Myanmar Efficient Power Solutions

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ooredoo

IFC International Finance Corporation
World Bank Group

GSMA

Green Power for Mobile

In partnership with Netherlands

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Ooredoo Network Summary and Objectives







- 3G only network operating initially in 900MHz and 2100 MHz
- Extensive use of 4 Way Rx diversity to improve site capacity and coverage
- Extensive use of outdoor solutions
- Rollout approx 4500 sites by end 2018
- Utilize smart controller at every site to maximize site operational efficiiency
- Provide a world class network for the people of Myanmar



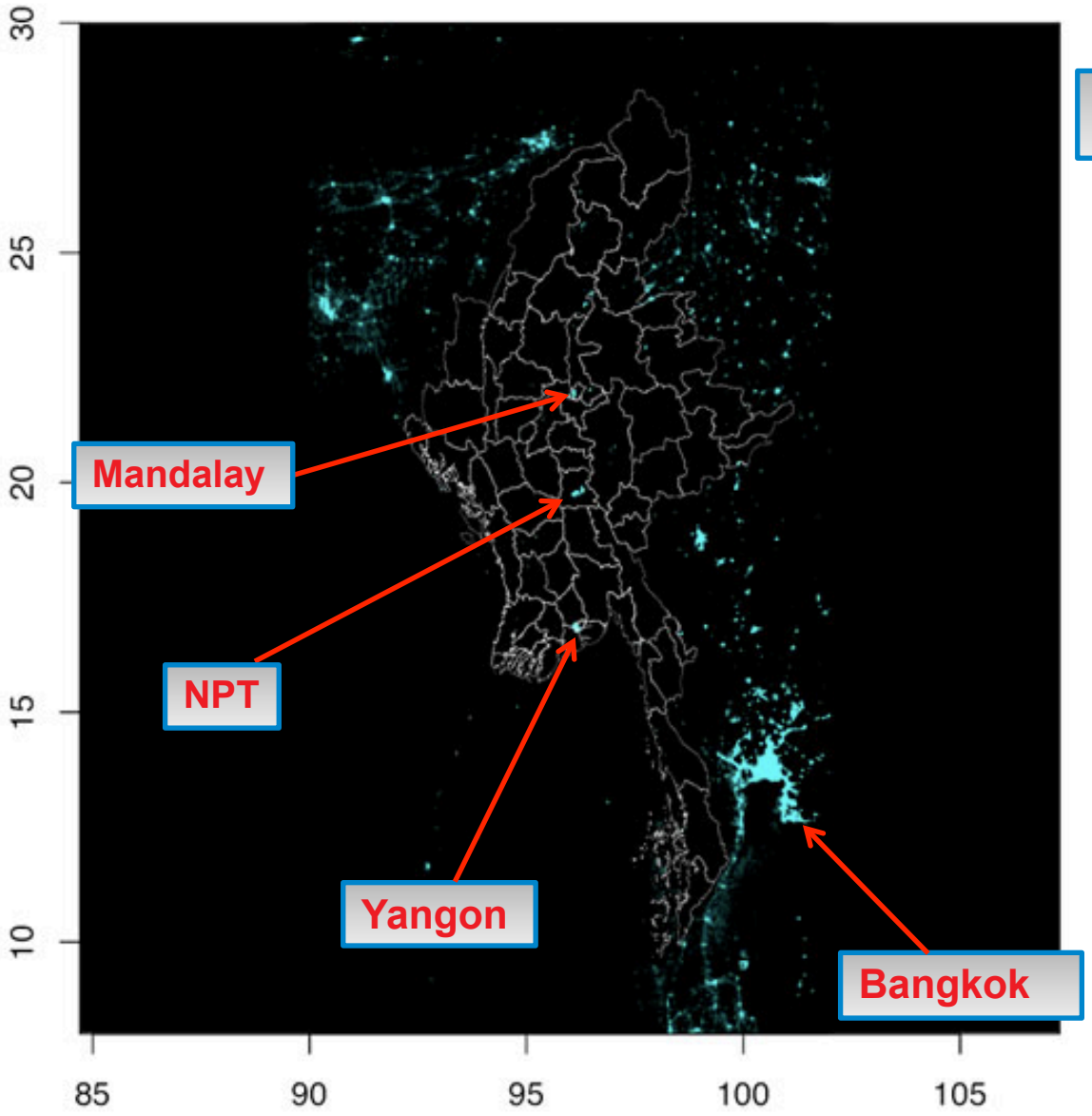








The Myanmar Power Challenge



Very Limited Grid Availability

Rollout Plans – Site Configurations - Objectives

Highlights

- ❑ Power for 1st 1000 sites to be built by Ooredoo under CAPEX model
- ❑ Model for building additional sites still under evaluation (Capex or Opex)
- ❑ Majority of sites within first 1000 will be grid sites – assume poor grid
- ❑ Majority of grid sites will be rooftop sites – difficult to locate generator

4 different categories of sites based on RAN and Tx configuration

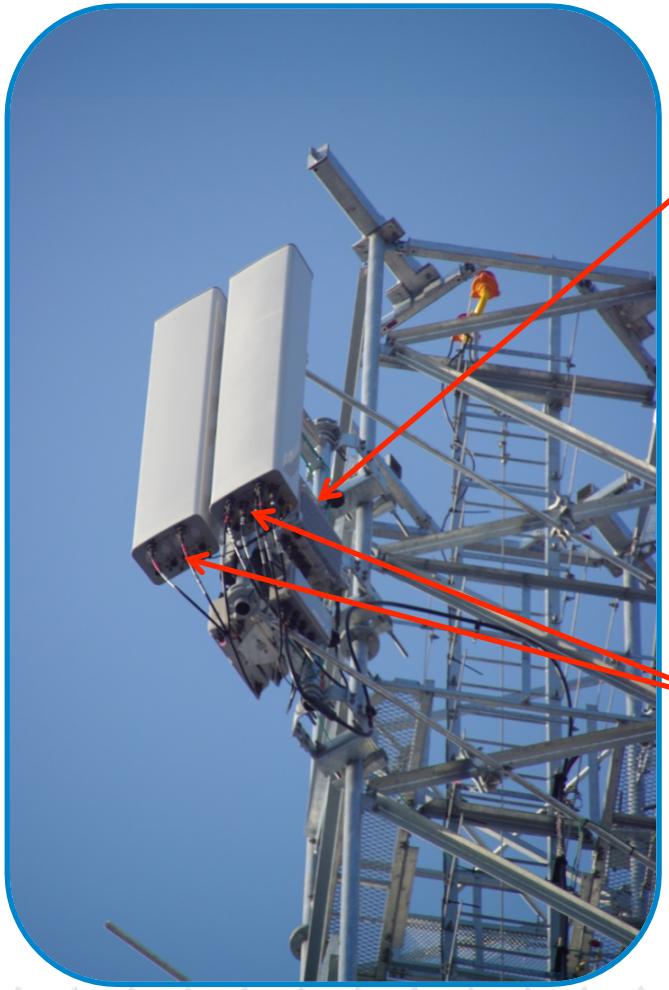
	Configuration		Power Consumption (Watts)		Forecasted Configuration + Grid (Up to 2018)	
	RAN Configuration	Tx Config	Maximum	Average	Grid	Off Grid
1	Full Configuration	Large	3900	2700	450	225
2	Full Configuration	Small	3600	2400	450	450
3	Reduced Configuration	Large	2400	1800	500	900
4	Reduced Configuration	Small	2100	1500	500	1025
					1900	*2600*

These figures used for dimensioning but actual figures are expected to be lower

Objectives

- ❑ Use innovative technology to minimize network power consumption
- ❑ Minimize generator runtime
- ❑ Maximize use of renewable energy (Solar)
- ❑ Share infrastructure to maximize use efficiency
- ❑ Monitor site performance to ensure site is always running at maximum efficiency

Minimize Total Network Power Consumption Before Deciding on Solutions



Minimize RF Losses

Place RRU's behind the antenna to provide minimum RF losses and maximize system margins

Maximize Per Site Coverage

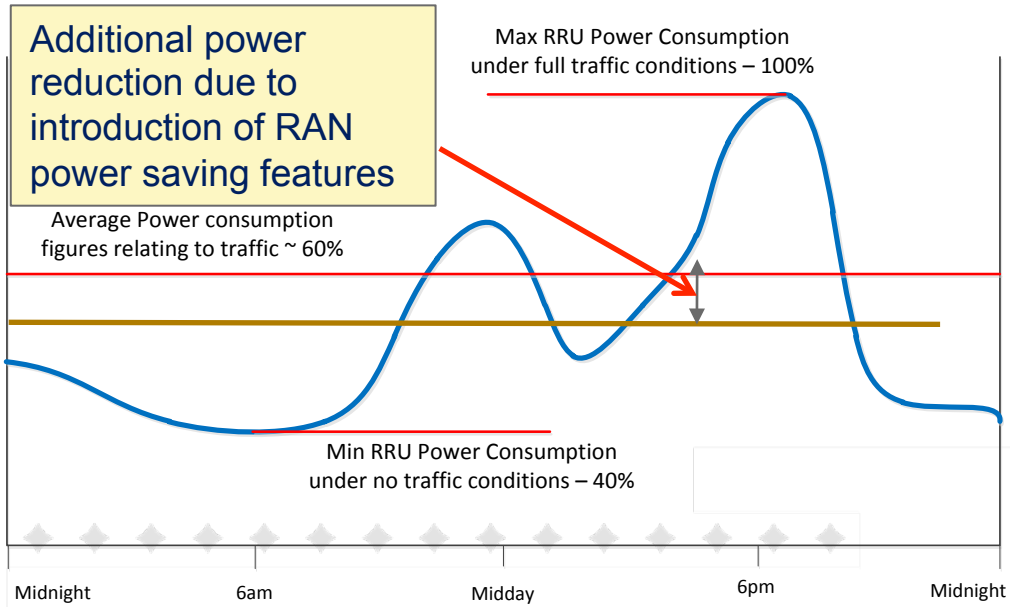
- Use of 4 way Rx diversity with dual antenna configuration to further enhance site coverage
- Can generate same coverage utilizing 30% less sites than traditional solutions
- Each site is around 20% higher power consumption on average than traditional solutions thus resulting in 10% network wide power reduction

Network Energy Minimization



Minimize Cooling Requirements

- Extensive Use of Outdoor Cabinets to Minimize Power Consumption
- Cooling – predominately DC Fans
- DC air conditioners for selected configurations



Minimize RRU Power Consumption

- RRU power consumption is related to traffic volumes.
- Historical average RRU consumption is around 60% of RRU peak consumption
- Additional power reductions can be achieved by employing innovative power reduction features provided by RAN Vendors

Potential Sources of Energy

- **Grid**
  - Select grid wherever possible – even very poor grid
- **Diesel Generators**
  - Will form the basis of an alternative energy source at the majority of sites.
  - The design and operational challenge is to minimize the generator runtimes
- **Solar**
  - Aim is to maximize solar use where possible either as hybrid or pure solar
- **Wind**
  - Not a viable solution for large scale greenfield rollout in Myanmar. Business case difficult to determine.
- **Fuel Cells**
  - Considered as a possible energy source on poor grid rooftops.

Energy Storage

- **Selection of more robust energy storage can minimize generator run time at poor grid sites**
  - Lithium, Sodium and Zinc Air batteries are viable technical solutions resistant to temperature, depth of discharge and partial state of charge operation.

Poor Grid Sites

Ooredoo's Strategy

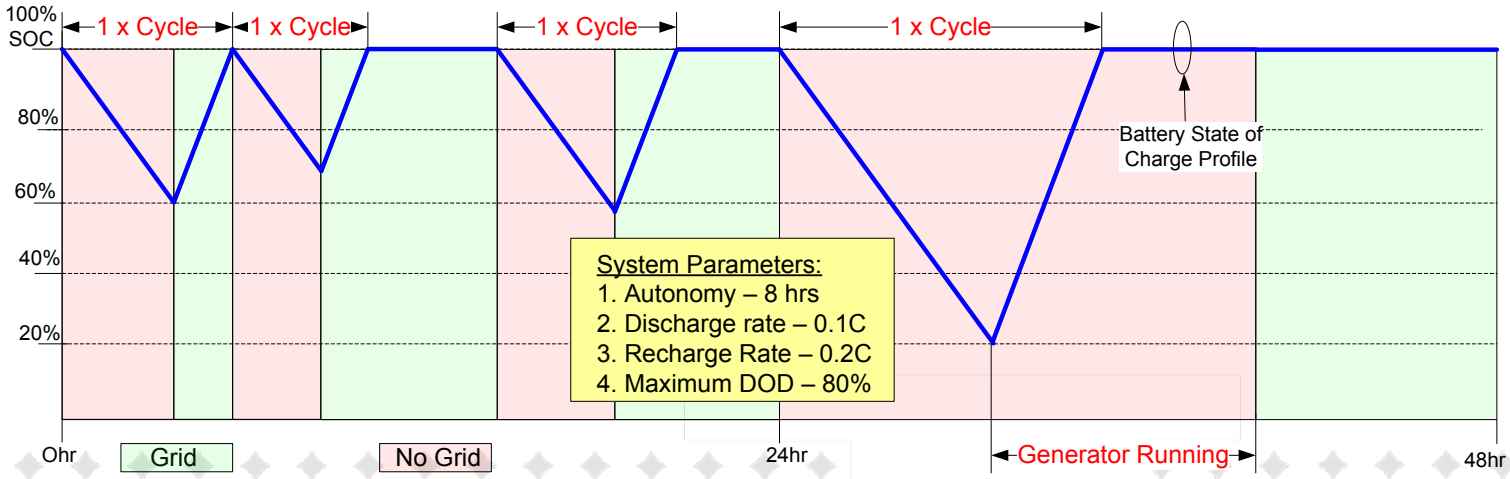
- Continually measure the quality of the grid by utilizing smater controller or Remote Infrastructure Management (RIM) devices.
- At sites of high importance (and typically high load), a generator must be installed as a backup.
- At sites of lower importance, do not install a generator initially, but monitor grid performance and install generator if grid quality is very poor. Utilize larger banks of PSOC resistant batteries at these sites to cater for longer outages.
- Assume all grid sites have poor grid

Key Point

Resist the temptation to install generator at all poor grid sites initially

Poor Grid Site Operation

- Operate all grid sites in a CDC mode. Use the batteries for a period of time to cater for the majority of outages before turning on the generator.



Poor Grid – Typical Charge Discharge Profile

Rooftop Sites

Ooredoo's Strategy + Observations

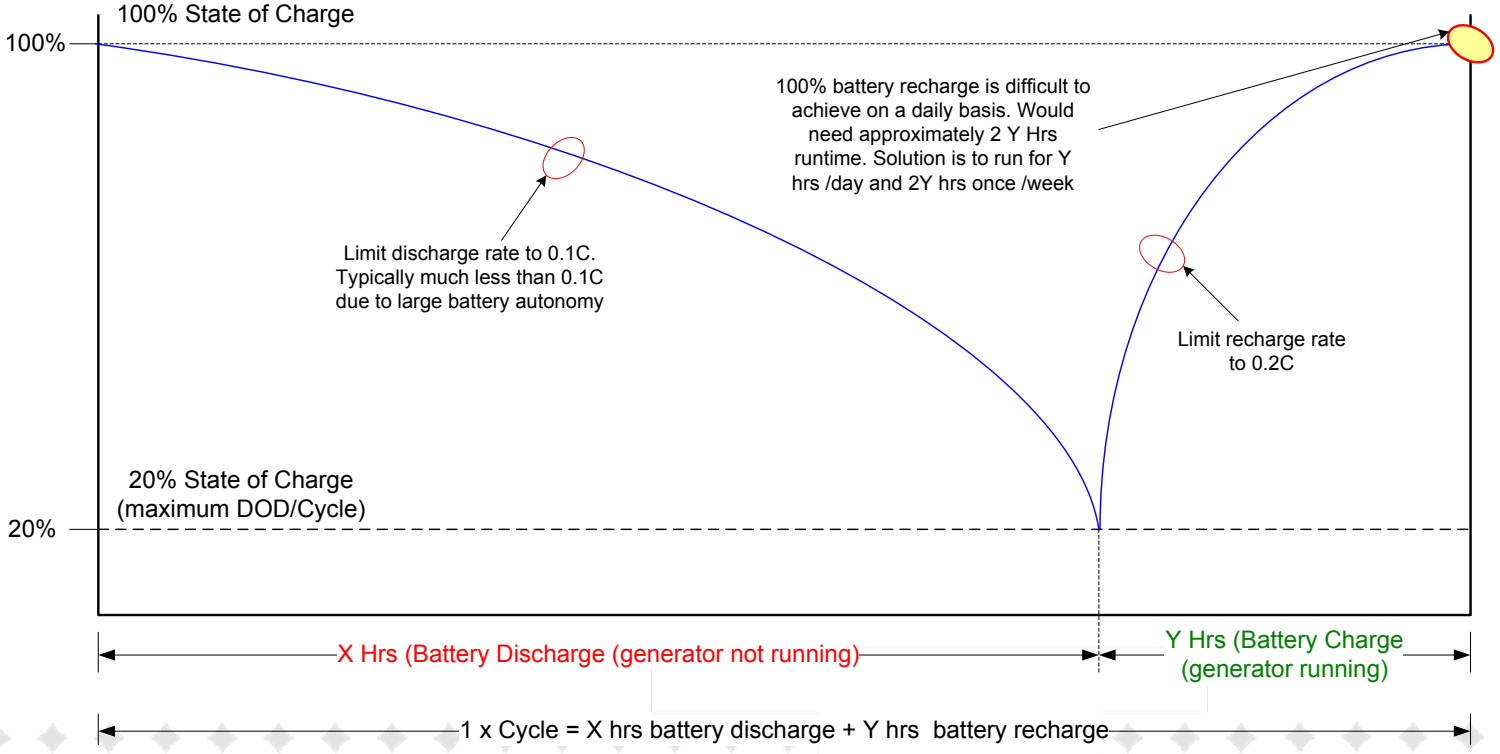
- Utilize rooftop sites where possible to minimize construction costs.
- Rooftop sites will have grid connected
- Grid quality at rooftop sites will generally be better than semi urban sites.
- If building has backup generator, try to tap into this generator rather than employ own generator. Regulations may not allow this.
- If alternative energy source is required, solar is typically not viable so choices are genset or fuel cell.
- Fuel cell cell has advantages of weight and noise. Need to investigate reliable fuel sources.
- If genset is required for rooftop – challenges with respect to placement and fuelling. Also noise.



Try to avoid proliferation of gensets installed in the streets

Main Technology Choices for Offgrid Sites

- **Charge Discharge (CDC)**
  - The predominant choice world wide for offgrid sites due to lower initial Capex and flexibility
  - Generator run time typically 8-10 hrs per day



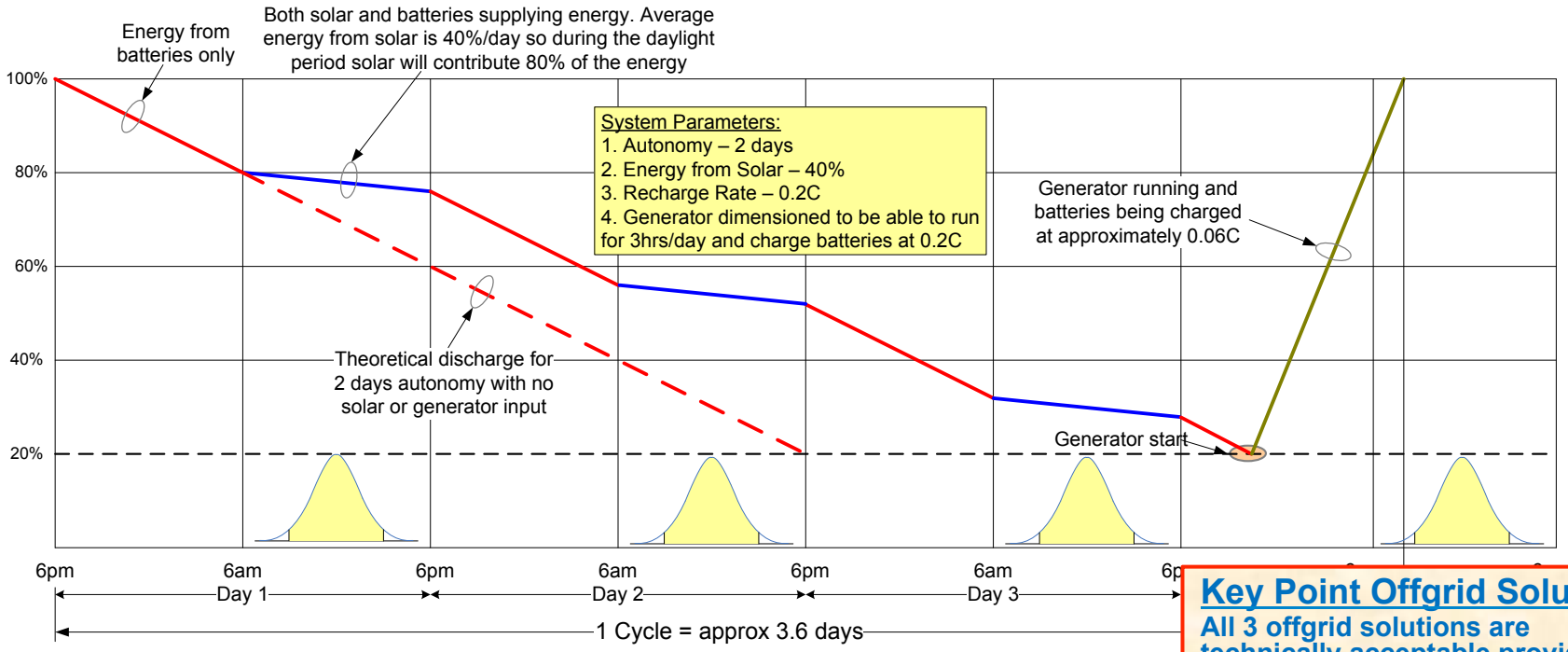
Typical Cycle Solution – Charge/Discharge Arrangement

Technology Choices – Off Grid Sites

Key Points for Solar

Requires larger site size which could limit site choices.
May be additional site rental compared to other solutions.

- **Hybrid Diesel Solar**
  - Technically viable solution
  - Provides for very low generator run time (typically 3-4 hrs per day)
  - Becoming more viable with lower solar panel prices



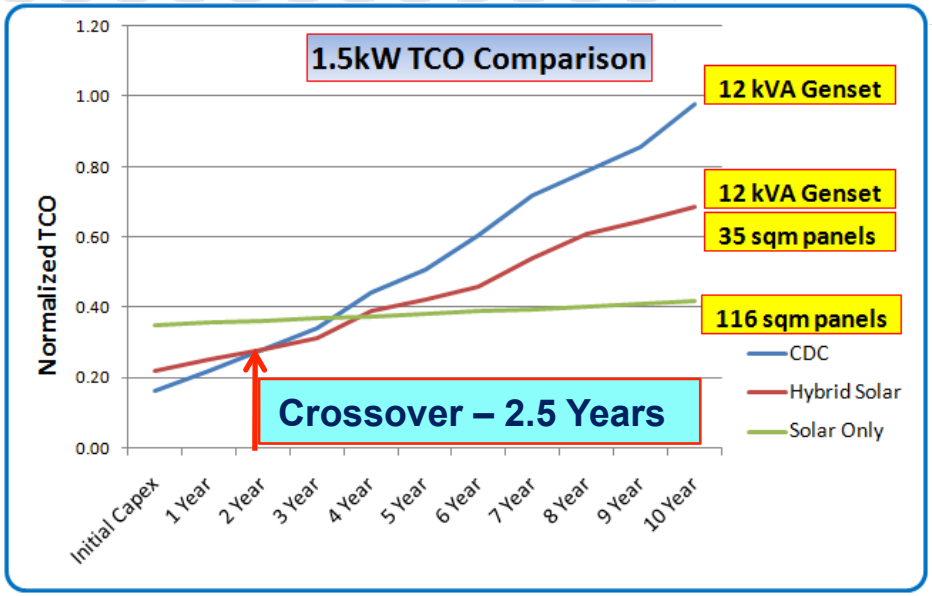
Typical Hybrid Solar Charge Discharge Cycle

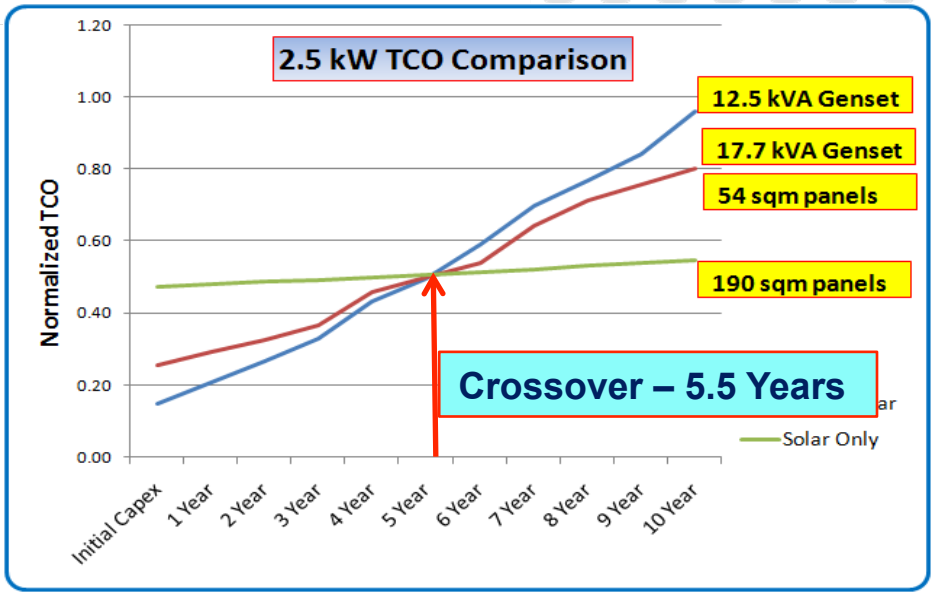
Key Point Offgrid Solutions

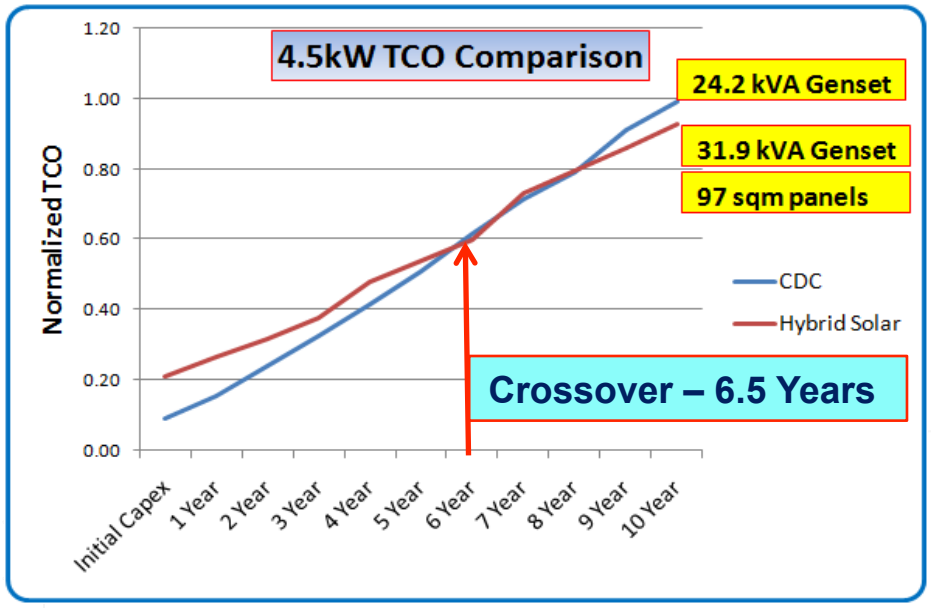
All 3 offgrid solutions are technically acceptable provided designed and operated correctly. The choice is purely a business case choice

- **Solar Only**
  - Typically only used for very remote, less important sites with low power consumption

TCO Comparisons







Key Points

- The CDC/Hybrid solar crossover point increases with load
- The technology choice decision is predominately related to financial considerations particularly the availability of appropriate funding
- The graphs assume no additional land rental for solar but some pentaly may apply for large solar arrays.

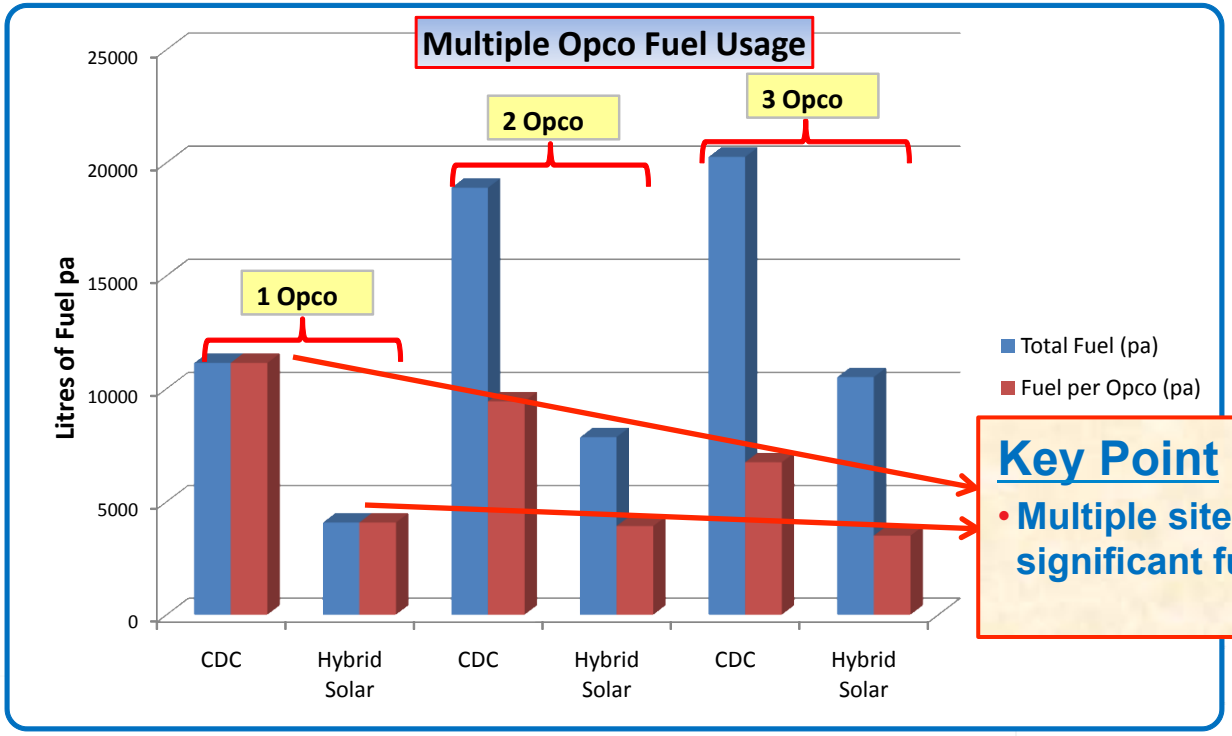
Some TCO Metrics

- **The following main metrics have been used in TCO Calculations**
  - **Fuel Price**. $1.30 per litre/delivered
  - **Solar Panels + Array**
    - Max panel power – 300 Watts
    - Panel Efficiency - 17%
    - Price per peak Watt - $.70
    - Solar array windspeed rating – average 160km/hr
    - Hybrid solar designed energy mix. 60% genset/40% solar
  - **Batteries.**
    - Industry standard OPzV patteries – 2V cells
    - Maximum battery DOD – 70%
  - **Generators.**
    - 70dBA Sound Pressure Level at 1m
    - 1000 hrs service interval
  - **Solar Battery Autonomy.**
    - 1 day for Hybrid sites
    - 2 days for solar only sites (low priority).
  - **Installation and service pricing. –** Related to existing Myanmar contracts

Power Sharing

Assume 3 potential users each with 1.5kw load

	Power Sharing Comparison (Each Opco 1.5kW)					
	1 Opco		2 Opco		3 Opco	
	CDC	Hybrid Solar	CDC	Hybrid Solar	CDC	Hybrid Solar
Genset Size	12 KVA	12 KVA	22 KVA	21.3	24.2 KVA	31.9
Solar Array Size		35 sqm		66 sqm		97 sqm
Genset Run Time	9.7	3.8	9.7	4.4	9.7	4.2
Litres/Annum	11150	4088	18898	7864	20264	10523
Litres/Annum/Opco	**11150**	**4088**	**9449**	**3932**	**6755**	**3508**
% Reduction/ v's 1 Opco			15%	4%	39%	14%



Key Point

- **Multiple site uses results in significant fuel reductions per user**

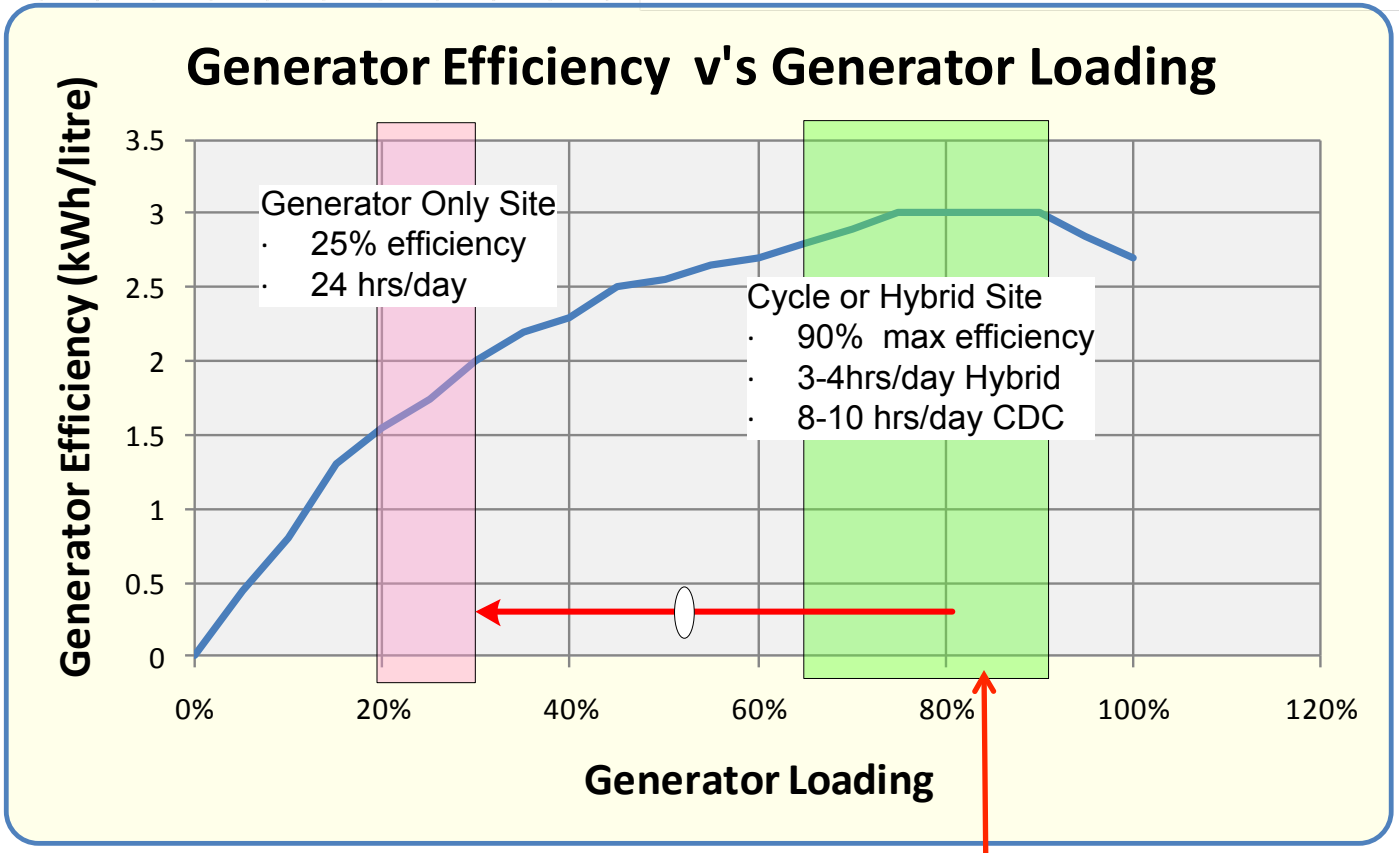
The Role of the Controller

- **The Controller has the following main Roles**
  - **Monitor Grid Performance**. In a network such as Myanmar where the grid is poor, monitoring the grid is important to provide input to the Opco in order to change the design or method of operation of a site.
  - **Ensure correct site operation**. This is mainly to operate CDC and Hybrid Solar in the most efficient manner. This is impossible without a controller.
    - Ensure generator runs at peak efficiency thus minimizing fuel usage
    - Limit generator runtime particularly on poor grid sites
    - Ensure cabinet cooling is working efficiently. Report on clogged filters.
  - **Monitor fuel usage.** Report if usage is outside normal paramaters
    - Fuel theft
    - Generator running inefficiently
    - Generator running excessively
  - **Monitor Solar Performance**
    - Parts of solar array not operating correctly
    - Dirty solar panels
  - **Verify Performance of ESCO**

Key Points

- **It is impossible to operate power systems at peak efficiency without a smart controller**
- **Monitoring site performance is fundamental to operational efficiency**

Generator Efficiency



Key Points

- **The controllers role is to ensure that the generator operates in this peak efficiency area as much as possible.**
- **The key savings in fuel usage to to both minimize generator run time and operate at maximum efficiency**

Conclusions

- Investigate innovative ways of minimizing network power consumption
- Always utilize the grid where possible – no matter how bad.
- Utilize a smart controller in your network to enable you to make informed decisions regarding power solution choice and well as ensuring power solutions are operating at peak efficiency.
- It is essential to install a secondary power source at important sites to provide network resiliance. This would typically be a generator due to high site load.
- Resist the temptation to install a generator at all poor grid site. Monitor the site and install more resiliant storage solutions.
- Operate all grid sites with generator in CDC mode
- Power sharing should significantly reduce fuel usage per user.
- Ensure alignment between technical and finance to ensure best TCO solution is adopted – not simply cheapest Capex solution.

Some Points for Clarification

- **Assistance in streamlinging the process and time for grid connection is urgently sought. Current process very cumbersome.**
  - **The current outcome is that many hundreds of sites will operate with temporary generators for a number of months. Environment and noise pollution.**
- **What licence requirements does an ESCO need to be able to sell power to 3rd party users?**
- **What are the rules relating to connection to building standby generators.**
- **What are the TowerCo's view regarding construction of larger sites with correct orientation to accommodate solar.**
- **If the ESCO is not a TowerCo, does the ESCO need to have a separate MLA with the TowerCo or can this be absorbed under the existing Opco MLA's. Significant additional site rental for the ESCO will severly affect the business case for power sharing.**

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