شركة أبوظبي للتوزيع

Abu Dhabi Distribution Co.

Developing an
Industrial Energy and Water Efficiency
Consultation Report

Purpose

- The purpose of this document is to provide guidance regarding how a consultation with an industrial customer can be planned and executed.
- The process involves planning the activity, gathering data, performing analyses, developing recommendations for efficiency improvements, and presenting this to the customer in report form.
- This process is based upon international best practice.

Demand Side Management

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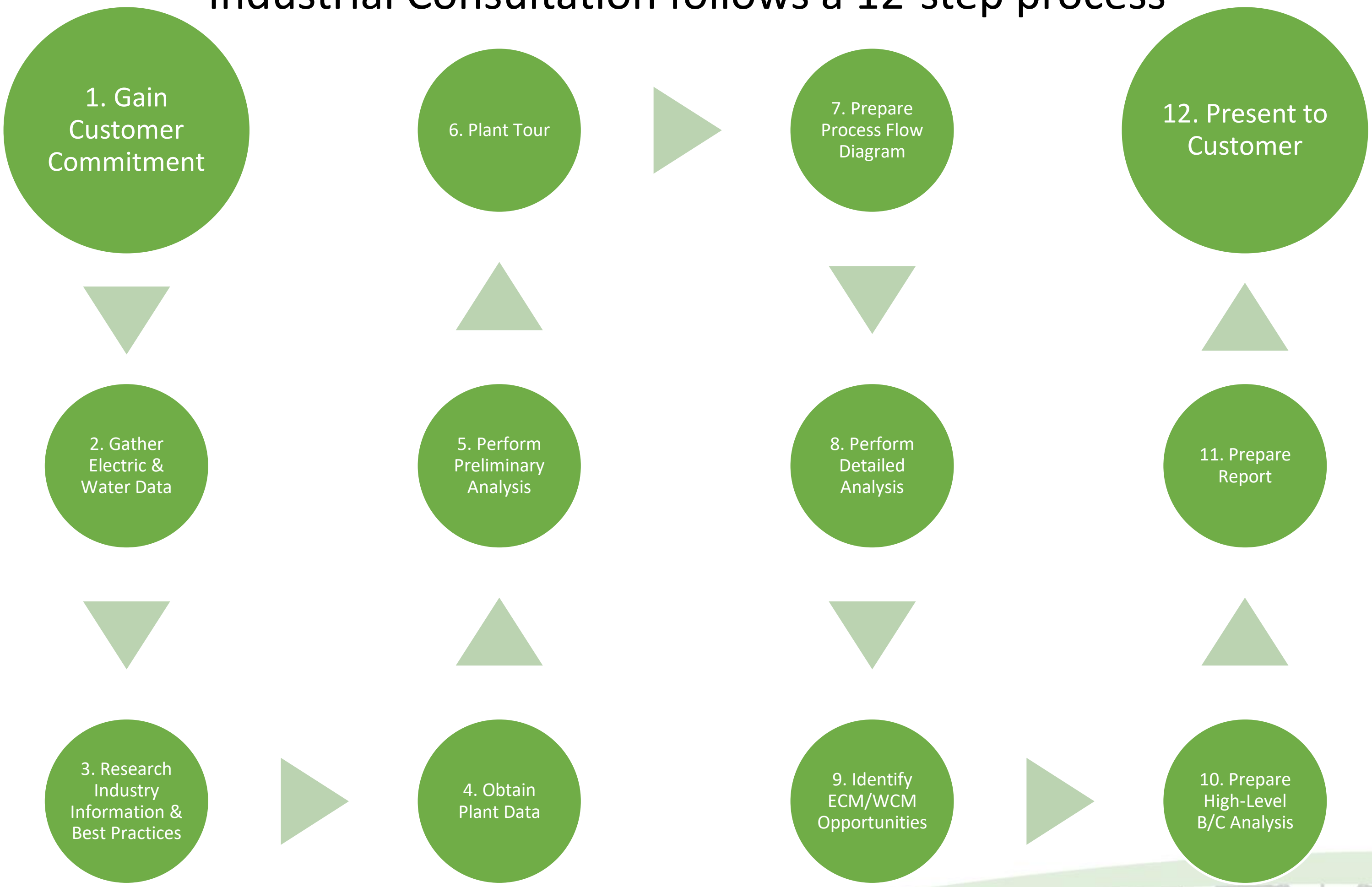
- One of ADDC's missions is to develop a Demand Side Management (DSM) programme that will encourage its customers to reduce their consumption of electricity and water, without compromising their functionality and establish ADDC as a trusted advisor to its customers.
- Consumption of electricity, and often water, in manufacturing processes has a significant impact upon cost of production and therefore profitability.
- Work in other countries and in the UAE has shown that cost effective savings in energy and water can often be delivered.
- Low cost-no-cost measures can often deliver 5-10% savings, while longer payback measures can deliver 15-20% savings.

Scope of the Industrial Consultation

- The scope of an industrial consultation report is to provide a high-level overview of industrial operations to identify practices that could be incorporated to utilise electricity and water more efficiently and effectively.
- The objective of a consultation is not to produce a comprehensive study, rather to provide an indicative consultation report that identifies the global best practices currently in use and the extent to which these best practices are employed in the subject plants studied.
- Following on from this high-level investigation and consultation, it is hoped that plants can then take simple actions that will reduce their utilisation of electricity and water per unit of output, and in turn reduce the cost of production.
- The study may also give recommended areas for further detailed study, such as conducting a detailed energy survey, so as to verify for investors the projected cost and savings associated with implementing a specific electricity or water conservation measure.

Flow of Consultation Process

Industrial Consultation follows a 12-step process



ECM is an Electrical Conservation Measure
WCM is a Water Conservation Measure

1. Customer Commitment

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It is important to first gain the commitment of the industrial customer to take action, based upon the results of the Industrial Consultation.

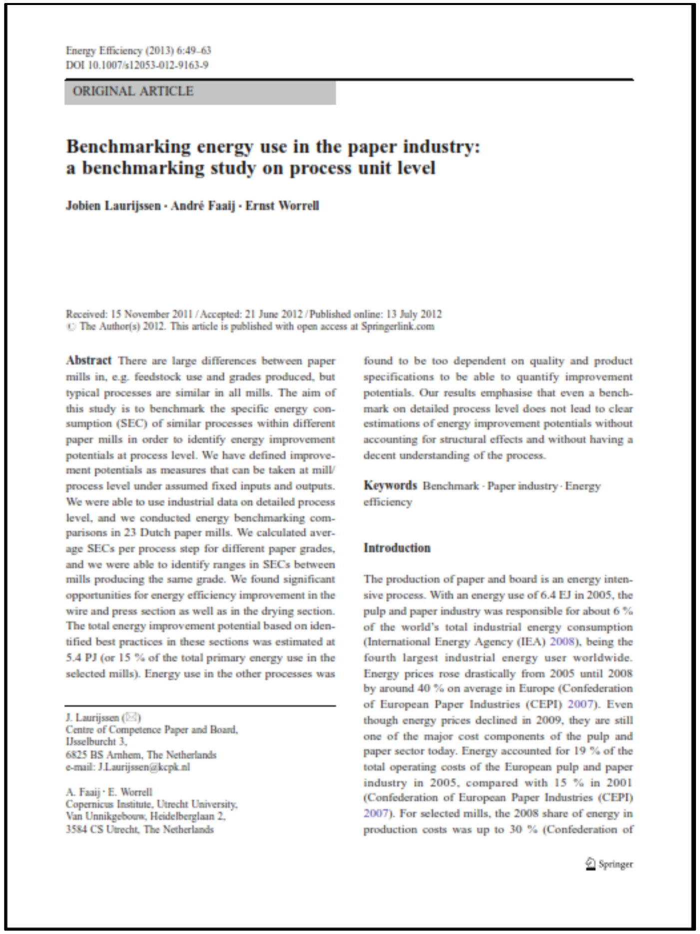
- The consultation represents a significant amount of effort and will require commitment from the customer to provide data, materials, and site access to support it.
- The consultation provides valuable insight into actions that could significantly reduce electricity and water consumption.
- The customer who commits to take action is more likely to value the effort made by the distribution company.
- Many industrial customers may be interested in such a consultation, and priority should be given to those who plan to take action, based upon its recommendations.
- The customer commitment also ensures that the customer’s expectations are aligned with the level of detail provided by the consultation report.

2. Gather Electric & Water Data

- Monthly electricity and water bills for a period of at least two years.
- If available, hourly data for at least one month (an entire year if possible).
- Identify the electric and water meter ID #'s associated with the account. Note that many industrial customers have multiple meters (e.g., Grand Mills has 21 electric meters).
- Create spreadsheets for the monthly electric and water data, by individual meters and consolidated, in order to understand how and when the industry uses these utilities – prior to visiting their plant.
- Create a spreadsheet of the hourly or daily data to understand how usage varies throughout the day and the week. In particular, note the usage during the period 15:00 to 18:00, which would coincide with system peak.

3. Research Industry Information

- Information on industrial processes and industry best practices can be found from sources available on the Internet. These include the following:
  - US Department of Energy
  - US Environmental Protection Agency
  - Electric Power Research Institute
- The Environment Agency – Abu Dhabi also has prepared reports for some of these industries, outlining their materials, processes, and emissions.
- The industrial plant itself may have reports, drawings, or specification documents that may provide insight into how electricity and water is used within the plant.
- Industry-specific Trade or Research Organisations may have materials on best practices and process improvements to increase efficiency.
- Industry information can often be found by searching on the Internet, using the company name or industry name.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ORIGINAL ARTICLE

Benchmarking energy use in the paper industry: a benchmarking study on process unit level

Jobien Laurijssen · André Faaij · Ernst Worrell

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Abstract There are large differences between paper mills in, e.g. feedstock use and grades produced, but typical processes are similar in all mills. The aim of this study is to benchmark the specific energy consumption (SEC) of similar processes within different paper mills in order to identify energy improvement potentials at process level. We have defined improvement potentials as measures that can be taken at mill/process level under assumed fixed inputs and outputs. We were able to use industrial data on detailed process level, and we conducted energy benchmarking comparisons in 23 Dutch paper mills. We calculated average SECs per process step for different paper grades, and we were able to identify ranges in SECs between mills producing the same grade. We found significant opportunities for energy efficiency improvement in the wire and press section as well as in the drying section. The total energy improvement potential based on identified best practices in these sections was estimated at 5.4 PJ (or 15 % of the total primary energy use in the selected mills). Energy use in the other processes was found to be too dependent on quality and product specifications to be able to quantify improvement potentials. Our results emphasise that even a benchmark on detailed process level does not lead to clear estimations of energy improvement potentials without accounting for structural effects and without having a decent understanding of the process.

J. Laurijssen (✉)
Centre of Competence Paper and Board,
IJsselburcht 3,
6825 BS Arnhem, The Netherlands
e-mail: J.Laurijssen@kcpk.nl

A. Faaij · E. Worrell
Copernicus Institute, Utrecht University,
Van Unnikgebouw, Heidelberglaan 2,
3584 CS Utrecht, The Netherlands

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Introduction

The production of paper and board is an energy intensive process. With an energy use of 6.4 EJ in 2005, the pulp and paper industry was responsible for about 6 % of the world's total industrial energy consumption (International Energy Agency (IEA) 2008), being the fourth largest industrial energy user worldwide. Energy prices rose drastically from 2005 until 2008 by around 40 % on average in Europe (Confederation of European Paper Industries (CEPI) 2007). Even though energy prices declined in 2009, they are still one of the major cost components of the pulp and paper sector today. Energy accounted for 19 % of the total operating costs of the European pulp and paper industry in 2005, compared with 15 % in 2001 (Confederation of European Paper Industries (CEPI) 2007). For selected mills, the 2008 share of energy in production costs was up to 30 % (Confederation of

Example Report for the Paper Industry

4. Gather Plant Information

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The following data can be gathered through data requests to the plant.

- Information on plant design, electrical connections, construction date.
- Monthly production data in either tons or units of product.
- Dates of plant shutdown or planned maintenance periods over the period covered by the operating data.
- Points in time where the plant capacity has been expanded, new processes added, or existing processes eliminated and the impact of these actions upon electrical and water demand.
- KPIs used by plant management and, if applicable, benchmarking of plant operation against other similar plants operated by the owner.
- Records of any completed or planned efficiency improvements.

5. Perform Preliminary Analysis

Intensity Values

- 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.
- Energy Intensity Value (EIV) is a method of comparing energy usage within a specific manufacturing process. It normalizes the energy input to a process by the output of product manufactured.

$$EIV = \frac{Electricity\ Consumption\ (kWh)}{Production\ Output\ (ton)}$$

- Water Intensity Value (WIV) provides the same basis of comparison for water-intensive industries.

$$WIV = \frac{Water\ Consumption\ (m^3)}{Production\ Output\ (ton)}$$

- These 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.

5. Perform Preliminary Analysis (cont.)

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Start by creating a monthly spreadsheet for at least two years of electricity and water data.

Year	Month	Production Output (tons)	Meter Serial No. 1234567890			
			Electricity Cost AED	Electricity Meter Reading kWh	Electricity Consumption kWh	Electricity Intensity Value
2015	January	12	1306.24	891662.00	8,164.00	680.33
	February	22	2194.24	905376.00	13,714.00	623.36
	March	50	5320.64	938630.00	33,254.00	665.08
	April	55.0	5992.64	976084.00	37,454.00	680.98
	May	43	4653.12	1005166.00	29,082.00	676.33
	June	9	1000.96	1011422.00	6,256.00	695.11
	July	0.3	47.52	1011719.00	297.00	990.00
	August	39	4254.40	1038309.00	26,590.00	681.79
	September	21	2201.28	1052067.00	13,758.00	655.14
	October	20	2141.60	1065452.00	13,385.00	669.25
	November	21	2275.68	1079675.00	14,223.00	677.29
	December	9	1013.44	1086009.00	6,334.00	703.78

Obtain from Plant

Obtain from ADDC Bills

Calculate by Dividing Consumption by Output

5. Perform Preliminary Analysis (cont.)

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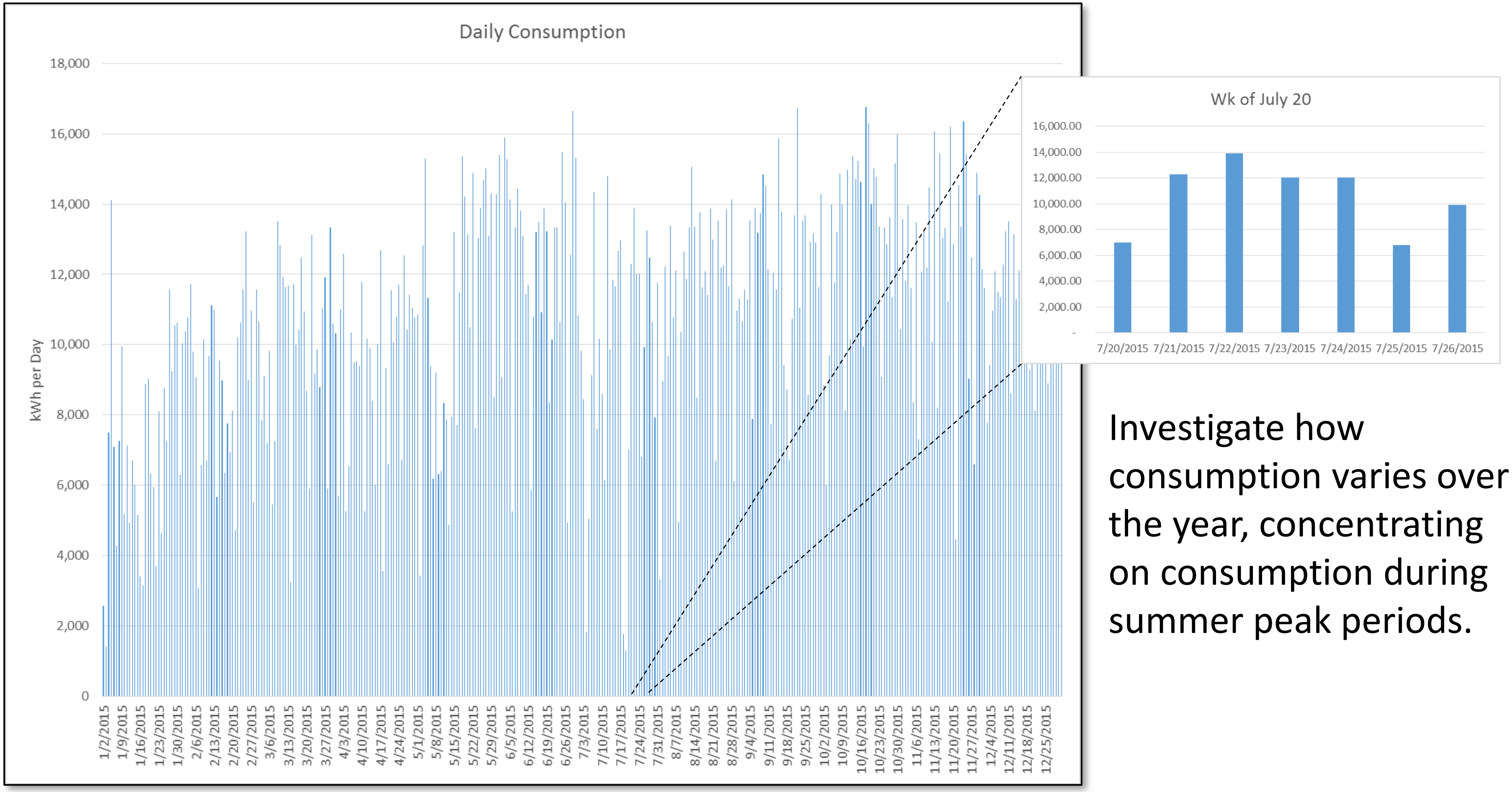

Investigate how consumption varies over the year, concentrating on consumption during summer peak periods.

5. Perform Preliminary Analysis

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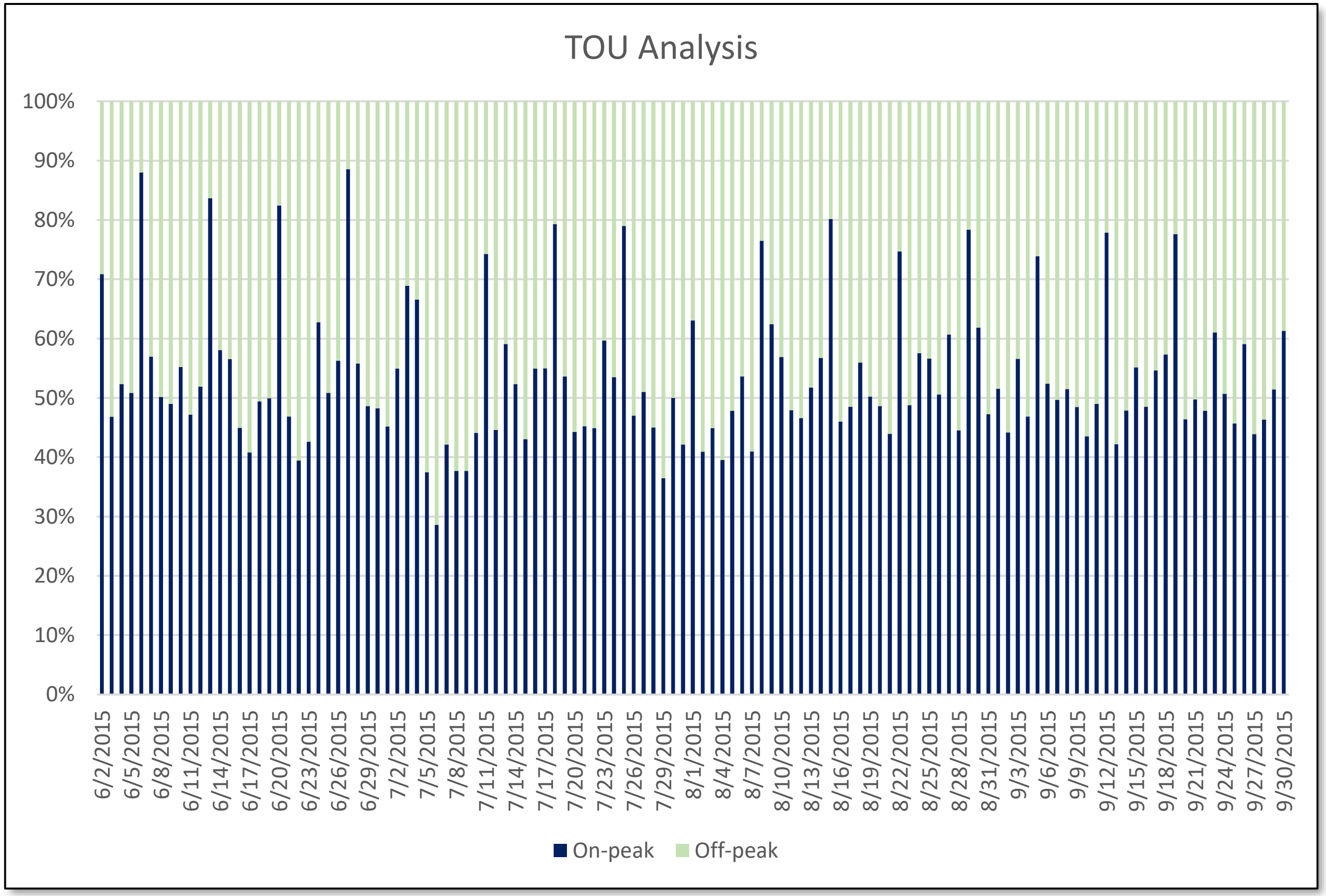
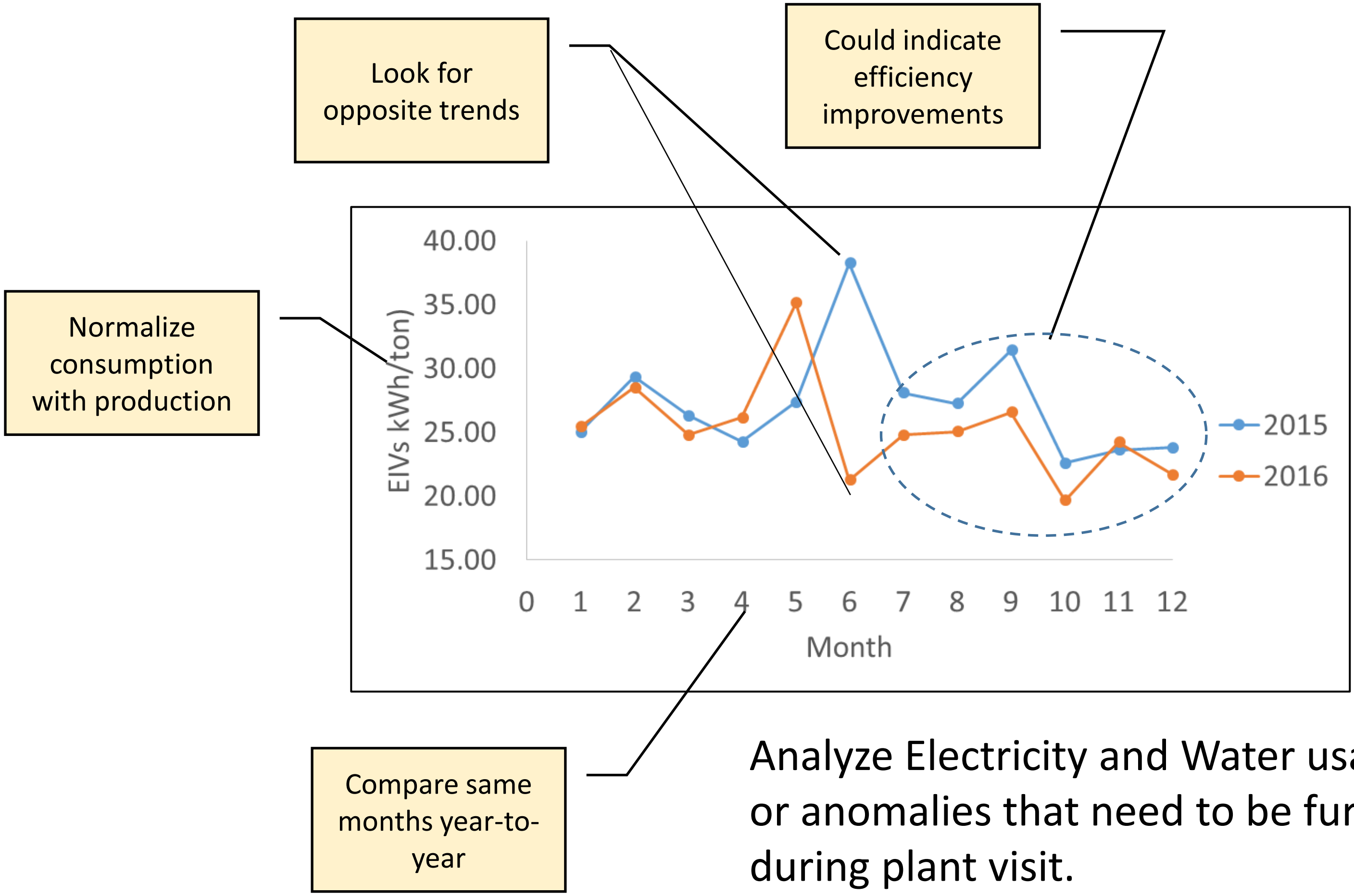


Investigate how consumption varies over the summer periods, when on-peak (10:00 to 22:00 hours) rates are higher than the off-peak rate.

5. Perform Preliminary Analysis (cont.)



Analyze Electricity and Water usage to spot trends or anomalies that need to be further investigated during plant visit.

6. Plant Tour

Purpose

- To gain an understanding of the processes used at this particular plant to develop a Process Flow Chart.
- To discuss any apparent anomalies observed in the analysis of electricity and water consumption data.
- To observe, first-hand, the major electricity and water-consuming equipment associated with the plant.
- To verify which of the best practices have been put into effect at the plant in order to identify which practices might be candidates for adoption by the plant.
- To understand what actions have been taken, or are contemplated, to reduce electricity and water consumption.

Preparation

- Review the consumption analysis to identify data that might indicate consumption anomalies.
- Review the Best Practices to determine what specific equipment you will be looking for or specific questions you will ask.
- Focus preparation on the following:
  - Steam systems
  - Process cooling or heating systems
  - Compressed air systems
  - Electric motor systems
  - Fan and pumping systems
  - Lighting systems
- Identify alternative technologies with greater efficiency or applicability.

6. Plant Tour (cont.)

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Safety

- Instructions by the plant host must be carefully followed.
- The plant tour should begin with an indoctrination into the safety requirements and practices at the plant.
- Proper Personal Protection Equipment (PPE) must be worn, consistent with plant requirements.
- Clothing should be comfortable for the plant environment and avoid loose fitting clothing that might become caught in process equipment.
- Footwear should be sturdy, recognizing that plant tours generally require extensive walking, un-level surfaces, and often some climbing.
- Do not stray from the tour group.

Tour Process

- If available, it is helpful to begin orientation using an overall plant layout drawing showing the location of various buildings.
- In general, the tour should progress along the process flow – beginning with raw material entry and ending with finished product storage/shipping.
- For competitive reasons, most plants do not allow pictures to be taken during the tour, however, they may be able to provide detailed information about specific processes through reports or drawings.
- The overall objective of the plant tour is to identify opportunities to cost-effectively reduce electricity and water usage, without compromising plant production.

7. Prepare Process Flow Diagram

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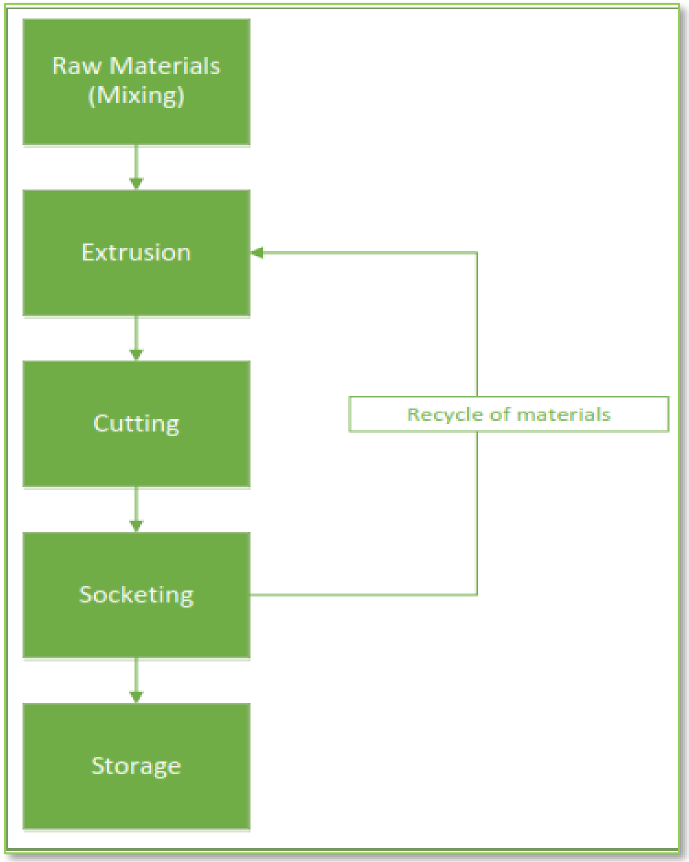
- The intent of a process flow diagram is to provide a high-level presentation of the individual processes conducted in the subject plan.
- This will not provide a detailed description of each individual process but will show how materials flow through the plant from raw material receipt to finished product prior to shipping.
- Where sub-metering is done, this more granular data can be used to identify which parts of the process contribute most significantly to overall electric and water consumption.
- Where sub-metered consumption data is not available, the rated capacity of connected equipment within the process can be used as a proxy for the energy and water usage intensity.



Example Process Flow Diagram

8. Perform Detailed Analysis

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Prepare a table of annual EIV and WIV by Individual Process.

Year	Annual EIVs					
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Total Plant
2015	61.75	82.60	87.42	26.77	27.97	53.19
2016	87.31	88.31	86.3	25.18	29.41	56.99
Change	29%	6%	−1%	−6%	5%	7%

- Look at how EIVs and WIVs are changing over time.
- Where more detailed data is available, evaluate which process is driving the change.
- Identify areas where good results can be repeated and bad results can be avoided elsewhere in the plant.

9. Identify Opportunities for Savings

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Start with the listing of Best Practices applicable to the plant.

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

Identify the potential savings from this practice

Process Sub-Category

Identify whether this practice is met at the plant

Where BP is not met, what action is recommended

10. High-Level Savings Estimate

In general, it is not possible to develop precise estimates of energy or water savings from the implementation of ECMs or WCMs without performing a detailed engineering evaluation of the actual consumption of the equipment and the cost of acquiring and installing more efficient replacement equipment. For purposes of this consultation, however, a rough approximation can be made using the following methodology:

1. Primary focus should be placed upon the equipment associated with the highest electrical- or water-consuming processes (determined through sub-metering or as total connected load) and equipment that has the highest utilisation (not just occasionally used but used whenever the process is active).
2. The potential conservation measures should be ranked in order of their approximate contribution to the plants overall electricity and water usage.
3. Best Practices with a high potential reduction in consumption should be preferred over those with lower percentage savings.
4. Best Practices where the expected implementation cost is modest (simple equipment change-out) should be preferred over those with high implementation cost (complete process change).

10. High-Level Savings Estimate (cont.)

For each of the top five ranked conservation measure (ECM or WCM) the potential savings can be approximated with the following:

1. Estimate the current annual energy consumption by taking the total connected load (D) for the specific equipment and multiplying it by the annual utilisation factor (U), where:

   $$U = \frac{\text{annual hours of equipment usage}}{\text{8,760 hour per year}}$$

   Energy currently consumed, E_c (kWh) = D (in kW) X U (%) X 8,760 hours per year

2. Estimate the savings in energy (S in %) by applying the expected savings from replacing the existing practice with the more efficient practice. If the savings are given as a range, use the mid-point of the range to be conservative.

   Energy consumed in future, E_f (kWh) = D (in kW) X U (%) X 8,760 hours per year X S (%)

   Energy saved per year $E_R = E_c - E_f$ (kWh)

   Value of savings = E_R (kWh) X average cost per kWh [from ADDC tariff – currently 28.6 fils average]

3. The potential cost of implementing the ECM or WCM (Cost) can be determined from contacting suppliers or evaluating bids from other such equipment installations.

4. The Benefit/Cost ratio = E_R X expected equipment life (years) / Cost

   B/C >1 indicates a positive investment.

11. Prepare Consultation Report

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<u>Contents of Report</u>

1. Executive Summary of Business Case
2. Introduction
3. Review of Production Process
4. Energy & Water Consumption Analysis
5. Industry Best Practices
6. Conclusions and Next Steps

12. Present Report to Plant Leadership

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- The stated purpose of the presentation to Plant Leadership is to demonstrate to them the findings from the consultation.
- A secondary purpose is to point out to Plant Leadership the next steps that they need to take in order to further evaluate the savings opportunities identified in the consultation and firm up the high-level estimates of benefits and costs.
- This secondary purpose will also serve to reinforce the point that the industrial consultation was being provided as a no-cost service by ADDC but is not a substitute for a detailed engineering evaluation of potential savings projects.
- The third objective is to gain from the Plant Leadership a further commitment to take the recommendations made in the consultation to the next level and, where further investigation proves them to be cost-effective, to make that investment in order to achieve reduction in the quantity of electricity and water required by the plant per unit of output.