Wires vs. Panels: Is Traditional Electrification a Poor Choice For Developing Countries?

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strategy & economic consulting

Introduction

- There are many countries around the world that have low rates of electrification.
  - For example: Africa, Papua New Guinea, East Timor, Laos and Myanmar
- In this presentation we pose the question: “Should these countries be trying to build grids, build large power stations and send electricity down ever smaller wires to consumers, or is this traditional view of an electricity supply industry a poor choice for developing countries?”
- Since we are in Asia, I will be using Myanmar as an example

The first, obvious, question is “Is it necessary to have electricity at all”?

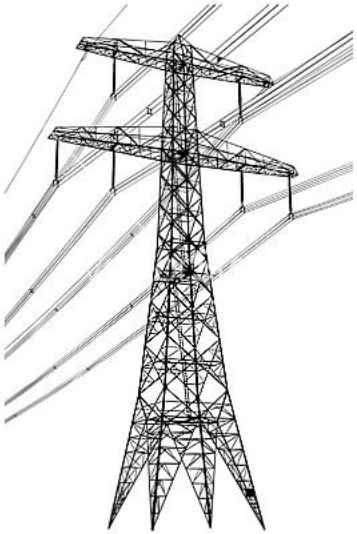
- The answer to this is clearly “YES”.
- A world bank report in 2008 highlighted that electrification brings many benefits, and people are often very willing to pay the associated costs:

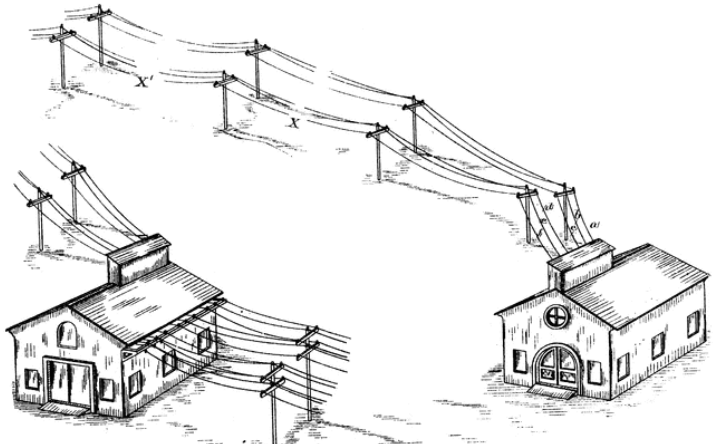
> *Lighting alone brings benefits such as increased study time and improved study environment for school children, extended hours for small businesses, and greater security.*
>
> *But electrification brings more than light. Its second most common use is for television, which brings both entertainment and information. The people who live in rural areas greatly appreciate these benefits and are willing to pay for them at levels more than sufficient to cover the costs.*

Source: The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits, 2008, World Bank

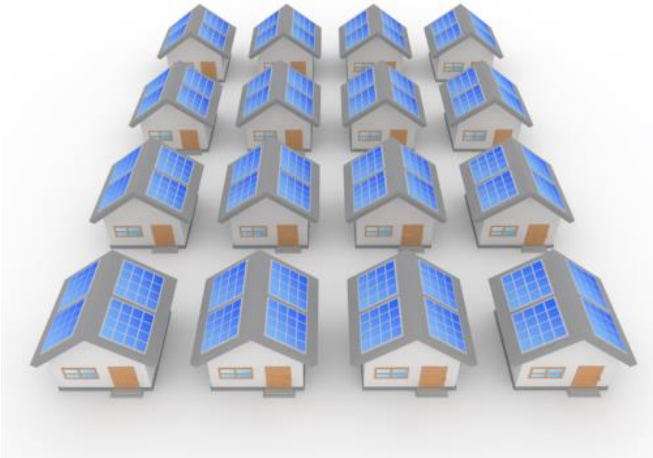
So – what should be implemented?

- This?





- Or this?



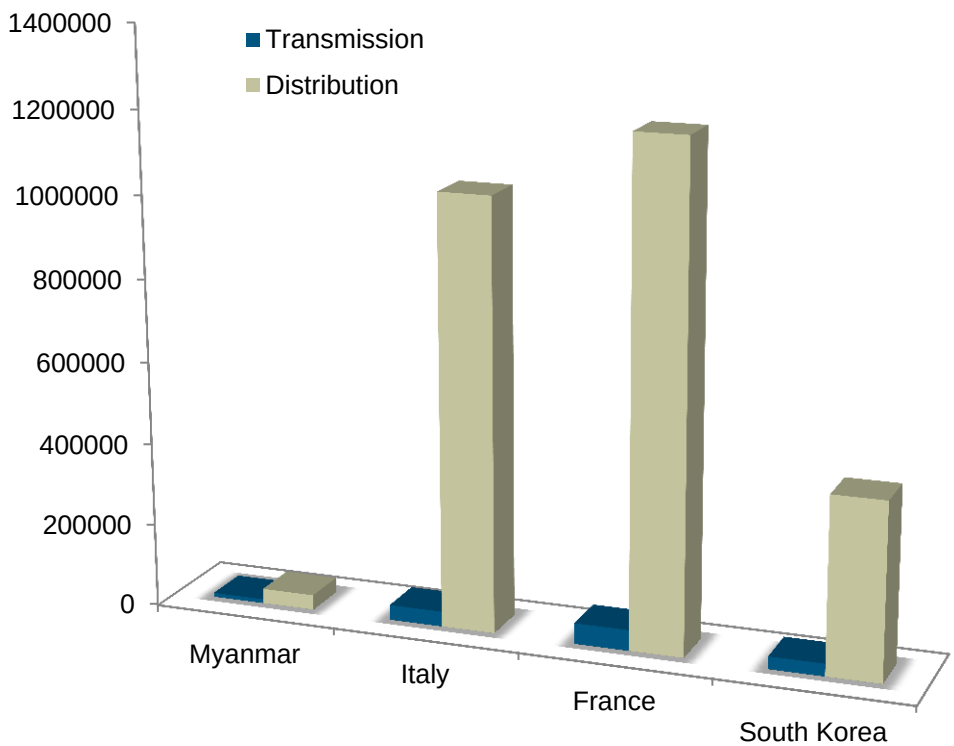
Just because everyone else has a grid, does that mean Myanmar should too?

- Most countries aim for a “traditional” grid system
  - Large (100MW and up) power stations located close to the fuel
  - A backbone of transmission lines linking the power stations with the major centres of demand
  - A network of smaller distribution lines connecting each customer with the transmission system
- However, these systems were installed at a time when:
  - There were very large economies of scale associated with generation
  - There were no small power stations
  - There were no economic renewable options, such as wind, solar, geothermal or micro-hydro
  - Reciprocating engines were dirty, unreliable and inefficient
  - Battery storage did not exist

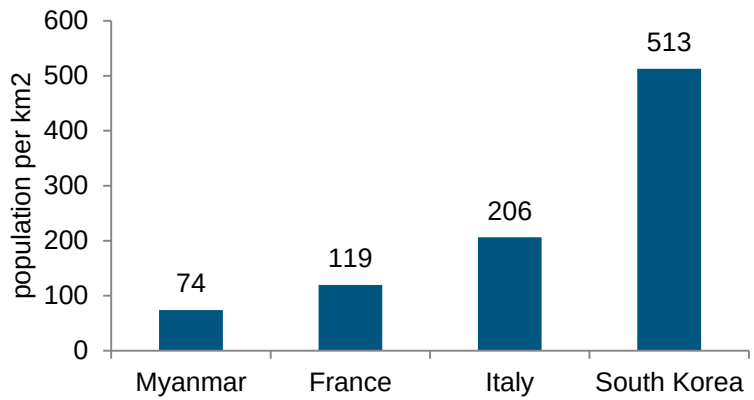
Assuming a traditional grid is the only answer ignores the changes in technology since the 1940’s

How does Myanmar compare internationally? Or, what is the size of the gap?

- In terms of population, with approx. 55m people Myanmar is squeezed between Italy (61.5million) and South Korea (49m) on an international scale
- In terms of land area, with 677 thousand sq km, Myanmar is a little larger than France (643 thousand sq km).

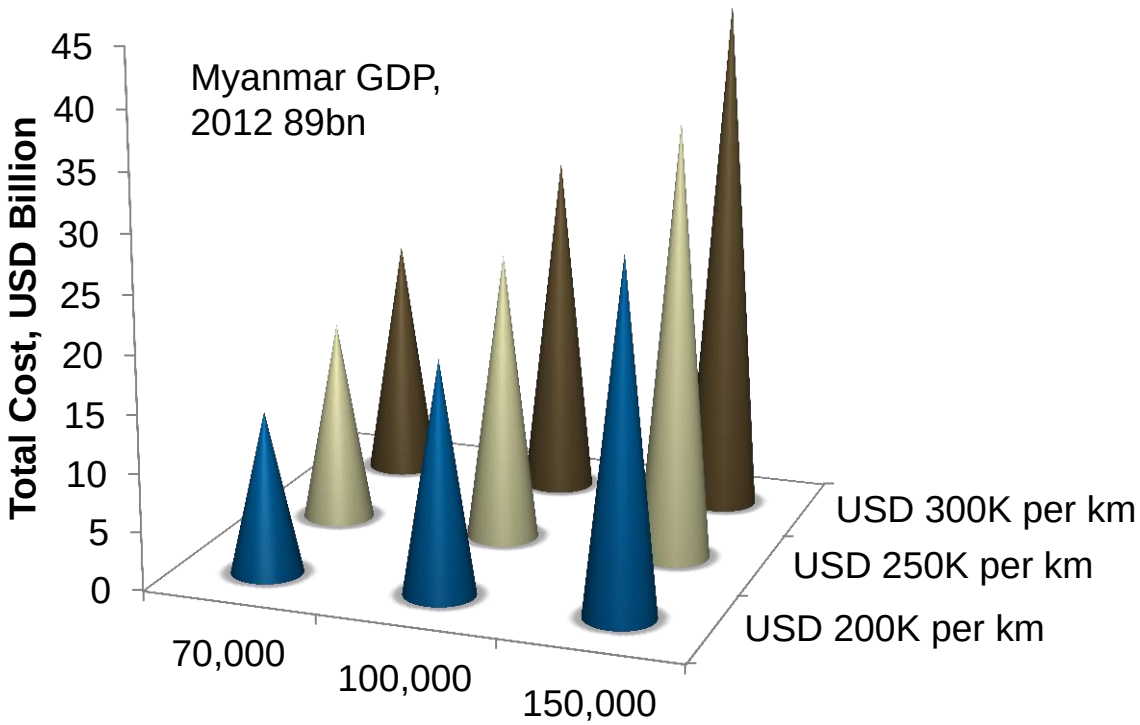


- When it comes to transmission and distribution lines, there is no comparison
- Myanmar's low population density also means that a fully-built T+D system would need to be even bigger than ones in France, Italy or South Korea



The cost of a transmission grid alone could be half of annual GDP

- Looking at the statistics of Italy, France and South Korea, we can see that Myanmar needs perhaps 2,000,000 to 3,000,000 km of additional distribution lines and around 70,000 to 150,000km of transmission



- The costs of transmission and distribution lines vary wildly around the world, however estimates in the area of USD 250K per km are not unusual
- This is for overhead wires, not underground, which would cost even more
- Maintenance is also not trivial – estimated to be in the order of USD1000 per circuit-km pa

Developing a traditional system will require a huge injection of capital

- A “traditional” system may require the following:

	Requirements		Costs (USD billion)	
	Low	High	Low	High
Transmission	70,000km	150,000km	18	38
Distribution	2 million km	3 million km	50	75
Generation	40 GW	60GW	52	78
Total			120	191

- Assumptions:
  - Transmission lines cost USD 250,000 per km
  - Distribution lines cost USD 25,000 per km
  - Generation stations cost USD 1.3 million per MW
  - **No fuel is included**
  - **No operating costs are included**

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THESE ARE HUGE NUMBERS!

Compare this to a **hypothetical** solar mini-grid system

- Assumptions:
  - Solar panels at USD 0.7/W
  - Inverter and balance of system, circa USD 0.5/W
  - Battery approx USD 3/W
  - Total cost, approximately USD 4.2 million per MW
- Assuming Myanmar needs 40,000MW of generation in total, the total cost of this would be USD 168 billion

Still a large number – but comparable to the “traditional grid”

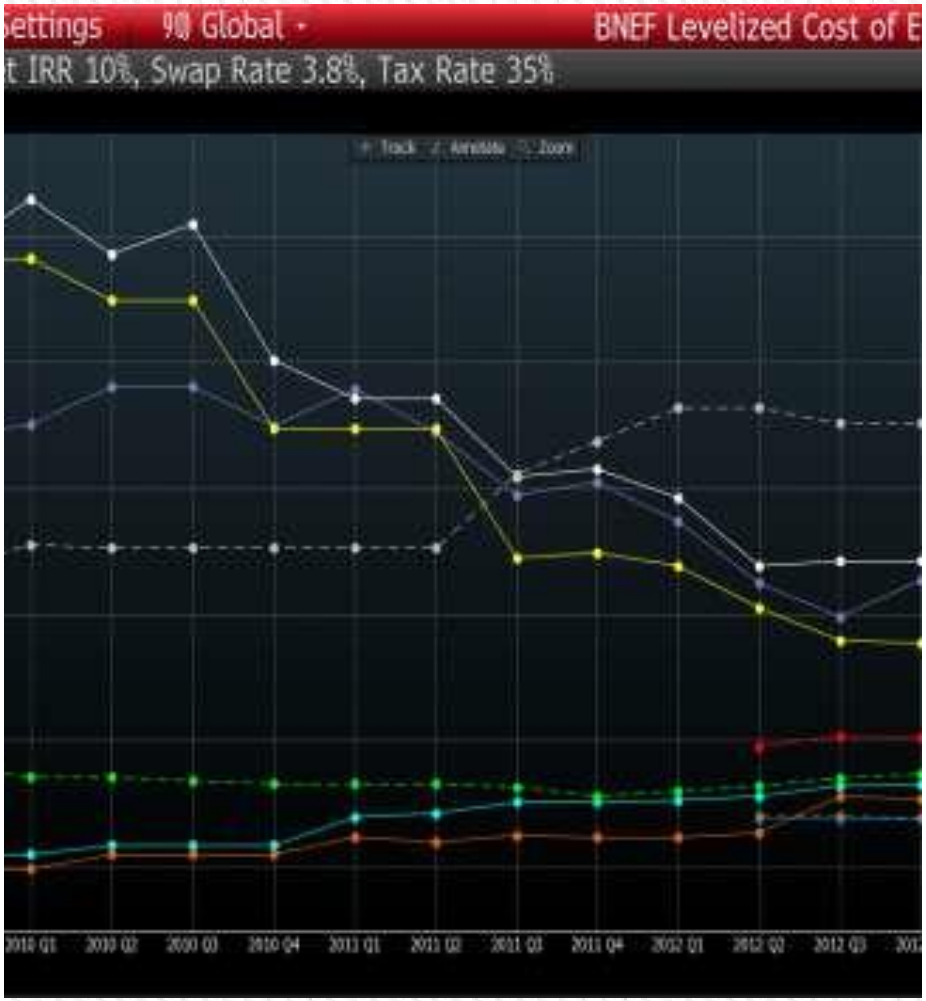
Renewables are becoming popular in many developed countries ….. for reasons that are entirely different to why they might have a place in Myanmar

- In many countries, renewable and distributed solutions are being touted as part of a "smart grid" to solve global energy problems
  - Wind, solar, geothermal, micro-hydro, wave power have no carbon emissions
- However, barriers to entry are many – often revolving around the need to recover the costs of existing infrastructure (regulatory barriers) or fitting "new" solutions into the existing system (technical barriers)
  - Meaning that developed countries have had to implement a slew of incentives, cross-subsidies, renewable credit schemes or feed-in tariffs to encourage renewables
- A developing country should not be wasting money on technologies which are not cost-effective and should certainly not be subsiding them
- However, the lack of existing infrastructure in Myanmar actually means many of the barriers to entry for renewables in developed countries are lower; and the small-scale, distributed nature of the "fuel" may actually mean renewables are more cost effective than a traditional grid for some consumers

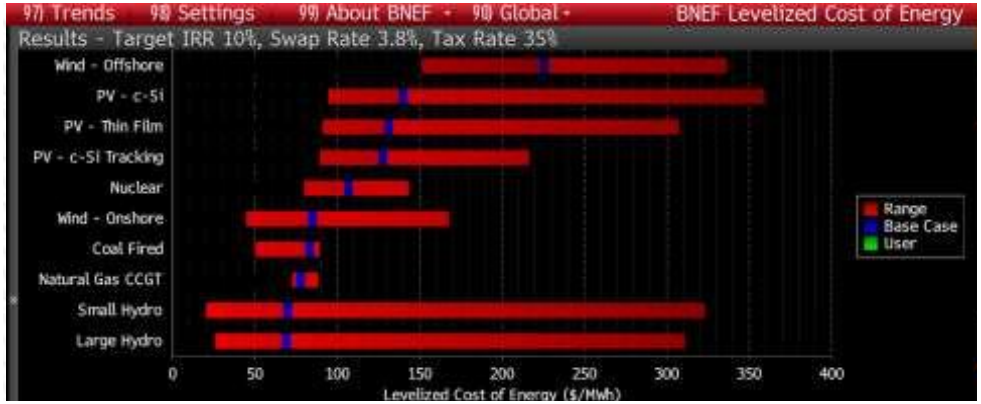
There are other benefits to distributed and mini-grid solutions

- The skills required can be taught to a wide range of people, meaning that locals can install and maintain many of these systems
  - Unlike distribution and transmission systems, which require skilled personnel to maintain power lines to avoid electrocution
  - Commercial and business skills involved are also transferrable
- The community based nature of mini-grids can enhance local economic growth
- The distributed skill base means that a wide base of people can benefit from this industry – spreading the value of the development across the economy rather than focusing it in a few specialized ESI staff
- Systems are modular – a small system can be upgraded to a larger one at a later point in time as demand grows, or integrated into a traditional grid as the grid expands
- Renewable solutions have “free fuel” – insulating the cost from world fuel prices – unlike coal or gas fired power generation

The costs of renewables have fallen significantly over the last few years



- As technology costs fall, the most economic new technology in any situation changes
- Economic analysis should review not only what is the most economic option today, but also how this might change in the future



Source: Bloomberg Industries <BI GO>

It would obviously be nonsensical to suggest the entire Myanmar system is developed using solar mini-grids!

- That is not the point
- The point is that, today, various technologies exist that did not exist previously
- The cost of those technologies is at its lowest point in history, and options that did not previously exist may now be worth examining
- Following “what others have done” may miss the opportunity to create something entirely new, completely different, and much more cost-effective than other markets

Myanmar may have the opportunity to leapfrog the situation in many countries and go straight to a “smart grid” and the most efficient mix of transmission, distribution, centralised generation, mini-grids and decentralised generation options

The key is to step back and think about what is the best to be achieved

- How can policy be designed to encourage home-installations; small mini-grids, fast track IPP's **and** the most cost effective larger grid infrastructure and power stations?
- How can the regulatory and policy frameworks be designed so that no cost-effective options are overlooked or discriminated against?
- Where is the money (limited resource) best spent?
- What are the best options for Myanmar's indigenous resources (fuel)?
- What training and capacity building will result in the most effective improvements in technical skills?

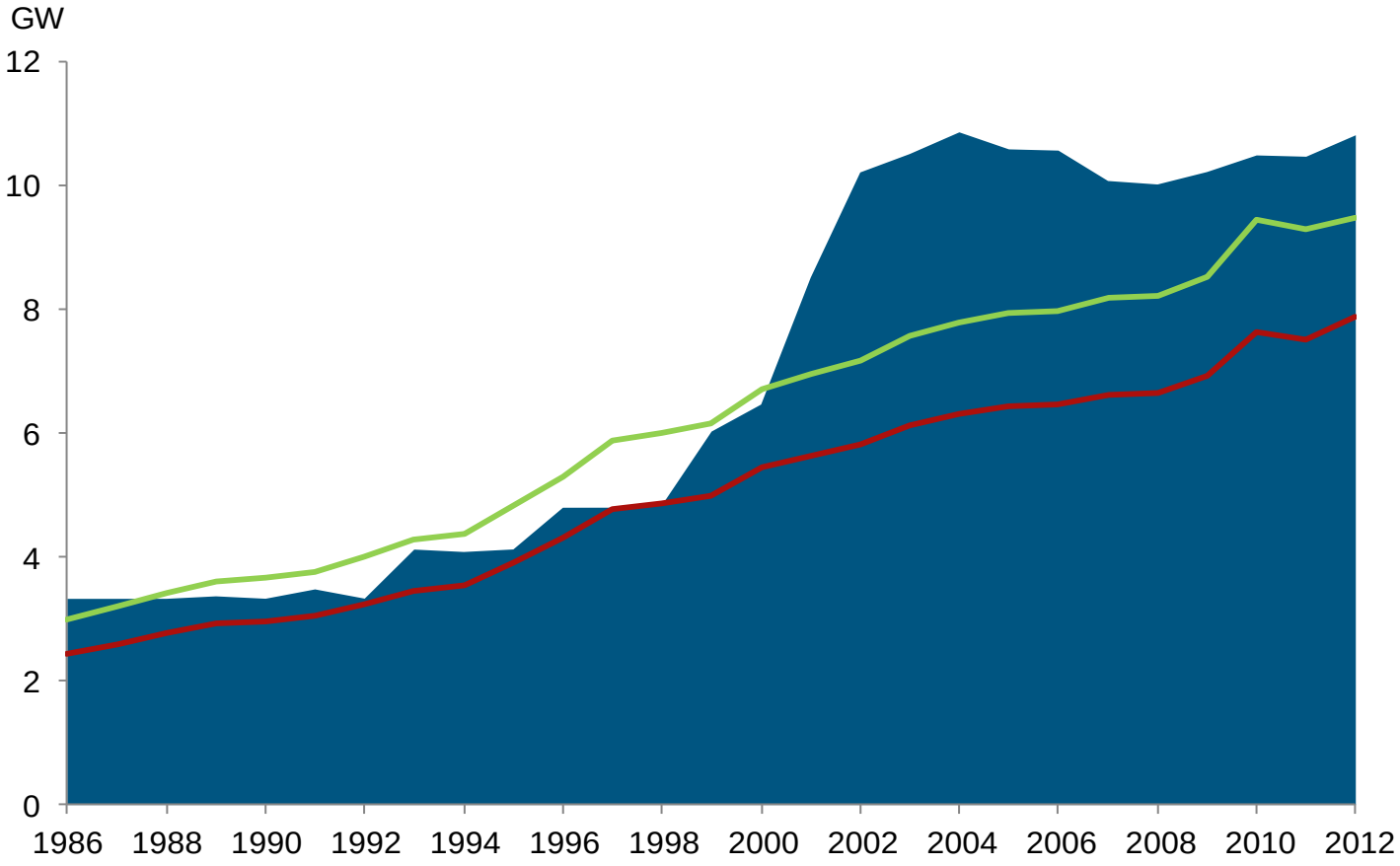
Think first; act later. The frameworks which are set up now will set the scene for the future and may preclude or close out sensible options if not well designed

Poor decisions cost consumers

- The Philippines turned to IPPs to try to solve the looming power crisis in the 1990s
- By 1998, foreign-owned IPPs had build **4,800MW** and invested US$6 billion
- But, just as the Asian financial crisis took its toll and demand flattened, **2,700MW** of natural gas-fired generation came online
- This meant that the government, through the National Power Corporation (NPC), quickly racked up debt, which accumulated to **US$22.35 billion** by the end of 2003
- Despite raising about **US$10.2 billion** from privatizing assets and contracts between 2007-11, Filipinos have only really just begun paying off these debts …
  - *Directly* through separate Universal Charges levied on every kWh consumed, currently PhP 0.1938/kWh (about 4.25 Khat per kWh), and
  - *Indirectly* through expensive gas-fired generation when coal could have been cheaper
    - since July 2007, Meralco alone has spent an extra US$300m on its gas-fired IPPs compared to the cost saving it could have got from its coal IPP

The Government's boom in capacity came just as demand flattened

Supply and demand in Luzon (1986-2012)



	%CAGR (1986-2012)
Demand + Required Reserve*	4.5*
Peak demand	4.6
Dependable capacity	4.6

Note: * Philippine Grid Code previously mandated 23.4% reserve be available, since 2011 it has required 4% for frequency regulation, a quantity equal to the most loaded unit for contingency and a quantity equal to the second most loaded unit for dispatchable

Source: DOE

Conversely, the USA is a bastion of free markets and economic thinking – how has this helped in their energy sector?

The US Shale Gas Revolution – An Example of Free Markets and Innovation

- Shale gas in the USA is an excellent example of market forces working in an environment which enables small and private sector players.
- The US commercial environment allows investors to make commercial decisions and take the rewards of good (and bad) investments.
- The energy sector in the USA has a good basis for allowing supply/demand factors to flow through to price and the infrastructure means that new discoveries can easily come to market in a network of pipelines with open access.
- This fostered an environment of innovation where high oil prices led to a focus on discovering new oil and gas reserves - the end result of which was the shale gas revolution which has increased US gas reserves by multiples over the previously known commercial reserves.

Economic analysis can help ensure good decision making

- The problem is that Myanmar wants electrification, but lacks the money and skills to make it happen “tomorrow”
- It needs to decide how to get the best outcome for the limited resources (time, money, skills) it currently has
- This requires a clear policy framework that results in the right kinds of investments
- Economics is about maximising utility when you have limited resources
  - Choosing which options have most benefit
  - How to ration resources
  - How to maximise utility (or benefit) from what is available
  - How to use optionality and flexibility to keep

A clear economic framework can assist in decision making and critical thinking

A good, economic framework for the energy sector in Myanmar would

Have an over-arching policy which:

- Encourages innovation
- Fosters an environment where decisions are open, transparent, based on sound analysis and consultation (without being bogged down in bureaucracy)

Has a regulatory environment which:

- Rewards good decisions and allows the impacts of poor decisions to flow through to the decision maker (and not the customer)
- Does not penalize good decisions that happen to have bad outcomes (luck is a factor)

Is implemented by companies and government departments that

- Question each decision
- Review each investment for efficiency, appropriateness, size and timing

However, the question of exactly what should be done is less obvious

- Money is like any other scarce resource and should be rationed appropriately. However the key is to think through what is needed and make good decisions upfront rather than tackling the problem using the status quo
- Focus on where the most benefit can be achieved for the least cost
  - Which requires a clear framework for identifying "benefit"
- Save money wherever possible using optionality and flexibly size assets
- Optimise the timing of spend
  - There is no point building a transmission line too far in advance of the power station whose load it will carry; and visa versa for the power stations
- Use "out of the box" thinking to lower costs and achieve benefits – even if these are not the "traditional options" or the "way things are done in other countries"

Some examples of how this kind of thinking is working elsewhere follow

If the private sector builds a large power station (IPP) it generally has certain minimum requirements

- The key requirement for an internationally financeable PPA is certainty of revenues
- This means that payments must be made under a very wide range of situations.
  - Except for fault or negligence of the power station, most internationally financeable PPA's will put most risk onto the buyer.
- For example:
  - Transmission connections will not be the responsibility of the IPP and they require certainty of revenue even if the transmission connection does not occur
  - Fuel supplies are not the responsibility of the IPP and payments are made even if fuel shortfalls occur
  - Payments continue even if the demand falls and the power station is no longer required
  - Payments are set in hard currency and the buyer takes the risk of foreign exchange fluctuations
  - Construction will not start until all the agreements are in place and financing has been secured

Fitting IPP's into the system is different depending on the size of the system and the demand

- The features of IPP's, as noted on the previous slide, can create constraints in the system:
  - If transmission construction does not keep pace with IPP construction, payments for energy not delivered may occur
  - If demand does not keep pace with IPP construction, payments are made for capacity not actually required
  - The complexities of international financing may also delay projects
- Therefore, relying solely on IPP's in a small system may mean that these constraints put an unbearable burden on the system

Care is therefore needed in planning and implementation to ensure that IPP's are well thought through, so that the right plants are selected at the right time so as not to overly burden the system

In summary

- Good outcomes generally result from good decisions
- Good decisions:
  - Require a clear framework
  - Benefit from good data and information inputs
  - Are a product of good analysis
  - Should require the investor to take some of the risk of the outcomes
- The best advice for the development of the energy sector in Myanmar is to set a policy and regulatory framework for good decision making
- And allow the decisions made under that framework to guide development

The Lantau Group: Who are we?

- Asia Pacific Energy Experts
- Competition, Markets, Regulation
- Economic Consulting
- Testimony
- Market Analysis
- Asset Valuation
- Business & Regulatory Strategy

The founding partners of TLG first worked in the Asia Pacific region as part of Putnam, Hayes & Bartlett (PHB) and later with Charles River Associates

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strategy & economic consulting

Focussed on the Asia Pacific energy sector

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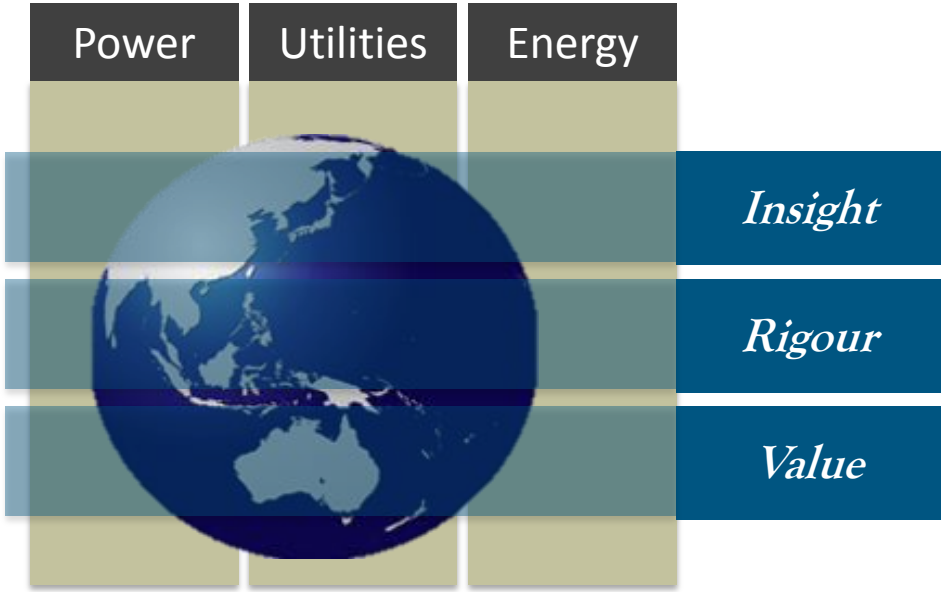

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