SEMI Technical Education Program
SEMI Standards / ISMI Present SEMI S23 - Energy Conservation
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ISMI S23 Supplier Application Guide and Total Equivalent Energy Tool

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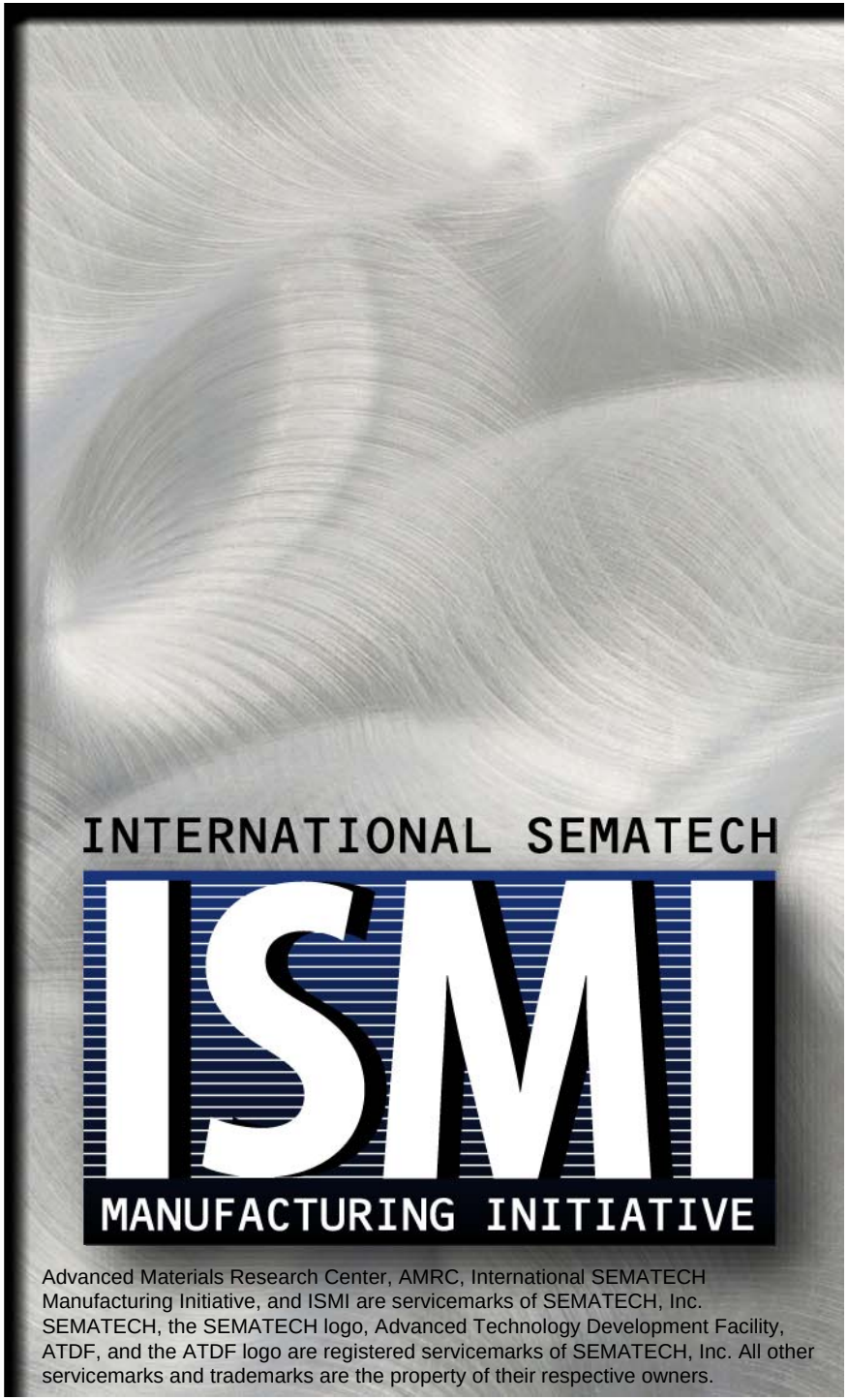
ISMI ESH Technology Program



ISMI S23 Application Guide overview

- Part 1: S23 Application Guide
  - Aid in the application of SEMI S23-0705 *"Guide for Conservation of Energy, Utilities, and Material Used by Semiconductor Manufacturing Equipment"*
  - Provide guidance in the selection and use of utility measurement instruments
  - Provide recommendations for resource use reduction
- Part 2: Total Equivalent Energy (TEE) Tool instructions
  - Converts various semiconductor manufacturing equipment utility consumption rates into *equivalent annual electrical energy usage*
  - TEE Tool exports S23 data to Microsoft Excel™
- Application Guide is published on SEMATECH public website or available on request:
  - www.sematech.org: **TTID # 06094783B-ENG**

ISMI S23 Application Guide Section I: Selecting and Using Measurement Instruments to Conserve Resources

- Intent: Facilitate SEMI S23 application by providing supplemental information
  1. Measurement practices
     - Recommended power, flow (gas, exhaust, liquid), pressure, temperature measurement methods
     - Comparison of instrument types: cost, ease, required accuracy
  2. Conservation practices
     - Understanding and applying recommendations
       - By major facility system
       - By parameter affecting system efficiency

Introduction – TEE Tool

- TEE Tool is a powerful Excel™ based application
- Converts tool utility consumption to KWh/year
  - Comprehensive analysis of *direct* and *indirect* energy consumption
  - Differentiate between “processing” & “idle”
- Provides a standard report format for S23
  - Export as an Excel™ spreadsheet
  - Data can be used in other applications

TEE Tool Benefits for Equipment and Device Manufacturers

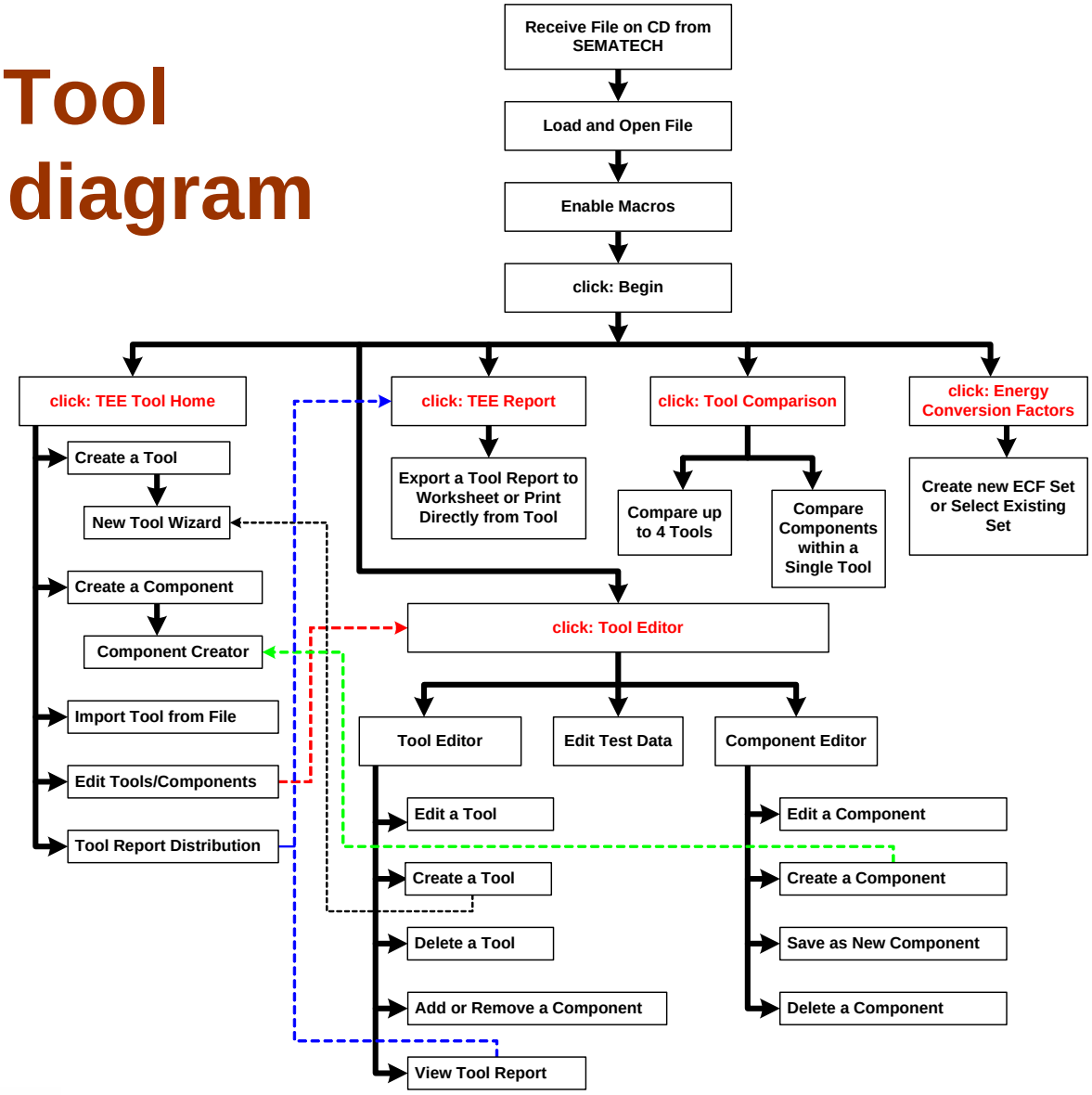
- Rapid calculation of Total Equivalent Energy
- Ability to compare up to 4 tools, graphically
- Aids in developing energy reduction improvement roadmaps
- Determine impact of utility flow changes on operating cost
- Assess operational cost impacts of component selections

TEE Tool – Key Features

- Default SEMI S23 Energy Conversion factors (ECFs)
  - Added Hot UPW, High Pressure CDA
  - Ability to create and assess alternate ECFs
- Calculates heat added to the cleanroom as “heat burden”
- S23 “processing” & “idle” tool modes
- Process Tool = summation of its Components
  - User defines Components and Tools
- Results can be graphed or exported to Excel™

TEE Tool enables users to easily assess and report total operational cost impacts

TEE Tool flow diagram



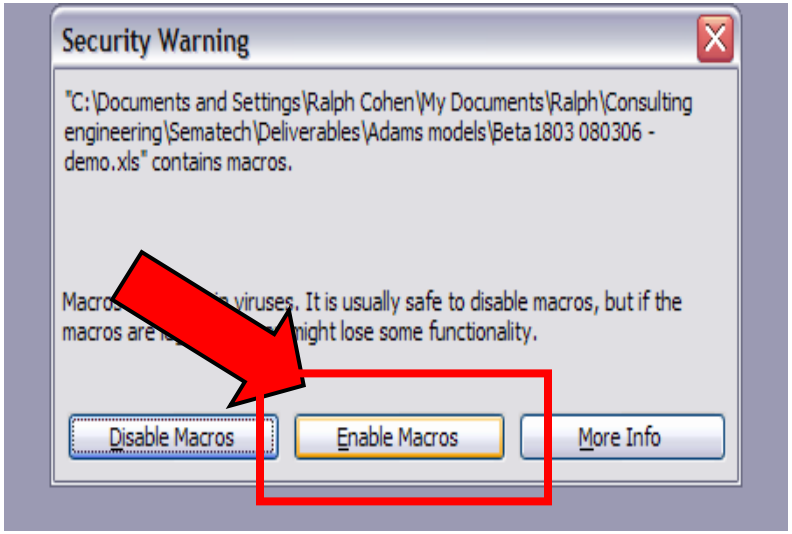
What You Need to Get Started

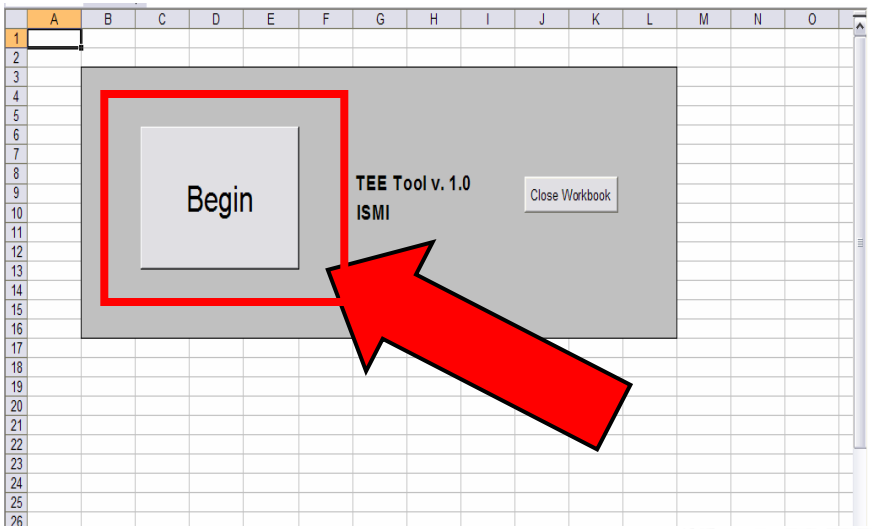
- Obtain TEE software CD or download from ISMI public website (available August 1, 2007)
- Verify computer meets software requirements
  - Microsoft Windows 2000, X/P Home or Professional
  - Microsoft Excel™: 2003 or later
  - TEE Tool might be unstable with earlier versions
    - Known issues with Excel 2000

Opening & Saving the TEE Tool file

- Click on **Enable Macros**
- Click on **Begin** button on opening screen

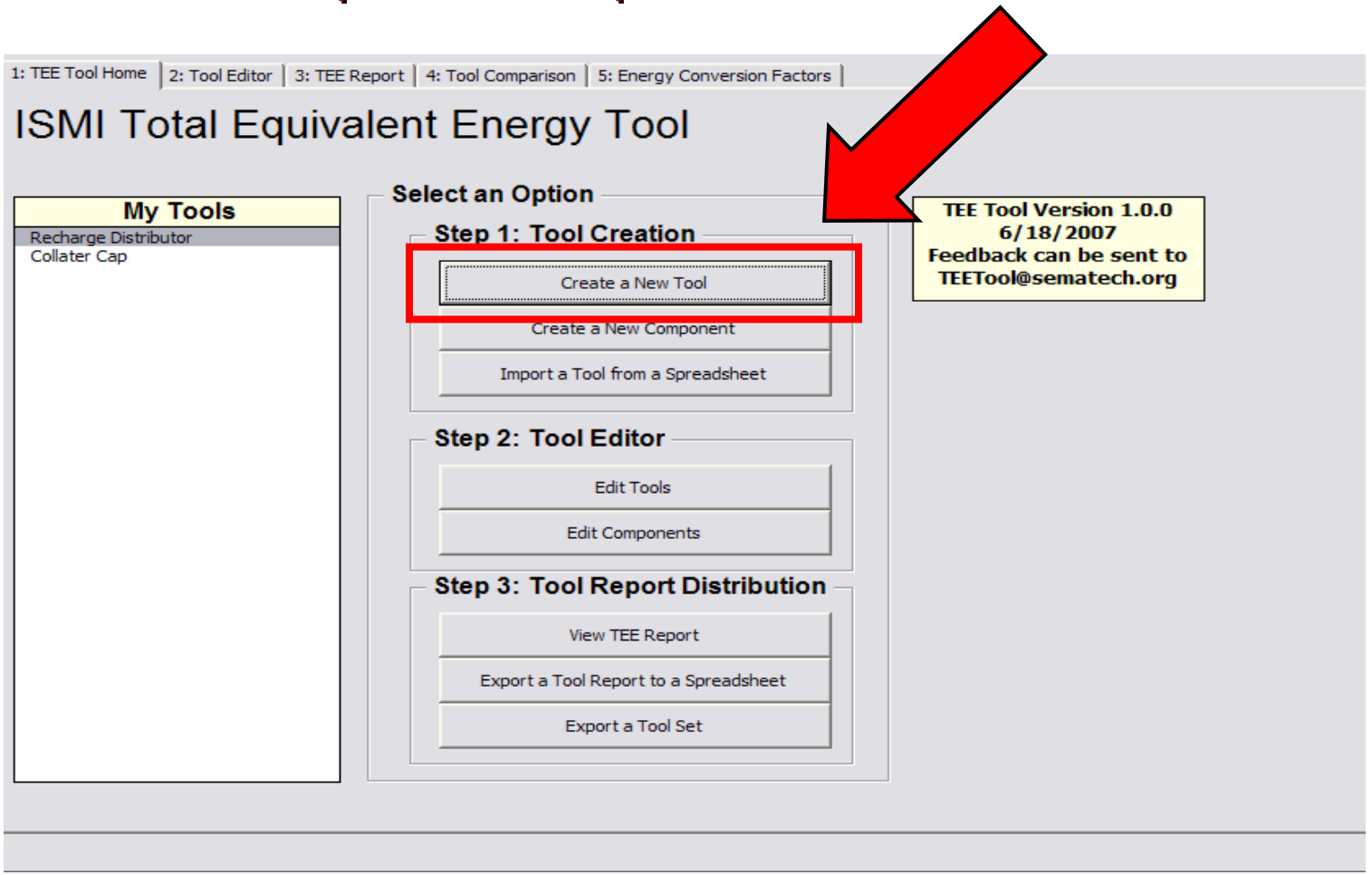
Hint: Save to new file name after opening 1st time



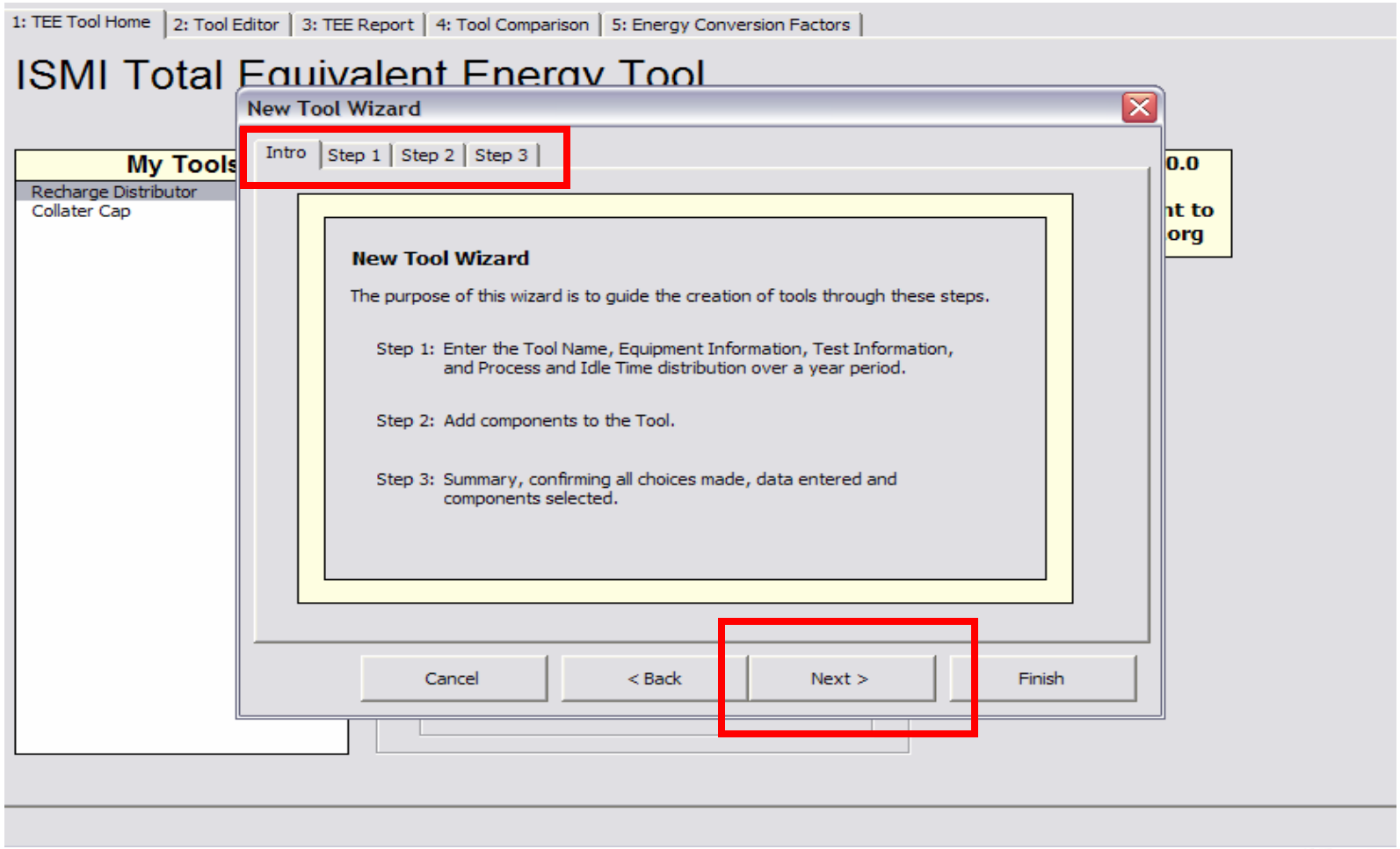


From TEE Tool Home

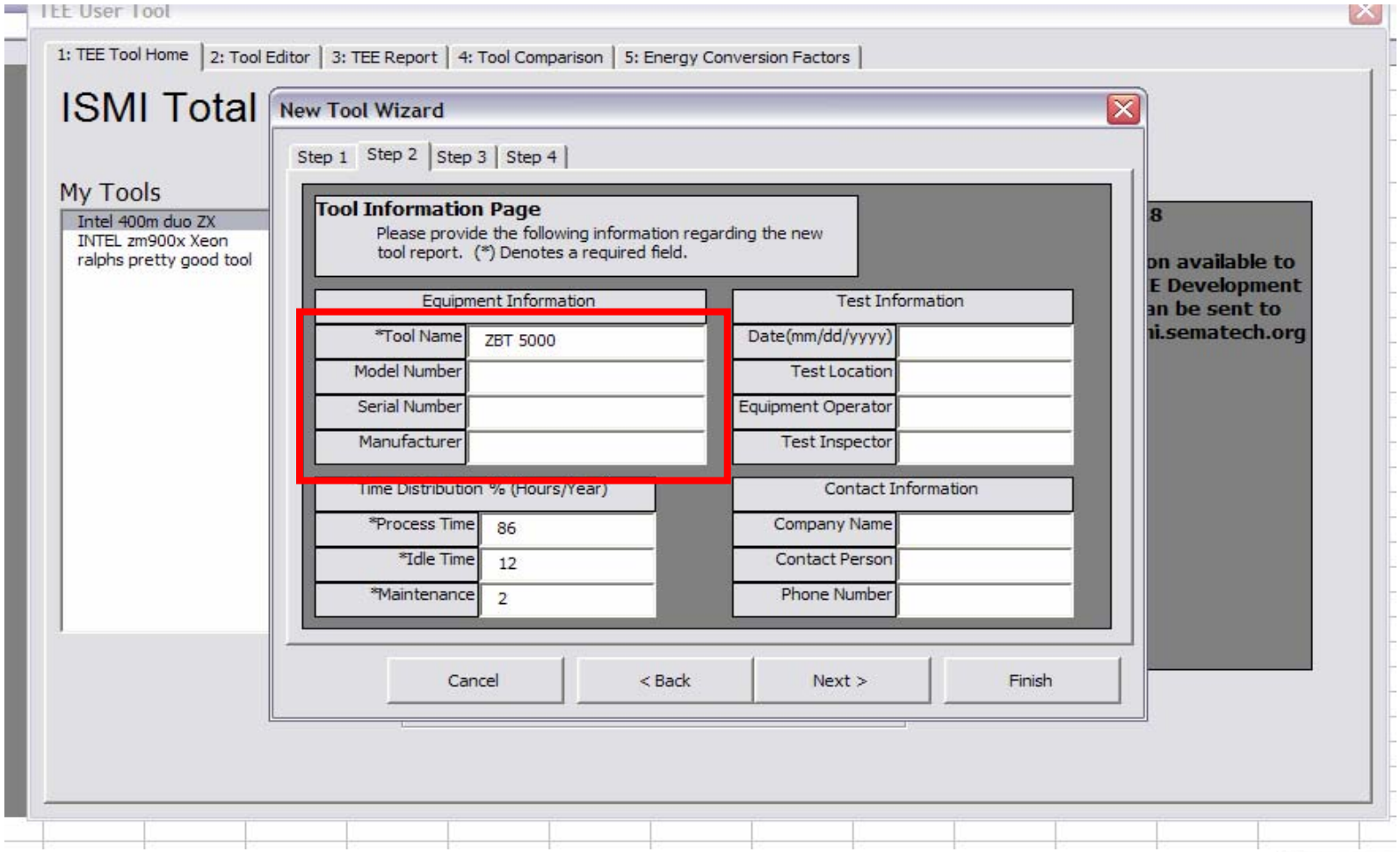
- Create/Edit tools or components
- View/Export tool report



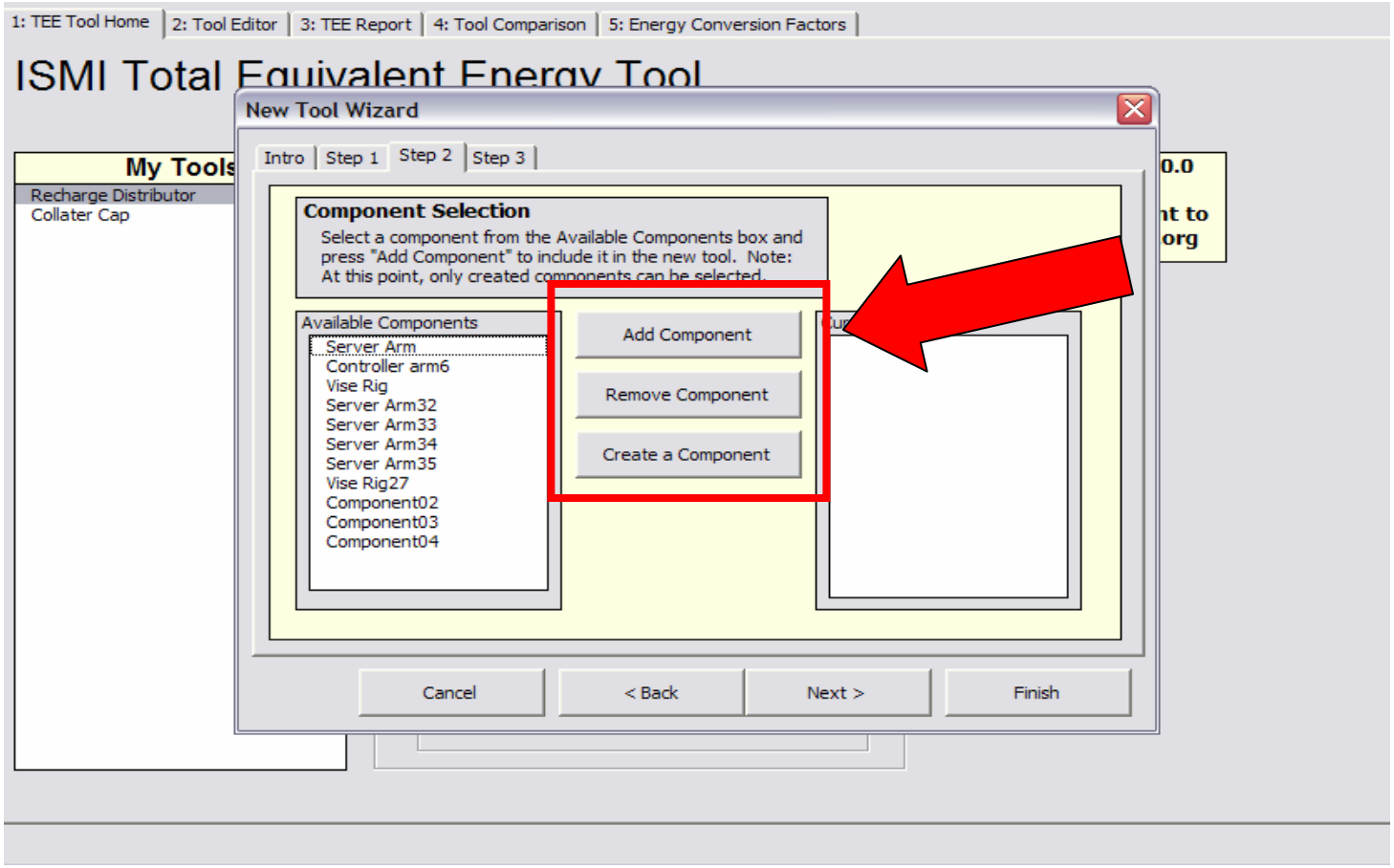
Clicking on **Create a New Tool** opens "New Tool Wizard" - Progress through steps 1-4 by clicking Next



Create a New Tool: Step 2
- Tool Information Page
- Fill in required fields (required)

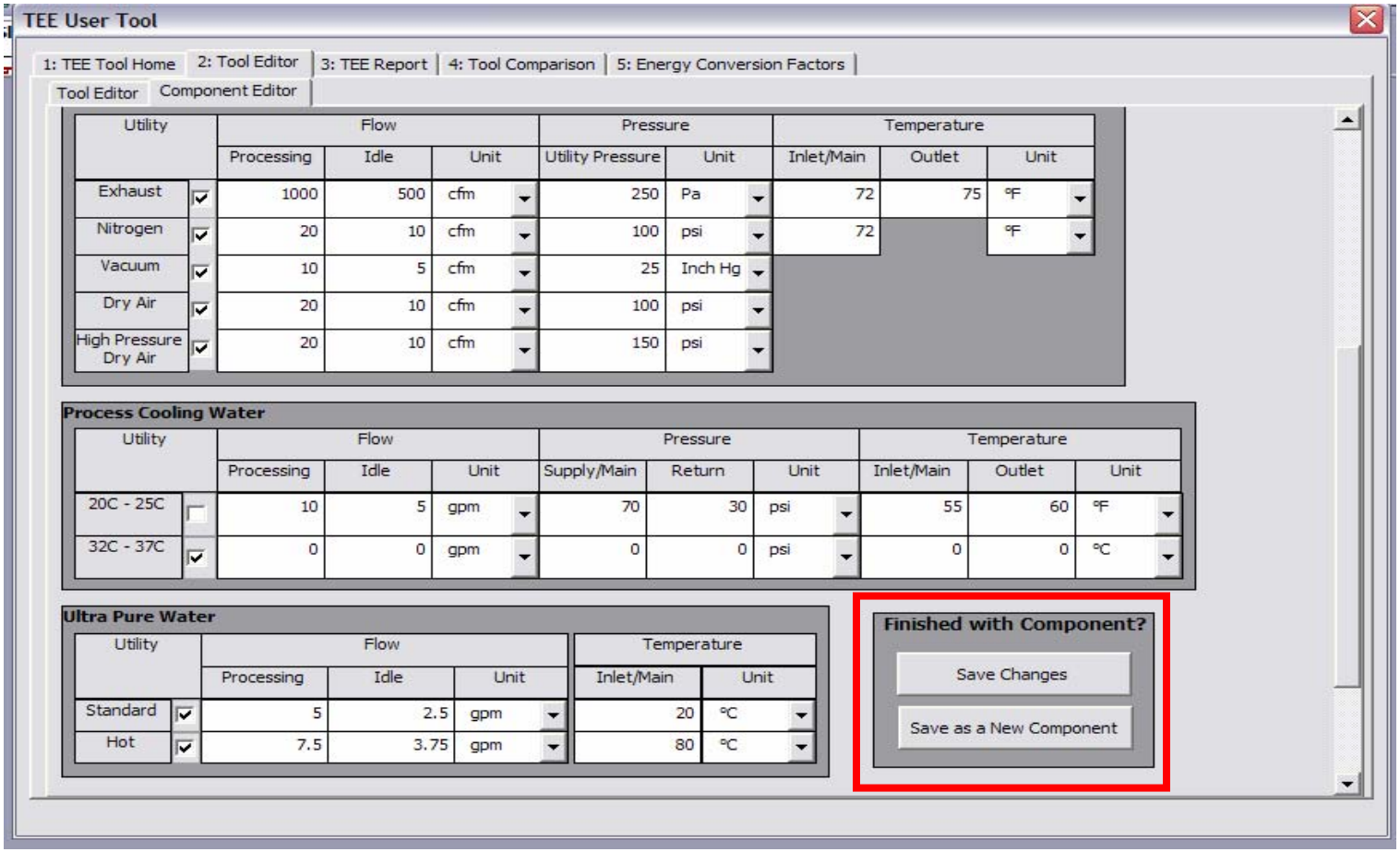


Create a New Tool: Step 3 - Component Selection - Click on **Add / Remove / Create**



Click on **Component Creator**

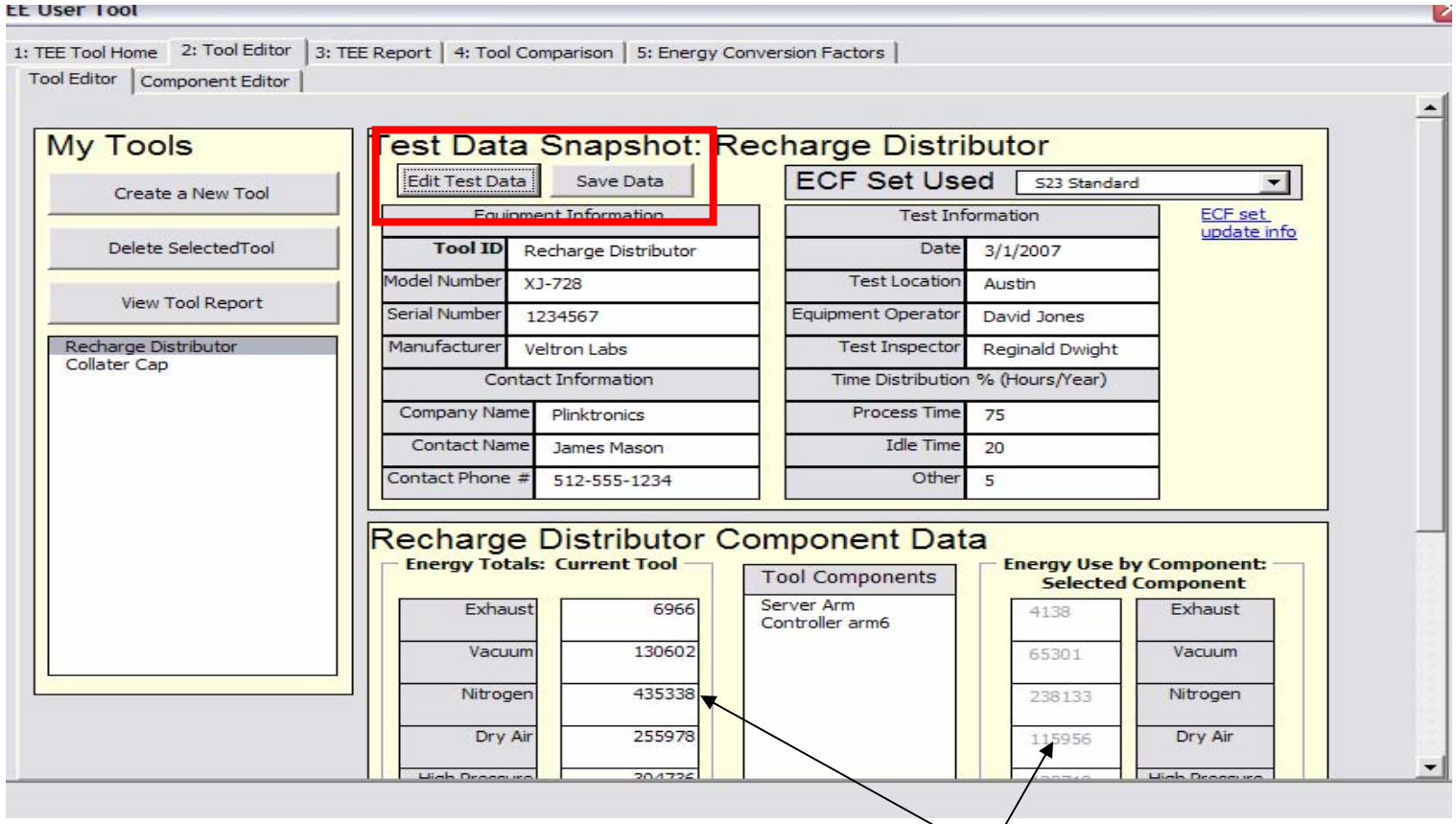
- Use pull down menus for units
- Enter data (gaseous in “standard conditions”)



Hint: Save Changes to an existing component, or Save Changes to a New Component

Click on **Tool Editor** tab

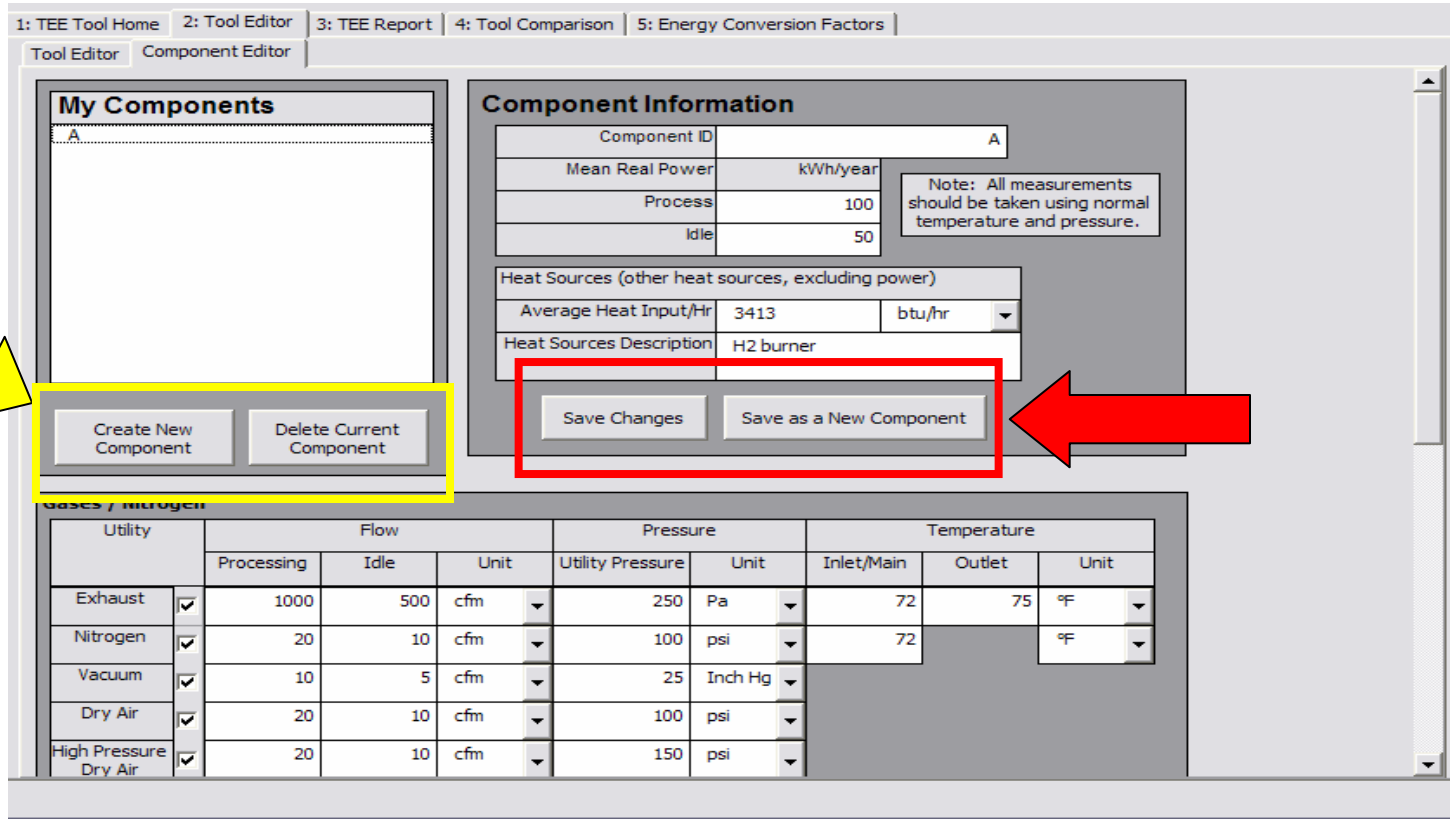
- Create / Delete Tool
- Edit Test Data ("Save Data" after change)
- View Tool Report or Tool / Component Energy



Data in units of "KWh/year"

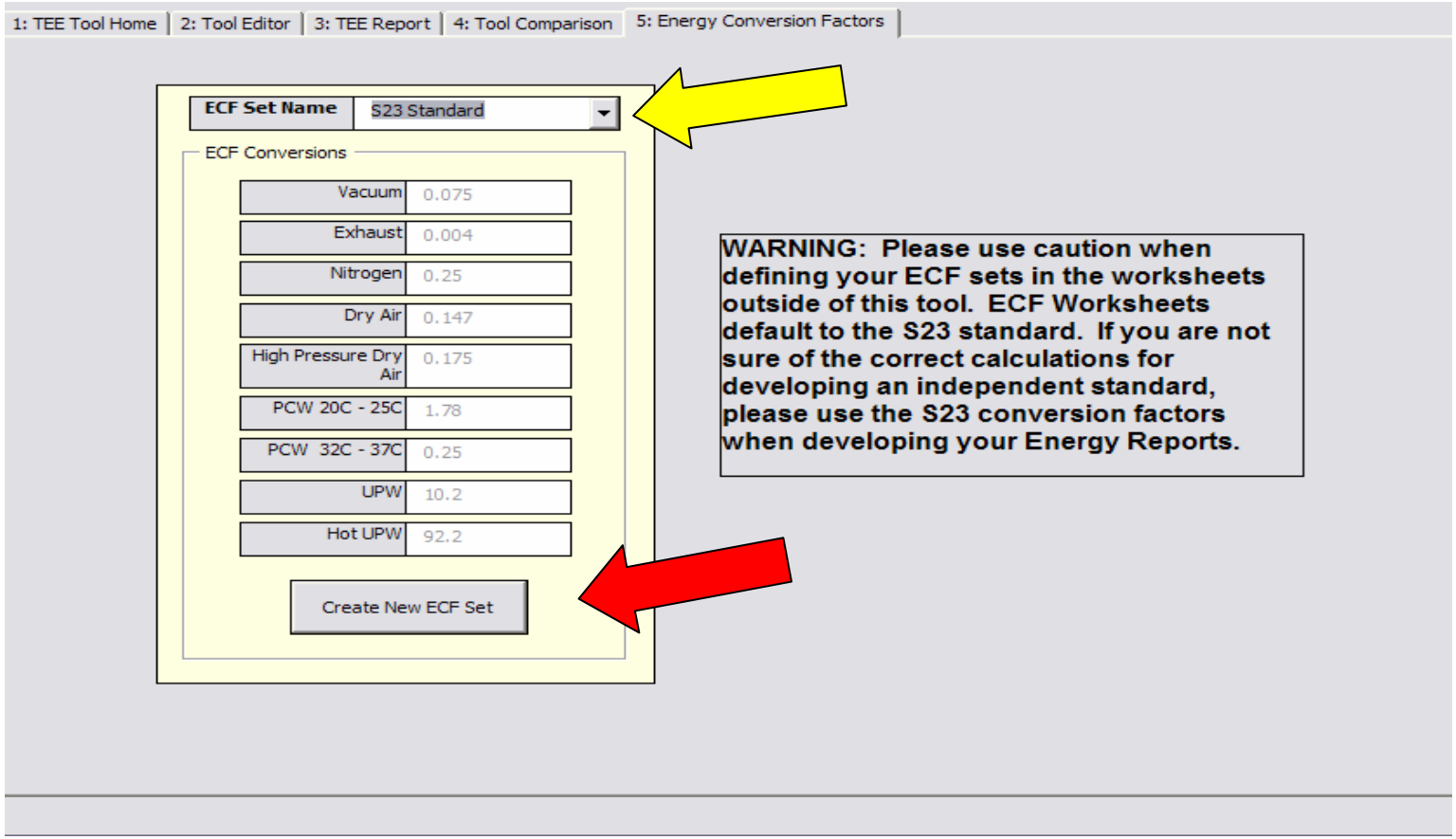
Click on **Component Editor** tab

- Create / Delete Component
- Edit Component information and Data (and “Save Changes”)
- Change the data (and “Save as a New Component”)



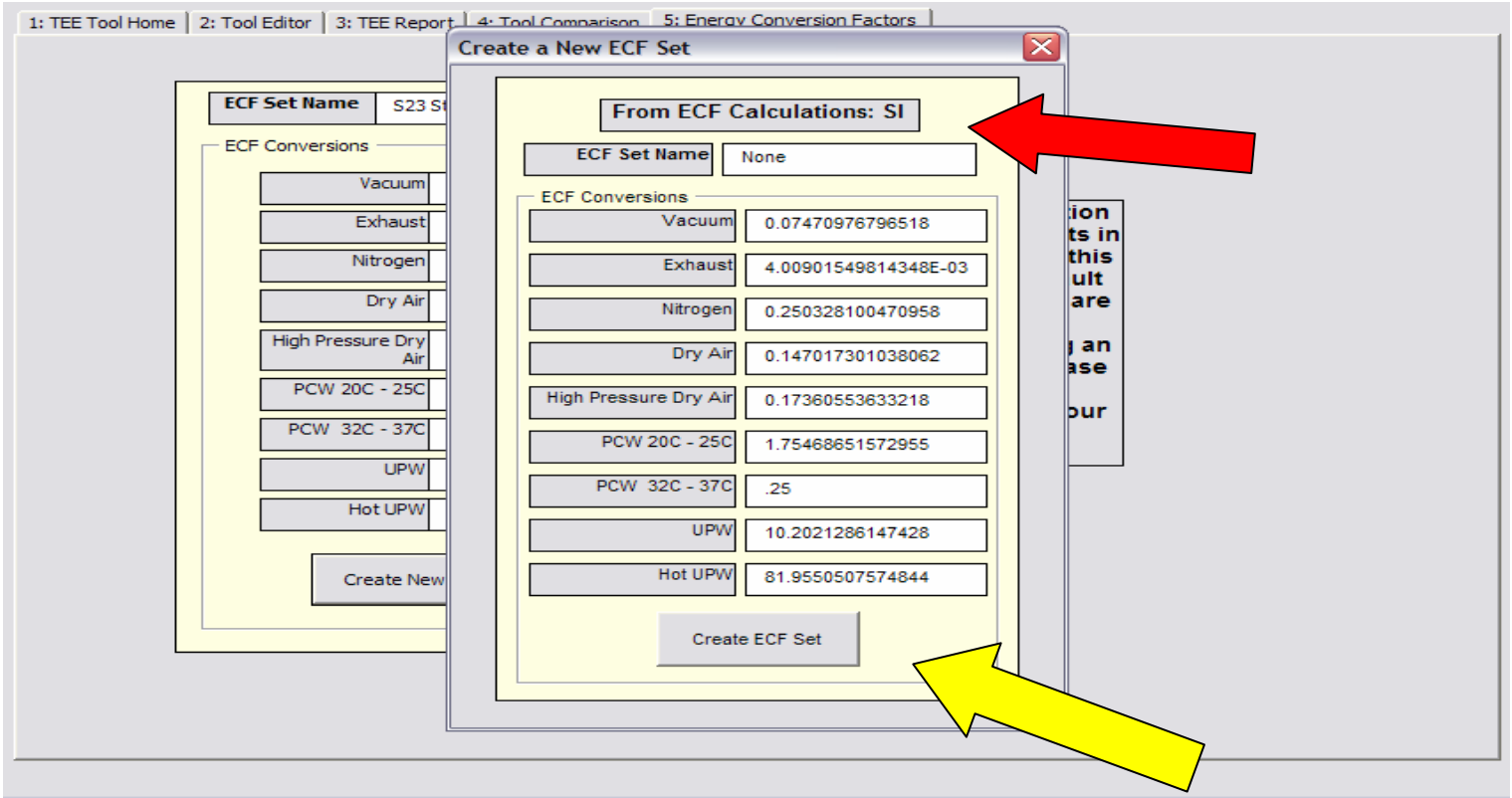
Click on **Energy Conversion Factors** (ECF) tab

- Click pull down tab for alternate ECF's
- OR create alternate ECF's from ECF Worksheet (see next slide)



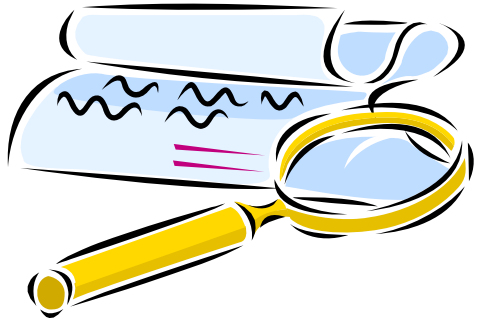
Click on **Create New ECF set** (see prior slide)

- User defined values may be inputted and saved with a unique name
- May use ECF calculation worksheets (SI or IPS) after closing TEE Tool



Obtaining TEE Tool Results

- Review: To create a TEE Report
  - Configure a specific tool's components
  - Enter component operating parameters / data
  - Associate tool components with the specific tool
  - Select the ECF (Energy Conversion Factor) set
- Click on **TEE Report** tab
  - Select process tool from Tool ID pulldown menu
  - Export to Worksheet or Print Report
  - ***S23 Equipment Energy Report!***



Generating a TEE Report (Click on **Tool ID** pulldown menu; select tool)

- Print report from screen
- Export to an Excel™ Workbook / Save as a new file

1: TEE Tool Home | 2: Tool Editor | 3: TEE Report | 4: Tool Comparison | 5: Energy Conversion Factors

Total Equivalent Energy Report		Tool ID	Recharge Distributor
Company Name: Plinktronics		Contact Person	James Mason
ECF Set Used: S23 Standard		Contact Phone #	512-555-1234

Export to Worksheet | Print Report | Return Home

Equipment Specification

Equipment Information		Test Information	
ID	Recharge Distributor	Date	3/1/2007
Model Number	XJ-728	Test Location	Austin
Serial Number	1234567	Equipment Operator	David Jones
Manufacturer	Veltron Labs	Test Inspector	Reginald Dwight

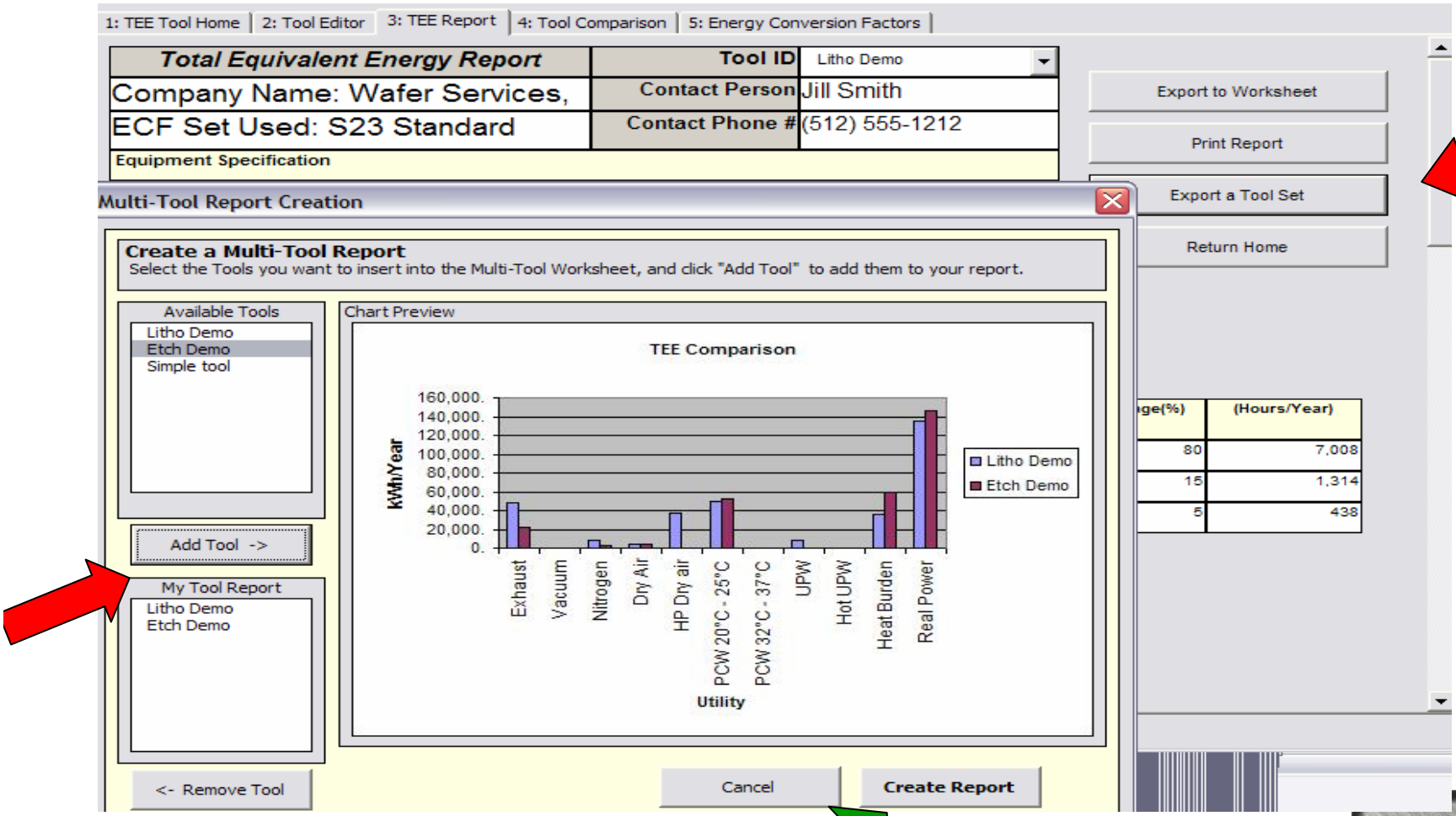
Annual Summary

Utility	Processing (kWh/Year)	Idle (kWh/Year)	Ratio (% of total kWh/Year)	Annual Total (kWh/Year)
Vacuum	117206	13396	8.0	130602
Exhaust	6252	714	0.0	6966
Nitrogen	390688	44650	26.0	435338
Dry Air	229724	26254	15.0	255978
High Pressure Dry Air	273481	31255	18.3	304736
PCW 20 - 25 C	390451	76497	28.1	466948
PCW 32 - 37 C	50362	11540	3.7	61902
UPW	0	0	0.0	0
Hot UPW	0	0	0.0	0
Mean Real Power	150	50	0.0	200
		Heat Burden	0.0	-1866522

Time Distribution	Percentage(%)	(Hours/Year)
Processing	75	6570
Idle	20	1752
Other	5	438

Note: Total Equivalent Energy excludes Heat Burden (the heat not removed by PCW or Exhaust)

Multi-Tool Report Exported to Worksheet
Click on **Export a Tool Set**
Click on **Add Tool,** then **Create Report** (page bottom)



Example of Tool Data Exported to an Excel™ Worksheet
Includes ALL Components Associated with the Tool

A	B	C	D	E	F	G
TEE Comprehensive Report				**Tool ID:**	Litho Demo	
ISMI				**ECFs Used:**	S23 Standard	
Company:	**Company Name: Wafer Services, In**			**Number of Components:**	3	
Equipment Specifications						
Equipment Info			**Test Info**			
ID	Litho Demo		**Date**	7/1/2007		
Model #	123456		**Location**	Austin		
Serial #	654321		**Operator**	Reginald Dwight		
Manufacturer	Keene Industries		**Inspector**	Declan McManus		
Contact Information			**Time**	**(Hours/Year)**	**Ratio(%)**	
Name	Jill Smith		**Process**	7,008	80	
Phone Number	(512) 555-1212		**Idle Time**	1,314	15	
			Other	438	5	

TEE Summary Report					
Utility	**Processing**	**Idle**	**Ratio (%)**	**Total(kWh/**	
Vacuum	447	0	0.15	447	
Exhaust	40,482	7,591	16.52	48,073	
Nitrogen	8,930	0	3.07	8,930	
Dry Air	3,501	0	1.20	3,501	
H.P. Dry Air	31,255	5,860	12.75	37,115	
PCW 20°C-25°C	45,331	3,718	16.85	49,049	
PCW 32°C-37°C	0	0	0.00	0	
UPW	8,578	0	2.95	8,578	
Hot UPW	0	0	0.00	0	
Real Power	126,144	9,198	46.50	135,342	
Heat Burden			153.77	447,534	
Total	264,668	26,367	100	291,035	

Annual Utility Energy Consumption by Component

Name	**Environmental Chamber**					
Utility	**Tool Mode**	**Conversion Coefficient**	**Amount of use (M3/h)**	**Real power (kWh/h)**	**Annual Energy (kWh/Year)**	**Subtotal (kWh/Year)**
Vacuum	Processing		0.0	0.00	0	
	Idle	0.075	0.0	0.00	0	0
Exhaust	Processing		843.5	3.40	23,813	
	Idle	0.004	843.5	3.40	4,465	28,278
Nitrogen	Processing		0.0	0.00	0	
	Idle	0.250	0.0	0.00	0	0
Dry Air	Processing		0.0	0.00	0	
	Idle	0.147	0.0	0.00	0	0
High Pressure Dry Air	Processing		0.0	0.00	0	
	Idle	0.175	0.0	0.00	0	0
PCW 20°C-25°C	Processing		1.4	2.43	17,464	
	Idle	1.780	1.4	2.43	3,274	20,738
PCW 32°C-37°C	Processing		0.0	0.00	0	
	Idle	0.250	0.0	0.00	0	0
UPW	Processing		0.0	0.00	0	
	Idle	10.200	0.0	0.00	0	0
Hot UPW	Processing		0.0	0.00	0	
	Idle	32.200	0.0	0.00	0	0

Heat Burden	**Mean Supply Temperature (°C)**	**Mean Return Temperature (°C)**	**Temperature Difference (°C)**	**Annual Flow Amount (m^3/Yr)**	**Coefficient**	**Removed Energy (kWh/Yr)**
Exhaust Air	22.00	25.00	3.000	7,069,585	0.000324	6,872
PCW 20°C-25°C	12.80	15.80	3.000	11,341	1.16	39,466
PCW 32°C-37°C	0.00	0.00	0.000	0	1.16	0
Mean Real Power	Process/Idle	43,056	9,198	**Annual Heat Input to Space**		277,254
er Heat Sources		219,000		**Calculated Space Heat Burden**		230,916

Use the exported spreadsheet file as S23 Tool Report!

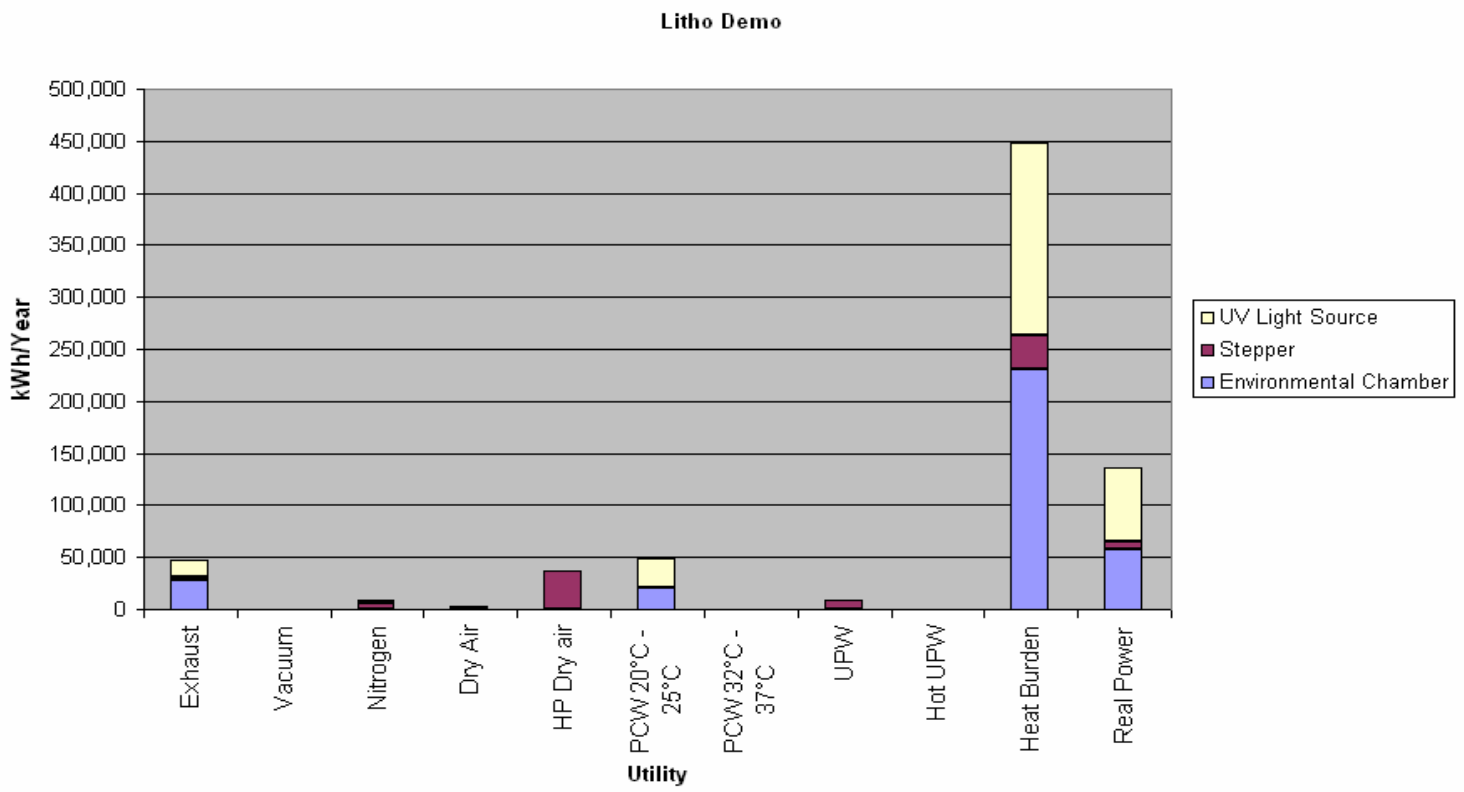
Note:

Heat burden **= Real power (–) heat removed by exhaust (–) heat removed by cooling water**

Heat burden **must be removed by the cleanroom air conditioning system**

Multi-Tool Cover Sheet for Tool Data Exported to Worksheet

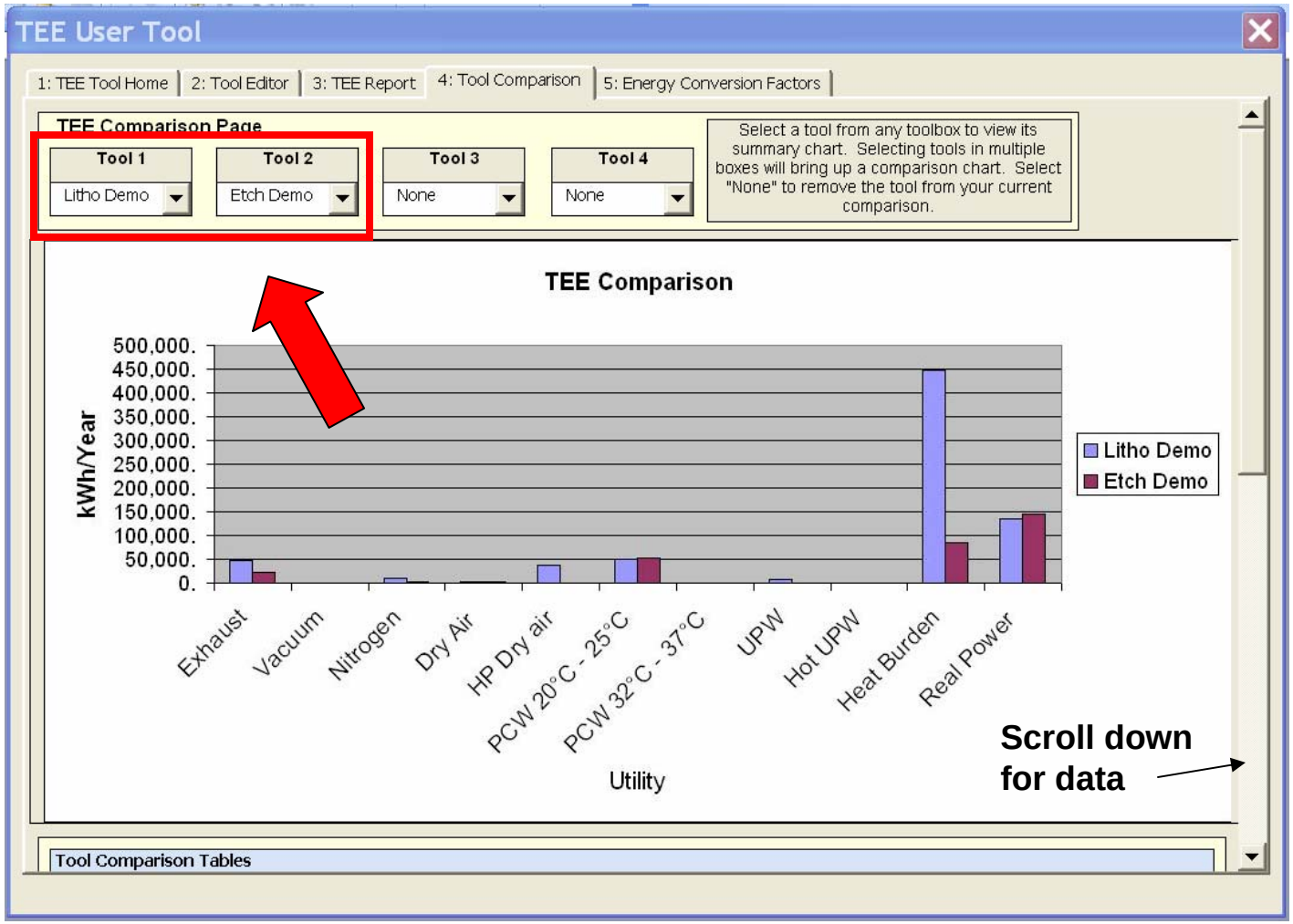
TEE Tool Multiple System Worksheet



Totals (kWh/m3)	TEE Total	Annual Utility Consumption	Annual Power Consumption	Annual Heat Input to Space	Heat Burden After Heat Removal
	(kWh/m3)	(kWh/m3)	(kWh)	(kW)	(kW)
Litho Demo	291035	155693	135342	556256	447,534

The **Tool Comparison** tab

- Select up to 4 tools for comparison (pulldown menu)
- Bar graph appears; data populates below graph



Revision Control

- Report software problems or suggestions to teetool@sematech.org
  - Your feedback is important
- Check that current revision of software is being used
  - Download from ISMI public website
- The Application Guide TEE Tool will be revised as S23 is revised

Acknowledgements

- Application Guide development and STEP notes: Ralph Cohen, *RMOCC Consultancy*
- Software Development: John Mason, *Mason Computing*
- STEP support: Ian McLeod, Susan Turner – SEMI
- ISMI Supplier ESH Leadership Team

Questions? Comments?

Thank you for your participation!

ISMI SEMI S23 Total Equivalent Energy (TEE) Reporting Tool

- The ISMI SEMI S23 Total Equivalent Energy (TEE) Reporting Tool is a software utility created by ISMI, Inc. in order to assist the semiconductor supplier and user community in assessing and converting various semiconductor manufacturing equipment utility consumption rates into equivalent annual electrical energy usage (i.e., kilowatt hours per year) by multiplying specific utility consumption rates—m3/hour, liter/minute, etc.—by S23-defined per utility conversion factors (energy conversion factors or ECFs). The data gathered and calculations made are based on the SEMI S23 energy efficiency and road mapping guideline.
- The TEE Reporting Tool is included in this training package for your company's ("User") use. To install and/or use the ISMI SEMI S23 Total Equivalent Energy (TEE) Reporting Tool, User must accept and agree to adhere to ISMI's Software License Agreement in the README file included on the enclosed CD. Thereunder, User is licensed solely for Internal Use of the TEE Reporting Tool. Other restrictions apply. Title to the TEE Reporting Tool remains with ISMI and no title is transferred to User.
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