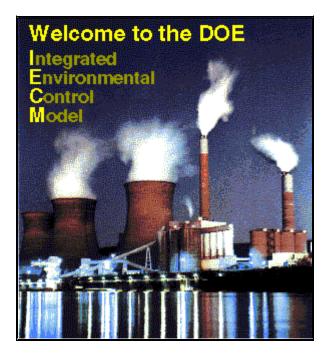
**Integrated Environmental Control Model** 

# **Model Tutorial**

Prepared for the National Energy Technology Laboratory U. S. Department of Energy

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# Introduction

# **The Integrated Environmental Control Model**

This Integrated Environmental Control Model (IECM) and Interface were developed for the U. S. Department of Energy's National Energy Technology Laboratory (NETL), formerly known as the Federal Energy Technology Center (FETC), under contracts No. DE-AC22-92PC91346 and DE-AC21-92MC29094.

# Purpose

The purpose of the model is to calculate the performance, emissions and cost of employing alternative environmental control methods in a coal-fired power plant. The model consists of a base plant and various control technology modules; these modules may be implemented together in any desired combination.

A Graphical User Interface (GUI) facilitates the configuration of the technologies, entry of data, and retrieval of results.

# **System Requirements**

The current model requires the following configuration:

- Intel-based computer running Windows 95 (or better) or Windows NT 4.0 (or better) operating system
- Pentium Processor
- any SVGA (or better) display—at a resolution of 800x600 (or more) pixels<sup>1</sup>
- at least 40 Megabytes of free hard disk space
- at least 32 Megabytes of total memory

<sup>&</sup>lt;sup>1</sup> Smaller screen resolution results in the interface screens being scaled smaller. The taskbar, part of the Windows operating system, reduces the useable resolution of the screen if it is always visible. This may force the IECM interface to be scaled down slightly. To avoid this situation, select the "Auto Hide" option of the Taskbar properties in Windows.

# **Uncertainty Features**

The ability to characterize uncertainties explicitly is a feature unique to this model. As many as one hundred input parameters can be assigned probability distributions. When input parameters are uncertain, an uncertainty distribution of results is returned. Such result distributions give the *likelihood* of a particular value, in contrast to conventional single-value estimates.

The model can run using single deterministic values or uncertainty distributions. The conventional deterministic form using single values for all input parameters and results may be used, or probabilistic analyses may be run—for instance, to analyze advanced technology costs.

# **Software Used in Development**

The underlying engineering models are written in Digital Equipment Corporation's Fortran. Fortran runtime libraries are included with the IECM Interface software. This language provides the flexibility to configure many various power plant designs while also providing the power to conduct probabilistic analyses.

All databases are in Microsoft<sup>®</sup> Access format and may be viewed in Access, as long as they are not changed. This format is a software industry standard and facilitates sharing and updating of information.

To simplify the use of the model, a Graphical User Interface (GUI) has been added. The interface eliminates the need to master the underlying commands normally required for model operation. The interface is written in Microsoft® Visual C++, a standard software development tool for the Windows environment. Visual C++ runtime libraries are included with the IECM Model software and do not need to be licensed separately.

Wise InstallBuilder was used to generate full and upgrade installer programs. This product was chosen based on its flexibility and its support of Visual Basic runtime libraries and Microsoft Data Access Components (MDAC)<sup>2</sup>. The Visual Basic runtime libraries provide the support needed to run the database file compactor program provided with the IECM. MDAC provides the software support needed to link Microsoft® Access data files to the IECM interface program. Wise InstallBuilder provides the VB and MDAC installation as an option, rather than forcing the user to download it from Microsoft and install it prior to installing the IECM.

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 $<sup>^{2}</sup>$  The current version of MDAC is 2.5. This is installed with the full installer for the IECM 3.4. Any update installers provided for upgrading the IECM from version 3.4 to a higher version does not upgrade MDAC unless the user updates MDAC separately.

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# **User Documentation and Help**

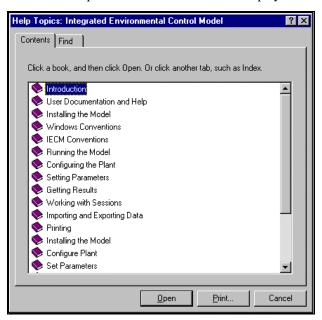
Getting Started	
	<i>Getting Started</i> gives step-by-step instructions for installing the model software and using the interface. It describes navigating the model, using the main program areas, working with sessions, and printing or exporting results.
User Manual	
	The <i>User Manual</i> gives further information on both the interface and the underlying model. It provides detailed descriptions of plant configurations, parameter settings, and result screens. It also describes technical details behind the model's operation and includes an introduction to uncertainty analysis.
Model Tutorial	
	The <i>Model Tutorial</i> is a pictorial introduction to the IECM. It presents a graphical tour of the interface, a case study to follow using the model, and an appendix, which reproduces every screen in the model. These tools help any user to quickly become more familiar with the interface and model.
Technical Manua	al
	The <i>Technical manual</i> is a detailed engineering description of the technologies and costing assumptions used in the IECM. This manual is not provided by default with the IECM software; however, it can be downloaded with any web browser from <a href="http://www.iecm-online.com/">http://www.iecm-online.com/</a> .
Online Help	
	Online help is provided via a Windows Help File containing the text of <i>Getting Started</i> and the <i>User Manual</i> .

#### Accessing the IECM Help file:

If you are not running the IECM interface, click the **Help** icon inside the IECM folder on the **Start** menu. This opens the help file to the table of contents.

If you are running the IECM interface, do any one of the following:

- Press the **F1** key. The IECM supports context-sensitive help and will open the help file to the topic associated with the item or screen you are viewing.
- Pull down the <u>Help</u> menu at the top of the IECM window. Select <u>Help</u> Topics. This opens the help file to the table of contents.
- Click the **Context-Sensitive Help** icon on the toolbar on the left side of the IECM window. The IECM supports context-sensitive help and will open the help file to the topic associated with the item or screen you are viewing.
- Click the **Help Topics** icon on the toolbar on the left side of the IECM window. This opens the help file to the table of contents.



The IECM Help File Contents window will display.

The IECM Help File Topics Window

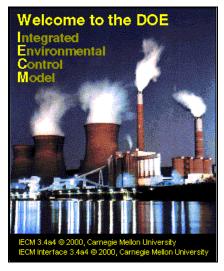
# A Tour of the Interface

# **The Tour**

This tour gives a graphical introduction to the interface. It reproduces and describes the commonly used screens of the interface so that you become familiar with how the model functions.

# The IECM Window and Logo Box

When you first start the model, the IECM Interface Window and Logo Box will display.



The IECM Logo Box

The Logo Box will disappear in 5 seconds, after which just the IECM Window will remain and the interface will be ready for use. The IECM Window contains all the screens used by the Interface.



The IECM Window

Note the various tools used to control the software:

- 1. Pull-down menus—<u>File</u>, <u>View</u>, <u>Window</u>, <u>Help</u> in the upper left hand corner of the screen.
- 2. The Toolbar—the row of buttons running down the left-hand side of the screen.

# **Opening a Session**

A session is defined as the power plant configuration and all the parameters associated with the plant technologies or components. The configuration, input values, and results are all stored in a file on your computer for each session you save.

The figure in the previous section shows the IECM with no sessions open. A session must be opened in order to use the IECM. You can open a new or existing session by using an option present under the **File** menu. Either clicking on the menu in the menubar or typing the letter "F" on the keyboard while holding down the "Alt" key can open the menu. A more detailed description of the menubar, its content and its use, can be found in the *Getting Started* manual.

Below is a figure showing the **File** menu after being clicked. Each item in the menu is described in more detail below the figure. Although the **New Session** and **Open Session** menu items are used to open a session, the other items in the menu are also described. They deal with other ways of dealing with the file holding your session data.



The <u>F</u>ile menu

You may choose the following commands from the file menu:

New Session – Creates a new session from model defaults.

Open Session – Opens a previously created session.

<u>Close Session</u> – Closes the currently active session.

**Delete Session** – Deletes a session.

**Unlock Session** – Unlocks a session that was not closed normally (e.g. because of a crash or loss of network connectivity.

Save Results – Saves the results from a session in an external file.

**Save**  $\underline{As}$  – Saves a session with a different name.

**Import** – Imports a session from an external database file.

**<u>P</u>rint** – Prints configuration settings, inputs or results.

 $E\underline{xit}$  – Closes the current session and exits the interface.

# **Configure Plant**

		<mark>M Interface</mark> dit <u>V</u> iew <u>W</u> indow <u>⊦</u>	lelp				
D	.,	Untitled					
	ſ	<u>C</u> onfigu	ire Plant	Set Pa	arameters	<u>G</u> et Results	
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<b>₹ ∾ № ⊡ 8 × № ⊡ №</b>							
9		Clf C			Direct Directory		
\$		Combustion C			-Plant Diagram		
		Furnace Type:	Tangential				
		NOx Control:	In-Furnace Controls	<u> </u>			
		Post-Combusti	ion Controls				
×		NOx Control:	Hot-Side SCR	•		T.	
<u></u>		Mercury:	Carbon + Water Injec	tion 💌		Inj.	
		Particulates:	Cold-Side ESP	•	└└╻╹┷┉	Ì▃ <mark>▖╗└</mark> ▃▐▓ <mark>▎▃▖</mark> ▋▁▎▕	
		SO2 Control:	Wet FGD		<b>▼</b> ←…	— <mark>∾</mark> ҹ Ψ Ť	
		SO2/NO <sub>X</sub> ;	None	~			
		Solids Manage	ement		↓ 	↓	
		Recovery:	None				
		Fly Ash	140116				
		Disposal:	mixed w/ Landfill	•			
	14						

The first program area—and the first screen displayed—is **Configure Plant**.

The Configure Plant Program Area

On this screen you choose the technologies implemented by the plant and how they operate. Available options are presented via pull-down menus on the left side of the screen. A "Plant Diagram" displays on the right side of the screen and reflects the various plant technologies you have chosen.

Note the three tabs at the top of the screen. Clicking one of these tabs chooses the program area you are in. The three program areas are **Configure Plant**, **Set Parameters**, and **Get Results**.

# **Set Parameters**

Configure Plant         Set Parameters         Get Results           Coveral         Coal         Ease         Emission         NOx         Mercury         Particulate         SOO General         Solids			<mark>M Interface</mark> dit ⊻iew <u>W</u> indow	<u>H</u> elp								□×
Configure Plant       Set Parameters       Get Results         Image: Set Properties       Plant       Emission Constraints       NOx Control       Mercury Control       Particulate Control       Solids Mgmt         Image: Set Properties       Plant       Constraints       NOx Control       Mercury Control       Particulate Control       Solids Mgmt         Image: Set Properties       Plant       Constraints       Control       Solids Mgmt         Image: Set Combustion Controls       In-Furnace Controls       Plant       Plant       Diagram         Image: Set Combustion Controls       In-Furnace Controls       Image: Set Control       Image: Set Control       Image: Set Control         Image: Set Control:       Hot-Side SCR       Image: Set Control       Image: Set Control       Image: Set Control       Image: Set Control         Image: Set Control:       Hot-Side SCR       Image: Set Control       Ima	Ы	1	📮 Untitled									<
Combustion Controls   Furnace Type:   Tangential   NOx Control:   In-Furnace Controls     Post-Combustion Controls   Nox Control:   Hot-Side SCR   Mercury:   Carbon + Water Injection   Particulates:   SO2 Control:   Wet FGD			<u>C</u> onfig	ire Plan	t	S	et <u>P</u> aramete	rs	ſ	Get Results	5	
Combustion Controls   Furnace Type:   Tangential   NOx Control:   In-Furnace Controls     Post-Combustion Controls   Nox Control:   Hot-Side SCR   Mercury:   Carbon + Water Injection   Particulates:   SO2 Control:   Wet FGD										SO2 Control	Solids <u>M</u> gmt	
Solids Management Recovery: None Fly Ash, mixed w/ Landfill	×		Plant     Pro       Combustion C     Furnace Type:       NOx Control:     NOx Control:       Mercury:     Particulates:       SO2 Control:     SO2/NOx:       Solids Manage     Recovery:	Controls Tangenti In-Furna Hot-Side Carbon - Cold-Sidd Wet FGD None	Plant ial ce Controls ce Controls ce Controls ce Controls ce ESP )	Constraints	Control	Control	Control			

The second program area is **Set Parameters**. From this area you can modify the input values for this session.

The Set Parameters Program Area

Note the nine tabs below the program area navigation tabs at the top of the screen. Clicking one of these tabs chooses the input area you will use. The input screens correspond to the various technologies chosen in **Configure Plant**.

## **Overall Plant**

The first tab of the **Set Parameters** program area is for the **Overall Plant** (see picture above). This screen displays the plant configuration settings on the left side of the page and a diagram of the plant as configured at the right of the page. No inputs are entered on this screen.

The Plant Diagram in <u>Set Parameters</u> may be used as an alternate way to move among input Technology Navigation Tabs. Clicking the button of the technology for which you would like to provide inputs chooses that input screen.

## **Coal Properties**

The second tab of the **Set Parameters** program area is for the **Coal Properties** input area. Inputs in this area define the composition of the coal, composition of the ash, and cost of the coal used in the plant for this session.

1		CIC DI		( L D		Ĩ	a	(D) to
_		<u>C</u> onfigure Pla	int	Set <u>P</u> ar	amete	rs	<u>u</u>	et Results
	Overall Plant	Coal P <u>r</u> operties	<u>B</u> ase Plant		Ox ntro1	Mercury Control	Particulate Control	O2 Control Solids Mgmt
ШГ	-Curi	ent Coal			Fav	orite Coals—		
	Name	: Default			Nam	e: Wyoming F	owder River Ba	sin
	Rank	: Bituminous			Ranl	k: Sub-Bitumi	inous	
	Sour	ce: Default			Eas	tern Bituminous	(HS)	
		osition (wt% as f	bre (beri		Eas	tern Bituminous	(LS)	
		er Heating Value			Wyo	iming Powder R	iver Basin	
	Tot 9	<b>6:</b> 100.0						
		Property	Value	Save As		Property	Value	Browse All
		Heating Value	14.22K	User-Defined		Heating Value	8335	Coals
		Carbon	78.48		2	Carbon	47.85	
		Hydrogen	5.50	Add to		Hydrogen	3.400	Use This
		Oxygen	8.00	Favorites	4	Oxygen	10.82	Coal
		Chlorine	0.12	Use Default	5	Chlorine	3.000e-02	Remove From
		Sulfur	0.60	Ash Properties		Sulfur	0.4800	Favorites
		Nitrogen Ash	1.30 3.80	Addit topenes		Nitrogen Ash	0.6200	- uvoittes
		Asn Moisture	3.80	Edit Ash		Asn Moisture	30.40	View Ash
		Noisture Cost (\$/ton)	2.20	Properties		Moisture Cost (\$/ton)	30.40	Properties
	10	cost (#/ wnj	32.07		11	Cost (#/ WR)	12.40	
				1		I		

The Coal Properties-1. Coal Prop. input screen

Note the two tabs at the bottom of the screen. Clicking one of these tabs chooses the input screen you will use. The two screens for **Coal Properties** are **1. Properties** and **2. Cost**.

#### 1. Properties

The first screen of the **Coal Properties** input area is the **<u>1</u>**. **Properties** input screen (see picture above). The type of coal and its properties are selected on this screen.

There are two panes: one for the ash and coal properties of the **Current Coal**, the other for those of **Favorite Coals**. The current coal is the coal which the model will conduct its calculations. Favorite coals are those that you use most. From this screen, you may choose a favorite coal, choose a coal from the model defaults, enter a user-defined coal, choose a previously saved user-defined coal, or manage your coal lists.

Ash properties are provided by default with each model default coal. User-defined coals must have ash properties provided by the user. If none are provided, properties of a similar coal are defined based on the sulfur content of the coal and coal rank.

Please refer to the "User Manual" for more information on the use of the buttons and other options on this input screen. Detailed instructions for choosing, modifying, or adding a coal and its properties are described there.

#### 2. Cost

The second screen of the **Coal Properties** input area is the <u>2</u>. **Cost** input screen. The cost of the cleaned coal, transportation costs, and other miscellaneous coal costs are accessed on the <u>2</u>. **Cost** input screen.

#### 3. Mercury

The third screen of the **Coal Properties** input area is the <u>3</u>. **Mercury** input screen. The concentration in the coal and speciation of Mercury in the flue gasare defined here.

## **Base Plant**

The second tab of the <u>Set Parameters</u> program area is for the <u>Base Plant</u> input area. Inputs in this area define performance and costs directly associated with the base power plant, particularly the boiler.

	C	Configure Pla	nt	S	et Para	met	ers	Ĩ		Get Res	ults
Overall Coal <u>B</u> ase Er					Particulate Control SO2 Control M						
	1	Ti	tle	Uni	ts	Unc	Value	Calc	Min	Max	Default
	1	Gross Electrical O	utput	MM	/g		500.0		100.0	1500	500.0
	2	Steam Cycle Heat	Rate	Btu/k	Wh		7880		6000	1.100e+04	7880
	3	Boiler Efficiency		%			89.36	M	0.0	100.0	calc
	4	Capacity Factor		%			75.00		0.0	100.0	75.00
	5	Excess Air For Fu	mace	% sto	ich.		20.00	M	0.0	40.00	calc
	6	Leakage Air at Pre	eheater	% sto	ich.		19.00	M	0.0	60.00	calc
	7	Gas Temp. Exiting	Economizer	deg.	F		700.0		250.0	1200	700.0
	8	Gas Temp. Exiting	, Air Preheater	deg.	F		300.0		150.0	400.0	300.0
	9	Ambient Air Temj	perature	deg.	F		80.00		-50.00	130.0	80.00
	0	Ambient Air Pres	sure	psi	ia		14.70		12.00	15.00	14.70
	_	Ambient Air Hum		16 H2O/18			1.800e-02		0.0	3.000e-02	1.800e-02
	2	Percent Water in I	Bottom Ash Sl	uice %			39.30	M	0.0	100.0	calc
	3	<u>Base Plant Energ</u>	<u>gy Requiremen</u>	ts							
		Coal Pulverizer		% M	<u> </u>		0.6000	M	0.0	2.000	calc
		Steam Cycle Pump		% M			0.6500		0.0	2.000	0.6500
-		Forced Draft Fans	,	% M'	~		1.500		0.0	4.000	1.500
		Cooling System		% M'	<u> </u>		1.800		0.0	2.000	1.800
	8	Miscellaneous		% M'	Wg		1.300		0.0	4.000	1.300
Pı	nce	ss Type: Rase	Plant								

The Base Plant-1. Performance input screen

Note the six tabs at the bottom of the screen. Clicking one of these tabs chooses the input screen you will use. The **Base Plant** input area contains a Performance screen and five screens having to do with cost parameters.

#### 1. Performance

The first screen of the **<u>Base</u> Plant** input area is the <u>1</u>. **Performance** input screen (see picture above). Inputs determining the overall plant size, temperature profiles, and major flow rates and concentrations of the gas and solids streams are entered on this screen. The first six inputs are highlighted in blue to point out their importance.

#### 2. Furnace Factors

The second input screen in this section defines the emission rates of various gas components of the flue gas during the combustion of fuel. The emission of carbon, ash, sulfur and nitrogen are specified by the United States Government's Environmental Protection Agency's (EPA) compilation of emission factors. Also included from the compilation are the incomplete transfer percentages of solid and gaseous forms of these substances.

	<u>C</u> onfigure Plant	Se	t <u>P</u> aramet	ers			Get Res	sults
Overall Coal <u>Base</u> Plant Properties Plant C		Emission Constr <u>a</u> ints				ar <u>t</u> iculate Control	Solid Solid	
	Title	Unit	s Unc	Value	Calc	Min	Max	Default
1	Percent Ash Entering Flue Gas	Stree %		80.00	V	10.00	100.0	calc
2								
3	Sulfur Retained in Flyash	%		2.500	Ľ	0.0	50.00	calc
4	Percent of SOx as SO3	%		0.8000	M	0.0	10.00	calc
5	Preheater SO3 Removal Efficier	ncy %		50.00	M	0.0	100.0	calc
6								
7	Nitrogen Oxide Emission Rate	16/MB	tu	0.5274	M	0.0	5.000	calc
8	Percent of NOx as NO	%		95.00	M	90.00	100.0	calc
9								
10	Conc. of Carbon in Collected A			0.0		0.0	1.000	0.0
11	Percent of Burned Carbon as C	0 %		0.0		0.0	10.00	0.0
12								
13								
14								
15								
16								
17								
18								

The Base Plant -2. Furnace Factors input screen

# 3. Financing

The third base plant input screen describes the factors required to determine the carrying charge for all capital investments. The carrying charge is defined as the revenue required to pay for any capital investment. The total charge can also be expressed as a levelized cost factor or fixed charge factor.

	Configure Pla	nt	Set	Param	iete	ers	Get Results			
Overai Plant		Base	Emission <u>N</u> Ox Me Constraints Control Co					ar <u>t</u> iculate Control	$\underline{S}O2 Control$ $\underline{S}O2 M$	
	T.	itle	Units	U	nc	Value	Calc	Min	Max	Default
	Year Costs Repor	ted				1996 💌		Menu	Menu	1996
2	Constant or Curr	ent Dollars?				Constant 🔻		Menu	Menu	Constant
3	Fixed Charge Fac	tor (FCF)	fraction	n	?	0.1034	M	None	None	calc
4	1 00	r the following:								
5	Inflation Rate		%/yr			0.0	V	0.0	20.00	calc
6		ook Life	years			30.00		5.000	60.00	30.00
7										
8	Real Bond Intere:	st Rate	%			4.600		0.0	15.00	4.600
9	Real Preferred Sto	ock Return	%			5.200		0.0	20.00	5.200
1	Real Common Sto	ock Return	%			8.700		0.0	25.00	8.700
1	Percent Debt		%			50.00		0.0	100.0	50.00
1:	2 Percent Equity (P	referred Stock)	%			15.00		0.0	100.0	15.00
1:	1 2 1	ommon Stock)	%			35.00	M	0.0	100.0	calc
1.	_									
1:	_		%			36.70		15.00	50.00	36.70
10			%			2.000		0.0	10.00	2.000
1			%			2.000		0.0	5.000	2.000
1	Investment Tax C	redit	%			0.0		0.0	20.00	0.0
Pr	cess Type: Rase	e Plant		-						

The Base Plant-3. Financing input screen

#### 4. Retrofit Cost

The fourth screen of the **Base Plant** input area is the <u>4</u>. **Retrofit Cost** input screen, shown below. The retrofit cost factor of each process is a multiplicative cost adjustment, which considers the cost of retrofitted capital equipment relative to similar equipment installed in a new plant. These factors affect the capital costs directly and the operating and maintenance costs indirectly. Every technology tab of the <u>Set Parameters</u> program area contains a retrofit cost input screen.

		Interface ∷⊻iew ⊻	⊻indow <u>H</u> elp												
ы	<b>.</b> -	Untitled													- 🗆 🗵
		<u>(</u>	<u>C</u> onfigure Pla	nt	Γ	Set	Para	mete	rs	Ĩ			<u>G</u> et Res	ults	
		Overall Plant	Coal P <u>r</u> operties	<u>B</u> ase Plant		mission onstr <u>a</u> ints	<u>N</u> C Cont		Mercury Control			r <u>t</u> iculate Control	SO2 Cont		lids gmt
8			Ti	itle		Units		Unc	Value	c	alc	Min	Max	Default	
*		1		Process Area											
<b>B</b>		2	Steam Generator Turbine Island			retro \$/ne		_	1.000	+		0.0	10.00	1.000	
		3	Turbine Island Coal Handling		_	retro \$/ne retro \$/ne			1.000	-	_	0.0	10.00	1.000	
		4 5	Coal Handling Ash Handling			retro \$/ne		_	1.000	+	_	0.0	10.00	1.000	
	Ш	6	Water Treatment			retro \$/ne			1.000	+		0.0	10.00	1.000	
?	Ш	7	Auxiliaries		_	retro \$/ne			1.000	+	-	0.0	10.00	1.000	
<b>?</b>	Ш	8	1100000000			10110 4/11	···· •		1.000	+		0.0	10.00	1.000	
- II	Ш	9								+					
	Ш	10													
	Ш	11								$\uparrow$					
	Ш	12								T					
	Ш	13													
		14													
		15													
		16													
		17													
	Ш	18									_				
		Proc	ess Type: Base	e Plant			~		Costs are	in	Сон	stant 1996	ó dollars.		
		<u>1</u> . Perf	ormance 🖌 <u>2</u> . Fu	mace Factors	(	3. Financin	ελ	<u>4</u> . R	etrofit Cost	/	5	. Capital C	ost / !	<u>6</u> . O&M Co	st
		<u>1</u> . Perf	ormance / <u>2</u> . Fu	mace Factors	<u> </u>	3. Financin	εÀ	<u>4</u> . R	etrofit Cost	/	5	. Capital C	ost / !	<u>6</u> . O&M Co	st

The Base Plant-4. Retrofit Cost input screen

## 5. Capital Cost

The fifth screen of the **<u>B</u>ase Plant** input area is the <u>5</u>. **Capital Cost** input screen, shown below. The necessary capital cost input parameters associated with the base plant are on this input screen. Every technology tab of the <u>**Set Parameters**</u> program area contains a capital cost input screen.

The capital cost parameters and terminology used in the IECM are based on the methodologies developed by the Electric Power Research Institute (EPRI). They have prepared a Technical Assessment Guide (TAG) to provide a consistent basis for reporting cost and revenues associated with the electric power industry. The IECM has been developed around this TAG system so that costs associated with various technologies can be compared directly on a consistent basis and communicated in the language used by energy engineers, researchers, planners, and managers.

Untitled	Configure Plant	C-4 D			Ŷ		Get Re	
	Configure Plant	Set P	aramet	ers			Get Ke	suits
Overall Plant	Coal <u>B</u> ase Properties Plant		<u>N</u> Ox ontrol	Mercury Control		ar <u>t</u> iculate Control	502 Con	trol Solids <u>M</u> gmt
	Title	Units	Unc	Value	Calc	Min	Max	Default
1	Construction Time	years		5.000		0.0	10.00	5.000
2								
3	General Facilities Capital	%PFC		10.00		0.0	20.00	10.00
4	Engineering & Home Office Fees	%PFC		6.500		0.0	20.00	6.500
5	Project Contingency Cost	%PFC		11.67		0.0	100.0	11.67
6	Proces Contingency Cost	%PFC		0.3000		0.0	100.0	0.3000
7	Royalty Fees	%PFC		7.000e-02		0.0	2.000	7.000e-02
8								
9	Pre-Production Costs							
10	Fixed Operating Cost	months		1.000		0.0	12.00	1.000
11	Variable Operating Cost	months		1.000		0.0	12.00	1.000
12	Misc. Capital Cost	%TPI		2.000		0.0	10.00	2.000
13								
14	Inventory Capital	%TPC		6.000e-02		0.0	10.00	6.000e-02
15								
16								
17								
18								
Pro	ess Type: Base Plant			Costs are	in Cor		and a start of the	

The Base Plant-5. Capital Cost input screen

## 6. O&M Cost

Inputs for the operation and maintenance costs of the base plant itself are entered on the **<u>6</u>**. **O&M Cost** input screen, shown below. O&M is a short form for "operating and maintenance." Every technology tab of the <u>**Set Parameters**</u> program area contains an O&M cost input screen.

Untitled							-				_
1	<u>C</u> onfigure Plant		Set	<u>P</u> aran	iete	rs			Get Res	sults	
Overail Plant	Coal P <u>r</u> operties	Base Plant	Emission Constr <u>a</u> ints	<u>N</u> Ox Contro	1	Mercury Control		ar <u>t</u> iculate Control	<u>S</u> O2 Cont		lids gmt
	Title		Units	ι [ι	Jnc	Value	Calc	Min	Max	Default	
1	Delivered Coal Cost	(as-fired)	\$/ton			32.07		5.000	75.00	32.07	1
2	Waste Disposal Cos	t	\$/ton			9.360		0.0	10.00	9.360	
3	Water Use		gailons/k			1.000		0.0	10.00	1.000	
4	Water Cost		\$/ton			0.7000		0.0	1.000	0.7000	
5	Base Plant Electricity	r Cost	\$/MW	'n		33.48	V	0.0	100.0	calc	
6											
7	Number of Operating	,	numbe			20.00		0.0	100.0	20.00	
8	Number of Operating	,	shifts/d	ay		4.750		0.0	10.00	4.750	
9	Operating Labor Cos	t	\$/hr			24.82		15.00	35.00	24.82	
10											
11	Total Maintenance C	ost	%TPC	;		1.822	M	0.0	10.00	calc	
12	Maint. Cost Allocate	d to Labor	%TM0	C _		35.00		0.0	100.0	35.00	
13											
14	Administrative & Su	pport Cost	% total la	abor		7.000		0.0	100.0	7.000	
15							<u> </u>				
16	Real Escalation Rate		%/yr			0.0	<u> </u>	0.0	10.00	0.0	
17							<u> </u>				
18	<u> </u>										
Proc	ess Type: Base P	lant		-		Costs are	in Cor	istant 199	6 dollars.		

The Base Plant—6. O&M Cost input screen

The EPRI TAG method of categorization has been also used for operating and maintenance cost screens. It provides a consistent basis of reporting for a wider audience of users.

## **Other Input Areas**

As has been noted, there are up to nine input areas, depending on the technologies selected in **Configure Plant**. Each contains performance and/or cost screens as is appropriate to the technology. Each will have at least one performance input screen, one retrofit cost screen, one capital cost screen, and one O&M cost screen.

The detail of each parameter on each screen is described in detail in the "User Manual." The general use of the options shown on the input screens is described in more detail in the *Getting Started* manual.

# **Get Results**

		<mark>4 Interface</mark> dit <u>V</u> iew <u>W</u> indow	Help								_ 🗆 ×
	—	Untitled	Tob								
		<u>C</u> onfig	ure l	Plant	Ĭ	Set <u>P</u> ar	ameters	Ĭ	<u>(</u>	<u>i</u> et Results	
			1el 0al)	Boiler	<u>A</u> ir Preheater	<u>N</u> Ox Control	Mercury Control	Particulate Control	<u>S</u> O2 Control	Solids Mgmt	Stac <u>k</u>
] 🖚 🖂 🖉 🔝 😁 😒		<u>Combustion</u> Furnace Type NOx Control: <u>Post-Combu</u> NOx Control: Mercury: Particulates:	: Tar In-F stion Hot Ca Co	igential Furnace Contr Controls -Side SCR rbon + Water d-Side ESP			Plant Diag	ram	[nj.] → ••••••••••••••••••••••••••••••••••••	 ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
		SO2 Control: SO2/NOx:	No	t FGD ne				`  _		╧┷┤	
		<u>Solids Mana</u> Recovery: Fly Ash Disposal:	No	_				1			
	l	<u>1</u> . Diagram		2. Perf. Summ	ary <u>3</u> . Flo	# Summary j	( <u>4</u> . Cost Su	unumary /			

The third program area is  $\underline{Get Results}$ . From this area you can view the results for the session.

*The Overall Plant*—1. *Diagram screen* 

Note the nine tabs below the program area navigation tabs at the top of the screen. Clicking one of these tabs chooses the result area that displays. The result screens correspond to the various technologies chosen in **Configure Plant**.

Note also the four tabs at the bottom of the screen. Clicking one of these tabs chooses the result screen in the particular area that displays.

# **Overall Plant**

The first tab of the <u>Get Results</u> program area is for the Overall Plant. This area contains result screens for the plant as a whole.

#### 1. Diagram

The first screen of the **Overall Plant** result area is the **1. Diagram** result screen (see picture above). It displays the plant configuration settings on the left side of the page and a diagram of the plant as configured at the right of the page. No results are displayed on this screen.

## 2. Performance Summary

The second screen of the **Overall Plant** result area is the 2. **Perf. Summary** result screen. It displays performance results for the plant as a whole. Values for the major input and outputs of the power plant are given.

		I Interface									_ 🗆 ×
		lit ⊻iew <u>W</u> ∎Untitled	indow <u>H</u> elp								
Ø	_	<u>C</u>	onfigure l	Plant		Set Pa	ameters		<u>e</u>	<u>i</u> et Results	
		Overall Plant	F <u>u</u> el (Coal)	Boiler	<u>A</u> ir Preheater	<u>N</u> Ox Control	Mercury Control	Particulate Control	<u>S</u> O2 Control	Solids Mgmt	Stac <u>k</u>
<b>M</b> × <b>A</b>						Plant Param	eter	Val	ue		
				1	Gross Electri	<u> </u>		500			
ď					Net Electrica	• ·	·	454			
				3	Gross Cycle	· · ·		881			
<b>?</b> <b>№?</b>					Net Cycle He			970			
<u></u>				5	Fuel Energy : Annual Pow	<u> </u>	· ·	2.98			
				7	Alligation		(DK00 DY)	2.30			
				8					-		
				9					-		
				10					_		
				11							
				12							
				13							
				14							
				15							
		Process	Type: Ove	rall		Y					
		<u>1</u> . Dia	gram	2. Perf. Summa	ary <u>3</u> . Flo	w Summary	/ <u>4</u> . Cost Su	mmary /			

The Overall Plant-2. Perf. Summary result screen

## 3. Flow Summary

The third screen of the **Overall Plant** result area is the **3. Flow Summary** result screen. It displays values for the major flows in, through and out of the power plant. Subtotals and totals are highlighted with yellow on this and all result screens.

		Configure Plant	Set <u>P</u> a	rame	ters <u>G</u> et Res	ults
	Ove P <u>l</u> a		r <u>N</u> Ox Control		ercury Particulate <u>S</u> O2 Solic ontrol Control Control Mgr	
		Stack Gas Component	Flow Rate (ton/hr)		Overall Flow Component	Flow Rate (ton/hr)
III '	1	Nitrogen (N2)	1743	1	Coal	155.0
III '	2	Oxygen (O2)	147.7	2	Natural Gas	0.0
111 '	3	Water Vapor (H2O)	264.1	3	Lime/Limestone	2.155
111	4	Carbon Dioxide (CO2)	446.8	4	Urea	1.252
111 '	5	Carbon Monoxide (CO)	0.0	5	Ammonia	0.1040
	6	Hydrochloric Acid (HCl)	1.913e-02	6	Activated Carbon	0.0
	7	Sulfur Dioxide (SO2)	0.5547	7	Total	158.5
	8	Sulfuric Acid (equivalent SO3)	5.780e-03	8	Bottom Ash	1.949
	9	Nitric Oxide (NO)	0.1637	9	Fly Ash	4.599
	10	Nitrogen Dioxide (NO2)	1.321e-02	10	FGD Waste	4.246
	11	Ash	6.614e-02	11	By-Product Ash	0.0
	12	Total	2602		By-Product Gypsum	0.0
		Total SOx (SO2 & SO3)	0.5605		By-Product Sulfur	0.0
		Total NOx (NO & NO2)	0.1770		By-Product Acid	0.0
Ш.	15			15	Total	10.79
Ш	n	cess Type: Overall				

The Overall Plant-3. Flow Summary result screen

#### 4. Cost Summary

The fourth screen of the **Overall Plant** result area is the <u>4</u>. **Cost Summary** result screen. It displays costs associated with the power plant as a whole. Details of each of the values shown on this screen can be accessed in the cost tables for each separate technology. This is described in more detail in the following sections.

- U	ntitle		(1 + T)		1		
		Configure Plant	Set <u>P</u> ara	meters		<u>G</u> et Re	sults
	veral Plant	Fuel <u>B</u> oiler <u>A</u> ir (Coal) <u>B</u> oiler Preheate:	r <u>N</u> Ox Control				lids gmt Stac <u>k</u>
		Technology	Capital Cost (M\$)	Capital Cost (\$/kW-net)	O&M Cost (M\$/yr)	Revenue Required (M\$/yr)	Revenue Required (\$/MWh)
	1	Combustion NOx Control	12.26	26.99	2.969	4.236	1.419
	_	Post-Combustion NOx Control	17.33	38.16	1.903	3.694	1.237
	-	Mercury Control	5.571e-02	0.1227	6.615e-02	7.191e-02	2.409e-02
	4	TSP Control	1.959	4.315	1.016	1.069	0.3582
	_	SO2 Control	58.09	127.9	8.362	15.29	5.121
	_	Combined SOx/NOx Control	0.0	0.0	0.0	0.0	0.0
	7	Subtotal	89.70	197.5	14.32	24.36	8.159
	_	Base Plant	432.2	951.7	55.26	96.30	33.48
	9	Total	521.9	1149	69.58	120.7	41.63
	10						
	11						
	12						
	13						
	14						
	15	L					
F	Proces	ss Type: Overall	T	Costs a	ire in Constant	1996 dollars.	

The Overall Plant-4. Cost Summary result screen

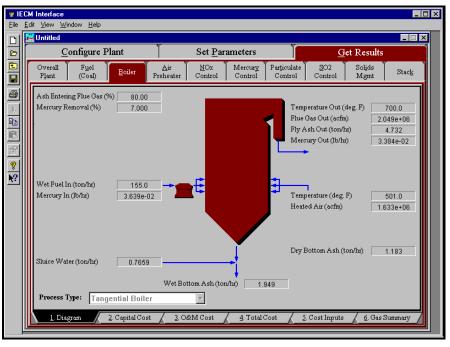
## Boiler

The third tab in the **<u>Get Results</u>** program area is for the **<u>Boiler</u>** result area. It contains result screens for flows and costs related to the Boiler itself. The individual result screens for this result area will be described in the following sections. They are representative of all the result screens for the remainder of the result areas in the <u><u>Get</u> **Results** program area.</u>

Each result area contains the same result screens. The first is a pictorial diagram with the major flow rates, temperatures, and performance values. The second screen is a table summarizing the capital costs. The third result screen shows a detailed breakdown of the O&M costs. The fourth screen summarizes the total costs shown on the second and third screens but on an annualized basis. The fifth screen summarizes the input parameters used to derive the results on the second, third and fourth screens. The sixth and last screen summarizes the flue gas component flow rates in and out of the device.

## 1. Diagram

The first screen in the <u>B</u>oiler result area is the 1. Diagram result screen. It displays an icon for the Boiler and values for major flows in and out of it.



The Boiler-1. Diagram result screen

## 2. Capital Cost

The second screen in the **<u>B</u>oiler** result area is the <u>**2**</u>. **Capital Cost** result screen. It displays tables for the direct and indirect capital costs related to the Boiler.

<b>V IEC</b> File <u>B</u>				<b>iace</b> w <u>W</u> indow <u>H</u> elp					
ام	r-	Ur	ıtit	ed					
6				Configure Plant		Set Para	ame	ters <u>G</u> et Re	sults
			ver 'lar		<u>A</u> ir neater	<u>N</u> Ox Control			lids gmt Stac <u>k</u>
5 1				Process Area	Dir	rect Capital Costs (M\$)		Process Area	Indirect Capital Costs (M\$)
2			L	Steam Generator		119.4	1	Process Facilities Capital	288.4
8			2	Turbine Island		86.50	2	General Facilities Capital	28.84
		2	;	Coal Handling		38.23	3	Eng. & Home Office Fees	18.75
<u> ?</u>		4		A sh Handling		5.259	4	Project Contingency Cost	33.66
?		1.5		Water Treatment		7.336	5	Process Contingency Cost	0.8652
-11		<u>(</u>		Auxiliaries		31.73	6	Interest Charges (AFUDC)	48.26
		2	_	Process Facilities Capital		288.4	7	Royalty Fees	0.2019
		<u> </u>					8	Preproduction (Startup) Cost	12.98
			_				9	Inventory (Working) Capital	0.2223
		1	-				10	Total Capital Requirement (TCR)	432.2
		1	-				11		
			_				12		
		$\left \frac{1}{1}\right $	-				13		
		$ \frac{1}{1}$					14		
		-		cess Type: Tangential Boiler		Y	15	Costs are in Constant 1996 dollars.	
	Ľ		j	1. Diagram <u>2</u> . Capital Cost	<u>3</u> . Oð	&M Cost /	4	l. Total Cost 🖌 <u>5</u> . Cost Inputs 🖌	<u>6</u> . Gas Summary /

The Boiler-2. Capital Cost result screen

#### 3. O&M Cost

The third screen in the **<u>B</u>oiler** result area is the <u>3</u>. O&M Cost result screen. It displays tables for the variable and fixed operation and maintenance costs involved with the Boiler.

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Ы		Un	itled										_ [=	×
	ľ		<u>C</u>	onfig	ure F	'lant	Ĩ	Set Pa	rame	ters	<u>G</u>	et Resu	lts	
			erall ant	F <u>1</u> (Co	iel Sal)	<u>B</u> oiler	<u>A</u> ir Preheat	er <u>N</u> Ox Control		ercury Particulate entrol Control	<u>S</u> O2 Control	Solids Mgmt		
M × A				Var	iable C	ost Compo	onent	O&M Cost (M\$/yr)		Fixed Cost	Component		O&M Cost (M\$/yr)	
		1	Fuel					41.43	1	Operating Labor			4.912	
P		2	Wate					1.570	2	Maintenance Labor			2.363	
		3						9.008e-02	3	Maintenance Materia	-		4.389	
?		4	Total	Variab	le Cost	s		43.09	4	Admin. & Support La	lbor		0.5093	
<b>N</b> ?		5							5	Total Fixed Costs			12.17	
		6							6					
		7	-						7					
		8							8					
		9							9 10					
		$\left \frac{\pi}{1}\right $							10					
		$\frac{1}{12}$	-						11					
		$\frac{1}{13}$	-						12					
		14	-						14					
		15							15	Total O&M Costs			55.26	
		Р	ocess ]	(ype:	Tang	ential B	oiler	<b>v</b>		Costs are in Cons	tant 1996 dol	lars.		
			<u>1</u> . Dia	gram	Κ.	<u>2</u> . Capital	Cost	<u>3</u> . O&M Cost		l. TotalCost 🖌 🧕	. Cost Inputs	<u>/ 6</u> .0	fas Summary	

*The Boiler*—3. *O&M Cost result screen* 

#### 4. Total Cost

The fourth screen in the **<u>B</u>oiler** result area is the <u>4</u>. Total Cost result screen. It displays a table which totals the annual fixed, variable, operations and maintenance, and capital costs associated with the boiler.

	dit ⊻iew <u>W</u> indow <mark>≅</mark> Untitled	Help							_ 🗆 🗡
	<u>C</u> onfig	ure	Plant	ſ	Set <u>P</u> ara	meters	Ì	<u>G</u> et R	esults
	Overall Fi Plant (Co	iel Dal)	Boiler	<u>A</u> ir reheater	<u>N</u> Ox Control		Particulate Control (		dids gmt Stac <u>k</u>
			Cost	Сонфонет	ıt	M\$/yr	\$/MWh	Percent Total	
		1	Annual Fixed Cos Annual Variable C			12.17 39.44	4.077	12.64	
		2	Annual Variable C Total Annual O&I			39.44 51.62	13.21	40.96	
		4	Annualized Capits			44.68	14.97	46.40	
		5	Total Annual Cos	t		96.30	32.25	100.0	
Ι		6							
Ι		7							
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Ι		9 10							
Ι		10							-
Ι		12							
Ι		13							
Ι		14							
Ι		15							
	Process Type:	Та	ngential Boiler		~	Costs	are in Constan	t 1996 dollars.	

The Boiler-4. Total Cost result screen

## 5. Cost Inputs

The fifth screen in the **Boiler** result area is the **5**. **Cost Inputs** result screen. It displays tables for the performance and economic inputs used in deriving total costs for the boiler.

<b>V IEC</b>	CIM E di			ndow <u>H</u> elj	0									_ 🗆 🤇
	r-	Unti	tled											×
0			<u>C</u>	onfigure	e Plant	Ĩ	Set Pa	ame	ters	Ĩ	<u>G</u>	et Resi	ults	
		Ove Pla		F <u>u</u> el (Coal)	Boiler	<u>A</u> ir Preheater	<u>N</u> Ox Control		ercury ontrol	Par <u>t</u> iculate Control	<u>S</u> O2 Control	Solid: Mgm		
*			Perf	òrmance li	mputs Used for 7 Results	Total Cost	Value		Eco		Used for Total sults	l Cost	Value	
	I	1	N et Pi	lant Size (A	AW)		454.1	1	Fixed C	harge Factor	(fraction)		0.1034	100
a 1	Ш	2	Annu	al Operatir	ng Hours (hours	5)	6575	2	Variabl	e Cost Leveliz	ation Factor (	fraction)	1.000	
<u> </u>	Ш	3						3	Project	Book Life (ye	ars)		30.00	
<b>?</b> <b>}</b> ?	Ш	4						4	Cost R	eporting Year			1996	
?	Ш	5						5						
-1	Ш	6						6						
	Ш	7						7		apital Require			432.2	
	Ш	8						8		ariable Costs	N 187		43.09	
	Ш	9						9	Total F	ixed Costs (M	\$/yr)		12.17	
	Ш	10						10						
		$\frac{11}{12}$						11						
	Ш	12						12						
	Ш	$\frac{13}{14}$	-					13						
	Ш	15						15						
		-	icess T	Type: Ta	ingential Boil	ler	Y		Ces	sts are in Con	stant 1996 do	llars.		
			<u>1</u> . Dia	gram /	<u>2</u> . Capital Co	ost <u>3</u> .	O&M Cost	4	l. Total (	Cost	. Cost Inputs	<u>6</u> .0	Gas Summary	Z

The Boiler-5. Cost Inputs result screen

#### 6. Gas Summary

The sixth screen in the **Boiler** result area is the **<u>6</u>**. **Gas Summary** result screen. It displays a table of quantities of flue gas components entering the boiler in heated air and exiting the boiler in the flue gas. For each component, quantities are given in both moles and mass per hour.

<u>(</u>	oni	figure Plant		Se	t <u>P</u> ara	ameter	s	<u>(</u>	<u>3</u> et Results	
Overall Plant	Ĩ	F <u>u</u> el (Coal) <u>B</u> oiler	<u>A</u> ir Preheater	<u>N</u> Cor		Mercu Contr			Solids Mgmt	Stac <u>k</u>
		Major Flue Gas	components			d Air In les/hr)	Flue Gas Out (moles/hr)	Heated Air In (ton/hr)	Flue Gas Out (ton/hr)	
	1	Nitrogen (N2)		-	1.07	3e+05	1.074e+05	1503	1504	
	2	Oxygen (O2)			2.85	2e+04	4730	456.3	75.69	
	3	Water Vapor (H2O)			3	914	1.273e+04	35.26	114.7	
	4	Carbon Dioxide (CO2)			(	D.O	2.026e+04	0.0	445.8	
	5	Carbon Monoxide (CC	9		(	D.O	0.0	0.0	0.0	
	6	Hydrochloric Acid (H	CD		(	D.O	10.50	0.0	0.1913	
	7	Sulfur Dioxide (SO2)			(	D.O	56.12	0.0	1.798	
	8	Sulfuric Acid (equival	ent SO3)		(	D.O	0.4526	0.0	1.812e-02	
	9	Nitric Oxide (NO)			(	D.O	48.02	0.0	0.7205	
	10	Nitrogen Dioxide (NO2	0		(	D.O	2.527	0.0	5.814e-02	
	11	Total			1.39	7e+05	1.452e+05	1994	2143	
	12									
	13									
	14									
	15			_						
Process	r	Tangential Boild								

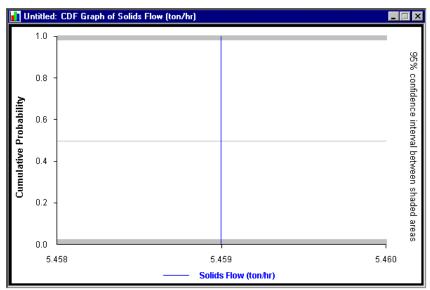
The Boiler-6. Gas Summary result screen

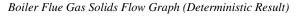
## **Other Result Areas**

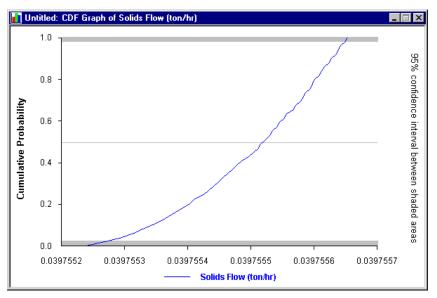
As has been noted, there are up to nine result areas, depending on the technologies selected in **Configure Plant**. Each contains diagram and/or cost screens as is appropriate to the technology.

# Graphs

Double-clicking any of the result values given on any of the result screens displays a graph of the value. While all of the values displayed in diagrams and tables are deterministic, some have uncertainty in their calculation. If there is no uncertainty in the value's calculation, the graph displays a vertical line. If uncertainty is present, the graph displays a curve of all possible values.







ESP Flue Gas Out Solids Flow Graph (Uncertain Result)

# **Case Study**

# The Case Study

This chapter is meant to be used with the IECM Interface installed and running. The case study takes you to the commonly used screens described in the previous chapter. It is recommended that you:

- 1. Follow the directions to set up a plant, enter input parameters, and look at results for the sample plant and
- 2. compare the screen shots to the screens you see.

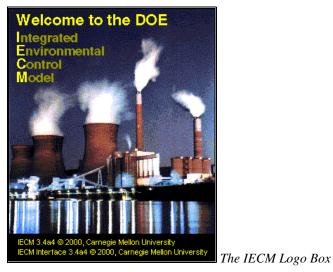
# Installing the IECM Software

To install the IECM software, see the instructions in *Getting Started* and the *User Manual*.

# The IECM Window and Logo Box



Once you have installed the IECM software, a program group called "IECM Interface" will appear in the **Programs** group in the Start Menu. To start the Model, click the **IECM Interface** icon in the Start Menu.



The model will launch, and the IECM Interface Window and Logo Box will display.

The Logo Box will disappear in 5 seconds, after which the interface will be ready for use. You may also click the **Close** button in the upper right hand corner of the logo box to begin.

Once launched, the IECM Window displays. The IECM Window contains all the screens used by the Interface and all the tools that control the software.



The IECM Window

# The New Session Dialog Box

The first time you use the software, you will have to create a new session. At subsequent startups, you can create a new session or use a previously saved session.

To create a new session:

- 1. Pull down the **<u>File</u>** menu and select <u>New Session</u> The New Session dialog box will display.
- 2. Type **Case Study**. The screen should look like the following:

New Session	×
Please enter the name of the new session:	Ok
Case Study	Cancel

The New Session dialog box

3. Click the **Ok** button.

A more detailed description of managing session data is described in the *Getting Started* manual.

Once you have created a session, a session window will display. It contains all the screens used by the session. The screen should look like the following:

	CM Interface Edit <u>V</u> iew <u>W</u> indow <u>H</u>	telp				_ <b>□</b> ×
-		- •				
	<u>C</u> onfigu	ıre Plant	Set Pa	arameters	<u>G</u> et Results	
	Combustion C	ontrols		- Plant Diagram-		
*	Furnace Type:	Tangential	T	Ū		
B	NOx Control:	None				
P	Post-Combust	ion Controls				
?	NOx Control:	None	•			₽
<u></u> ?	Mercury:	None	·			
	Particulates:	None	•		→ <mark>~</mark> ~	
	SO2 Control:	None	-			
	SO2/NOx:	None	•			
	Solids Manag	ement				
	Recovery:	None	Y			
	Fly Ash Disposal:	mixed w/ Landfill	•			
	Disposar:	I'moo in canam				

The Session Window

# **Configure Plant**

The **Configure Plant** Program area will be the first screen displayed in the session window. On this screen, use the menus to choose the following technologies:

Combustion Controls:

NOx Control:	In-Furnace Controls
Post-Combustion Contro	ls:
Particulates:	Cold Side ESP
Mercury:	Carbon + Water Injection
SO2 Control:	Wet FGD

A description of drop-down or pop-up menus is given in the *Getting Started* manual. Detailed descriptions of all individual settings are given in the *User Manual*.

The screen should look like the following:

	<mark>CM Interface</mark> Edit <u>V</u> iew <u>W</u> indow <u>H</u> elp		
Ъ	F Untitled		
Ø	<u>C</u> onfigure Plant	Set <u>P</u> arameters	<u>G</u> et Results
	Combustion Controls Furnace Type: Tangential NOx Control: In-Furnace Controls Post-Combustion Controls NOx Control: None Mercury: Carbon + Water Inje Particulates: Cold-Side ESP SO2 Control: Wet FGD SO2/NOx: None Solids Management Recovery: None Fly Ash Disposal: mixed w/ Landfill	Plant Diagram	

The Configure Plant Program Area

Once you have chosen the options, move on to the <u>Set Parameters</u> program area. (You may return to <u>Configure Plant</u> to change the settings at any time: click its tab at the top of the screen.)

# **Set Parameters**

Click the tab for the **Set Parameters** program area. The screen should look like the following:

The Set Parameters Program Area

You may return to <u>Set Parameters</u> and change the inputs at any time: click its tab at the top of the screen. Detailed descriptions of all inputs are given in the *User Manual*.

## **Overall Plant**

When you first enter the **Set Parameters** program area, the active Technology Navigation Tab is for the **Overall Plant**. This screen displays the plant configuration settings on the left side of the page and a diagram of the plant as configured at the right of the page. No inputs are entered on this screen.

You can navigate to the other Technology Tabs by either clicking on them or using a keyboard equivalent (described in more detail in the *Getting Started* manual). You may use the Plant Diagram as an alternate way to move among input Technology Navigation Tabs. Click the button for the technology for which you would like to provide inputs and it will activate the corresponding tab for that technology. You may also move through the Plant Diagram by pressing the **Tab** key (a highlighting box will surround the technology selected) and press the **Space bar** to activate the corresponding tab for that technology.

## **Coal Properties**

Click the Technology Navigation Tab for the **Coal P<u>r</u>operties** input area. Inputs in this area define the composition and cost of the coal used in the plant.

#### 1. Properties

When you first enter the **Coal Properties** input area, the **<u>1</u>**. **Properties** input screen is displayed. On this screen you select the particular coal and its properties.

There are two panes: one for the ash and coal properties of the **Current Coal**, the other for those of **Favorite Coals**. The current coal is the coal which the model will conduct its calculations. Favorite coals are those that you use most. From this screen, you may choose a favorite coal, choose a coal from the model defaults, enter a user-defined coal, choose a previously saved user-defined coal, or manage your coal lists.

Choose the Appalachian Medium Sulfur coal for this model run:

- 1. Click the Browse All Coals button in the Favorite Coals pane.
- 2. Click **Appalachian Medium Sulfur** in the drop-down menu of the **Select Coal** pane.
- 3. Click the Use This Coal button.

When you are finished, the screen should look like the following:

1 🛃	Untitled								_ 🗆 ×	
		Configure Pl	ant	Set Par	amet	ers		Get Result	s	
	Overal Plant	1 Coal P <u>r</u> operties	<u>B</u> ase Plant		Ox atro1	Mercury Control	Parțiculate Control	<u>S</u> O2 Control	Solids <u>M</u> gmt	
	Cur	rent Coal			Fa	vorite Coals-			1	
	Nam	e: Appalachiar	Medium Sulfur		Name:					
	Ran	k: Bituminous			Rank:					
	Sou	rce: Model Defau	It Coals							
	Сон	position (wt% as	fired) and							
	Higl	er Heating Value	(Btu/h)							
	Tot	% <b>:</b> 100.0								
		Property	Value	Save As		Property	Value	Brows	se All	
'		Heating Value	1.326e+04	User-Defined	1	Heating Value		Co	als	
	2	Carbon	73.81		2	Carbon				
		Hydrogen	4.880	Add to	3	Hydrogen		Use		
	4	Oxygen	5.410	Favorites	4	Oxygen		Co	al	
	5	Chlorine	6.000e-02	Use Default	5	Chlorine		Remov		
	6	Sulfur	2.130	Ash Properties	6	Sulfur		Favo		
	7	Nitrogen Ash	1.420 7.240	Ashritopenes	7	Nitrogen Ash		1 400	meo	
	9	Ash Moisture	7.240	Edit Ash	9	Ash Moisture		View	Ash	
		Cost (\$/ton)	32.07	Properties	10	Cost (\$/ton)		Prope	erties	
	11	Cust(#/Init)	52.07		11	Cust(#/mit)			II	
						-				
	Proce	ss Type: Coal	Properties	~						

The Coal Properties-1. Properties input screen

# **Base Plant**

Click the Technology Navigation Tab for the **<u>Base Plant</u>** input area. Inputs in this area define performance and costs directly associated with the power plant, particularly the boiler.

#### 1. Performance

When you first enter the **<u>Base Plant</u>** input area, the <u>**1**</u>. **Performance** input screen is displayed. Inputs for the major flow rates and concentrations of the gas and solids streams are entered on this screen.

The first six inputs are highlighted in blue to point out their importance. Detailed descriptions of all inputs are given in the *User Manual*. Descriptions of how to enter inputs and replacing calculated values are given in the *Getting Started* manual.

Enter the following values for the first five inputs:

#### Gross Electrical Output: 600 MW

Steam Cycle Heat Rate: 8100 Btu/kWh

Boiler Efficiency: this is calculated by the model - do not change it

Capacity Factor: 80 %

Excess Air For Furnace: this is calculated by the model - do not change it

Leakage Air at Preheater: 10 % (override calculated value)

When you are finished, the screen should look like the following:

Overall Plant         Coal Properties         Base Plant         Emission Constraints         NOx Control         Mercury Control         Performed Control         Soil Control         Mercury Mgmt           I         Gross Electrical Output         MWg         500.0         100.0         1500         500.0           2         Steam Cycle Heat Rate         Btu/kWh         8100         6000         1.100e+04         7880           3         Boiler Efficiency         %         09,58         ×         0.0         100.0         calc           4         Capacity Factor         %         80.00         0.0         100.0         calc           5         Excess Air For Furnace         % stoich.         20.00         ×         0.0         60.00         calc           6         Leakage Air at Preheater         % stoich.         10.00         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70.0           8         Gas Temp. Exiting Air Preheater         deg. F         800.00         -50.00         130.0         80.00           10         Ambient Air Temperature         deg. F         80.00         -50.00         100.00 </th <th>9</th> <th>Configure Pla</th> <th>nt Ì</th> <th>Se</th> <th>t <u>P</u>ara</th> <th>met</th> <th>ers</th> <th>Ĩ</th> <th></th> <th>Get Res</th> <th>ults</th>	9	Configure Pla	nt Ì	Se	t <u>P</u> ara	met	ers	Ĩ		Get Res	ults
1         Gross Electrical Output         MWg         500.0         100.0         1500         500.0           2         Steam Cycle Heat Rate         Btu/kWh         8100         6000         1.00e+04         7880           3         Boller Efficiency         %         89.58         ✓         0.0         100.0         calc           4         Capacity Factor         %         80.00         ✓         0.0         100.0         75.00           5         Excess Ait For Furnace         % stoich.         20.00         ✓         0.0         40.00         calc           6         Leakage Ait at Preheater         % stoich.         10.00         ✓         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70.0           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         40.00         300.0           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Humidity         Ib H2O/Ib dry air         1.800e-02         0.0         3000e-02         1.800e-02										SO2 Contr	
2         Steam Cycle Heat Rate         Btu/kWh         8100         6000         1.100e+04         7880           3         Boler Efficiency         %         89.58         ≰         0.0         100.0         calc           4         Capacity Factor         %         80.00         0.0         100.0         75.00           5         Excess Air For Fumace         % stoich         20.00         ≰         0.0         60.00         calc           6         Leaksge Air at Preheater         % stoich         20.00         ≰         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         700.0           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         300.0           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Tenseure         psia         14.70         12.00         150.0         44.70           11         Ambient Air Humidity         1b/20/1b dry air         1.800e-02         0.0         300.0e         21.800e-02           12         Per		Ti	tle	Unit	s	Unc	Value	Calc	Min	Max	Default
3         Bollet Efficiency         %         99.58         ✓         0.0         100.0         calc           4         Cepacity Factor         %         80.00         0.0         100.0         75.00           5         Excess Air For Furnace         % stoich         20.00         ✓         0.0         100.0         calc           6         Leakage Air at Preheater         % stoich         20.00         ✓         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         700.0           8         Gas Temp. Exiting Air Preheater         deg. F         80.00         -50.00         130.0         80.00           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Pressure         psia         14.70         12.00         15.00         14.70           11         Ambient Air Humidity         Ib H20/Ho dry air         1.800e-02         0.0         30000-02         1.800e-02           12         Percent Water in Bottom Ash Stuice         %         39.30         ✓         0.0         100.0         calc	1	Gross Electrical O	utput	MW	g		500.0		100.0	1500	500.0
4         Capacity Factor         %         80.00         0.0         100.0         75.00           5         Excess Air For Furnace         % stoich.         20.00         x'         0.0         40.00         calc           6         Leakage Air at Preheater         % stoich.         10.00         x'         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg. F         300.0         150.0         420.0         700.0           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         300.0           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           12         Percent Water in Bottom Ash Stuice         %         39.30         0.0         3000e-02         1.800e-02           13         Base Plant Energy Requirements          -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -	2	Steam Cycle Heat	Rate	Btu/kV	Wh		8100		6000	1.100e+04	7880
5         Excess Air For Furnace         % stoich.         20.00         ¥         0.0         40.00         calc           6         Leakage Air al Preheater         % stoich.         10.00         =         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200.0         70.0           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         300.0           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           12         Percent Water in Botom Ash Sluice         %         39.30         ¥         0.0         100.0         calc           13         Base Plant Energy Requirements             calc           14         Coal Pulverizer         % MWg         0.6000         £         0.0         2.000         calc           15         Steam Cycle Pumps         % MWg         0.6500         0.0         2.000         calc           14	3						89.58	M			
6         Leakage Air at Preheater         % stoich.         10.00         □         0.0         60.00         calc           7         Gas Temp. Exiting Economizer         deg, F         700.0         250.0         1200         700.0           8         Gas Temp. Exiting Air Preheater         deg, F         300.0         150.0         400.0         300.0           9         Ambient Air Temperature         deg, F         80.00         -50.00         130.0         80.00           10         Ambient Air Temperature         deg, F         80.00         -0.00         130.00         80.00           10         Ambient Air Pressure         psia         14.70         12.00         15.00         14.70           11         Ambient Air Pressure         psia         18.000-02         0.0         3000e-02         1.800e-02           12         Percent Water in Bottom Ash Sluice         %         39.30         ✓         0.0         100.0         calc           13         Base Plant Energy Requirements         -         -         -         -         -           14         Coal Pudverizer         % MWg         0.6000         ✓         0.00         2.000         0.6500           15	4		%			80.00		0.0	100.0	75.00	
7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         700.0           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         300.0           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           11         Ambient Air Temperature         psia         14.70         12.00         15.00         14.70           12         Percent Water in Bottom Ash Sluice         %         39.30         ✓         0.0         100.00         calc           13         Base Plant Energy Requirements											
8         Gas Temp. Exiting Air Prehester         deg. F         300.0         150.0         400.0         300.0           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80.00           10         Ambient Air Pressure         psia         14.70         12.00         15.00         14.70           11         Ambient Air Humidity         1b H2O/lb dry air         1.800e-02         0.0         30.00e-02         1.800e-02           12         Percent Water in Bottom Ash Stuice         %         39.30         ✓         0.0         100.0         calc           13         Base Plant Energy Requirements              12         0.0         100.0         calc	_	w									
9         Ambient Air Temperature         deg F         80.00         -50.00         130.0         80.00           10         Ambient Air Tessure         psia         14.70         12.00         15.00         14.70           11         Ambient Air Fussure         psia         14.70         12.00         30.00e-02         1.800e-02           12         Percent Water in Bottom Ash Sluice         %         39.30				deg.	F						
10         Ambient Air Pressure         psia         14.70         12.00         15.00         14.70           11         Ambient Air Humidity         1b H20/1b dry air         1.800e-02         0.0         3.000e-02         1.800e-02           12         Percent Water in Botton Ash Sluice         %         39.30         ✔         0.0         100.0         calc           13         Base Plant Energy Requirements                14         Coal Pulverizer         % MWg         0.6000         ½         0.0         2.000         calc           15         Steem Cycle Pumps         % MWg         0.6500         0.0         2.000         0.6500           16         Forced Draft Fans         % MWg         1.500         0.0         4.000         1.500           17         Cooling System         % MWg         1.800         0.0         2.000         1.800	8		,	deg.	F						
11         Ambient Air Humidity         1b H2O/lb dry air         1.800e-02         0.0         3.000e-02         1.800e-02           12         Percent Water in Bottom Ash Sluice         %         39.30         ≥         0.0         100.0         calc           13         Base Plant Energy Requirements         %         0.0         0.00         2.000         calc           14         Coal Putverizer         % MWg         0.6000         ≥         0.0         2.000         calc           15         Steam Cycle Pumps         % MWg         0.6500         0.0         2.000         0.6500           16         Forced Draft Fans         % MWg         1.800         0.0         2.000         1.800           17         Cooling System         % MWg         1.800         0.0         2.000         1.800	9		•	deg.	F		80.00				
12         Percent Water in Bottom Ash Stuice         %         39,30         ✓         0.0         100.0         calc           13         Base Plant Energy Requirements											
13         Base Plant Energy Requirements         ■         ■         ■           14         Coal Pulverizer         % MWg         0.6000         ½         0.0         2.000         calc           15         Steam Cycle Pumps         % MWg         0.6500         0.0         2.000         0.6500           16         Forced Draft Fans         % MWg         1.500         0.0         4.000         1.500           17         Cooling System         % MWg         1.800         0.0         2.000         1.800	11				dry air		1.800e-02		0.0	3.000e-02	1.800e-02
14         Coal Pulverizer         % MWg         0.6000         ✓         0.0         2.000         calc           15         Steam Cycle Pumps         % MWg         0.6500         0.0         2.000         0.6500           16         Forced Draft Fans         % MWg         1.500         0.0         4.000         1.500           17         Cooling System         % MWg         1.800         0.0         2.000         1.800							39.30	M	0.0	100.0	calc
15         Steam Cycle Pumps         % MWg         0.6500         0.0         2.000         0.6500           16         Forced Draft Fans         % MWg         1.500         0.0         4.000         1.500           17         Cooling System         % MWg         1.800         0.0         2.000         1.800			<u>zy Requiremen</u>	-							
16         Forced Draft Fans         % MWg         1.500         0.0         4.000         1.500           17         Cooling System         % MWg         1.800         0.0         2.000         1.800					w			1			
17 Cooling System % MWg 1.800 0.0 2.000 1.800	_				~						
			;		0						
<b>18</b> Miscellaneous % MWg <b>1.300</b> 0.0 4.000 1.300	_	· · ·			-						
	18	Miscellaneous		% MV	Vg		1.300		0.0	4.000	1.300

The Base Plant-1. Performance input screen

Uncertainty distributions are provided by default with several of the cost input parameters of the technologies accessible from the various navigation tabs. These are described in more detail in the *User Manual*. For this case study, only one performance parameter will be used to demonstrate the use of uncertainty.

Define a triangular distribution for boiler efficiency:

- 1. Click the **Boiler Efficiency** (%) uncertainty button in the **Unc** column. This will bring up the **Uncertainty Editor** window.
- 2. Select **Triangular** from the **Distribution:** drop-down menu.
- 3. Assume the boiler efficiency can be 1% higher or lower than the nominal value calculated by the IECM. This would be represented by entering 0.99, 1.00, and 1.01 in the **Mid**, **Mode**, and **Max** input fields respectively. Notice that these are multiplicative factors. The nominal or actual values are displayed immediately below the normalized values you entered.

After you are finished entering the triangular distribution parameters, the screen should look like the following:

Uncertainty Editor				×
Plant Parameter	Units	Value	Minimum	Maximum
Boiler Efficiency	%	89.58	0	100
Distribution: Triangular	-	Min	Mode	Max
	Normalized:	0.9900	1.000	1.010
	Nominal:	88.68	89.58	90.48
<b>Description:</b> Triangular(a,b,c) describes a triangu represent the minimum, most likely			alues a,b and c	Cancel

Uncertainty Editor

4. Click the **Done** button to close the **Uncertainty Editor**.

Notice that a "?" appears inside the uncertainty button. This is a reminder that uncertainty has been applied to this input parameter. This is shown in the following:

I         Gross Electrical Output         MWg         500.0         100.0         1500         500           2         Steam Cycle Heat Rate         Btu/kWh         8100         6000         1.100e+04         70           3         Bodier Efficiency         %         ?         89,58         ✓         0.0         100.0         70           4         Capacity Factor         %         80.00         0.0         1000.0         70           5         Excess Air For Fumace         % stoich.         20.00         ✓         0.0         40.00         c           6         Leakage Air at Preheater         % stoich.         10.00         ✓         0.0         60.00         c           7         Gas Temp. Exiting Air Preheater         deg. F         700.0         250.0         1200         70           8         Gas Temp. Exiting Air Preheater         deg. F         80.00         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         150.0         400.0         30           10         Ambient Air Teressure         psia         14.70         12.00         15.00         14           11         Ambient Air Humidity <th>rties Plant Constraints Control Control Control Mgm Title Units Unc Value Calc Min Max Default</th>	rties Plant Constraints Control Control Control Mgm Title Units Unc Value Calc Min Max Default
1         Gross Electrical Output         MWg         500.0         100.0         1500         66           2         Steam Cycle Heat Rate         Btu/kWh         8100         6000         1.100e+04         74           3         Boiler Efficiency         %         ?         89.58         ✓         0.0         100.0         c           4         Capacity Factor         %         ?         89.58         ✓         0.0         100.0         c           5         Excess Air For Furnace         % stoich.         20.00         ✓         0.0         400.0         c           6         Leakage Air a Preheater         % stoich.         10.00         ✓         0.0         600.0         c           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Teresure         psia         14.70         12.00         15.00         30.00e-02         1.800	
2         Steam Cycle Heat Rate         Btu/kWh         8100         6000         1.100e+04         74           3         Bolart Efficiency         %         ?         89,58         ✓         0.0         100.0         c           4         Capacity Factor         %         ?         89,58         ✓         0.0         100.0         c           5         Excess Air For Fumace         % stoich.         20.00         ✓         0.0         40.00         c           6         Leakage Air at Preheater         % stoich.         10.00         ✓         0.0         60.00         70           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Tersesure         psia         14.70         12.00         15.00         1           11         Ambient Air Humidity         Ib H2O/Ib dry air         1.800e-02         0.0         3.000e-02         1.800	vicel Output MWg 500 0 100 0 1500 500 0
3         Boiler Efficiency         %         ?         89,58         ✓         0.0         100.0         c           4         Capacity Factor         %         80,00         0.0         100.0         7           5         Excess Air For Furnace         % stoich.         20,00         ✓         0.0         40,00         c           6         Leakage Air at Preheater         % stoich.         10,00         ✓         0.0         60,00         c           7         Gas Temp. Exiting Economizer         deg. F         700.0         ✓         0.0         40.00         33           9         Ambient Air Temperature         deg. F         80,00         -50.00         130.0         80           10         Ambient Air Tensure         psia         14.70         12.00         15.00         4           11         Ambient Air Humidity         Ib H2O/Ib dry air         1.800e-02         0.0         3.000e-02         1.800	
4         Capacity Factor         %         80.00         0.0         100.0         75           5         Excess Air For Furnace         % stoich.         20.00         ✓         0.0         40.00         c           6         Leakage Air at Freheater         % stoich.         10.00         ✓         0.0         60.00         c           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Terssure         psia         14.70         12.00         15.00         180           11         Ambient Air Humidity         Ib H20/Ib dry air         1.800e-02         0.0         3.000e-02         1.800	le Heat Rate Btu/kWh <b>8100</b> 6000 1.100e+04 7880
5         Excess Air For Furnace         % stoich.         20.00         ¥         0.0         40.00         c           6         Leakage Air at Preheater         % stoich.         10.00         □         0.0         60.00         c           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         77           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Tensesure         psia         14.70         12.00         15.00         14           11         Ambient Air Humidity         Ib H2O/Ib dry air         1.800e.02         0.0         3.000e-02         1.800	iency % ? 89.58 🗹 0.0 100.0 calc
6         Leakage Air at Preheater         % stoich.         10.00         i         0.0         80.00         c           7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Tensesure         psia         14.70         12.00         15.00         13.00           11         Ambient Air Humidity         Ib H2O/Ib dry air         1.800e-02         0.0         3.000e-02         1.800	actor % 80.00 0.0 100.0 75.00
7         Gas Temp. Exiting Economizer         deg. F         700.0         250.0         1200         70           8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         33           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Tensesture         psia         14.70         12.00         3.000e-02         1.800           11         Ambient Air Humidity         1b H2O/Ib dry air         1.800e-02         0.0         3.000e-02         1.800	For Furnace % stoich. 🗾 20.00 🗹 0.0 40.00 calc
8         Gas Temp. Exiting Air Preheater         deg. F         300.0         150.0         400.0         30           9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Pressure         psia         14.70         12.00         150.0         14           11         Ambient Air Humidity         1b H20/1b dry air         1.800e.02         0.0         3.000e-02         1.800	ir at Preheater % stoich. <b>10.00 II</b> 0.0 60.00 calc
9         Ambient Air Temperature         deg. F         80.00         -50.00         130.0         80           10         Ambient Air Pressure         psia         14.70         12.00         15.00         14           11         Ambient Air Humidity         1b H20/1b day air         1.800e-02         0.0         3.000e-02         1.800	Exiting Economizer deg. F 700.0 250.0 1200 700.0
10         Ambient Air Pressure         psia         14.70         12.00         15.00         14           11         Ambient Air Humidity         1b H2O/1b dry air         1.800e-02         0.0         3.000e-02         1.800	Exiting Air Preheater deg. F <b>300.0</b> 150.0 400.0 300.0
III         Ambient Air Humidity         Ib H2O/Ib dry air         I.800e-02         0.0         3.000e-02         1.80	ir Temperature deg. F <b>80.00</b> -50.00 130.0 80.00
	ir Pressure psia <b>14.70</b> 12.00 15.00 14.70
12 Persent Weterin Pottern & als Stuize 96 20.20 97 0.0 100.0 a	ir Humidity 1b H2O/1b dry air <b>1.800e-02</b> 0.0 3.000e-02 1.800e-02
12 Fercent water in Bottom Ash Stude 26 39,30 2 0.0 100.0 C	ater in Bottom Ash Sluice % 🛛 39.30 🗹 0.0 100.0 calc
13 Base Plant Energy Requirements	it Energy Requirements
14 Coal Pulverizer % MWg 0.6000 ⊻ 0.0 2.000 c	rizer % MWg 0.6000 🗹 0.0 2.000 calc
	le Pumps % MWg <b>0.6500</b> 0.0 2.000 0.6500
16 Forced Draft Fans % MWg 1.500 0.0 4.000 1.	te r umps 70 0.0 0.0 0.00 0.8500
17 Cooling System % MWg 1.800 0.0 2.000 1.	
18 Miscellaneous % MWg 1,300 0.0 4.000 1.	ft Fans % MWg <b>1.500</b> 0.0 4.000 1.500

The Base Plant – 1. Performance input screen

## **Other Input Areas and Technologies**

Default parameters will be used for all the other input areas for the base plant and other technology tabs. You may browse these input screens to view the defaults.

# **Get Results**

	E <mark>CM Interface</mark> Edit <u>V</u> iew <u>W</u> indow <u>H</u> elp	
Ы	The Untitled	
Ø	Configure Plant Set	Parameters Get Results
	Overall Fuel <u>Boiler Air NC</u> Plant (Coaf) <u>Boiler</u> Preheater Com	
<b>1</b>	Combustion Controls	Plant Diagram
	Furnace Type: Tangential NOx Control: In-Furnace Controls	
<b>?</b>	Post-Combustion Controls	
▶?	NOx Control: None Mercury: Carbon + Water Injection	
	Particulates: Cold-Side ESP	
	SO2 Control: Wet FGD	▏ <mark>▕</mark> ▝╇┽──────────────────────
	SO2/NOx: None	
	Solids Management	📥 📥 📕
	Recovery: None	
	Fly Ash Disposal: mixed w/ Landfill	
	1. Diagram 🖉 2. Perf. Summary 🖉 3. Flow Summ	ary / 4. Cost Summary /

Click the tab for the <u>**Get Results**</u> program area. From this area you can view the results for this session.

The Get Results Program Area

You may return to <u>Get Results</u> to look at results at any time: click its tab at the top of the screen. Detailed descriptions of all results are given in the *User Manual*.

## **Overall Plant**

When you first enter the <u>Get Results</u> program area, the Technology Navigation Tab which is active is for the **Overall Plant**. This area contains result screens for the plant as a whole.

#### 1. Diagram

When you first enter the **Overall Plant** result area, the **1. Diagram** result screen is displayed. This screen displays the plant configuration settings on the left side of the page and a diagram of the plant as configured at the right of the page. No results are displayed on this screen.

You may use the Plant Diagram as an alternate way to move among input Technology Navigation Tabs, similarly to the alternatives available on the **Set Parameters** program area. See "Overall Plant" on page 29 to see the alternatives.

#### 2. Performance Summary

Click the Result Navigation Tab for the <u>2</u>. **Perf. Summary** result screen. It displays performance results for the plant as a whole. Values for the major input and outputs of the power plant are given. The screen should look like the following:

	CM Interfac Edit <u>V</u> iew	e <u>W</u> indow <u>H</u> elp								
٥	📻 Untitled									×
		<u>C</u> onfigure	Plant	Ĩ	Set Par	ameters	Ĭ	<u>G</u>	et Results	
	Overall Plant	F <u>u</u> el (Coal)	Boiler	<u>A</u> ir Preheater	<u>N</u> Ox Control	Mercury Control	Particulate Control	<u>S</u> O2 Control	Solids Mgmt	Stac <u>k</u>
					Plant Param	eter	Value			
			1	Gross Electri Net Electrical			500.0 457.3			
đ			3				9042	-		
?			4	Net Cycle He	at Rate (Btu/	kWh)	9887			
<b>N</b> ?			5	Fuel Energy	Input (MBtu/	hr)	4521			
<u> </u>			6	-	er Generation	(BkWh/yr)	3.207			
			7	_				_		
			8					_		
			9	_				_		
			11	-				-		
			12							
			13							
			14	1						
			15	5						
	Proces	s Type: Ove	erall		-					
	<u>1</u> . D	iagram 🗼	2. Perf. Sumr	nary <u>3</u> . Flor	w Summary	/ <u>4</u> . Cost Su	mmary /			

The Overall Plant-2. Perf. Summary result screen

When you first enter a screen with results, there may be a short delay as results are calculated. Once results are calculated, there should be little more than a split second delay when you move to other screens. (However, if you change the plant configuration or input values and then return to **<u>Get Results</u>**, the results will have to be recalculated, causing another delay.)

You should notice that the **Gross Plant Size** is the same as you entered earlier. The other parameters are calculated by the model as a function of the other input parameters and technologies loaded. Each result is described in detail in the *User Manual*.

#### 3. Flow Summary

Click the Result Navigation Tab for the **3. Flow Summary** result screen. It displays values for the major flows in, through and out of the power plant. The screen should look like the following:

	Configure Plant	Set Pa	rame	ters Get Res	sults
Ove P <u>l</u> e		r <u>N</u> Ox r Control		ercury Particulate <u>S</u> O2 Soli ontrol Control Control Mg	
	Stack Gas Component	Flow Rate (ton/hr)		Overall Flow Component	Flow Rate (ton/hr)
1	Nitrogen (N2)	1696	1	Coal	170.5
2	Oxygen (O2)	117.1	2	Natural Gas	0.0
3	Water Vapor (H2O)	256.1	3	Lime/Limestone	9.886
4	Carbon Dioxide (CO2)	465.1	4	Urea	1.289
5	Carbon Monoxide (CO)	0.0	5	Ammonia	0.0
6	Hydrochloric Acid (HCl)	1.052e-02	6	Activated Carbon	0.5516
7	Sulfur Dioxide (SO2)	1.352	7	Total	182.2
8	Sulfuric Acid (equivalent SO3)	1.326e-02	8	Bottom Ash	4.097
9	Nitric Oxide (NO)	0.3372	9	Fly Ash	10.36
10	Nitrogen Dioxide (NO2)	2.721e-02	10	FGD Waste	17.91
11	Ash	6.781e-02	11	By-Product Ash	0.0
12	Total	2536	12	By-Product Gypsum	0.0
13	Total SOx (SO2 & SO3)	1.365	13	By-Product Sulfur	0.0
14	Total NOx (NO & NO2)	0.3644		By-Product A cid	0.0
15			15	Total	32.37
	cess Type: Overall				

The Overall Plant-3. Flow Summary result screen (maximum hourly values)

As mentioned before, the totals are highlighted for you in yellow. Each result is described in detail in the *User Manual*.

The results above are based on a maximum hourly flow rate which assumes 100% capacity. To see the annual average values, which takes into consideration the capacity factor you entered earlier, do the following:

1. Select **<u>Result Tools</u>** from the <u>View</u> menu. This displays a window with result menu options.

Result Tools: Case S	itudy	×								
Result Type:	Deterministic	F								
Unit System: English Time Period: Default Perf. Table: Default Cost Table: M\$(Cap), M\$Ayr(O&M)										
Unit System:	English	•								
Time Period:	Default	•								
Perf. Table:	Default	•								
Cost Table:	M\$(Cap), M\$/yr(O&M)	•								
	Revenue									
Cost Year:	1996	•								
Inflation Ctrl:	Constant	•								

Result Tools

- 2. Select **Avg Annual Avg.** from the **Time Period:** menu. The flow rates on the result screen are automatically updated.
- 3. Select **<u>Result Tools</u>** from the <u>View</u> menu again. This closes the window. (An alternative way to close the window is to click the "X" box in the upper right corner of the window.)

The numbers on the result screen will automatically be updated. The year costs are reported can be changed on this tool window.

i U	nau	~	0.7										
		Configure Plant	Set P	arameters <u>G</u> et Results									
	ver Plar		er Ontrol	<u>N</u> Ox Mercury Particulate <u>S</u> O2 Solids Control Control Control Mgmt									
		Stack Gas Component	Flow Rate (ton/yr)	Γ	Overall Flow Component	Flow Rate (ton/yr)							
	1	Nitrogen (N2)	1.189e+07	1	Coal	1.196e+06							
	2	Oxygen (O2)	8.212e+05	2	Natural Gas	0.0							
	3	Water Vapor (H2O)	1.796e+06	3	Lime/Limestone	6.933e+04							
117	4	Carbon Dioxide (CO2)	3.262e+06	4	Urea	9040							
	5	Carbon Monoxide (CO)	0.0	5	Ammonia	0.0							
	6	Hydrochloric Acid (HCl)	73.78	6	Activated Carbon	3868							
IIE	7	Sulfur Dioxide (SO2)	9482	7	Total	1.278e+06 2.873e+04							
	8	Sulfuric Acid (equivalent SO3)	92.99	8	Bottom Ash								
	9	Nitric Oxide (NO)	2365	9	Fly Ash	7.265e+04							
1	0	Nitrogen Dioxide (NO2)	190.8	10	FGD Waste	1.256e+05							
1	1	Ash	475.6	11	By-Product Ash	0.0							
1	-	Total	1.778e+07		By-Product Gypsum	0.0							
1	3	Total SOx (SO2 & SO3)	9573	13	By-Product Sulfur	0.0							
1	4	Total NOx (NO & NO2)	2556	14	By-Product Acid	0.0							
	5			15	Total	2.270e+05							
Π.		ess Type: Overall											

The Overall Plant—3. Flow Summary result screen (annual average values)

## 4. Cost Summary

Click the Result Navigation Tab for the <u>4</u>. Cost Summary result screen. It displays costs associated with the power plant as a whole. Costs are in constant 1996 dollars. The screen should look like the following:

-	Untitle	1							
		Configure Plant		Set <u>P</u> ara	meters		<u>G</u> et Re	sults	
	Overal P <u>l</u> ant	Fuel (Coal) <u>B</u> oiler	<u>A</u> ir Preheater	<u>N</u> Ox Control	Mercury F Control			lids gmt Stac <u>k</u>	
	Γ	Technology		Capital Cost (M\$)	Capital Cost (\$/kW-net)	O&M Cost (M\$/yr)	Revenue Required (M\$/yr)	Revenue Required (\$/MWh)	
Ш	1	Combustion NOx Control		12.26	26.80	3.243	4.510	1.406	
Ш	2	Post-Combustion NOx Con	trol	0.0	0.0	0.0	0.0	0.0	
	3	Mercury Control		5.503	12.03	4.326	4.895	1.526	
	4	TSP Control		16.28	35.61	1.747	3.263	1.018	
Ш	5	SO2 Control		62.27	136.2	10.28	17.65	5.505	
	6	Combined SOx/NOx Contro	1	0.0	0.0	0.0	0.0	0.0	
	7	Subtotal		96.31 210.6		19.60	30.32	9.456	
Ш	8	Base Plant		446.9	977.3	62.97	106.0	34.05	
	9	Total		543.2	1188	82.57	136.3	43.50	
	10								
	11								
	12								
	13								
	14								
Ш	15								
	Proces	ss Type: Overall		v.	Costs	are in Constant	1996 dollars.		

The Overall Plant—4. Cost Summary result screen

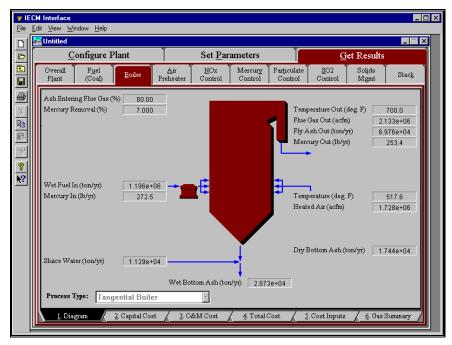
Each result is described in detail in the User Manual.

## Boiler

Click the Technology Navigation Tab for the **Boiler** result area. This area contains result screens for flows and costs related to the Boiler itself.

## 1. Diagram

When you first enter the **Boiler** result area, the **1. Diagram** result screen is displayed. This screen displays an icon for the Boiler and values for major flows in and out of it. The flow rates are shown in annual average units (tons/yr) due to the unit change made earlier. Due to the trace flow rates of mercury, it's flow rate is reported in lb/yr. The screen should look like the following:



The Boiler-1. Diagram result screen

Each result is described in detail in the User Manual.

## 2. Capital Cost

Click the Result Navigation Tab for the <u>2</u>. Capital Cost result screen. It displays tables for the direct and indirect capital costs related to the Boiler. Costs are in constant 1996 dollars. The screen should look like the following:

<b>V IEC</b> File - E	_		_	<b>face</b> w <u>W</u> indow <u>H</u> elp							_ 0						
ام	<b>.</b> -	Un	tit	led													
2				Configure Plant		Set <u>P</u> ar	Parameters Get Results										
			vei lar		<u>A</u> ir neater	<u>N</u> Ox Control	Me Co	s it Stac <u>k</u>									
3				Process Area	D	irect Capital Costs (M\$)		Proces	Indirect Capital Costs (M\$)								
3	Ι	1		Steam Generator		121.7	1	Process Facilities Cap		297.9							
7	Ш	2		Turbine Island		88.11	2	General Facilities Cap		29.79							
	Ш	3	:	Coal Handling		41.00	3	Eng. & Home Office F		19.36							
? ?	Ш	4		A sh Handling		7.331	4	Project Contingency (		34.76							
2	Ш	5		Water Treatment		7.438	5	Process Contingency		0.8937							
-	Ш	6	i	Auxiliaries		32.33	6	Interest Charges (AF	UDC)		49.84						
	Ш	7		Process Facilities Capital		297.9	7	Royalty Fees			0.2085						
	Ш	8					8	Preproduction (Startu	p) Cost		13.90						
	Ш	9	•				9	Inventory (Working)			0.2296						
	Ш	1	D				10	Total Capital Require:	ment (TCR)		446.9						
	Ш	1					11										
	Ш	1:					12										
	Ш	1:	_				13										
	Ш	1.	- I				14										
	Ι	1:	5				15										
		P	10	cess Type: Tangential Boiler		Y		Costs are in Cons	tant 1996 dol	lars.							
			1	1. Diagram <u>2</u> . Capital Cost	<u>3</u> . C	D&M Cost /	( 4	, TotalCost 🖌 🧕	Cost Inputs	<u> </u>	Gas Summary 🖉						

The Boiler-2. Capital Cost result screen

Each result is described in detail in the User Manual.

#### 3. O&M Cost

Click the Result Navigation Tab for the <u>3</u>. **O&M Cost** result screen. It displays tables for the variable and fixed O&M costs involved with the Boiler. Costs are in constant 1996 dollars. The screen should look like the following:

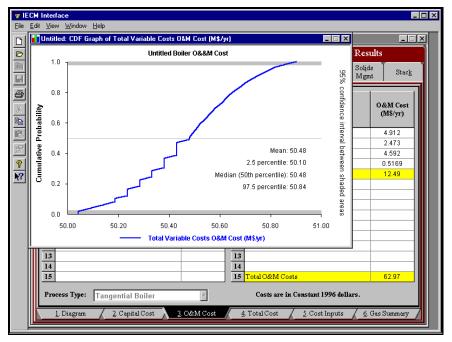
V IE File				f <b>ace</b> w W		. II-k	_																			_ 0	×
	_		_	w <u>w</u> Iled	Indow	Hel	2																				
	r				onf	igure	P	lant	;		Ť		Set Pa	rameters Get Results													
				verall Fuel <u>Boiler</u> <u>Air</u> Jant (Coal) <u>Boiler</u> Preheater									<u>N</u> Ox Control	Mercury Particulate <u>S</u> O2 Solids Control Control Mgmt									Stack				
					v	ariabl	e Co	ost C	ompo	ıent			&M Cost M\$/yr)				Fix	ed Co	ost (	Сотрон	ent				M Co: I\$/yr)		
R		ĺ	-	Fuel	_	_	_	_	_	_			48.59	1			ng Lai								.912		
P	Ш	-	2	Water								1.686	2									2	_111				
	Ш	-	3	Dispo									0.2020 3 Maintenance Material										4.592				
<b>?</b> <b>№?</b>	Ш	-	4	Total	Vari	able C	osts	;					50.48	4									0.5169				
<b>N?</b>	Ш	-	5											5	Tota	1Fi	ced C	osts						1	2.49		
	Ш	-	6 7											6	-												
	Ш	-	, 8											8	<u> </u>								_				
	Ш	-	9											9									_			_ !!!!	
	Ш	-	, 10											10	-								-				
	Ш	11-	11											11									-				
	Ш	1-	12											12													
	Ш		13											13													
	Ш	114	14											14													
	Ш		15											15	Tota	108	&M C	osts						6	2.97		
			Pro	cess	Гуре:	Ta	ng	enti	al Bo	iler			Y		C	ost	s are	in Co	onsi	ant 199	96 do	llars	•				
		/		<u>1</u> . Dia	gram	_/		<u>2</u> . Ca	pital C	ost	<u>}</u> 3	.0&	M Cost		<u>4</u> . Tot	al C	ost	X	<u>5</u> .	Cost Inj	puts		<u>6</u> .G	as S	ummai	y /	

The Boiler-3. O&M Cost result screen

Each result is described in detail in the User Manual.

# Graphs

Double-click the result value on the Boiler—3. O&M Cost result screen for the Total Variable costs. A graph of the value will display. The screen should look like the following:



Graph of Total Variable Costs (Uncertain)

When you first bring up a graph, there will be a short delay as all result graphs are drawn. Once all the graphs are drawn, there should be little more than a split second delay when you choose another graph. (However, if you change the plant configuration or input values and then return to **<u>Get Results</u>**, the graphs will have to be redrawn, causing another delay.)

While all of the values displayed in diagrams and tables are deterministic, some have uncertainty in their calculation. If there is no uncertainty in the value's calculation, the graph displays a vertical line. If uncertainty is present, the graph displays a curve of all possible values.

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