

BUILDING TUNE UPS FOR ONGOING ENERGY SAVINGS

**Bryon Price
A.G. Coombs Group**

“The Key to Ongoing Energy Efficiency”

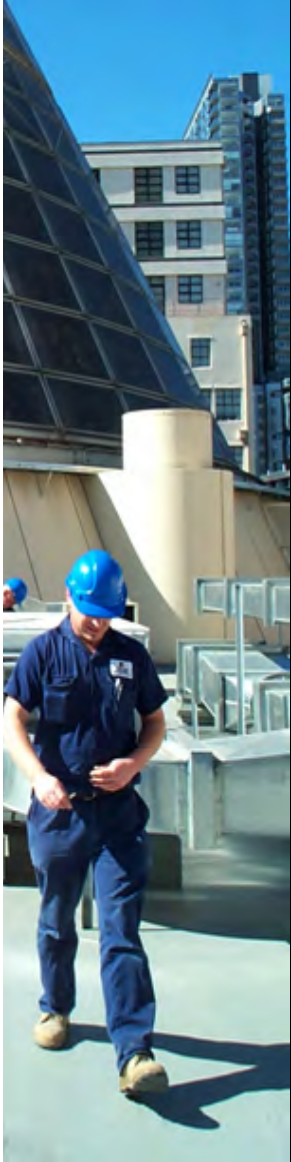
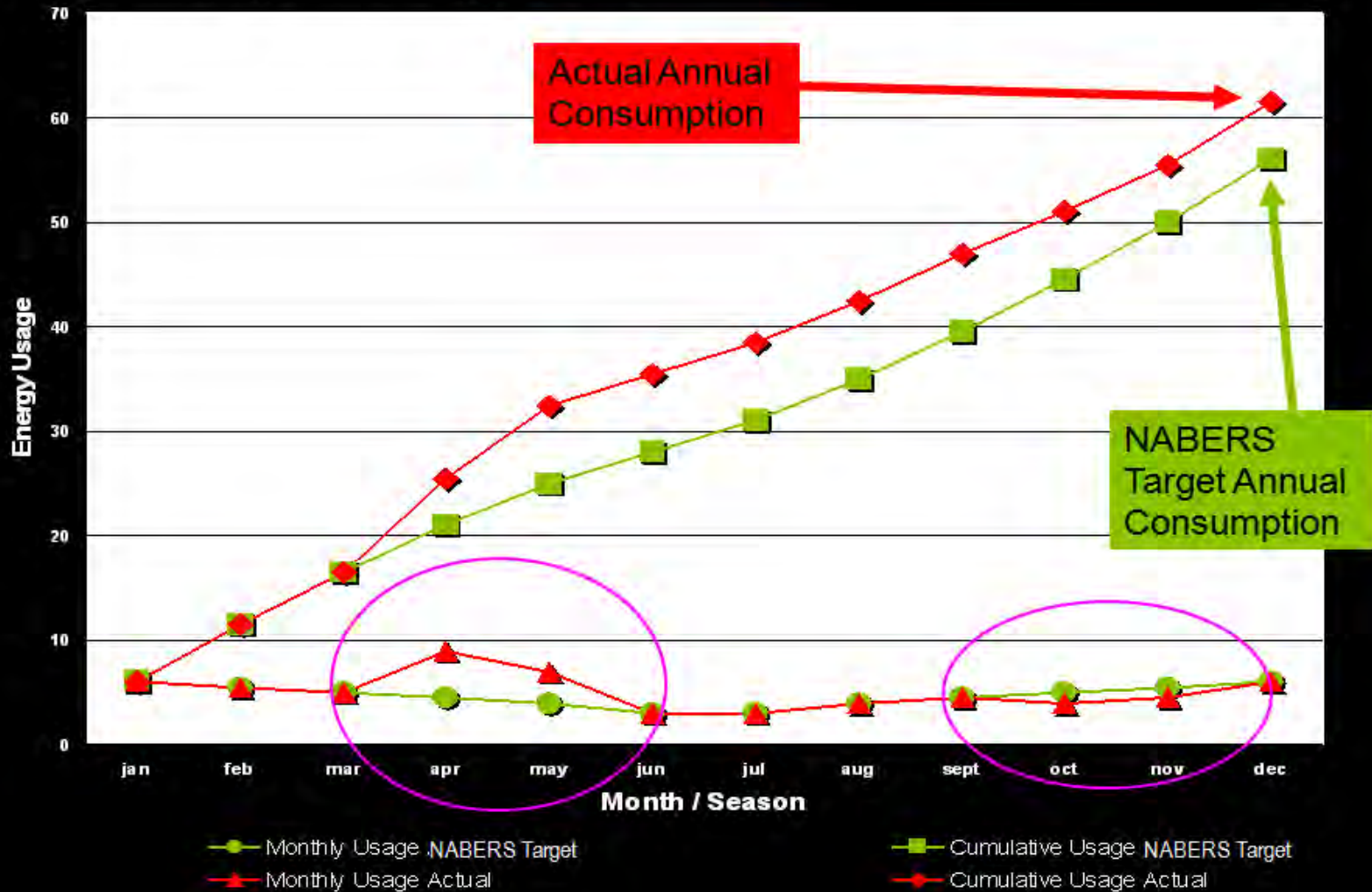
- The New Reality
- Current Practices and Problems
- New Paradigm or Back to Basics?
- Case Study – Building Tuning
- An Integrated Approach
 - *Building tuning AND energy efficiency maintenance*

The New Reality

- Operational Performance = \$\$\$\$\$
- Design Performance \neq Operational Performance
- Tenant comfort AND Star Ratings
- The 'low hanging fruit' are being picked
- Real carbon cuts are in tuning energy systems – AND KEEPING THEM TUNED
- BMCS are the tools for tuning building systems to achieve and then ensure ongoing performance

Outcome Based Team Approach

Cumulative Energy Usage NABERS Target Vs Actual Risk Management Approach



Building CARBON Efficiency

3 Steps

1. Tuning and Building Optimisation

- *Making the best of what you have*

2. Transformation and Upgrade

- *Cost benefit driven*

3. Energy Efficiency Maintenance

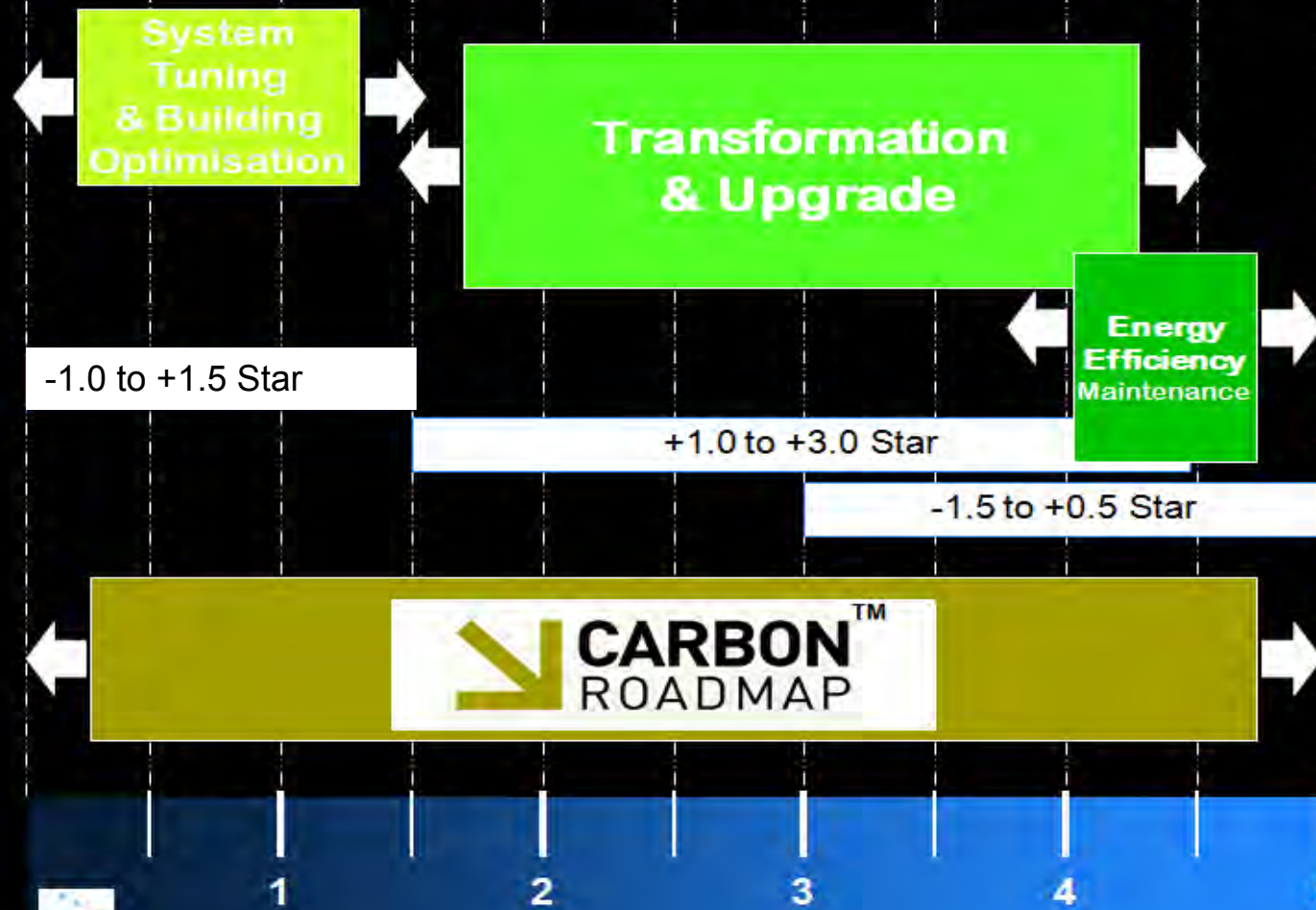
- *Keeping what you achieve*

= *An Integrated Program*

- ***Assuring ongoing PERFORMANCE***

Building CARBON Efficiency

The Transformation to CARBON Efficiency for Buildings



Energy Inefficient
HVAC Systems

Excessive
Energy Usage

Review of operation and
condition of systems and
equipment

Energy
usage
monitoring

**Maintenance
Regime**

*Structured and
documented*
Energy waste
specific items
Systems specific
regimes
Inspection and
testing
Checking and
Calibration
Records keeping and
reporting

**Building
Tuning Plan**

Staged & prioritised
System resistance
Heating and Cooling
Operating times
Controls regimes
Outside air control
Air flows and
balances
Central Plant
operation
Records keeping and
knowledge base
development

**Replacement
& Upgrade**

*Policy and
procedure*
Energy Efficient
Alternatives
Right Sized
Replacement
Future Proofing
Metering
Control
opportunities

Management & Reporting

Energy
Efficiency
Targets

Energy Efficient
HVAC Systems

Optimal Energy
Usage

**New Paradigm
or
Back to Basics?**

New Paradigm or Back to Basics?

- A new focus on BMCS
- A structured process
 - *Building specific and HVAC system performance focused*
 - *Coordination of controls and mechanical maintenance*
 - *Integrated Approach, Structured Tuning Program linked to Maintenance Regime*
 - *Management, monitoring and reporting*
- About internal conditions, reliability and achieving **AND RETAINING** energy efficiency!

Current Issues - Existing Buildings

- **Maintenance practices dislocated from energy performance**
 - *general and not building and system specific*
 - *attendance and compliance driven*
 - *focused on components not systems*
 - *internal conditions / reliability objectives*
- **Mechanical and Controls maintenance not complimentary**
 - *specialisation of trades – non technical management*
 - *piecemeal / separate / cloistered / adversarial*
 - *controls focused on 'point to point' not on correct, stable and efficient operation of the controlled systems*
- **'Tuning' doesn't happen**
- **Nil or inaccurate documentation**
- **Result = problems with many causes**
 - *layer upon layer of fixes – maze of problems*
 - *system changed with no understanding of bigger picture*
 - *local changes / global changes – not overarching strategy*
 - *system changes not documented*
 - *building changes not addressed*

Current Issues - New Builds & Upgrades

- **Controls Systems = 'Black Box'**
 - *lack of construction QA - not getting what you think*
 - *systems that work but don't perform*
- **Programming shortcuts**
 - *"I'll fix that later"*
 - *limited Graphics and Headend control*
- **'Old' software and components**
 - *the '7 year band'*
- **Lack of overall system performance strategies**
 - *lack of system integration*
 - *commissioning and Tuning requirements not specified*
 - *ongoing operational and maintenance requirements not adequately defined and specified*
- **DLP maintenance Vs appropriate maintenance**
- **Lack of 'tuning' tools**
- **System Replacements**
- **Embedded system knowledge is discarded**
 - *return to original design making no use of building experience only to repeat mistakes*

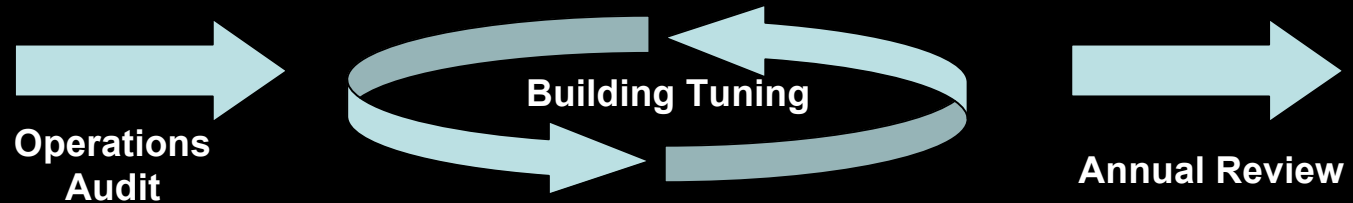
What is Building Tuning?

- Building specific and SYSTEM focused
- About internal conditions, reliability and energy efficiency across all building services including HVAC, L&P, Lifts etc.
- All energy systems working in 'CONCERT'
- Is a structured process
 - *Review of strategies is at code level*
 - *Initiatives for energy reduction are developed, documented and prioritised based on savings*
 - *Seasonal adjustments and occupancy considerations are developed and built back into the system over 2 seasons*
 - *Feedback provided into maintenance regime to prioritise maintenance tasks*
- Results in specific and integrated energy CONTROL strategies which in league with energy efficiency focused MAINTENANCE ensures ongoing energy savings

What is Building Tuning?

- Process – Where to Start
- ‘Unlock the Secrets’
- Is the System Open for Tuning?
- Graphical Interface
- The Tuning Approach
- Tracking and Reporting
- Example

Building Tuning Flowchart



Engineering
Energy review;
• Water, Electrical, & Gas Usage
• Capacity issues
• Fit for purpose
• Tunable? BMCS
Upgrades Required

Operational
Operational review inc;
• Actual plant usage
• Tenant usage
• Age and condition
• Documentation

Metering
Determine metering requirements based on customer outcomes.

Metering and Reporting
Reporting on NABERS status and benchmarking against similar buildings

Engineering
Documentation of building processes
Building Review, Reporting
Asset Replacement Strategy
Life cycle, retrofit and replacement
NABERS Review

Operational
High level strategy review
Daily Energy tracking and resolution
Prioritization of Service
Update of building manuals

Maintenance
Site Trending and analysis
Metering validation
DDC maintenance overview
Physical verification of critical controls

Engineering
Retrospective Energy review
Summary report
• Did we achieve our goals
• Review savings
• Review rating
Roadmap for Building energy Improvement
Model next 12 months

Roadmap
Next 12 months

Building Tuning
Documentation of new processes

Review &
Update Roadmap

Unlock the Secrets

- Understand the CODE - Continuous improvement in energy efficiency in buildings cannot be built on assumptions
- Need to understand the system inputs and observe how these variables are used by the system to drive the outputs.
- This methodology provides a clear differentiation;
 - *Control strategies are modified with an energy overlay*
 - *Strategies becoming energy limiting*
 - *Strategies compensate for different modes of operations*
 - *Strategies compensate for seasonal variations*
- This means the system has an energy focus and not just a temperature focus

Is the System 'OPEN' for Tuning?

- Any debate on “open systems” is somewhat moot as it has failed to deliver its ultimate goal of vender choice.
- For energy efficient performance the real test of the BMCS is, **“has it been configured to provide access to parameters required to tune the building?”**
 - *Can you see the code and how the data is manipulated through the logic?*
 - *Can you easily view and verify normal hours schedules and after hours operation?*
 - *Can you adjust thresholds that call for the main plant to start.*
 - *Can you access staging delays and setpoints to tune the chiller plant in line with the chiller settings?*
 - *Can you access supply air reset schedules?*
 - *Can you access ambient lockouts for fine tuning?*
 - *Can you add trends, remote connect?.*
- **Ability to work and successfully partner with the BMCS provider is a key factor in the process and cannot be understated.**

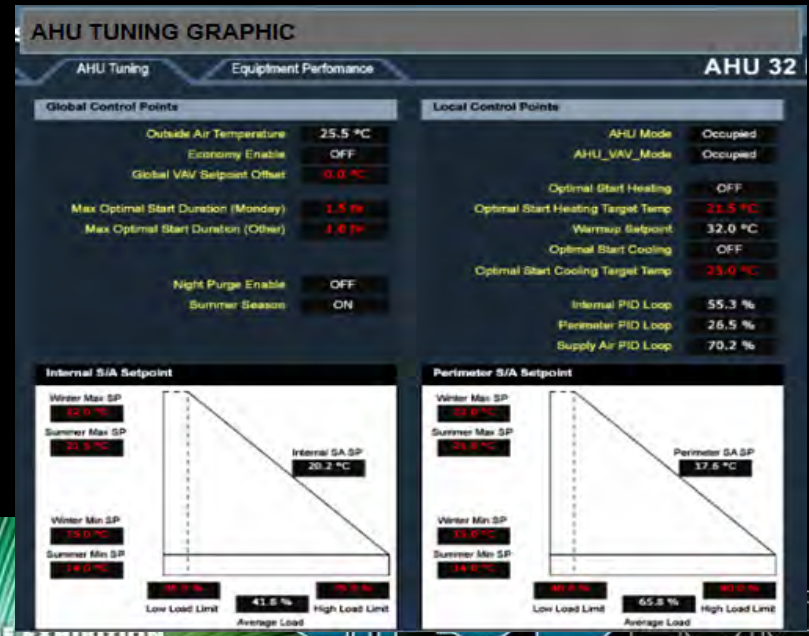
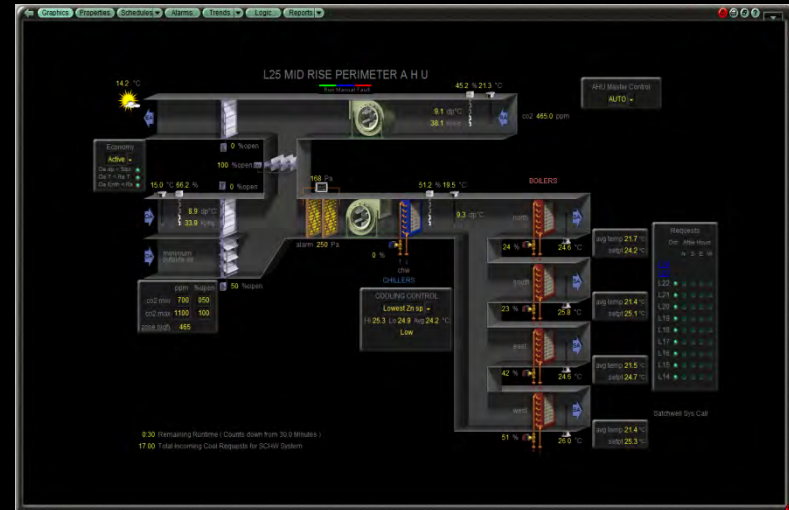


BMCS Graphical Interface

Most BMCS systems are provided with Graphics that have simple overviews with no real intuitive information.

As part of the building tuning, Graphics are typically updated to provide a sufficient level of detail to enable the operator to determine not just what is happening but why it is happening.

For Air Handling Units this includes energy limiting reset schedules with seasonal adjustments.



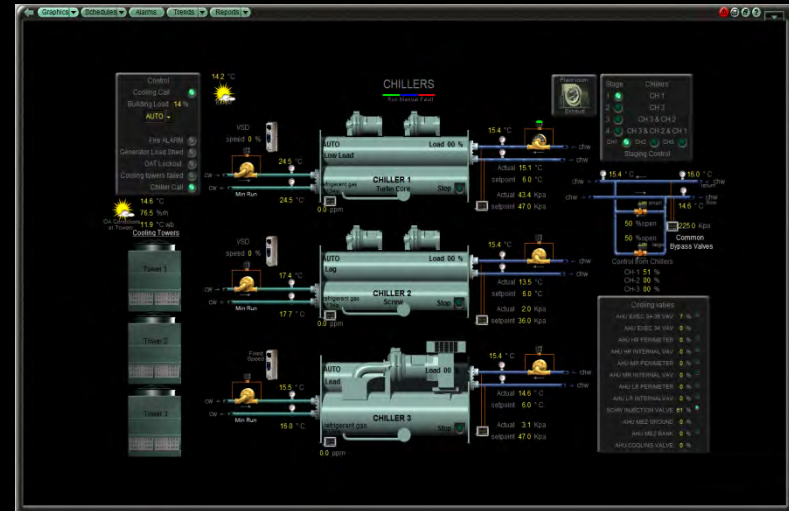
BMCS Graphical Interface

For central plant it is important to know what is causing a heating and cooling call so you can drill down further and eliminate short cycling observed in many buildings

It is important that strategies are flexible and can be tuned for;

- Occupied Mode
- Unoccupied Mode
- Seasonal conditions

Each scenario requires its own parameters so that energy consumption is “limited”.



Stage No.	Stage Up	Stage Down	CH 1 Lead	CH 2 Lag1	CH 3 Lag2	CH 4 Low-Ld
0	Cooling Call On	-	OFF	OFF	OFF	OFF
1	[CH1>76% Load OR CHWRT >14°C] AND maintained 15min	Cooling Call Off	OFF	OFF	OFF	ON
2	[CH2>85% Load OR CHWRT >14°C] AND maintained 45 min	[CH2< 40% Load OR CHWRT < 10°C] AND maintained 45 min	ON	OFF	OFF	OFF
3	[CH2&CH3>170% Load OR CHWRT >14°C] AND maintained 50 min	[CH2&CH3<80% Load OR CHWRT < 10°C] AND maintained 45 min	ON	ON	OFF	OFF
4	-	[CH2&CH3&CH4 <150% OR CHWRT < 10°C] AND maintained 50 min	ON	ON	ON	OFF

BMCS Trending and Reporting

In addition to system graphical displays, the BMCS system should also be capable of providing useful trends and reports

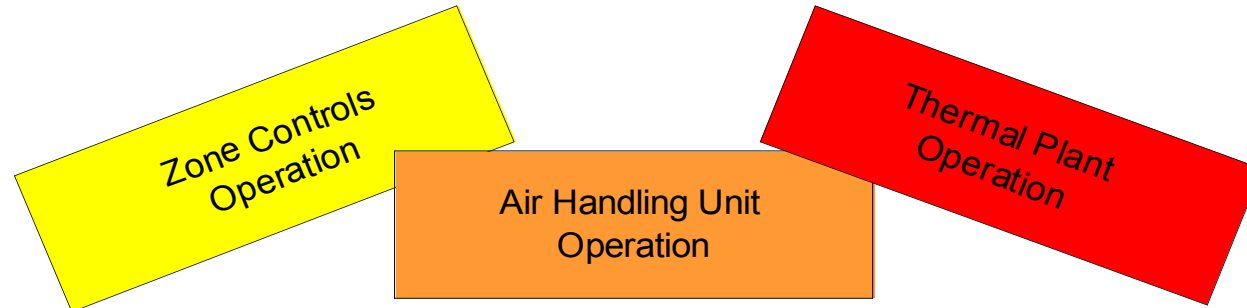
Trend data is important when determining the stability of control algorithms and when tuning the system.

Reports are pivotal when demonstrating current building performance against historical performance and sustainability targets such as NABERS.



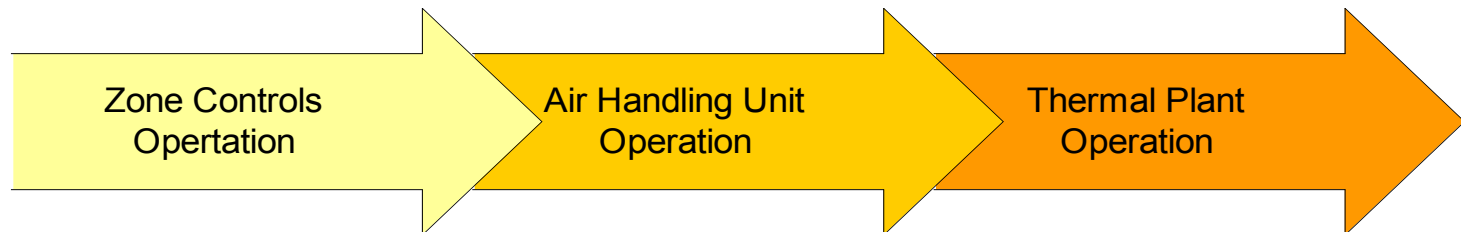
Building Tuning Approach Year 1

Operation at Commencement of Program



Poor or No Interaction Between Individual Systems

Operation at End of Year 1 of Program



Correct Interaction Between Individual Systems

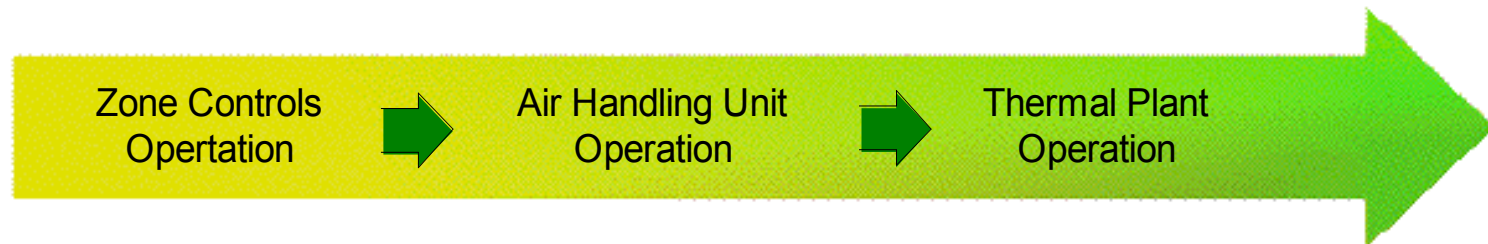
Building Tuning Approach Year 1+

Operation at End of Year 1 of Program



Correct Interaction Between Individual Systems

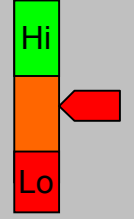
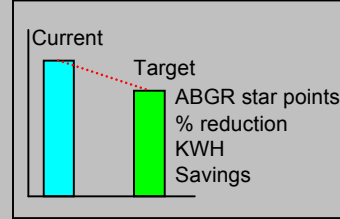
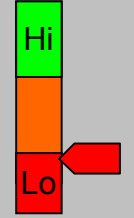
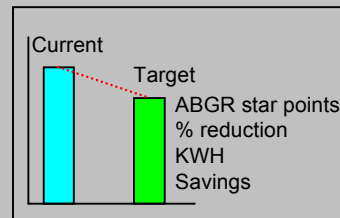
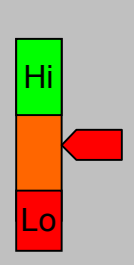
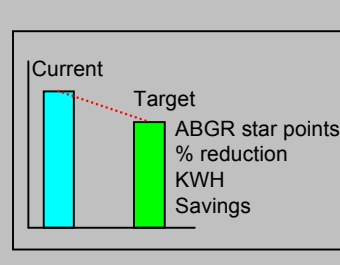
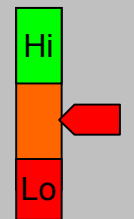
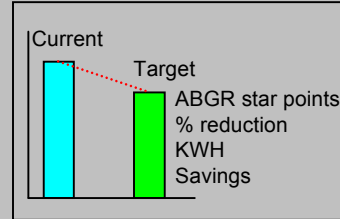
Operation at End of Year 2 of Program



Correct Interaction Between Individual Systems - Overlap Removed

Tracking and Reporting

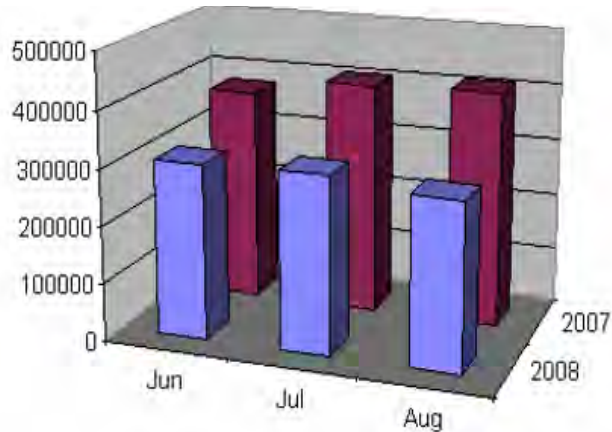
Executive Summary – Mechanical Services

Plant Item	Opportunity	Success Factor	Energy
<p>Chillers</p> <ul style="list-style-type: none"> • Number 2 • Type 3 Centrifugal • Strategy Primary/Secondary & decoupler • Secondary DP Control • 3 ways No 	<p>Opportunity</p> <ul style="list-style-type: none"> • Document initiatives 		
<p>Boilers</p> <ul style="list-style-type: none"> • Number 2 • Type Gun Burners • Strategy Primary/Secondary & decoupler • Secondary DP Control • 3 ways No 	<p>Opportunity</p> <ul style="list-style-type: none"> • Document current operation 		
<p>AHUs</p> <ul style="list-style-type: none"> • Number 20 North & South • Type VAV • Strategy SA reset based on zone avg • Economy Yes, modulating dampers • Static Yes, perimeter duct static @ SP 	<p>Opportunity</p> <ul style="list-style-type: none"> • Document new strategies 		
<p>VAVs</p> <ul style="list-style-type: none"> • Number >200 • Type Celmec airofoil • Strategy Velocity control for cooling. • Reheats Perimeter HHW only • Setpoints Individually adjustable 	<p>Opportunity</p> <ul style="list-style-type: none"> • Document expected outcomes, payback • Review. 		

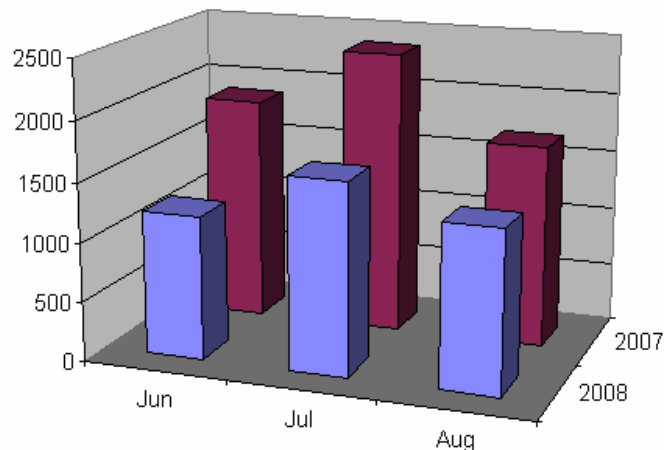


Tuning Example

Electricity usage, 20% reduction



Gas usage, 28% reduction



For our example the following initiatives were identified and executed to increase the system efficiency. As a result the tenant comfort levels improved and the energy usage decreased.

- BT-01 Open the system to be tuned
- BT-02 Boiler strategies improved
- BT-03 Implement Cascading Setpoint Strategy
- BT-04 Cooling Tower, CW strategies improved
- BT-05 AHU strategies improved
- BT-06 VAV strategies improved
- BT-07 Focus now on Chiller Strategies

One of the key elements of building tuning is the ability to access the DDC code and review the data as it cascades through the system. Reliance on normal Operating and Maintenance manuals does not provide the level of detail required.

Tuning Example

Building Tuning Initiative Summary – Cascading Setpoint Strategy

Observation

Currently internal box setpoints are set to 21°C and perimeter box setpoints are set to 22°C which is causing heating/cooling overlap issues. While reviewing setpoints and their relation to optimal start routines, building reset schedules and general temperature control algorithms it was established in general there is no relationship between the demand and the adjustable zone setpoint.

Initiative

In order to improve temperature control and reduce energy usage in the future we recommend a clear relationship between the zone demand and the control algorithms be established. Temperature setpoints will also be set to the same value 22°C to stop heating cooling overlap issues.

Impact

Energy

Small reduction in the short term with further reduction to follow once control algorithms are altered.

Tenant Environment

Small improvement in the short term with major improvement to follow once control algorithms are altered.

Equipment/Maintenance

None

Resources

DDC programming

Mechanical works

Other

BMCS Graphics

Recommissioning works

DDC field devices added

Electrical works

Status

Reviewed with Facility Manager

Planned Date: 07/07/08

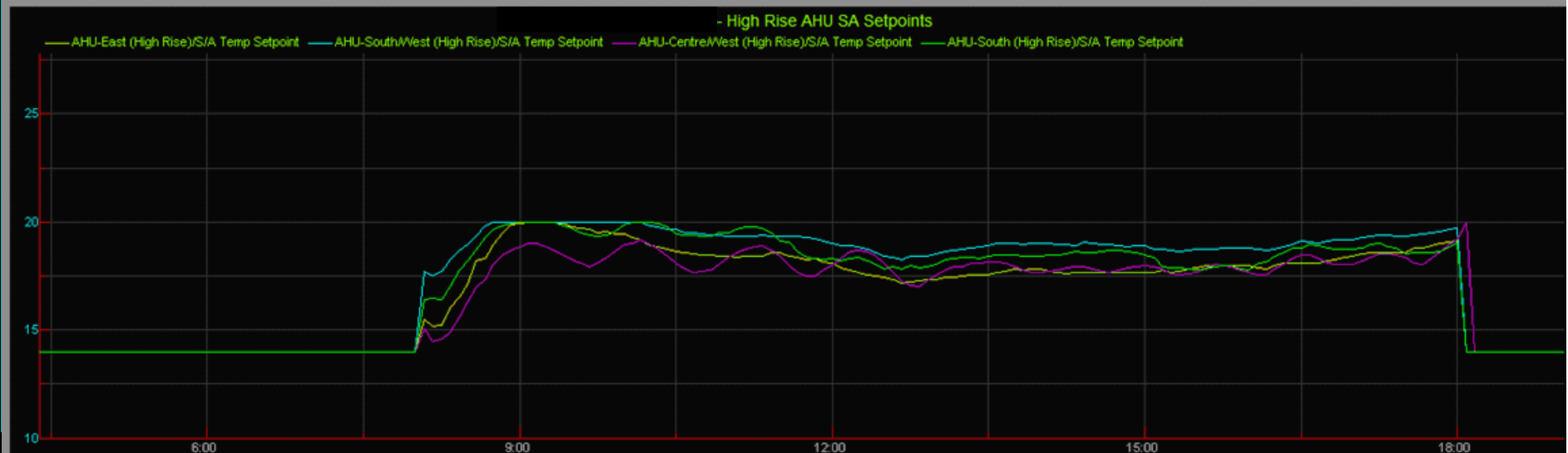
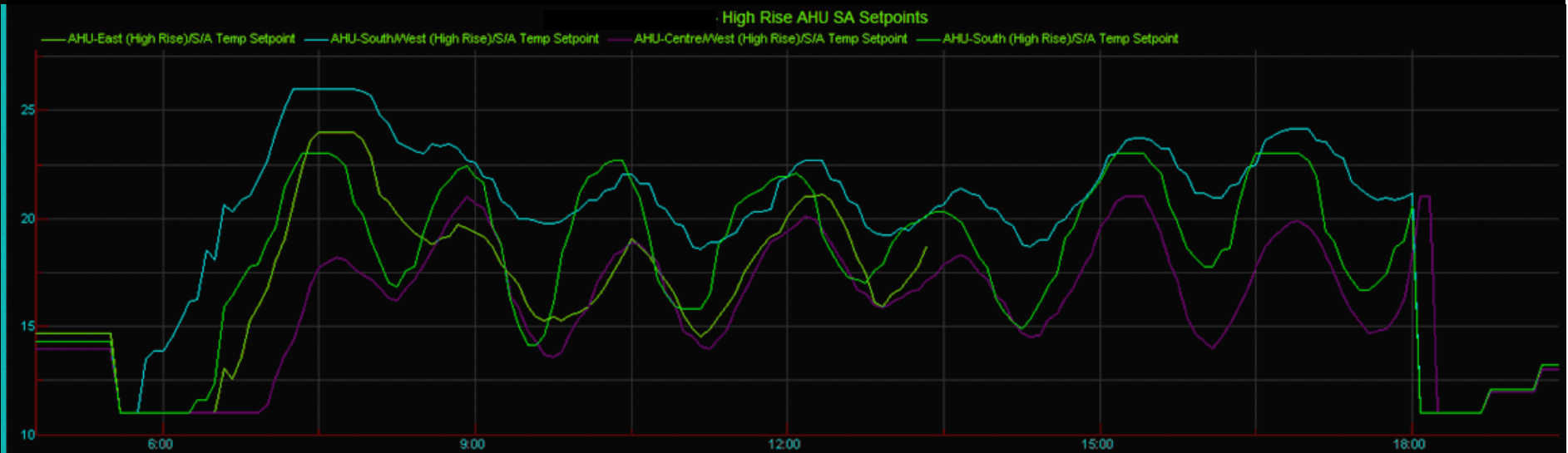
Status: 90% Initiative complete

Permission to proceed

Duration: 2 weeks

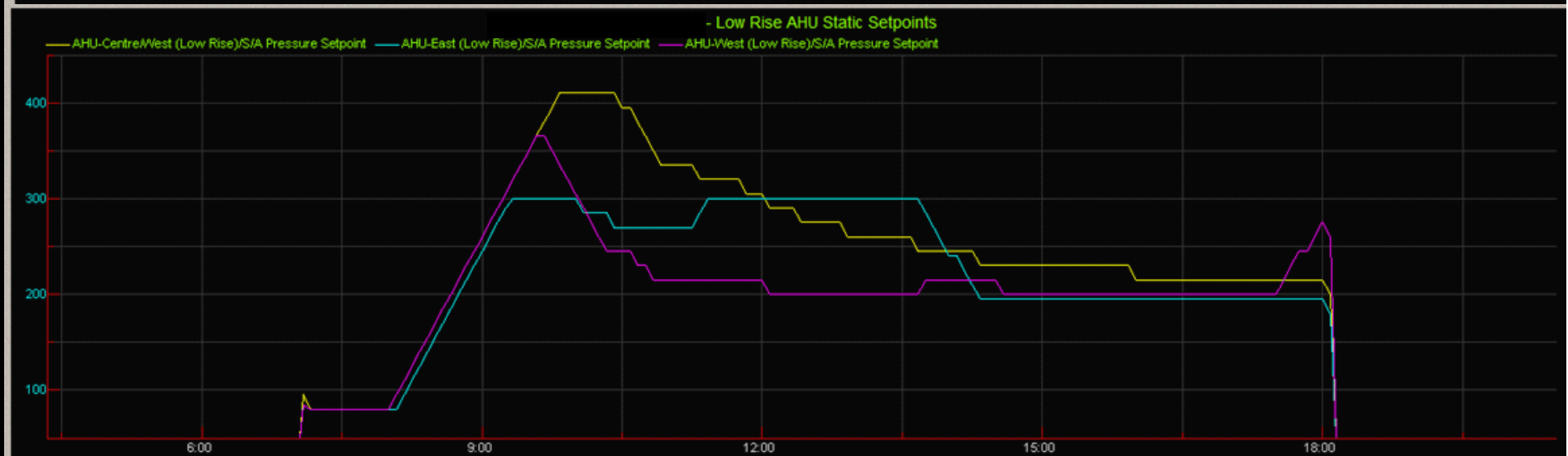
Tuning Example

AHU Temperature Set Points



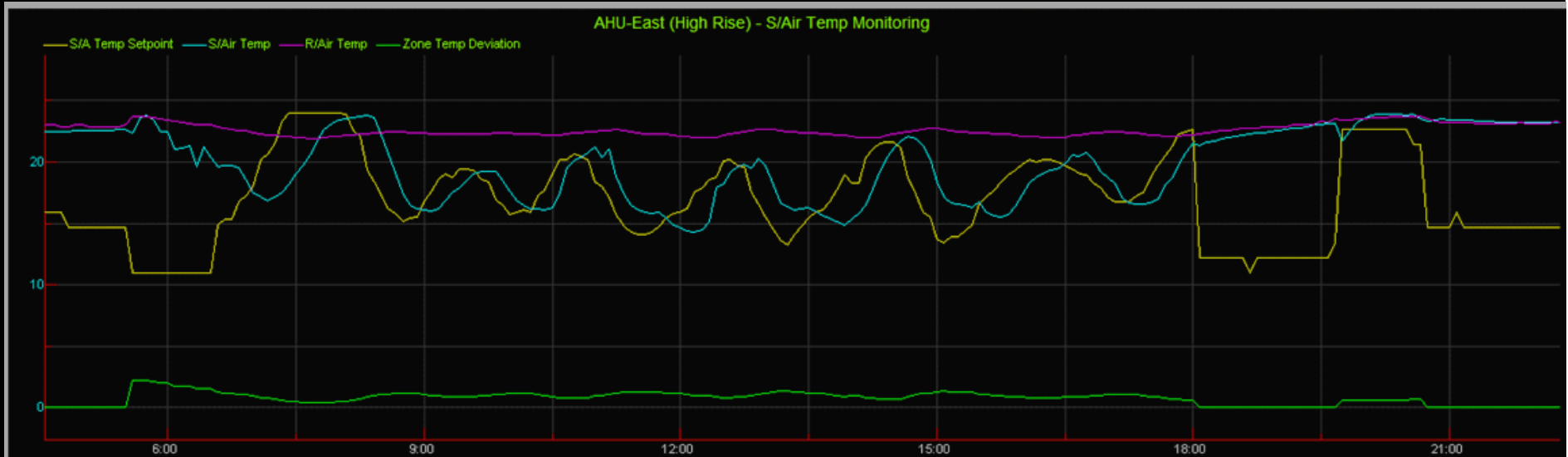
Tuning Example

AHU Pressure Set Points



Tuning Example

Supply Air Temperature



Tuning Example

Chiller Operation



Energy Efficiency Maintenance

- Building specific and energy focused
- About internal conditions, reliability and efficiency!
- It is outcome based providing a structured process coordinating and integrating all facets of building services.
 - *Energy Management, monitoring and reporting*
 - *Coordinates Maintenance regimes*
 - *Dovetails with a Building Tuning program*
 - *Consideration of equipment replacement & upgrade*
- Controls maintenance is re-organised and technicians are provided with a maintenance log book that provides specific focus on key energy consuming elements of the system.
- The maintenance becomes dynamic with a focus on energy consuming elements of the system, specifically targeted to deliver lower operating costs. **Management, Monitoring and Reporting – CLOSE THE LOOP**



An Integrated Approach

- **Building Management and Control Systems**
 - *Is it OPEN for tuning?*
 - *Does it have the tuning tools?*
 - *Replacements should build on the past.*
- **Structured tuning and maintenance process**
 - *Coordination of controls and mechanical maintenance*
 - *Integrated approach; structured and iterative tuning Program linked to maintenance regime*
 - *Planning, documentation*
- **Strategic - Management, monitoring and reporting**
- **New Paradigm!**
 - *Internal conditions, reliability and achieving AND RETAINING energy efficiency!*

BUILDING TUNE UPS FOR ONGOING ENERGY SAVINGS

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