
THE SMARTEST
BATTERY
IN THE ROOM
University of Tasmania

# AGENDA

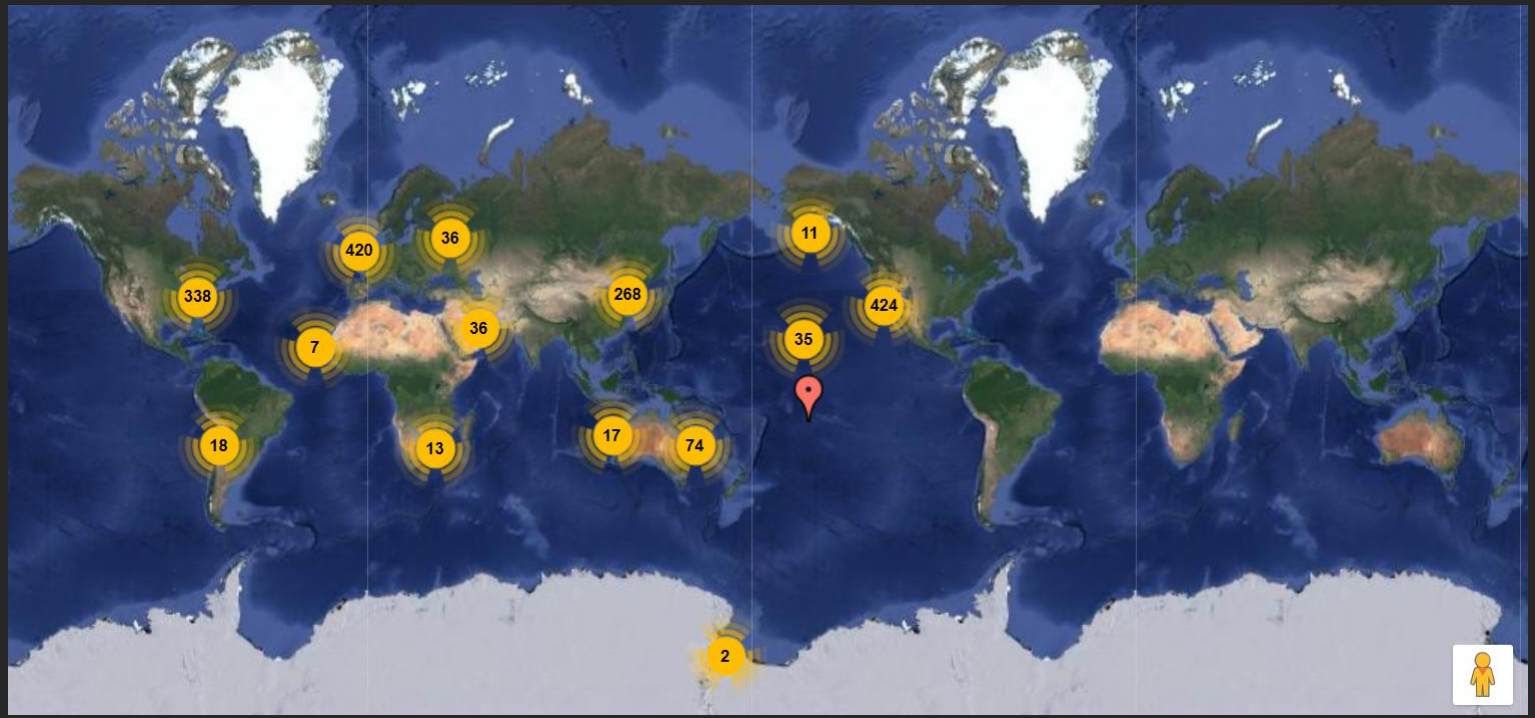
# There is no agenda*

*used to think I knew it all | but I don't

# STAKEHOLDERS

- The University of Tasmania are leading a number of concurrent low load and variable speed diesel initiatives, with funding provided by the ARC, ENA and ONRG
- Hydro Tasmania are currently hosting our largest demonstration, the 1.2MW King Island low load diesel pilot.
- Opportunities for host and commercialisation partner exist to support co-funded utility scale deployments.
- We are also working with ACEP, HNEI, ComAp, Siemens, Juwi, EDL

# A LOT OF BS



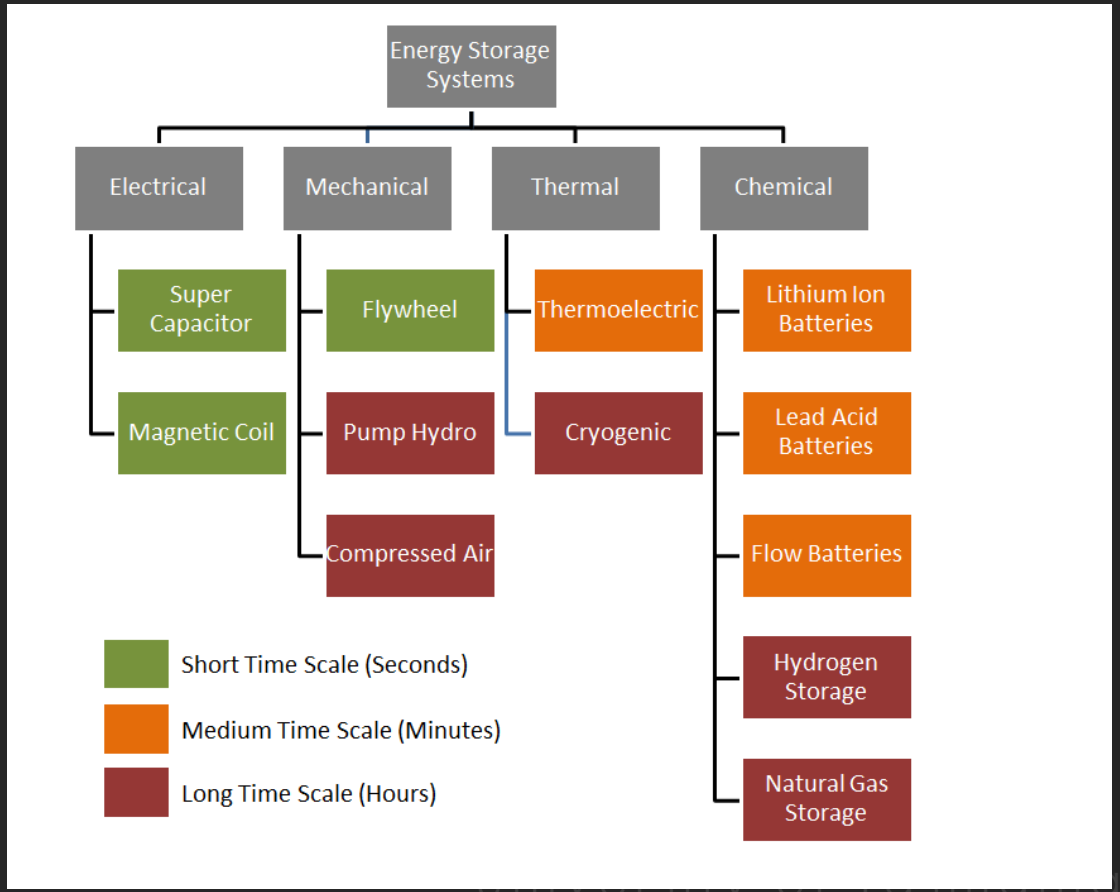

http://www.energystorageexchange.org/projects

# MORE BS

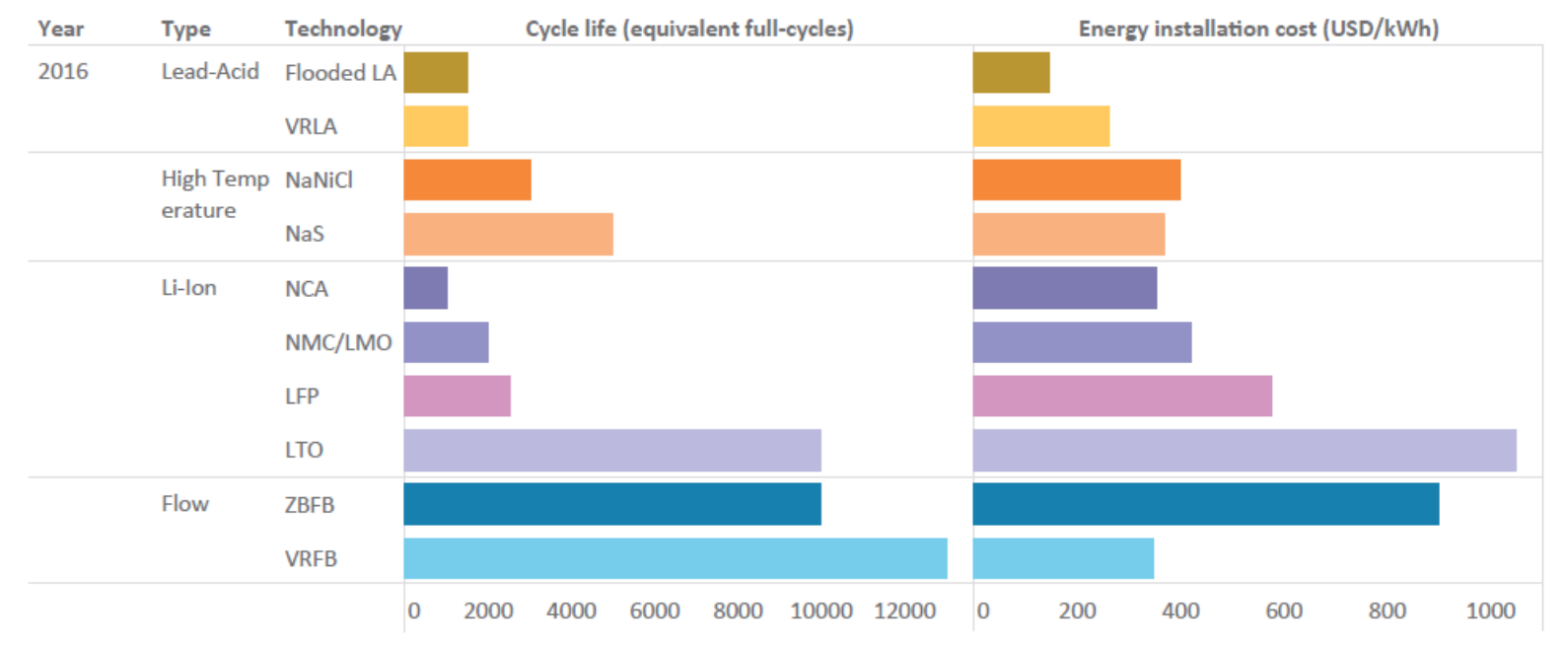

http://www.energystorageexchange.org/projects

# Keep It Simple

# BS RULE #1 – ESS IS NOT BS

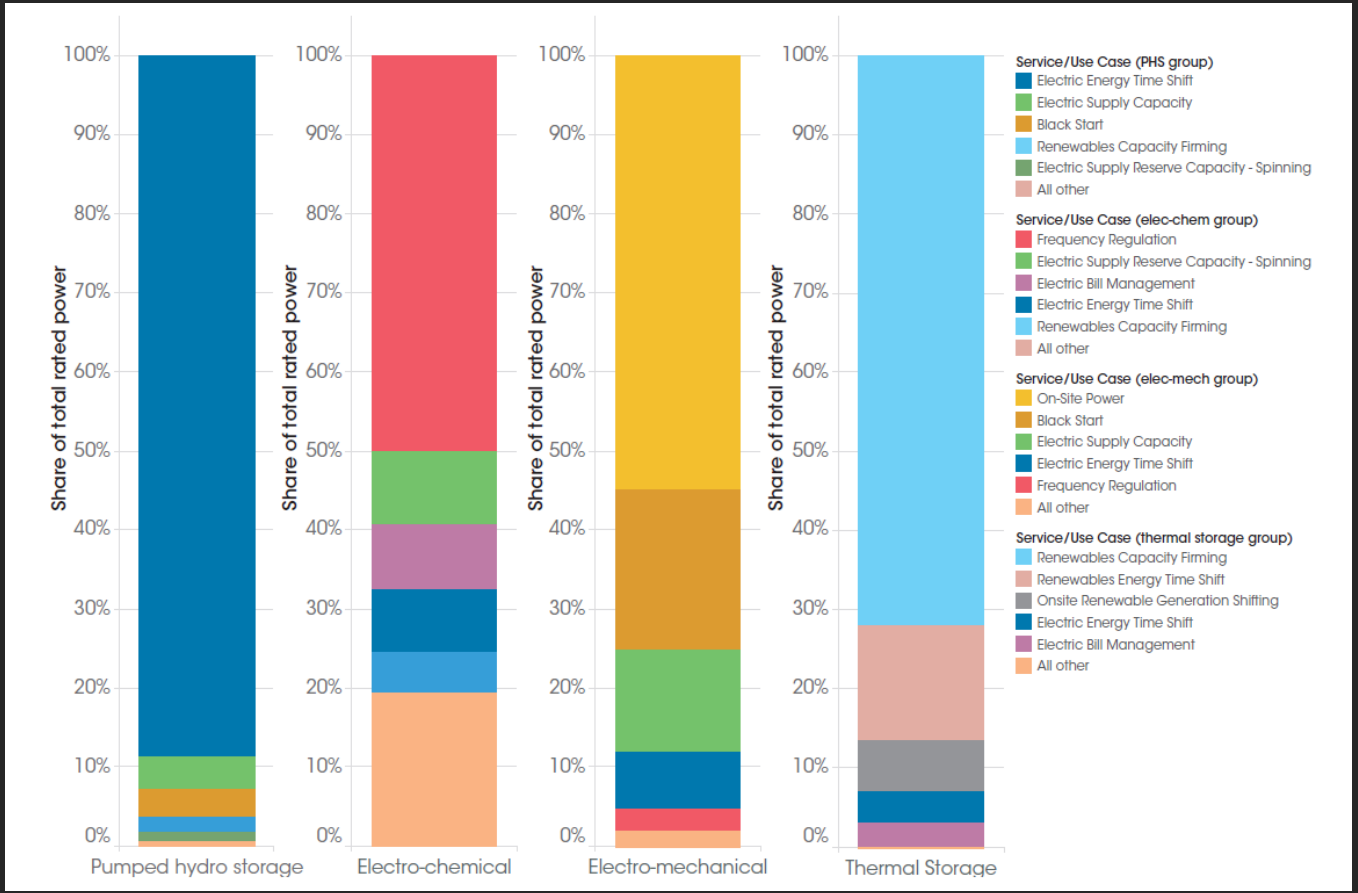


# BS RULE #2– BS IS NOT Lion



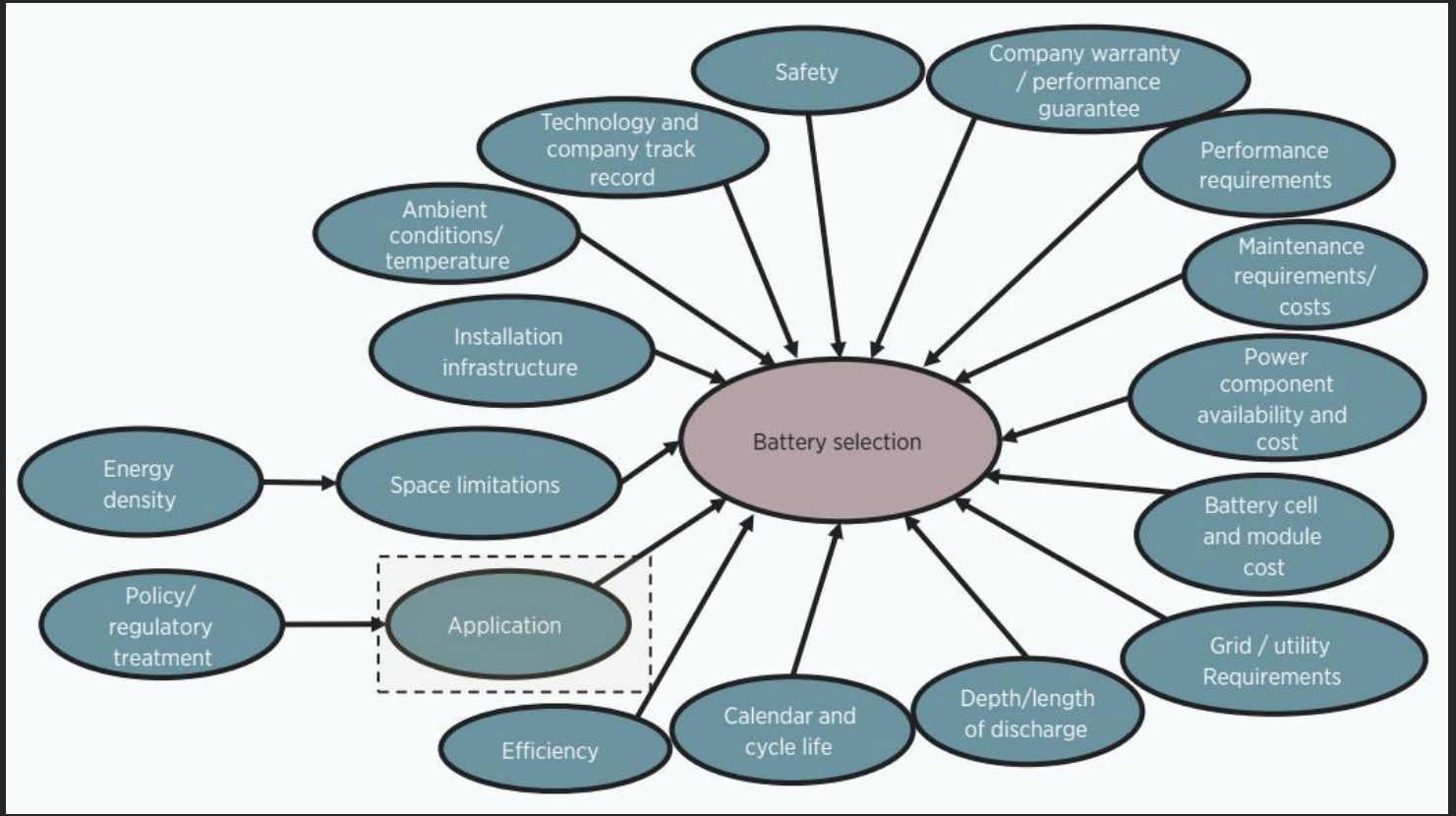

Source: Battery Storage for Renewables, IRENA, Jan 15

# BS RULE #3 – Lion IS NOT ENERGY OR POWER




Source: US DOE, 2017

# BS RULE #4- BS is Hard Work




Source: Battery Storage for Renewables, IRENA, Jan 15

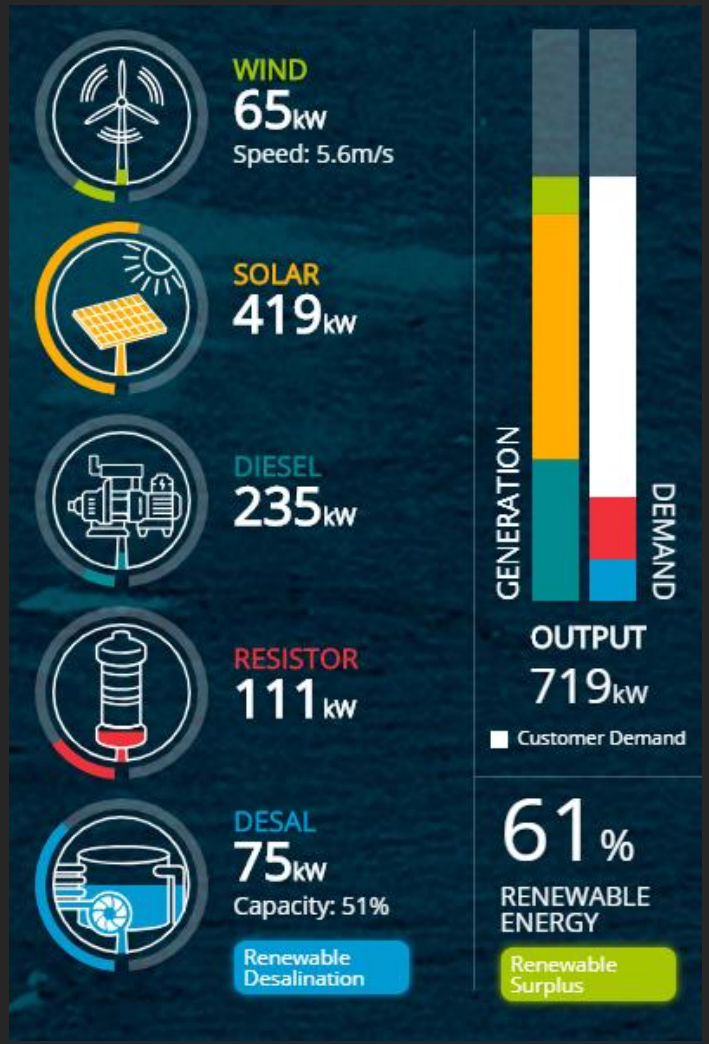
# Start Here

# A Tale of Three Islands

**King Island, Tasmania** is Australia's most prestigious MW scale island power project. Integrating wind from as early as1992, the island runs 65%-75% renewable on an annual average basis.
http://www.kingislandrenewableenergy.com.au

**Flinders Island, Tasmania,** represents a modernised King Island power system, deployed as a modular, containerised technology suite.
https://itunes.apple.com/au/app/flinders-island-energy-hub/id1372617413?mt=8

**Rottnest Island, Western Australia**, is the most recent Australian high renewable penetration island. Able to run 45-55% renewable p.a. the island is unique given the absence of any storage enablers.
https://indicium-dynamics.com.au/projects.html



Hydro Tasmania
The power of natural thinking

# King Island Renewable Energy Integration Project

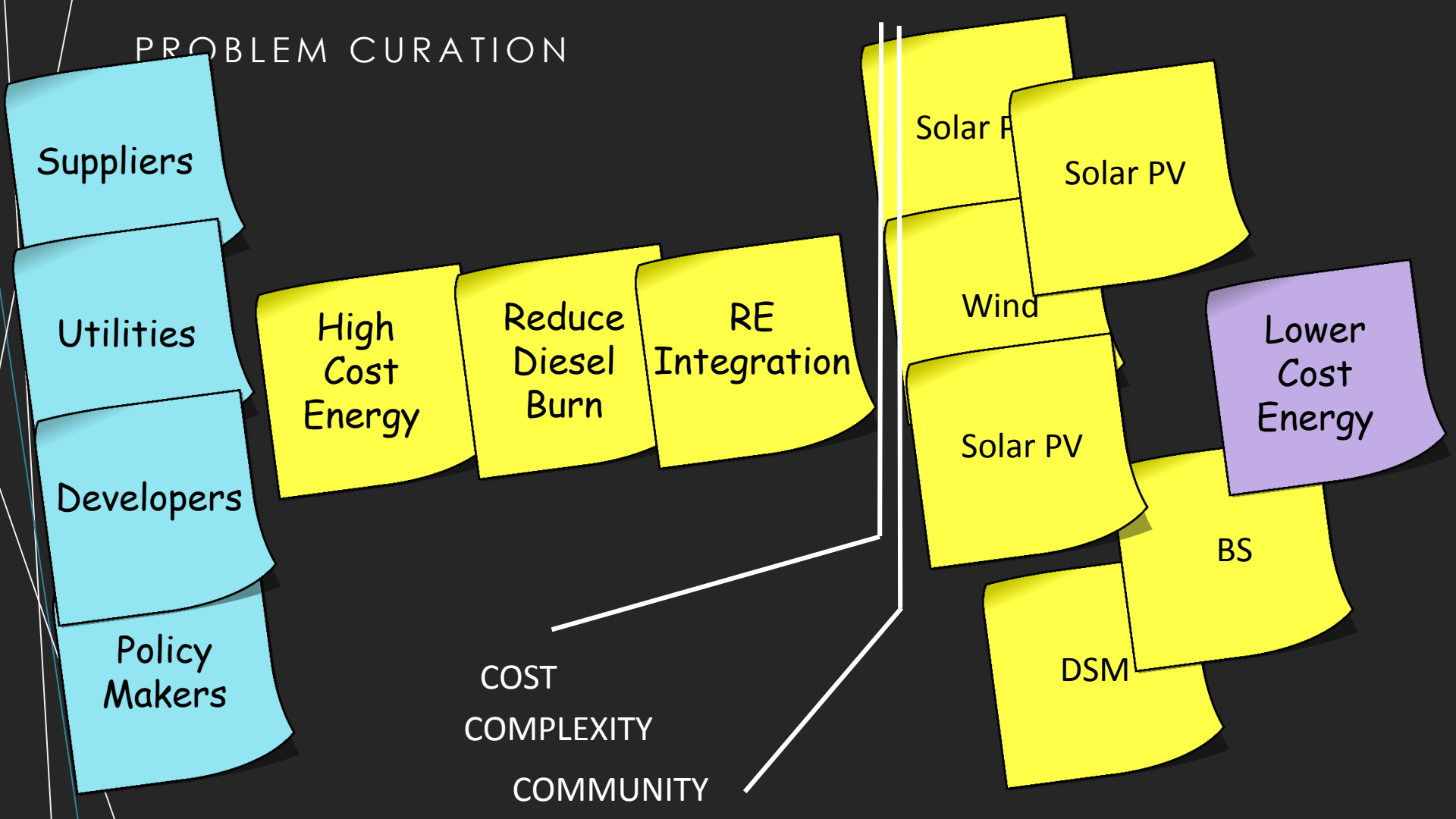
Project Information | History | Hybrid Off-Grid Power Systems | News | King Island Community | Links | App | Contact

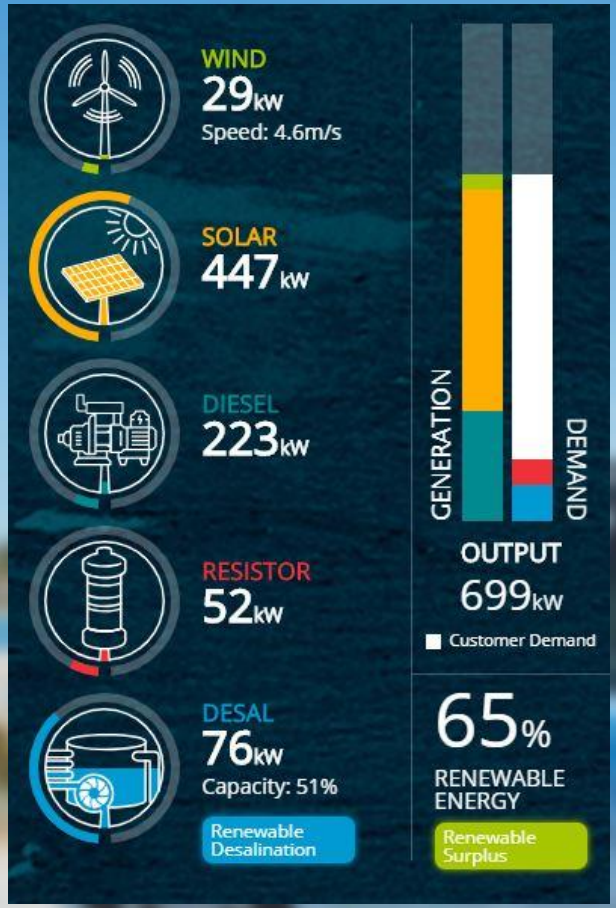




visit www.kingislandrenewableenergy.com.au

# PROBLEM CURATION







http://www.rottnestisland.com/the-island/travel-tools-and-tips/apps

Myth One of Four

Diesel engines are inflexible and unable to operate at low loads

# MYTH BUSTED:

Modern diesel engines can operate sustainably across their full load range. During sustained operation at low load a purge routine will be required to discharge carbon from the system. One hour every 8 to 12 hours of low load operation is typical.

References:
A. E. Surosky, "The Effects of Long Term High Idle Operation on Diesel Engines," Belvoir Research and Development Center, 1983.
R. Welz, "Low Load Operation for s1600 gendrive engines," Application Newsletter 15-005, MTU Friedrichshafen 21/04/2015.
M. Jensen, "Low Load Operation," Service Letter SL11-544/MTS, MAN Diesel & Turbo, June 2011.

Myth Two of Four

Diesel engines operate inefficiently at low loads

# MYTH BUSTED:

Fixed speed diesel engines consume more fuel per kWh at low loads. The solution is to release the engine from the fixed speed environment. Variable speed diesel concepts offer dramatic efficiency gains, and are able to use stock standard diesel engine technologies.

References:
D. H. Wang, C. V. Nayar, and C. Wang, "Modeling of stand-alone variable speed diesel generator using doubly-fed induction generator," in 2nd International Symposium on Power Electronics for Distributed Generation Systems, PEDG 2010, June 16, 2010 - June 18, 2010, Hefei, China, 2010, pp. 1-6.

Myth Three of Four

Engines wear and emissions prohibit low load application

# MYTH BUSTED:

Emissions intensity resultant from low cylinder temperature and pressure have historically been problematic. However, a range of approaches can stabilise cylinder temperature and pressure under low load operation.

References:
Danvest, "CAT PON Performance Test Report 41711," August 2015.

# Myth Four of Four

Manufacturer warranties prohibit low load operation

# MYTH BUSTED:

Fixed speed diesel engines consume more fuel per kWh at low loads. The solution is to release the engine from the fixed speed environment. Variable speed diesel concepts offer dramatic efficiency gains, and are able to use stock standard diesel engine technologies.

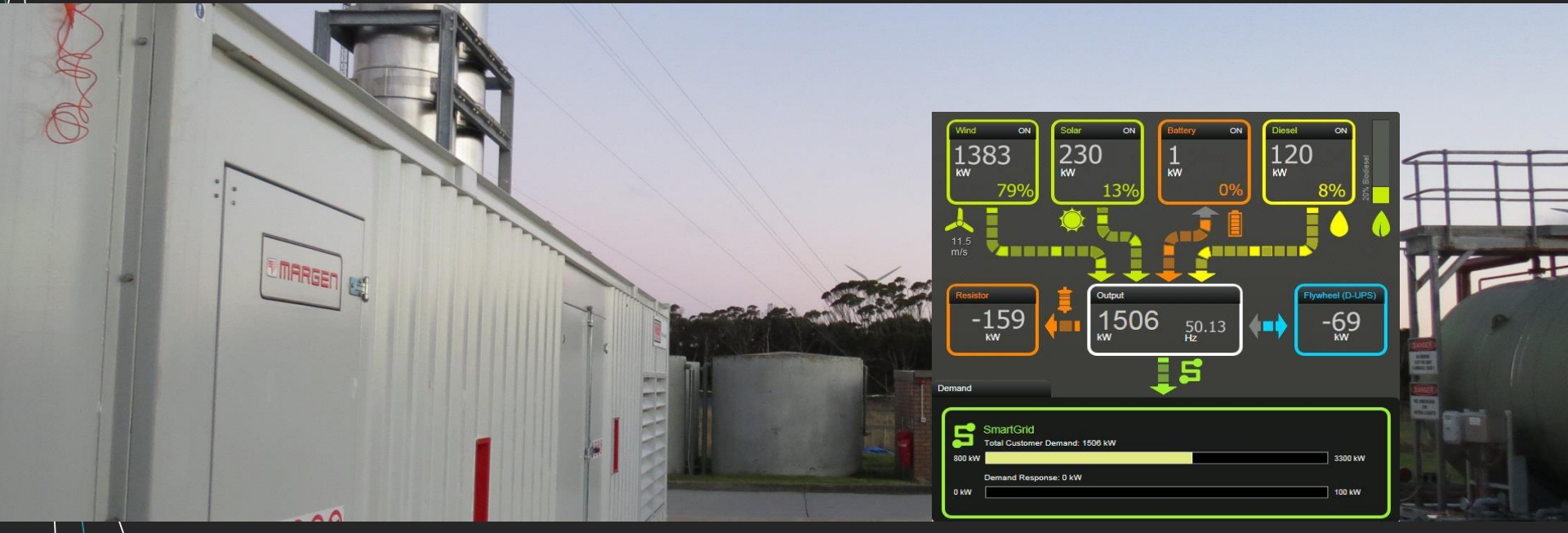
References:
P. Brooks, "Limitations on low load operation for fixed speed engines," in Cummins marine application bulletin, 2005.

# Low Load Diesel

- Running diesel assets lightly for improved RE utilisation.
- Typically returns a 20-30% improvement in RE penetration, extracting improved value from low penetrations systems.
- Engine temperature and purge frequency are key metrics.
- King Island anticipating a 10% fuel savings.

# King Island LLD Pilot

- MTU1.2MW 12V4000 DS1650 3B diesel generator
- 70% single step load application, within 2Hz deviation

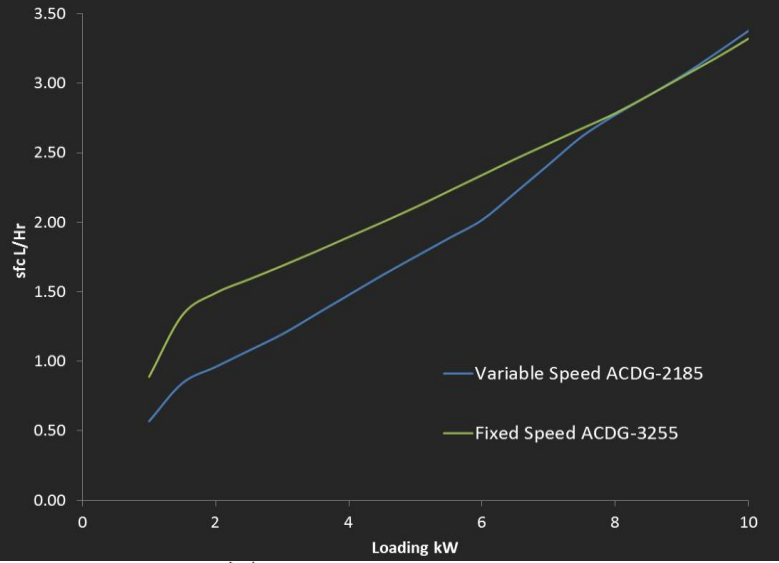


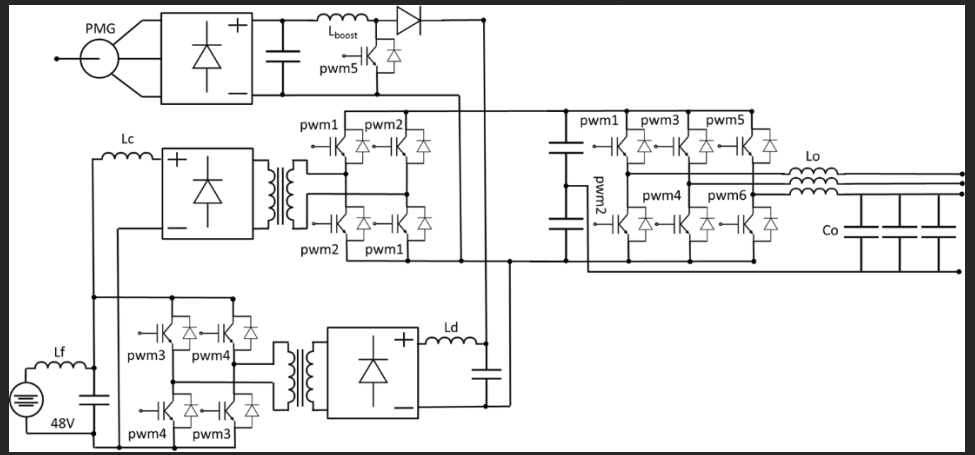
# Variable Speed Diesel

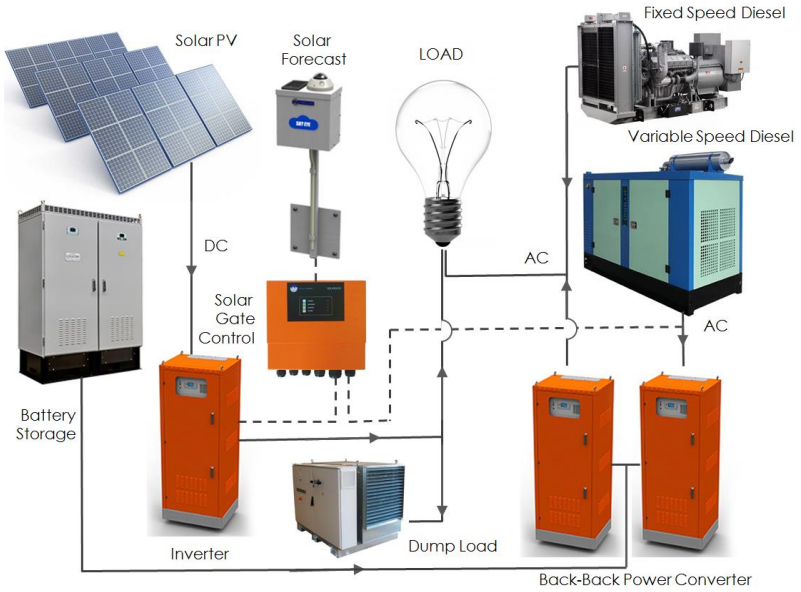
- Technology solution adopted from modern MW scale wind turbines.
- Standard components in isolation – a diesel engine coupled to a permanent magnet generator and full power converter.
- Integrated they represent an innovative new technology.
- Variable load cooling improves low load thermal inertia.
- Fuel savings exceeding 50% are observed.

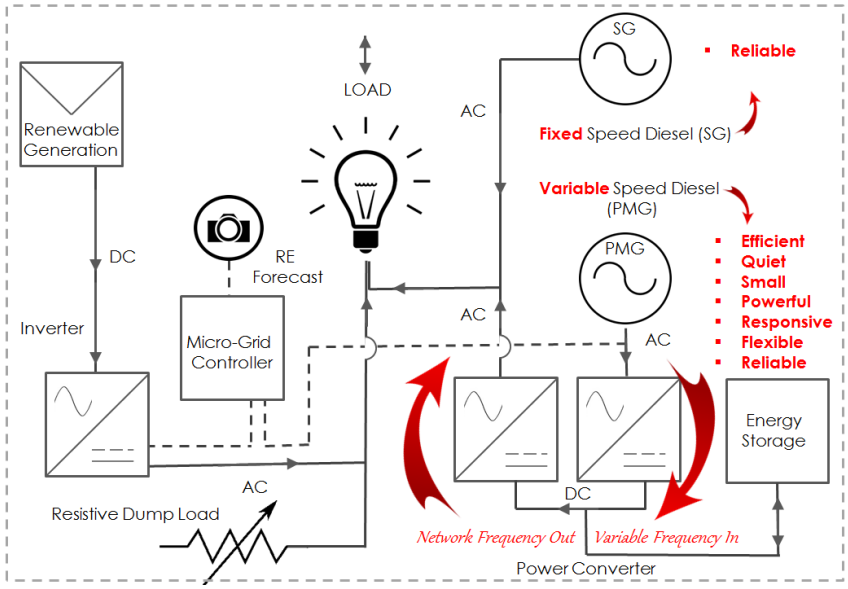
# Hobart, Tasmania

- 1 x 12kW variable speed diesel generator set
- 1 x 15 kw fixed speed diesel generator set




Solar PV
Solar Forecast
LOAD
Fixed Speed Diesel
Variable Speed Diesel
DC
AC
Solar Gate Control
AC
Battery Storage
Inverter
Dump Load
Back-Back Power Converter


Renewable Generation
LOAD
SG
Reliable
AC
Fixed Speed Diesel (SG)
Variable Speed Diesel (PMG)
DC
RE Forecast
PMG
Efficient
Quiet
Small
Powerful
Responsive
Flexible
Reliable
Inverter
Micro-Grid Controller
AC
AC
Energy Storage
AC
Resistive Dump Load
DC
Network Frequency Out
Variable Frequency In
Power Converter

THE END

# Thank you

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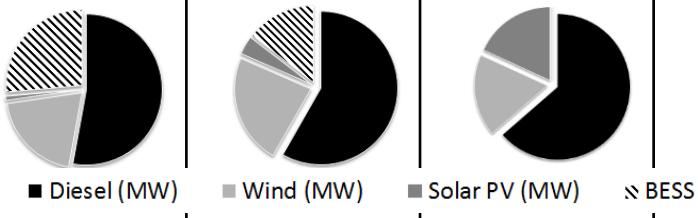
# Island Comparison

| | King Island renewable energy integration project | Flinders Island hybrid energy hub | Rottnest Island water and renewable energy nexus | Lord Howe Island Hybrid Renewable Energy System | Garden Island Microgrid Project (excludes wave energy R&D technologies) |
|---|---|---|---|---|---|
| Generation Configuration |  | | | | |
| Peak Load (MW) | 2.5 | 1.3 | 1.2 | 0.5 | |
| Average Load (MW) | 1.4 | 0.8 | 0.6 | 0.3 | |
| Annual Generation (GWh p.a.) | 12 | 6.7 | 5 | 2.1 | |
| Generation Capacity Total (MW) | 8.35 | 4.4 | 3.3 | 1.9 | 4.6 |
| | | | | | |
| Generation Capacity Renewable (MW) | 2.35 | 1.4 | 1.2 | 1 | 2 |
| Renewable Capacity (MW) WIND | 2.25 | 1.2 | 0.6 | 0.55 | 0 |
| Renewable Capacity (MW) Solar PV | 0.1 | 0.2 | 0.6 | 0.45 | 2 |
| Battery ESS Capacity (MW,MWh) | 3, 1.6 | 0.75, 0.3 | n/a | 0.4, 0.4 | 2, 0.5 |
| Flywheel System | Yes | Yes | No | No | No |
| | | | | | |
| Renewable Energy Penetration (% p.a.) | 65% | 60% | 50% | 70% | 40% |
| Development Period | 1998-2015 | 2014-2017 | 2016-2017 | current | current |
| Utility Network Connection | No | No | No | No | Yes |
| Capital Cost ($m) | 28.15 | 15.38 | 9.81 | **11.6** | **7.49** |
| **Capital Cost ($m/per MW installed)** | **11.98** | **10.99** | **8.18** | **11.6** | **3.745** |