



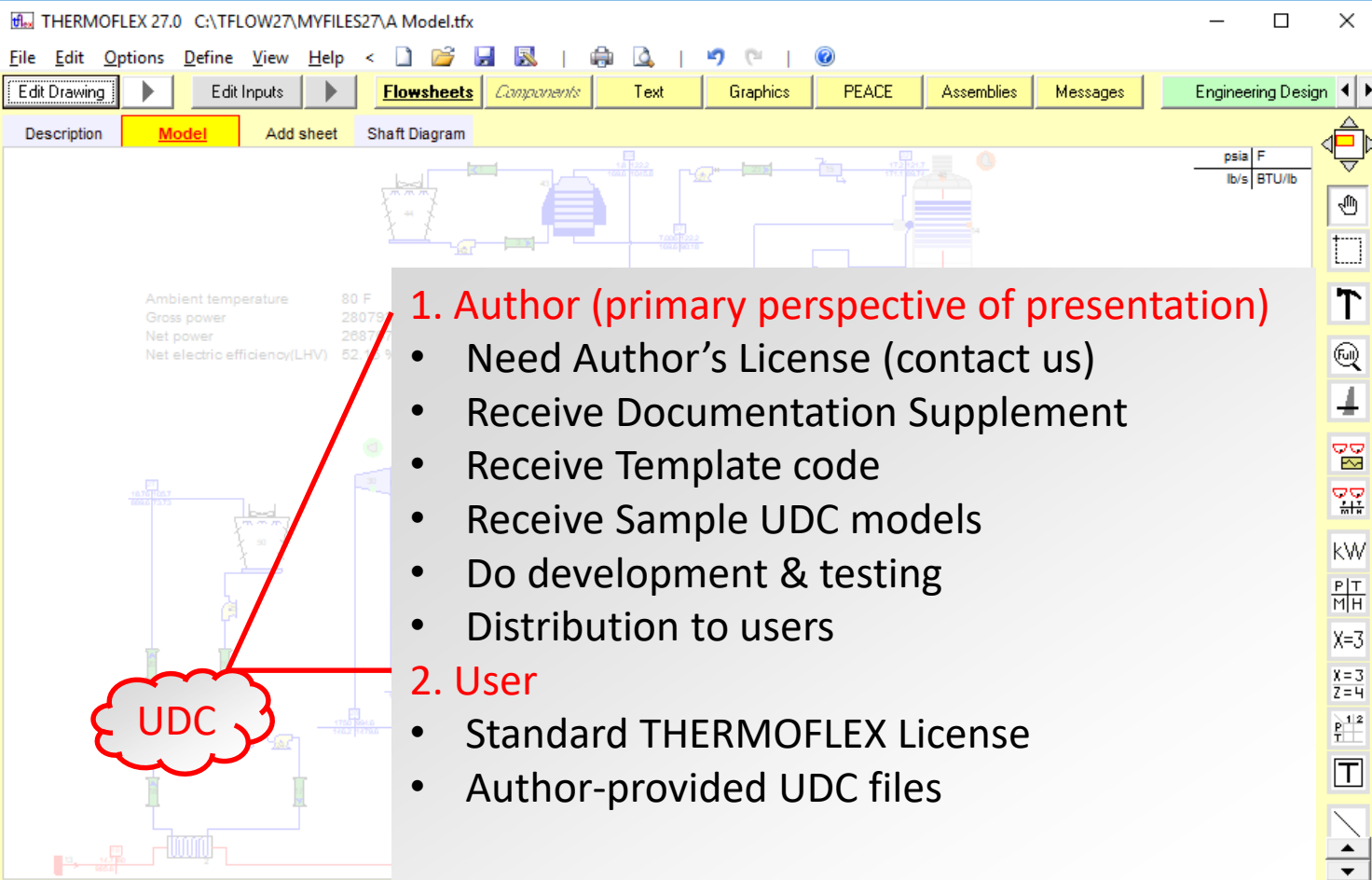
# Thermoflow's User-Defined Component (UDC)

Creating, using, and distributing a THERMOFLEX component (icon) to run your calculation code

# UDC: Who, What, Where, When, & Why

- **Who:** OEMs, R&D, IP Developers, Tinkerers
- **What:** system to create & use your own code & methodology in our modeling environment
- **Where:** THERMOFLEX– fully flexible modeling environment with > 220 standard built-in components handling 7 fluid types
- **When:** THERMOFLEX since 1995, UDC since 2004
- **Why:** Model systems built with widely-accepted, proven, robust components in commercially-available and widely-used modeling environment, including your code.

# UDC: Overview



The screenshot shows the THERMOFLEX 27.0 software interface. The main window displays a process flow diagram with various components connected by lines. A table of data is visible on the left side of the diagram:

Ambient temperature	80 F
Gross power	28077
Net power	2667
Net electric efficiency(LHV)	52.3%

Overlaid on the screenshot is a semi-transparent grey box containing the following text:

**1. Author (primary perspective of presentation)**

- Need Author's License (contact us)
- Receive Documentation Supplement
- Receive Template code
- Receive Sample UDC models
- Do development & testing
- Distribution to users

**2. User**

- Standard THERMOFLEX License
- Author-provided UDC files

A red cloud labeled "UDC" is positioned at the bottom left of the diagram area, with two red lines pointing from it to the "1. Author" and "2. User" sections of the text box.

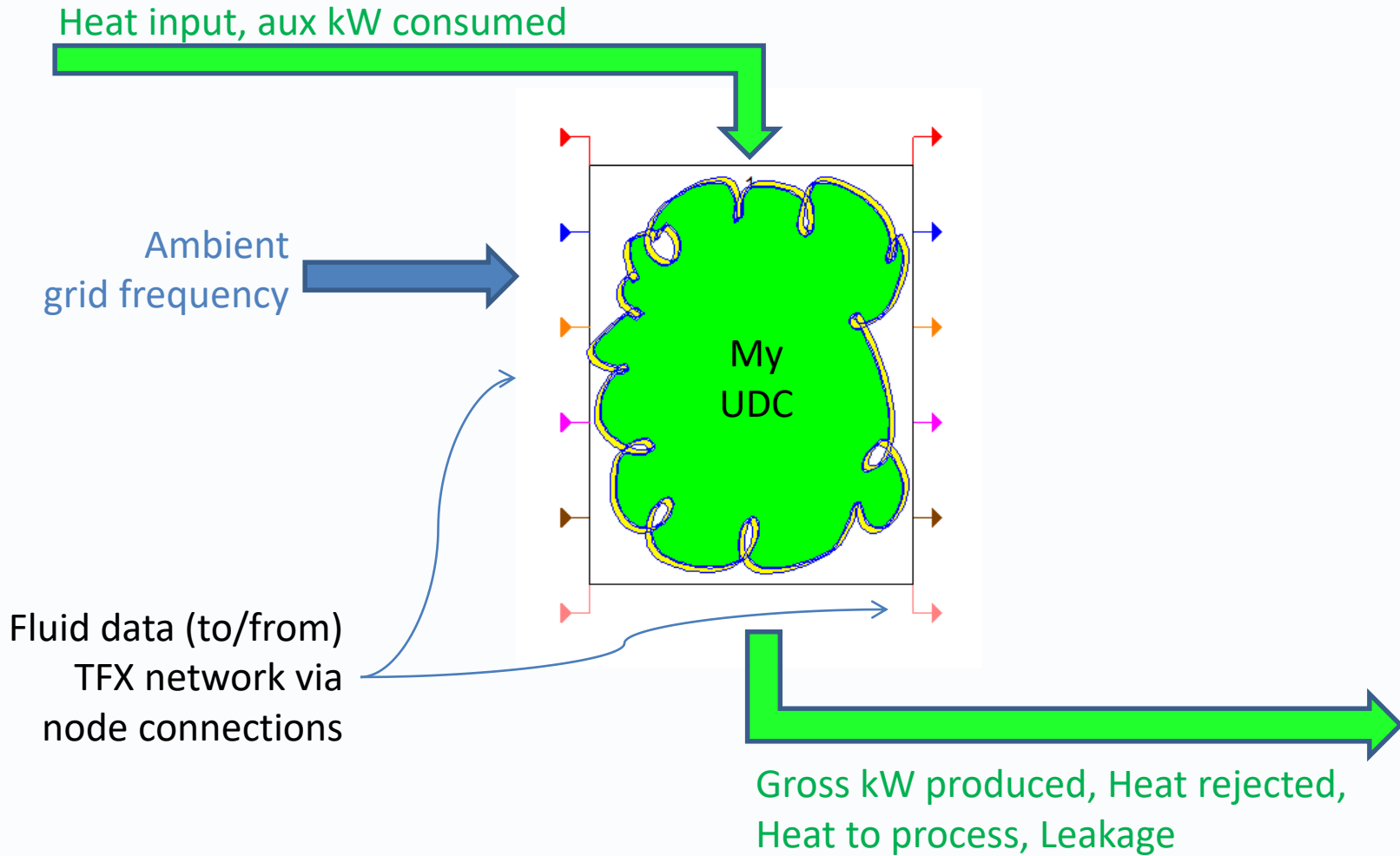
# Component **Author** – TFX Build Steps

- Define icon's shell (image & nodes) so THERMOFLEX knows how to connect your component into a network and it has a visage
- Define inputs so the user can edit parameters needed by your model
- Define outputs that will be returned to the user so s/he knows how the calculation turned out
- Define messages (error, warning, advisory, or remarks) so your code can communicate with the user
- Add your code to the automatically-generated Excel workbook or to the template FORTRAN project. (EXE's can be built in any language).
- Test, fix, test, fix, ... so the component is robust and useful
- Distribute UDC files - (model.myc, model.xlsx/model.exe, any required datafiles used by the component) to THERMOFLEX users.

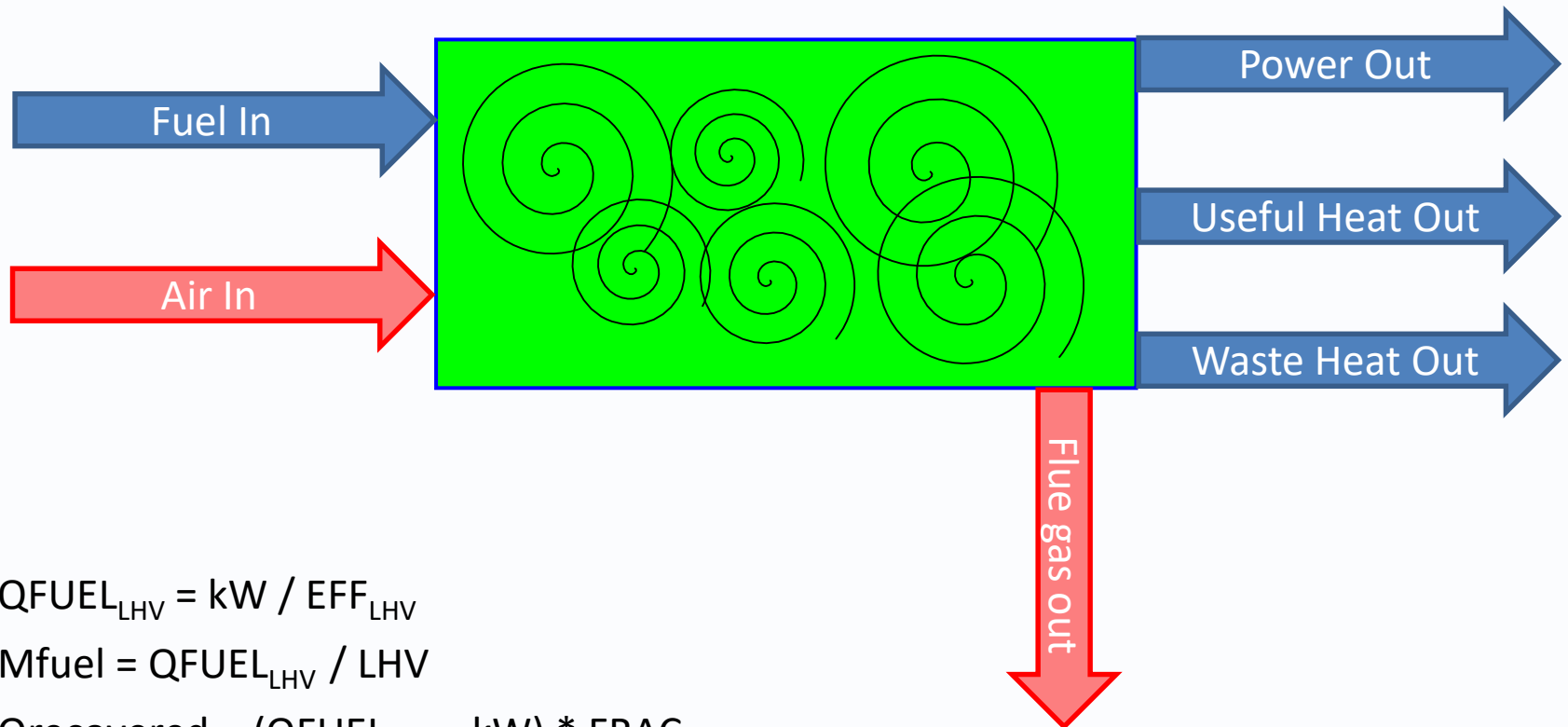
# Component **Users** – How To

- Acquire UDC file package (model.myc, model.xlsx/model.exe, any required datafiles used by the component)
- Place UDC file package in your `MyComponents` folder
- Start THERMOFLEX - all UDC models are listed under My Components tab of the icon bar
- Use like any other built-in THERMOFLEX component to create system models

# TFX ↔ UDC Information Flow



# Demo Model – Basic Fuel Cell (at design)



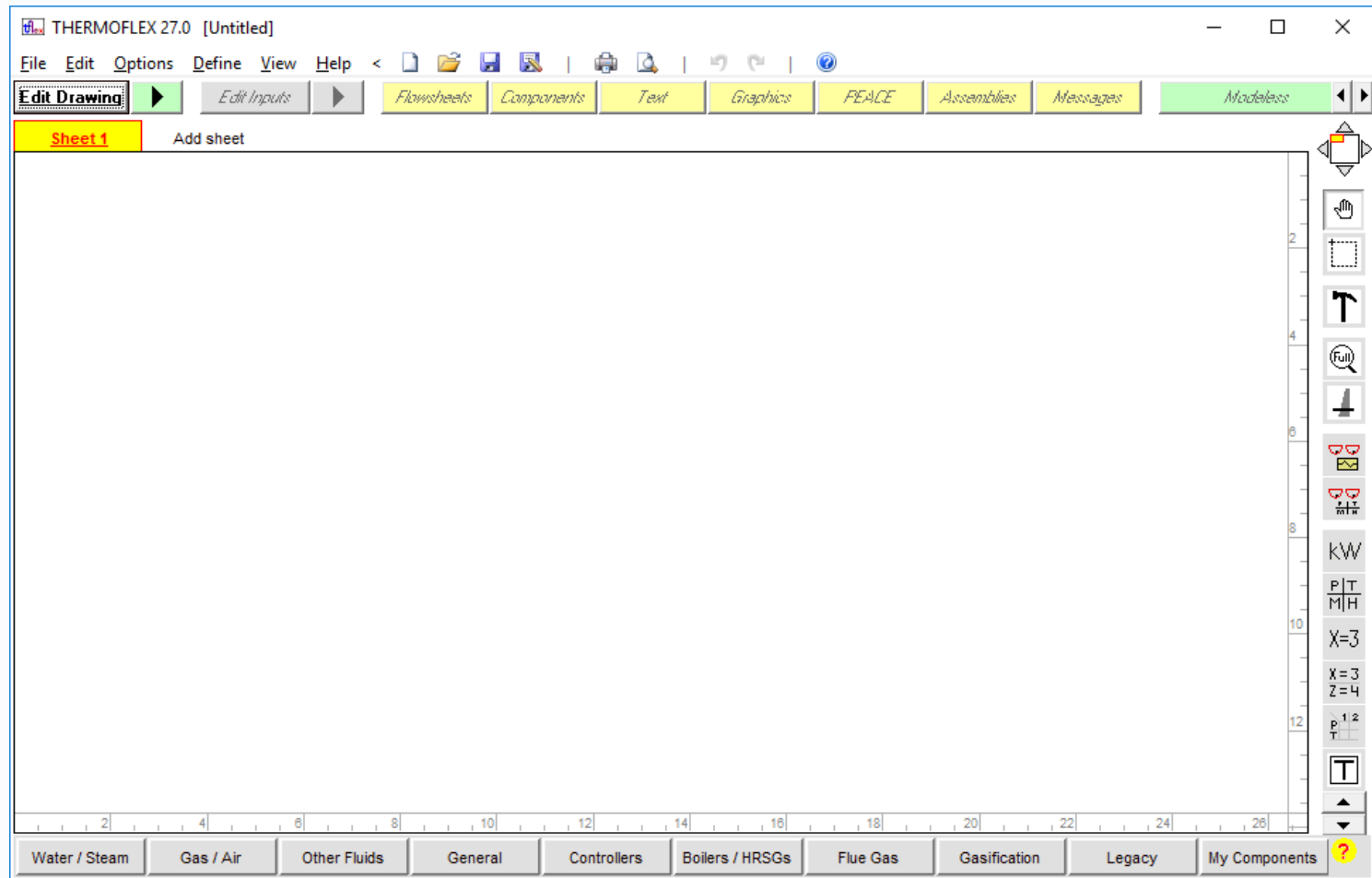
$$Q_{\text{FUEL}_{\text{LHV}}} = kW / \text{EFF}_{\text{LHV}}$$

$$M_{\text{fuel}} = Q_{\text{FUEL}_{\text{LHV}}} / \text{LHV}$$

$$Q_{\text{recovered}} = (Q_{\text{FUEL}_{\text{LHV}}} - kW) * \text{FRAC}_{\text{RECOVER}}$$

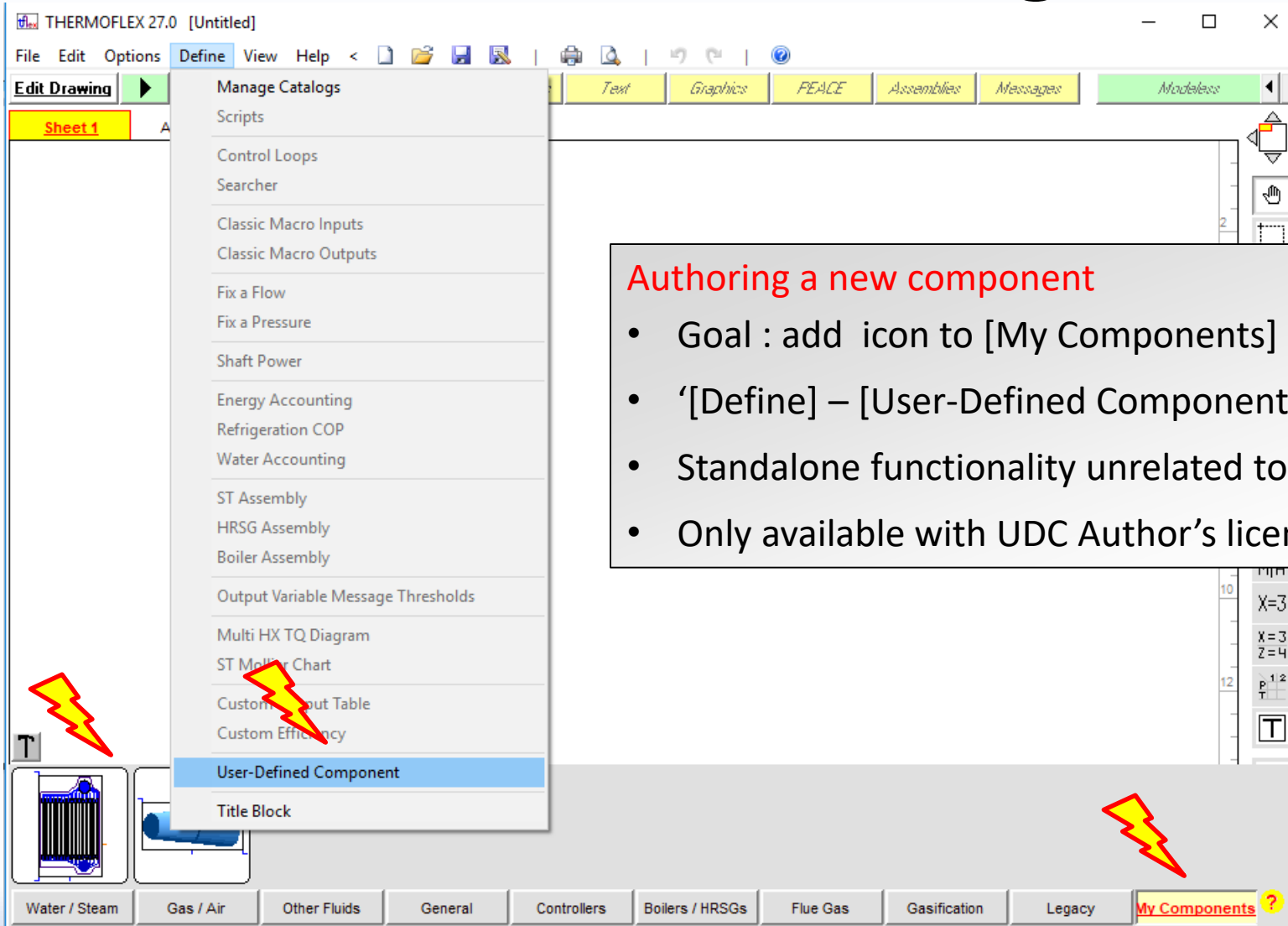
$$Q_{\text{rejected}} = (Q_{\text{FUEL}_{\text{LHV}}} - kW) * (1 - \text{FRAC}_{\text{RECOVER}})$$

# Start THERMOFLEX





# #UDC Author – Getting Started



THERMOFLEX 27.0 [Untitled]

File Edit Options Define View Help

Manage Catalogs  
Scripts  
Control Loops  
Searcher  
Classic Macro Inputs  
Classic Macro Outputs  
Fix a Flow  
Fix a Pressure  
Shaft Power  
Energy Accounting  
Refrigeration COP  
Water Accounting  
ST Assembly  
HRSG Assembly  
Boiler Assembly  
Output Variable Message Thresholds  
Multi HX TQ Diagram  
ST Mollier Chart  
Custom Output Table  
Custom Efficiency  
**User-Defined Component**  
Title Block

Text Graphics FEACE Assemblies Messages Modeless

Sheet 1

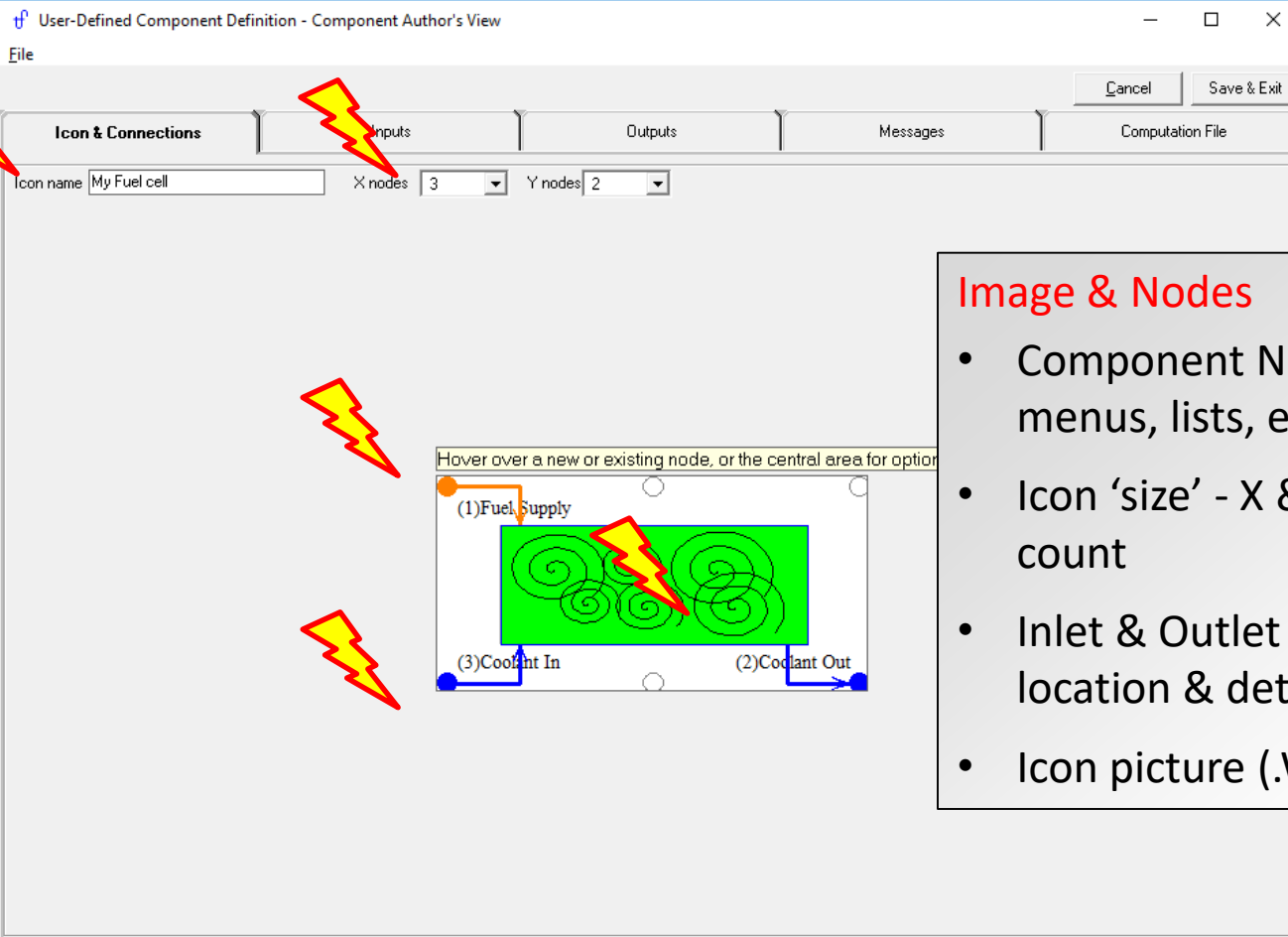
Water / Steam Gas / Air Other Fluids General Controllers Boilers / HRSGs Flue Gas Gasification Legacy **My Components** ?

X=3  
X=3  
Z=4  
P<sup>1,2</sup>  
T

## Authoring a new component

- Goal : add icon to [My Components] icon bar
- '[Define] – [User-Defined Component] menu
- Standalone functionality unrelated to a TFX model
- Only available with UDC Author's license

# #UDC Author – Define ‘Shell’



User-Defined Component Definition - Component Author's View

File

Cancel Save & Exit

Icon & Connections Inputs Outputs Messages Computation File

Icon name My Fuel cell X nodes 3 Y nodes 2

Hover over a new or existing node, or the central area for options

(1) Fuel Supply

(2) Coolant Out

(3) Coolant In

**Image & Nodes**

- Component Name – for menus, lists, etc.
- Icon ‘size’ - X & Y node count
- Inlet & Outlet nodes – location & details
- Icon picture (.WMF file)

# #UDC Author – Node Details

Define Inlet Stream at Node(1)

Description: Fuel Supply

Fluid type: Fuel

**Stream Massflow Determination**

Priority is set by component with strength defined below **GT Fuel**

Flow Priority Index

High flow priority  User defined flow priority

Priority is set by network

Priority is set by network and propagates through component to a conjugate node

Select conjugate node for massflow priority propagation

N/A

**Stream Pressure Determination**

Priority is set by component with strength defined below

Pressure Priority Index

High pressure priority  User defined pressure priority

Priority is set by network

Priority is set by network and propagates through component to a conjugate node

Select conjugate node for pressure priority propagation

N/A

Define Inlet Stream at Node(3)

Description: Coolant In

Fluid type: Water /Steam

**Stream Massflow Determination**

Priority is set by component with strength defined below **Heat adder**

Flow Priority Index

High flow priority  User defined flow priority

Priority is set by network

Priority is set by network and propagates through component to a conjugate node

Select conjugate node for massflow priority propagation

N/A

**Stream Pressure Determination**

Priority is set by component with strength defined below

Pressure Priority Index

High pressure priority  User defined pressure priority

Priority is set by network

Priority is set by network and propagates through component to a conjugate node

Select conjugate node for pressure priority propagation

(2) Coolant Out

## Nodes

- Name – for menus, lists, etc.
- Network Handling:
  - Massflow Priority
  - Pressure Priority

# #UDC Author – Component Inputs

Icon & Connections

**Inputs**

Outputs

Define the isolated inputs used by your component. These are editable by the user and only meaningful to your component. These inputs are not relevant to the rest of the THERMOFLEX network.

Number of isolated inputs

Highlight cell of 'Units Selection' and right click to select unit

#	Input	Units	Value	Units Selection	Native Units	Native Value
1	Electric power output	kW	100	Power #1	kW	100
2	LHV electric efficiency	%	40	Percent #1	%	40
3	Recoverable heat percentage	%	80	Percent #1	%	80
4	Coolant temperature rise	F	45	Temperature difference	R	45

## Inputs

- What these are (isolated)
- What these are not (inter-related)
- Description
- Units (native vs. current)
- Default values

# #UDC Author – Component Outputs

Icon & Connections
Inputs
Outputs

Define the isolated outputs computed by your component. These results are meaningful to users of your component and will calculation. These outputs are not relevant to the rest of the THERMOFLEX network, which are handled separately.

Number of isolated outputs  Highlight cell of 'Units Selection' and right click to select

#	Output	Units	Value	Units Selection	Native Units	Native Value
1	Heat rejected to cooling stream	BTU/s	0	Heat transfer	BTU/s	0
2	Heat rejected to environment	BTU/s	0	Heat transfer	BTU/s	0
3	Total weight	ton	0	Mass, big #1		

## Outputs

- What these are (isolated)
- What these are not (inter-related)
- Description
- Units (native vs. current)
- Whatever is defined is included in 'Component Output' reports

# #UDC Author – Component Messages

Icon & Connections

Inputs

Outputs

**Messages**

Define the isolated messages that may be raised by your component as a result of the calculation. These messages are under your control and are included in THERMOFLEX's overall message list. You may raise a remark, advisory, warning, or error depending on the severity of the issue you want to communicate.

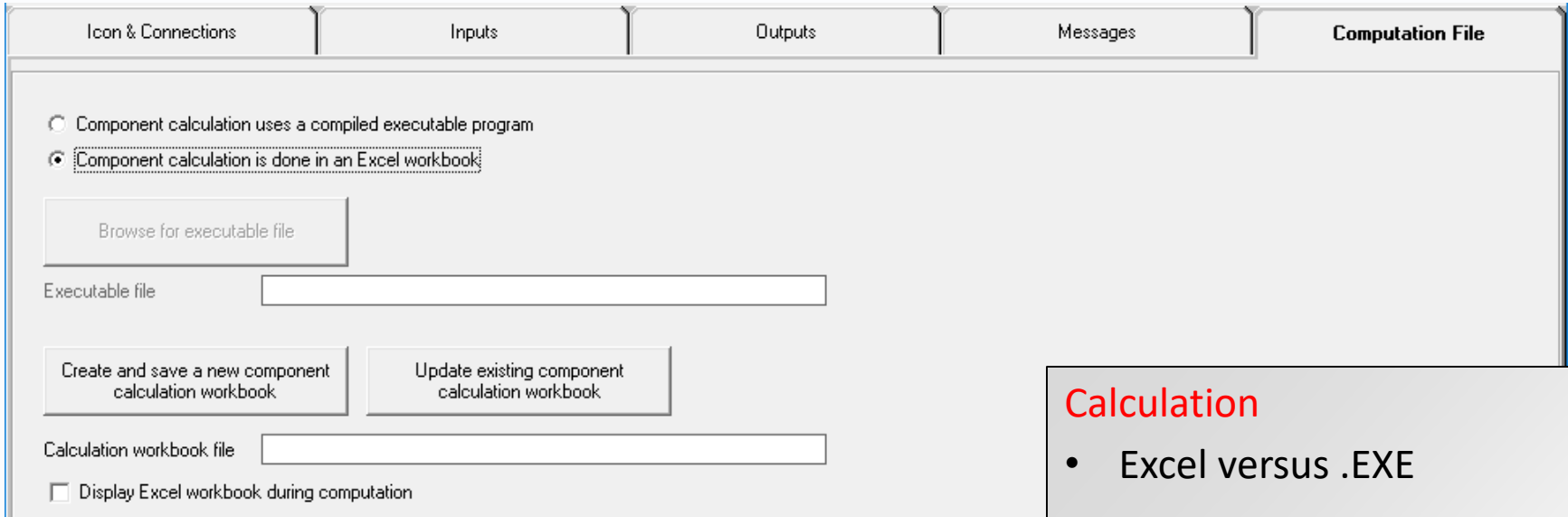
Number of messages your component may raise

#	Messages
1	LHV electric efficiency was cutoff

## Messages

- What these are (isolated)
- What these are not (inter-related, ie. not overall HBE)
- Description
- Severity (set in code)
- Presented in TFX message stream as for all other components

# #UDC Author – Define “Guts 1”



Icon & Connections    Inputs    Outputs    Messages    **Computation File**

Component calculation uses a compiled executable program

Component calculation is done in an Excel workbook

Browse for executable file

Executable file

Create and save a new component calculation workbook    Update existing component calculation workbook

Calculation workbook file

Display Excel workbook during computation

## Calculation

- Excel versus .EXE
- At each loop:
  - TFX sets inputs (native units)
  - TFX runs your program & waits
  - TFX reads outputs (native units)
- Template code (Excel & EXE)