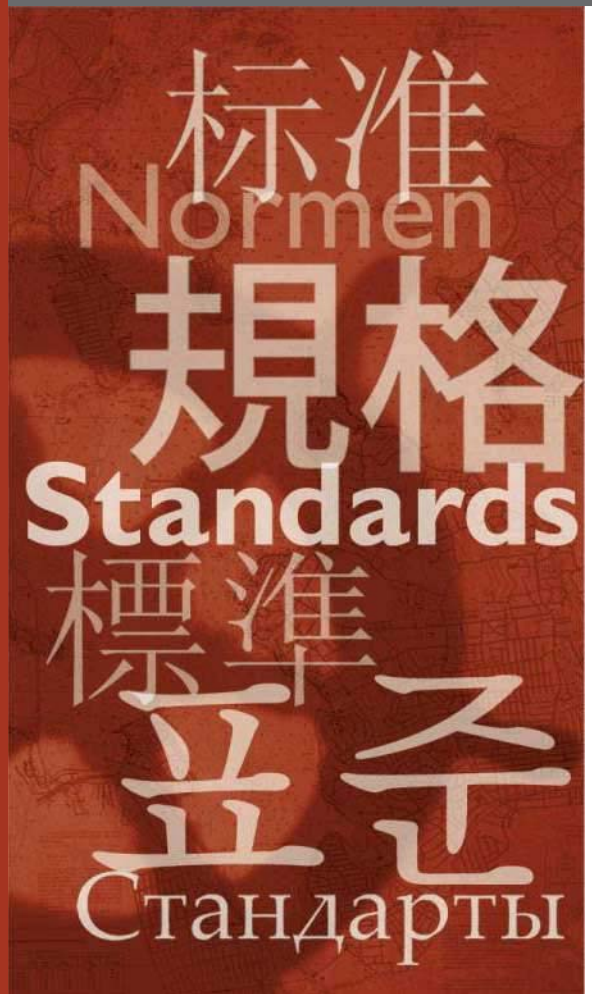
S23 – The Guideline Basics



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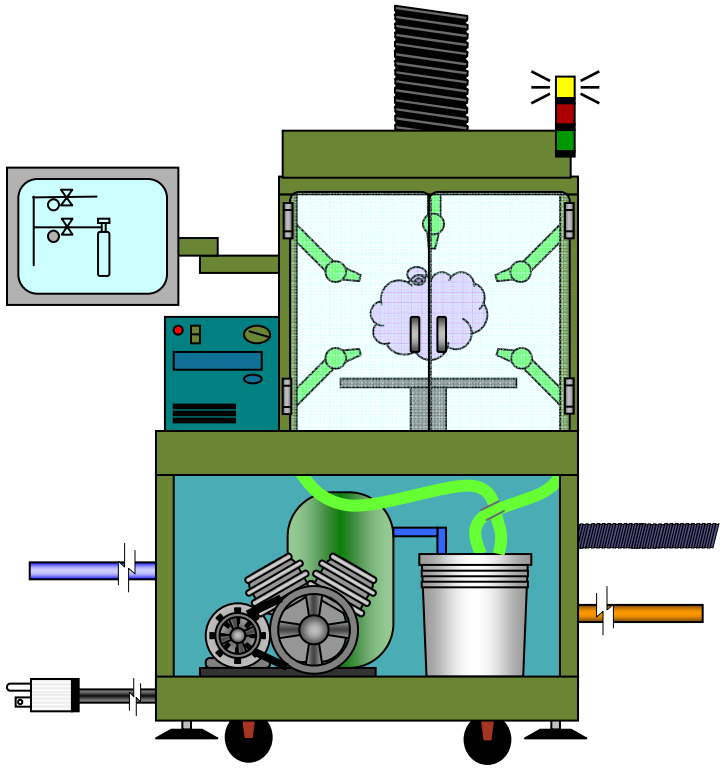
Safety Technical Staff
Product Regulatory Analyst

Presentation For

SEMI/ISMI S23 STEP
SEMICON West, 2007

Outline

- Basic S23 Method
- Equipment Lifecycle
- Baseline Recipe
- Use Rate Measurements
- Conversions
- Conversion Factors
- Improvement Roadmap
- Monitoring and Reporting



SEMI S23 – Purpose and Rationale

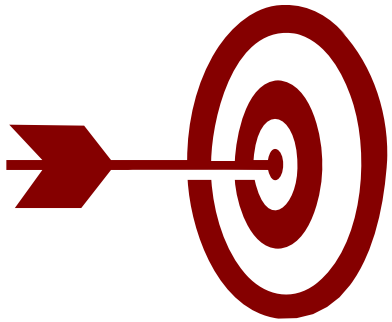
6.5 An equipment user can consider supplier-reported utilities and materials use-rates, energy equivalent values, and planned improvements when making the [sic] purchasing decisions.

1.4 This guide is a series of options and instructions intended to increase awareness of the reader to available techniques in the area of energy, utilities and materials conservation. A particular course of action is suggested for utilities and materials use measurement and conversion of use measurements into equivalent energy.

Note1: Because this standard is a Guide, all criteria using “should” may be considered optional.

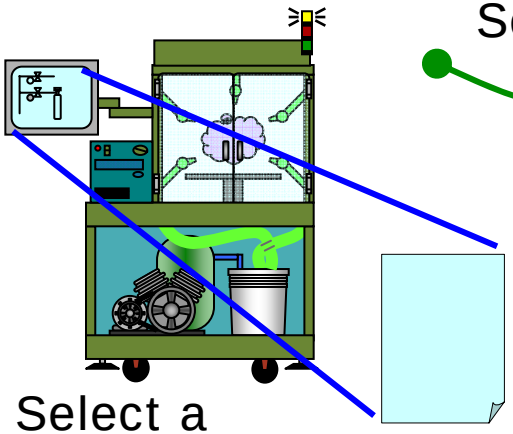
SEMI S23 - Limitations

3.2 This guide is not intended to provide definite targets for utilities and materials usage or energy conservation.



3.3 The information suggested in this guide may be provided by the equipment supplier to the user if that is the agreement between those parties.

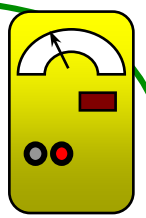
Basic S23 Method



Select a product & a baseline recipe

Select a life cycle stage

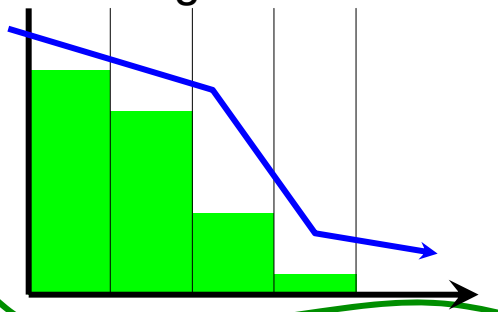
Select utility to measure & gather use rate data



Select conversion factors & determine equivalent energy

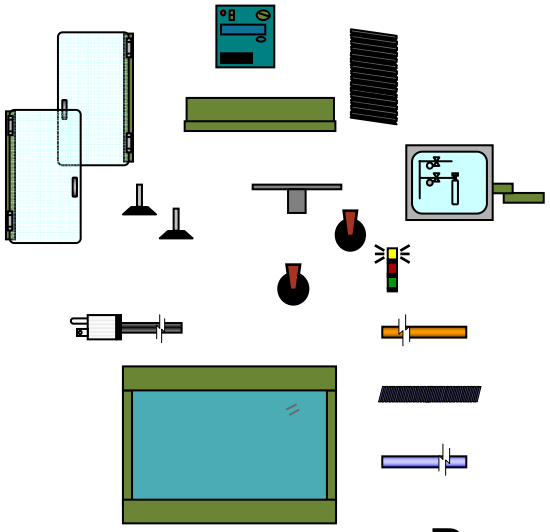
$$Energy = \textbf{Conversion Factor} \times Period \times Use\ Rate$$

Set reduction targets & strategies

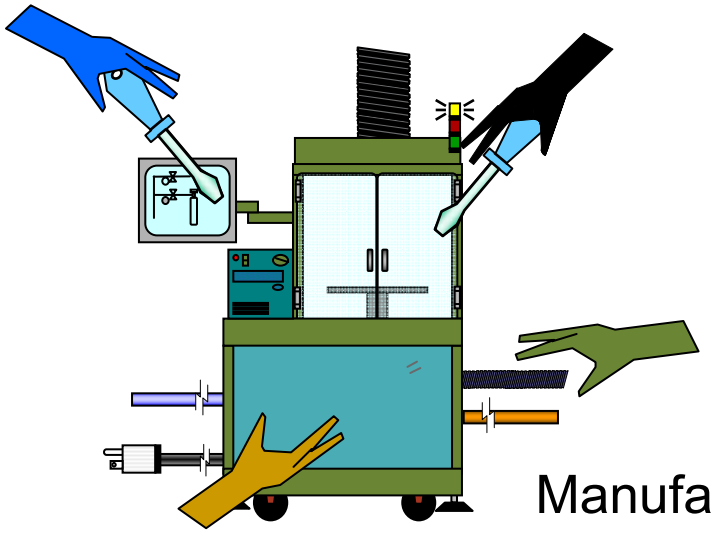


Monitor & report results

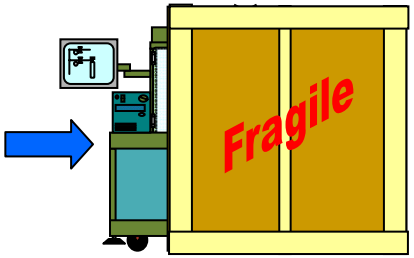
Lifecycle - Beginning

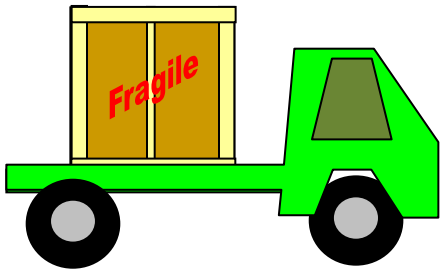


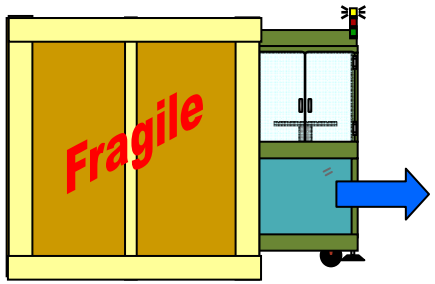
Procurement



Manufacturing

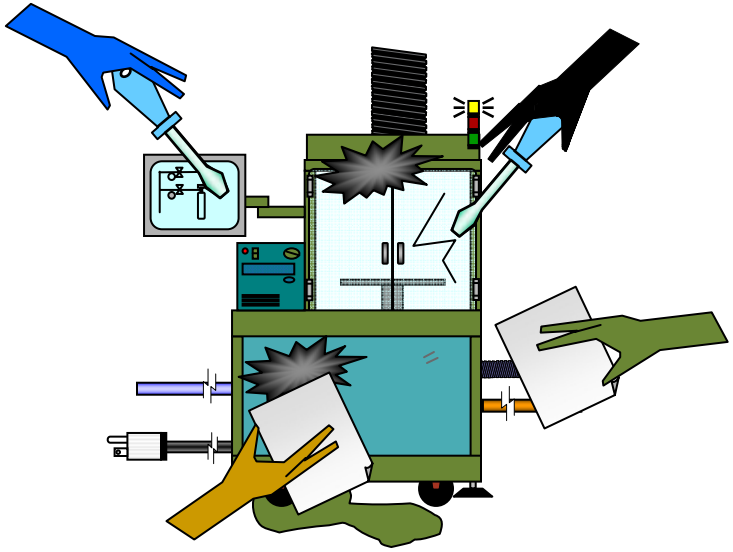




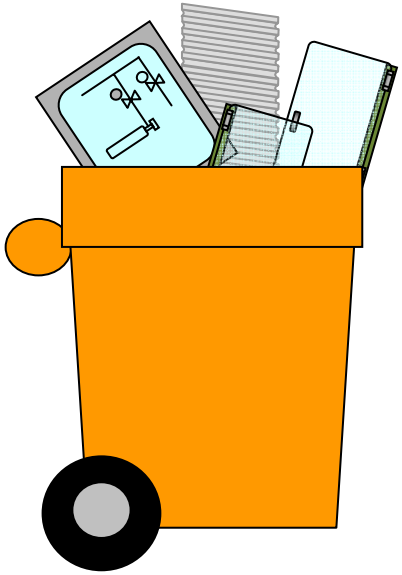


Crating
Shipping
Installation

Lifecycle - End



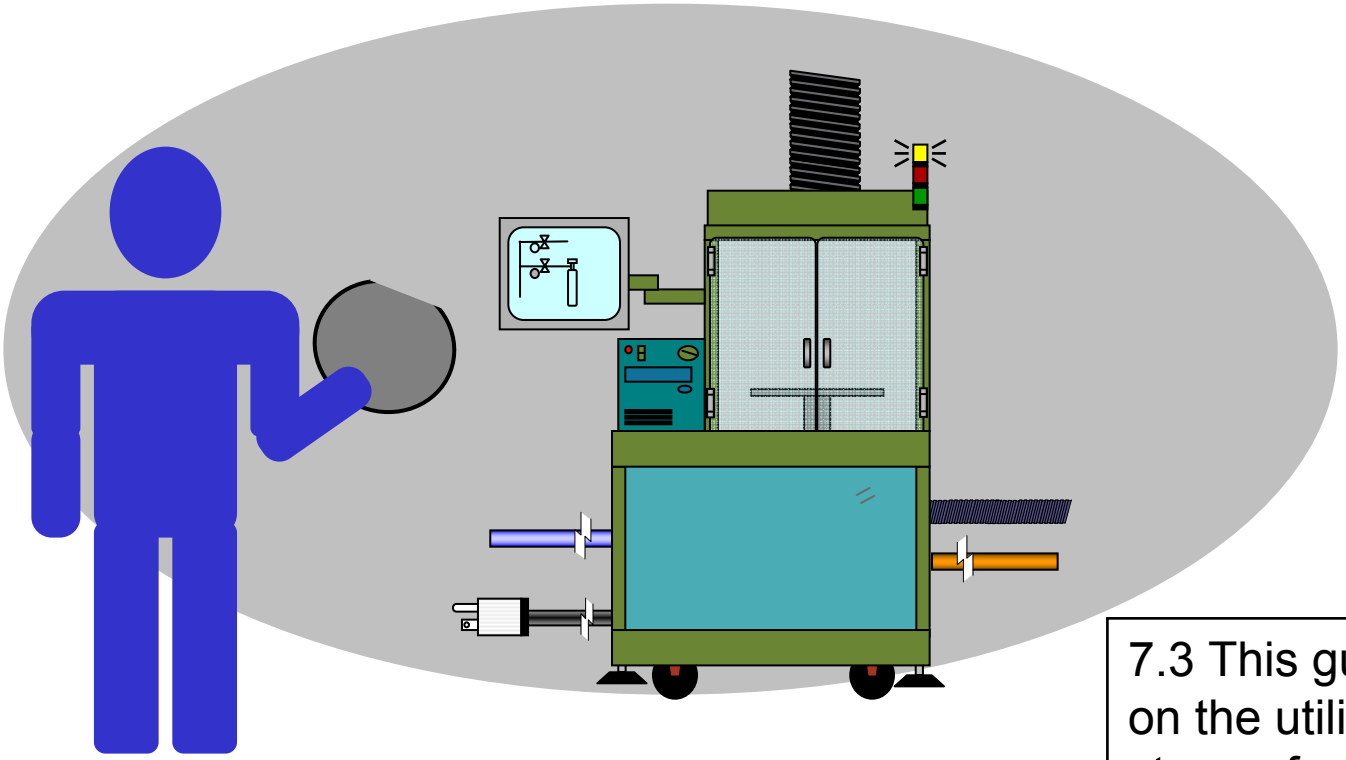
Decommissioning



Disposal

Lifecycle - S23 Focus

Utilization (use)

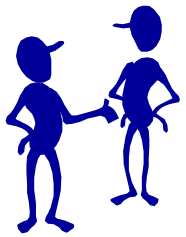


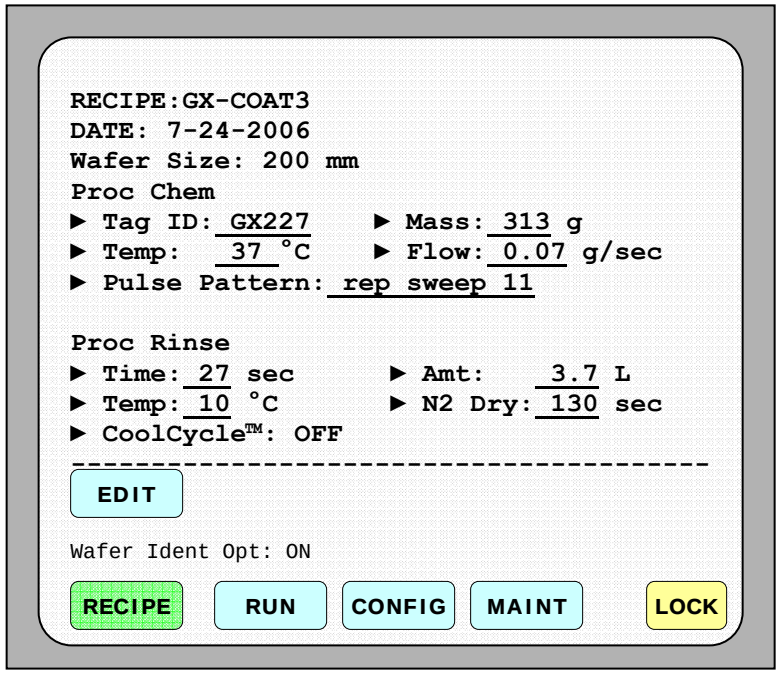
7.3 This guide focuses only on the utilization (or use) stage of equipment life cycle.

Baseline Recipes

One or several baseline processes may be appropriate to completely characterize a product.

Considering how end users will actually use the equipment and what they may desire for tool to tool comparisons can make energy conservation projects more effective.

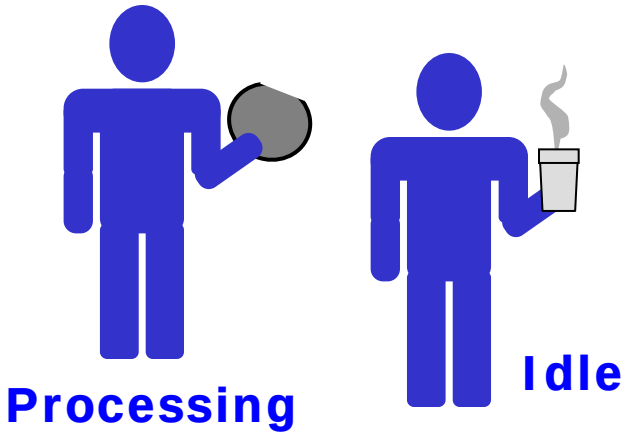




Within this guide, “baseline recipe” should be understood as the collection of recipe parameters intended to produce a specific desired effect. Therefore, baseline recipes (i.e. the desired effect) can be the same from equipment to equipment even though the parameters of the recipes may be different. [RI1-1.2]

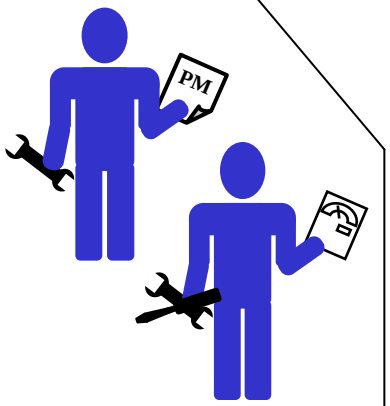
What is done vs. **How** it is done

USE Stage = Processing & Idle



5.2.9 process mode - The condition where the equipment is energized and performing its intended function on target materials (such as implanting wafers, pumping gas, or inspecting photo-masks)

Maintenance and Service tasks are out of scope

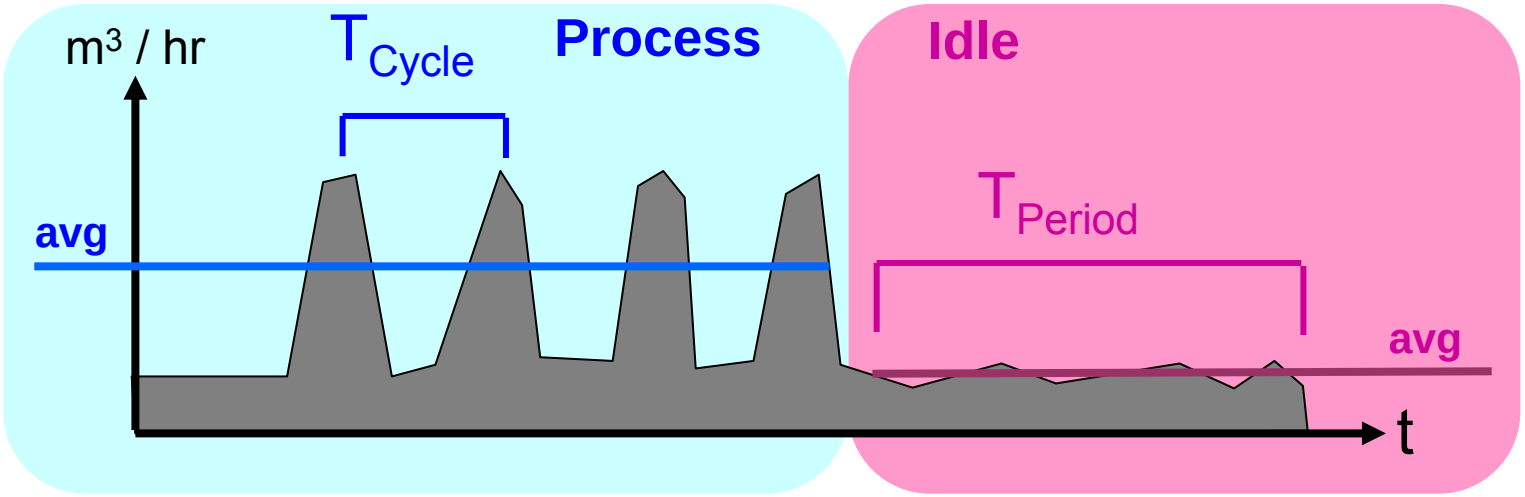


5.2.7 idle {mode} The condition where the equipment is energized and readied for processing (all systems ready and temperatures controlled) but is not actually performing any active function such as materials movement or processing.

Use Rate Measurements

9.4 For the processing measurements, the **average value** of each parameter over the course of several processing cycles should be recorded as well as the **length of the cycle**.

9.5 For the idling measurements, the **average value** of each parameter over a period of idling should be recorded as well as the **length of the period**.



RI-1 recommends an average over at least 10 cycles while processing and 30 minutes while in idle.

Basic Conversion Calculation

Equivalent Energy = *Use Rate x Period x* ***Energy Conversion Factor***

$$\mathbf{E}\ kWh = \mathbf{U}\frac{V}{t} \times \mathbf{P}\ t \times \mathbf{ECF}\ \frac{kWh}{V}$$

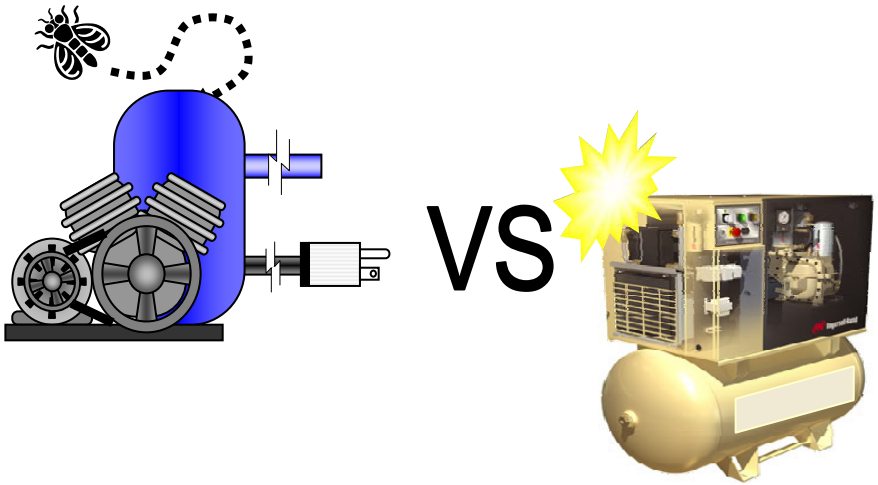
10.9 Determining reasonable energy conversion factors for most **process chemicals** has not yet entered the state of the art. Therefore, conversion factors are not recommended for them.

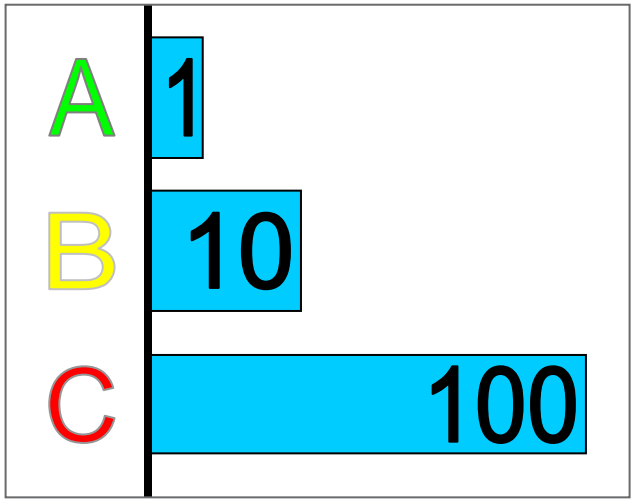
10.7 The equipment supplier may also use an **alternate set** of conversion factors.

The ISMI TEE Tool will provide a method of automatic calculation and reporting.

Energy Conversion Factor Basics

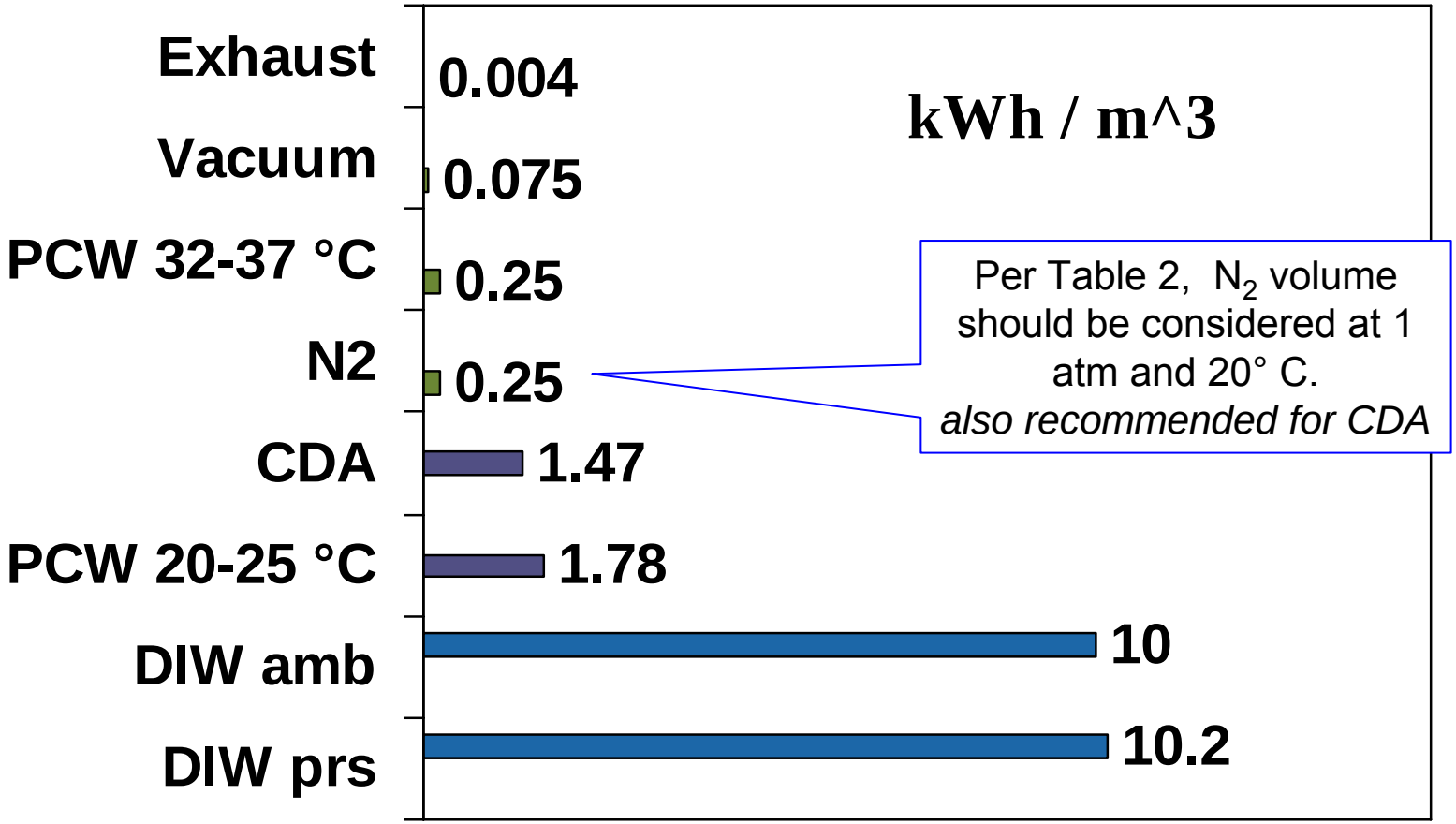
10.8 A conversion factor is better if it accurately represents the actual electrical energy required to create and distribute a particular utility or material at the equipment's end use location.





The actual energy required to generate a utility will vary, so the S23 ECFs will not be exact for any location, but they can provide a relative ranking of importance and order of magnitude to assist in prioritization of conservation efforts.

Volumetric Conversion Factors



S23 sets the electrical energy conversion factor at 1 (i.e., it is assumed that it takes an input energy of 1 kWh to produce 1 kWh of electrical energy).

SEMI S23 – Heat Burden

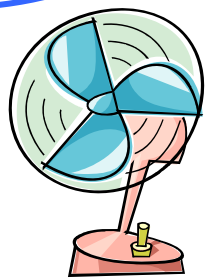
Removal via Air	3.24×10^{-4} kWh / (m^3 °C)
Removal via Water	1.16 kWh / (m^3 °C)
Burden	0.382 kWh / kWh

Y kWh **OUT** via Exhaust and PCW

Z = (X – Y) kWh radiated

X kWh Electricity **IN**

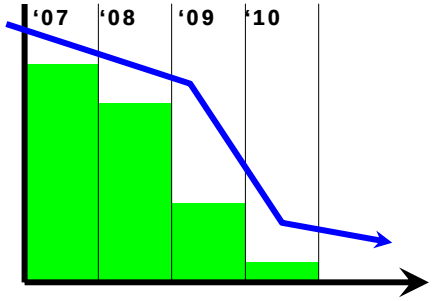
0.382 Z kWh for Factory Air Cooling



The Improvement Roadmap

11.9 The following data should be considered to be included in an improvement roadmap.

- Equipment (model, options, configuration)
- Targeted utilities and materials
- Baseline recipe(s) selected
- Measured use-rate data
- Conversion factors used
- Target date for improvement
- Justification of why a target is achievable and how it will be achieved
- A cost/benefit analysis



Notes

- Decide on use rate reduction, or equivalent energy reduction, or both.
- Set target - Develop timeline to achieve target - Justify each target
- Discuss utility assumptions and cost/benefit with End Users
- Consider various means for achieving target
- Recommend how users should supply utilities
- Create improvement roadmap

Ex: Roadmap Plan

Equipment: GX 300 Coater **Baseline Recipe:** GX COAT3

Target Utilities: Electricity, CDA

ECFs: Electrical Power - 1 kWh/kWh CDA - 0.110 kWh/m^3 (see Justification)

Use Rate Basis: Process and Idle values were extrapolated from average data for a 1 hour period. Average processing rate = 6 wafers per hour.

Improvement Plan: Adjusting the process rinse time of the GX COAT3 recipe from 27 to 24.6 seconds achieves the desired process results but uses 5% less CDA per wafer.

Electrical efficiency can be improved by removing the GX300 air compressor and utilizing in-fab CDA supplies.

Our 3 key customers offer CDA to the tool at 90psi and report to us an average ECF of 0.110 kWh/m^3. (S23 value = 0.147)

The GX300 compressor operates at .7 kWh/m^3. The EnerLite compressor operates at .5 kWh/m^3.

Ex: Roadmap Data

►6,132 hrs processing ►2,190 hrs idling ►438 hrs (5%) downtime	Processing				Idle				Total kWh
	Elec kWh	CDA m^3	CDA kWh	Total kWh	Elec kWh	CDA m^3	CDA kWh	Total kWh	
3/2008 – Baseline for project	1,230	0	0	1,230	110	0	0	110	1,340
2/2009 – Roll out GX COAT4 recipe	1,040 **1,020**	0 **0**	0 **0**	1,040 **1,020**	110 **110**	0 **0**	0 **0**	110 **110**	1,150 **1,130**
3/2009 – ECO for Enerlite compressor	**870**	**0**	**0**	**870**	**90**	**0**	**0**	**79**	**949**
1/2010 – ECO and retrofit to replace compressor with house CDA.	**310**	**184**	**20.2**	**330**	**40**	**18.1**	**2.0**	**42**	**372**

Elec ECF=1 CDA ECF = 0.11
Blue numbers are predicted values.
Full analysis and data available in file "GX COAT3 EnCon.doc"

Values are Per Year

Ref 10.3

Monitoring and Reporting

Monitor

Review progress to roadmap periodically. Once every 2 years is recommended.

If targets are not achieved, it is useful to capture contributing factors as feedback to improve future estimates.

Adjust strategy and goals as needed.

Reporting

Provide minimum recommended roadmap data (ref 11.9).

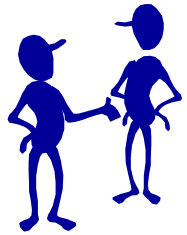
Include analysis of missed targets and resulting revised goals or strategies.

Consider including data that end users would find beneficial.

Be careful about including confidential information without appropriate NDA's in place.

User / Supplier Considerations

A contract statement to the effect of "Product must conform to S23" does not imply any specific criteria, except that the supplier pursue the basic method of the guide (see slide 5).



Suggested topics for discussion between end user and supplier

- Equipment models and configurations to be included in the process.
- Cost/benefit of implementing changes to conserve energy. [NOTE 3, 11.2]
- What baseline processes are similar to what the user actually uses, or has implemented for "apples to apples" tool comparisons? [8.1 & Note 7]
- Do the selected conversion factors make sense? Do they reflect the actual conditions at end use locations? [10.8]
- Actual utility generation methods vs. S23 assumptions. [11.4]
- Content and update frequency for improvement roadmaps. [12.2.1, 12.2.2]

Related Information

Use rate measurement details

- Suggested minimum periods for establishing processing and idle averages.
- Expressing energy use in per wafer rates, or per cm^2 rates.
- Measurement report data.

Conversion Factors

- Basis for table 2 values.
- Estimated hours per year.
- Basis of a conversion factor.
- Alternate conversion factors.
- Process chemical conversion factors.
- The heat load calculation & example.
- Electrical energy generation.