How to Green Your Existing Fleets: Improving Your Green Footprint

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Present Scenario

- Climate change is forcing the consideration of CO_2 emissions in the operation of power plant fleets throughout the world for both new and old facilities
- Carbon Capture and Sequestration (CCS) is talked about as if it is already available for implementation
  - Costly
  - Unproven in large scale application for power plants
  - Reduces kW generation
  - Highly site specific (need of geological structures that can keep the CO_2 safely and for thousands of years)
  - Realistically it may become commercially available 10 to 20 years from now

Scenario

- Compounding issues
  - Expected higher electricity demand
  - Cost of fuels going up
  - Regulations taxing CO_2 further increasing electricity costs to the consumer
  - Increase use of electrical devices in the average home
- Electric cars are coming!
  - Huge increase in electricity use
  - Further aggravating the scenario

Scenario

- There are no panaceas
  - Even natural gas-fueled power plants emit CO_2
- We do have quite a few power plants operating today
  - Have served as workhorses for the utilities
  - Many are 30 to 40 years old
    - Conservatively designed
      - Providing the ability to burn different fuels
    - Lower efficiencies than current designs providing opportunity to improve efficiency in the power cycle
    - Fueled by oil, coal and recently, natural gas

Alternatives

- CCS today!
  - Unrealistic
  - Extremely costly
  - By the time it is made to work on a large scale, it may be 15 to 20 years from today
  - We will all be in the poor house paying for these costs
- Decommission existing fleets and **replace with new gas fueled power plant technologies**
  - Unrealistic
  - Extremely costly, even if the gas is reliably available, but less costly than the first alternative
  - Still produces CO_2, but not as much as the plants they replace
  - It may take 10 to 20 years to do so due to costs, lack of infrastructure to produce these number of power plants' equipment in relatively short time

Alternatives

- **Decommission existing fleets and replace with new renewable power plant technologies**
  - Unrealistic
  - Extremely costly due to the economies of scale and shortage of fuel in the case of biomass, and not reliable in the case of wind and solar. Renewables are also quite costly on a capital cost basis
  - Renewables could never be used to generate all the power loads the various countries in SEAsia have
  - They can assist and should be part of the solution to meet loads as the South East Asian economies develop to support higher standards of living for their people
  - It may take 7 to 15 years to optimize their use due to costs, existing lack of infrastructure to produce these number of power plants' equipment in relatively short time. And even then, they would not be able to meet all the load demands

Alternatives

- Nuclear Power
  - Safe and reliable
  - NO CO_2 at all!
  - Takes 6-8 years to develop the human and regulatory infrastructures to implement the first nuclear plants in the region
  - After that, they could be built in as little as 5 years for each power plant
  - Low economic cost ($/kw-hr) to the consumer, but high capital investment ($/kw)
  - Provides for many job opportunities locally
  - This is the ultimate solution which some countries are exploring or have decided to follow

Alternatives

What to do in the interim??

- Look at existing fleets
  - What can be improved relative to CO_2**?**
    - Economically
    - Timely
    - Creating new jobs
    - Getting the world economies moving again

Alternatives

What to do in the interim??

- **The best CO_2 is the one you do not generate!**
  - Improve efficiencies
    - Repower
    - Co-generate
    - Reduce use of fuel through efficiency improvements
  - Use renewables (which are considered carbon neutral)
  - Combination of the two strategies

Alternatives

- Using renewables (which are carbon neutral) to participate in the generation fleet
  - Build new renewable units
    - However, generally smaller plant sizes
    - Cost per kW is high because of the economy of scale
  - Repower existing power plants with new boilers which are more efficient and allow for biomass co-burning combined with cycle efficiency improvements, e.g., the steam turbine upgrades, co-generation

Alternatives

- Using renewables (which are carbon neutral) to participate in the generation fleet
  - Use renewables to assist in the generation of power in existing power stations
    - Co-burn biomass in existing boilers
    - Repower existing power plants by using biomass boilers which could preheat the feedwater going into the existing boilers thus reducing CO_2 generation by lowering use of hydrocarbon-based fuels

Alternatives

- Using renewables (which are carbon neutral) to participate in the generation fleet
  - Use renewables to assist in the generation of power in existing power stations
    - Displace auxiliary power or house loads with the use of wind and solar in existing power stations to eliminate auxiliary power needs so that all the base load power goes to the consumer
      - It reduces fuel consumption – reducing CO_2 and other emissions
      - Lowers the cost of renewable usage simply because the electrical and other infrastructure is already at the plant site reducing the cost per kW of its application
      - In times when the renewable fuel is not available for whatever reason, the consumer is still served simply by turning the existing power plant full blast

Costs and Risks

- The next slide presents the approximate costs and schedules for implementation from development, financial closing to operations
- By the time large scale applications of renewables are supported, 8 to 10 years would have gone by, which is the time frame needed for the nuclear plants to come into operations
- Again, renewables cannot fulfill the large load demands presently or in the future for the SEAsian economies but can play an intermediate role if proper implementation plans are developed
- Only nuclear plants provide a long term solution at this time

Technology	Range of Costs in $/kW	Time Frame for Implementation from development to operations	Comments
New Biomass -20 MW/station -150 MW	$ 3000 to $ 4000/kW $ 1750 to $ 2250/kW	~ 3.5 to 4 years per plant ~ 4 to 5 years per plant	Biggest challenge is to obtain a reliable and sufficient biomass supply for the long term for both cases Manufacturing lead times remain a problem while large supercritical coal plants continue to be built outside North America
New Wind - 300 Mw/park	Over $2,000/kW	~ 3 to 3.5 years per 300 MW park	Manufacturing lead times remain a problem Unfortunately these wind parks need to be backed up by the same capacity of generation for the times the wind stops while the load still is on. Impact on the grid by wide swings in generation can be severe. This puts a limit on this technology application in SE Asia.
Solar – PV Distributed Generation - < 1 MW	$7,000 to $10,000/kW	~ 2 to 3 years if enough sites are supported	Manufacturing lead times for the cells are increasing as more interest in PV develops in the industrialized nations This approach is good for remote areas with at least 8 hours of sun. Storage is a problem which needs further study in the localized applications
Solar – Concentrating Solar 300 MW per plant	~ $3000 to $5000/Kw	3.5 to 5 years per 300 MW plant	Lead times for ordering and manufacturing from the very few suppliers of solar mirrors in the world is a growing problem
Biomass Assisted Generation – Co-firing up to 20%	$ 300 to $ 1000/kW	~ 1 to 2 years for an existing plant	Existing plants have the capability to handle limited amounts of biomass, or can be easily be modified to do so
Addition of a small biomass package boiler to assist in the thermal cycle	$ 300 to $ 500/kW	~ 1 to 2 years for an existing plant	Depends on the size of the biomass plant and the amount of feedwater desired to be preheated in the coal plant
Repower an existing 250 MW plant with a CFB boiler with 20% biomass co-firing	$ 1300 to $ 2500 per KW	~2 to 3 years for an existing plant	CFB market has tighten in the last few years; however, North American sales have slowed allowing for other worldwide applications

Conclusions

- Renewables have a role to play in SEAsia to generate power
- They are not the total answer – only base loaded plants of the 600 to 1200 MW size are of an economic size to make sense in SEAsian economies
  - Coal can play a role with biomass co-burning as a possibility
  - Natural gas plants can be in the mix as long as the gas can be reliably and economically supplied
  - Only nuclear power assures no CO_2 releases; It provides a solution for base loaded power plants in the 2018 and beyond years
- Renewable-assisted solutions can be implemented now at relatively economic costs, but the applications are specific to the power station under evaluation

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