TARSHEED
Rethink فكر

Energy Management Training: Conducting a simple walk-around survey

Contents

- The goals of the walk-around survey.
- The ADDC 12 Step Approach
- Planning and practical preparation for the survey.
- Things to watch out for and how to gather information on the survey.
- Developing the analysis
- Developing the report.
- Developing the business case presentation.

SURVEY GOALS

Efficient companies target energy wastage:

Unnecessary Service

- Providing service that is never needed

Poor Control of Delivery

- Providing service at the wrong time or over provision of service.

Inefficient Utilization

- Outdated or poorly maintained equipment

Unsuitable Form

- Using energy in ways that would be better supplied with other forms of energy.

What can we deliver to stakeholders?

- For shareholders:
  – Improved returns and reduced risks.
- For financial managers:
  – Improved cost forecasting and control.
- For production and plant managers:
  – Better insights into the interplay between process resource intensity and quality.
- For maintenance managers:
  – Stronger business cases for maintenance and investment.
- For procurement directors:
  - Better insights into procuring cost-efficient equipment.

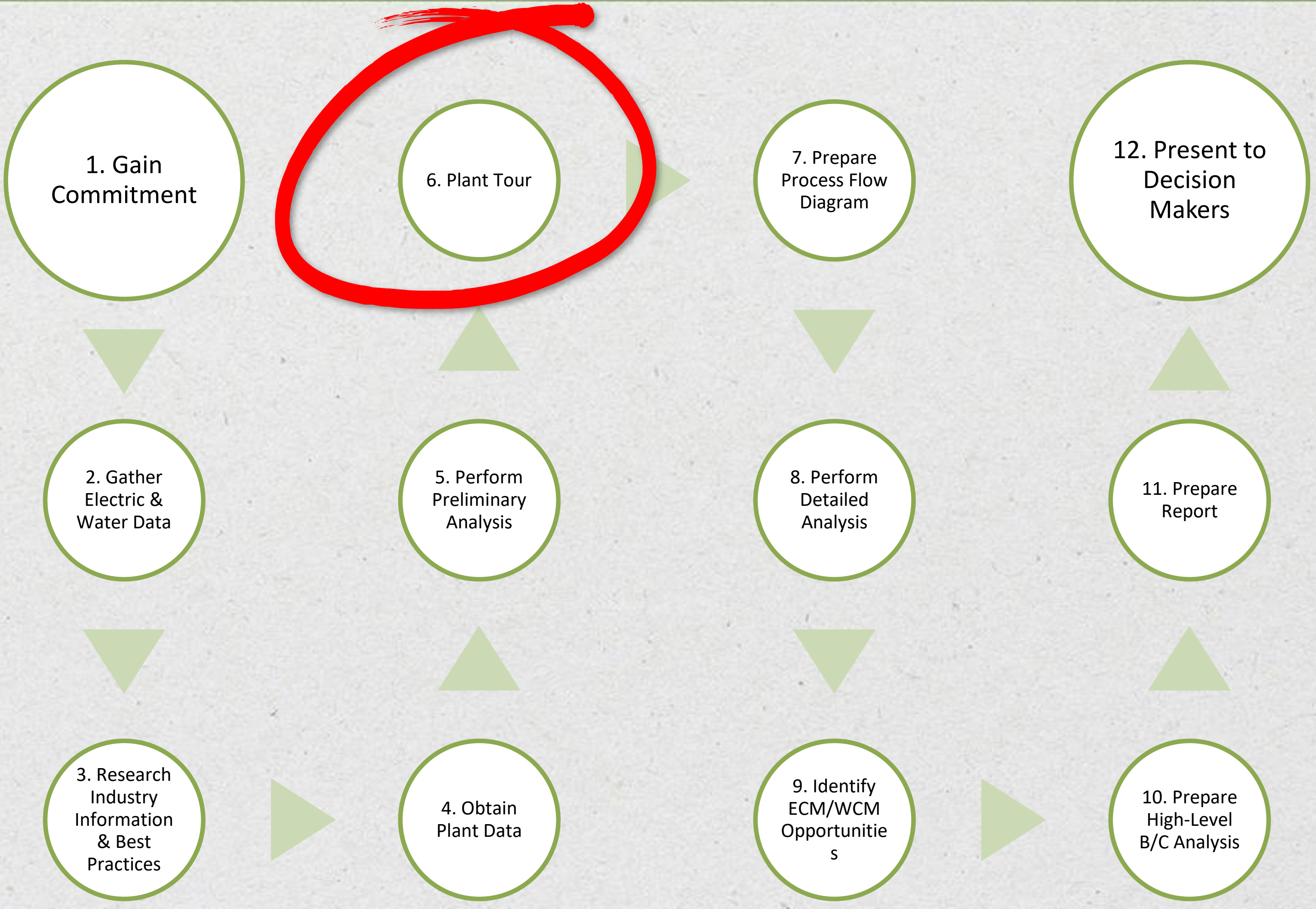
The walk-around starts the improvement process

- A walk around your premises to:
  - Build a picture of the workflow through the facility.
  - Identify which equipment uses energy.
  - Understand why energy is being used.
  - Identify when energy is used.
  - Understand what the process needs.
  - Identify areas for savings.
- Conducted in collaboration with the production team.
  - Go for practical, credible ideas.
  - Use a fresh pair of eyes and keep an open mind.

Structured approach highlights and quantifies waste

- Gather consumption and production data over time and develop a time series for product energy intensity.
- Develop picture of international best practice.
- Prepare for and conduct survey that will develop a process map for the site, and examine management systems, staff awareness and process control.
- Benchmark product resource intensity against international best practice.
- Benchmark site processes, equipment and management systems against international best practice.
- Develop gap analysis and provide a high level estimate of potential savings matched against estimates of investment required.
- Develop opportunities report detailing findings and aimed at driving action.
- Present to management to identify next steps.
- Follow up and support ongoing process.

Survey is halfway along a 12 step process



SURVEY PREPARATION

The survey helps process raw information

Survey Perspective

Inputs
Consumption time series for power and water
Production time series
Process information
International performance benchmarks
International process best practice

Outputs
Process maps
Resource intensity time series
Performance against benchmarks
Cause and effect diagrams
Assessment of process efficiency
Assessment of equipment efficiency
Recommendations for change and investment

Gather equipment

- Camera – and permission to use it!
- Infra-red thermometer.
- Temperature probe.
- Notebook.
- A good pair of eyes.
- If you can:
  - Infra red camera.
  - Ultrasonic leak detector.
  - Vibration meter.
  - Power analyser.
  - Airflow meter.

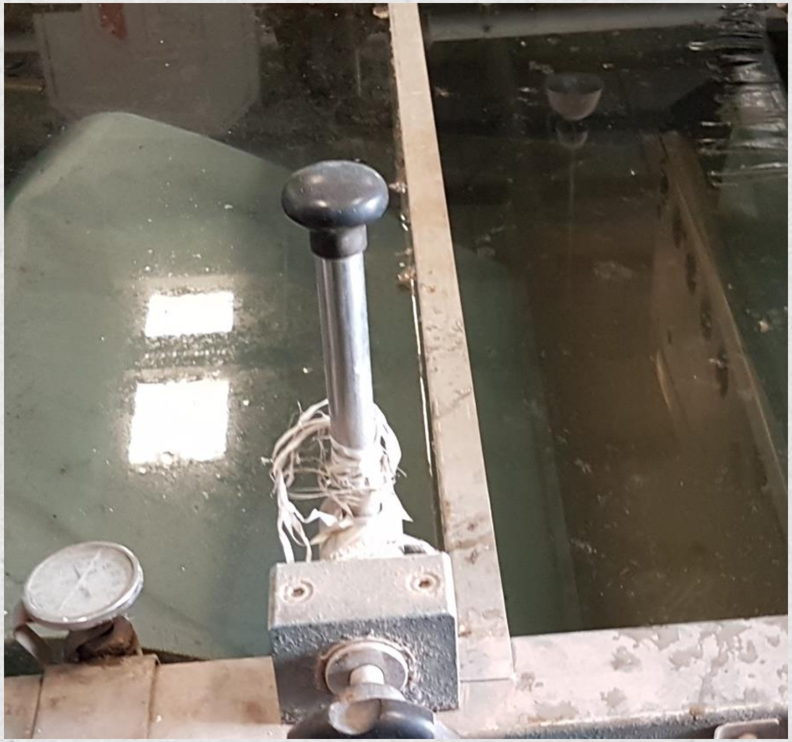
SPOTTING PROBLEMS

When should we conduct the walk-around?

- Perform your main walk-around during a period of full production.
- Back up with higher level checks at different periods to spot differences against your main findings:
  - During lunch breaks.
  - At night or during weekends.
  - Maintenance and cleaning.
  - When the cooling season starts and finishes.
  - During production changeovers.
  - During shift changes.
- This approach can be very useful for spotting wastage!

Process - A Whole Topic Area on its Own!

- Process intensification – concentrating the changes in the product into a shorter time period.
- Why is the process set to be this long?
- What are the safety factors?
  - Are they necessary?
  - What is the cost of playing too safe?
- What are the risks of change?
- Are experiments possible?



Lighting: situation

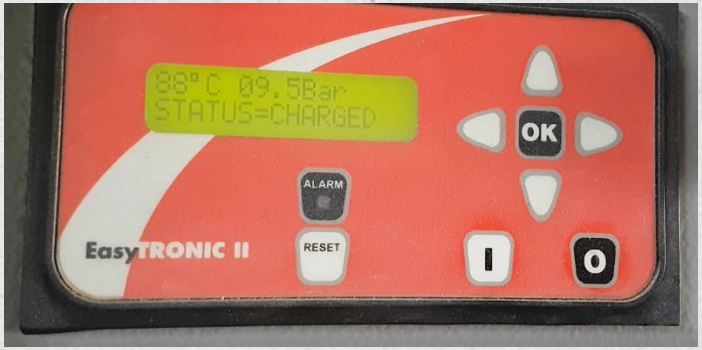
- Existing luminaires are a mixture of mostly mains frequency fluorescent tubes with some LED units substituted for units that have failed.

Lighting: outcomes

- Change existing 18W tubes to LED tubes of 9W and save around 50%.
- Always fully replace fittings: never upgrade with LED tubes, because dedicated LED fittings offer better light distribution, efficiency and quality.
  - Power cost savings of around 7.5 AED per fitting per year plus maintenance savings of around 2 AED per fitting per year.
  - Additional benefits will come from reduced heat load and AC costs, plus improvements to light quality and distribution.

Compressed air: generation

- What are compressor(s) capacities?
- What pressure is system set at?
  - Normal industrial level is 7 Bar.
  - 9 bar is too high and costs money!
- Is an air drier present? Is it working?
- How clean is the compressed air?
  - Water and oil should stay in the traps!



Compressed air: storage and operation

- What is power consumption of compressor at full load?
- From system on-off cycling the average consumption can be estimated.
- What is volumetric capacity of the air storage tank?
- From a no-load pressure drop test, combined with the storage vessel and pipework volume the system leakage can be estimated.
- Work out the potential leakage savings.

Compressed air: distribution system

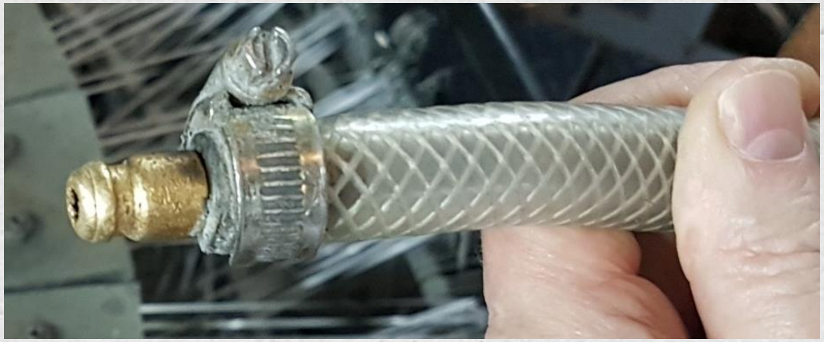
- What is the condition of the system? Can you hear hissing?
- Leakage could be as high as 60% - 80%!
- Leakage best practice is 5-10% and takes a lot of work to achieve.

Large mains leak with entirely ineffective attempt at repair

Incorrectly stuffed pipe joint with leak

Compressed air: use

- Is equipment getting the pressure it really needs?
- Too much pressure can cause over-actuation and excessive wear.
- Is each element of the system using the air efficiently?



Compressed air: savings

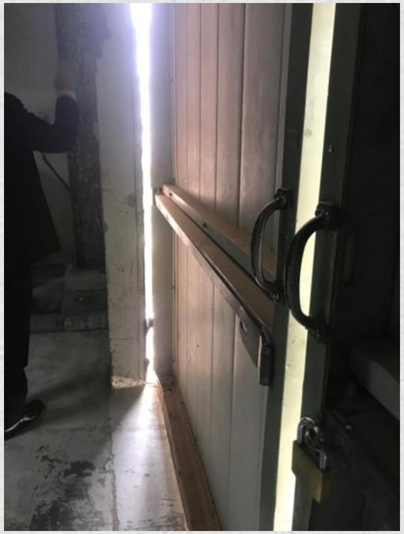
- Reduce pressure:
  - 16% savings (9.5 Bar to 7 Bar)
- Reduce leaks:
  - 55% savings (60% to 5%)
- Overall savings:
  - Compounded to yield 62%
- How much will this save per year?
  - On our medium-sized case study system, AED12,367/Year
- Investment: Negligible or low.

Insulation

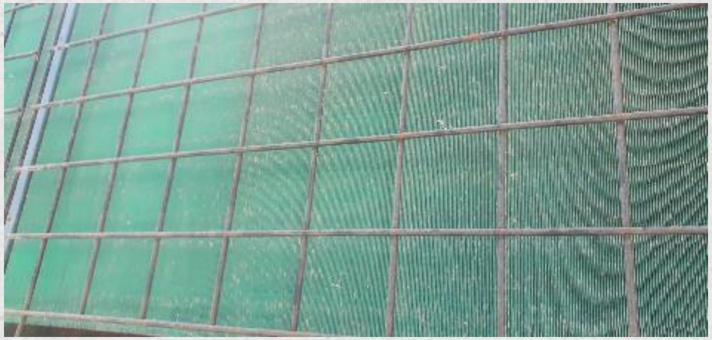
- Is insulation on equipment and pipework complete?
- Are the layers thick enough?
- Use engineering toolbox calculators to work out the potential savings.

Building fabric

- What is the general state of the building fabric?
- Is insulation complete?
- What is the internal temperature of the roof?
- Are window and door seals intact?



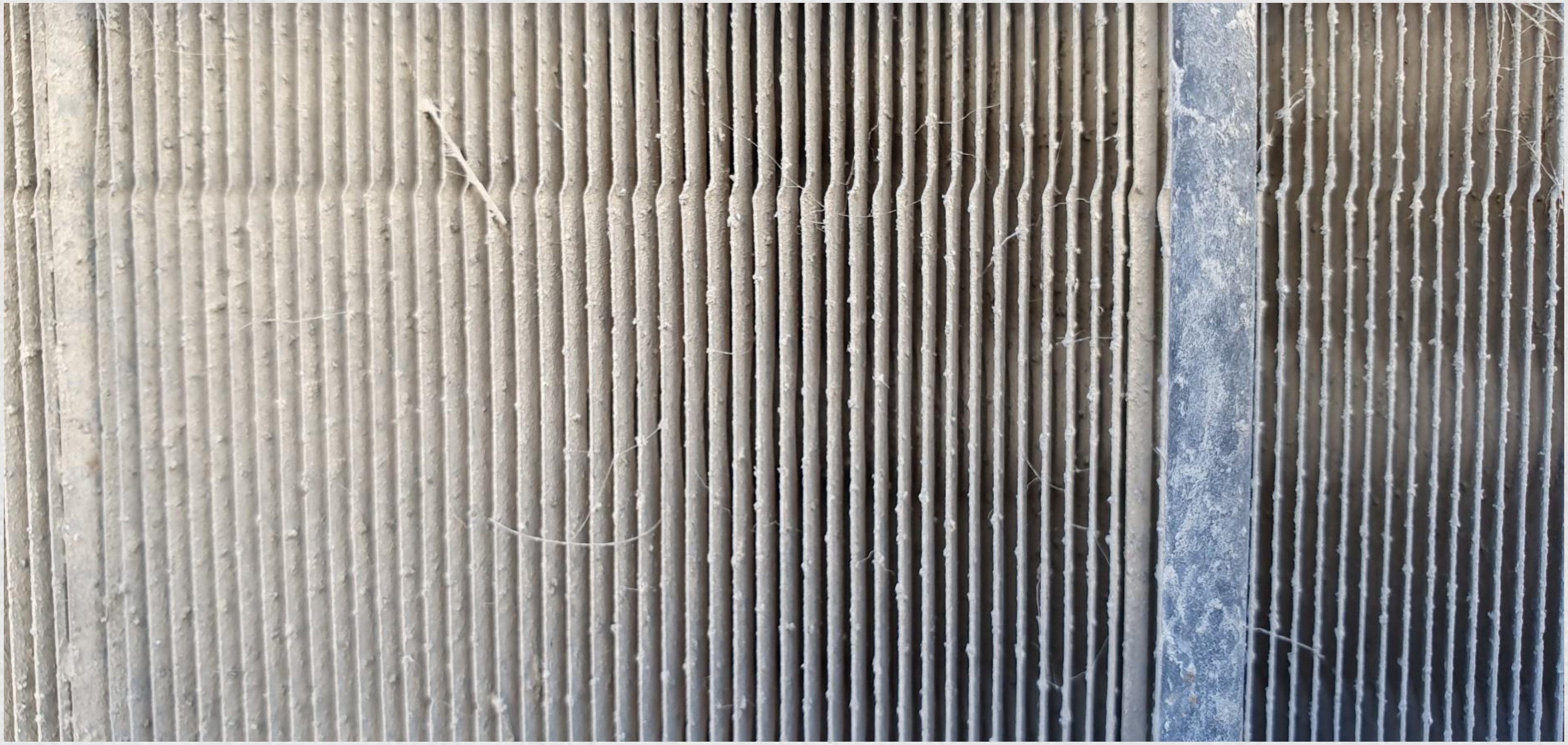
Air conditioning units and chillers



- Good maintenance access?
  - Easy access = easy to maintain and more efficient
- How old are the units?
  - Efficiency has greatly improved in recent years.
- Multiple small split units?
  - Larger chillers tend to be more efficient than multiple smaller units.
- Are heat exchanger surfaces clean?
  - Dirty heat exchangers can reduce efficiency by 10%*
- How are maintenance schedules set?
  - How frequent is routine cleaning?
  - How frequent is full maintenance?
  - Has frequency been determined by life cycle costs?

* HVAC-HESS Factsheet: The Importance of Cleaning Coils, www.energy.gov.au

Is this a clean and efficient heat exchanger?



General observations are important

- A walk-around survey can act as a fresh pair of eyes for spotting problems.
  - Is the facility safe?
  - Is it clean?
  - Does everything look well-maintained?
- Poor housekeeping can be a symptom of deeper underlying problems.

Safety rails removed……

Dirt, clutter and trip hazards……

IT

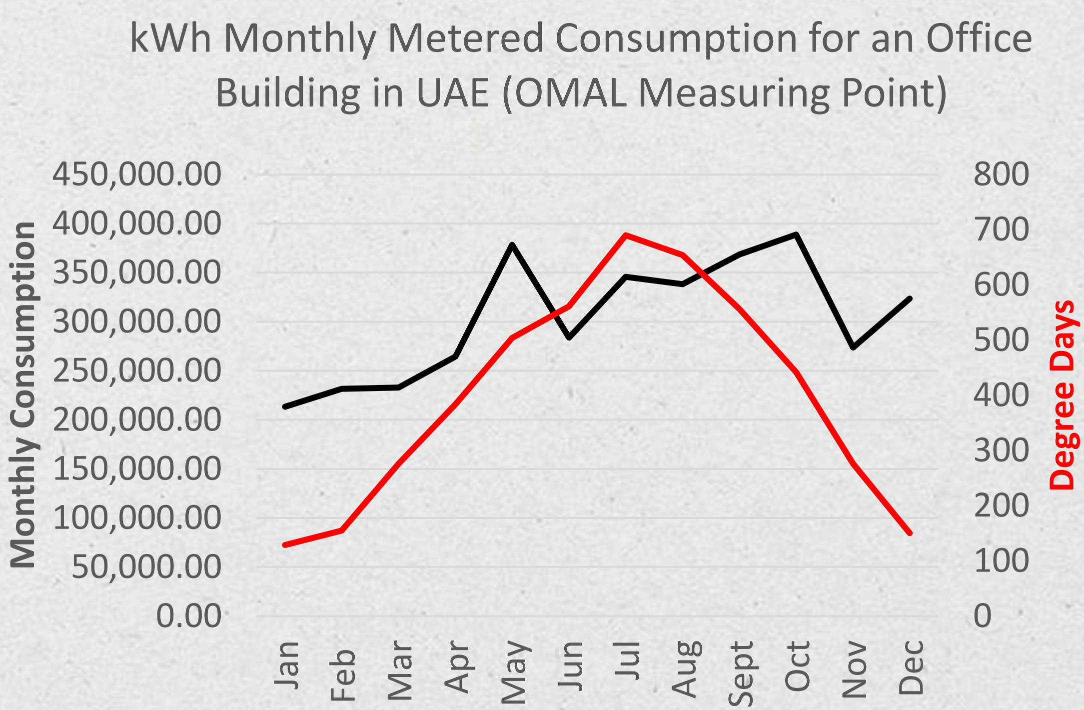
- Does the IT Department insist on leaving desktop systems on overnight in order to download updates?
  – How much time does it save at switch-on in the morning?
  – Is this time saving worth the overnight energy waste?
- Do you have a large data room or centre?
  – What temperature is it set at?
  – Does it need to be this cold?

Water – Just a general observation…..

- 1 drip/second wastes up to 12 litres a day, 5m^3 per year.
  - AED7.84/m^3
- Many water leaks are invisible – they occur after the meter but underground.
- As ground shifts and settle around buried pipes, joints become stressed and progressively fail.
- Leaks can persist, invisibly, for years.
- A meter reading check at the start and end of a period of shut down will indicate whether leaks are present or not.

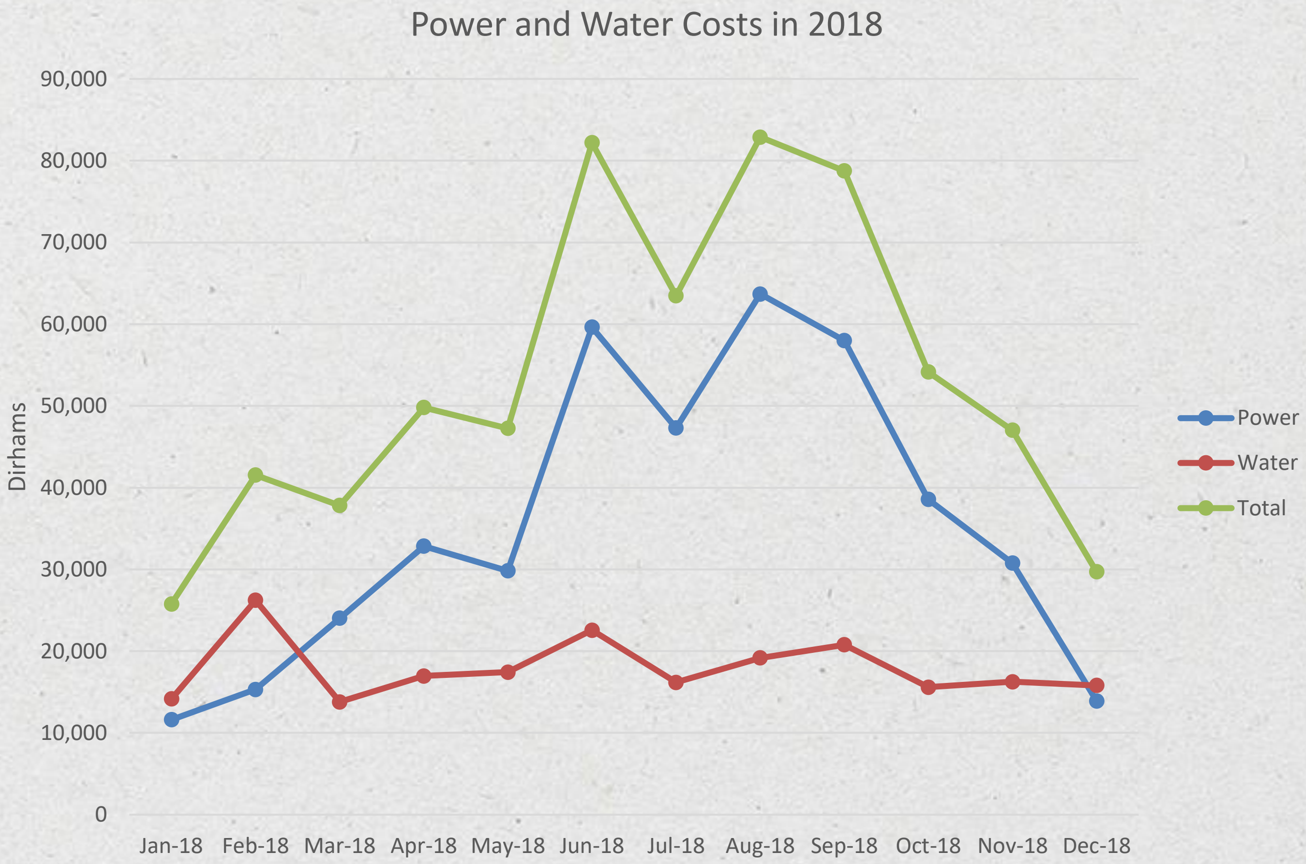
BASIC ANALYTICAL TOOLS: GETTING THE OVERALL PICTURE

Looking for clues: degree days and consumption

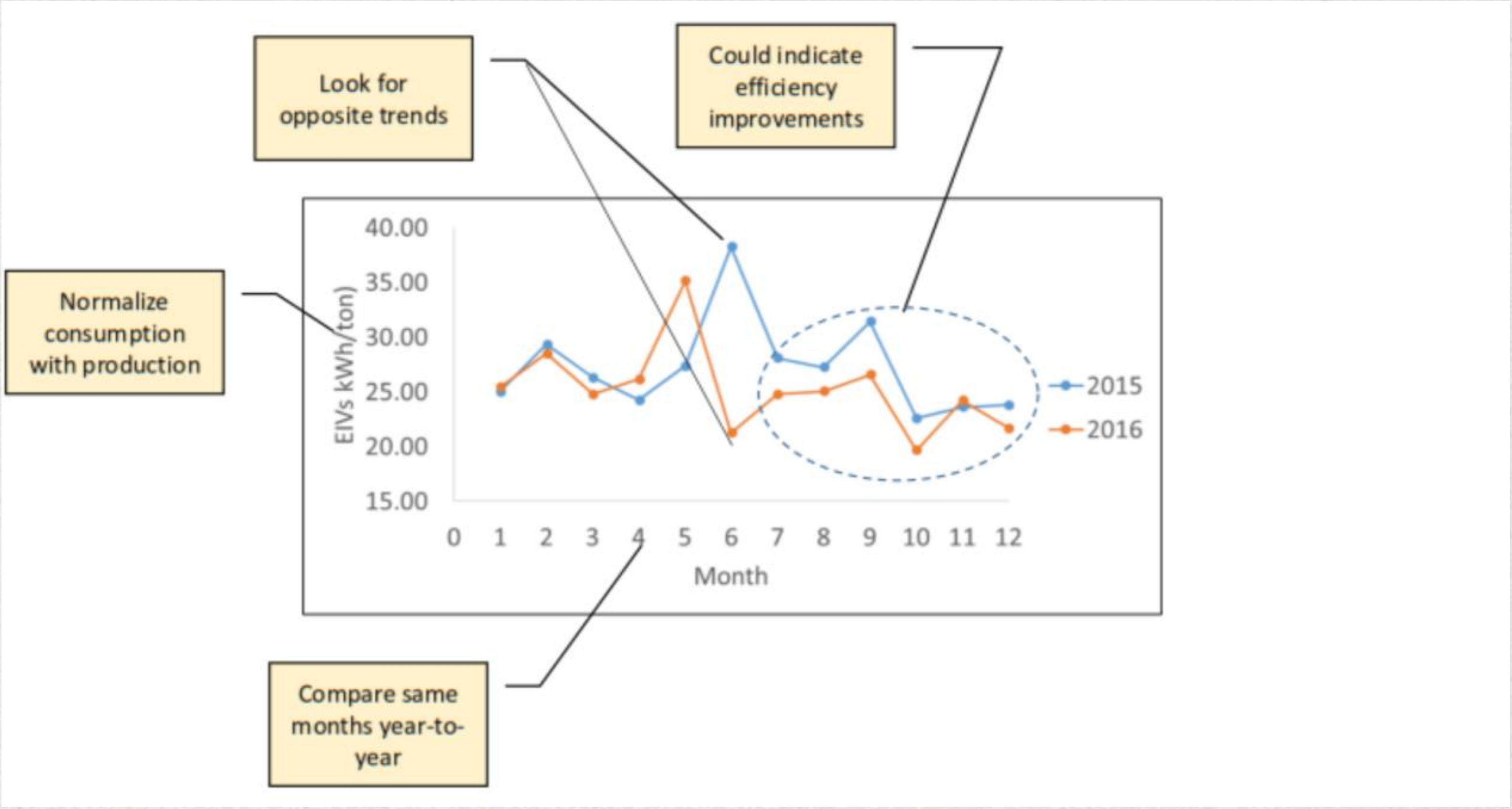


- If HVAC and chiller consumption is driven by outside temperatures, surely consumption should track the same profile as degree day data?
- If it does not, as in the graph above, then this is clear evidence of poor control and maintenance.

Looking for clues: more sensible profiles



Insights from annual trends



Courtesy of Gov.uk

Insights from daily/weekly timing of consumption

- Obtain hourly meter reads, either from your Distribution Company or from installing monitoring equipment on your supply.
- Plot consumption over 24 hours for every day of the week.
- How does consumption change over time?
- How does it match against shift patterns and at changeovers?
- If you do not run for 24 hours, how far down does consumption drop during periods of no production?
- If production varies between different day of the week, such as at weekends, how is this reflected in consumption?

Consumption intensity

- Unlike commercial and governmental facilities, where electricity consumption primarily varies with weather and occupancy alone, consumption by industrial manufacturing facilities is overwhelmingly influenced by production rates.
- Intensity Values allow comparison of consumption within a specific manufacturing process. They normalize the energy or water inputs to a process by the output of product manufactured.

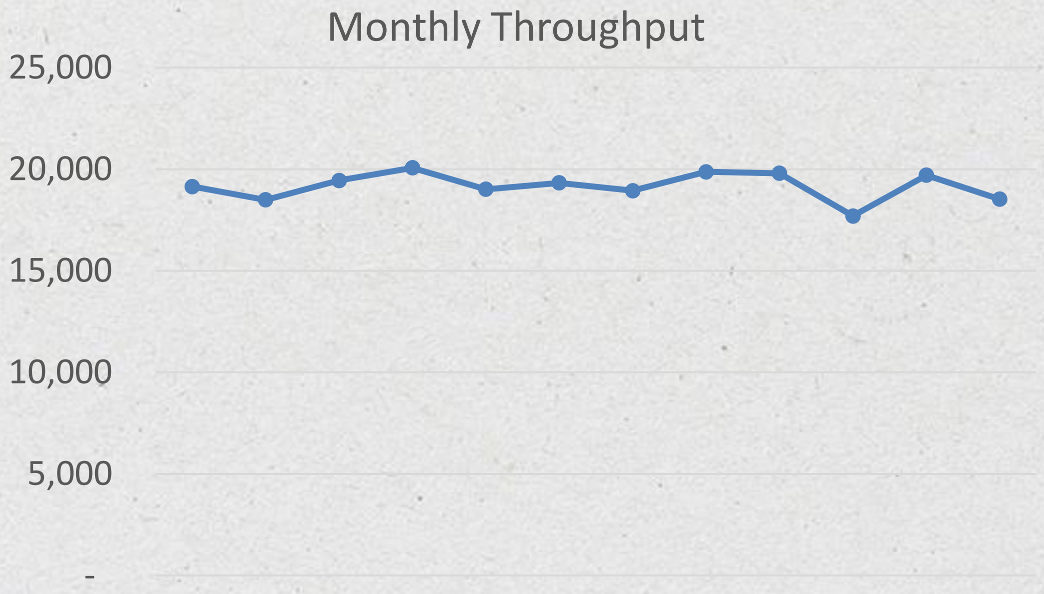
$$\text{EIV} = \frac{\text{Pow}er\ Consumption(\text{kWh})}{ProductionOutput(\text{Units})}$$

$$\text{WIV} = \frac{Water\ Consumption(m3)}{Production\ Output(\text{Units})}$$

- Intensity Values enable the comparison of consumption from different periods of time, based upon the level of production, allowing for evaluation of different operating practices that might have been employed during each period.

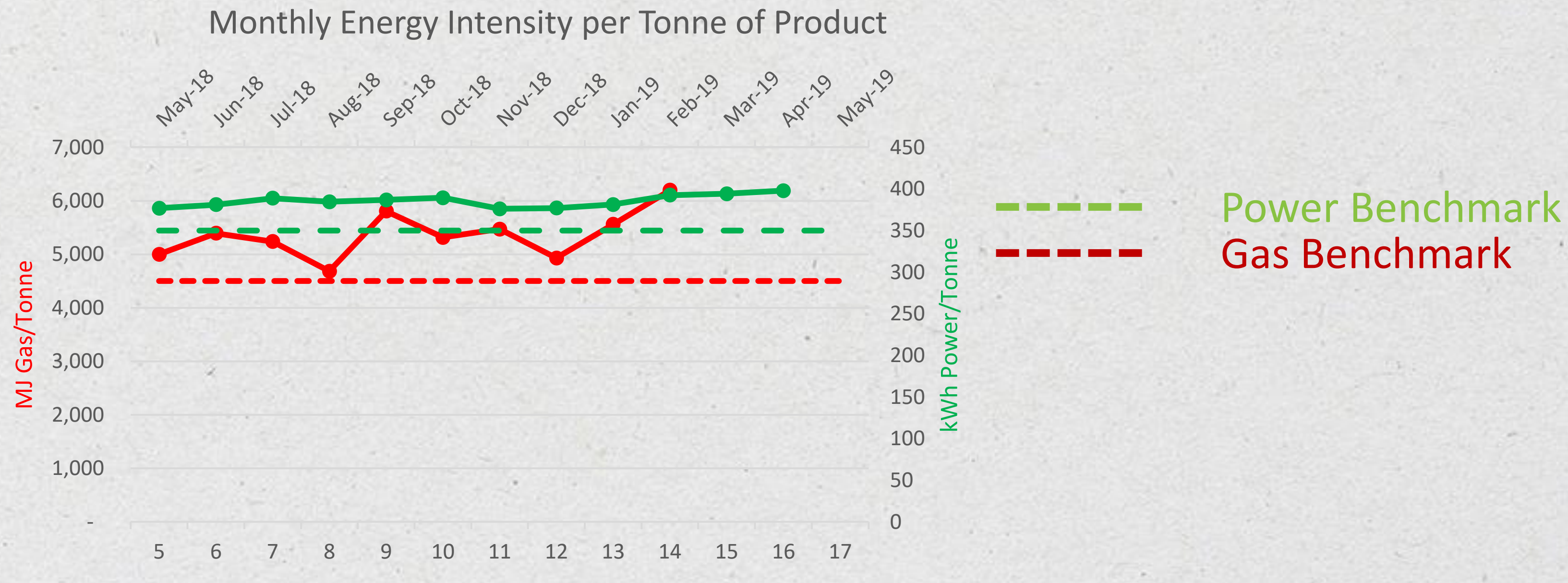
Influence of changing production levels

- Check the rate of production over time.
- Make sure that production variations are understood, otherwise they can distort the findings.



Plot energy intensity

- Hourly power consumption data is available from ADDC metering systems.
- Obtain figures for other fuels – usually available daily, although some gas meters might allow hourly recording.
- Combine with production figures to plot intensity figures per unit of production.
- Plot representative benchmarks to add impact.
- In this example is energy consumption falling or rising?

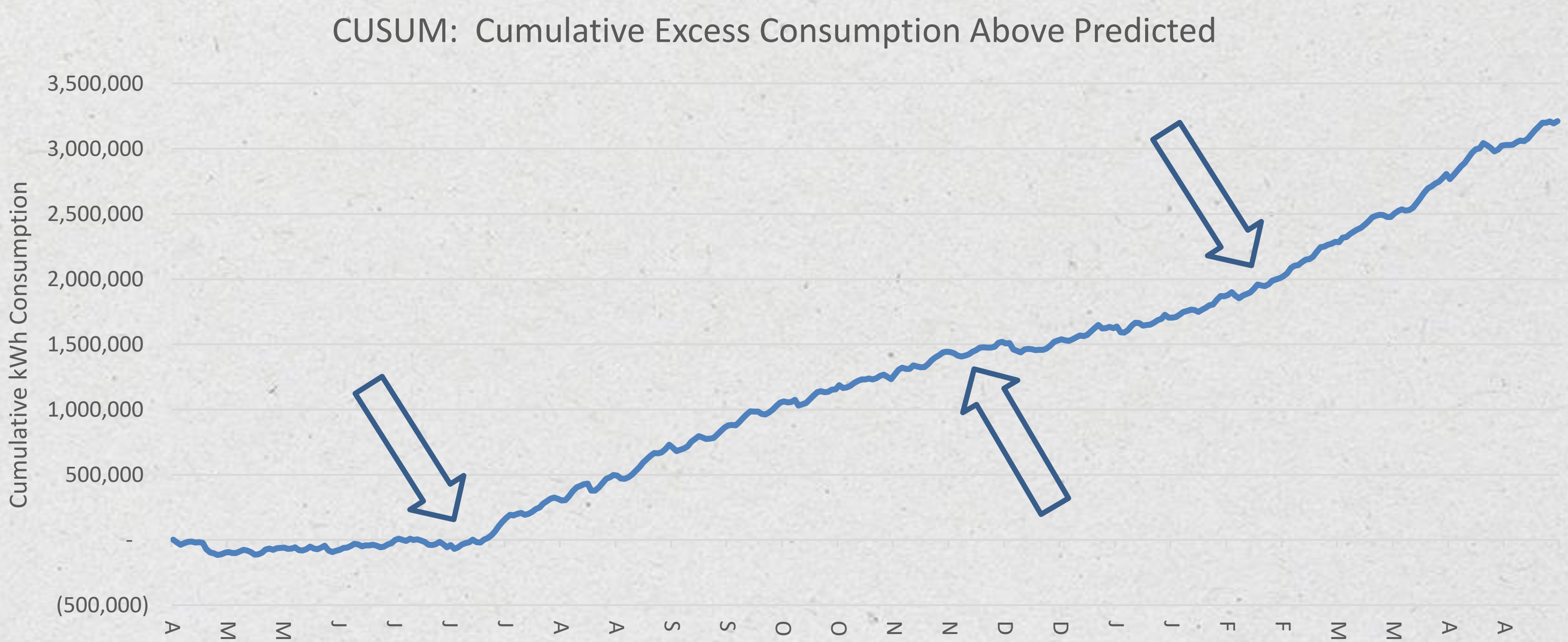


CUSUM analysis: powerful but simple

- Define a baseline period when the process was known to be stable:
  - no changes in product type, equipment or process settings other than volumes.
- Selecting the baseline is critical and requires skill!
- From linear regression develop a model to relate production output to energy consumed.
- Use the model to predict energy consumption based on product output.
- Predicted consumption is then compared with ACTUAL consumption.
- The CUmulative SUM of the difference between actual and expected consumption is plotted to identify the total surplus consumption and changes in the slope of the accumulation curve.

Using the CUSUM curve

- Identified systematic changes in efficiency.
- ~10,500kWh excess power consumed per day, or 3,000 AED per day
- A reduction in the magnitude of the excess consumption was registered in Nov/Dec, but the improvement tailed off. Why?



Potential drivers of changes in efficiency trends

- Changes in activity mix.
- Deterioration in condition of key utility infrastructure from as-new condition:
  - Boilers, air compressors, AC heat exchangers, motors and drives, etc.
  - Potentially driven by fouling processes on heat exchangers, wear in drives etc.
- Change in process settings to improve product quality.

Suggested high level approach

- Plot process settings against CUSUM chart.
- Compare magnitude of rate of consumption deviation to levels of energy consumption in key use categories.
- Identify any obvious correlations.
- Add timelines for any settings, process inputs or other changes.
- Build cause-and-effect diagram.
- Develop remediation programme.

PRESENTING INITIAL FINDINGS: GAP ANALYSIS AND PRIORITISATION

Gap analysis: best practice vs. actual practice

No.	Target Process	Best Practice	Practice at Plant	Practice Met?	Recommendations	Potential Savings[1]
Pumps						
10	Operation and Maintenance	Preventative maintenance measures are scheduled and conducted accordingly.	Preventative maintenance actions are done routinely.	Yes	N/A	—
11	Monitoring	Monitoring (wear, vibration, pressure, flow, power, temperature, scaling) is conducted regularly at the plant.	Regular monitoring is not conducted at the plant.	No	A study should be conducted on the feasibility of oxygen enrichment.	Up to 40% in energy savings.
12	Controls	Remote controls are used to shut off unneeded pumps or reduce load of individual pumps.	Remote controls are not used efficiently at the plant.	No	Studies should be conducted to implement controls for pumps on-site.	Up to 62% of energy consumption in savings.
13	Efficient Pumps	All pumps on-site have the highest energy efficiency.	Not all the pumps at the plant are running at the highest efficiency.	No		Up to 10% of energy savings.
14	Proper Pump Sizing	All pumps on-site are sized appropriately. Pump capacity matches operation.	Pump capacities do not always match operation.	No	Further studies should be conducted on the feasibility of replacing the pumps with new pumps of proper capacity size.	Up to 25% of electricity consumption.
15	Multiple Pumps for Varying Loads	If VFDs are not utilized, loads are allocated to different pumps according to size.	Multiple pumps are used for varying loads.	Yes	N/A	—

BP = Industry Best Practice
ECM = an energy conservation measure
WCM = a water conservation measure

Process Sub-Category

Identify whether this practice is met at the plant

Where BP is not met, what action is recommended

Identify the potential savings from this practice

Courtesy of Gov.uk

Prioritising energy efficiency options

Efficiency Option	Capex	Annual kWh Savings	Annual Cash Savings	Payback	NPV	IRR
Improved Warm Up Procedure						
Improved Insulation						
Upgraded Economiser and Condensate Pre-Heater						
Totals	**A**	**B**	**C**	**-**	**D**	-

- How to prioritise?
  - Simple payback is a very good tool for early stage screening.
  - Capex limits and IRR can offer a second tier of discrimination.
  - NPV assists in identifying the relative magnitude of returns.

42

Presenting carbon efficiency options

Carbon Abatement Option	Cost Saving per/tonne $CO2_e$	Upfront Capital Costs (€'000)	NPV Excluding CER Allowance Value (€'000)	NPV (€'000) CER Allowance price €10	Emissions Savings over period (Tonnes CO2e)	Payback Period (Years)
Improved Warm Up Procedure	39.31	-	219	270	7,000	0.0
Improved Insulation	27.00	2,000	4,000	4,800	560,000	1.5
Upgraded Economiser and Condensate Pre-Heater	16..10	5,000	5,245	6,340	400,000	3.1 (no allowance sales)
Totals		**7,000**	**9,464**	**11,410**	**967,000**	

43

PRESENTING INITIAL FINDINGS: GETTING AGREEMENT ON FEASIBILITY

Survey report approach

- Executive Summary is the most important single element:
  - 1 page that explains at a high level the findings and the expected savings and necessary investment.
  - This is the sales pitch!
- Philosophy:
  - Keep initial suggested actions simple and low risk!
- Topic-by-topic presentation of findings
  - Brief explanation of changes and estimate of savings
- Summaries of savings and changes:
  - Tabular.
  - List measures, changes needed investment, savings, simple payback.
  - Describe next steps.

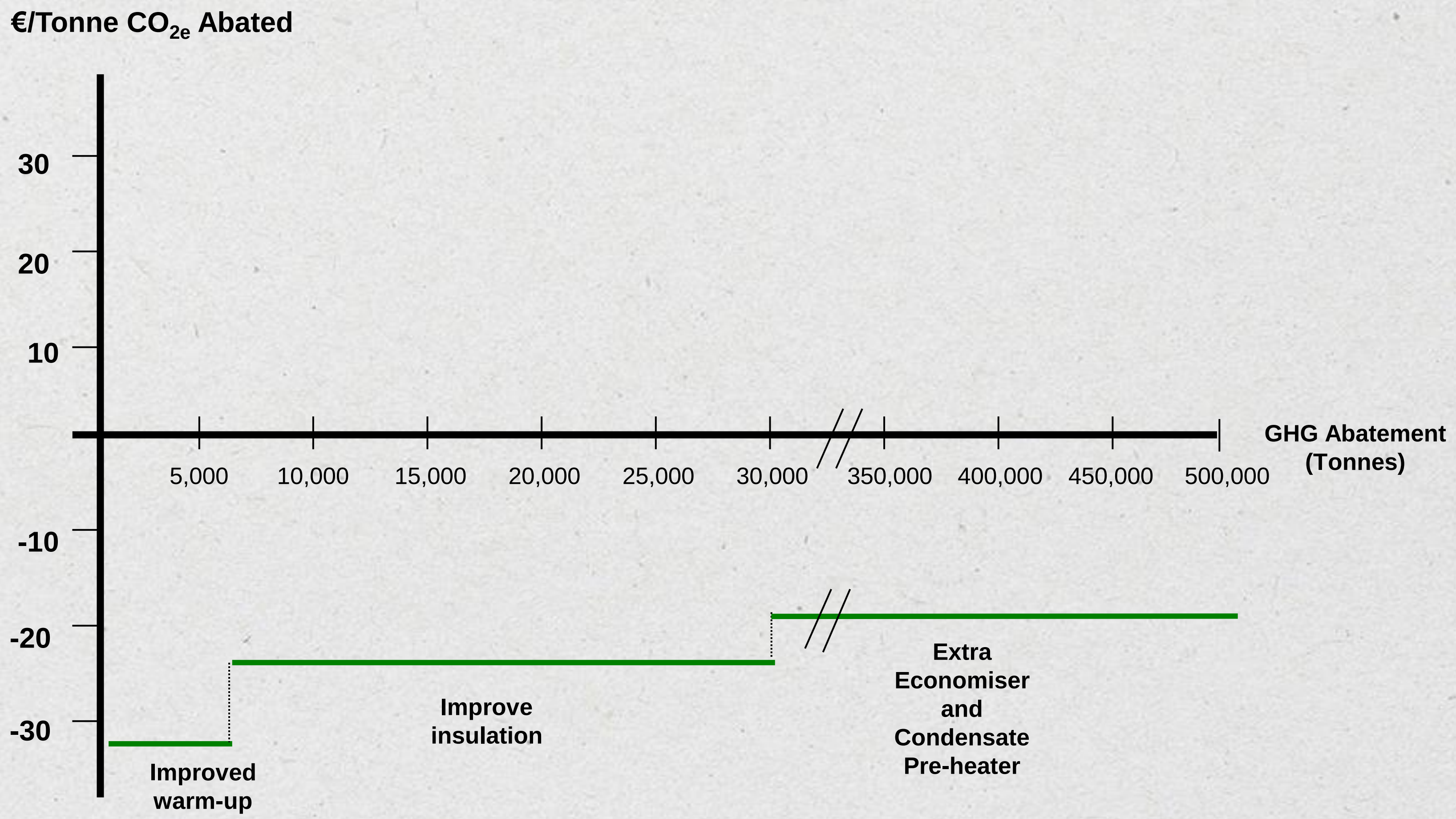
Survey report structure

1. Executive Summary of Business Case
    a. One page summary of findings and business potential.
2. Introduction
    a. Overview of activities conducted to generate the report.
3. Review of Production Process
    a. Simple flow diagram.
    b. Appreciation of technology compared to current best-available. processes.
4. Energy & Water Consumption Analysis
    a. Overall volume of consumption.
    b. Trends in absolute levels of consumption and commentary.
    c. Trends in specific consumption and commentary.
    d. CUSUM trends and commentary.
5. Industry Best Practice Gap Analysis
    a. Tabular list of applicable global best practice and whether it is applied.
    b. Table of gaps in best practice and estimated savings and investment costs.
6. Prioritisation of Opportunities
    a. Application of screening criteria and commentary.
    b. List of options for further investigation and preparation of business cases.
7. Conclusions and Next Steps

Important to:

- Differentiate between no-regrets measures and issues that require further study.
- Examples of no regrets measures:
  - Compressed air tiger team.
  - Door and window seal replacement.
  - Clean heat exchanger surfaces.
- Examples of measures requiring further study:
  - Rationalising AC chillers.
  - Compressed air pressure control.
  - Equipment insulation.
  - Process settings.
  - Pump resizing.
  - Variable Speed Drives.

Advanced graphics: Marginal Abatement Cost Curve



APPENDIX 1:
SAVINGS TOPICS BY SECTOR

General manufacturing best practice

- Energy
  - Monitoring and targeting
  - Measurement and verification
  - Performance based maintenance
  - Compressed air management
  - Motors and drives efficiency
  - Variable speed drives
  - Pump and fan management
  - Cooling plant management and upgrade
  - Maintenance of heat transfer surfaces
  - Process control improvement
  - Process intensification
  - Alternative processes
  - Throughput increases
  - Insulation improvement
  - Heat/cooling recovery
  - Combustion controls
  - Flue gas controls
  - Flameless combustion
  - Boiler controls
  - Steam distribution system insulation
  - Steam distribution system maintenance
  - Boiler economisers
  - Boiler blowdown heat recovery
  - Cogeneration
  - Use of recycled materials
- Water
  - Monitoring and targeting
  - Irrigation controls
  - Water recovery and recycling
  - Process redesign
  - Improved cleaning processes

Savings – 5% - 30%
Paybacks 6 months to 7 years

Plastic extrusion best practices

- Automatic process controls
- Insulation
- Speed of extrusion
- Die design
- Maintenance
- Compressed air management
- Ancillary equipment
- Performance enhancing additives
- Extruder drive
- Cooling water recycling
- No cooling during idle time
- Efficient treatment and distribution of cooling water
- Minimum cooling of extrudate
- Most efficient chiller technology
- Efficient control of supply and return loops

Steel best practices

- Automatic process controls
- Efficient EAF selection
- Improved process controls
- Increasing power
- Foaming slag practices
- Oxy-fuel burners/lancing
- Post combustion of flue gases
- Bottom stirring/stirring gas injection
- Engineered refractories
- Waste fuel injection
- Scrap preheating
- Airtight operation
- Ladle preheating
- Tundish preheating
- Integrated casting and rolling
- High efficiency VSDs
- Lubrication systems
- Proper reheating temperatures
- Avoiding overloading of reheating furnaces
- Recuperative or regenerative burners
- Flameless burners
- Insulation of reheating furnaces
- Walking beam furnaces
- Hot charging
- Hot linking
- Heat recovery to the product
- Compressed air management
- Waste heat recovery from cooling water
- Water recycling
- Alternative water sources

Cement best practices

- Automatic process controls
- Homogenising raw materials
- Raw meal process control
- Advanced raw meal grinding
- Separate raw material grinding
- High efficiency classifiers/separators
- Fluxed clinkers
- Oxygen enrichment
- Mixing air technology
- Kiln seals
- Kiln and preheater insulation
- Efficient clinker cooling technology
- Clinker heat recovery
- Multi-stage preheater cyclones
- Preheater/precalciner kiln
- Heat recovery for power generation
- Conversion of long dry kin to preheater/precalciner kiln
- Use of alternative cementitious materials
- Compressed air management
- Water recycling
- Alternative water sources

Concrete products best practices

- Automatic process controls
- Wet-batch plant replacement
- Optimise mixing time
- Mixer technology
- Multiple step mixing
- Cleaning and maintenance of mixers
- Improve insulation of curing
- Reduce curing system leaks
- Improve curing process controls
- Use of accelerants during curing
- Automated curing systems
- Reclaim excess materials into process
- Recycle cured waste into process
- Stoning out
- Use construction waste in raw materials
- Compressed air management
- Recycle washing water into process water
- Use Treated Sewage Effluent as an alternative water source

Paper and board best practices

- Automatic process controls
- Pulp bale conditioning and spreading
- Pulper rotor
- Pulping process
- Refiner
- Motors and drives
- Advanced dryer controls
- Dryer dew point control
- Forming and pressing
- Forming, pressing and drying
- Reduced air requirements
- Optimising pocket ventilation temperature
- Waste heat recovery
- Shoe (extended nip) press
- Paper machine vacuum optimisation
- Gap forming
- Heat felt water
- Air impingement drying
- Raw material quality control
- Raw material
- Drying cylinder design
- Compressed air management


فكّر
RETHINK