)
- » [Dispersed Generation Impact On CE Region Security - European Network of Transmission System Operators for Electricity \(ENTSOE\)](#)

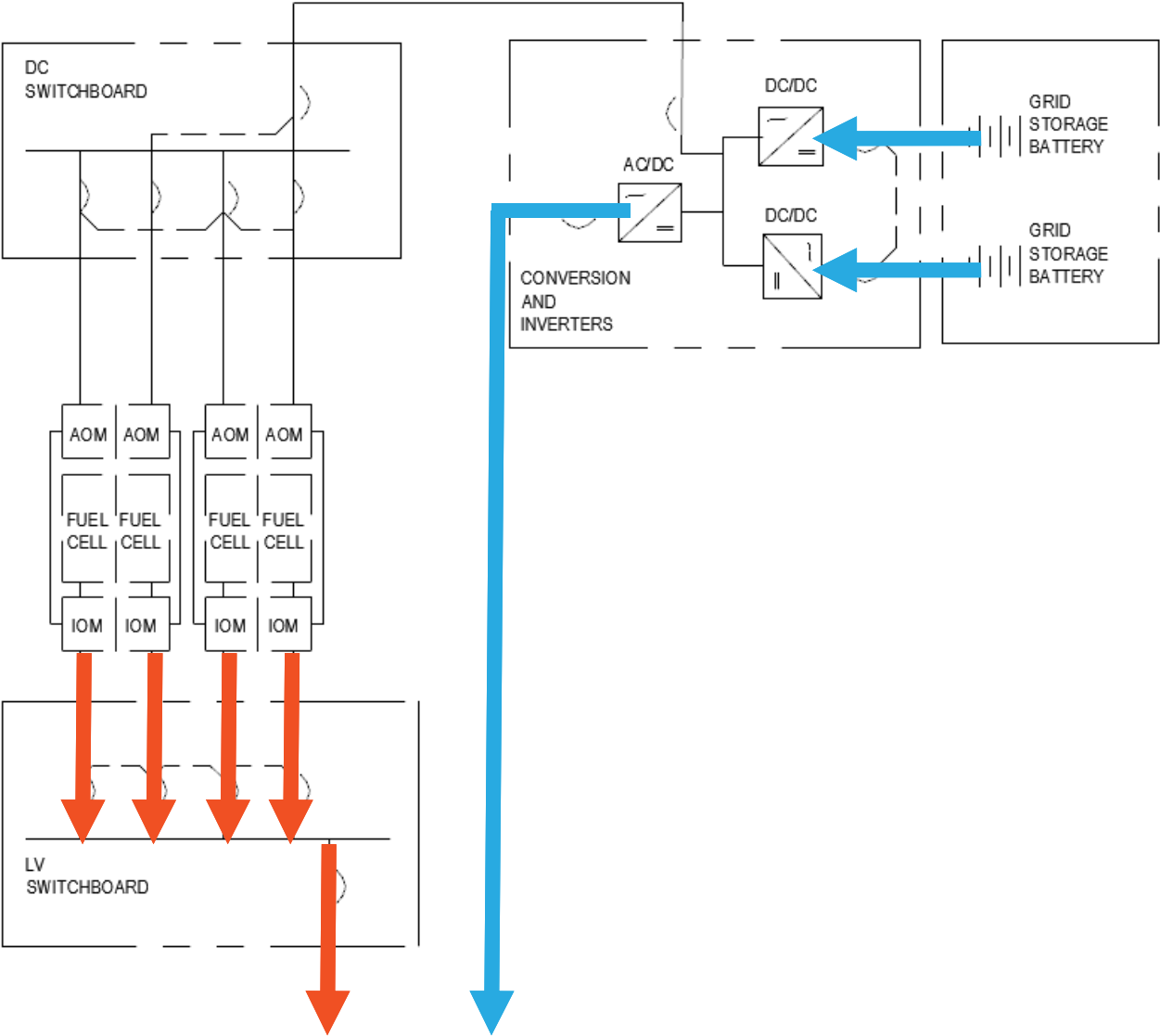
Background Materials:

- [European 50.2 Hz Frequency Problem](#)
 - [VDE study \(2012\)](#)
 - [Presentation of the VDE Study](#)

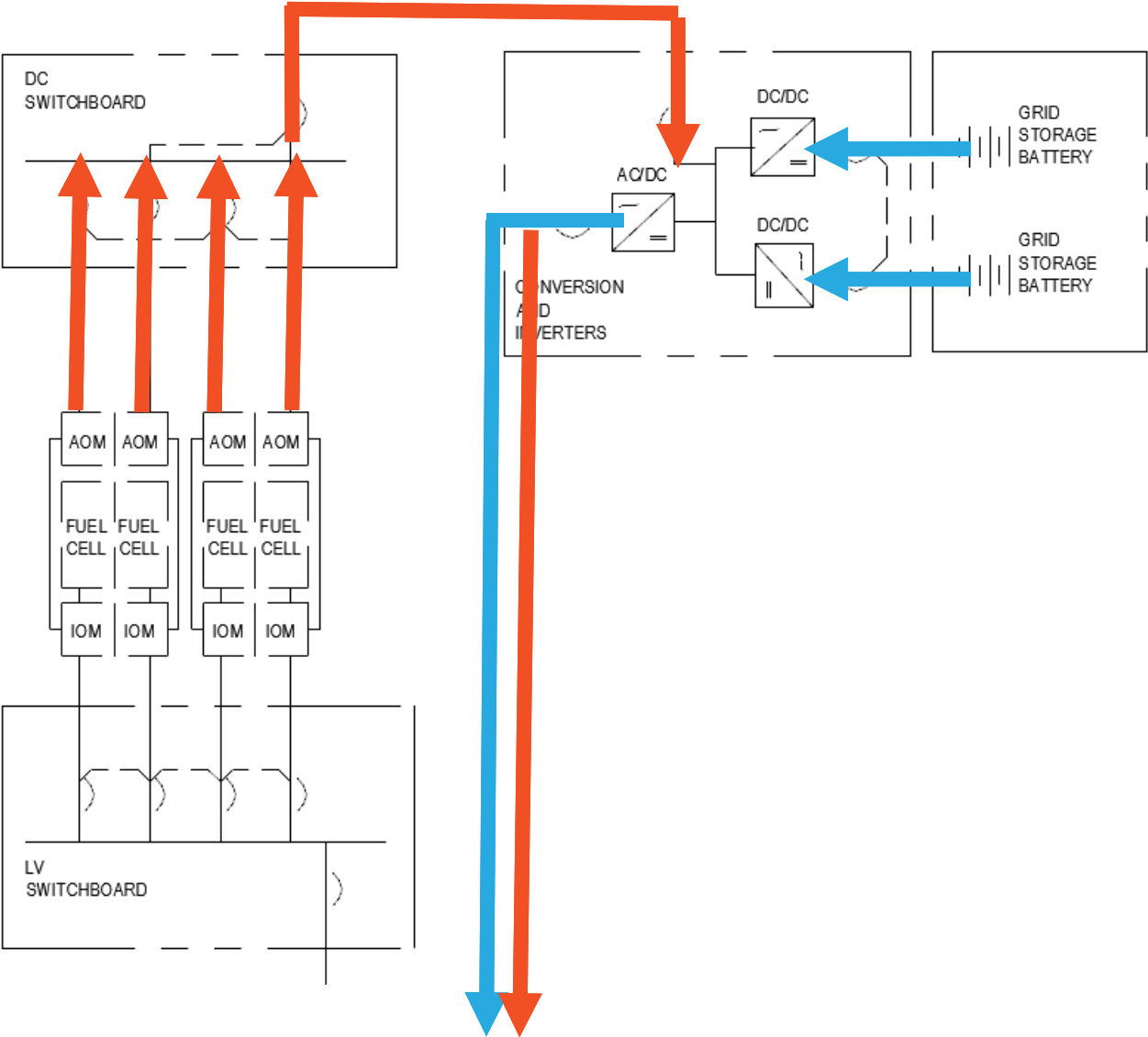
Solutions



Solutions



Solutions



Summary

- Lessons Learnt
 - Use case process is key to success
 - Engage with vendors early
 - Cost v benefit assessment
 - Utility engagement

Russell Carr
Arup
Russell.carr@arup.com
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ARUP