A2EP Innovation X-press 2020

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

A2EP Compressed Air Workshop

11 November 2020

NSW GOVERNMENT | Planning, Industry & Environment

Member & partner organisations

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

CAS audit program

- DPIE and A2EP designed a program to focus on demand side usage of compressed air and show the issues and $$ lost from poorly operating CAS
- $5,000 site audits fully funded by NSW DPIE
- The audits were demand focused and not only on leaks but inappropriate or poor usage of compressed air
- Heavily oversubscribed program showing interest in the area
- Opened peoples eyes about potential savings. Most participants will now do routine leak fixes

CAS audit program

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Preliminary findings from approximately 40 studies from a limited range of industries

Average % of electricity used by CAS	19%
Average energy cost for CAS per site	$125,000
System efficiency	From 6.5 to 23 kW/M3/min Avg 9.2 kW/m3/min
% of air lost to leaks	From 3-66% Avg: 30%
Annual cost of air leaks	Range $1,000-$150,000 Avg: $30,000
Approximate time to fix an air leak	20 minutes
Average payback on fixing leaks	<6 months

CAS industry observations

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- Well-executed audit and leak correction nearly always shows excellent paybacks
- The good news, if you have lots of leaks, you're not alone.
  The bad news is, you're losing $$.
- **Mixed messages and being pulled in different directions**

CAS Operation Observations

- The 4th utility but usually without a bill!
- If you had a water leak, would you let it go?
- Easy to use but easy to lose

CAS Audit Program – main findings

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Three key issues

- Lack of performance/cost visibility
- Operational silos and non-alignment of incentives to maintain an efficient system (maintenance budget vs CAPEX budget)
- CAS systems are inherently inefficient and over time always tend towards inefficient

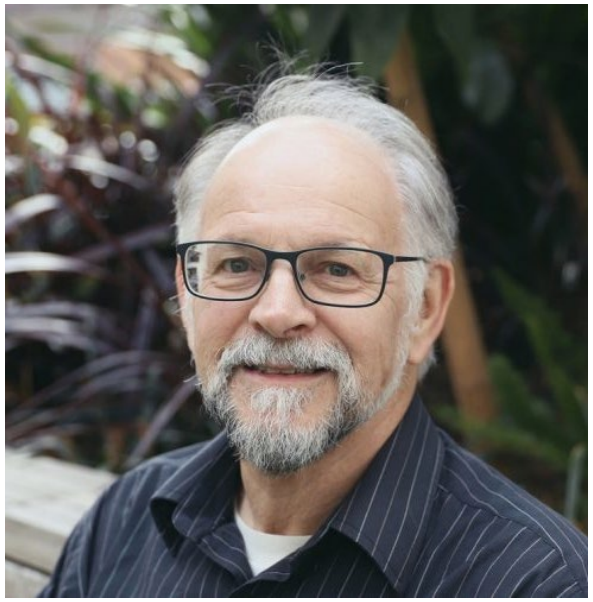
Three key actions

- The need for great metering and monitoring solutions
- The need for routine CAS auditing and maintenance
- Focus on end use reduction wherever possible to reduce the impact of inherently inefficient systems

Our Chair for this session:

Kylie Hargreaves
Director – Hargreaves International
Chair – Australian Alliance for Energy Productivity

Our first presenter:



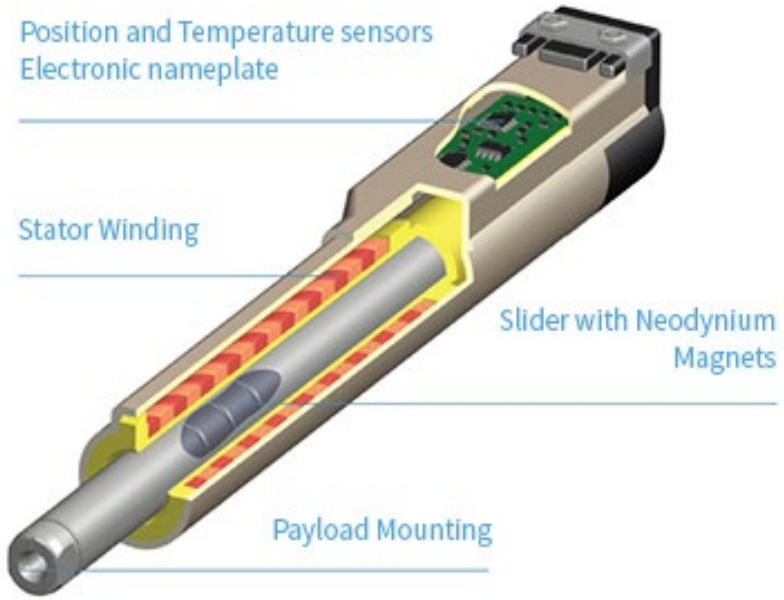
Alan Pears
Senior Industry Fellow, RMIT University

Energy and productivity revolution: alternatives to compressed air

Alan Pears AM, Senior Industry Fellow, RMIT

Compressed air session – A2EP Energy Innovation X-press

11 November 2020



https://www.linearmotiontips.com/electric-actuators-displace-other-motion-options-including-manual-designs-a-motion-trends-report/

https://linmot-usa.com/products/linear-motors/

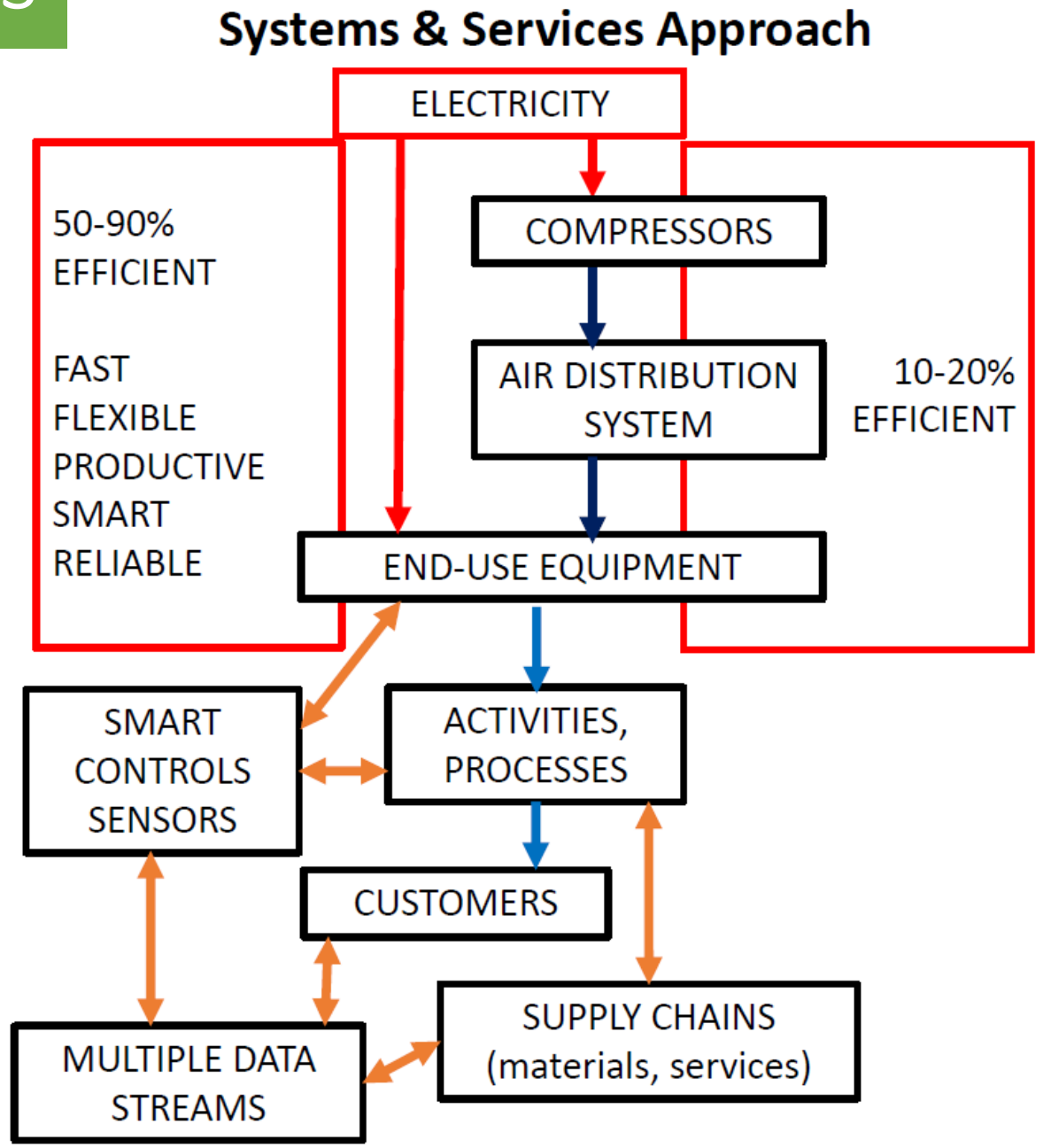
https://www.smac-mca.com/it/smart-screwdriver?language=en

https://www.aircontrolindustries.com/air-knife-systems/

Operating cost savings 96% by replacing compressed air with air knife system; payback nine months

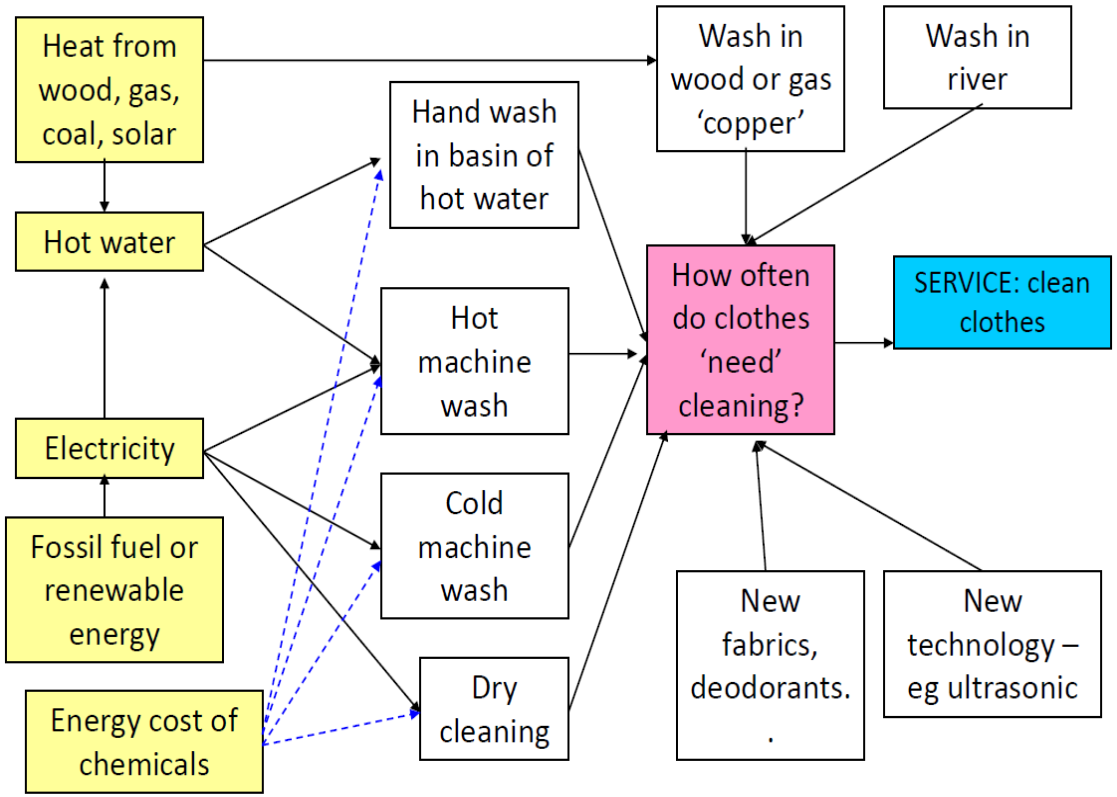
The big picture - alternatives

- **Change supply chain, customer requirement and/or process to cut YOUR need for energy and equipment – fundamental services**
- **Enter the world of efficient, flexible, precise, smart, connected electric CAS options**
- **Capture multiple business benefits**
  - Increase productivity – identify bottlenecks, optimise speed, reduce reject rates, OH&S
  - Avoid loss of production – identify and address signs of emerging problems
  - Preventive maintenance – improved scheduling and staff management
  - Cut energy costs, manage peak demand
- **But it's not 'all or nothing':**
  - Add 'connected, smart actuators', sensors to existing CAS to enhance performance



What are the fundamental services? What options can provide them?

An example of an energy service: supply of clean clothes (adapted from Pears & Versluis, 1993)



Energy Productivity
= (Enhanced value)/(energy used)

How do I improve business AND energy productivity?

- What are financial and energy flows? Where and when are energy losses and financial waste now occurring? What extra benefits can we capture?
- Can I avoid need for process – Change design, process, customer expectations, inputs?
- Challenge assumptions:
  - How much could flexible, better-informed management improve operations, quality, maintenance, equipment life?
  - How can process speed be increased – bottlenecks?
  - What temperatures, how much energy in what form, potential heat sources?
  - How efficient is system at full, part, low load and during transients (start-up, varying weather etc)
- Consider 'multiple benefits' of options
- How do we build an innovative, 'learn from doing' culture?

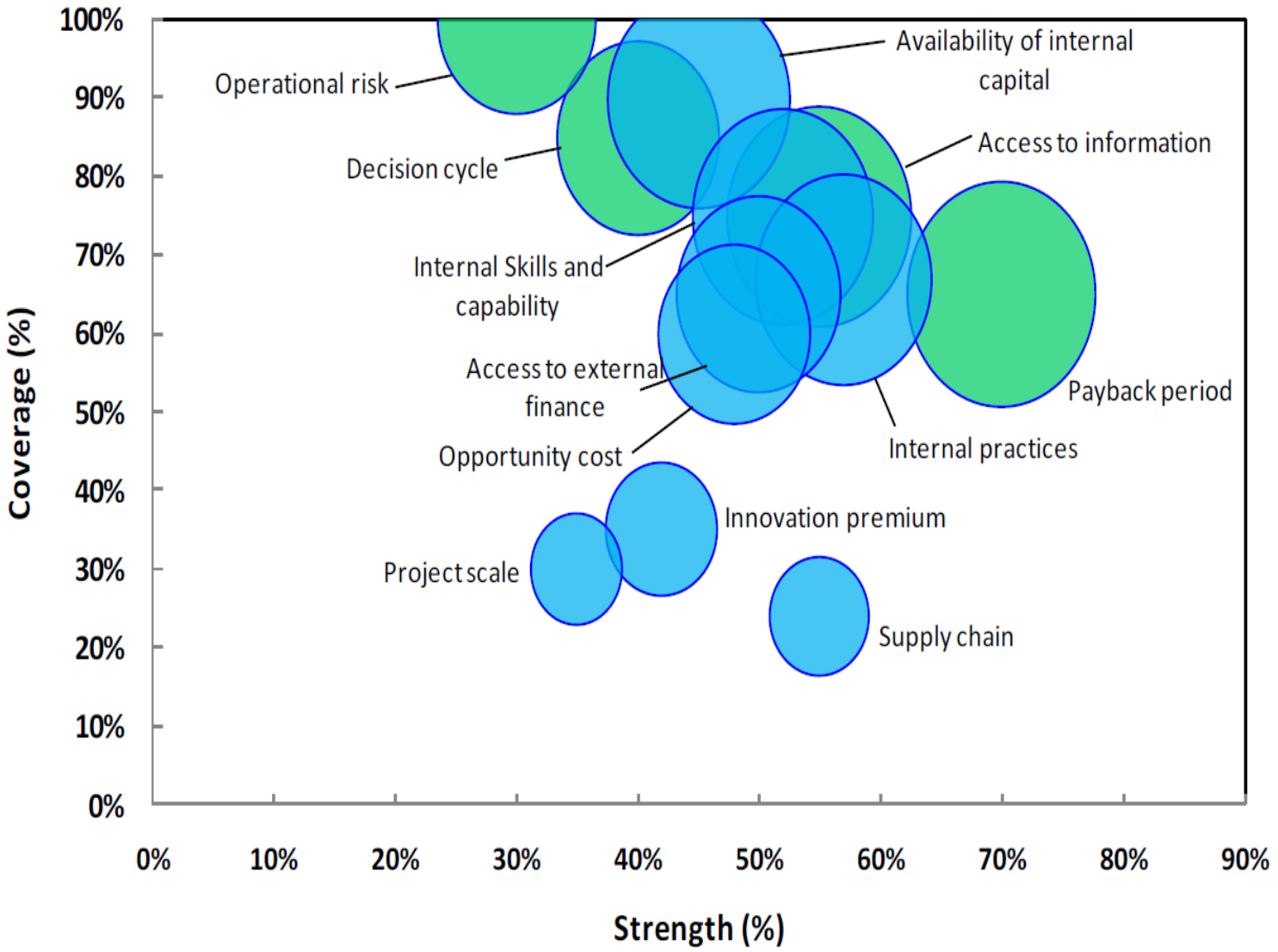
Alternatives to compressed air

ACTIVITIES	OPTIONS (see A2EP CAS Alternatives report for detail)
Conveying, sorting	Electric, magnetic or piezo-electric actuators (linear and rotational)
Tools	Cord or cordless smart screwdrivers, drills etc, 3-D print, glue, avoid
Motors, pumping	High efficiency, flexible (eg VSDs) appropriately sized electric motors, modular point-of-use equipment
Clean, dry, heat, surface preparation	Electric fans, blowers, brushes, mechanical motion, abrasive belts, solvents, heat pump, waste heat, microwave, radiation, induction, optimal management, heat recovery + HP temperature increase, avoid
Cool	Fans, evaporative cooling, heat pump/chiller, thermo-electric, waste 'coolth', avoid (eg heat tolerant equipment, ambient cooling)
Mix, aerate	Mechanical motion, low pressure blower, gravity, avoid
Vacuum	Alternative handling methods, point-of-use electric vacuum pump, advanced motors/fans/flow efficiency
Painting, coating	Alternatives, airless/low pressure spray guns, high pressure hydraulic, avoid
ENABLERS	
Digitalisation	Sensors/monitoring, analytics, information flows/connection, use of multiple data sources, user interfaces, organisational use of information (Industry 4.0 – see A2EP report)
'Watching brief'	Tracking of emerging innovations, business models, interaction with rest of value chain
Energy	Demand Response, On-site renewable energy, energy storage (batteries, part-processed product, thermal), management systems

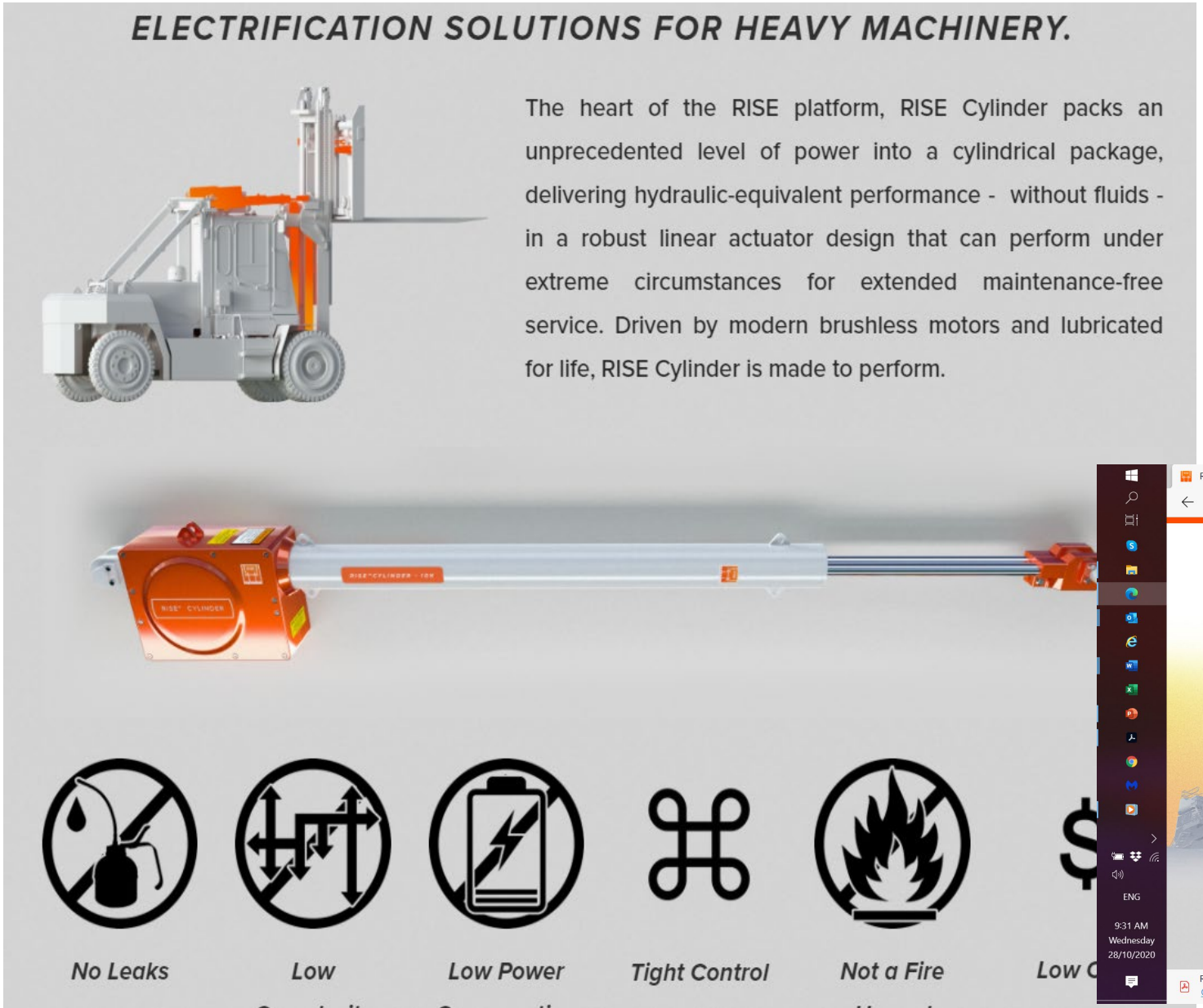
Overcoming barriers, cultural and policy issues

- Capital costs, financing, perceptions of financial risks, comparisons with 'sunk capital'
- Supply chain fragmentation, conflicts of interest, capability, long term stability ('orphan risk')
- Limited recognition of multiple benefits and emerging options
- Making a strong business case to operational + senior management, finance staff
- Possible loss of production, quality, lack of contingency strategies
- Organisational change; allocation of costs, benefits, credit/blame; cultural silos
- Limited in-house expertise, time
- Site-level issues – training, awareness, confidence

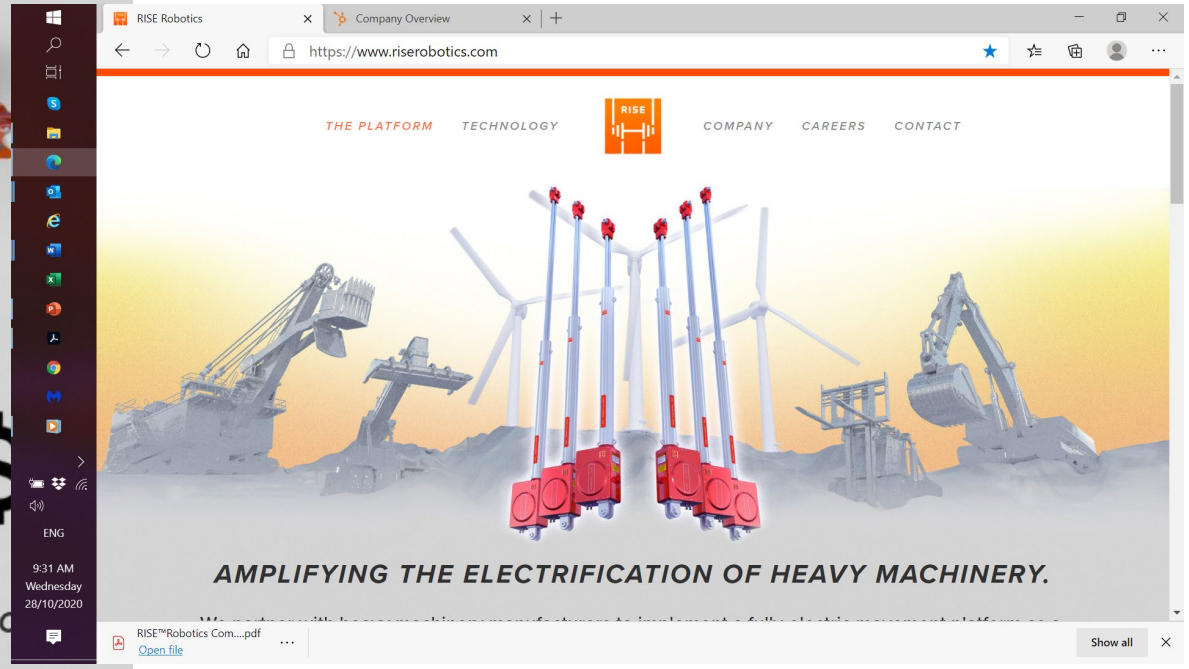
Source: Reproduced from *Industrial energy efficiency data analysis project*, ClimateWorks Australia, 2013



Beyond compressed air alternatives

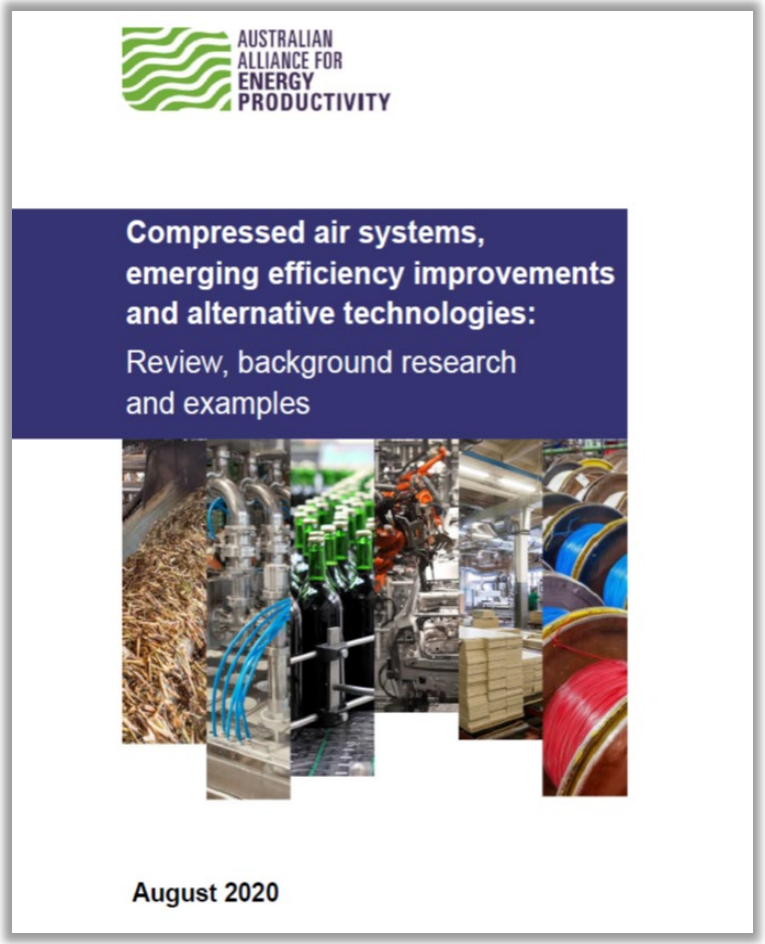


Electrification replacing hydraulics in heavy machinery with multiple benefits eg Rise Robotics (riserobotics.com)



THE END

Thanks for your attention



Check out Compressed Air Systems, Emerging Efficiency Improvements and Alternative Technologies: Review, background research and examples

at

https://www.a2ep.org.au/publications

Our next presenter:

Warwick Rampley
Managing Director – Warwick Rampley

Compressed Air Alliance

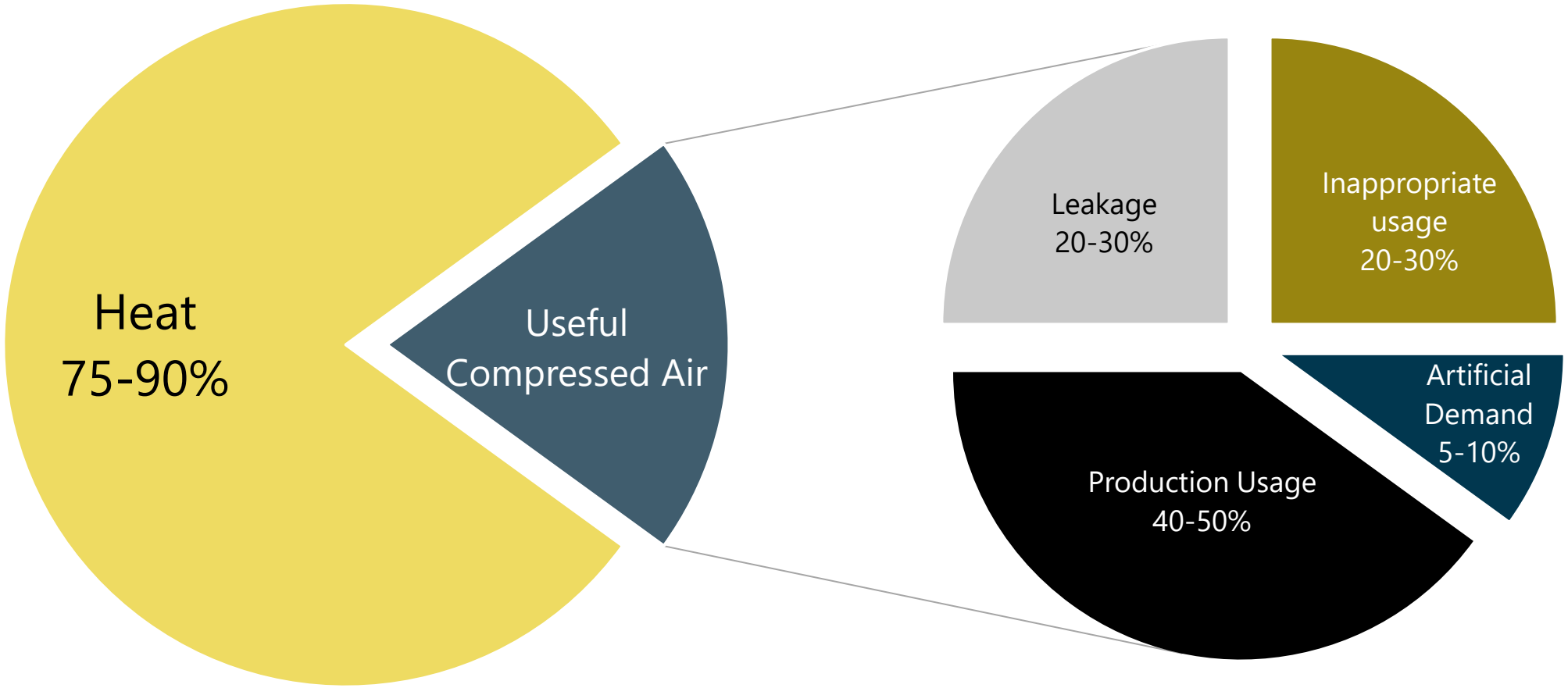
Warwick Rampley, Managing Director

Who is Compressed Air Alliance?

- Compressed Air Alliance was born from the desire to eliminate compressed air waste
- Compressed air is extremely expensive
- Compressed air systems are poorly maintained
- Compressed air systems are poorly understood
- Compressed air is an abused resource in manufacturing globally!

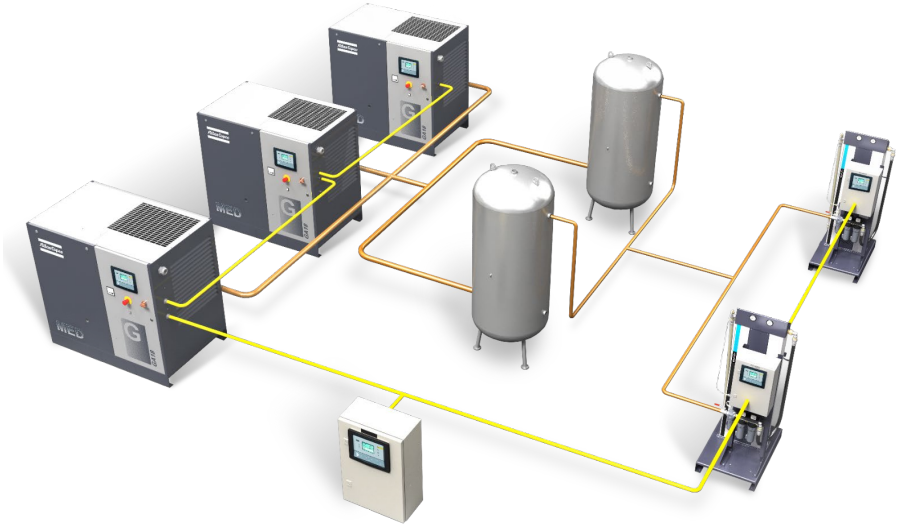
The cost of ownership over a 10 year period

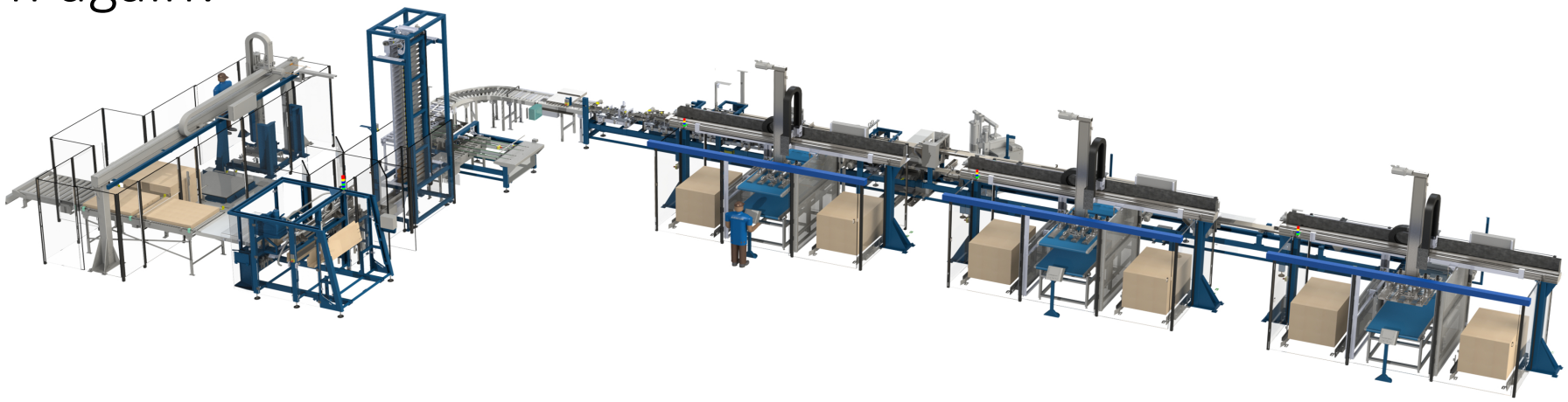
Where does the energy go?



Get the basics right!

- Measure the system – Establish a baseline
- Leakage audit and repairs
- Remove inappropriate use
- Eliminate artificial demand
- Measure the system again!



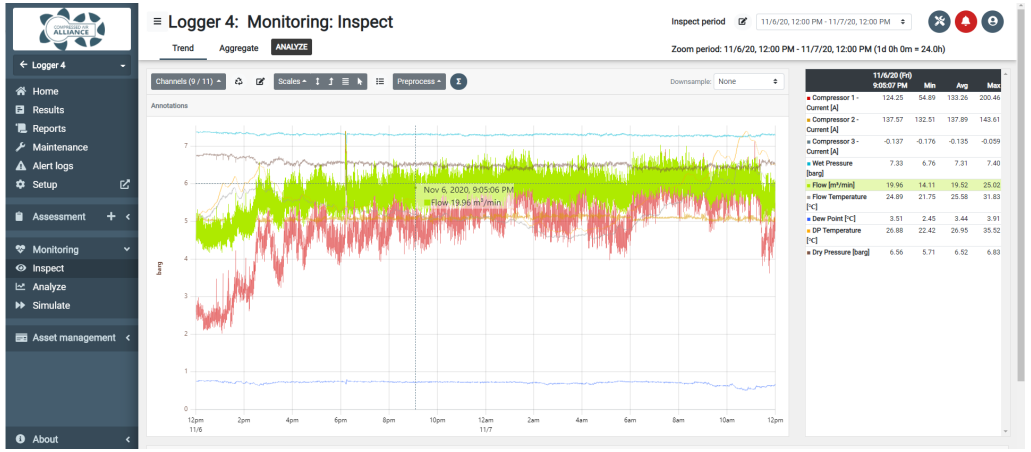


What do you need?

- **Knowledge**
  - Compressed air systems are extremely complex
  - Understand interactions of thousands of components
- **Power**
  - Measure energy use of compressors
  - Used with flow gives you specific power
- **Flow**
  - Measure factory supply flow rate and consumption
  - Used with power to give specific power
- **Pressure**
  - Measure supply pressure from compressor and to factory
  - Difference identifies issues in filtration, dryers and pipework

What do you need?

- **Ambient Temperature, Pressure and Humidity**
  - These conditions affect compressor, dryer and system performance
  - May be needed to correct readings of other instruments
- **Dew Point**
  - Measure moisture content of the compressed air
  - Identifies dryer and condensate drain issues
- **Data logging**
  - Logging needs to be at very high sample rates
  - Logging needs to be for 7 days or more



Remote Monitoring

- We can monitor, analyse and advise on your compressed air system from anywhere in the world
- Changes can be verified in real time

Leakage

- Don’t conduct an leak survey without a plan for repairs
- Most companies fail to record enough information for the leak to be fixed
- Most people underestimate the cost and time required leak repairs
- Approximately 90% of surveys fail to complete repairs when conducted in house

Thank You

Warwick Rampley

Managing Director

Compressed Air Alliance

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Phone: 0422 748 645

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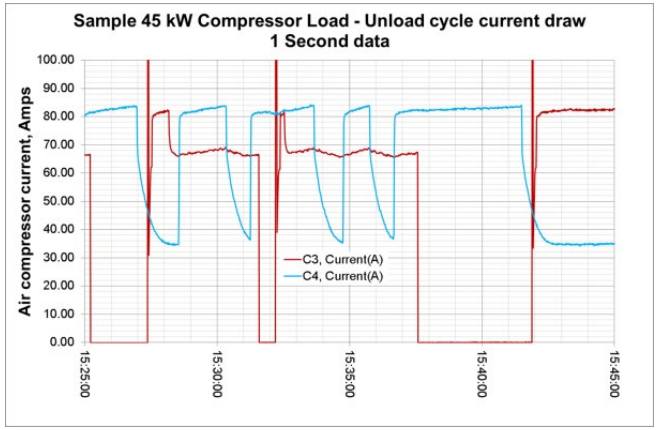
Our next presenter:

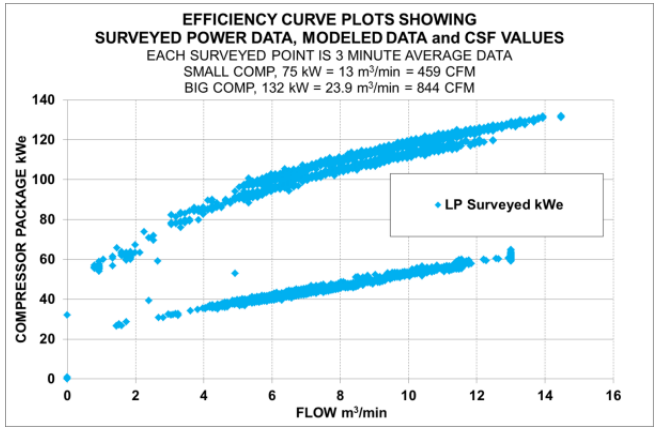
Murray Nottle

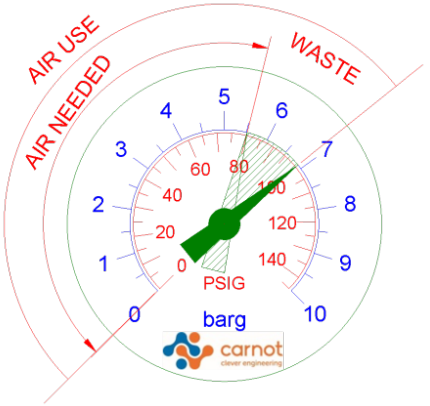
Mechanical and Process Engineer – The Carnot Group

Easy Compressed Air Power Savers

Murray Nottle, The Carnot Group







Four activities:

Do in this order for maximum success

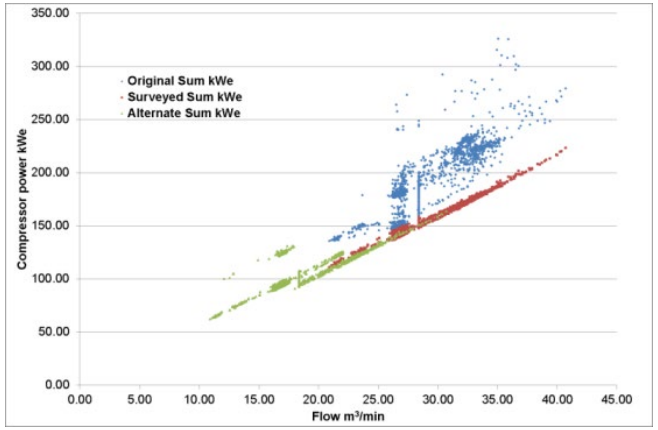
1. Rethink business compressed air EE economics
2. Ensure compressor capacity controls are working properly - healthy
3. Sequence compressors for best system efficiency and yield
4. Demand side air saving

The Carnot Group

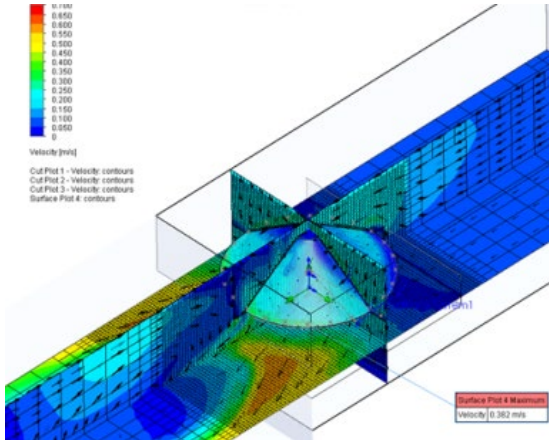
Easy Compressed Air Power Savers

Murray Nottle

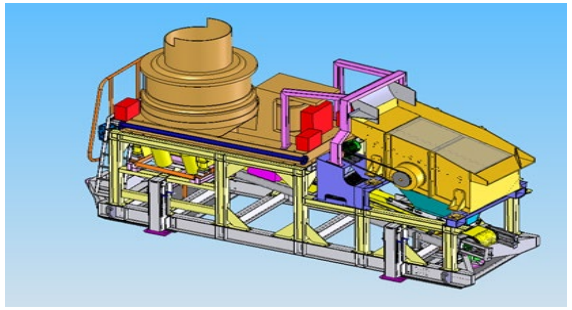
- Engineering Consultants, Mechanical and Process
- Troubleshoot and upgrade old, design new, equipment, processes and plant services.
- Computer modelling: FEA stresses & fluid dynamics
- Data collection. > 20 Logging devices & other instruments
- Manufacturing, mining, water utilities, renewable energy



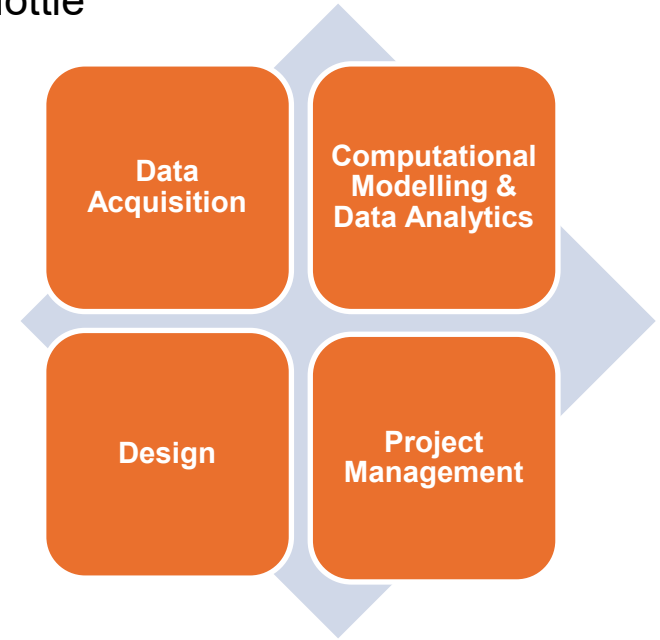
Compressed air system efficiency curve with surveyed data and modelled power draw using the surveyed flow profile. Survey and modelling by The Carnot Group



CFD - Water velocities at a conical filter screen. Design and modelling by The Carnot Group

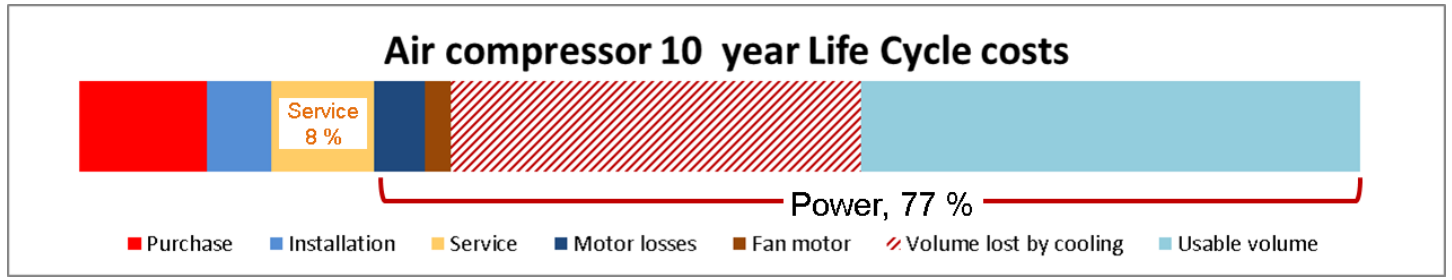


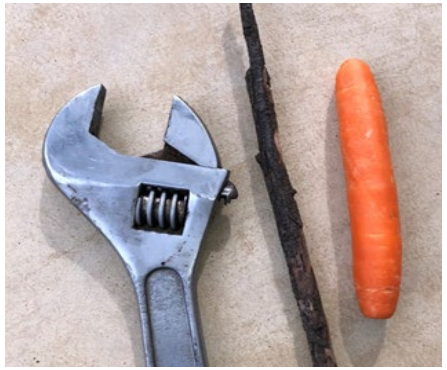
Underground Mine, Modular Ore crusher By The Carnot Group: Design, 3D model, FEA of Static and Dynamic stresses.



Activity 1:
Rethink business compressed air EE economics

Easy Compressed Air Power Savers
Murray Nottle





Maintenance EE budget , stick or carrot

1) Circular funding of maintenance budget for EE

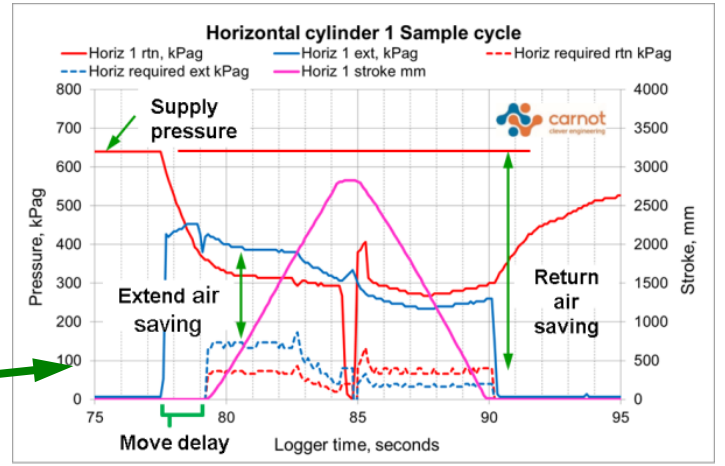
"Why spend site maintenance money on EE with no return to maintenance budget?"

Maintenance budget affects how efficiently equipment operates, but equipment is operated to save maintenance budget not energy bill.

Business needs to refund/reward maintenance budget (in real time) for EE work so no penalty and allow EE mindset in fitters.

2) Value the double benefits of production gains & EE

- Stable production machine pressures gives greater reliability
- Fitting regulators to actuator's ports save 58 % air, 19% faster
- Wasted work project. 82 % air saving, 60 % faster cycle



Activity 1:
Rethink business compressed air EE economics

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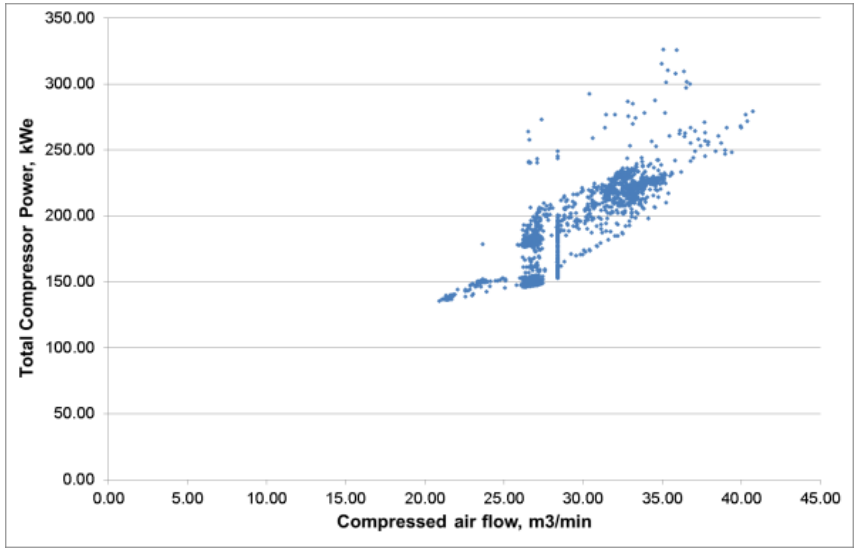
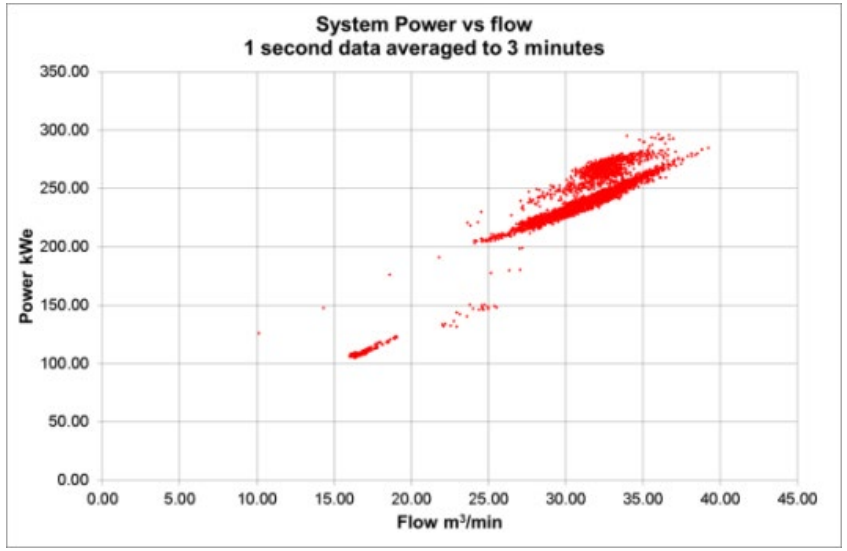
3) Realistic Savings estimates

- Don't over promise savings – it can ruin chances for future EE.
- Base on Yield of system, not average specific power (kWh/m^3) from long term data.
  Yield is:
  - kWh saved / m^3saved = slope of Efficiency (Power vs flow) curve.
  - Different to average specific power (kWh/m^3) and is rarely linear.



Step, down= yield huge, left = yield small



Bad VSD trim, Yield not line to 0,0

Activity 2:
Compressor controls health check

Easy Compressed Air Power Savers
Murray Nottle

carnot clever engineering

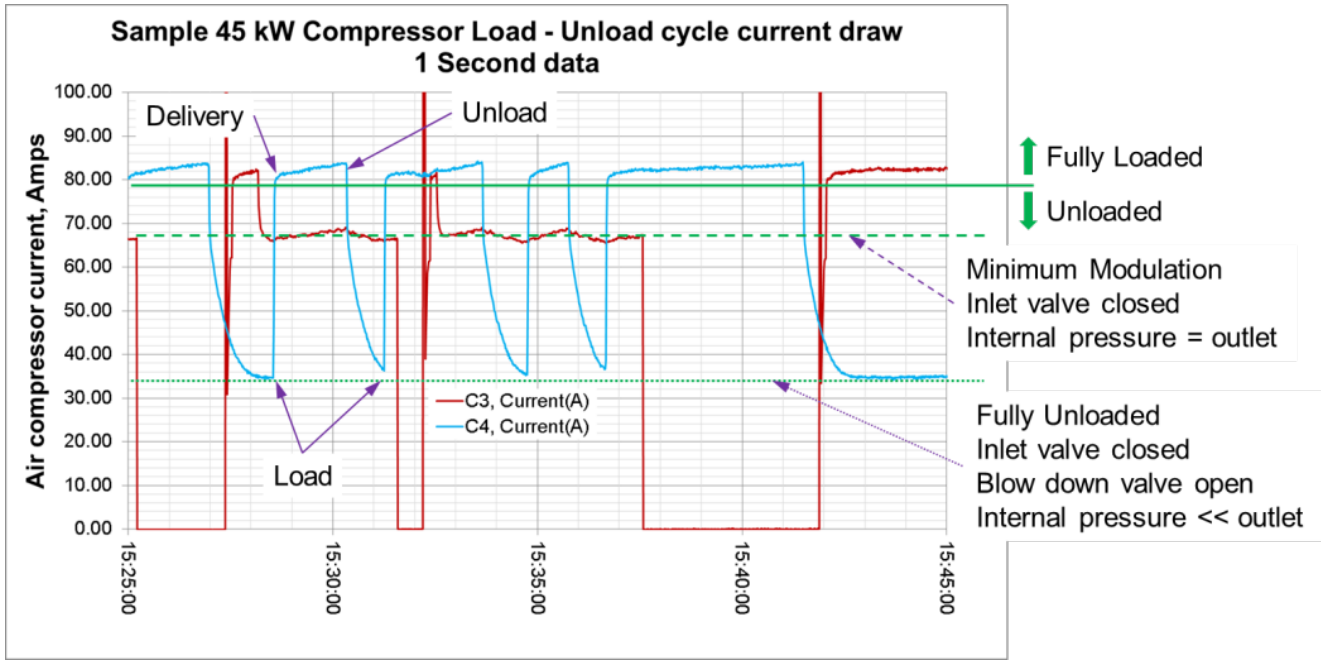
One in five systems have a compressor with a faulty inlet or blow down valve.

Despite failure the compressor runs normally. Site pressure may be low affecting production (Running out of air?). C3 (red) faulty blow down valve wasted 5% of CAS power. C4 (light blue) was healthy.

Valves wear as compressor cycles load/unload, 0-300 cycles per hour. Can't predict valve life in hours so not in service programs. Servicemen miss fault as not trained to test or not given time to do so.

Health check.
Measure compressor current using clamp meter as load/unload. Use table to find health of valves.
If Amps or time windows aren't met, call service co..

Event	Amps % Unload pt	Seconds Typical	Result
Unload to Min Mod	<80	<5 butterfly in <3 other inlet	Inlet valve good
To Fully Unloaded	< 55	45-120	Blow down valve opens
Load To Delivery	> 90	<5 butterfly in <3 other inlet	Both valves good



Activity 3:
Sequence compressors for best system efficiency

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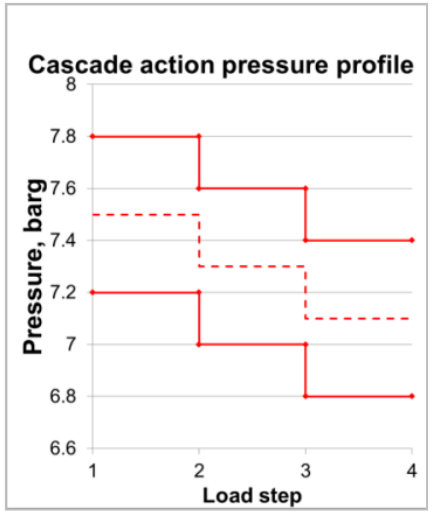
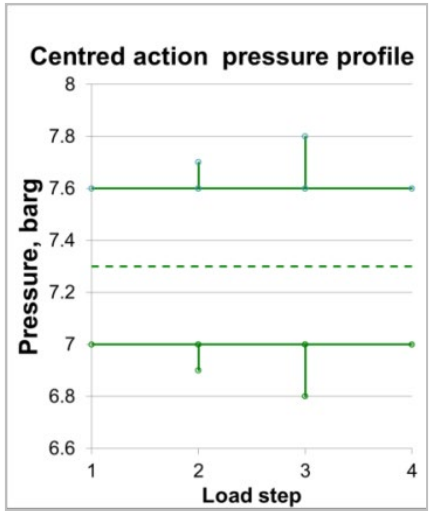


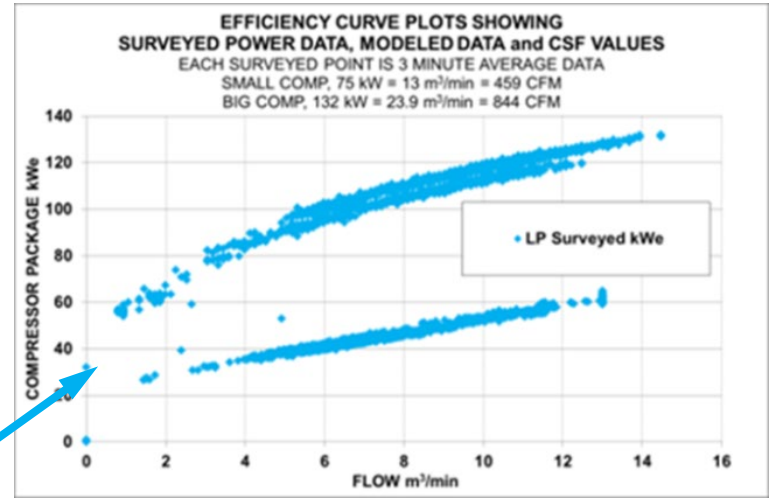


Forget historic terms and ideas for sequencing work:

- "Lead – Lag" = compressor place in a list
- "Equal compressor run time". Maintenance budget not power. Power = 10x service
- Fixed sequence using FILO (First In Last Out) logic & Cascade action. Trimming machine and average pressure change.

Think:

- "Full load" and "trim" = Function on CAS
  Trim with: VSD then spiral/poppet valve and smallest fixed capacity.
- Variable sequence using FIFO (First In First Out) logic & Centred action. Trimming machine & pressures unchanged

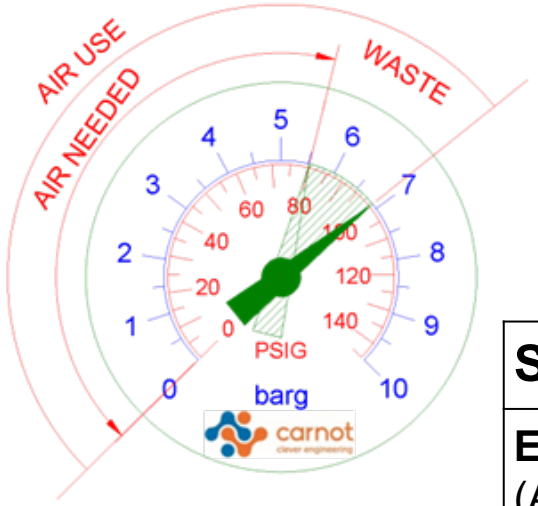


New sequence could save 36% in power

NSW Compressed air guide for CSF & sequencing. Compressed Air Best Practice for CSF &Yield
http://www.environment.nsw.gov.au/resources/business/170257CompressedAirGuide_web.pdf
http://www.airbestpractices.com/technology/compressor-controls/view-australia-efficiency-curves-system-volumes-and-compressor-system

Activity 4:
Point Of Use (POU) pressure regulation

Easy Compressed Air Power Savers
Murray Nottle



All compressed air saving techniques belong to one of six savings methods

Artificial Demand = Air a device uses above what it needs to do its task

Saving Method	Description
Excess pressure (Artificial Demand)	Higher pressure supplied to a device = more air used. Actuators: It is the pressure difference between ports that does work.
Excess volume (Artificial Demand)	E.g. tube volume between actuator ports & its control valve
Excess "Air On time" (Artificial Demand)	E.g. **air leaks**, timer operated valves, uncontrolled blowing nozzles
More efficient Device	E.g. **"Poor"** (inappropriate) air use, better nozzles, blowers, electrics
Wasted Work	E.g. Moving any weight other than product, especially against gravity.
Air reuse	Reusing the air in an actuator at the end of stroke at a lower pressure

Activity 4:
Point Of Use (POU) pressure regulation

Easy Compressed Air Power Savers

Murray Nottle

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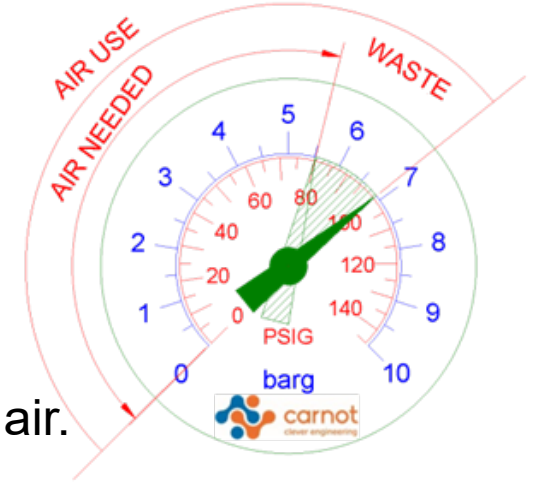
Aim is to set all pressure regulators on site, ideally (if practical) on all ports of air devices:

1. Start at the “Critical POU”, the first machine to suffer during a system “low pressure event”.
2. Fastest cycling devices and other big air users.
3. Last slow cycling and small devices.



Regulator pressure gauge needle movement, ideally barely moves:

- No regulator on a device port, faulty/no gauge ? Fit right size new ones.
- Slow = the regulator is fully open, not regulating = outlet at system pressure.
- Quick, large movement = regulator or supply pipe are too small = upgrade.

When were these items replaced? They block up, need higher pressure, wasting air.

- Exhaust silencers on the control valves.
- The filter elements at the machine air supply inlet (service unit).

The NSW Compressed Air guide tells how to tune actuators, select and set regulators.

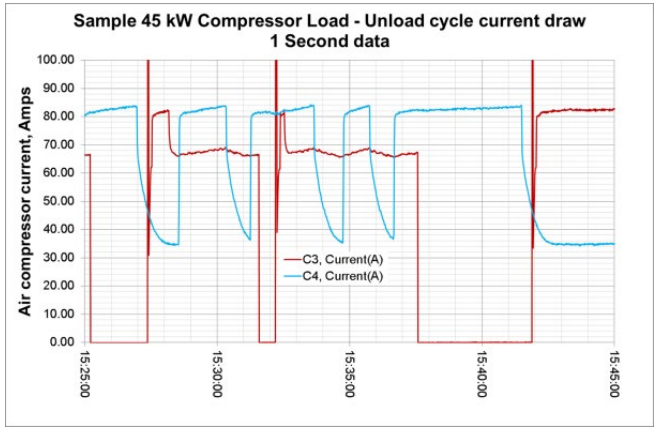
http://www.environment.nsw.gov.au/resources/business/170257CompressedAirGuide_web.pdf

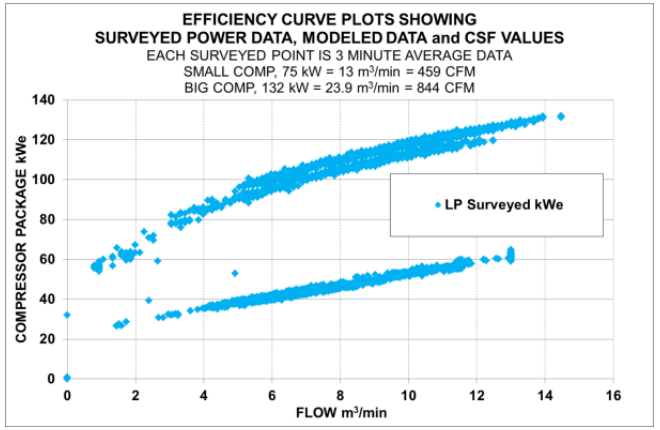
Compressed Air Best Practices magazine 2 part article on regulators and artificial demand

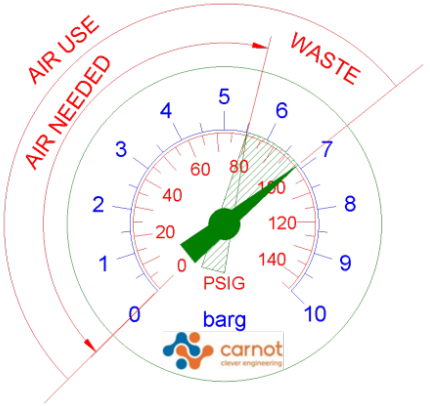
https://www.airbestpractices.com/technology/instrumentation/managing-pressure-regulator-artificial-demand-part-1

Set regulator pressure to “min to operate”. Tag with “flow & no flow” values for future use.

Thank you







Murray Nottle, The Carnot Group
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www.carnot.com.au

Easy Compressed Air Power Savers

Murray Nottle

Cylinder port pressures (unregulated) & piston rod extension (stroke) were logged at 25 Hz:

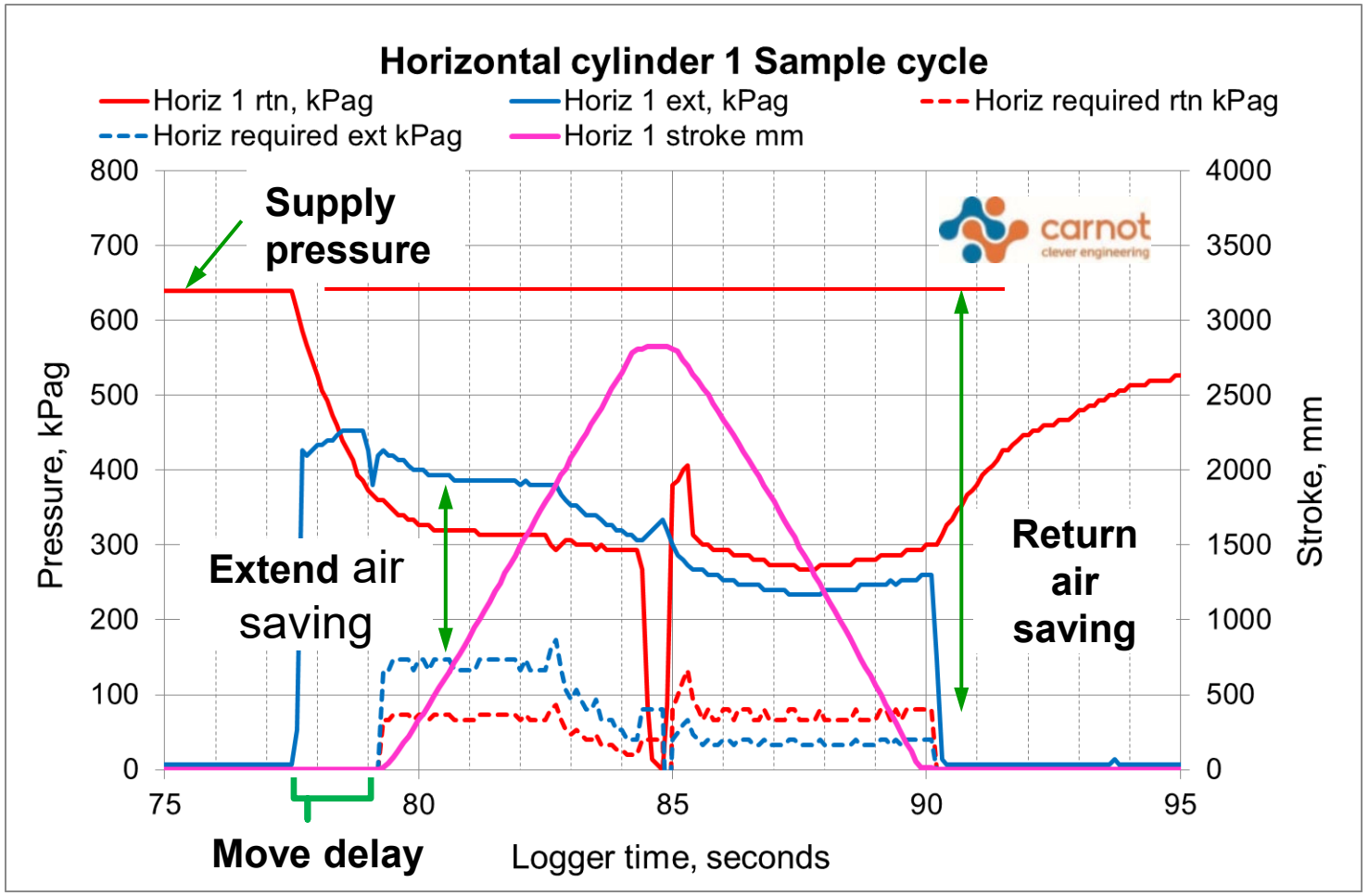
- Supply 630 kPag,
- Extend difference 80 kPa,
- Return difference 40 kPa.

Pressure difference = work,
Pressure when end next exhausted is air used.

Regulating both ends of this actuator could save 58 % air use and 19% production gain.

Whole machine review. With regulation & air reuse:

- air savings = 65 % / cycle
- cycle 25 % faster.



Questions and answers

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Submit any questions to the questions tab at the top.

Thanks to session supporters

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