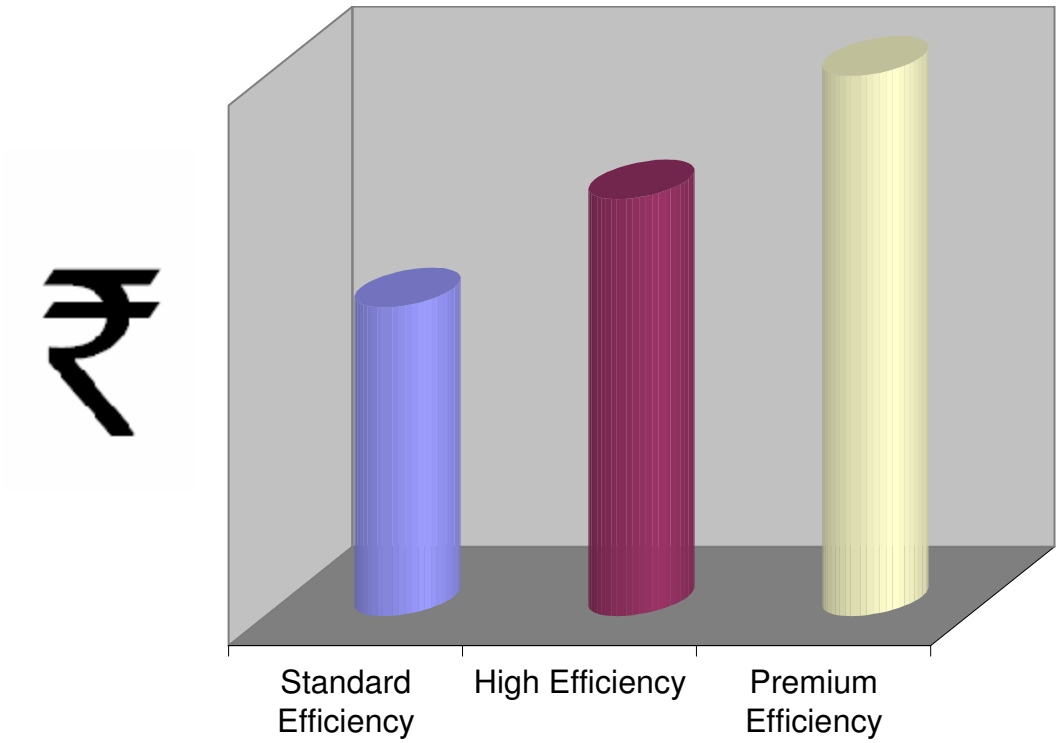
The Design Envelope

The Integrated Demand Based Answer for Energy Efficient HVAC and Pumping Systems

Brent Ross – Director Core Solutions - Armstrong

The Cost Efficiency Paradox

- The traditional mindset



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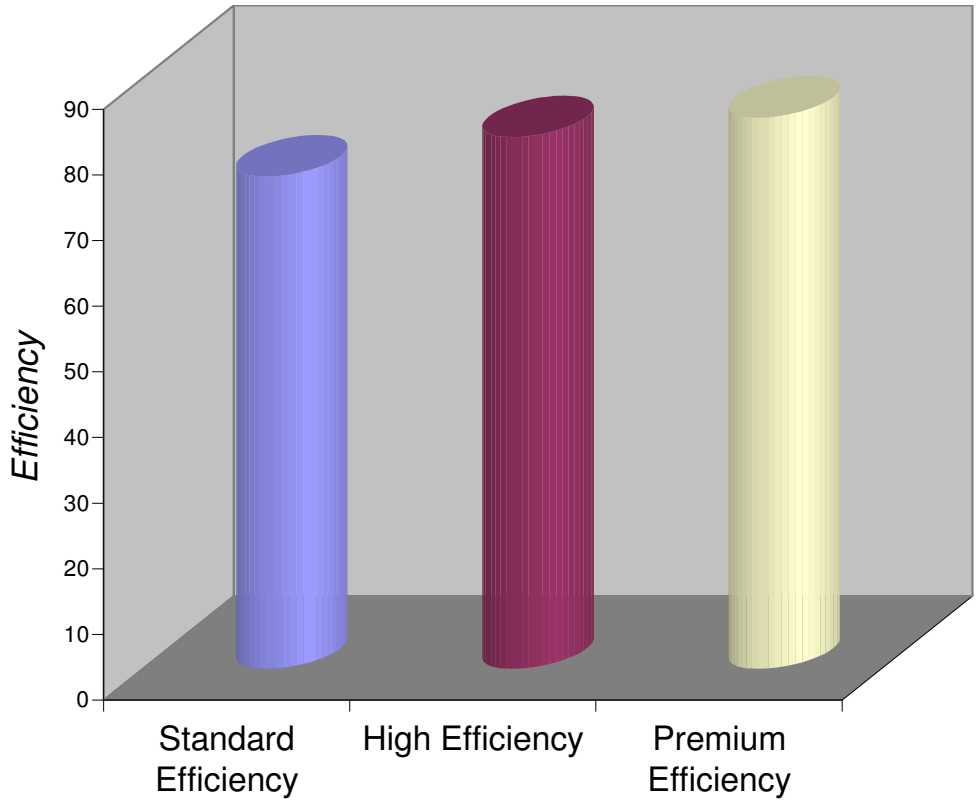
The Cost Efficiency Paradox

- The traditional mindset



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Some Non-Intuitive Data

- What impact have the following had?

New mechanical technologies in the market

Installation of VFDs (variable freq drives)

Integrated Control Technology

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What Impact Have the Following Had?

	Savings
New mechanical technologies in the market	15%
Installation of VFDs (variable freq drives)	30%
Integrated Control Technology	40-60%

(Component integration vs Griha function integration

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Integrated Control Technology

Other Benefits;

-Lower installed cost

-Lower life-cycle cost

-Paybacks of <6 months

-Better Occupant Comfort

-Reduced Project Risk

-Ability to incorporate Renewable Technologies Efficiently

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HVAC Is A Variable Load World

How can we develop the "best sized" solution when we know and need to accommodate for future changes to the building loads?

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Rate of change with buildings (new and existing building stock)

- Today, designs finalized during construction
- Mechanical systems redesign 3-4 times, +/-15%
- Tenant “refit” for new mix (data servers example)

Our HVAC world is recognized as “variable load”,

- The expectation today is that equipment will come as variable speed,
- VFDs have become cost economic and reliable,
- a great deal of benefit is gained from an “integrated” approach to determining how that VFD is controlled to it’s connected load / mechanical equipment.

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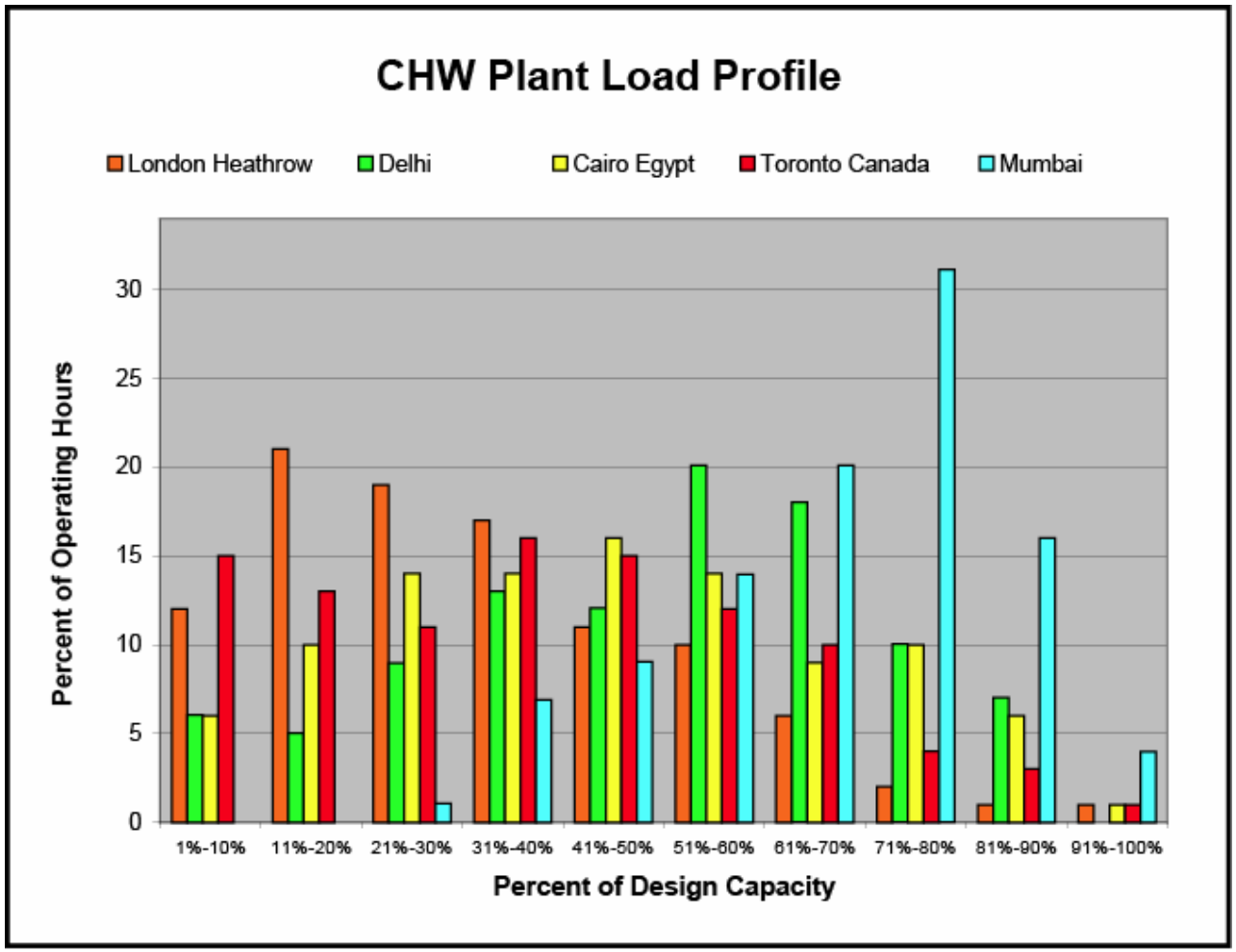
Part Load Performance is key!



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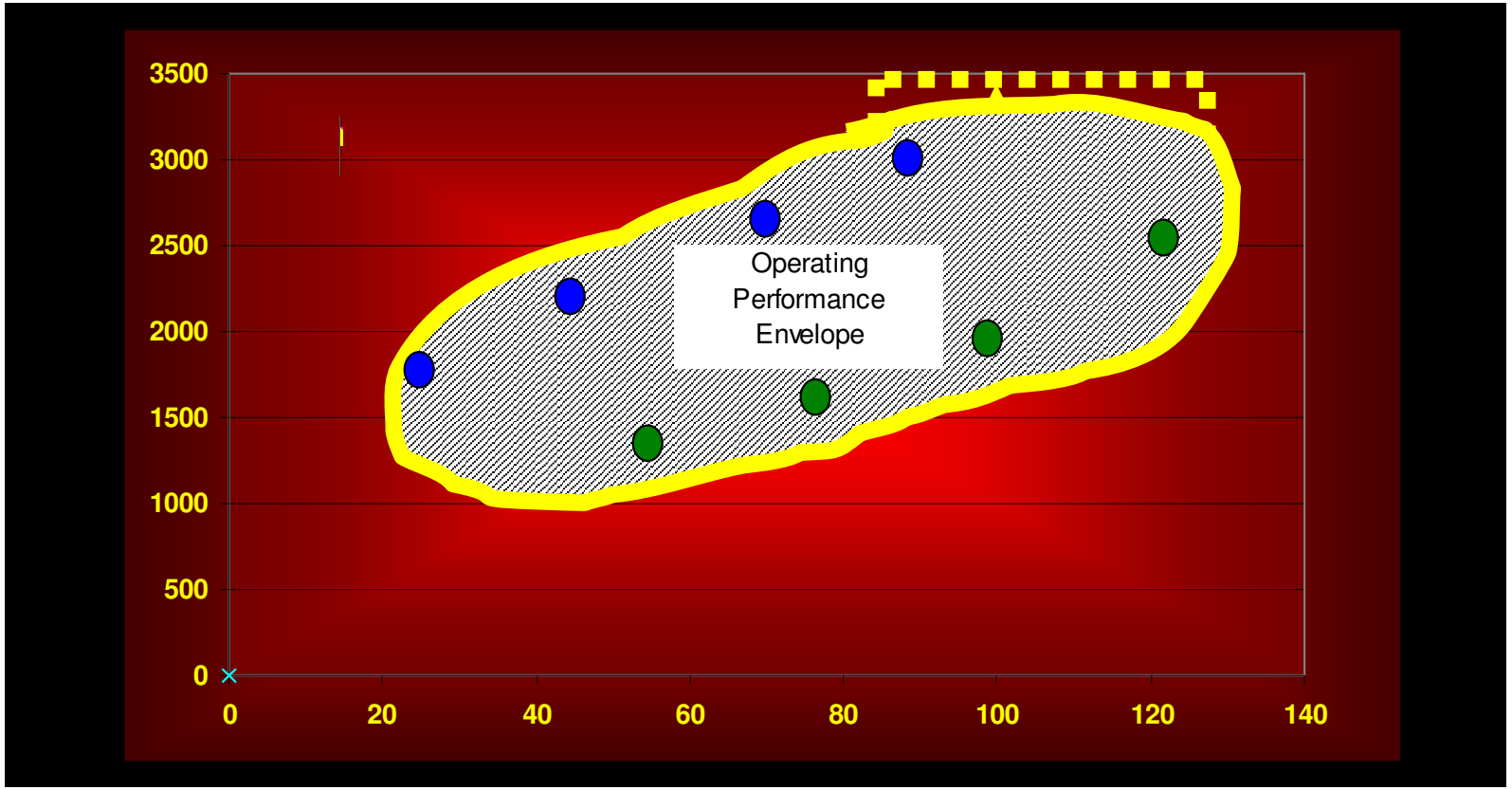

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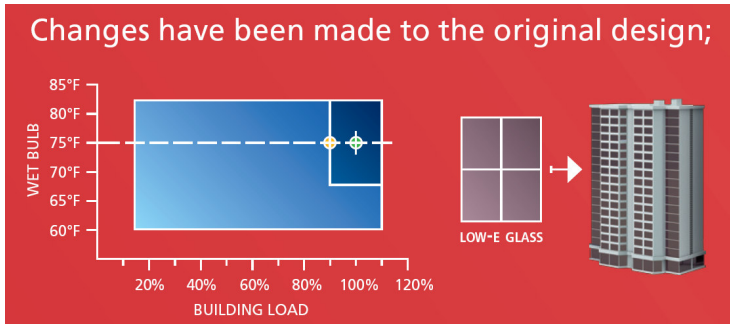
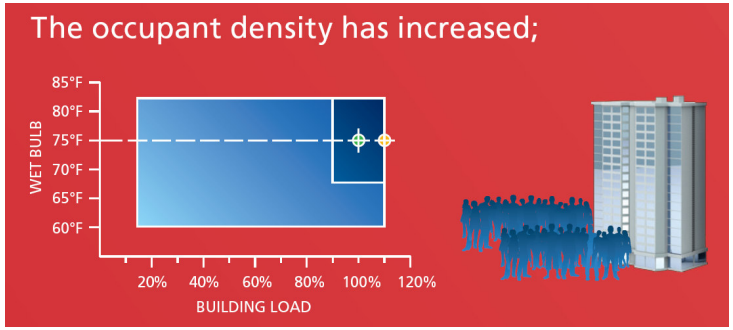
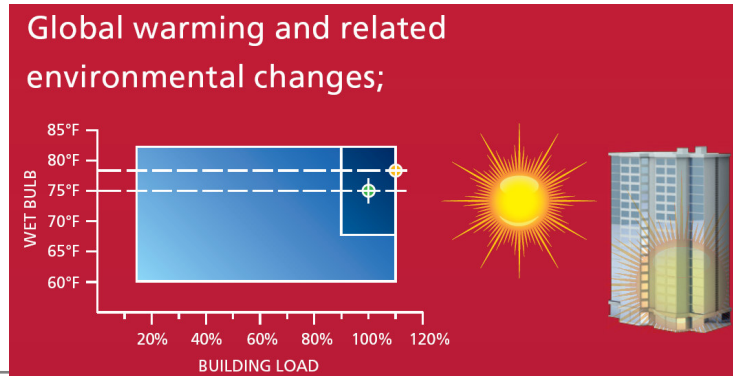
The Challenge… provide a new approach to:

- optimize for the variable load world
- accommodate new causes of change without additional time, expense and risk
- prevent “over-sizing”
- provide an “integrated” factory approach that is intended for tuning to site conditions, thereby offering “future proofing”







Design Envelope

Fixed Speed World thinking;

- Mechanically tuned equipment at the factory and then mechanically tune the system on site

Variable Load / Speed World Thinking with Design Envelope

- A fixed range of mechanical gear with integrated control enabling factory tuning by controls, and further site system tuning by controls.

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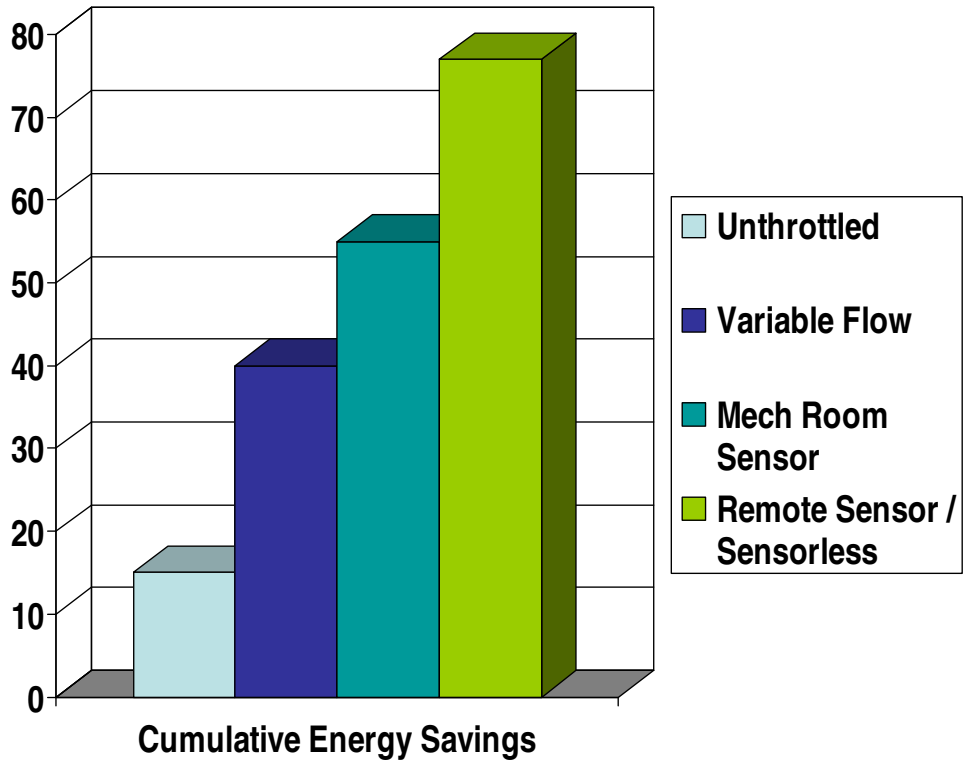
Pumping Cumulative Energy Savings 77%

		Power	Energy Savings	
A	Constant Speed throttled	32.03	Incremental	Cumulative
B	Reduced Speed unthrottled - Constant Flow	27.11	15%	15%
C	Reduced Constant Speed - Variable Flow	19.36	29%	40%
D	Variable Speed - Variable Flow - Mech Rm Sensor	14.35	26%	55%
E	Variable Speed - Variable Flow - Remote Sensor	7.32	49%	77%



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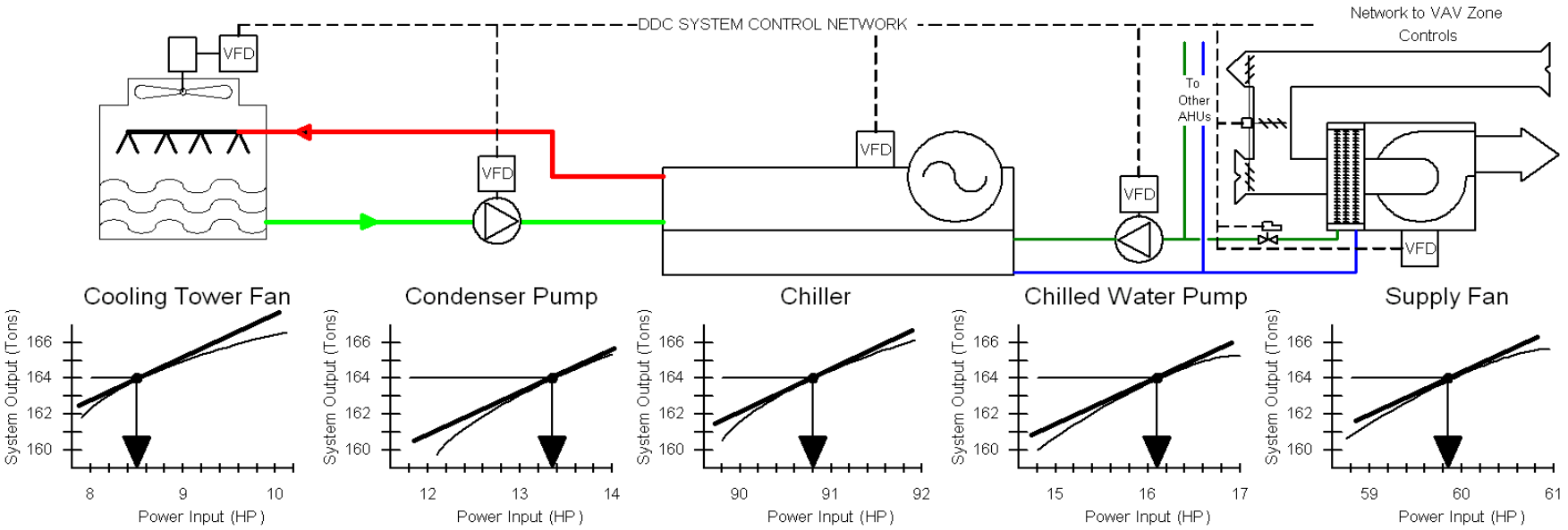
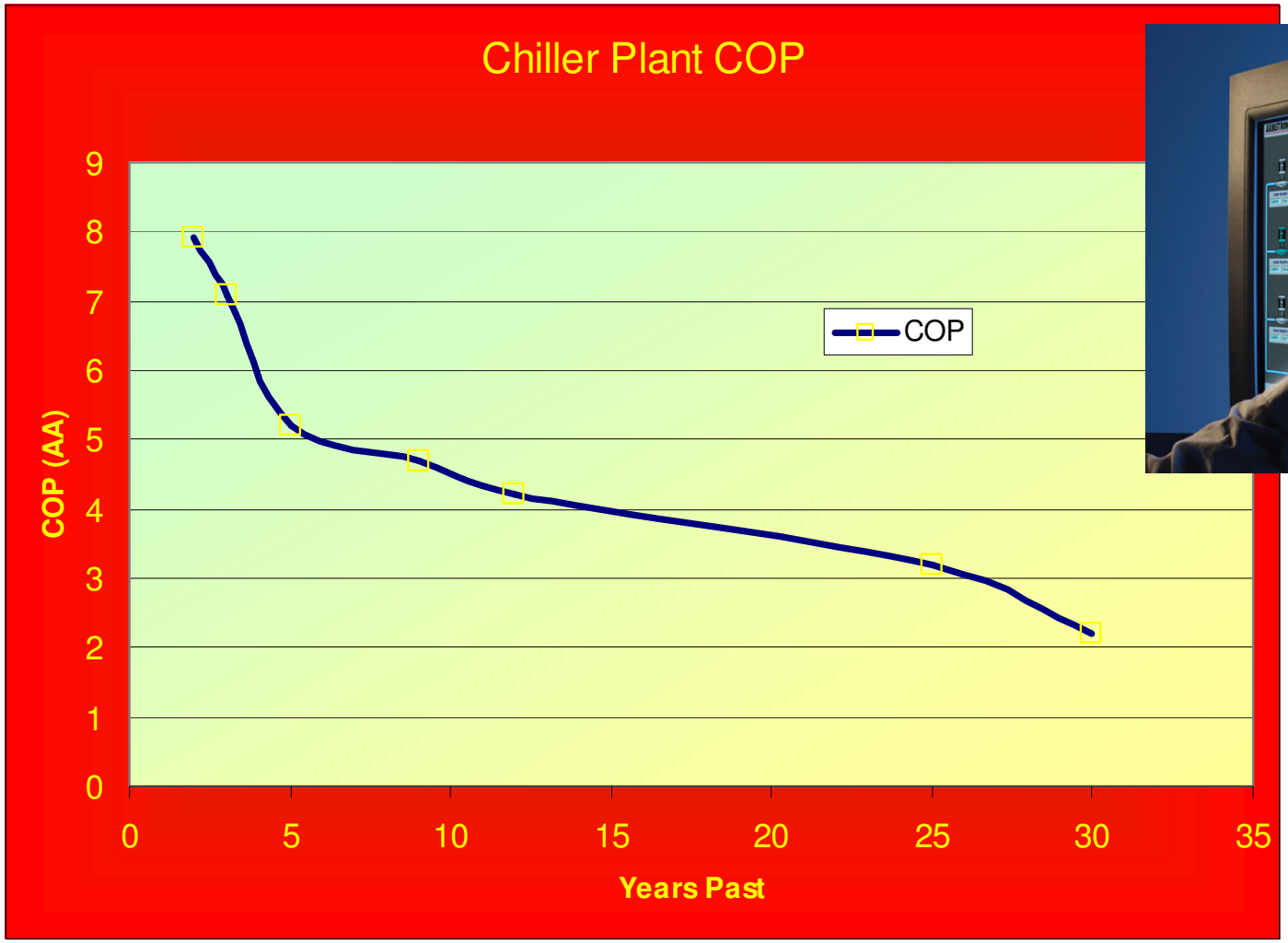
Demand Based Control

Demand based control is a relational method of control that has been developed from the Equal Marginal Performance Principle. Demand based control operates individual components based on relative power input rather than to maintain an intermediate temperature or pressure setpoints.



Because continuous error correction is not an essential element of demand based control , operating stability is almost never an issue. The above system is optimized at the relative power settings shown by the arrows because , in accordance with the Equal Marginal Performance Principle , the marginal performance (slope of the curve of total system output per unit input for the component) is the same for all system components.

Consider the Impact of CHW Plant Efficiency



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Variable Speed Pump Specifications for your Buildings

- Does the industry select in the same manner as a constant speed pump and specify a VFD for it?
- Are life cycle costs calculated from design point efficiency?
- Do you suspect that you cannot truly lower the carbon footprint without extra costs?

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Taking “Premium” out of Efficiency

- What constitutes the highest (Pumping Unit) customer value proposition in our business?
  - Lowest equipment cost?
  - Lowest installed cost?
  - Highest equipment efficiency?
  - Lowest energy costs?
  - Lowest Life Cycle (LLC) costs?

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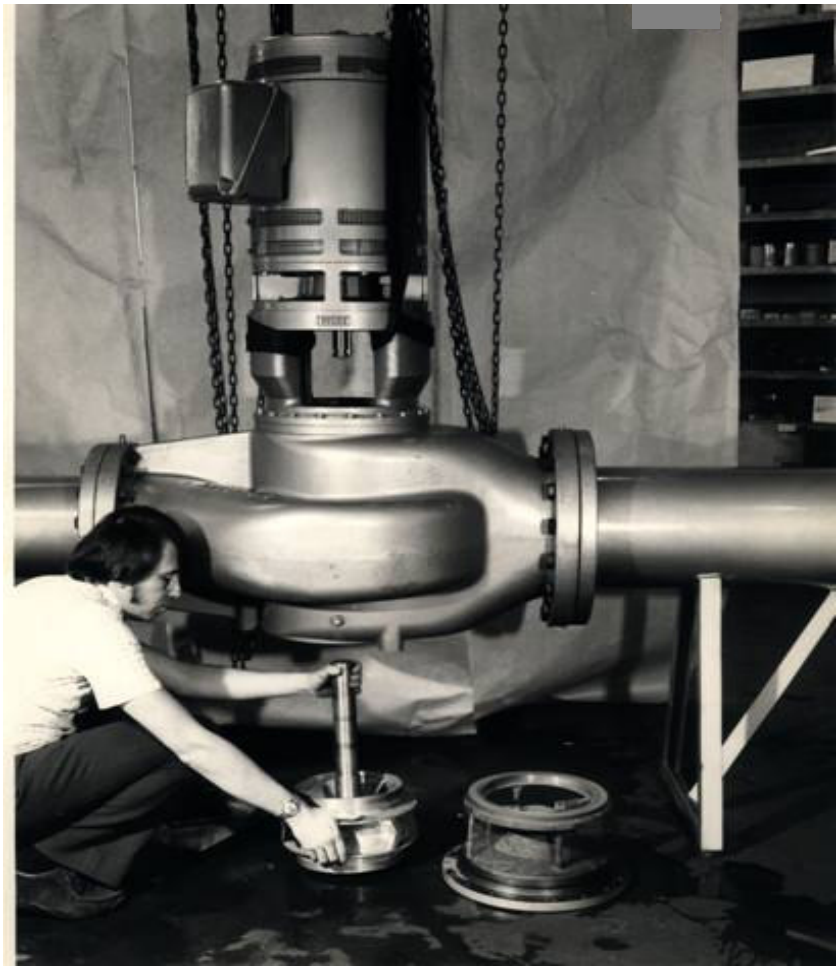
HVAC customer needs – 1960's

- Smaller footprint
- Easy to install
- Easy to maintain
- Reliable
- (Flexibility of use)



Vertical In-Line (VIL) Pump. Circa: 1970

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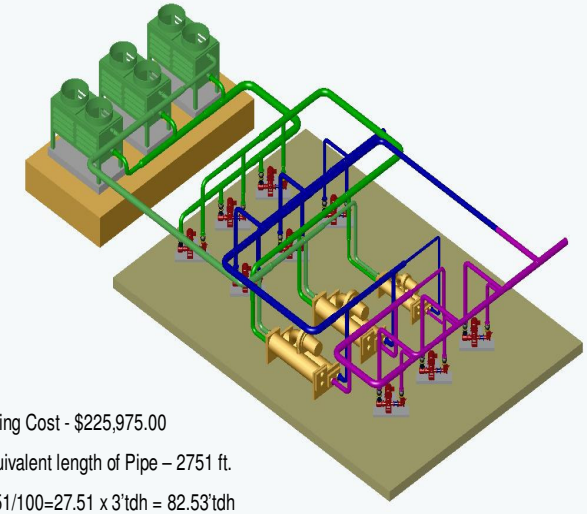
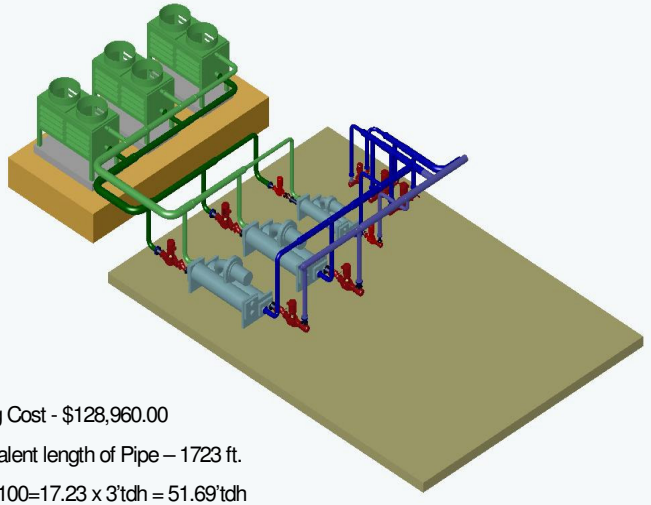
Best Practice



Piping Cost - $225,975.00

Equivalent length of Pipe – 2751 ft.

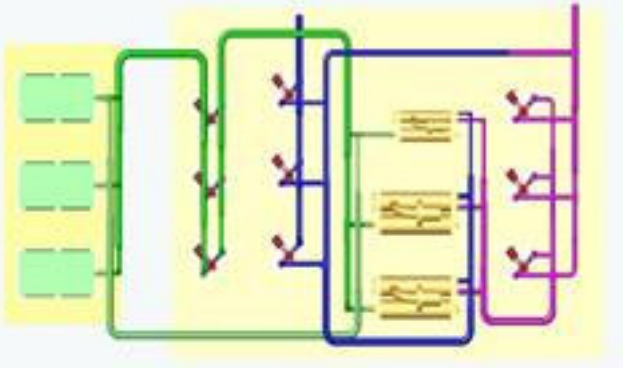
2751/100=27.51 x 3'tdh = 82.53'tdh



Piping Cost - $128,960.00

Equivalent length of Pipe – 1723 ft.

1723/100=17.23 x 3'tdh = 51.69'tdh



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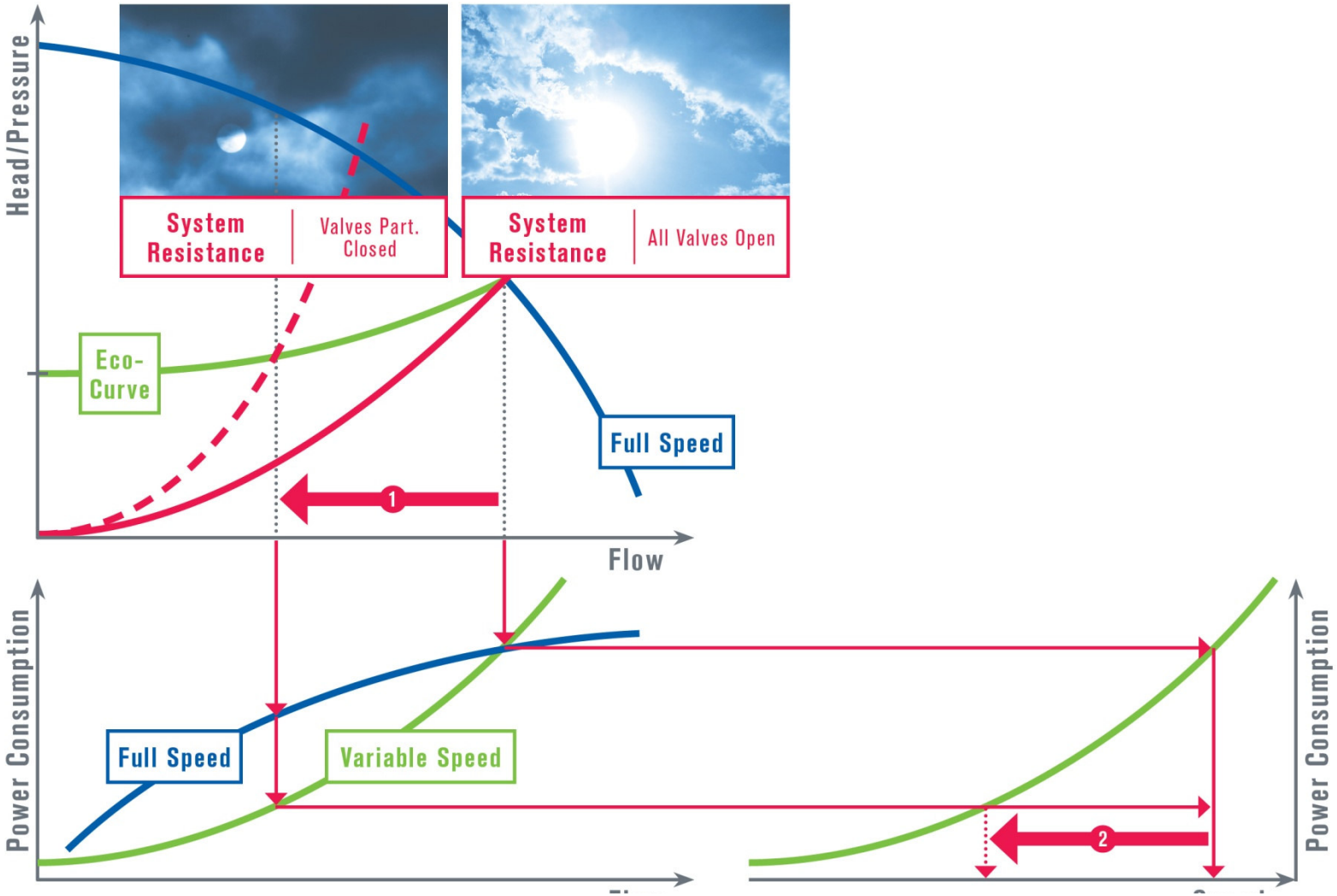
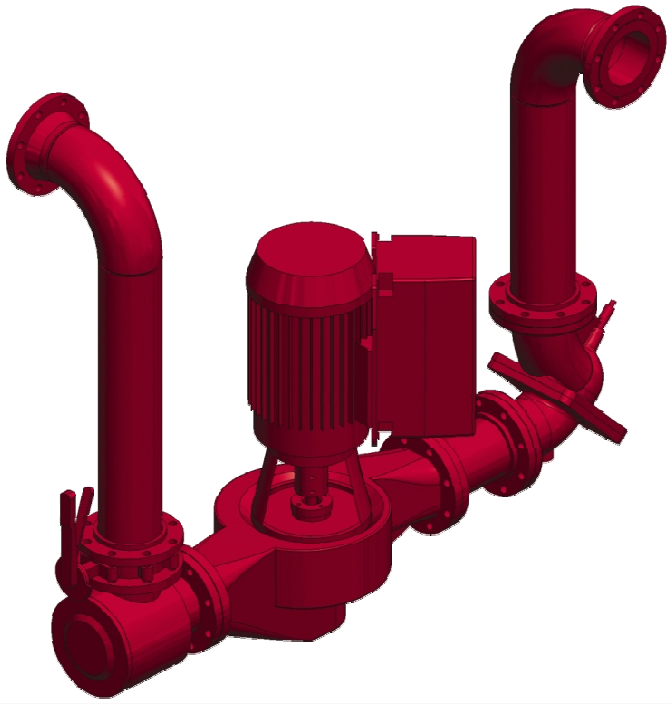
SENSORLESS CONTROL LOOP

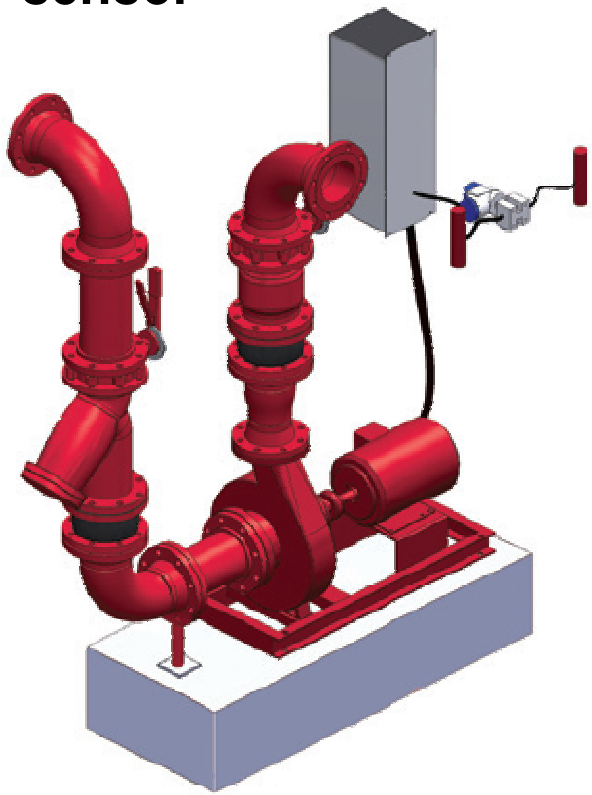


Value Proposition data IVS VIL & ES-RMT CTRLS

- **Vertical In-Line – Integrated Controls**
  - Save 30% installed cost
  - Save 35% LCC



- **End Suction – wall mounted VFD & remote sensor**



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Summary

- HVAC Technologies readily available today
  - Design Envelope / Part Load World Thinking
  - Use of variable speed and integrated design and controls
    - Variable speed chillers / pumping vs constant speed
    - Demand based chiller controls vs PID loop
      - Complete chiller plant COP's > 7.0 vs 5.0

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Summary

- HVAC Technologies readily available today
  - Vertical Inline pumps with integrated control vs end suction pumps with wall mounted standard controls
    - Suction guides / triple duty valves
    - 30% installed cost savings
    - 35% life cycle savings
    - Additional mechanical room pipe savings and pipe energy savings (37% savings)
    - Savings in control wiring and sensors

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We must Ask Ourselves

Are we using the best technologies to achieve lowest carbon footprint at no increase in cost

In Every New and Existing Building!

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Our obligation to use Best Technologies

For our customers

The public (2030 5X power demand projection)

Professional Ethics

Our greatest responsibility is to be good ancestors

~ Jonas Salk – Polio Vaccine

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