# Right-sizing Renewables through Smart Metering Technology

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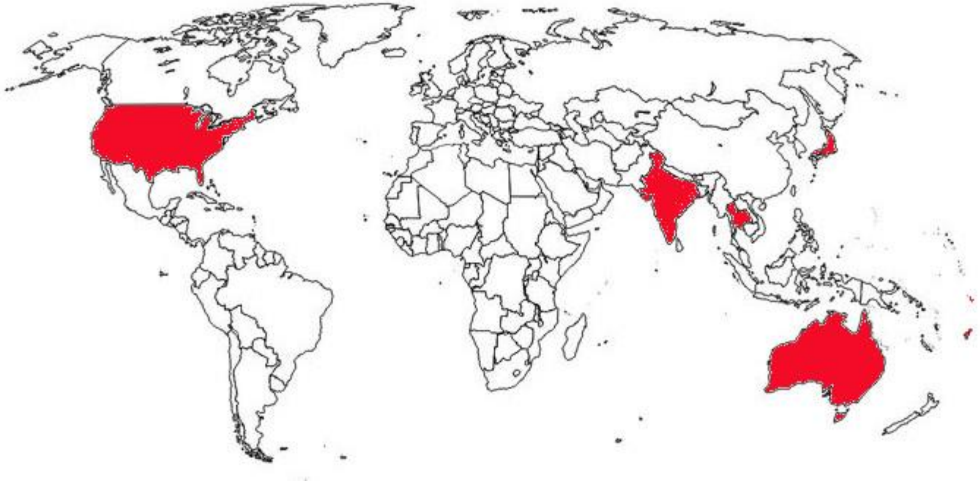
# MOVING TO A RENEWABLE ECONOMY

*Many Paths to the Same Destination*

Factors that define the transition strategy

- » The prevailing manner in which energy is used
- » The existing regulatory framework
- » How energy is traded / bought
- » The capacity limits of the Electrical Network
- » Carbon Reduction



# FINANCIAL CONSIDERATIONS

*The Which and the When of Implementation*

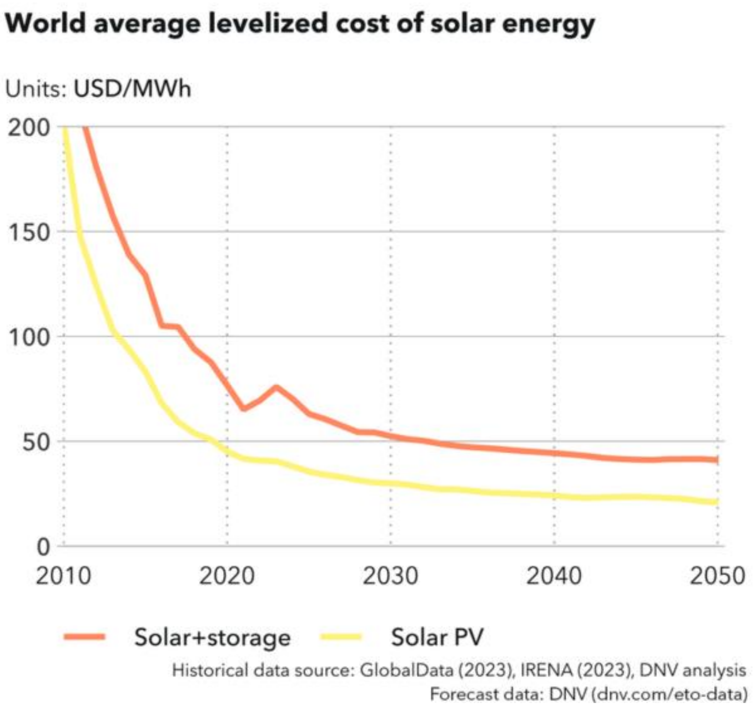
Different renewable technologies available

» Solar, Wind, Hydro, Geothermal, Biomass

» Different states of Maturity

» Cost to Implement Decreasing over time

How do you balance the need to progress against the financial benefits of deferral?



# THE GOLDILOCKS PRINCIPLE

*Balancing Generation & Storage*

Renewable generation is Intermittent and doesn’t often co-exist with the period in which energy needs to be consumed.

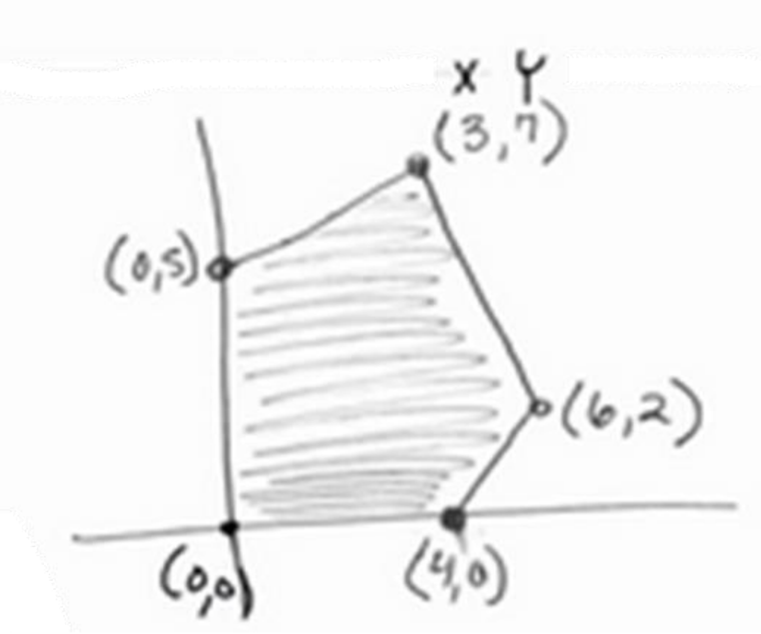
» Storage is needed to be able to transfer the Energy from the generation time period to the deficient usage periods.
» Too much generation and not enough storage means energy is spilled and lost
» Too much storage and not enough generation means that batteries aren’t charged to financial efficiency

# A FRAMEWORK FOR OPTIMIZATION

*Building a means to evaluate how to navigate to our goals*

An optimization problem:

» Minimize the cost of ownership / generate given a set of physical and operational constraints:
  - Energy Balance Constraints
  - Generation Dispatch Constraints
  - Network Capacity Constraints
  - Storage Charging Constraints




Define an equation based on costs and allowed generation. Minimize given the constraints to find the OPTIMAL mix given the costs to generate

# AN ISLAND ENVIRONMENT

*What can this framework us about our choices ?*

Looking for guidance to our investment choices.

Starting Point

- A range of renewable technologies available
- A self-contained environment
- What does “lowest cost” mean?

Formulating the problem

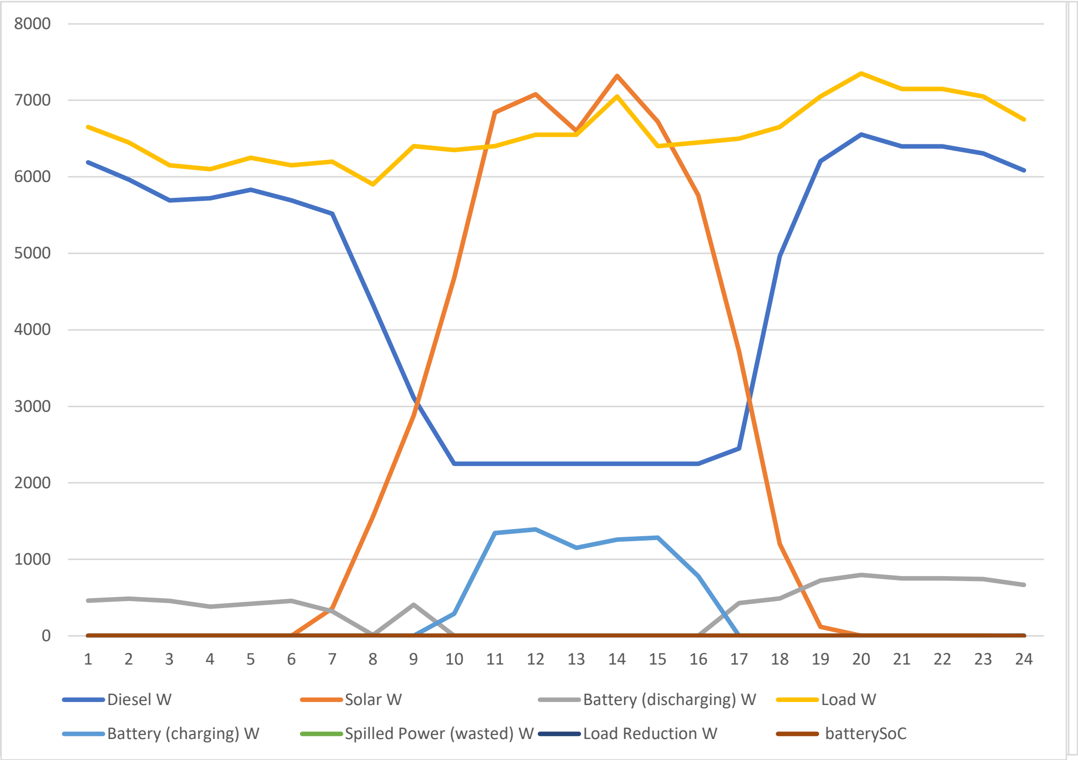
- Marshall islands publicly available data from 2012
- The corresponding weather data for the time period
- Illustrative energy costs for diesel, solar and storage

How does a typical day balance with different mixes?

# BALANCING SOLAR, BATTERY AND DIESEL

*What can we learn?*

*Find the least cost mix of grid-connected generation that satisfies aggregate demand for power subject to the operating constraints of the network and the operating constraints of the grid-connected generation units.*



# RESULTS

*Defines the most optimal solution between generation sources*

We solved for the most cost optimal solution.

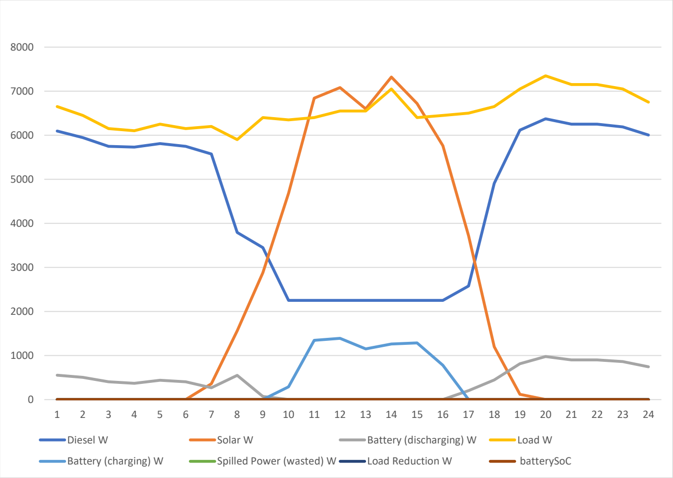
» Varying the mix of sources illustrates bottlenecks

» Can include multiple sources

» The need to balance Solar with Battery

» Effect of Rate of Charging / Discharging

» The importance of ensuring a full charge / discharge cycle




Balanced generation to demand – not balancing generation and demand.

» By manipulating the demand profile we could lower demand at times when it is expensive to serve.

# MODELLING LOAD CONTROL

*Manipulating the Demand Profile in the same means as Battery Storage does*

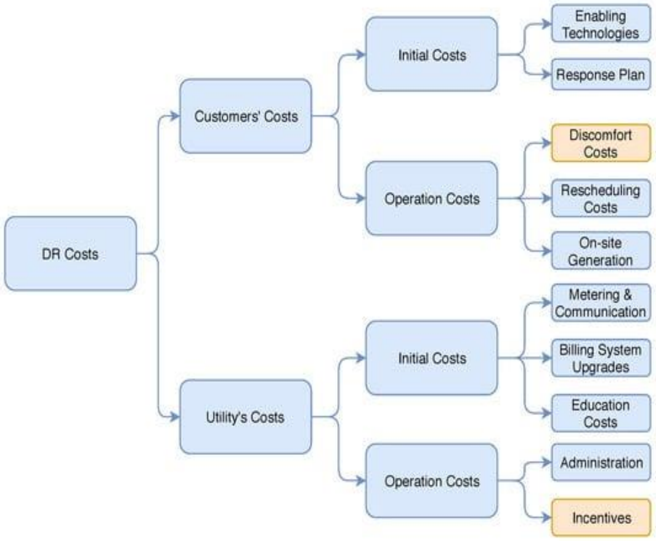
» Batteries & Peak Shifting Load Control

» How would Battery Storage and Load Control Interact

- Refine the model to account for the cost of load control

» Load Control – the Options

- Passive Load Control (Load Limiting, ToU tariffs)
- Active Load Control (Load Control, CPP, Interruptible Services)



# ATTRIBUTING A COST TO LOAD CONTROL

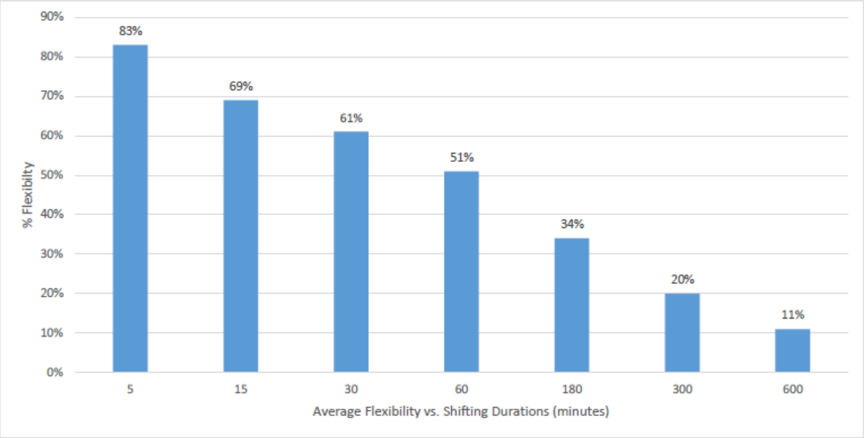
*Determining the cost*

To be effective a load control program needs to match the compensation offered to Customers against their willingness (and ability) to alter their consumption pattern

- Understanding of what loads are being used at each time period – and how “Dependent” the user is.

Case Study:

- Most users have some ability to shift usage
- Further the shift required the less participate
- Greater reward creates flexibility
- Limits to people’s capability

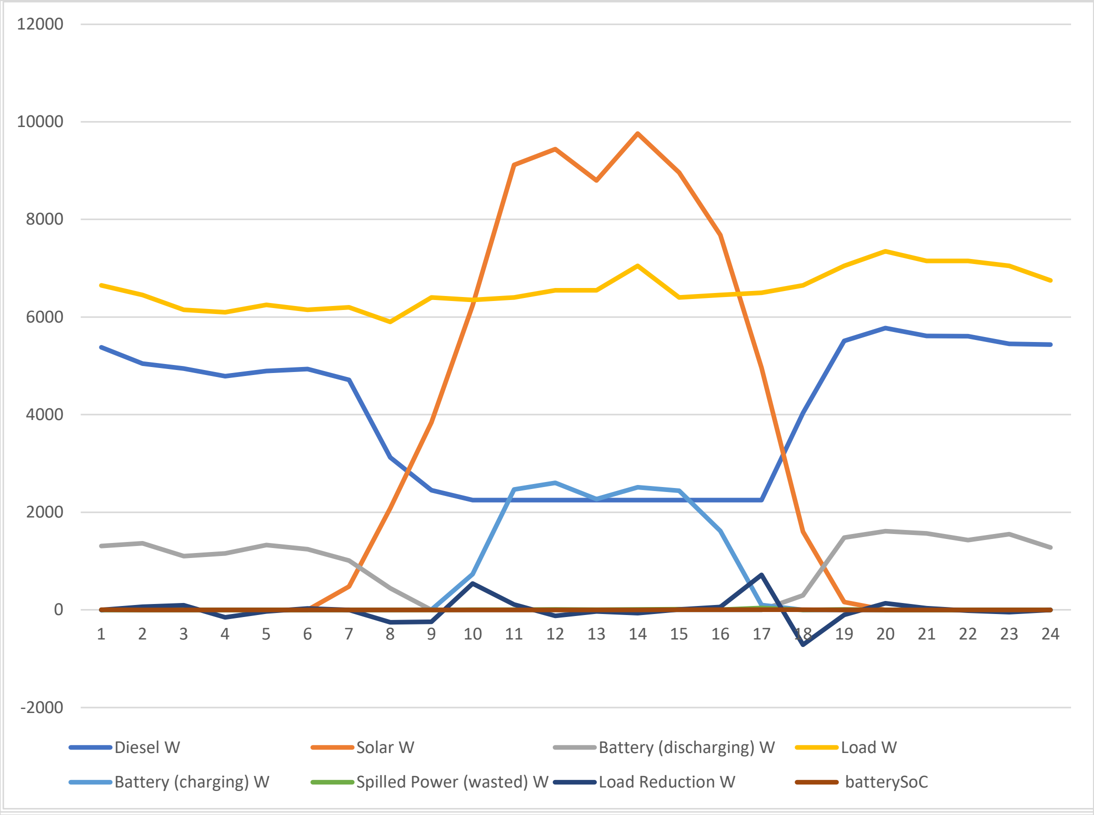



https://www.mdpi.com/1996-1073/12/9/1617#B33-energies-12-01617

# BALANCING WITH PEAK SHIFTING LOAD CONTROL

*How does this compare ?*

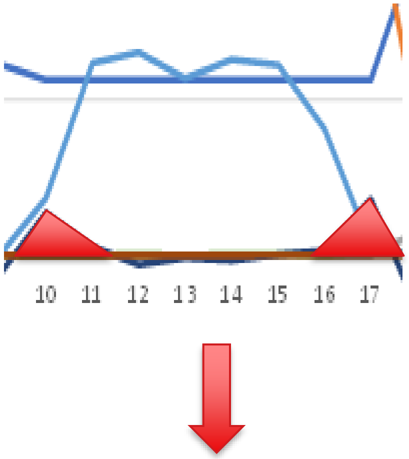
*Find the least cost mix of (a) grid-connected generation and BESS and (b) consumer-side generation and load control that satisfies aggregate demand for power subject to the operating constraints of network, the operating constraints of the grid-generation and BESS units, and the operating constraints of consumer side load control.*



# THE LESSONS LEARNT

*Adding Load Control alongside Battery Deployment complements transition*

- As long as there is a higher cost fuel, load control has an effect
- Battery Charging takes precedence over load control
- Battery charge rate is increasingly important for two to coexist.
- Even after including the cost of compensation to Consumers the overall cost to include load control was lower than with battery usage alone




*Cost to move X Magnitude*

The compensation strategy defines the response profiles

Informs on the budget available for load control program

# ADDING COMPATIBLE LOAD CONTROL

*Taking advantage of another Lever*

#1 – Understanding Consumption

» Profiling Consumers to Groups

» Identifying Load Patterns & “Dependency”

» Determining extent of potential

#2 – Control & Implementation

» Interval Billing for ToU

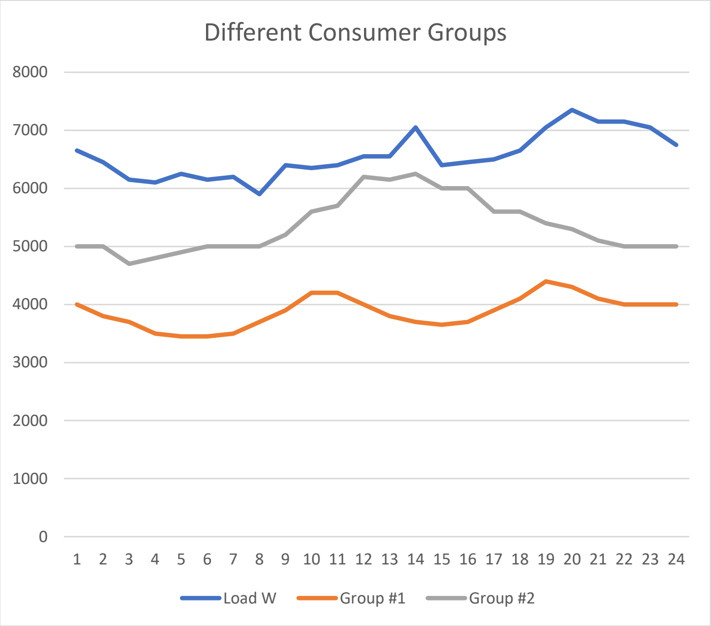
» Load Limiting

» Emergency Connect / Disconnect

#3 – Reward

» Determining Participation & Rate Calculation

» Demand Response / CPP

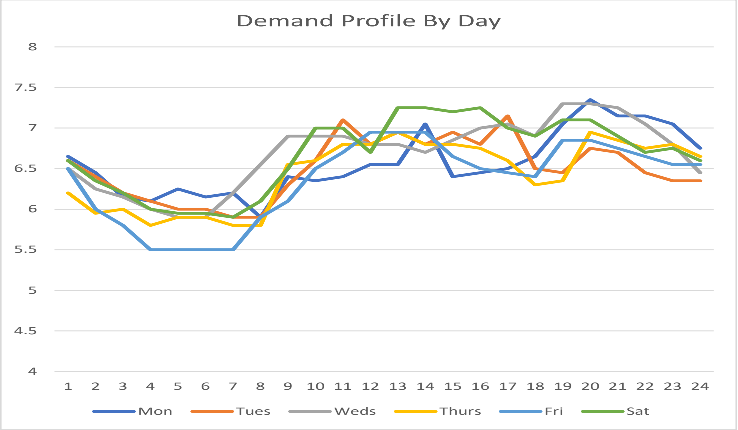


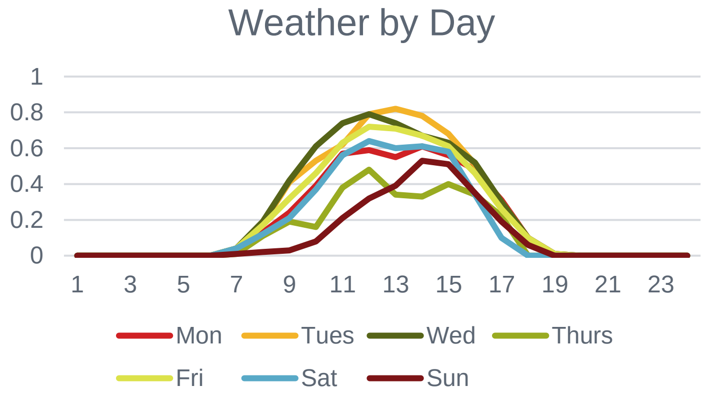
# NATURAL VARIABILITY

» Peak shifting provides a comparable effect to a storage capacity
» Saves battery storage for out of hours periods

Maximising Battery use essential to efficiency

» Inherent variability in both weather & demand profile by day
» ToU programs can be fitted to day types
» Other forms of Load Control can be used to protect battery ability to charge



# CONCLUSION

*Modelling & Load Control Options*

» Developed a framework for modelling optimization of renewable integration

» Like storage, manipulating the load profile matches demand to generation

» To take advantage, must understand the amount of load that is moveable.

» Smart metering provides that alongside traditional business cases for revenue collection

» Different usage to CER monitors but playing the same role of managing renewable integration

# THANK YOU